by Dr. Raun Lohry

Managing Reduced Tillage Systems

Nutrient and residue management are key components in a cohesive program to maximize crop yields

Summary: *Soil sampling is the beginning point of nutrient management in a reduced-till program. Problems routinely observed in reduced-till are stratification of immobile nutrients and loss of the mobile nutrient N via volatilization, nitrification, etc. Overliming can be a problem in reduced-till. Keys to success in reduced-till are proper placement of nutrients (surface banding or subsurface banding) and timing of application (especially N). Starter fertilizer is a foundation for proper nutrient management in a conservation tillage system. Effects of surface residues must be accounted for and fertilizer contact with residues minimized.*

A reduced-till system consists of at least five components: cropping strategy, pest management, residue management, nutrient management, and tillage. Each part must work in harmony with the different elements of the system. The ideal plan incorporates these essential components to form a cohesive whole. In this article, we'll focus on nutrient and residue management.

Where to begin

Management in a reduced-till system begins by accounting for all nutrients and matching supply with crop demand. Soil testing, applying legume credits, and taking into consideration nutrient loading from manures and sludges are all necessary to accurately predicting fertilizer needs.

Soil testing is usually accomplished by one of two methods: grid sampling or by soil type.

Grid sampling involves taking samples from small tracts of land and performing computer analyses. Fertilizer applications are based on the nutrient need of each tract.

Sampling by soil type involves collecting cores from similar soil types on areas smaller than 25 acres. Fertilizer is then applied to the whole soil type in the sample area.

Soil tests and fertilizer recommendations for individual nutrient application rates can be obtained from local fertilizer dealers, testing labs or university cooperative extension services.

Regardless of the soil sampling system employed, the soil zone between six and eight inches often is used to estimate availability of non-mobile elements such as phosphorus, potassium, zinc, and other micronutrients. The sampling area for nitrogen can vary by area, so be sure your soil testing lab knows how deep the sample was taken. Some states use a four-foot average and others use two or just the top foot.

Manures and sludges should be analyzed for N, P and K before application. Care should be taken to apply as evenly and accurately as possible. Document for future reference where manure applications have been made.

Don't overlime

P and K soil tests usually check for lime requirements. Because conservation tillage reduces the soil volume that can react with lime, the quantity of lime applied must be adjusted to avoid overliming. As a general rule, conservation tillage systems reduce soil volume that reacts with lime by half. Liming recommendations should be reduced accordingly. Overliming can induce micronutrient deficiencies such as zinc, manganese, and iron. It can also increase carryover potential of some herbicides. Lime often needs to be applied more frequently in reduced-till because the volume of soil that acidifying fertilizers react with is less.

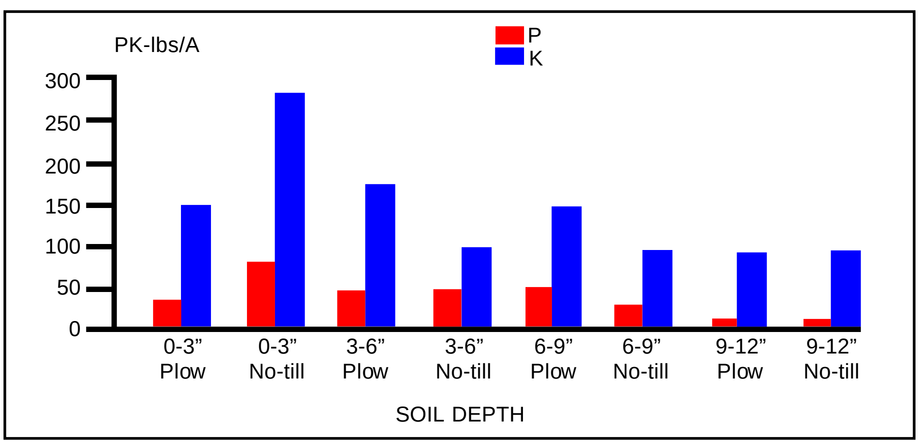

Figure 1. Stratification of P and K in different tillage systems.

Stratification

One problem that can develop with conservation tillage is stratification of immobile elements (e.g., P, K, and Zn) in the top few inches of soil. This is observed routinely. Surface applications and nutrient cycling without deep mixing cause nutrients to accumulate on the surface. Note the highest accumulation of P and K in the top three inches as shown in Figure 1. Crop residue decomposition is what mines nutrients from subsurface soils and deposits them on the surface. Although some no-till soils may be moist enough to support root growth closer to the surface, roots ultimately will have to explore deeper soils for water and nutrients as surface soils dry during warm weather.

Controllable factors

Two controllable factors in reduced-till are timing and placement of nutrients.

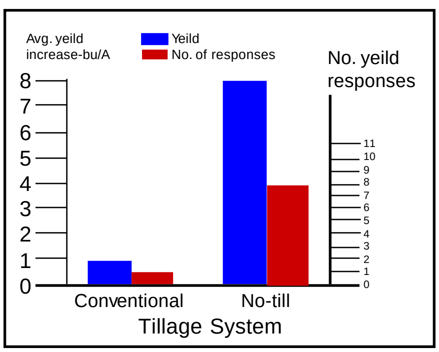

Figure 2. Effectiveness of starter on corn yield in a reduced-till system, 11 experiments, Mengel, Purdue University 1990.

Nitrogen and sulfur are affected by timing and placement while the non-mobile elements P and K are more affected by placement. Because a lack of regular soil mixing can cause nutrient stratification, as already mentioned, subsurface banding and surface banding have been investigated as alternative remedies. A number of such studies have shown the advantages of banding or surface banding under low fertility or high nutrient fixation conditions.

P/K placement. Starter fertilizer is a foundation for proper nutrient management in conservation tillage. Starter application is the strategic placement of supplemental plant nutrients near the seed at planting time. Studies throughout the United States have shown crop response (yield) has increased markedly when starters are used. One such study at Purdue University showed that the probability of a profitable corn yield response to starters in reduced-till increased dramatically at all soil fertility levels (Figure 2). In the no-till system, yield improved in eight of eleven experiments! All sites were high fertility locations where starter would not have been recommended with conventional tillage.

In the upper Midwest, particularly Minnesota and Wisconsin, band applications of K are an important part of fertility programs in no-till and ridge-till, even at high K soil test levels. A small amount of K applied at planting has given consistent yield increases in many soils in this area.

N placement. Surface residue present in conservation tillage systems serves as a protecting mulch against erosion and increases water infiltration. It also affects a number of other soil properties such as soil temperature, moisture content and aeration. All of these factors have implications on how efficiently N from fertilizers, manures, legumes, and native soil will be used by crops.

Increased surface residue increases microbiological activity. Nitrification, denitrification, and mineralization rates increase under reduced-till systems, which suggests N transformations occur more quickly in reduced-till systems. Greater microbial activity increases the likelihood that N will be immobilized or tied up by soil microbes.

Significant N loss from volatilization may occur without sufficient rain (quarter inch or below) to incorporate surface-applied urea-containing fertilizers. Volatilization is the transformation of urea to gaseous ammonia and subsequent loss to the atmosphere. Recent research has quantified volatilization from different sources. Figure 3 shows results from

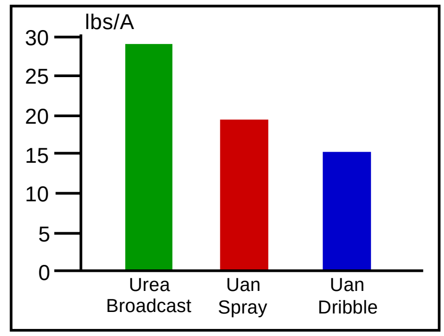

Figure 3. Total ammonia loss over 16-day period using different sources and methods, Fox et al., Penn State University, 1993.

very sensitive micrometeorological measurements in fields that did not receive any moisture for six days after application. The smallest loss was from dribbled UAN and the largest from broadcast urea. Ammonia loss from the 120 Ibs/A of N applied ranged from 13 percent for dribbled UAN to 24 percent for broadcast urea.

The best assurance to obtaining maximum performance from N fertilizers in reduced-till is to minimize contact with surface residues. Studies have shown the dramatic effect subsurface placement of N can have in reduced-till. Figure 4 contrasts surface broadcast and injected N in three tillage systems. Note placement method had no effect on yield in the plow system. However, injected N was clearly more efficient in the system leaving more residue.

Injecting N below residue causes some tillage action and may require relatively high-powered equipment. At the same time, surface banding, new technology (equipment), and fertilizer

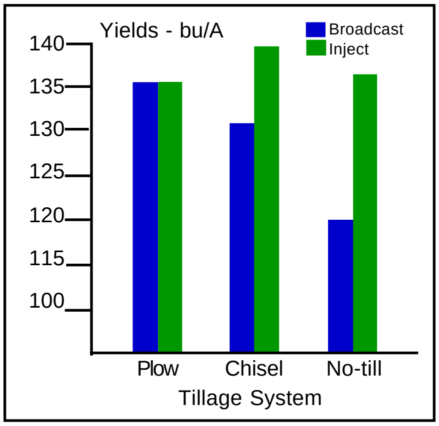

Figure 4. Effect of N placement on corn yield in three tillage systems, Griffith et al., Purdue University, 1974.

additives such as NBPT may help improve N efficiency. A recent multi-location study in Indiana that compared lower-power-demanding , less- soil-disturbing methods with subsurface methods of applying N in no-till corn is shown in Figure 5. Note all of the alternatives were more effective than surface broadcast. Note also that the most effective method of N placement was deep injection. All plots received 25 Ibs/A as starter and 100 lbs/A of N sidedressed.

Timing. As was noted earlier, N placement is especially sensitive to timing. Increased water infiltration and reduced evaporation from increased surface residue can increase N leaching and denitrification and affect crop performance. Coarse-textured soils and irrigation can also increase potential N loss. This is where timing comes in. Research has shown that waiting until after plant emergence to soil test for N need opens the door to better timing of N applications. N is put in the soil at the optimum moment the plant needs it, thus improving N-use efficiency. End result: better yields.

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