Ridge Plant Systems: Fertility

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This NebGuide contains information on managing fertilizers in ridge-plant systems.

The Soil Sample

The starting point for any fertilizer program, regardless of the tillage system, is obtaining a representative soil sample. Without knowing which nutrients are needed, the questions of what fertilizer and how much to apply become irrelevant. Two types of soil samples should be obtained: the traditional, zero to 8-inch sample for general fertility (pH, phosphorus, potassium, organic matter, etc.) and deep, subsoil samples for nitrate. Subsoil samples for nitrate should be taken to a depth of at least 3 feet.

The problem of how to obtain a representative soil sample is particularly relevant in ridge-tilled fields. On conventionally tilled fields, mixing occurs and fertility levels may be fairly uniform throughout the top 6-8 inches of soil. In a ridge-till system, much less soil mixing occurs. This is a concern where phosphorus fertilizer has been banded in the past, since phosphorus is relatively immobile in the soil. This is in contrast to nitrogen which is relatively mobile and will dissipate away from a band with time.

If ridges are maintained for several years and phosphorus is banded each year in the same relative location, concentrated phosphorus zones can develop. These can cause wide variations in soil test results and fertilizer recommendations. In order to know how to sample a ridge-tilled field, it helps to know the fertilization history of the field, including how fertilizer was applied in the past, and how long the practice was maintained.

This situation presents somewhat of a dilemma: should the band be avoided or included in the soil sample? This question is still being researched. For now, the best suggestion is to sample in the shoulder of the ridge (Figure 1), where some soil mixing will have occurred. Any bands placed in the ridge, or fertilizer broadcast and located in the furrow, will be mixed with bulk soil during planting, cultivation and ridging. Consequently, the shoulder of the ridge may be representative of the field in general. Also, the shoulder of the ridge will normally be drier than the furrow and easier to sample.

Band placement of phosphorus, with or without other nutrients, can result in concentrated zones of phosphorus building up in the soil (Figure 1). After several years of repeatedly banding phosphorus in the same location, it may be advisable to separately sample the banded zones and areas between bands. If soil phosphorus levels are quite high where bands have been repeatedly applied, it may not be necessary to apply phosphorus until these levels are reduced.

The Ridge Environment

The use of any conservation tillage system can impose restrictions on the types of fertilizers used and how those fertilizers are applied. In a ridge-till system, fertilizer should be applied in a manner which allows the fertilizer to be used efficiently by the crop, while at the same time maintaining the integrity of the ridge prior to planting.

The presence of a ridge tillage system creates two distinct environments at the soil surface during much of the year. At planting, the ridge is likely to have less residue cover than the furrow and be better drained. Most residue will be in the furrow, insulating the soil under the residue. Consequently, soil in the furrow can be relatively moist and cool, while soil on the ridge will be relatively dry and warm. These two environments will affect how fertilizers should be applied (knife, broadcast, surface-band, or row-band [starter]) and how fertilizers react chemically after application.
Nitrogen

The method by which nitrogen fertilizer is applied depends primarily on the fertilizer source. Anhydrous ammonia requires knife placement below the soil surface. Urea and ammonium nitrate most often are surface broadcast, although they can be banded on top of or below the soil surface with the proper equipment. Urea ammonium nitrate (UAN) solution can be surface broadcast, surface banded or banded below the soil surface.

Potential Nitrogen Loss Mechanisms and Their Control

Broadcast application of urea, ammonium nitrate, or urea ammonium nitrate solution in ridge-till systems has the potential for reduced fertilizer efficiency compared to placement below the soil surface, or even band application on the soil surface. Because of the residue present at the soil surface, there is potential for ammonia volatilization from broadcast fertilizers containing urea or ammonium, and for immobilization in decomposing residue for any source of nitrogen. Most residue has a much higher urease activity than soil, meaning that the rate that urea breaks down can be higher on residue than in soil if moisture and temperature are adequate. Also, microbes decompose residue, nitrogen can be immobilized for a time and will not be available to the crop. Placing urea, ammonium nitrate, or a urea ammonium nitrate solution below the soil surface (and below the residue) will greatly reduce the potential for ammonia volatilization or immobilization. If placement below the soil surface is not an option, surface-banding may help improve fertilizer use efficiency because of the reduced fertilizer-residue contact due to placement of the fertilizer in a more concentrated zone. However, only knifeing in the fertilizer will ensure the same availability as anhydrous ammonia.

Urea ammonium nitrate solutions can be used as herbicide carriers when applied as a broadcast treatment, reducing the number of trips over the field. However, this advantage should be weighed against the prospect of decreased efficiency of broadcast, unincorporated nitrogen. Band application of urea ammonium nitrate solutions as herbicide carriers will reduce the potential for ammonia volatilization from the fertilizer solution and also reduce the herbicide cost.

As with any other tillage system, fertilizer rates, placement methods, and timing of nitrogen fertilizer for ridge-plant systems should be carefully selected. Other nitrogen sources such as from soil or irrigation water, legumes, and waste materials, should be accounted for before calculating fertilizer rates. For more information see NebGuides G87-829, Fertilizer Nitrogen Best Management Practices and G89-913, Adjusting Nitrogen Fertilizer for Corn Based on Nitrate Levels in Soil and Irrigation Water.

Phosphorus

To be effective, phosphorus needs to be placed in the upper root zone (top 6-8 inches of soil). In a ridge-till system, this would seem to rule out surface broadcast application. However, results from a study conducted at the West Central
Research and Extension Center at North Platte indicate that surface broadcast application can be an effective means of phosphorus application in a ridge-till system (Table 1). With the soil mixing that occurs with planting, cultivating and hilling operations in a ridge plant system, there is sufficient soil movement that phosphorus is incorporated, increasing the soil test phosphorus level to a depth of 4-6 inches. The data from North Platte also indicates that phosphorus should be applied annually under such conditions, rather than in one large application on a less frequent basis. On soils with less tendency to fix phosphorus, such as acid to neutral pH soils, less frequent, larger applications of phosphorus may be as effective as smaller, more frequent applications for some crops. In most cases, especially on soils with a high capacity to fix phosphorus, phosphorus should be applied in smaller increments more frequently for most efficient utilization.

Band placement is the most common application method for phosphorus in ridge-till systems in Nebraska. This includes row-band and pre-plant knife application methods. The most widely used fertilizer source for band placement is liquid ammonium polyphosphate (10-34-0). Dry fertilizer sources of phosphorus also can be banded below the soil surface, either at planting with or beside the seed, or with applicators using an air distribution system to place dry fertilizer in the soil behind knives.

**Other Nutrients**

If a soil test indicates the need for other nutrients such as zinc or sulfur, application at planting is probably the best method for ridge-till systems. Quantities required of zinc or sulfur are usually small enough that deficiencies can be adequately corrected with a row-band application, and such placement will place the fertilizers where they can be used efficiently. Sulfur also can be applied through center pivot irrigation systems.

**Lime Application**

If a soil test indicates the need for lime application, the options for addressing the need are limited. Current lime recommendations are based on incorporation of the recommended amount of lime into the top six inches of soil, with thorough mixing in that layer. Some research has been conducted on the effect of fluid lime applied to a band over the ridge, but this concept has not been tested in Nebraska. If the soil pH is low enough that yields will be reduced without lime application, it is probably best to spread the lime material, incorporate with a tillage implement such as a tandem disk harrow or field cultivator, plant conventionally, and re-establish ridges during cultivation.

**Knife Placement Options**

In Nebraska, anhydrous ammonia is the fertilizer most commonly applied with knives. However, fertilizer solutions or even dry fertilizers can be injected below the soil surface with knives and the proper metering equipment. There are a variety of knife arrangements to apply fertilizer on ridges. Some arrangements may be simpler or less expensive in terms of application equipment, but may decrease fertilizer use efficiency.

**One Knife Per Row**

The use of one knife per row is the simplest applicator arrangement. The knife can be placed either at the furrow center (Figures 2A and 2B) or in the ridge shoulder (Figure 2C). If the knife is placed in the furrow, use a coulter to cut through residue, which will be heaviest in the furrow center. If the knife is placed in the ridge shoulder, the applicator should be balanced by placing half the knives on one side and half the knives on the opposite side of the ridge (Figure 2C). This will help center the applicator and keep it from sliding to one side. To avoid destroying the ridge, the knives should not be closer than 6 or 7 inches to the center of the ridge.

If a goal is to keep wheel traffic confined to the same furrows on a continuous basis, fertilize the same number of rows with the applicator as there are rows on the planter. The knife arrangements illustrated in Figures 2B, 2C, and 2D offer a controlled-traffic option by having the knife-applicator swath width match the planter swath.
Figure 2. Knife position in relation to row and furrow for fertUizing ridged fields.

Two Knives Per Row

Using two knives per row (Figure 2D) automatically results in the applicator being balanced. Knives should be placed 6-7 inches to either side of the row in the furrow shoulder. Using two knives per row provides for efficient placement of phosphorus when phosphorus is dual-placed with nitrogen. By placing the phosphorus band closer to the row, root interception of the band is more likely than if the band were in the center of the furrow. Consequently, for soils testing low in phosphorus, placing phosphorus in two bands is better than one. For mobile nutrients such as nitrogen, there is little advantage to placing the band closer to the row.

Using two knives per row means that each knife is applying one-half the normal rate of fertilizer, so knives can be placed shallower when anhydrous ammonia is applied, minimizing soil disturbance near the ridge. Using two knives per row can help maintain ridge symmetry which will aid in keeping the planter on the ridge. However, using two knives per row may disrupt the ridge more, making it more difficult to keep the planter on the ridge. Coulters (either smooth or rippled with a smooth edge) should be used to help minimize knife disruption of the ridge. Initial equipment expense and equipment maintenance will be higher with two knives per row, and power requirements may be greater, depending on how deep the knives are placed.