Nitrogen management alternatives for ridge tillage corn

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$6,000
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Goals

As soil and resource conservation become dominant themes in modern agriculture, researchers seek practices that will maintain profitability while reducing inputs. Ridge tillage, which has received increasing attention as an alternative to the flat-surface, no-till system, may be one such practice.

Ridges offer a more favorable soil environment for root growth and early seedling development. The previous crop's residue is deposited in the interrows, leaving the peak of the ridge mostly bare and exposing it to direct solar radiation. The soil in the ridge therefore warms and dries faster than the interrow or the flat no-till. The ridge environment also favors root growth because the soil in it is less compact.

Ridges also have the potential to reduce nitrate leaching. Because ridges have sloping sides, much of the rainfall runs off the ridge, concentrating infiltration and downward movement of water in the interrow. If fertilizer were placed in the ridge, it would be isolated from the zones of greatest downward flow; hence, losses to leaching (percolation to groundwater) might be reduced.

A newly developed fertilizer applicator, the spoke-wheel injector, makes ridge-till, subsurface fertilizer applications more practical than previous subsurface application methods. But little work has been done to identify the most efficient nitrogen (N) placements for crops grown in ridges.

Thus, the specific objectives of this study included investigating com's response to ridge-till, N fertilizer placement methods and examining the distribution of inorganic (fertilizer) N resulting from point-injecting N to fertilize corn in a ridge-tillage, corn-soybean rotation at two central Iowa locations.

Approach

The locations chosen for this study featured an established rotation on silty, poorly drained, clay loam soils.

The experiment involved 16 treatments, each with four replications (duplications used to minimize the effect of natural variation on validity of results). Rotating corn and soybeans among duplicate plot areas at each location provided corn data for three consecutive years, 1986-1988. The three treatments consisted of no N (as a control) and combinations of three placements (surface broadcast, interrow injection, and row injection) with urea-ammonium nitrate (UAN), a type of N fertilizer, applied at five rates: 20,40,60,100, and 140 pounds (lb) per acre.

The broadcasted treatments consisted of a surface spray with no incorporation. Fertilizer was injected along the length of the row either midway between plant rows (interrow injection) or within about 2 inches (in.) of the plant row (row injection). Workers used a hand injector designed to simulate the spoke-wheel injector mentioned above.

Recovery of N by the corn crop was determined by substituting a solution of N-15 "tracer" fertilizer for the UAN. Soil in control treatments as well as injected treatments was sampled for nitrate (NO_3-N) and ammonium nitrate (NH/). In 1986 and 1987, workers sampled at five row positions and three depths, adding two depths in 1988. Five random samples were also analyzed for each sampling position and depth within a replication (see Fig. 1). Although hard, dry soil thwarted efforts until early September, samples were taken after rains in 1986 and 1987.

Then, at various growth stages, *whole corn-plant* samples were taken from the 0, 60, and 140 lb/acre treatments and separated into stover (the stalk and leafy parts of the plant after the ears are harvested), and grain components. After being dried, weighed, and ground, these plant samples were divided into subsamples, which were analyzed for total N and other properties.

Workers calculated what percentage of N in the plant was derived from fertilizer as well as what percentage of the fertilizer N applied was recovered in plant material. Data were combined across locations and analyzed by year to adjust for variations.

Findings

Soil N distribution: Ridge surface NO_3-N accumulations were generally greater in treated than in control plots. These accumulations were also higher in the ridge than at other depths except in controls and at injection points of 140 lb/acre treatments. The 140 lb/acre treatments had no significant effect on NO_3-N levels except in the tracked interrow (where the implement wheel has traveled) in 1988. Distributions of NO_3-N at positions 2 and 4 (see Fig. 1) were generally not affected by treatments except for surface accumulations and accumulations from the fertilizer applications on position 4 in 1988. The differences between tracked and untracked interrows were also significant only in 1988, when the highest application amount resulted in very high NO_3-N at the 2.3 in.-3.5 in. depth interval of the tracked interrow.

Ammonium distributions seemed to parallel NO_3-N distributions; with some exceptions, the 140 lb/acre treatments resulted in higher NH_4-N levels at the injection point than other treatments.

One interesting trend seemed to follow soil moisture conditions each year: The lowest NO_3-Nlevels, measured in 1986, corresponded to the highest NH_4-N levels and the wettest soil conditions. Progressively drier soil in 1987 and 1988 corresponded to a *decrease* in NH_4-N from 1986 to 1988 and a concomitant *increase* in NO -N. High NO -N levels in the unfertilized rows in 1988 may be related to greater mineralization of organic N than in the wetter years, reduced plant uptake resulting from low levels of soil moisture, and/or NO_3-N movement to the ridge surface.

Plant N uptake: *In general, in 1987 and 1988, placement and N rate significantly affected the percentage ofplant N derivedfrom fertilizer. But the interaction between placement and rate did not.* Plant N derived from injected N was greater than that derived from broadcast N during most stages of plant growth

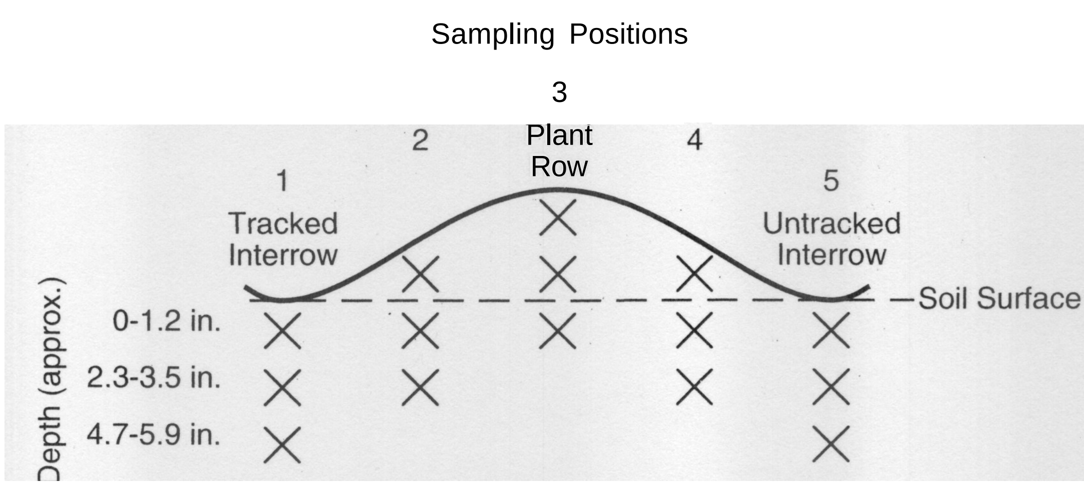

Fig. 1. Sampling depths and positions for determining N recovery by crop.

in 1988. In general, more fertilizer was recovered from the 140 lb/acre treatment than from the 60 lb/acre rate. The greater efficiency at the high N rate is likely due to greater root proliferation in the application zone and generally larger plants.

Yield response: In 1988, yield response to N treatments was limited by below-normal precipitation. Although the effects of rate and placement interactions on yields were not significant in 1986 and 1987, there were significant differences between broadcast and injected N. Interrow versus row injection did not differ much, however. Lack of significant interaction between N rate and placement suggests that a unit of broadcast N is equal to a unit of injected N, but that some over-application using that method is needed to compensate for the N lost.

Summary: Generally, higher nitrogen application rates resulted in higher soil NO_3-N and NH_4-N levels. The greatest N accumulations were measured around the injection point and in the ridge surface soil.

Injected N resulted in significantly greater corn yields, percentage N derived by the corn from the fertilizer, and percentage of fertilizer N recovered than did broadcast. But in general, results suggest that in-ridge versus between-ridge placement does not affect N uptake efficiency.

Implications

Although only 2-3 percent of Iowa farmland is currently farmed with ridge tillage, ridge tillage acres in Iowa are increasing annually. Fertilizer nitrogen use frequently includes surface applications. Results of this study indicate that N efficiency is increased significantly if applications are injected instead, although it does not seem to matter if applications occur in the row or between the ridges.

This does not, however, suggest that leaching potential is equal between placements, only that plant uptake and retention of fertilizer N are not influenced by subsurface placement.

Farmers may benefit from this study in two ways: Additional effort and cost to inject N in ridges instead of the furrow seem unwarranted, particularly if maximum uptake efficiency is the reason for the ridge injection. Subsurface application, whether via tillage device or through applicator placement, seems warranted instead. *Because injection of N fertilizer puts fertilizer to work more efficiently than surface applications, ridge-till farmers can reduce N application by 20-30 lb/acre to obtain N uptake similar to that achieved with broadcast surface applications.* And if less fertilizer is used, less is subject to leaching or runoff—regardless of whether it is applied in the ridges or the furrows.

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