Soil Fertility Management for Conservation Tillage

By Harold F. Reetz, Jr.

Changes in crop rotations and the shift to reduced tillage, which leaves more crop residues on the soil surface, have raised some new questions and problems relating to fertility management.

FARMERS are conserving soil resources and reducing the potential for erosion contaminating surface water. Improved field equipment, better pest control options, and innovative management systems have helped make this possible.

Compliance with government program mandates and regulations will force further adoption of conservation practices in the next few years.

Build Fertility First

Farmers should consider taking care of buildup fertilizer needs before switching to reduced tillage systems. Where serious nutrient deficiencies exist, it is important to mix nutrients with as much of the root zone as possible. Deeper tillage provides best mixing. Moldboard plowing usually mixes deeper and more thoroughly than chisel systems. Chisel plows and field cultivators mix fertilizer materials about half the depth of the tillage. This will vary with different types of tillage implements.

If fertility is high, timing and placement of fertilizer are less critical. More options are available for supplying maintenance fertilizer. A Minnesota study, evaluating placement systems for ridge planted and chisel plow systems on corn, demonstrated the value of building soil test levels before changing tillage systems (**Table 1**). With high fertility, yields were higher in both systems, and with all placement options. There was little difference among the placement options. With low fertility, placement of the fertilizer in a subsurface band was beneficial, although yields were still lower than the high fertility treatments.

The cost of buildup fertilizer should be considered a capital investment to be amortized over a period of 5 years or more. In most cases, the buildup from a medium to a high soil test level will increase yields enough that the buildup cost will be recovered in the first 2 to 3 years. The benefits continue to accrue as long as the soil test is maintained at the higher level. So the cost of NOT building soil tests, as measured in lost opportunity for higher yields and profits, should also be considered in evaluating the economics of building soil fertility.

Stratification of Nutrients

Under reduced tillage, nutrients tend to concentrate within 3 to 4 inches of the soil's surface, particularly potassium (K)

Table 1. Corn yields as affected by fertilizer placement, soil fertility, and tillage method.

	Low Fertility		High Fertility	
Placement	Ridge	Chisel	Ridge	Chisel
No P or K	79	77	152	145
Broadcast	98	109	156	151
Surface Band	109	103	150	153
Subsurface Band	115	116	154	154

44 lb/A P_2O_5 and 87 lb/A K_2O. Minnesota
Subsurface bands placed 6 and 8 inches deep.

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CONDITIONS associated with conservation tillage systems can affect nutrient availability to plants.

and phosphorus (P) which are relatively immobile. Both P and K applied to the surface move down very slowly, and over time accumulate in the top part of the root zone. Nutrients taken up by the plant from deeper in the root zone are also left on the surface in crop residues. As those residues decompose, the nutrients are released at the surface and move only slowly into the soil.

Since there is little downward movement, there is not much opportunity to replenish the nutrients removed in the lower part of the root zone. The nutrient content of that area decreases, while the accumulations near the surface result in increased nutrient content of the upper part of the root zone. See **Figure 1**.

The net effect is a stratification, or layering, of nutrients in the soil. The amount of stratification for each nutrient will depend upon on how much each individual nutrient actually moves in the soil. Because P and K move very little in most soils, they will be more likely to concentrate near the surface and become depleted lower in the root zone. Nitrogen moves readily in the soil, so it will be moved lower in the root zone as water moves downward.

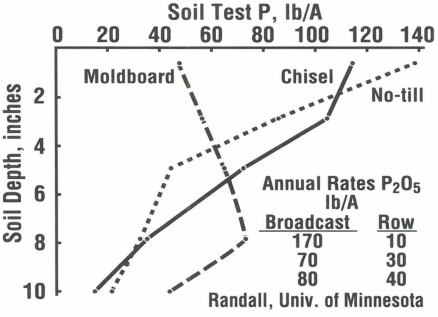

Figure 1. Tillage systems can have significant effects on soil nutrient stratification. Phosphorus was concentrated in the surface soil by reduced tillage in this study (Minnesota).

Long-term tillage studies throughout the Midwest show this stratification to be common on many soils. However, it is usually not a major deterrent to reduced tillage because the roots are often more concentrated near the surface in reduced tillage systems, and therefore better able to utilize the shallow supplies of nutrients.

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Since water is also more likely to be available near the surface in reduced tillage systems in humid areas, another factor for efficient use of shallow nutrients is in place. On the other hand, nutrient stratification in reduced tillage systems may be more important and yield-limiting under restricted rainfall conditions in the western Corn Belt and Great Plains.

As a result of greater water availability near the soil surface, reduced tillage systems in the Midwest do not usually suffer yield loss from the stratification of nutrients. A study at Purdue University that has been in place for nearly 20 years shows that comparable yields can be obtained under a variety of tillage systems—moldboard, chisel, no-till—if plant populations and pest management are adequate.

Starter May Be More Beneficial

In reduced tillage systems, there is usually a greater chance for a response to starter fertilizer. Extra residue left on the surface helps hold soil in place and increases infiltration of water, but it also reflects sunlight and reduces evaporation, so the soil tends to be cool and wet longer into the growing season. Such conditions increase the response to starter fertilizer.

Twenty years ago, researchers and Extension specialists were telling farmers they did not need starter fertilizer, especially on dark-colored soils, if P and K soil tests were in the high range. Under those conditions, that was sound advice. But conditions have changed as farmers have adopted conservation tillage practices. Even the dark-colored soils dry out and warm up more slowly when crop residues are left on the surface. The root system develops more slowly under cool, wet conditions, so nutrients and water must be supplied by a limited number of roots.

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Starter fertilizer provides a concentrated supply of nutrients that helps meet the crop needs until the root system can develop. Starter fertilizer is now more likely to produce a yield response than it was 20 years ago, because the root environment has been changed through conservation tillage.

Recent research from the University of Wisconsin, reported in another article in this issue, shows that the benefits of starter fertilizer may actually be greater for late-May planted corn than for late-April planting dates, especially for no-till systems.

Research at a number of universities and locations has shown a greater starter response with no-till or reduced tillage systems compared to systems with a large amount of tillage (**Table 2**).

Reduced tillage systems tend to produce lower soil temperatures which enhance responses to starter.

Teamwork in Conservation Plans

As farmers work toward meeting conservation compliance mandates and regulations, they should develop a team approach. The farmer, any landowners involved in the operation, the local Soil Conservation Service (SCS), Cooperative Extension agents, and the fertilizer dealer should all be involved in the planning wherever possible. When these people work as a team to develop the plan, their expertise and experience can be drawn upon to make sure the plan includes the best management practices for the individual fields involved.

The farmer and landowners ultimately must make the decisions as to which

Table 2. Starter responses are frequently greater in no-till or reduced tillage systems.

Tillage System	Response to Starter, bu/A Alabama Grain sorghum	Alabama Corn	Wisconsin Corn
Conventional	7	20	9
No-till	16	47	20
Soil test P	High	High	Medium

"Changing tillage changes the environment in which roots will grow and in which soil nutrient reactions take place."

practices will be adopted. The fertilizer dealer probably has the most detailed input into the final plan. The role of SCS and Extension staff is to provide technical assistance, but they cannot possibly provide detailed site-specific management plans for each farm in their area. Reduction in force of both SCS and Extension will make this type of involvement even more difficult in the coming years.

Agronomic consultants will play a greater role in farming decisions in the future. These may be consultants working in conjunction with the fertilizer dealer, or they may be independent consultants. In either case, the consultant can provide assistance with soil testing and interpretation, with pest management decisions, and a variety of other technical inputs. A local consultant can offer more individualized assistance than the SCS or Extension staff, because the consultant will have a smaller number of clients. The farmer's own experience and expertise will help determine the role for the consultants he hires.

Summary

Planning fertility management for conservation tillage requires a systematic approach. Changing tillage changes the environment in which roots will grow and in which soil nutrient reactions take place.

A team of local support people should be involved in working out the details of a conservation/fertility management plan, taking advantage of the expertise and experience available to develop a program that is agronomically sound, economically efficient, and environmentally beneficial. ■

"Roots of Plant Nutrition" Conference Set for July 8-10, 1992

THE Potash & Phosphate Institute (PPI) and the Foundation for Agronomic Research (FAR) will host a research conference, "Roots of Plant Nutrition," July 8-10, 1992 at the Chancellor Hotel and Convention Center in Champaign, IL.

The conference will address the physical, biological, chemical, and environmental considerations relating to root growth and plant nutrition. It will be a unique opportunity for basic researchers to share their work with those who apply the technology in the field. Ample time is allowed for open discussion of what is known about the crop rhizosphere and the questions that remain to be answered.

Invited papers will be presented by leading researchers in these subject areas. Volunteer poster papers from other researchers and graduate students will be accepted for either indoor displays and presentations or field demonstrations. Commercial displays will feature latest technology in equipment for root research, soil sampling, soil and plant analysis, field monitoring, and other related work. A published proceedings will be available at the conference.

The conference is oriented toward university (teaching, research, extension) and industry agronomists, crop consultants, SCS and Extension Service field staff, and others interested in the application of agronomic technology to the field. Research presentations will emphasize the practical application of the latest knowledge of crop root systems and their environment. Graduate students are encouraged to present poster papers on their research in progress on topics related to roots and plant nutrition.

Registration materials can be obtained from the Potash & Phosphate Institute (PPI), 2805 Claflin Road, Suite 200, Manhattan, KS 66502, (913) 776-0273. For further information, contact Dr. Harold Reetz, Potash & Phosphate Institute (PPI), R.R. #2, Box 13, Monticello, IL 61856, phone/FAX (217) 762-2074 or the PPI Manhattan, KS office. ■