Hairy vetch helps solve nitrogen problems with conservation tillage

by Roger Samson

One of the greatest challenges for the 1990s will be to develop crop production systems which are more energy efficient as well as soil conserving. Conservation tillage has been heralded as one mechanism to do this but most studies have failed to show significant improvements in the total energy efficiency of crop production. This is particularly true for crops with high nitrogen demand such as corn. A primary reason is that nitrogen fertilizer consists of approximately 50% of the energy requirements for corn production. To make matters worse, recommendations for no-till corn systems are to increase nitrogen fertilizer use by approximately 1015%.

Hairy vetch holds a great deal of potential for improving the energy efficiency of conservation tillage systems for cash crop production of high N demanding crops. The reasons are two fold; firstly, hairy vetch winter cover crops produce as much or more N than other winter cover crops and, secondly, hairy vetch decomposes faster than other cover crops, making N release to the following crop more complete.

This latter point is particularly important in reduced tillage systems where there is a great deal of evidence that decomposition and mineralization of N is slower where residues are left on the soil surface rather than incorporated. Hairy vetch is a soft, leafy and essentially immature plant which has a C:N ratio of approximately 12:1. The plant is approximately 4.5 % N which is considerably higher than red clover (3 %) or alfalfa (3.5%). Hairy vetch's characteristics are ideal for rapid turnover of nutrients. Almost all winter cover crop studies in the U.S. have found that hairy vetch is the best N source for no-till corn production.

In addition to high nitrogen fixation potential, the biggest agronomic advantage vetch has shown, particularly in longer term studies, is to increase corn yields above conventionally fertilized corn. The accompanying table shows research results on continuous corn with fall sown hairy vetch cover crops in Kentucky and demonstrates this advantage as well as the interactions of no till and conventional tillage on N requirements.

This trial and others indicate that achieving N see sufficiency appears to be more likely in conventionally tilled systems of production using hairy vetch. It is apparent from a number of recent research studies that the N provided to the following crop directly from the legume residue N is considerably smaller than soil organic N (ie. typically 25-35% of

total N uptake by the following corn crop, so that if a legume cover crop is harvested for forage, most of the N contribution remains).

What researchers are beginning to try to understand is how mineralization of sold organic N (the soil priming effect) is affected by legume cover crops and tillage. Some of the difference in soil organic N availability between these factors may be related to the soil microbial biomass.

A study conducted at the Rodale Research Centre by Doran et al. (1987) found that plots under a hairy vetch cover crop had soil microbial biomass levels 30 % higher than those under row crop production. A large increase in nitrate nitrogen (103 kg N/ha) after plow-down of the vetch apparently resulted from mineralization of organic N. Part of this mineralized N was suggested to come directly from microbial biomass, which decreased an equivalent of 37 kg N/ha during the same time period (ie presumably microbes that increased in population from growing under the hairy vetch were killed by the tillage process and were part of the N supplied to the corn).

This apparent manipulation of microbial biomass to supply nitrogen to crops may be more difficult to achieve under no-till management. Doran (1980) found that higher microbial populations exist in the surface soil under no-till systems and that they act as a greater sink for immobilization of surface applied fertilizer N. This results in an increased labile N reserve that may not become available unless tillage is performed.

Another way an over-wintering vetch may help N management is by reducing NO_3 leaching. There is considerable concern that because less water evaporates in minimum tillage systems, more nitrogen is likely to move through the soil profile, potentially carrying NO_3 with it. Varco (1986) found that N accumulated in vetch is less subject to leaching than fertilizer N during the growing season.

Time of seeding of cover crops and time and method of killing and tillage of cover crops plays an important role in nitrogen cycling. From an energy efficiency and nitrate leaching standpoint a crop production system using a hairy vetch cover crop combined with a reduced tillage system such as ridge-till is an economically and environmentally superior way to farm than current conservation tillage strategies.

References

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