Splitting manure application best yield and environmental choice

Summary prepared by Chantal Foulds from a draft of the final report entitled "Manure Management in Conservation Farming for Pollution Control" by Roger Samson, Anne Weill, Allison Arkinstall and Jeff Quinn.

As part of REAP-Canada's on-farm research program, trials on manure management in conservation tillage systems were carried out from 1989 to 1991. In this article, the results from the corn production trials using oilradish to recycle manure nutrients to corn in the subsequent year are summarized. In subsequent issues of Sustainable Farming the results from the soybean, winter wheat and forage trials will be presented. A final scientific report will be published later this summer and copies made available from the SWEEP program. Readers will be notified when and where to obtain a copy.

The combination of intensified livestock rearing and crop production since the early 1960s has created significant water pollution problems. Of primary concern is nitrate losses to ground water and phosphorus losses to surface water through runoff and sediment contained in the runoff.

The agronomic use of manure was evaluated in four major field crops in Southern Ontario (corn, soybeans, winter wheat and alfalfa) over a three year period (1989-91). The principle objective of the research was to identify manure management systems which minimize environmental pollution and result in good agronomic yields of the crops being evaluated. The experiments were conducted on farms with the active participation of four farmer cooperators: Keith and Quentin Martin, Carl Ruby, Vernon Ruby and Harry Wilhelm.

The overall approach in the research trials was to apply manure either :

1) prior to the seeding of a fast growing cover crop and subsequently establish the main crop using a conservation tillage system; or

2) directly to an established crop prior to a period of high biomass accumulation in the crop.

Effect of Oilseed Radish, Timing of Manure Application and Tillage System on Nutrient Cycling and Corn Performance (Within a Winter Wheat-Corn Sequence)

Manure alone cannot be optimized in its application without complementary measures such as green manure (which store available N in the fall for subsequent crop growth) and crop rotation (the use of species with different rooting depths to facilitate vertical recycling as well as the aeration of the entire soil profile). Based on preliminary REAP-Canada studies on cover crops, it was judged that a midsummer application of manure followed by a fall catch crop of oilseed radish would fit ideally into this concept. The oilseed radish is planted after winter wheat and followed by corn. The application of manure to brassica catch crops has been recommended to ensure growth of the cover crop and to improve performance of the crop the following year.

The hypothesis was that a brassica catch crop seeded in August after a manure application would significantly increase ground cover and reduce soil nutrient status, thereby reducing erosion losses, nitrogen leaching and P runoff. This experiment compared the efficiency of a late summer application of manure, with or without an oilseed radish catch crop, to that of spring applied manure in terms of nutrient availability. In addition, each time of manure application was evaluated with 4 different tillage systems to assess the most efficient management approach for nutrient conservation, pollution control and corn performance. For each of the treatment combinations the plots were separated into two, one of which received 50 kg N /ha and the other no fertilizer. The experiments were carried out on a sandy and silt loam, both in 1989 and 1990.

Tillage Treatments (Main Plots)

- Fall moldboard plowing
- Fall chisel plowing
- Spring Aerway
- No-till
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Manure Treatment (Main Plots)

- Summer manure application + oilseed radish catch crop
- Summer manure application
- Spring manure application

Nitrogen Fertilizer Treatments (Subplot)

- No nitrogen added
- 50 kg N added

Spring liquid manure applications resulted in higher N availability in corn than manure applied during the late summer of the previous year. Seeding of an oilseed radish catch crop following the summer manure application improved nutrient cycling. Oilseed radish took up approximately 100 kg N, 15 kg P and 125 kg K from the soil in the fall. The potential for fall nitrate leaching was reduced by the oilseed radish as soil nitrate levels (at 4 sites) and soil moisture levels were lowered (at 1 site). At the silt loam site in 1990, oilseed radish caused a temporary immobilization of P at the time whole corn plants were sampled at the 5 leaf stage. Potassium uptake was lowest in plots where corn was no-tilled into oilseed radish residue and highest where oilseed radish was plowed in the previous fall. Use of oilseed radish generally increased fall soil cover but was generally lower in the following spring as the residue rapidly decomposed. Minimum tillage systems (Aerway and no-till) were the most effective systems for maintaining residue cover and reducing runoff and soil loss. Tillage reduction improved P nutrition at the 5 leaf stage but reduced N and K uptake by corn at the ear leaf stage. Minimum tillage corn yields were generally competitive with conventional tillage systems when sufficient levels of N were available.

While spring application of manure provided the best agronomic response in most instances, it is necessary to take into consideration capital investment for manure storage, spring labour requirements and weather risks of applying all the manure in the spring. Applying liquid manure prior to seeding of an oilseed radish catch crop or possibly to an established catch crop appears to be a desirable practice from a nitrogen standpoint.

Other potential benefits of the oilseed radish is improved aggregated stability and weed suppression. Potentially, herbicide inputs could be reduced as the oilseed radish is winter killed and could act as a mulch in low herbicide, conservation tillage systems.

In addition to high herbicide use, the other problems associated with some of the no-till treatments in this study was a greater fertilizer N requirement (in the summer manure treatments) and lower potassium uptake (particularly in the no-till corn planted into oilseed radish residue). However, early season P uptake at the 5 leaf stage appeared to be improved under no-till planting. Overall, spring applying manure in the no-till system appeared to be the most effective means of minimizing fertilizer inputs in the no-till system.

While oilradish is clearly effective in reducing nitrate pollution from summer manure applications, strategies such as post emergent liquid manure application to early August seeded oilradish need to be assessed to further reduce N losses. While the spring applied nitrogen in this study provided good agronomic response it still could be a source of pollution.

High rates of spring applied manure are known to cause significant N loss in the fall following corn harvest because late season nitrogen

use by corn is low and the manure N continues to mineralize after corn reaches physiological maturity.

To minimize pollution risks it would probably be advantageous to split the high liquid manure application into two modest doses; one in late summer in combination with the use of oilseed radish and one in spring either pre- or post-emergent in corn. The late summer manure application would ensure the establishment of a productive, soil improving and weed suppressing oilseed radish catch crop while the spring manure application would alleviate potential spring nutrient problems such as P immobilization by the oilseed radish or availability of N or K under the various tillage systems.

The risk of fall leaching could probably be further reduced after corn harvest by interseeding the corn with ryegrass when the corn was approximately 20-30 cm tall. This practice would also increase soil cover after harvest, improve soil structure and reduce late season weed pressure while having no significant effect on corn productivity.

. . . Soybean, Winter Wheat and Forage Trial Results to Follow!