Cover Crop Impact on Manure Nitrogen Sequestration and Availability to Corn in Ontario.

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Introduction

Use of cover crops is encouraged in Ontario following summer applied manure because it is assumed that: 1) potential for loss of nitrogen via leaching and/or denitrification during the fall and winter period is reduced, and 2) manure credit to next year's crop is increased.

Objectives: Determine the ability of oat, oilseed radish and field pea cover crops planted after summer applied manure to: 1) sequester manure N, and 2) increase manure N availability to next year's corn.

Materials and Methods

- Conducted on 29 on-farm sites in southern Ontario from 2003-2007. On 22 of these sites corn yield response was also evaluated. Table 1 summarizes the number of sites associated with various manure types applied, the average application rate of manure and amount of manure N. Table 1 also summarizes soil fertility in the surface 15cm for sites where corn response was also evaluated.

Manure Type	Sites	Corn Sites	Manure Properties			Soil Properties		
			Rate	NH_4-N	Total-N	pH	P_2O_5	K_2O
			kl / Mg ha^{-1}	kg N ha^{-1}	kg N ha^{-1}		ppm	ppm
Liquid Cattle	5	5	74.3	125	234	6.8	34	124
Liquid Hog	11	8	46.4	139	185	7.1	38	146
Solid Cattle	7	4	48.3	61	304	7.3	26	142
Solid Poultry	7	5	10.3	56	283	7.2	39	150

Table 1. Summary of type of manure applied, *average* application rates and manure-N applied and soil fertility in surface 15cm.

- Experimental design was a strip block replicated at least twice where the cooperator's typical manure rate was applied in either the front or back of the replicate block. Manure was applied following wheat harvest in August and was usually incorporated within 1 to 4 days. Oat, oilseed radish, and field pea cover crops were established on the same day as manure incorporation. A no-cover control which may contain weeds/volunteer wheat was also included.
- Corn was planted using cooperator's typical production practices except for nitrogen fertilizer. All plots received the cooperators starter N rate which ranged from 0 to 30 kg-N ha^{-1}. Cover crop plots were split with half of the plot receiving no nitrogen and the other half receiving 150 kg-N ha^{-1} as sidedress UAN.

Results

Cover Crop Growth and N Sequestration

- Relative differences in cover crop growth and N sequestration were not affected by manure type (data not shown).
- For oats, application of manure on average increased end of season biomass by 1 Mg ha^{-1} (max. observed - 2.4 Mg ha^{-1}) and biomass-N by 40 kg-N ha^{-1} (max. observed - 90 kg-N ha^{-1}) (Fig. 1).
- Oats reduced end of season soil N; levels following oats with manure were similar to the no-cover control without manure (Fig. 1).
- Oilseed radish had growth and N uptake similar to oats (data not shown).
- Following manure, field peas and oats had similar biomass-N but field peas did not reduce soil N levels as much as oats.
- C:N ratio averaged 13 for field peas, 25 for oats without manure and 19 for oats with manure.

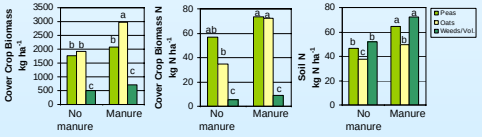

Figure 1. End of season cover crop yield, N content and soil mineral N in surface 30cm following oat and field pea cover crops where manure was applied and not applied (averaged over 29 sites). Note: biomass, biomass-N and soil N bars that contain the same letter are not different at the 5% level of probability. Statistical differences were identified using log(x+1) transformed data.

Corn Yield Response

- Relative corn yield response was similar across manure types (data not shown).
- Average corn yield with no fertilizer N following oats was not greater than the no-cover control indicating that oats did not increase N availability to corn (Fig. 2).
- Corn yield response to oilseed radish was similar to oats (data not shown).
- Corn yield response to fertilizer N following peas was less than the no-cover control without manure indicating that peas slightly increased N availability.

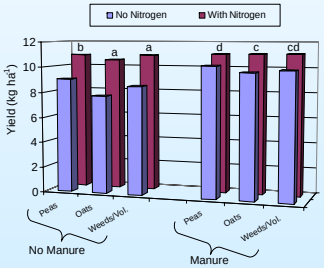

Figure 2. Grain corn yield response to oat and field pea cover crops, manure and fertilizer N averaged over 22 sites. Note: Bar pairs (ie. manure/cover crop treatments) with the same letter have grain corn yield response to fertilizer N that are the same at the 5% level of probability.

Manure Type	Potential for Loss			Cover-Manure Credit		
	Suggested	Cover Biomass N	Diff.	Recommended	Fertilizer N Req.	Diff.
	kg-N ha^{-1}					
Liquid Cattle	22	25	-3	10	6	4
Liquid Hog	41	45	-4	36	-23	59*
Solid Cattle	13	25	-12	2	-31	33t
Solid Poultry	35	63	-28*	-4	29	-32t

Table 2. Reduction in potential for manure N loss and increase in recommended manure N credits associated with use of cover crops following the various types of manure. *, t identify differences significant at the 5 and 10% level, respectively, based on a paired difference test.

Implications for Nutrient Management In Ontario

- Increase in manure–N sequestration for oat and oilseed radish cover crops for each manure type were similar or greater than suggested reductions for potential loss of manure-N (oat results in Table 2).
- Cover crop N sequestration did not account for below-ground biomass, so suggested reductions in potential loss of manure N due to cover crops are probably underestimated.
- A 32 kg-N ha^{-1} increase in liquid hog manure credit following cover crops was recommended but reduction of fertilizer N requirements to optimize corn yield did not occur (oat results in Table 2).
- Cover crops did not consistently increase manure N availability to corn as predicted by Ontario's Nutrient Management Recommendations following most of the manure types.

Conclusions

- Field peas were not as effective as oats or oilseed radish at sequestering manure N and were associated with only a slight increase in N available to next year's corn.
- Oat and oilseed radish cover crops can sequester a significant amount of N from late summer applied manure but do not increase manure-N availability to next year's corn.
- Oat or oilseed radish cover crops will reduce risk of soil erosion and N loss from summer applied manure during the fall and over winter period, but often will not increase manure credits for next year's corn.