Tracking Down Cover Crop Nitrogen

Purpose:

This field trial was designed to evaluate the potential for cover crops established following winter wheat to sequester residual fertilizer N and(or) summer applied plant available manure N. Corn was planted in the following year to evaluate the availability of manure N to the next corn crop and the effect that cover crops have on manure N availability.

Methods:

The field trial was established in August of 2005 on a silt loam soil near Embro, Oxford County. The Ap horizon organic matter was 3.8 to 4.8%. The previous crop was winter wheat with straw baled.

Solid Chicken manure was applied to manured treatments on August 10, 2005 at a rate of 3.8 ton/ac and incorporated within 3 to 24 hrs of application using a tandem disk. The analysis of the manure was 68.6% dm, 5370 ppm NH_4-N, 2.9% Total N, 1.2% Total-P and 1.8% Total-K. The manure credit to the next year's corn crop was 86 kg-N/ha.

The cover crops (Annual Ryegrass, Oats, Oilseed Radish and Field Peas) were planted using a drill immediately following seedbed preparation using a Tandem Disk (which also incorporated manure). All cover crops were burned down in early November and the whole site was fall disked again a couple of weeks following the burn down treatment. Corn was planted on this site on May 8, 2006. Plots were split and sidedress N rates of either 1. 0 (check) or 2. 150 kg-N/ha of UAN applied in mid-June.

Results:

<u>Fall following Manure Application</u>
Soil NO_3-N 1 week after manure application (August 18, 2005) in the surface 30cm was 72 kg-N/ha where manure was not applied and 160 kg-N/ha where manure was applied. This difference in soil NO3-N in the no cover plots was also evident later in the fall of 2005 (Table 1).

Establishment of cover crops significantly reduced soil NO3-N amounts by mid fall, especially where manure was applied (Table 1). The soil N values for no cover treatments in Table 1 are actual observed soil nitrate N amounts whereas the values for the cover crops are the soil nitrate N levels relative to the no cover treatment. A negative value indicates that soil NO3-N was less than no cover, positive indicates that soil NO3-N for cover crops was greater than no cover. Clearly by mid fall (late October/Early November) annual ryegrass, oat and oilseed radish cover crops reduced soil NO3-N levels by about 35 kg-N/ha where manure was not applied and 95 kg-N/ha where manure was applied. Peas also reduced soil NO3-N levels by mid-fall, but were only about 2/3 as effective at reducing soil NO3-N as annual ryegrass, oats or oilseed radish.

Table 1. Soil NO3-N content in the surface 30cm on various sample dates as affected by manure application and cover crops. Values for no cover are actual observed soil NO3-N contents while values for the various cover crops are the difference between values observed for cover crops and no cover (i.e. Cover Soil NO3-N – No Cover soil NO3-N).

Manure Sampling Date	No Cover	Annual Ryegrass	Oats	Oilseed Radish	Field Peas	LSD (10%)+
No Manure	**kg-N/ha**	**kg-N/ha (Relative to No Cover)**				
Oct 18, 2005	72	-38	-37	-35	-24	15.1
Nov 11, 2005	81		-35	-30		15.9
Apr 11, 2006	46		2	-4	10	7.7
May 02, 2006	66	-3	-18	-1	8	21.4
May 16, 2006	78	20	-6	8	17	ns
May 30, 2006	89	22	-5	-4	24	15.0
Jun 06, 2006	127	43	-1	20	26	ns
Jun 13, 2006	109	20	-8	5	14	ns
Jun 20, 2006	89	25	-1	18	42	ns
Jun 27, 2006	94	0	1	11	31	ns
Jul 11, 2006	62	44	-3	33	21	26.7
Oct 25, 2006	31	7	14	6	7	ns
Manured						
Oct 18, 2005	139	-97	-90	-97	-64	15.1
Nov 11, 2005	164		-99	-89		15.9
Apr 11, 2006	45		-4	8	10	7.7
May 02, 2006	97	-33	-26	-16	-25	21.4
May 16, 2006	103	-16	-15	-14	10	ns
May 30, 2006	111	5	-8	13	7	15.0
Jun 06, 2006	114	30	9	37	20	ns
Jun 13, 2006	124	24	14	17	19	ns
Jun 20, 2006	109	36	8	36	26	ns
Jun 27, 2006	134	-7	-24	9	5	ns
Jul 11, 2006	59	10	7	22	3	26.7
Oct 25, 2006	49	5	0	4	11	ns

(+ Least significant difference among cover crops at 10% level of probability. NS indicates that differences among cover crops were not significant at the 10% level of probability.)

Manure increased growth of annual ryegrass, oats and oilseed radish with yields by late October that were about 2 times of those where manure was not applied (Table 2). Manure also increased yield of field peas, but not to the same extent as the other cover crops.

Table 2. End of season cover crop yield and nitrogen content as affected by manure application.

Cover Crop	Yield	N Content
No Manure	**Mg/ha**	**kg-N/ha**
Annual Ryegrass	2.1	50
Oats	3.2	47
Oilseed Radish	2.9	46
Field Peas	3.9	156
Manured		
Annual Ryegrass	5.3	166
Oats	5.0	129
Oilseed Radish	5.7	130
Field Peas	5.8	225
se	0.70	15.7
LSD(10%)$^{+}$	ns	52

($^{+}$ Least significant difference among cover crops within manure treatment at 10% level of probability. NS indicates that differences among cover crops were not significant at the 10% level of probability.)

Similarly, manure increased N uptake of cover crops with above-ground N content for annual ryegrass, oats and oilseed radish by late October that was 3 times higher following manure when compared to where manure was not applied (Table 2). Manure also increased N uptake of field peas with above ground N content of field peas following manure application that was 225 kg-N/ha.

The Fall 2005 soil NO3-N levels (Table 1) and cover crop N content (Table2) both clearly indicate that cover crops sequestered significant amounts of residual and manure NO3-N. Where manure was applied, above ground N content was about 150 kg-N/ha for the non-legume cover crops and 225 kg-N/ha for field peas. This is probably a conservative estimate of N uptake since root N content has not been included in the cover crop N contents reported in Table 2.

Corn Growing Season

In early April soil NO3-N levels were substantially reduced when compared to the previous fall, especially on the manured plots where soil NO3-N was reduced by about 110 kg-N/ha. This loss in soil NO3-N was probably due to leaching deeper in the soil profile (below 30 cm) with a very real possibility that a significant proportion of this NO3-N was not available for crop uptake. There is no difference in soil NO3-N amounts among cover crop treatments in early April (2006).

From early April to mid-June, soil NO3-N levels where a cover crop was not planted increased by 2.8 times (Table 1). Applying manure the previous summer had minimal effect on soil NO3-N where no cover crop was applied by early June. Cover crops did appear to occasionally increase soil NO3-N levels by late May and June, however, rarely were the increases statistically significant (Table 1). Similarly, cover crops did not affect soil NO3-N levels in early summer or at the end of the corn growing season.

Grain corn yields when fertilized with 150 kg-N/ha of sidedress UAN consistently exceeded 12 Mg/ha for all manure and cover crop treatments (table 3). When manure was applied, fertilizer N did not economically increase yields for any cover crop treatment. However, when manure was not applied, fertilizer N did increase yields by 1.1 to 1.8 Mg/ha following all cover crops except annual ryegrass. It appears that the 50 kg-N/ha sequestered by the oat and oilseed radish cover crops did not substantially reduce corn fertilizer N requirements of the next corn crop. Even more troubling is that very little of the 150 kg-N/ha that was sequestered and(or) fixed by the field pea cover crop was available to the next corn crop. Since there was little fertilizer N response to fertilizer N where manure was applied in the no cover treatment, it is not possible to evaluate cover crop N transfer to corn where manure was applied.

Table 3. Grain corn yield at 15.5% as affected by cover crop, manure and fertilizer N.

Cover	0-N	150-N	Response+	MERN++
No Manure	**Mg/ha**			**kg-N/ha**
No Cover	10.60	12.17	1.57	83
Annual Ryegrass	12.62	12.53	0.00	0
Oats	10.84	12.61	1.77	88
Oilseed Radish	11.27	12.55	1.28	74
Field Peas	11.33	12.42	1.08	67
Manure				
No Cover	12.41	12.77	0.36	1
Annual Ryegrass	12.93	12.44	0.00	0
Oats	12.24	12.25	0.01	0
Oilseed Radish	12.83	12.04	0.00	0
Field Peas	12.52	12.77	0.26	0
se	0.60			
LSD(10%)+++	1.69			

+ Yield increase associated with applying 150 kg-N/ha of sidedress fertilizer.
++ Maximum Economic Nitrogen Rate at aNitrogen:Corn price ratio of 7.5 estimated from the size of yield response to adding fertilizer N.
+++ Least significant difference among yields at 10% level of probability.

It is noteworthy that the manure N credit was estimated at 86 kg-N/ha, which is similar to the 82 kg-N/ha difference in MERN between the manure and no manure treatment where no cover crop was established (Table 3).

Summary:

This trial clearly demonstrated that cover crops can sequester significant amounts of soil NO3-N, especially when manures with high amounts of readily available N are applied. This trial also has clearly demonstrated that little of cover crop N may be available, or transferred, to the next corn crop. The fate of cover crop N in this trial is not clear except that little of it probably was taken up by the next corn crop.

Next Steps:

A thorough evaluation of all similar cover crop trials that were conducted by OMAFRA staff should be completed and results compiled. Be sure to read next year's issue of Crop Advances to find out the results of the complete analysis of all cover crop trials.

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