Squeezing More Value from Manure with Cover Crops

Purpose:

Establishment of cover crops following late summer applied manure has been promoted as a means of reducing manure nitrogen (N) losses to the environment through leaching and increasing manure-N availability to the following corn crop. Except for red clover, changes in corn N requirements associated with cover cropping have not been extensively evaluated in Ontario. The objective of this project was to evaluate the potential of three commonly available cover crops (oats, oilseed radish, field peas) for their ability to sequester manure N when seeded immediately, following manure applied in August on wheat stubble fields and their impact on corn N requirements the next year.

Methods:

Results summarized in this article were from 17 on-farm trials conducted in southern Ontario from 2003-2008. Shortly following cereal harvest (usually in August), manure was applied and oat, oilseed radish and field pea cover crops were seeded. Strips where manure was not applied were included in each trial to evaluate the impact of manure on cover crop growth, N uptake and N transfer to next year's corn. The rate of manure applied was typical for each farm with an overall average manure ammonium-N application of 80 lb-N/ac. The cover crops were allowed to grow until the end of the growing season (November) at which time fall tillage was conducted according to the cooperator's discretion.

Corn was planted the next spring using the cooperator's usual production practice with the exception of fertilizer N application. Cooperators were asked to not apply more than 30 lb-N/ha as a starter. The plots were split with half of the plots receiving an additional 150 lb-N/ac of fertilizer N sidedress applied as UAN in early to mid-June. The other split plot only received the fertilizer N associated with the starter fertilizer.

About 3-4 months after cover crop seeding (November), above-ground cover crop yield, cover N content and soil nitrate-N concentration to a depth of 30cm were measured in order to assess the N sequestration potential of the cover crops. The following year's corn grain yields were measured and the yield response to sidedress N (i.e. delta yield) was used to estimate corn fertilizer N requirements that were in addition to the N included in the starter.

Results:

Cover Crop Growth and N Uptake

Both oat and oilseed radish growth and N uptake were clearly higher where manure was applied. Table 1 shows the cover crop and N uptake values averaged across all sites. Applying manure increased oat and oilseed radish growth by about 1000 lb/ac and N uptake by about 35 lb-N/ac.

Both oat and oilseed radish cover crops resulted in late fall soil N levels following manure that were similar to levels observed where manure was not applied (Table 1). This suggests that establishing either oat or oilseed radish cover crops can reduce the potential for fall N leaching following summer applied manure to levels that are similar to where manure is not applied.

Field peas often were more difficult to establish and generally did not produce more above-ground growth than oats (Table 1). Field pea is a legume and can fix N resulting in above-ground N content that was about twice of either oats or oilseed radish where manure was not applied. Following manure, field peas had N contents similar to either oats or oilseed radish. Higher late fall soil N levels following field peas suggest that either oat or oilseed radish are a better choice for reducing fall soil N levels following late summer manure application.

Corn Response

Corn yield response to manure, cover crops and fertilizer N application averaged across all 17 sites is shown in Table 2. When nitrogen was not applied, corn yields were not significantly increased by either oat or oilseed radish cover crops when compared to where a cover crop was not planted. Also, the yield response to applying 150 lb-N/ac following oats or oilseed radish was not less than when a cover crop was not planted. These corn yield responses to either oat or oilseed radish cover crops suggest that fertilizer N requirements were not reduced compared to when a cover crop was not planted. The Maximum Economic Rate of Nitrogen (MERN) estimates included in Table 2 clearly indicate that either oat or oilseed radish cover crops, on average, did not reduce corn fertilizer n requirements when manure was or was not applied the previous summer.

Field peas did slightly increase yields when fertilizer was not applied and did have a slightly smaller yield response to adding fertilizer N when manure was not applied (Table 2). The field pea credit averaged about 23 lb-N/ac when manure was not applied. When manure was applied, use of field peas did not significantly increase N availability to corn.

Corn yields following any of the cover crops were similar to where a cover crop was not planted (Table 2) suggesting that these cover crops are not consistently associated with a rotation benefit that increases corn yield potential.

Summary:

Either oat or oilseed radish cover crops usually did successfully establish and grow when August seeded into cereal stubble fields, especially when manure was applied. Sufficient growth of oats or oilseed radish usually occurred to reduce the risk of soil erosion and soil N leaching losses following summer incorporated manure. However, fertilizer N requirements of corn planted next year were not reduced by either oat or oilseed radish cover crops.

Table 1. Effect of late summer manure application on cover crop yield, nitrogen content and associated soil N levels in surface 12" measured in November.

Manure Cover Crop	Cover Crop Yield (dry matter)	Cover Crop N	Soil N
No Manure	**lb/ac**	**lb N/ac**	**lb N/ac**
Oats	1800	28	29
Oilseed Radish	1360	25	31
Field Peas	1590	53	37
No Cover Planted+	470	5	40
Manure Applied			
Oats	2620	61	40
Oilseed Radish	2530	65	35
Field Peas	1850	63	50
No Cover Planted+	650	9	56

+ Yield and N content of weeds and volunteer cereal growth.

Table 2. Corn yield response to manure application, cover crops and fertilizer N.

Manure	Corn Yield			MERN++
Cover Crop	0 lb-N/ac	150 lb-N/ac	Response+	
No Manure	**bu/ac**			**lb N/ac**
Oats	123	167	44	83
Oilseed Radish	131	170	39	77
Field Peas	144	174	30	53
No Cover Planted	136	175	38	76
Manure Applied				
Oats	157	177	20	40
Oilseed Radish	161	179	18	37
Field Peas	162	176	15	29
No Cover Planted	159	177	18	37

+ Yield increase associated with applying 150 lb-N/ac of fertilizer N

++ Estimate of **Maximum Economic Rate of Nitrogen** predicted by the size of yield response to fertilizer N assuming corn price of $5.00/bu and fertilizer N price of $1.00/lb-N.

Field peas were more difficult to establish and did not significantly reduce risk of soil N loss following manure application. Field pea credit when manure is not applied averaged about 23 lb-N/ac, a reduction in fertilizer N cost which, even at current N prices would not cover the seeding cost of a pea cover crop.

Reducing the risk of soil erosion and fall soil N leaching losses on susceptible fields is sufficient reason to justify establishment of either oat or oilseed radish cover crops following summer incorporated manure. Field pea cover crops, owing to their ability to fix N, are best suited as a cover crop for fields with low N availability where either oat or oilseed radish cover crop growth would be limited by N availability.

These short-term trials were not designed to evaluate the potential long-term benefits that use of cover crops may potentially have on corn yield and/or N availability. Unfortunately, it does not appear that August seeding of oat, oilseed radish or field pea cover crops into cereal stubble fields will reduce corn fertilizer N requirements and/or increase yield sufficiently to cover the cost of seeding the cover crop.

Next Steps:

The results of this study should be used to make the following extension efforts:

1. Update nutrient management guidelines with respect to manure N availability to corn. There was no evidence that oat, oilseed radish or field pea cover crops increased manure N credits.
2. Oat, oilseed radish and field pea cover crops do have a place for N sequestration and erosion protection for the fall period following summer applied manure. Use of cover crops should continue to be promoted for their ability to sequester soil N and provide cover for erosion protection. Field pea cover crops should be promoted for use where natural soil N levels are low since other non-legume cover crops would be growth limited due to lack of sufficient soil N.
3. The fate of soil N sequestered by cover crops could not be determined. The environmental benefits of N sequestration can only be validated if the fate of cover crop N is known. Future cover crop work should have a focus on determining the fate of cover crop N.

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Project Contacts:

Greg Stewart (OMAFRA) **greg.stewart1@ontario.ca** and
Ken Janovicek (University of Guelph) **kjanovic@uoguelph.ca**