Nitrogen Survey And Verification Of A Cross Section Of Farm Types Across Ontario - A Survey And Sampling Approach

Purpose:

This study surveyed the amounts of mineral nitrogen remaining in the top 30 cm of soil at specific points in the year. It is assumed that this mineral N could be lost from the rooting zone prior to subsequent crops being able to utilize the residual nitrogen. The study was conducted over a 3 year period to look at the impact of different cropping system and management practices on the amounts of residual nitrogen remaining in the various systems.

Methods:

Approximately 200 sites were chosen with farm cooperators across the province. Site selection was crucial to the success of the project. Cooperators were selected based on criteria of geographic location, soil type, primary enterprise type and tillage systems employed. The goal was to select a minimum of 10 farms in any category to ensure enough data was collected to allow for summarization of the data.

Sites were established in the fall of 2001 for Field crop sites and the spring of 2002 for Hort crop sites. Each site was set up as a 1 acre area within a larger field. A centre point was established for each area, and 25 cores were collected from within a circle surrounding this point at each sampling time. Samples were collected four times during each year: Crop maturity (for grain crops) or harvest (for crops harvested before maturity); Late fall, just before freeze-up; Early spring, as soon after thaw as possible; and late spring/early summer, to correspond to the maximum soil N contents during the year. Each site was sampled for three years, finishing in the fall of 2003 for the field crop sites, and the fall of 2004 for the hort crop sites.

Results:

Results for the soil samples collected at Thaw, Crop Maturity/Harvest, and Freeze are shown in the following table. The late spring results are not shown, since they are highly variable according to whether the samples were collected before or after fertilizer application. The data for both ammonium and nitrate nitrogen is highly skewed, so the median is a better indicator of the central tendency of the data than the mean.

There was not a large spread in nitrate or ammonium contents between horticulture and field crop sites. The one consistent pattern was that the soil nitrate contents were higher at crop maturity/harvest than at either freeze, or thaw. This indicates that mineral N was lost from the soil during the period from the end of crop uptake of nitrogen to the end of the season, although it is not clear whether this is from leaching, denitrification, or uptake by cover crops. The change in mineral N content was much smaller over the winter period, when the soil was frozen.

Table 1: Number of mineral soil sites with soil nitrate-N and ammonium-N values of less than 10 mg/kg, between 10 and 20 mg/kg, between 20 and 30 mg/kg and over 30 mg/kg for the 2001-2003 average, for thaw (T), crop maturity/harvest (CM/H) and freeze (F) sample times. Including the average, median, min and max for each. For all sites, field crop sites and horticulture crop sites.

	All Sites						Field Crop Sites						Hort Crop Sites					
	Average 2001/2002/2003						Average 2001/2002/2003						Average 2002/2003					
N Type	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-	NH_4+	NO_3-
Sample Timing	T	T	CM/H	CM/H	F	F	T	T	CM/H	CM/H	F	F	T	T	CM/H	CM/H	F	F
mg/kg	# of sites																	
<10	324	146	493	131	499	226	236	96	389	104	386	172	88	50	103	27	113	54
10 - 20	10	156	14	243	17	218	8	124	12	202	15	177	2	32	2	41	2	41
20 - 30	5	35	1	80	3	56	4	28	1	65	3	43	1	7	0	15	0	13
>30	3	5	1	55	5	24	3	3	1	32	5	17	0	2	0	22	0	7
Total #	342	342	509	509	524	524	251	251	403	403	409	409	91	91	105	105	115	115
	mg/kg																	
Average	2.6	12.4	1.8	17.1	2.3	13.0	2.7	12.9	1.9	16.5	2.7	13.0	2.3	10.9	1.3	19.1	1.1	12.9
Median	1.0	11.0	1.0	14.1	0.7	10.8	1.2	11.5	1.0	13.9	0.7	11.1	0.8	9.5	0.3	14.5	0.0	10.2
Min.	0.0	1.5	0.0	2.4	0.0	1.8	0.0	2.3	0.0	3.2	0.0	1.8	0.0	1.5	0.0	2.4	0.0	3.0
Max.	35.1	47.9	34.2	70.3	68.9	46.9	35.1	35.4	34.2	70.3	68.9	46.9	26.4	47.9	17.7	54.1	11.7	40.2

Considering all sites, the at harvest or crop maturity levels of ammonium in the system were minimal and levels showed 97% of samples being less then 10 kg/kg. On the nitrate side, 25% of sites had levels below 10 mg/kg and 77% had levels below 20 mg/kg. On average the levels were below 14 mg/kg at crop maturity

Table 2: Soil Nitrate Levels by Sampling Time Across All Sites, Field and Hort Sites 2001-2003

Value	Sample Timing	All	Field	Hort
Max	Thaw	192	140	192
	Harvest	280	280	216
	Freeze	188	188	160
Median	Thaw	44	46	38
	Harvest	56	56	58
	Freeze	43	44	41

Table 2 shows that although maximum levels for soil Nitrate were excessive, the median values show acceptable levels of N at harvest and freeze up. Although the thaw values seem close to the freeze values, there would be a tremendous leap of faith to suggest that there was no N loss over the winter period as suggested by the data.

Table 3: Soil Nitrate Levels by Sampling Time by Soil Textural Class Across All Sites 2001-2003

Value	Sample Timing	Coarse	Medium	Fine
Max	Thaw	124	192	108
	Harvest	232	248	280
	Freeze	164	188	168
Median	Thaw	32	48	52
	Harvest	44	60	64
	Freeze	36	44	48

Table 3 shows that soil type on average had very little impact on residual N levels across all field and hort sites in the study. Median levels were almost equal for medium and fine textured soils. Maximum levels were very high, but represented a small portion of the overall data.

Summary:

On the first analysis of the data, in general, the amount of residual N left in the various systems is less then 14 mg/kg at harvest and drops to levels around 10 mg/kg by freeze up suggesting that not much nitrogen is being lost as nitrate at the end of the growing season. Regardless of the system, considerable N is available in the spring and should be accounted for in adjusting N rates to meet specific crop demands. Soil type did not have as big a factor as anticipated with the N levels in medium and fine soil being very similar at all sampling times during the season. Course textured soils did contain lower levels but the difference is likely not significant.

The maximum levels of residual N, although representing a low number of the total sites, is problematic and needs to be evaluated further.

Next Steps:

Data has been collected on management practices at each of the cooperating farms, and these will be correlated to the soil mineral N concentrations at each site. This will be used to validate whether the risk of high residual N concentrations predicted by the N Index within NMAN is reflected in the field. The data will also be analyzed to determine which management practices are related to low residual soil N concentrations.

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