Enhancing Ontario Farm Environmental Quality Through Improving Efficiency of Nitrogen Utilization In Field Crops

for

The Ontario Farm Environmental Coalition
c/o Mr. Dave Armitage
Ontario Federation of Agriculture
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from

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by

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The following segments are from the individual research stations at the Kemptville and Ridgetown Colleges of Agricultural Technology and Greenhouse and Processing Research Centre, Harrow (AAFC). Although field experimentation was completed and results are briefly discussed in the following. Various soil and plant analyses are in the process of being done and were generally not completed for presentation herein.

Kemptville College Agricultural Technology

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Experimental Layout:

In the spring of 1996, an 1.6 ha area with a slope of 6 % containing forage killed by Round-up, was selected as the test area. Each plot was 9 metres by 57 metres. The four slope positions that the plots represented were as follows:

a) the depression
b) the slope
c) the crest
d) the top

In addition to the slope position, two other experimental factors were introduced:

1) tillage vs. no tillage; and
2) 150 kg. of additional nitrogen fertilizer vs. no additional nitrogen fertilizer. Each treatment was replicated twice.

Agronomic Program: On October 5, 1995, the area was sprayed with Round-up at the rate of 1 litre/ha. The site selection and staking occurred on April 20, 1996. The first tillage operation occurred on May 21 following three weeks of wet weather. The treatments receiving 150 kg. of N as urea occurred on May 23. The corn crop was planted with Hyland 2298 at 70,000 seeds/ha, 180 kg. of 0-46-0 as starter, and fertilized on the same day.

A herbicide application using Primextra Light at 7.7 L/ha was sprayed on all plots on May 25. On June 6, 1996, the herbicide Banvel was sprayed at 1.0 L/ha to kill some late emerging weeds.

The crop was harvested on November S, 1996. This information is summarized in tabular form in Table 1.

Table 1 CROPPING SEQUENCES	
Oct. 5, 1995	Round-up applied
April 20, 1996	Site selection
May 21, 1996	Tillage operation
May 23, 1996	Fertilizer applied
May 25, 1996	Herbicide applied
June 6, 1996	Herbicide applied
November S, 1996	Corn harvested

The schedule of plant and soil analysis can be found in Table 2. All chemical analysis will be carried out by E. G. Beauchamp, Land Resource Science, University of Guelph. Three soil samples were taken over the cropping year. The first two sampling periods used as a 1.8 cm core at three depths: 0-15 cm, 15-30 cm, and 3060 cm. The final sampling used a S-cm core at three depths: 0-15 cm, 15-30 cm, and 30-60 cm. Due to stony and/or shallow soils, not all the 30-60 cm depths could be sampled from each plot. All the soil samples were frozen and sent to the Lab in Guelph.

On July 4th, a random sampling of corn leaves were taken from each plot. The corn was in the 8th leaf stage of growth and the leaf below and opposite the ear was harvested. The samples were frozen, dried and ground. The ground samples were sent to the lab for analyses. Grain corn samples were collected and frozen from each plot.

TABLE 2. SOIL AND CROP SAMPLING PROGRAM	
June 4, 1996	Initial soil sampling: 0-15 cm, 15-30 cm, and 30-60 cm
July 4, 1996	Summer soil sampling: 0-15 cm, 15-30 cm, and 30-60 cm
July 4, 1996	Tissue samples - 8 leaf stage
Nov. 5, 1996	Grain corn samples harvesting
Nov. 21, 1996	Final soil sampling: . 0-15 cm, 15-30 cm, and 30-60cm

Results

All the soil and tissue analysis samples have been sent to L.R.S. in Guelph for analysis. The work is currently in progress. The corn yields for each treatment have been calculated. The test average was (125 bu/ac) 7955 kg/ha. The plots receiving no nitrogen had yields which were 94 % of those plots receiving additional nitrogen as urea.

Slope position appears to have an influence on yield. The lowest yields occurred in the depressional areas with no nitrogen; 88 % of the test average. The highest yields occurred on the slope where additional nitrogen was applied to the corn, 113 % of the test average. These results may reflect the amount of alfalfa killed by the Round-up in the fall of 1995.

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Introduction

In 1996 a cooperative trial was initiated with Dr. Eric Beauchamp of the University Guelph to determine the nitrogen availability and contributions from red clover cover crops to following corn crops. A brief summary of what was done in the 1996 growing season and yield results from the plots are presented below.

Materials and Methods

The experiment that is being used for this trial in 1996, is located on the Ridgetown College research farm, on a Brookston clay loam soil with clay contents varying from 31 to 37 % . Soil organic matter contents are all greater than 5 % at this site. The site is systematically tiled every 9 metres with rows planted perpendicular to the tile line direction.

The site used in the 1996 growing season was initially designed to study the interaction of tillage, crop rotations and nitrogen rates. Two tillage systems, five rotations and four nitrogen rates are present with tillage as the main plot, rotation a split plot on tillage and nitrogen rate a split plot on rotation. The overall design is a split-split plot. The two tillage systems are conventional tillage and zone tillage, the five rotations are continuous corn, continuous soybeans, corn-soybeans, corn-soybeans-winter wheat (underseeded to red clover) and soybeans-winter wheat. Nitrogen rates applied to corn were: 0, 60, 120 and 180 kg N/ha.

Results

The growing season of 1996 was challenging. Spring was very cool and wet so that planting was delayed until May 28, 1996. The weather remained cool and wet until late June when the temperature warmed up. In the evening of July 7, 1996 a severe thunderstorm hit

Ridgetown with extremely high winds and hail. Corn leaves were shredded but the corn survived. The remainder of July and August were exceptionally dry with the corn plants suffering from drought stress. Autumn turned wet and corn was not harvested until late November.

As a result of the adverse weather conditions corn yields were approximately half of what is considered normal for the site (Table 1). There were several plots where there was not enough corn to harvest or not enough was harvested to get a grain moisture content. Therefore, it was decided that the yields were suspect and no statistical analysis of the yield data was conducted. Despite no statistical analysis being available for the corn yield data, the yields are not very different within treatments of the experiment indicating that they were most likely not yield limiting in 1996. The weather was more likely a greater limiting factor than any of the experimental factors studied.

Table 1. Corn Yields of Tillage, Rotation and Nitrogen Rate at RCAT, 1996.

Treatment	Corn Yield (t/ha)
Tillage	
Conventional Tillage	4.85
Zone Tillage	4.84
Rotation	
Continuous Corn	4.51
Corn Soybeans	4.91
Corn-Soybeans-Winter Wheat (underseeded)	5.14
Nitrogen Rate	
0 kg N/ha	4.71
60 kg N/ha	4.75
120 kg N/ha	4.64
180 kg N/ha	5.28

Other Activities

The research project also included other sampling of the various plots involved. Due to the late season, all the data has not yet been collected and analysed so results are not included. Several corn growth parameters have been taken including: emergence, early plant heights, silking date, lodging at harvest and broken stalks at harvest. Soil measurements included: soil N03 in early spring and samples for nitrogen mineralization. The nitrogen mineralization samples were taken January 6, 1997 and are currently being analysed.

Summary

The 1996 growing season was challenging. The weather conspired to stress the corn crop resulting in depressed yields. The experiment will be conducted again in 1997 when it is hoped that the weather will be more cooperative and provide better growing conditions.

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1. Site Specific Management for Corn Production on a Brookston clay loam soil

This study was initiated to examine the variability in corn grain yield response to added N over a field and the soil factors that affect the variability and whether the high and low yielding areas are consistent over time.

Materials & Methods

A study was initiated on a Brookston clay loam soil in 1995 to evaluate the variability in corn grain in a field and responsiveness to applied N fertilizer. Nitrogen was applied in strips at 0, 50, 100, 150 and 200 kg N ha^{-1} rates. Additional check strips (ON) were also included to determine the yield increase from applied N fertilizer. In this study 120 plots were sampled in both 1995 and 1996 for spring nitrate N at 0-30 and 30-60 cm depths. Corn grain yields and N uptake were also determined at harvest.

In 1996, additional soil samples were taken for the N mineralization study. Inorganic N and plant biomass was measured during the growing season over three week intervals. In the fall of 1996, soil N samples were taken at a depth of 0-15 cm on the 40 check plots. These fall samples have been analysed for extractable ammonium and nitrate as well as for a hot KCl (100°C) as described by Jalil *et al.*, 1996 (Soil Science Society of America Journal volume 60: pg. 1954-1960). Additional extractants will be used to estimate the N mineralization pool in consultation with Dr. Eric Beauchamp.

Results

In 1995 there was considerable variability in both the check yields, the fertilizer N yields and the delta yield values (Table 1). Corn yields increased with added N up to a maximum of 150 kg N ha'. In some locations, yields were increased by over 4 t ha^{-1} whereas in other locations there was no benefit to applying N fertilizer. Preliminary soil organic C data also vary across the

site. Hence this is a good site to examine the factors which affect the varying yield response. Yield maps indicated both responsive and non-responsive zones. Soil analysis for cold and hot extractable N is currently being evaluated.

N Rate	Yield Mean	Yield Range	Delta Yield Mean	Delta Yield Range
kg N ha^{-1}	(t ha^{-1})	(t ha^{-1})	(t ha^{-1})	(t ha^{-1})
0	8.58	6.59-10.5		
50	9.45	8.63-11.0	1.38	0-2.9
100	10.5	10.0-11.2	1.72	0-4.45
150	10.6	9.56-11.7	2.05	0.8-3.68 .
200	10.4	9.70-11.7	1.83	0.3-4.03

2. Evaluation of Zone Tillage versus No Tillage and Conventional Tillage systems for Corn & Soybean Production in Southwestern Ontario

Recent advances with zone tillage mechanization for corn production have shown promise to overcome the limitations with no-till corn. Using a triple coulter or a commercial unit (such as a "Trans Tiller" which has a centre shank and two fluted coulters) corn yields have increased over no-till corn and were similar to those for a conventional tillage system (Vyn, Green Plan Workshop, 1996). The objectives of this study was to compare zone tillage with no-tillage and conventional tillage systems for corn production in a corn-soybean rotation on a sandy loam over clay soil. Conventional and zone tillage was performed in the spring. In addition to grain yield and N uptake, corn rate of emergence, soil structure, spring soil nitrate 0-30 and 30- 60 cm were determined.

Additional analysis were performed for the N mineralization study. Soil and plant biomass samples were taken during the growing season at three weekly intervals. In the fall of 1996, soil N samples were taken at the 0-15 cm, 15-30 cm and 30-45 cm on the 15 check plots.

Results

Corn grain yields, moisture contents and delta yield values were determined of the 3 tillage treatments for both the 0 and 175 kg N ha^{-1} rates (Table 2). It was interesting to note that the delta yield increase was greater for the no-tillage and zone tillage sites than the conventional tillage sites. Perhaps the additional N facilitated the breakdown of the previous crop residue. Soil samples will be analysed with hot KCl as well as with other extractants by Dr. Eric Beauchamp.

Table 2: Corn grain yields and moisture content for the tillage study on the sandy loam site (over clay) for the 1996 growing season.

Treatment	Yield N (t ha^{-1})	Yield N (t ha^{-1})	Delta Yield (t ha^{-1})
Conventional Tillage	7.68	5.76	1.92
No-till	7.50	4.98	2.53
Zone-till	7.30	4.92	2.38