The Effects of Imposing Tillage on Long-term No-till Soils

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Introduction

During the last two decades technology has advanced enough for producers to manage their soil with little or no tillage. Producers that have adopted the no till system have realized reduced erosion, increased moisture conservation, better soil structure and higher net returns (Singh and Singh, 1994; Larney *et al.,* 1997).

With maturing no-till fields, some issues have been brought forward:

- Concerns with nutrient stratification near the soil surface (Grant & Bailey, 1994)
- Perennial/herbicide resistant weeds (Derksen et al., 1993)
- Low soil temperatures in the spring (Wolf and Eckert, 1999)

This may lead a producer to consider imposing tillage to alleviate one or all of these problems.

The objective of this project was to study the effect of imposing one cycle of tillage of different intensities on a long-term no-till soil (10+years) in the Brown, Black, and Gray soil zones.

We hypothesized that one cycle of tillage will:

1) encourage organic matter decomposition & nutrient release
2) decrease nutrient stratification, alter soil density, structure and moisture content of the surface soil
3) Reduce heavy thatch on soil surface and increase spring soil temperatures.

Materials & Methods

Study Sites:

Each site had a completely randomized design with four replications and a plot size of 24X50 feet.

Treatments included:

1. No-till: control
2. Min-till: Spring pass with 12” sweeps
3. Conv.-till: Fall + spring passes with 12” sweeps
4. Max-till:Fall + spring passes with 12” sweeps + one pass with a tandem disc.

Sampling techniques:

After tillage treatments were imposed and prior to seeding, polyvinyl chloride (PVC) cores were punched 15 cm into the soil and intact soil cores were removed. Surface (5cm depth) temperatures were also taken at this time

A punch truck was used to determine the moisture regime in the soil down to 90 cm

Fall harvest samples were analyzed for yield and nutrient content.

Following harvest another set of intact soil cores were taken

Core soil analysis

The intact soil cores collected in the spring were then subjected to a two week incubation to determine CO2 production as a result of microbial respiration and decomposition. Gas samples were taken from the PVC cores which were capped with an airtight seal. Seven days into the incubation, the cores were rewetted to simulate a light rainfall.

Also during the incubation, nutrient ion supply rates were determined by plant root simulator (PRS™) probes which use resin membranes as an ion sink (Qian and Schoenau, 2002).

After the incubation the cores were sectioned into 5cm increments, bulked, and analyzed for bulk density, pH, EC, organic matter and extractable nutrients.

Extractable P and K were determined by modified Kelowna solution and ammonium and nitrate extracted with 2M KCl.

Grain and straw yield were measured and N and P concentrations were assessed by wet digestion(Carter, 1993).

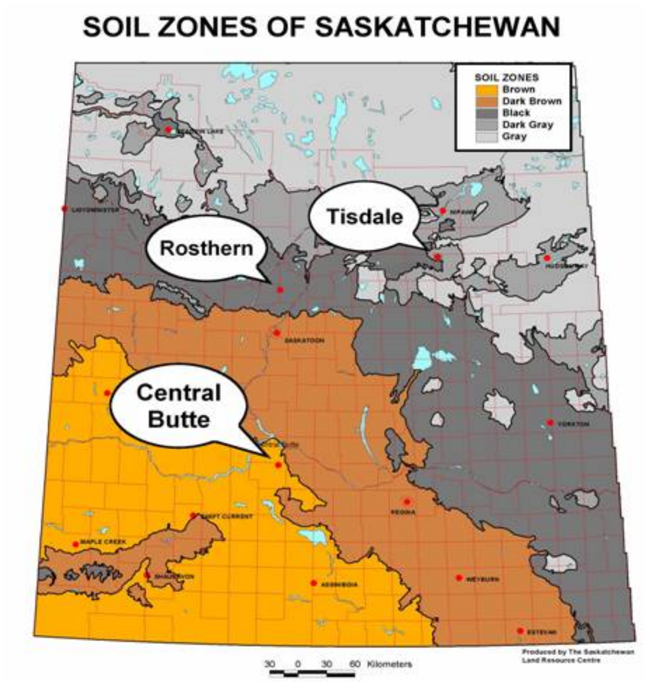

Figure 2. Plot sites in Brown, Black, and Gray soil zones

Figure 1. Tilling Brown soil zone site

Figure 4. Tilled Black soil zone site

Figure 3. Tilled Gray soil zone site.

Results and Discussion

All three sites showed that the soil that was not tilled produced the least amount of CO_2. Tillage exposes organic matter to attack from microorganisms and thus produces higher fluxes of CO_2 due to increased microbial activity and decomposition rates.

At the Central Butte site, one tillage operation in the spring appeared to reduce the supply rate of nitrate while more intensive tillage had no effect. At Rosthern and Tisdale sites, intensive tillage significantly reduced the supply rates of soil nitrate.

The reduced nitrate supply rates at Rosthern and Tisdale are most likely due to the fresh straw (high C:N ratio) incorporated during tillage. The Central Butte site had been in

Figure 6. Incubation chambers containing intact soil cores with PRS probes inserted.

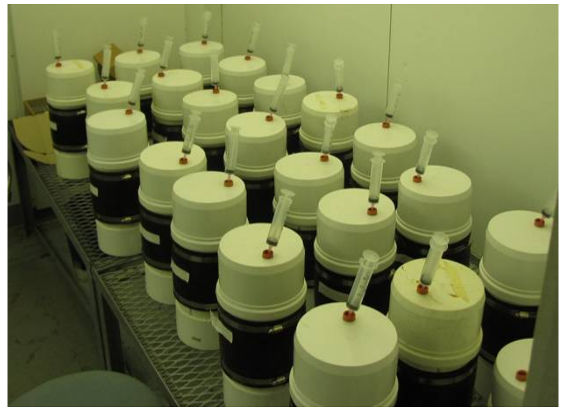

Figure 5. CO2 chambers with intact core sealed in and ready for gas sampling

chem-fallow the previous year and had lower amounts of more highly weathered, degraded straw.

Shortly after tillage, soil density was reduced and increased soil temperatures of about 0.5 to 1.5 degrees C were observed. It generally only took one tillage operation (spring only) to produce these effects.

Tillage showed no significant effect on pH, E.C., and total soil organic matter.

No significant differences were noted in the grain and straw yields among the tillage treatments but there was a trend to decreased yields at Rosthern and Tisdale, possibly reflecting the N immobilization. Mixing of soil reduced nutrient stratification near the soil surface.

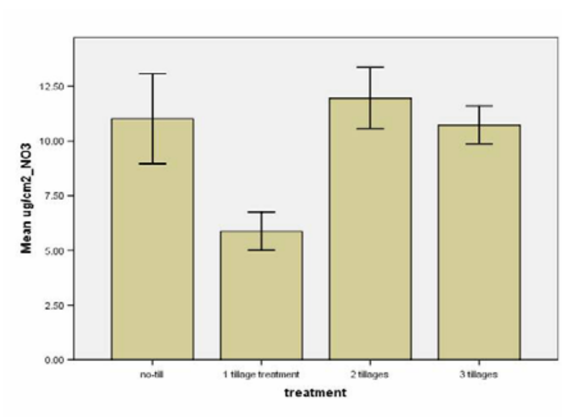

Figure 7. Mean NO_3 in Brown Soil Zone +/-1 SE

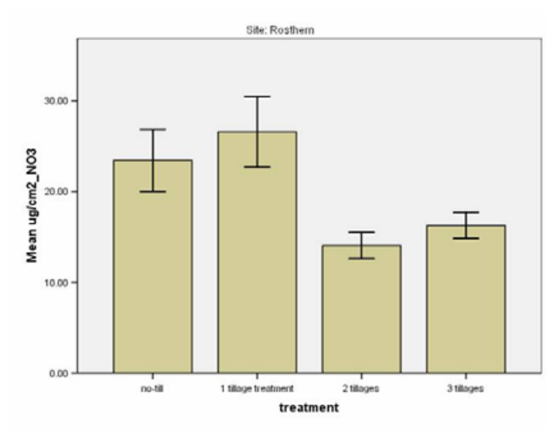

Figure 8. Mean NO3 in Black Soil Zone +/-1 SE

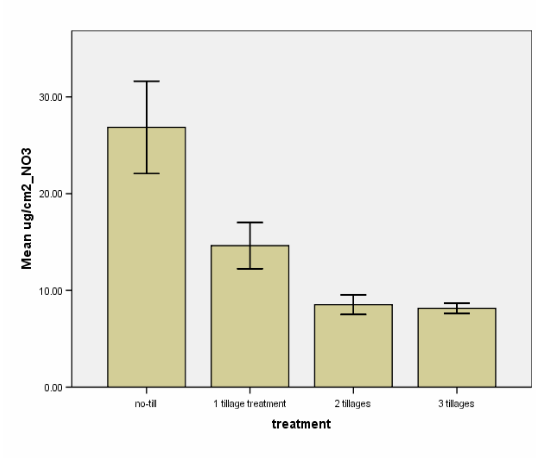

Figure 9. Mean NO_3 in Gray Soil Zone +/- 1 SE

Conclusions

- Soil incubation of intact cores revealed higher CO2 fluxes in tilled soils than no-till soils.
- An apparent effect of tillage on enhancing immobilization of available N due to fresh straw incorporation was observed
- Soil density was reduced and temperatures were increased by tillage
- Total soil organic carbon, pH, and E.C. were unaffected by tillage
- Tillage increased uniformity of nutrient distribution with depth.

Acknowledgements

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- **For more information contact Chris at cdb661@mail.usask.ca**

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