Relative Location of Strips Influences Sweet Corn Yields, Potentially Leachable Nitrate, and Trace Gas Flux Under Strip Tillage

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Introduction

In strip tilled (ST) fields, tillage is limited to the crop row (IR) and the soil between rows (BR) is left undisturbed.

- Contributes to soil conservation
- Provides a good seed bed for smaller seeded crops, unlike no till—important consideration for vegetable growers
- May reduce the number of field passes, saving on fuel costs
- Fertilizers can be deep banded behind strip tiller shank

Trade-offs are involved in relative strip placement

- When strips are in the same location from year to year…
  - Soil quality improvements may accrue BR
  - But crop residues from the previous year may affect establishment
- When strip location is offset from year to year…
  - More of the soil surface is tilled over the long-term, which may mitigate soil quality improvements.
  - But residues break down more before tillage and planting which may improve crop establishment

Compared to conventional full-width tillage (CT) with broadcast fertility, ST with deep fertilizer banding may lead to lower losses to the environment from partial denitrification and nitrate leaching through:

- *Improved agronomic nutrient use efficiency*
- *Improved soil quality*

Methods

Three treatments, replicated four times in an RCBD in 2011 (see Figure 1):

1. Strip till—strips in 2010 location **(ST same)**
2. Strip till—strips offset from 2010 **(ST offset)**
3. Chisel plow followed by field cultivator **(CT)**

Table 1. Timing of field operations

Operation	Date
Oat cover crop established—variety Ida	4/13
Cover crop terminated with glyphosate	6/9
Residue flail mowed	6/16
Fertilizer applied (P,K, 45 kg N/ha as urea), tillage (Table 2; Figures 2, 3) • Banded 15 cm deep in ST • Broadcast in CT	6/17
Sweet corn planted—var. Luscious (45 kg N/ha as urea placed with seed; Table 2)	6/17
Nitrogen side dress application (45 kg N/ha as urea; Table 2)	7/25
Sweet corn harvested	8/31
1 m deep soil core samples collected (Figure 4)	9/12, 4/4/12
Rye cover crop planted	10/10

- P, K applied according to soil test results
- Weeds were controlled with pre-emergence herbicides (atrazine, s-metolachlor)
- Irrigation applied as needed.

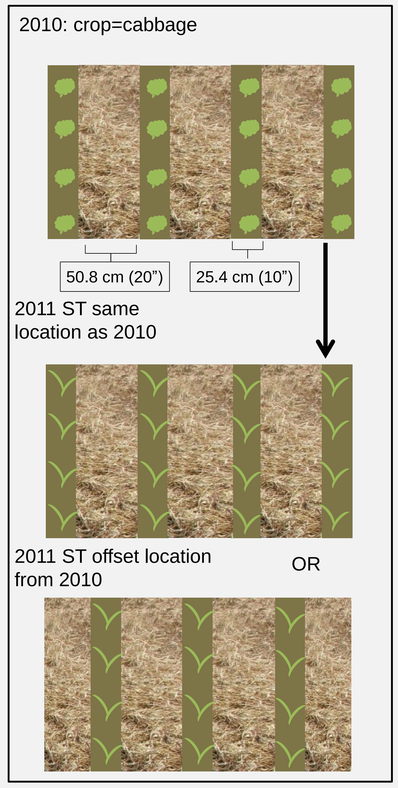

Figure 1. Strip location in 2011 ST treatments relative to 2010 location

Table 2. Summary of N rates, placement, and timings. Refer to Table 1 for dates. All rates given in kg N/ha.

Tillage type	Broad-cast pre-till (IR and BR zones)	Deep banded pre-till (IR zone only, 15 cm deep)	Banded with seed (IR zone only, 5 cm deep)	Side-dress (IR zone only)	Estimated N in IR zone[1]
CT	45	0	45	45	105
ST	0	45	45	45	135

[1] All ST N was applied IR. For CT, we estimate 1/3 of broadcast N will fall IR because IR (25.4 cm wide) occupies 1/3 of plot area (with row spacing of 76.2 cm)

Data collection
- Sweet corn yield (Figure 4)
- Final weed biomass in and between rows (not shown)
- N_2O flux every 7-10 days (Figure 5)
- Nitrate content to 1 m depth after harvest and the following spring (Figure 6)
- Soil N content every 10-14 days (not shown)

Figure 2. Strip establishment with oat cover crop residue

Figure 3. Hiniker two row strip tiller

Results

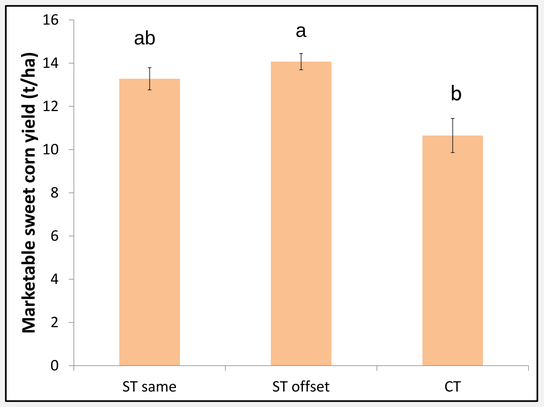

Figure 4. Marketable sweet corn yield (>5 cm diameter), +/- SE (include banded/broadcast in X axis labels)

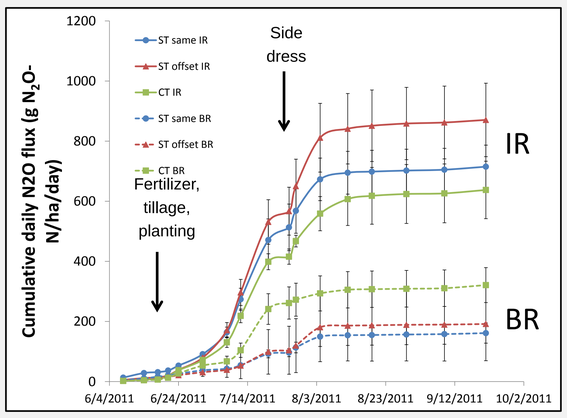

Figure 5. Nitrous oxide flux (+/- SE) measured in and between row.

- *Yield of marketable sweet corn ears* (>5 cm diameter) was higher in **ST offset** compared to **CT**. **ST same** yield was intermediate **(Figure 4)**.
- *Cumulative nitrous oxide flux* was higher **IR** compared to **BR** ($p<0.001$) (**Figure 5**). **Within BR**, N_2O flux was higher in **CT** compared to the **two ST treatments** ($p=0.019$). Within **IR**, there were no flux differences between the three treatments.
- *There was more residual surface soil nitrate* remaining after sweet corn harvest **IR** compared to **BR** ($p<0.001$; **Figure 6**). The **two ST treatments** had less residual surface nitrate than **CT** ($p=0.07$). In April 2012, residual nitrate was low in all treatments (0.3-0.9 mg NO_3^--N/kg soil; data not shown)
- *Sum of potential N losses on a field scale* were calculated by correcting for the differences in zone width (Figure 1). Despite differences in means, variability in these estimates precluded detection of treatment differences ($p=0.21$).

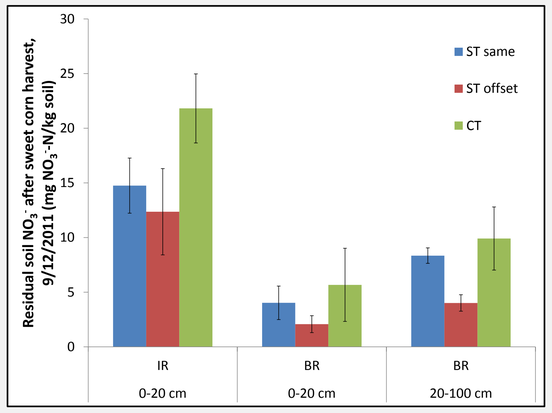

Figure 6. Soil nitrate remaining on 9/12/11 after sweet corn harvest, +/- SE. Multiply by 0.32 to convert to kg NO_3^--N/ha

Table 3. Average potential N loss pathways extrapolated to field scale for comparison (SE in parentheses)

treatment	potentially leachable nitrate (kg NO_3^--N/ha)	cumulative N_2O flux (kg N_2O-N/ha/105 days)	sum
ST same	15.3 (1.7)	1.0 (0.16)	16.3 (1.7)
ST offset	9.1 (2.5)	1.2 (0.04)	11.0 (3.0)
CT	20.1 (5.8)	1.3 (0.08)	21.4 (5.8)

Conclusions

- The initial N fertilizer application was deep-banded in both of our ST treatments, but broadcast in CT. All subsequent applications were to the crop rows in all treatments.
- Similar or higher sweet corn yields were observed in ST plots compared to those with CT, but we cannot separate the effects of tillage and deep N banding.
- Differences in fertilizer application patterns and soil disturbance likely affected N_2O flux in IR and BR
  - *Higher flux in IR compared to BR was coincident with higher IR soil nitrate levels in the top 20 cm in all treatments (data not shown).*
  - *BR: N_2O flux was lower in the two ST treatments compared to CT. The ST treatments had no N fertilizer applied and were not disturbed.*
  - *IR: no treatment effects were observed, but the trend shows higher flux in ST which may result from concentrating fertilizer in this area.*
- ST plots had less residual nitrate, which is prone to leaching, in surface soils after sweet corn harvest. Residual soil nitrate the following spring was low in all plots, suggesting that nitrate remaining after harvest was either leached or taken up by the over-wintering rye cover crop.
- When extrapolated to a field scale, these data suggest that N loss may be lower in ST fields compared to CT, though variability is high.

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