Spatial distribution of N and PMN in ridge tillage systems with rye cover crop

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Background

- Reducing losses of N from agricultural systems is a primary challenge to sustainability
- Utilizing plant residues has been proposed as a way to supply crops with biologically sourced N, however, it can be difficult to synchronize the supply of N from these residues with crop demand
- Ridge tillage systems may help growers manage N inputs by offering them control over when and where residues and SOM are processed
- Ridge tillage:
  - Creation of permanent ridges in row space
  - Ridges are rebuilt when corn is between V6-V8
  - RT improves early season soil drying in the planting zone
  - RT increases soil C and SOM-N over the long-term
- Spatial dynamics of N turnover in ridge till systems is poorly understood

Figure 1.

Plant residues remain undisturbed on the surface of the soil in the early season in RT systems. At re-ridging , they are incorporated into the soil and relocated to in-row space.

Hypotheses

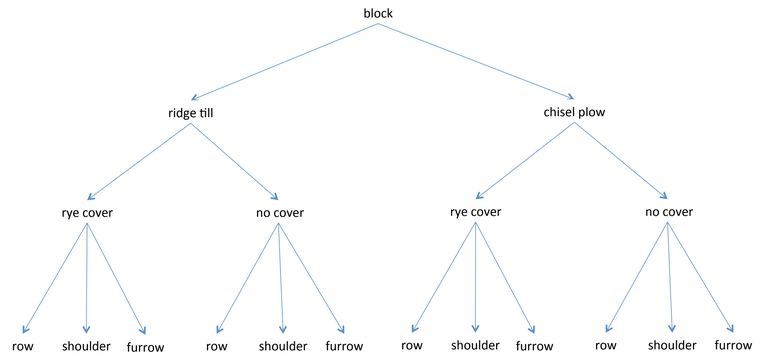
- Early season N immobilization will be mitigated by relocating crop and cover crop residues away from planting zone into inter-row space
- Residues will be sufficiently decomposed by ridging, and N will be redistributed to planting zone in mineralized or potentially mineralizable forms at re-ridging operation
- Re-ridging operation will accelerate turnover of N from biological sources

Objectives

1. Determine concentrations of inorganic N and potentially mineralizable N across the row/inter-row space at important stages in phenology
2. Determine turnover rates of NO_3 and NH_4 from SOM throughout the season across the row/inter-row space
3. Measure plant N at important stages in phenology

Methods

- Two sites: University of Illinois and Michigan State University
- All sampling conducted in 0 N subplots to isolate biological-N signal
- Sampling design:



- Soil sampling:
  - KCl-extractable N
  - Potentially Mineralizable N (PMN)
- Ion exchange resins:
  - Installed/extracted every 3 weeks throughout growing season at MSU
  - KCl-extractable N
- Chlorophyll content in leaves (SPAD meter) at important growth stages

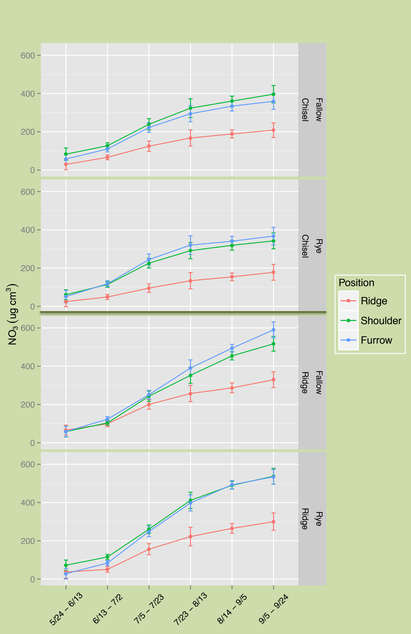


Figure 2.

Cumulative NO_3 turnover at MSU.

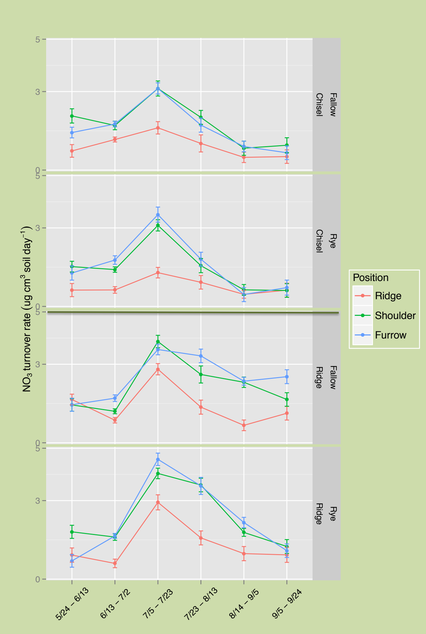


Figure 3.

NO_3 turnover rates throughout season at MSU.

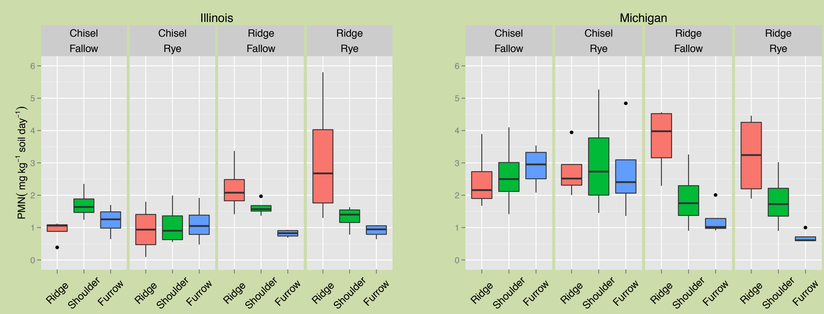


Figure 4.

PMN by treatment at both sites immediately following re-ridging (corn @ V6).

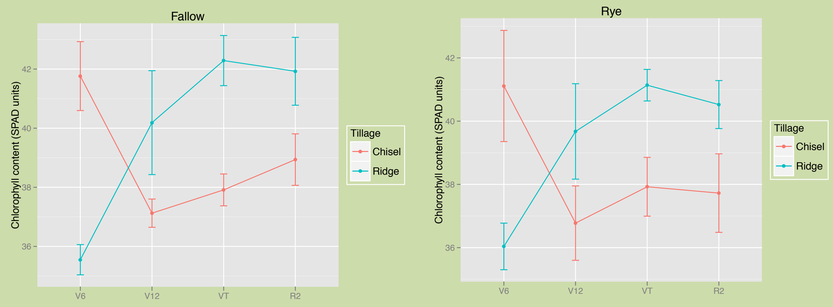


Figure 5.

Chlorophyll content of leaves at MSU throughout season.

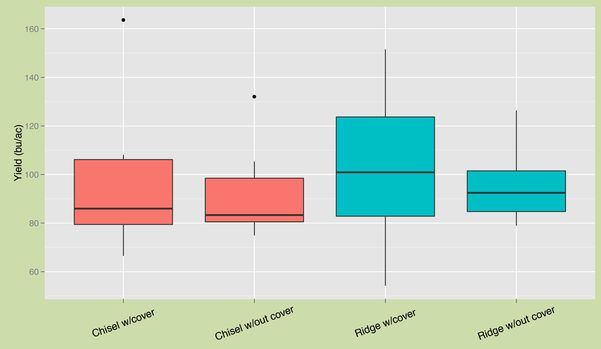


Figure 6.

End of season yield of 0 N subplots at MSU.

Results

- Initial soil N low in all treatments immediately after planting
- Turnover rates of NO_3 can differ between zones (Figure 3)
- Turnover rate in ridge/row zone increased in RT systems after re-ridging (Figure 3)
- Cumulative NO_3 turnover was higher in ridge tillage systems (Figure 2)
- RT plots initially lower in chlorophyll content, but increased following re-ridging operation (Figure 5)
- Concentration of PMN in ridge position increased in RT following re-ridging operation (Figure 4)
- PMN distribution patterns conserved across sites, indicating the pattern is related to effects of tillage rather than site differences (Figure 4)
- Yields in ridge till systems higher (Figure 6)

Conclusions

- Preliminary evidence suggests that RT can improve synchrony of N supply from biological sources (SOM-N, cover crops)
- Spike in PMN at ridge position suggests N from residues is somewhat decomposed during early season into readily mineralizable forms, this N is then relocated around the plants during re-ridging and turnover is accelerated by disturbance
- Patterns of N availability/synchrony reflected in SPAD measurements and end of season yield
- Further thoughts/questions:
  - Is RT a more sustainable approach to managing biological-N?
  - What about RT modulates turnover: soil C profiles, differences in soil moisture/physical properties, differences in soil microbial communities?

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