Effect of a Radish Cover Crop on Nitrogen Availability to Corn Following Small Grains in Minnesota

Miriam Gieske, Bev Durgan, and Don Wyse

University of Minnesota

Introduction

- Soil nitrate remaining after crop harvest can be lost from the field, contributing to greenhouse gas emissions and reductions in water quality (Robertson and Vitousek, 2009).
- Cover crops (catch crops) may be able to take up nitrate after a main crop and release it to the next main crop (Thorup-Kristensen et al., 2003).
- Radish (*Raphanus sativus* L.) is being promoted as a catch crop, but has not been tested in Minnesota or neighboring states.

Objectives

- To determine the nitrogen fertilizer replacement value of a fall-planted radish cover crop in a small grain-corn rotation, as well as the effect of the radish cover crop on nitrogen availability and grain yield in a rotational corn crop.

Materials and Methods

- In August 2010 and 2011, daikon radish (cultivar "Groundhog"; 19 kg ha^{-1}) was planted into oat stubble at two sites in southern Minnesota.
- Before radish planting, urea was applied to the whole field as needed and incorporated to provide residual nitrogen for the cover crop to take up (Table 1).
- The experimental design was a split-plot in randomized complete block with four replications per site-year. Cover crop (radish or no cover) was the main plot treatment and nitrogen level was the subplot treatment.
- Radish root and shoot biomass samples were collected in mid to late October, before the radish cover crop winterkilled.
- In spring, nitrogen was applied at rates of 0, 45, 90, 135, and 179 kg ha^{-1} in the form of urea.
- Corn (*Zea mays* L.) was planted as a test crop.
- Corn shoot biomass samples were collected in the zero-nitrogen treatment when the corn reached the V7-V8 growth stage (henceforth "V8").
- Soil samples were collected in the zero-nitrogen treatment in late fall, in spring before corn planting, and at V8.

Table 1. Initial plant-available nitrogen (PAN), radish biomass production, and radish nitrogen uptake.

Site	Year	Initial PAN†	Biomass	Nitrogen uptake‡
		----------------------	kg ha^{-1}	----------------------
Lamberton	2010	101	3186	65
	2011	68	2950	89
Rosemount	2010	91	2546	77
	2011	67	1014	32

† Initial PAN equals 0-60 cm nitrate nitrogen measured in August plus urea nitrogen applied before radish planting.
‡ Plots where the entire sample was dirty or moldy were excluded from biomass nitrogen calculations.

Figures

Figure 1. Radish residue decomposed almost completely over the winter and early spring.
Left: Lamberton, Oct. 26, 2011.
Right: Lamberton, Apr. 6, 2012.

Figure 2. Close-up of radish residue. Rosemount, Apr. 8, 2011.

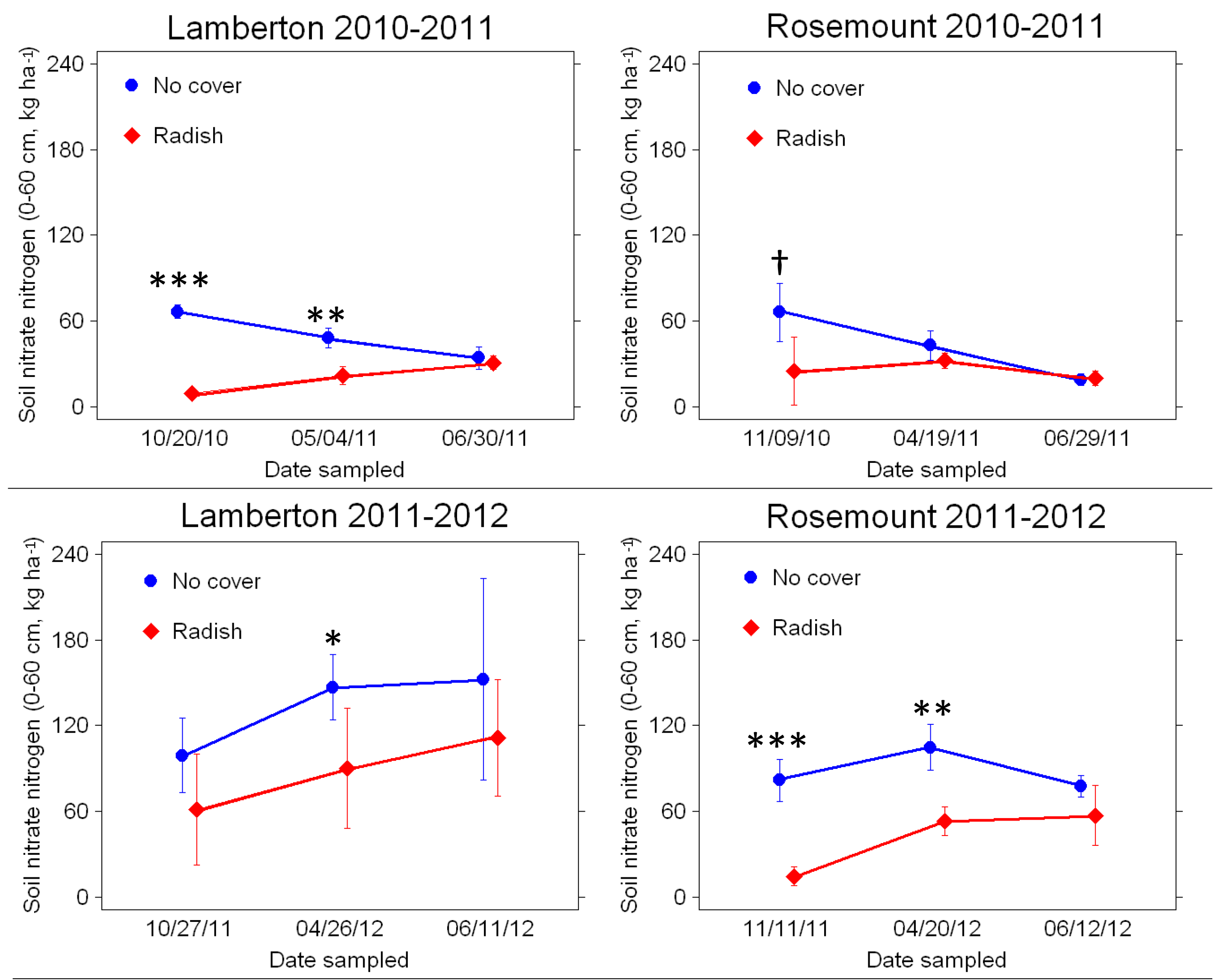

Figure 3. Effect of a fall-planted radish cover crop on soil nitrate levels. Error bars denote one standard deviation.
, **, ** The difference between cover crop treatments is significant at the 0.05, 0.01, or 0.001 probability level, respectively.
† Rosemount, Fall 2010: composite samples were taken from the entire main plot.

Table 2. Effect of a fall-planted radish cover crop on V8 biomass, V8 nitrogen uptake, and grain yield of an unfertilized rotational corn crop.

Cover crop	Lamberton 2011	Lamberton 2012	Rosemount 2011	Rosemount 2012
	---------------------------- V8 corn biomass, g plant^{-1} ----------------------------			
Radish	9.4	3.4	12.3	8.0
No cover	12.2	3.6	11.6	9.4
p-value	*0.288*	*0.762*	*0.069*	*0.022*
	---------------------- V8 corn nitrogen uptake, g plant^{-1} ----------------------			
Radish	0.21	0.12	0.33	0.25
No cover	0.25	0.12	0.29	0.33
p-value	*0.481*	*0.970*	*0.075*	*0.034*
	----------------------------- Corn grain yield, kg ha^{-1} -------------------------------			
Radish	9470	7839	9167	7077
No cover	9849	5197	8286	9091
p-value	*0.739*	*0.222*	*0.787*	*0.068*

Results

- Radish biomass production ranged from 1014 to 3186 kg ha^{-1} (Table 1). Radish nitrogen uptake ranged from 32 to 89 kg ha^{-1} (Table 1).
- The radish cover crop sometimes reduced soil nitrate levels in late fall and spring, but did not affect soil nitrate level at V8 (Figure 3).
- Radish cover crop effects on V8 biomass and nitrogen uptake of unfertilized corn were inconsistent (Table 2).
- The radish cover crop did not affect corn grain yield (Table 2) or response to nitrogen. Therefore, nitrogen fertilizer replacement value was not calculated.

Discussion

- The effect of a cover crop on nitrogen availability to rotational crops is a function of cover crop nitrogen uptake, timing of mineralization of cover crop nitrogen, and potential for nitrogen loss without a cover crop in the system (Thorup-Kristensen et al., 2003).
- In these trials, the effect of the cover crop may have been limited by a low risk of nitrogen loss, at least during the very dry fall and winter of 2011-2012.
- Nitrogen can be lost from radish biomass by leaching (Miller et al., 1994), ammonia volatilization (de Ruijters et al., 2010), or denitrification (Petersen et al., 2011).
- The rapid decomposition of the radish residue (Fig. 1 and 2) suggests that much of the nitrogen taken up by the radishes may have been available for denitrification, volatilization, or leaching over the winter and spring.
- The distribution of nitrate by depth in the fall and spring did not suggest that leaching was a major pathway of nitrogen loss in the radish treatment.

Conclusion

- Although a radish cover crop planted following small grains can take up nitrogen rapidly, it does not appear that using a radish cover crop in this situation will improve nitrogen availability for the following year's rotational corn crop.

References

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