Cool Season Grass Cover Crops following Corn Silage Harvest and Manure Application

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INTRODUCTION

Winter rye (*Secale cereale* L.) is commonly used in the upper Midwest as a cover crop to prevent soil erosion, and can be planted in the fall after early harvested crops such as corn (*Zea mays* L.) silage. Alternative cool season grasses, including triticale (x *Triticosecale* L.), annual ryegrass (*Lolium multiflorum* L.*)* and barley (*Hordeum vulgare* L.) may provide different benefits and increase diversity of options for growers. Fall manure applications are often a necessity, but can pose environmental challenges. Cover cropping with fall manure may reduce NO_3 leaching, with potential consequence of plant-available N immobilization.

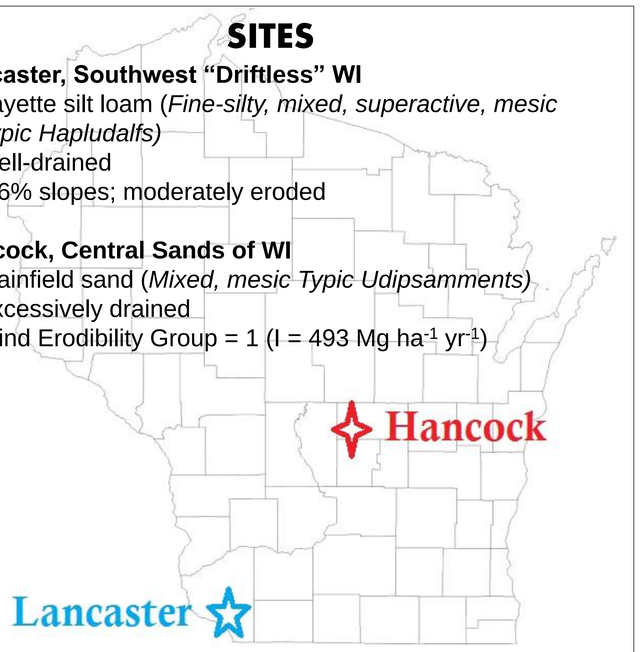
OBJECTIVES

- Evaluate performance of several cool season grass cover crops, with regards to fall growth and N uptake, and spring growth (winter rye) and spring forage production potential (triticale) prior to corn planting
- Measure soil NO_3-N concentration changes under various cover crops
- Determine differences in corn yield response to N following fall manure application and cover cropping

SITES

Lancaster, Southwest "Driftless" WI
- Fayette silt loam (*Fine-silty, mixed, superactive, mesic Typic Hapludalfs)*
- Well-drained
- 2-6% slopes; moderately eroded

Hancock, Central Sands of WI
- Plainfield sand (*Mixed, mesic Typic Udipsamments)*
- Excessively drained
- Wind Erodibility Group = 1 (I = 493 Mg ha^{-1} yr^{-1})



STUDY DESIGN

- RCB strip-split plot arrangement; four replicates
- **Whole plot factor was fall-seeded cover crop**:
  - Winter rye (112 kg ha^{-1} PLS)
  - Winter triticale (157 kg ha^{-1} PLS)
  - Spring barley (118 kg ha^{-1} PLS)
  - Annual ryegrass (ARG; 22 kg ha^{-1} PLS)
  - No cover crop (No CC)
  - No manure/no cover crop control
- **Split-plot factor was N fertilization rate**:
  - Lancaster: 0, 56, 112, 168, 224, 280 kg ha^{-1} N broadcast applied at planting
  - Hancock: 0, 67, 134, 202, 269, 336 kg ha^{-1} of N split broadcast applied at V4, V6, V10
  - N applied as urea with urease enzyme inhibitor

Statistical Analysis
- Yield was subjected to an ANOVA using the MIXED model procedure in SAS (9.4) and statistical significance was determined at α≤0.10.

METHODS

Field Practices & Data Collection
- Following corn silage, liquid dairy manure was applied fall 2014 (~5% solids, 10,000 gal ac^{-1}; ~105 kg ha^{-1} N available in the first year).
  - Hancock: surface applied and incorporated
  - Lancaster: applied using AERWAY vertical aeration technology ▶

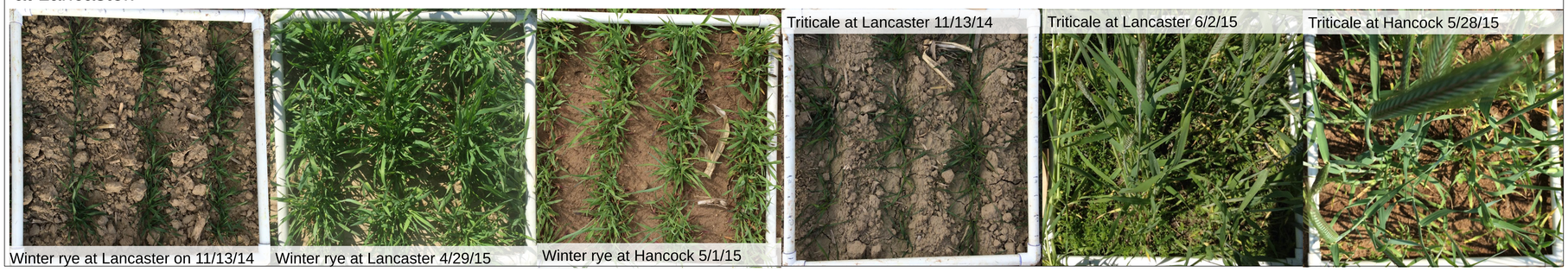
- Cover crop seed was drilled ~ 5d following manure (Hancock: 1 Oct. 2014; Lancaster: 29 Sept. 2014)
- Winter rye was terminated using standard burndown rate of glyphosate. Triticale was harvested at boot stage.
- Grain yield was determined (15.5% moisture) in all treatments and silage yield was determined (65% moisture) in No CC, W Rye, and Triticale at 224N (Lancaster) and 269N (Hancock).

This research is also being conducted also in Arlington, WI and Marshfield WI, and will continue through two more seasons. Funding is provided by the Wisconsin Fertilizer Research Council.

COVER CROP GROWTH & N UPTAKE VARIES BY SITE

Table 1. Cover crop biomass production, N content, and C:N at fall hard frost, winter rye spring termination, and triticale forage harvest. Both winter rye and triticale immobilized fall and spring N, as demonstrated by soil NO_3–N trends at Lancaster.

	Winter Rye						Triticale					
	Hard frost			Termination			Hard frost			Spring Harvest		
Site	Dry matter	N content	C:N	Dry matter	N content	C:N	Dry matter	N content	C:N	Dry matter	N content	C:N
	----------kg ha^{-1}----------			----------kg ha^{-1}----------			----------kg ha^{-1}----------			----------kg ha^{-1}----------		
Lancaster	339	16	10	1772	41	17	427	18	10	5082	53	41
Hancock	--	--	--	1029	18	24	--	--	--	2248	31	31

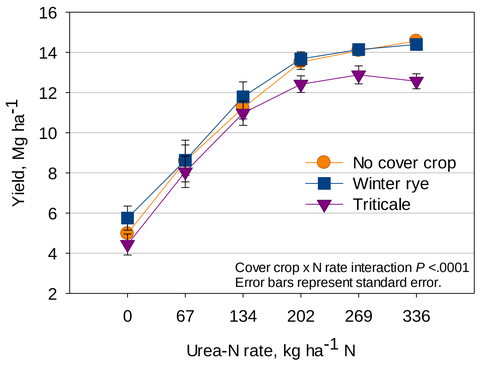


NO CHANGE IN GRAIN YIELD ATTRIBUTED TO COVER CROPS

Table 2. Grain and silage yield in 2015. At Lancaster, grain yield was similar across No CC, ARG, barley, and winter rye. The No manure treatment resulted in 1-1.5 Mg ha^{-1} lower grain yield. The triticale treatment had low yields; the forage harvest was likely late and weed management was also poor. At Hancock, grain yield was similar across all cover treatments, except triticale, which produced approximately 1 Mg ha^{-1} less grain.

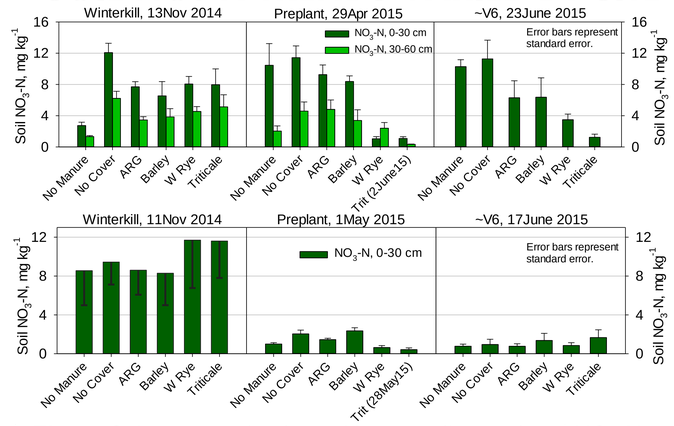
Corn was planted 8 May 2015 (Hancock), 13 May 2015 (Lancaster), with delayed planting in triticale treatment (28 May 2015, Hancock and 3 June 2015, Lancaster).

	Lancaster		Hancock	
Treatment	Grain	Silage	Grain	Silage
Cover crop	----------Mg ha^{-1}----------			
No manure	9.9 b	--	11.9 ab	--
No cover crop	11.1 a	60.7 a	12.4 a	61.8 a
ARG	11.0 a	--	12.4 a	--
Barley	10.3 ab	--	12.3 a	--
Winter rye	10.4 ab	62.2 a	12.5 a	56.4 b
Triticale	4.7 c	47.1 b	11.4 b	58.6 ab
N rate, kg ha^{-1}				
56	6.5 d	--	67 8.1 d	--
112	8.7 c	--	134 11.3 c	--
168	10.3 b	--	202 13.3 b	--
224	11.2 a	--	267 13.9 ab	--
280	11.2 a	--	336 14.1 a	--
Variation	*P* value			
Cover crop	<.0001	0.0519	0.0014	0.0772
N rate	<.0001	-	<.0001	-
Cover crop × N rate	0.7468	-	<.0001	-

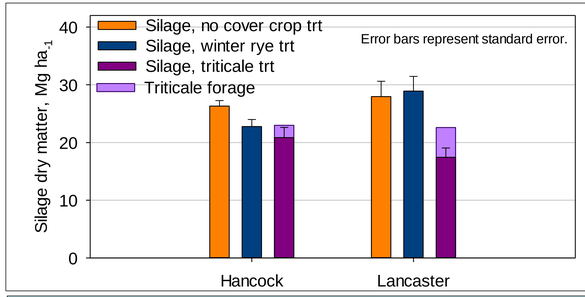


▲ **Figure 1.** Grain yield at Hancock. Interaction effect is driven by response at high N rates within the triticale treatment.

SOIL NO_3-N TRENDS VARIED BY SITE



▲ **Figure 2.** Lancaster (top) and Hancock (bottom) soil NO_3-N by cover crop treatment. At Lancaster, treatments planted to cover crop had lower soil NO_3-N at winterkill compared to No CC. At preplant, NO_3-N was lower in winter rye and triticale treatments, which actively grew in the spring. These trends continued through V6. At Hancock, we observed high error in NO_3–N at winterkill, and suspect that the manure had moved into the no manure treatment through surface movement and dragging via tillage. By the following spring, NO_3-N was very low, notably in the No CC treatment, which did receive manure but no cover crop. Soil NO_3 at Hancock is typically very low due to excessively draining sandy soil and low organic matter/clay.



TOTAL PRODUCTION WITH TRITICALE

Figure 3. Silage dry matter yield with added triticale forage production. At both sites, triticale harvest added to total production in that treatment, However, at Lancaster, where we had significantly lower corn silage yield in the triticale treatment, we did not make up the full deficit. In a concurrent study at a different location with winter rye as forage, in two out of three years we saw triticale production increase total dry matter production, and break even in the third year, during drought. The corn crop planted in the triticale treatment at Lancaster also experienced very weedy conditions due in part to late planting (not allowing for early season weed management), and wet conditions that prevented good weed control later in the season.

CONCLUSIONS

- Fall-seeded cover crops that winterkilled (annual ryegrass and barley) or were terminated early spring (winter rye) did not reduce yields compared to no cover crop treatments.
- Seeding triticale and harvesting for forage prior to late-planted corn resulted in corn grain yield losses, and silage yield loss at one site. However, the triticale forage is worth considering in total production.
- Soil NO_3–N concentration decreased under cover cropping at one site in the fall, with differences carrying through to preplant and V6.
- Corn yield response to N was highest at 224 kg ha^{-1} of applied urea-N at Lancaster, and 267 kg ha^{-1} applied urea N at Hancock.