Stover Removal and Cover Crop Effects on Corn Production and Water Use Under Full and Limited Irrigation

Aaron J. Sindelar[1], Virginia L. Jin[1], Marty R. Schmer[1], Brian J. Wienhold[1], Richard B. Ferguson[2], and Meghan E. Sindelar[2]

[1]USDA-ARS, Lincoln, NE (Aaron.Sindelar@ars.usda.gov), [2]Univ. of Nebraska, Lincoln, NE

Introduction

Harvest of corn (*Zea mays* L.) stover for forage or cellulosic ethanol production is of great interest in south-central Nebraska. Current thought is that cover crop inclusion may offset negative effects of stover harvest. However, little is known regarding the effects of these practices on agronomic productivity and crop water use under full and limited irrigation.

Objective

Evaluate corn stover removal and cereal rye (*Secale cereale* L.) cover crop inclusion effects on corn grain yield and water use efficiency (WUE) under full and limited irrigation in two distinct growing seasons (Fig. 1 & 2).

Materials and Methods

- Trials were established in 2010 on a Hastings silt loam in a no-till continuous corn rotation at the Univ. of Nebraska South Central Agricultural Laboratory near Clay Center, NE (40.582°N, 98.142°W).
- Corn residue was either retained or removed. Removal occurred following harvest through swathing and baling (~67% removal) (Fig. 2). No residue management occurred in plots where it was retained. Rye cover crop seeding occurred after residue management via drill (7.5-cm spacing) at 112 kg ha^{-1}. The cover crop was chemically terminated prior to corn planting.
- Corn was planted on April 24, 2012 and May 2, 2014, respectively with 47 L ha^{-1} of 10-34-0 simultaneously applied. Fertilizer N as 32-0-0 was applied at 200 kg N ha^{-1} 6 wk after planting.
- Full and limited irrigation treatments were applied with a linear sprinkler irrigation system. Full irrigation treatments met crop ET demand, and 4.1 and 3.4 cm water was applied with each irrigation event in 2012 and 2014, respectively. Limited irrigation satisfied 60% of ET demand, and 2.5 and 2.0 cm was applied with each event in 2012 and 2014, respectively.
- Watermark granular matrix sensors were installed after fertilizer N application at four depths (0.30, 0.60, 0.90, and 1.20 m) within the crop row for soil water monitoring as soil matric potential on an hourly basis (Fig.3). Soil matric potential was converted to available soil water using the van Genuchten (1980) equation and field-specific constants developed by Rudnick (2015). Seasonal ET was estimated through the following soil water balance:

$$\sum_{i=1}^{t} ET = (S_i - S_{i+1}) + P_i + IR_i - RO_i$$

where S_i is available soil water for the previous day, S_{i+1} is soil water for the current day, P_i is precipitation, IR_i is net irrigation, and RO_i is runoff.

- Grain yield was determined by machine harvest on Sept. 24, 2012, and Oct. 10, 2014 and adjusted to 155 g kg^{-1} moisture. Crop (CWUE) and irrigation water use efficiency (IWUE) was calculated as:

CWUE = Grain yield / Et

IWUE = Grain yield / irrigation water applied

- Data analyzed using the GLIMMIX procedure in SAS ($P \leq 0.05$). Treatment comparisons made using the PDIFF option with SIMULATE adjustment ($P \leq 0.05$).

References

Rudnick, D.R. 2015. Maize evapotranspiration, canopy and stomatal resistances, crop water productivity, and economic analysis for various nitrogen fertilizer rates under full irrigation, limited irrigation, and rainfed settings. Ph.D. diss., Univ. of Nebraska, Lincoln.

van Genuchten, M.T. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Sci. Soc. Am. J. 44:892-898.

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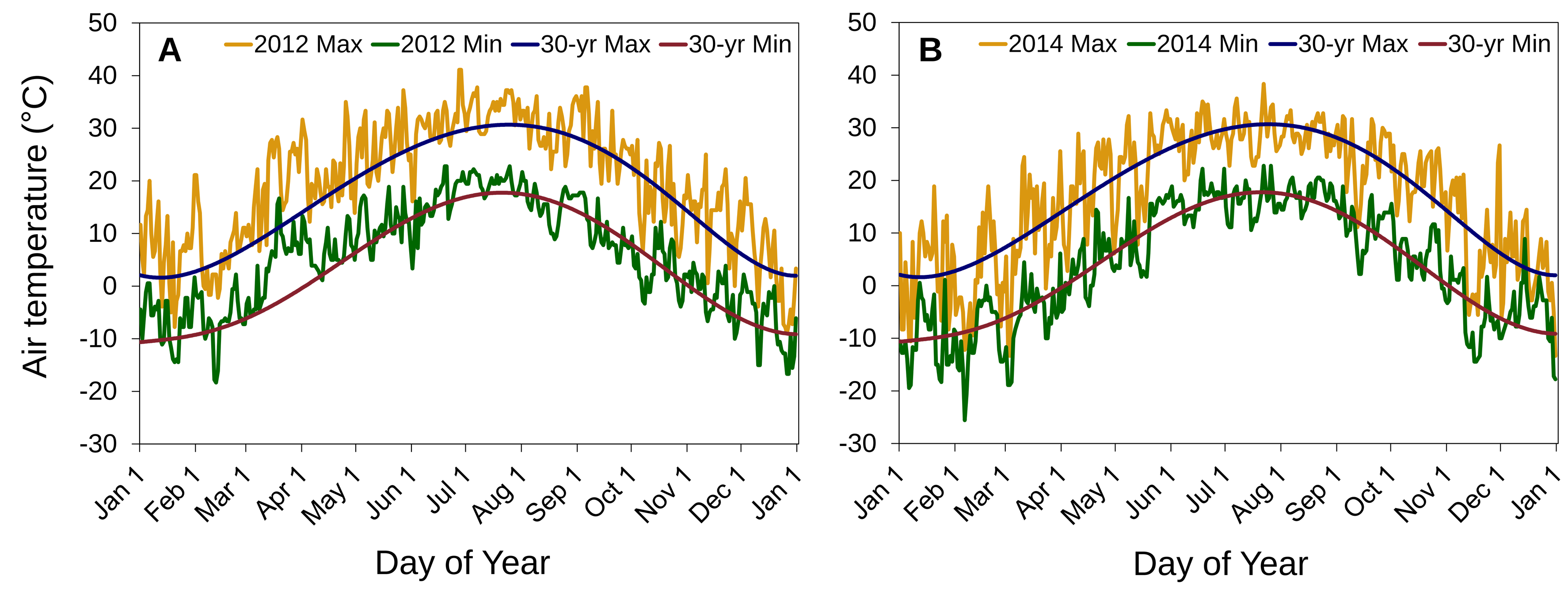


***Fig. 1**. Minimum and maximum air temperature in 2012 and 2014 and the 30-yr normal*

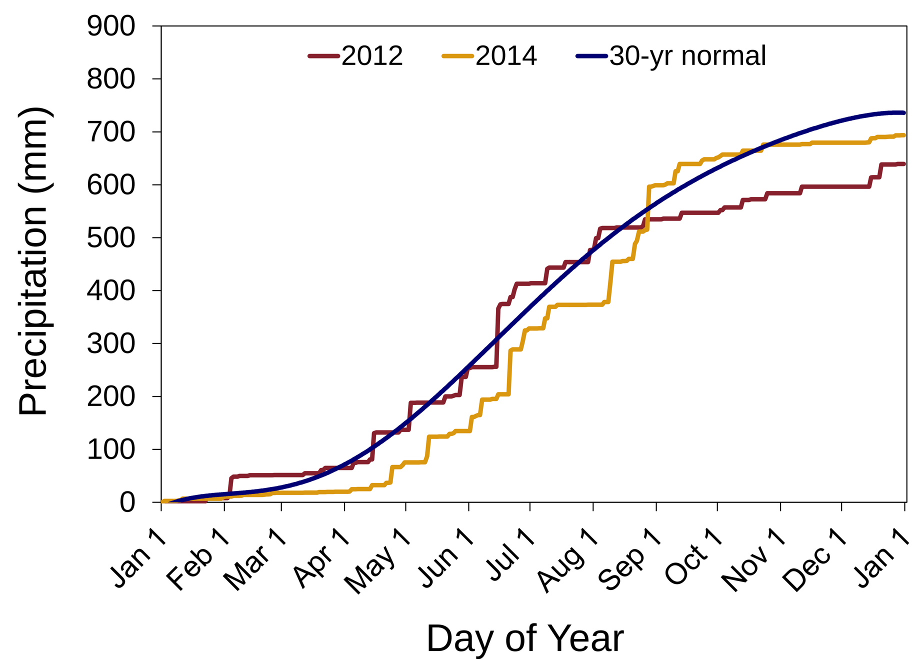


***Fig. 2**. Cumulative precipitation in 2012 and 2014 and the 30-yr normal*

***Table 1.** Significance of F-values for fixed sources of variation for corn grain yield, crop WUE, and irrigation WUE in 2012 and 2014.*

Fixed source of variation	2012 Grain yield	2012 Crop WUE	2012 Irrigation WUE	2014 Grain yield	2014 Crop WUE	2014 Irrigation WUE
			P > F			
Irrigation level (I)	***0.0062***	***0.0060***	***<0.0001***	0.2762	***0.0253***	***<0.0001***
Cover crop (C)	0.9050	0.4865	0.7127	0.3969	0.2301	0.2268
Residue mgt.(R)	***0.0003***	***0.0424***	***0.0003***	***0.0458***	***0.0189***	0.1762
I × C	0.2260	0.8269	0.2696	0.5333	***0.0295***	0.3265
I × R	***0.0474***	0.3496	***0.0132***	***0.0089***	***0.0468***	***0.0288***
R × C	0.7860	0.3032	0.6219	0.4776	0.9021	0.3297
I × R × C	0.2329	0.2258	0.2610	0.2763	0.7147	0.2085

***Fig. 3**. Corn stover was swathed and baled after grain harvest.*

***Fig. 4**. Watermark sensor installation after fertilizer N application.*

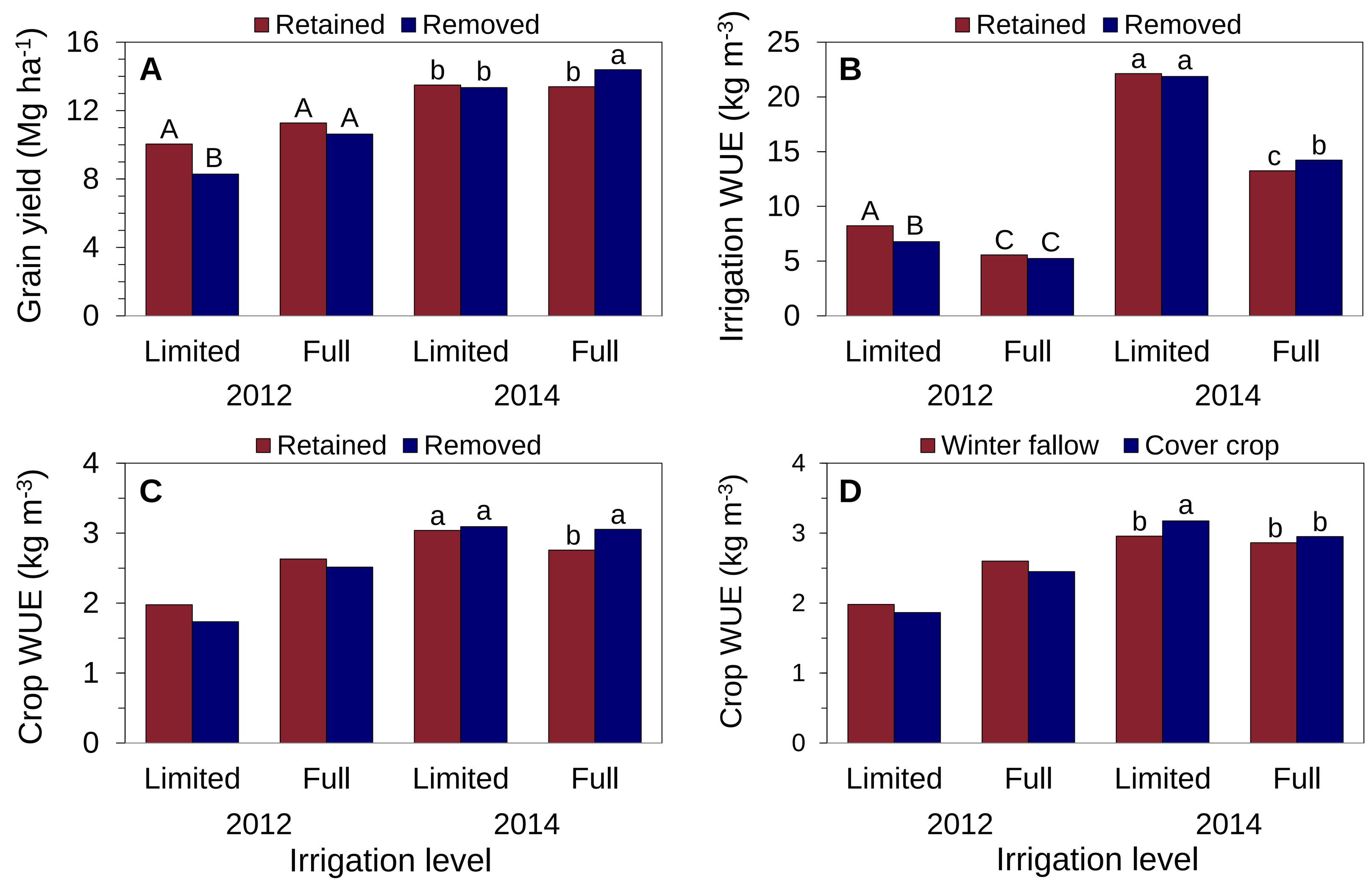
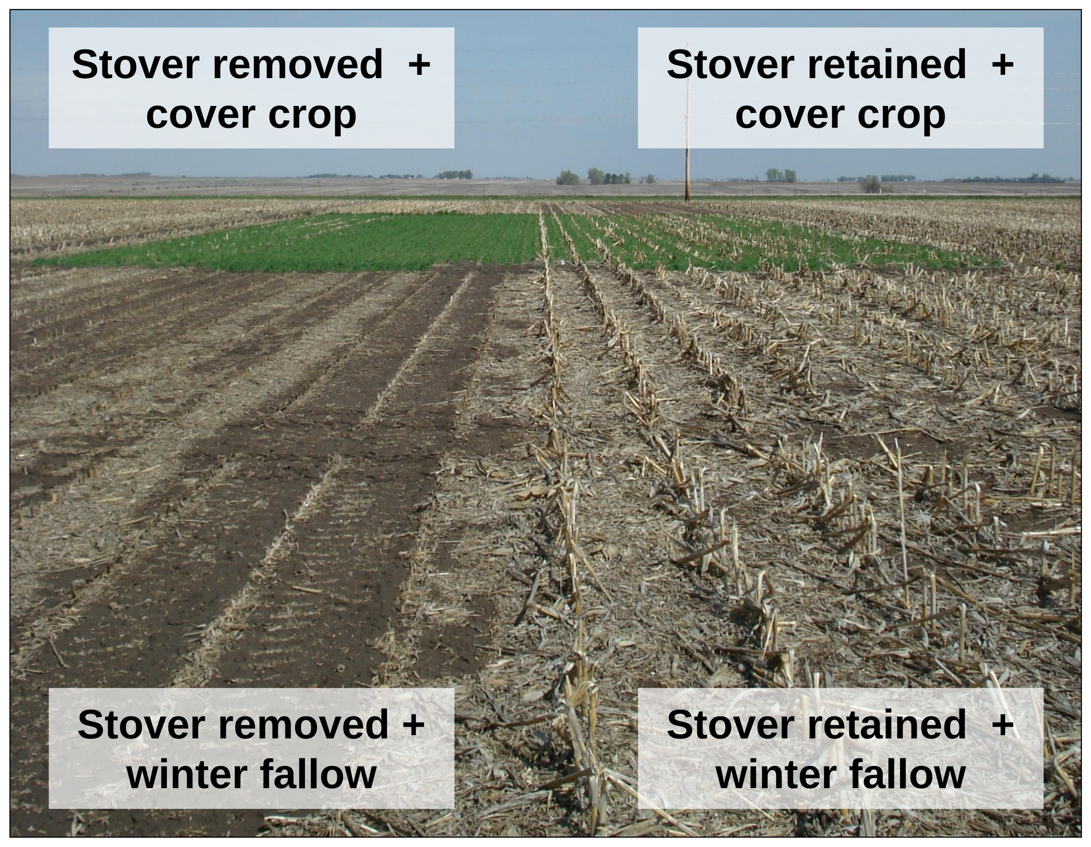


***Fig. 5**. Grain yield, irrigation WUE, and crop WUE response to irrigation and stover management and cover crop and irrigation management (lower right) in 2012 and 2014. Uppercase letters denote differences among irrigation × stover management treatments in 2012. Lowercase letters denote differences in 2014.*



Soil coverage in various stover management × cover crop treatments on April 4, 2012.

Results

2012

- Grain yield was affected by the irrigation × stover management interaction (Table 1). Stover removal reduced grain yield by 11% with limited irrigation (Fig. 5A). No reduction occurred with full irrigation. Cover crop did not affect grain yield.
- IWUE increased by 32 and 23% under limited irrigation compared with full irrigation when stover was retained and removed, respectively (Fig. 5B). Stover removal reduced IWUE by 18% under limited irrigation.
- CWUE was 28% less with limited irrigation (Fig. 5C). Stover removal reduced CWUE by 8%, across irrigation levels. Cover crop addition did not affect CWUE (Table 1).

2014

- When early-season air temperature was below average (Fig. 1B), grain yield with stover removal under full irrigation was ≥7% greater than all other treatments (Fig. 5A). Cover crop inclusion did not influence grain yield (Table 1).
- IWUE improved with stover removal under full irrigation by 7%, but did not have an effect under limited irrigation (Fig. 5B).
- Stover retention under full irrigation reduced CWUE by ≥9% (Fig. 5C). No differences existed among the other treatments ($P \leq 0.05$).
- Cover crops improved CWUE under limited irrigation by 7% under limited irrigation, but had no influence under full irrigation (Fig. 5D).

Summary

- Seasonal conditions between years affected the response of corn grain yield and water use to stover management, cover crops, and irrigation.
- Grain yield and CWUE reductions with stover removal under limited irrigation in 2012 illustrates the importance of stover retention in years when ET potential is high.
- The lack of cover crop effect on grain yield and nearly all WUE measurements suggests that its inclusion in continuous corn rotations may not adversely affect subsequent corn grain yield and water utilization under limited and full irrigation.
- For information on response of seasonal soil water availability to stover removal and cover crop inclusion, see Poster #1304 (423-4, Jin et al.)