Effect of rye cover crop on soil water dynamics during spring rainfall events for a corn-soybean rotation in Iowa

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INTRODUCTION

Cover crops can affect the following components of the hydrological system, and, therefore, soil water (Dabney 1998, Unger and Vigil 1998):

1. Amount of precipitation in field/Trapping snow
2. Evaporation and transpiration
3. Runoff
4. Infiltration
5. Soil structure and water holding capacity
6. Soil temperatures; freeze and thaw cycles
7. Subsurface drainage
8. Partitioning of soil water inputs

Many studies have investigated how different cover crops and vegetative covers affect soil water content and soil water storage over growing seasons and at longer time scales, but the ability to continuously monitor soil water through new technology provides more opportunities to understand the mechanisms controlling soil water under different land covers.

Objective: The objective of this research is to determine how a rye cover crop and rainfall characteristics affect infiltration and soil water redistribution in a corn-soybean rotation.

MATERIALS & METHODS

Research Sites:

- ADW (northwest Iowa)
- ISUAG (central Iowa)

Study period: March 1 – May 9 2012

Treatments (all in corn-soybean rotation):

1. Corn (C)
2. Corn with rye cover crop (rC)
3. Soybean (S)
4. Soybean with rye cover crop (rS)

Site management:

Management	Site: ADW	Site: ISUAG
Rye seeding	12 Oct 2011	3 Oct 2011
Termination of rye followed by corn	12 Apr 2012	6 Apr 2012
Termination of rye followed by soybean	9 May 2012	11 May 2012

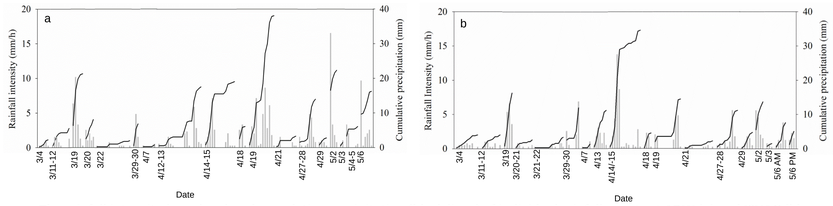
Soil water content measurements:

- Decagon Em50 DataLogger – 1 hr intervals, 5 min intervals
- Five soil sensors: 10, 20, 40, 60, 100 cm

RESULTS & DISCUSSION

Air temperature and precipitation normals vs. observed weather at ADW and ISUAG sites during the study period. Pocahontas is 19 km west of ADW, and AMES-8-WSW is 5 km northwest of ISUAG.

	Max. Temp. (°C)	Min. Temp. (°C)	Daily Avg. Temp. (°C)	Precip. (mm)	Max. Temp. (°C)	Min. Temp. (°C)	Daily Avg. Temp. (°C)	Precip. (mm)
Pocahontas Normal					**AMES-8-WSW Normal**			
March	6.2	-4.8	0.7	55.9	8.2	-2.6	2.8	52.1
April	14.9	1.8	8.3	78.5	16.4	3.4	9.9	88.9
May 1-9	20.0	6.1	13.0	27.2	20.6	7.7	14.1	29.7
Total				161.5				170.7
ADW 2012					**ISUAG 2012**			
March	16.5	3.1	9.4	52.8	17.4	4.8	11.0	43.4
April	18.0	4.3	10.8	102.6	17.9	5.8	11.8	84.3
May 1-9	23.8	12.7	17.3	46.7	24.1	13.4	18.4	27.9
Total				202.2				155.7



The rainfall intensity (grey bars) and cumulative precipitation (black lines) of individual rainfall events at ADW (a) and ISUAG (b). Rainfall events with a cumulative precipitation of less than 1 mm were not included.

Average rye yields for 2012 at ADW and ISUAG sites.

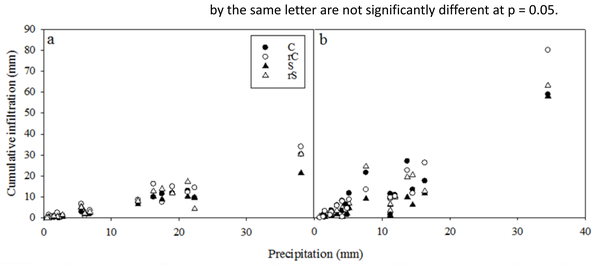
Site and treatment	Rye yield (kg/ha)
ADW rC	136
ADW rS	322
ISUAG rC	1039
ISUAG rS	2207

Differences between mean magnitude of volumetric soil water content increase following 21 rainfall events at ADW and 20 at ISUAG for 10 and 20 cm soil depths.

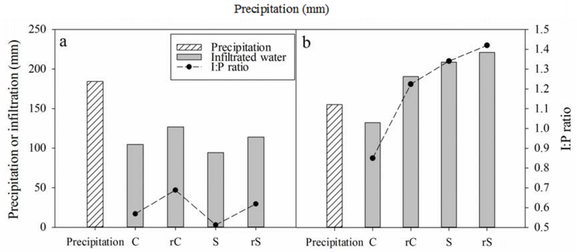
	Mean magnitude of volumetric soil water content increase following rainfall event (cm^3/cm^3)[a]			
	ADW		ISUAG	
Treatment	10 cm	20 cm	10 cm	20 cm
C	0.029a	0.016a	0.016b	0.010b
rC	0.026a	0.016a	0.026ab	0.018ab
S	0.018a	0.013a	0.025b	0.015ab
rS	0.026a	0.013a	0.052a	0.018a

[a] Means within depths at sites (i.e., within columns) followed by the same letter are not significantly different at p = 0.05.

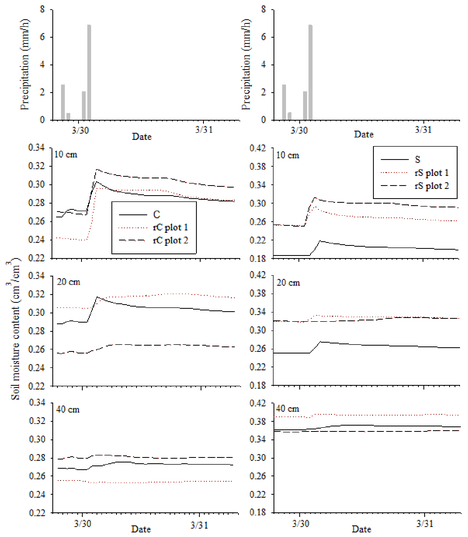
Cumulative infiltration during single rainfall events vs. precipitation of single rainfall events for ADW (a) and ISUAG (b).

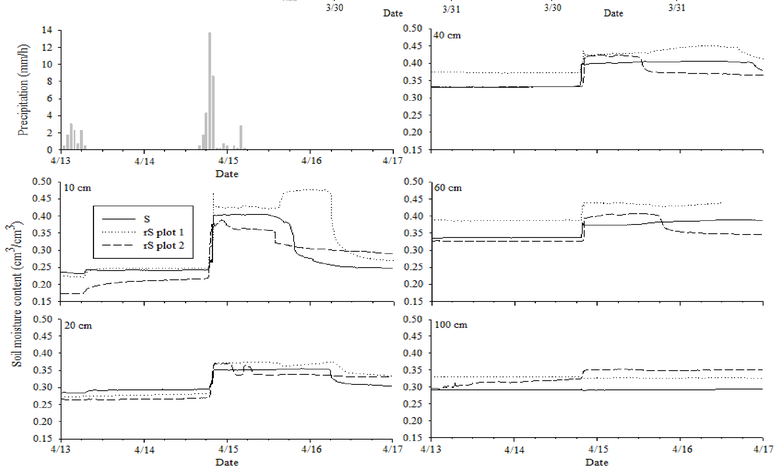


Cumulative precipitation and infiltration over entire study period at ADW (a) and ISUAG (b). I:P is infiltration to precipitation ratio. At ADW, precipitation (totaling 10.2 mm) and infiltration for rainfall events on 3/20 and 3/22 are omitted due to removal of sensors for field management.



Hourly rainfall intensity and volumetric soil moisture content of soils at ISUAG in plots without and with rye for the 3/29-30 rainfall event (preceding corn on the left, and preceding soybean on the right). Soil water content measurements were taken at 1 hr intervals.





Hourly rainfall intensity and volumetric soil water content of soils at ISUAG in plots without and with rye, preceding soybeans. Soil water content measurements were taken at 5 min intervals. Data is absent from last hours of 4/16 from rS plot 1 at 60 cm depth because of sensor malfunction.

CONCLUSIONS

- ADW – no significant differences in soil water content increase in upper soil layers or in infiltration
- ISUAG – significantly larger soil water content increase in top layers found in plots with rye that would be planted to soybean, but no significant difference in infiltration – modified soil water holding capacity in top soil layers, possibly due to increased transpiration, increased soil fauna activity, or modified soil (Dabney 1998, Unger and Vigil 1998)
- Varying soil moisture redistribution patterns with different types of rainfall events at ISUAG

ACKNOWLEDGEMENTS
Thanks to Xiaobo Zhou for help managing soil moisture data.

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This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190 "Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems"
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