Supplementary Material for 'Winter Cover Cropping Effects on Soil Water-Holding Capacity Vary by Site'

Nichols et al. 2021

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Supplemental material S1. Map of sites

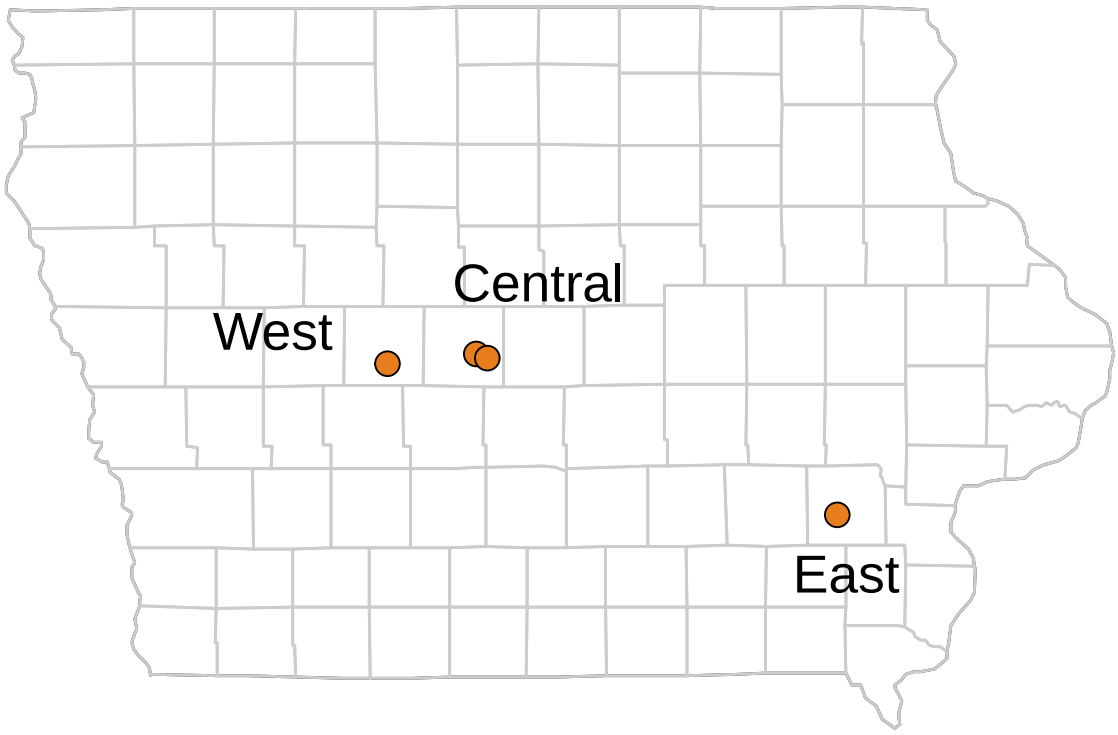

Figure 1: Map of site locations in Iowa

Supplemental material S2. General Site Management Summary

Table 1: General Site Description

Site Description	General Location	Treatment Description	Year of Initiation	Crop Planted in 2019	Number of Treatment Replicates	Sampled in 2019
Central Grain	Boyd Farm, Boone, field 44	maize/soybea grain rotation, with and without rye cover crop	2009	maize	5	Y
	Boyd Farm, Boone, field 42	maize/soybean grain rotation, with and without rye cover crop	2009	soy	5	Y
Central Silage	Boyd Farm, Boone, field 44	maize silage/soybea grain rotation, with and without rye cover crop	2002	maize silage	5	Y
	Boyd Farm, Boone, field 42	maize silage/soybean grain rotation, with and without rye cover crop	2002	soy	5	N
West	Jefferson, IA	maize/soybea grain rotation, with and without rye cover crop	2008	maize	4	Y
East	Washington, IA	maize/soybean grain rotation, with and without rye cover crop	2009	soybeans	4	Y

Table 2: 2018-2019 Herbicide Use

Site Description	Herbicides Used in 2018 Growing Season	Herbicdes Used in Fall 2018	Herbicides Used in Spring 2019
Central Grain	glyphosate 1 week before soybean planting	none	glyphosate 1 week before maize planting; metalochlor, atrazine, and mesotrione at planting
Central Grain	glyphosate 1 week before maize planting; metalochlor, atrazine, and mesotrione at planting	none	glyphosate 1 week before soybean planting
Central Silage	glyphosate 1 week before soybean planting	none	glyphosate 1 week before maize planting; metalochlor, atrazine, and mesotrione at planting
Central Silage	glyphosate 1 week before maize planting; metalochlor, atrazine, and mesotrione at planting	none	glyphosate 1 week before soybean planting
West	glyphosate before planting; glyphosate and fluthiacet-methyl at planting	none	glyphosate before planting; glyphosate and fluthiacet-methyl at planting
East	glyphosate and acetochlor before planting (April 15), atrazine, acetochlor at planting (May 14); acetochlor and glyphosate after planting (June 15)	none	chlorimuron-ethyl, flumioxazin, pyroxasulfone, and glyphosate before planting, dicamba and acetochlor after planting

Table 3: General Management

Site Description	General Herbicide Regime	General Date of Cover Crop Termination	General Date of Crop Planting	Inorganic Fertilizer Used	Organic Fertilizer Used	Tillage Used
Central Grain	burndown, residual herbicide at maize planting	15-Apr	26-Apr	Y	NA	N
Central Grain	burndown, residual herbicide at maize planting	25-Apr	5-May	Y	NA	N
Central Silage	burndown, residual herbicide at maize planting	15-Apr	26-Apr	Y	NA	N
Central Silage	burndown, residual herbicide at maize planting	25-Apr	5-May	Y	NA	N
West	burndown, pre-emergent herbicide	1-May	10-May	Y	chicken or turkey manure	N
East	burndown, residual herbicide at planting, another application on maize at ~V6	1-May	5-May	Y	liquid swine, ~3000 gal/ac every other year to entire field	N

Cover crop biomass production over past 10 years of trials

Table 4: Historical cover crop biomass production (Mg/ha) by trial

trial	2010	2011	2012	2013	2014	2015	2016	2017	2019	2018
Central_grain	0.86	0.28	1.37	0.25	0.47	0.61	2.22	2.76	1.29	NA
Central_silage	1.59	1.72	3.32	1.26	0.91	1.76	4.23	2.21	2.05	NA
East_grain	2.11	1.46	0.00	0.92	0.00	0.36	0.51	7.30	0.30	0.19
West_grain	2.11	0.21	1.33	0.00	0.00	0.04	0.45	0.63	0.00	0.09

Supplemental material S3. Statistical summaries

Clay, silt, and sand components

Table 5: Statistical analysis of cover crop effect on clay

site_sys	respvar	cc	no	contrast	est_diff	diff_se	diff_pval
Central_grain	clay	27.740	28.000	cc - no	-0.260	0.186	0.164
Central_silage	clay	28.751	29.895	cc - no	-1.144	0.208	<0.001
East_grain	clay	31.730	34.606	cc - no	-2.876	0.208	<0.001
West_grain	clay	27.349	29.511	cc - no	-2.162	0.208	<0.001

Table 6: Statistical analysis of cover crop effect on silt

site_sys	respvar	cc	no	contrast	est_diff	diff_se	diff_pval
Central_grain	silt	39.772	40.399	cc - no	-0.627	0.206	0.003
Central_silage	silt	41.313	40.793	cc - no	0.520	0.230	0.025
East_grain	silt	55.552	55.557	cc - no	-0.005	0.230	0.983
West_grain	silt	41.896	44.728	cc - no	-2.831	0.230	<0.001

Table 7: Statistical analysis of cover crop effect on sand

site_sys	respvar	cc	no	contrast	est_diff	diff_se	diff_pval
Central_grain	sand	32.486	31.600	cc - no	0.886	0.299	0.003
Central_silage	sand	29.811	29.233	cc - no	0.578	0.335	0.085
East_grain	sand	12.715	9.837	cc - no	2.877	0.335	<0.001
West_grain	sand	30.506	25.610	cc - no	4.896	0.335	<0.001

Soil organic matter

Table 8: Statistical analysis of cover crop effect on organic matter, with and without sand covariate

cov	site_sys	respvar	cc	no	contrast	est_diff	diff_se	diff_pval
none	Central_grain	om	2.360	2.480	cc - no	-0.120	0.051	0.02
none	Central_silage	om	2.640	2.416	cc - no	0.224	0.057	<0.001
none	East_grain	om	3.575	3.675	cc - no	-0.100	0.057	0.082
none	West_grain	om	2.750	2.975	cc - no	-0.225	0.057	<0.001
sand	Central_grain	om	3.034	3.066	cc - no	-0.032	0.082	0.696
sand	Central_silage	om	3.049	2.772	cc - no	0.278	0.088	0.002
sand	East_grain	om	2.290	2.105	cc - no	0.185	0.093	0.048
sand	West_grain	om	3.228	2.968	cc - no	0.260	0.096	0.007

Soil bulk density

Table 9: Mean bulk density (g/cm3) by trial

site_name	sys_trt	crop_trt	cc_trt	bulkden_mean	bulkden_sd
Central	grain	soy	cc	1.42	0.08
Central	grain	soy	no	1.37	0.07
Central	silage	soy	cc	1.46	0.06
Central	silage	soy	no	1.44	0.07
East	grain	soy	cc	1.44	0.05
East	grain	soy	no	1.49	0.04
West	grain	corn	cc	1.57	0.14
West	grain	corn	no	1.47	0.21

Table 10: Statistical analysis of cover crop effect on bulk density, with and without sand covariate

cov	site_sys	respvar	cc	no	contrast	est_diff	diff_se	diff_pval
none	Central_grain	bd	1.422	1.374	cc - no	0.048	0.010	<0.001
none	Central_silage	bd	1.464	1.436	cc - no	0.028	0.011	0.012
none	East_grain	bd	1.437	1.488	cc - no	-0.050	0.011	<0.001
none	West_grain	bd	1.573	1.472	cc - no	0.101	0.011	<0.001
sand	Central_grain	bd	1.309	1.275	cc - no	0.033	0.013	0.011
sand	Central_silage	bd	1.395	1.386	cc - no	0.010	0.014	0.483
sand	East_grain	bd	1.653	1.752	cc - no	-0.098	0.015	<0.001
sand	West_grain	bd	1.493	1.473	cc - no	0.020	0.015	0.188

Soil moisture (%vol) at saturation

Table 11: Statistical analysis of cover crop effect on soil water at saturation, with and without sand covariate

cov	site_sys	term	contrast	estimate	std.error	df	statistic	adj.p.value	param
sand	Central_grain	cc_trt	cc effect	-0.013	0.008	26.000	-1.688	0.103	saturation
sand	Central_silage	cc_trt	cc effect	0.004	0.008	26.000	0.510	0.614	saturation
sand	East_grain	cc_trt	cc effect	0.011	0.009	26.000	1.271	0.215	saturation
sand	West_grain	cc_trt	cc effect	-0.007	0.009	26.000	-0.729	0.473	saturation
none	Central_grain	cc_trt	cc effect	-0.016	0.008	13.050	-1.959	0.072	saturation
none	Central_silage	cc_trt	cc effect	0.002	0.009	14.068	0.246	0.809	saturation
none	East_grain	cc_trt	cc effect	0.002	0.009	13.050	0.228	0.823	saturation
none	West_grain	cc_trt	cc effect	-0.022	0.009	13.050	-2.430	0.030	saturation

Soil moisture (%vol) at field capacity (-100 cm water)

Table 12: Statistical analysis of cover crop effect on soil water at field capacity, with and without sand covariate

cov	site_sys	term	contrast	estimate	std.error	df	statistic	adj.p.value	param
sand	Central_grain	cc_trt	cc effect	-0.002	0.006	26.000	-0.430	0.671	field capacity
sand	Central_silage	cc_trt	cc effect	0.012	0.006	26.000	2.041	0.052	field capacity
sand	East_grain	cc_trt	cc effect	-0.002	0.006	26.000	-0.353	0.727	field capacity
sand	West_grain	cc_trt	cc effect	0.012	0.007	26.000	1.835	0.078	field capacity
none	Central_grain	cc_trt	cc effect	-0.004	0.005	13.044	-0.800	0.438	field capacity
none	Central_silage	cc_trt	cc effect	0.012	0.006	14.005	2.242	0.042	field capacity
none	East_grain	cc_trt	cc effect	-0.007	0.006	13.044	-1.317	0.211	field capacity
none	West_grain	cc_trt	cc effect	0.003	0.006	13.044	0.597	0.561	field capacity

Fitted parameters a and n

Table 13: Table of 'a' Gardener parameter estimate

site_sys	cc_trt	rep	estimate	std.error
Central_grain	cc	1	0.043	0.010
		2	0.025	0.006
		3	0.015	0.012
		4	0.021	0.010
		5	0.002	0.001
	no	1	0.020	0.010
		2	0.025	0.009
		3	0.010	0.005
		4	0.013	0.007
		5	0.041	0.014
Central_silage	cc	1	0.028	0.014
		2	0.030	0.013
		3	0.011	0.008
		4	0.015	0.011
		5	0.044	0.013
	no	1	0.049	0.029
		2	0.046	0.014
		3	0.048	0.014
		4	0.016	0.007
East_grain	cc	1	0.100	0.027
		2	0.180	0.046
		3	0.054	0.022
		4	0.085	0.024
	no	1	0.088	0.022
		2	0.080	0.028
		3	0.073	0.026
		4	0.080	0.024
		5	0.092	0.029
West_grain	cc	1	0.007	0.008
		2	0.026	0.006
		3	0.039	0.016
		4	0.032	0.015
	no	1	0.013	0.013
		2	0.029	0.012
		3	0.051	0.017
		4	0.102	0.017

Table 14: Table of 'n' Gardener parameter estimate

site_sys	cc_trt	rep	estimate	std.error
Central_grain	cc	1	0.987	0.079
		2	1.099	0.073
		3	1.106	0.219
		4	1.086	0.141
		5	1.468	0.198
	no	1	0.999	0.154
		2	1.007	0.110
		3	1.291	0.139
		4	1.264	0.153
		5	0.949	0.112
Central_silage	cc	1	0.813	0.158
		2	0.850	0.137
		3	1.006	0.220
		4	1.173	0.212
		5	0.639	0.116
	no	1	0.923	0.197
		2	0.705	0.108
		3	0.614	0.121
		4	1.041	0.125
East_grain	cc	1	0.772	0.104
		2	0.817	0.115
		3	0.994	0.140
		4	0.740	0.105
	no	1	0.651	0.099
		2	0.973	0.133
		3	0.880	0.131
		4	0.880	0.110
		5	0.737	0.116
West_grain	cc	1	1.009	0.305
		2	0.834	0.071
		3	0.488	0.175
		4	0.997	0.145
	no	1	1.039	0.268
		2	0.970	0.133
		3	0.837	0.110
		4	0.743	0.064

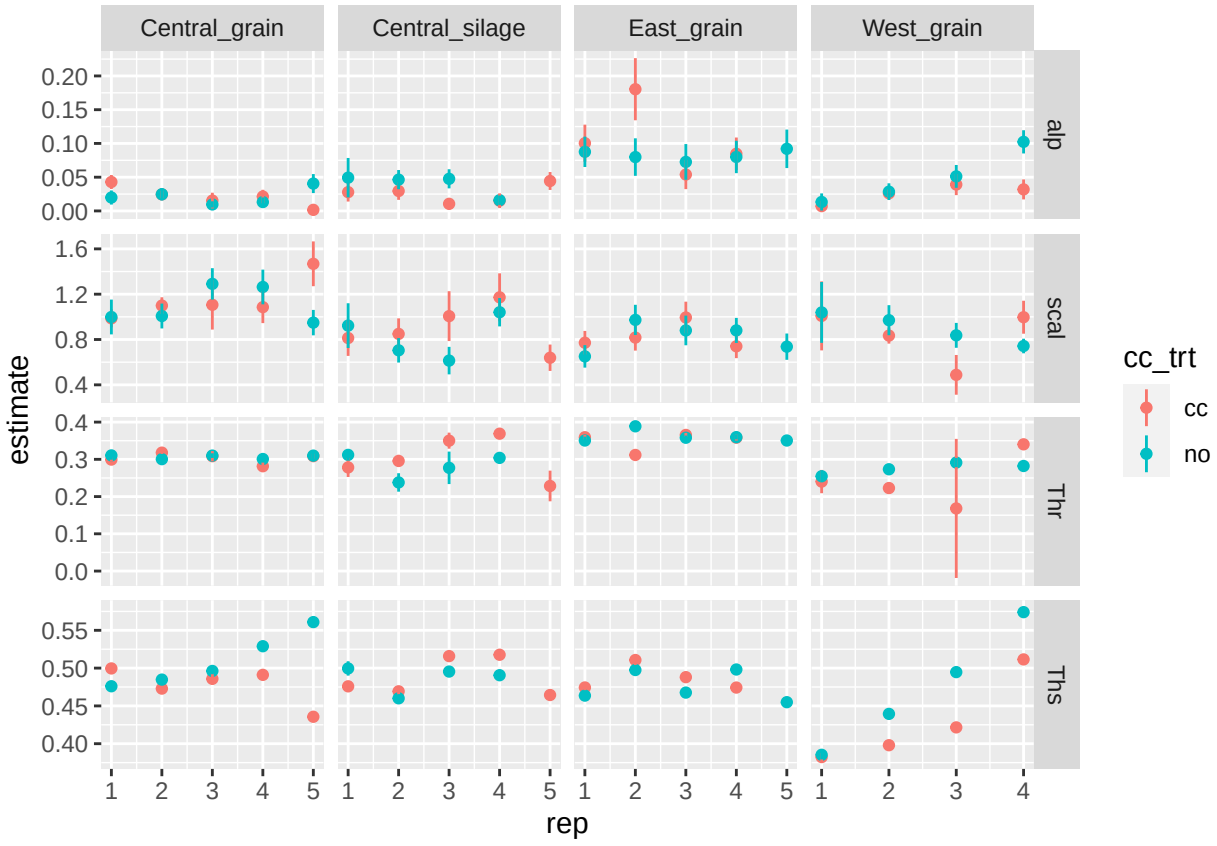

Figure 2: Non-linear model fitted parameters

Macro-pore percentages

Table 15: Table of macropores estimates and comparisons

site_sys	cc_trt	estimate	df	conf.low	conf.high	contrast	est_diff	pval_diff
Central-grain	cc	0.589	26.228	0.518	0.660	cc - no	-0.029	0.606
	no	0.618	26.228	0.547	0.689	cc - no		
Central-silage	cc	0.535	26.228	0.464	0.606	cc - no	-0.051	0.403
	no	0.586	26.989	0.506	0.665	cc - no		
East-grain	cc	0.731	26.989	0.651	0.811	cc - no	0.019	0.750
	no	0.712	26.228	0.641	0.783	cc - no		
West-grain	cc	0.478	26.989	0.399	0.558	cc - no	-0.127	0.053
	no	0.605	26.989	0.525	0.685	cc - no		

Supplemental material S4. Detailed soil texture results

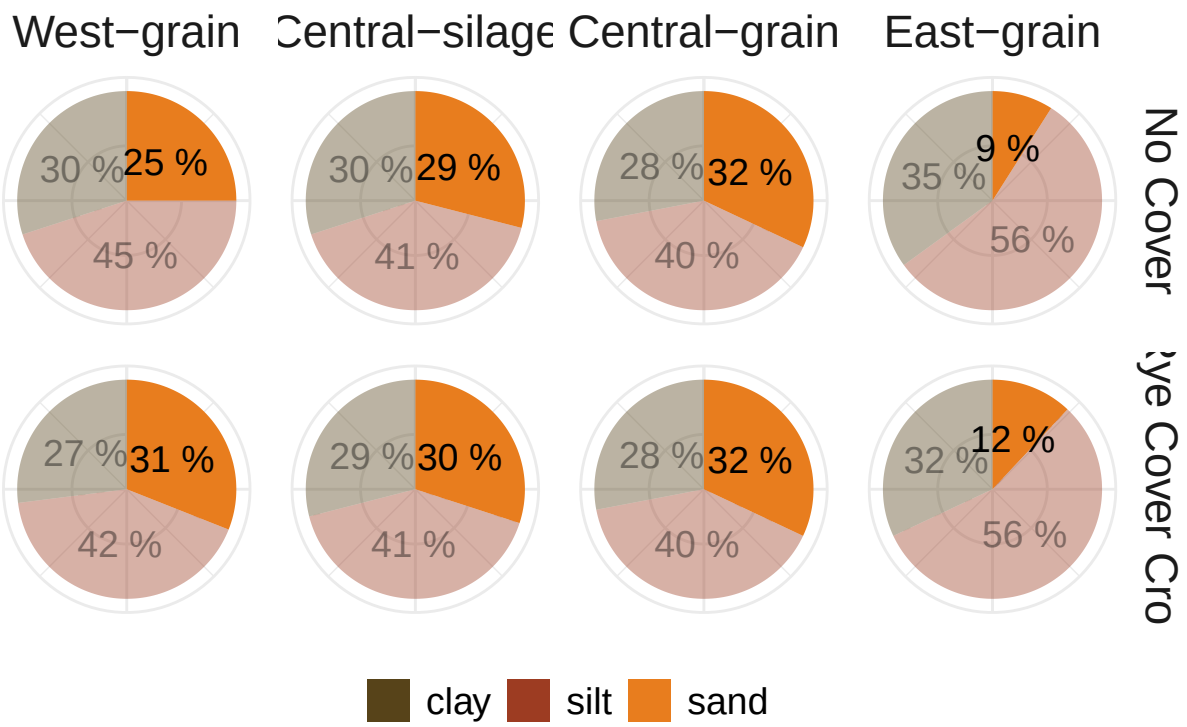

Figure 3: Soil texture components varied by trial and cover crop treatment, with the cover cropped plots having significantly more sand bolded orange color, and significantly less clay at the West-grain and East-grain trials both, commercial fields

Table with values:

Table 16: Table of values

site_sys	cc_trt	clay	sand	silt	tot	sig_sand_diff
Central-grain	cc	0.28	0.32	0.40	1	No
	no	0.28	0.32	0.40	1	
Central-silage	cc	0.29	0.30	0.41	1	
	no	0.30	0.29	0.41	1	
East-grain	cc	0.32	0.12	0.56	1	Yes
	no	0.35	0.09	0.56	1	
West-grain	cc	0.27	0.31	0.42	1	
	no	0.30	0.25	0.45	1	

Table 17: Table of sand statistics

site_sys	respvar	cc	no	contrast	est_diff	diff_se	pval
Central_grain	sand	32.486	31.600	cc - no	0.886	0.299	0.003
Central_silage	sand	29.811	29.233	cc - no	0.578	0.335	0.085
East_grain	sand	12.715	9.837	cc - no	2.877	0.335	<0.001
West_grain	sand	30.506	25.610	cc - no	4.896	0.335	<0.001