Supplementary Material for 'Effects of long-term use of cover crops on weed seedbanks'

Nichols et al. 2020

7/15/2020

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

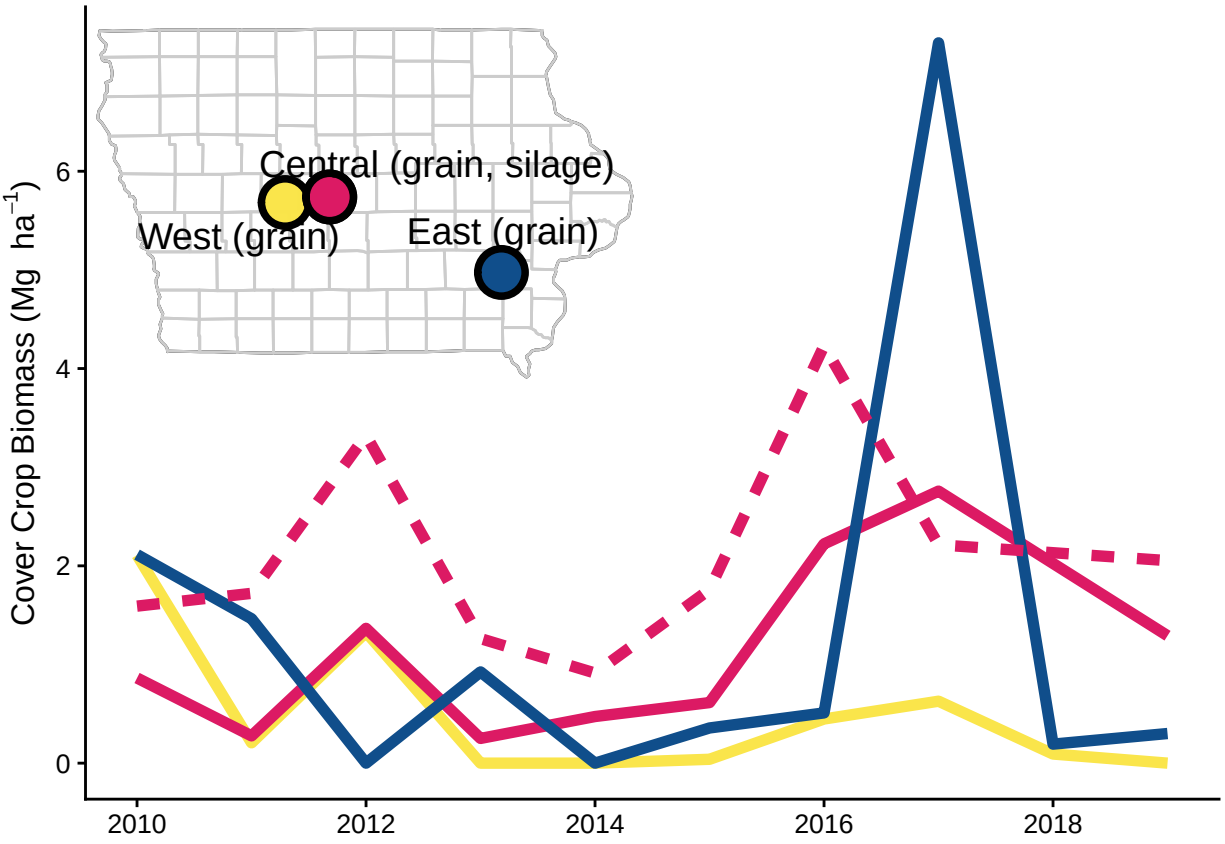


Figure 1: Winter rye cover crop biomass production at each trial (inset map, more information in Table 1) from 2010-2019 with solid lines representing grain-based maize (Zea mays)-soybean (Glycine max) systems and the dashed line the silage-based system.

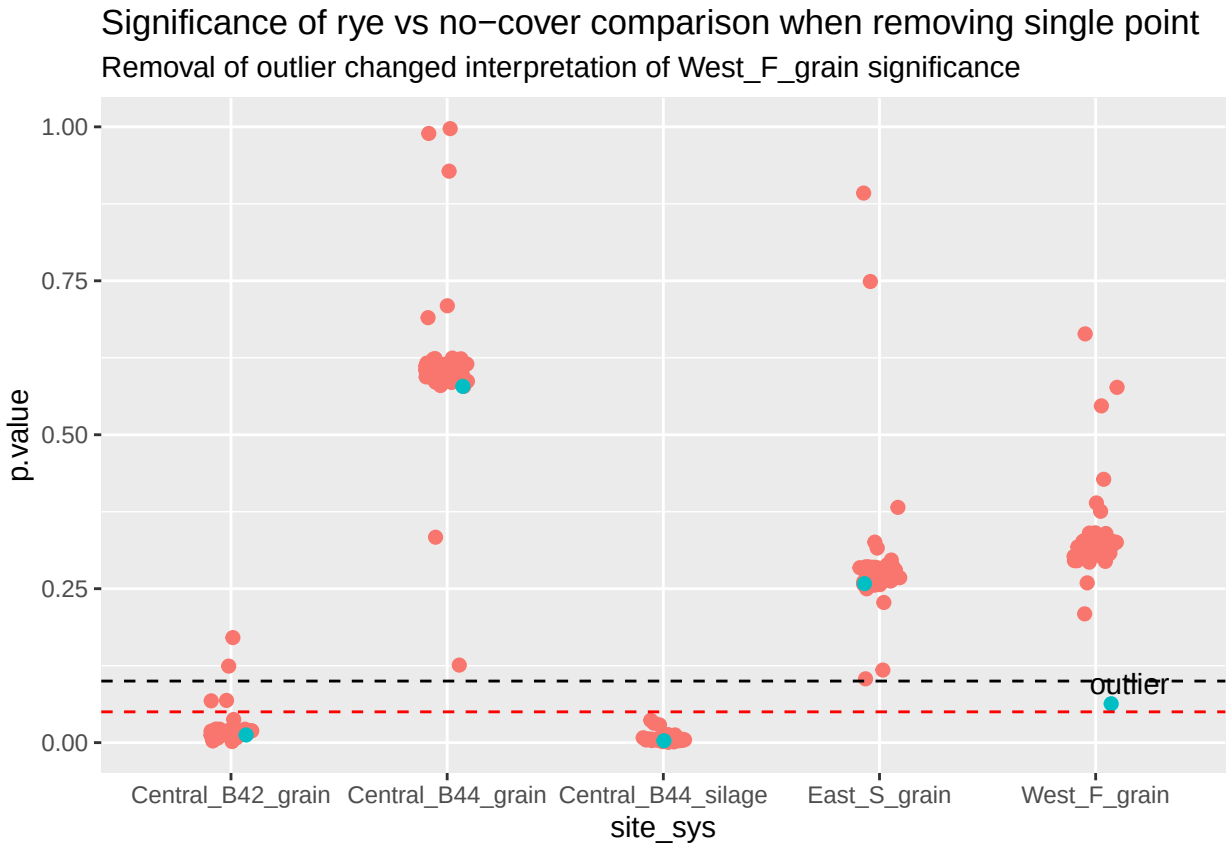
Field wet soil amounts

Table 4: Wet Soil Weights Immediately After Sampling

site	cc_trt	rep	soilwt_g	notes
BC	no	1	6718.3	sampled 4/8, 12-6pm
	rye	1	6936.2	sampled 4/8, 12-6pm
BC	no	2	6838.6	sampled 4/8, 12-6pm
	rye	2	5965.2	sampled 4/8, 12-6pm
BC	no	3	6260.4	sampled 4/8, 12-6pm
	rye	3	6136.0	sampled 4/8, 12-6pm
BC	no	4	5554.9	sampled 4/9
	rye	4	6312.7	sampled 4/9
BC	no	5	5866.2	sampled 4/9
	rye	5	5981.1	sampled 4/9
Bcsil	rye	1	6340.0	sampled 4/16, 2-6pm
	no	1	5800.0	sampled 4/16, 2-6pm
Bcsil	rye	2	5990.0	sampled 4/16, 2-6pm
	no	2	6100.0	sampled 4/16, 2-6pm
Bcsil	no	3	6245.5	sampled 4/8
	rye	3	6160.2	sampled 4/8
Bcsil	no	4	6240.2	sampled 4/8
	rye	4	6007.5	sampled 4/8
Bcsil	no	5	6682.9	sampled 4/8
	rye	5	6045.7	sampled 4/8
BS	rye	1	6068.7	sampled 4/9
	no	2	6240.3	sampled 4/9
BS	rye	2	5950.5	sampled 4/9
	no	3	5885.7	sampled 4/9
BS	rye	3	5734.1	sampled 4/9
	no	4	6213.3	sampled 4/9
BS	rye	4	5968.2	sampled 4/9
	no	5	6175.8	sampled 4/9
BS	rye	5	6050.4	sampled 4/9
	no	1	5349.6	sampled 4/6, 8-5pm
East	rye	1	5460.6	sampled 4/6, 8-5pm
	no	2	5235.5	sampled 4/6, 8-5pm
East	rye	2	5055.2	sampled 4/6, 8-5pm
	no	3	5211.1	sampled 4/6, 8-5pm
East	rye	3	4991.7	sampled 4/6, 8-5pm
	no	4	5401.6	sampled 4/6, 8-5pm
East	rye	4	5163.9	sampled 4/6, 8-5pm
	no	1	6314.0	sampled 4/17, 9-2pm
West	rye	1	6401.0	sampled 4/17, 9-2pm
	no	2	5841.0	sampled 4/17, 9-2pm
West	rye	2	5543.0	sampled 4/17, 9-2pm
	no	3	5698.0	sampled 4/17, 9-2pm
West	rye	3	5947.0	sampled 4/17, 9-2pm
	no	4	6057.0	sampled 4/17, 9-2pm
West	rye	4	5989.0	sampled 4/17, 9-2pm

Statistical Results

Linear models on seedbank density



Values are presented for the models run with the full dataset (XX_full) and with the outlier removed (XX_out-rm)

Table 5: Contrasts using full dataset (full) and dataset with outlier removed (out-rm)

model	site_sys	level1	level2	estimate	std.error	z.ratio	p.value
pois_out-rm	Central_B42_grain	no	rye	-0.85	0.34	-2.50	0.01
	Central_B44_grain	no	rye	0.18	0.33	0.56	0.58
pois_out-rm	Central_B44_silage	no	rye	0.95	0.32	2.96	0.00
	East_S_grain	no	rye	0.42	0.38	1.13	0.26
pois_out-rm	West_F_grain	no	rye	0.71	0.38	1.86	0.06
	Central_B42_grain	no	rye	-0.85	0.35	-2.39	0.02
pois_full	Central_B44_grain	no	rye	0.18	0.34	0.52	0.60
pois_full	Central_B44_silage	no	rye	0.95	0.33	2.83	0.00
pois_full	East_S_grain	no	rye	0.43	0.39	1.09	0.28
	West_F_grain	no	rye	0.36	0.36	1.00	0.32
binom_out-rm	Central_B42_grain	no	rye	-0.97	0.34	-2.88	0.00
	Central_B44_grain	no	rye	0.24	0.32	0.75	0.45
binom_out-rm	Central_B44_silage	no	rye	1.01	0.31	3.24	0.00
	East_S_grain	no	rye	0.44	0.36	1.22	0.22
binom_out-rm	West_F_grain	no	rye	0.71	0.37	1.89	0.06
	Central_B42_grain	no	rye	-0.98	0.36	-2.69	0.01
binom_full	Central_B44_grain	no	rye	0.24	0.35	0.70	0.49
binom_full	Central_B44_silage	no	rye	1.01	0.34	3.00	0.00
binom_full	East_S_grain	no	rye	0.44	0.39	1.14	0.26
	West_F_grain	no	rye	0.28	0.37	0.74	0.46

Table 6: Estimates using full dataset (full) and dataset with outlier removed (out-rm)

model	site_sys	cc_trt	estimate	std.error	asymp.LCL	asymp.UCL
pois_out-rm	Central_B42_grain	no	2.59	0.32	1.97	3.21
	Central_B42_grain	rye	3.44	0.31	2.84	4.05
pois_out-rm	Central_B44_grain	no	3.33	0.31	2.73	3.93
	Central_B44_grain	rye	3.15	0.31	2.55	3.75
pois_out-rm	Central_B44_silage	no	4.35	0.30	3.77	4.94
pois_out-rm	Central_B44_silage	rye	3.41	0.30	2.81	4.01
pois_out-rm	East_S_grain	no	3.33	0.34	2.65	4.00
	East_S_grain	rye	2.90	0.35	2.21	3.59
pois_out-rm	West_F_grain	no	6.02	0.33	5.38	6.66
	West_F_grain	rye	5.31	0.37	4.59	6.04
pois_full	Central_B42_grain	no	2.59	0.33	1.94	3.24
	Central_B42_grain	rye	3.44	0.32	2.81	4.06
pois_full	Central_B44_grain	no	3.33	0.32	2.70	3.95
	Central_B44_grain	rye	3.15	0.32	2.52	3.77
pois_full	Central_B44_silage	no	4.35	0.31	3.74	4.96
pois_full	Central_B44_silage	rye	3.41	0.32	2.79	4.03
pois_full	East_S_grain	no	3.32	0.36	2.62	4.02
	East_S_grain	rye	2.90	0.36	2.18	3.61
pois_full	West_F_grain	no	6.02	0.34	5.35	6.69
	West_F_grain	rye	5.66	0.34	4.99	6.33
binom_out-rm	Central_B42_grain	no	2.65	0.31	2.04	3.25
	Central_B42_grain	rye	3.62	0.30	3.02	4.21
binom_out-rm	Central_B44_grain	no	3.45	0.29	2.88	4.03
	Central_B44_grain	rye	3.21	0.30	2.63	3.79
binom_out-rm	Central_B44_silage	no	4.49	0.29	3.92	5.05
binom_out-rm	Central_B44_silage	rye	3.47	0.29	2.90	4.05
binom_out-rm	East_S_grain	no	3.42	0.34	2.76	4.08
	East_S_grain	rye	2.98	0.34	2.31	3.64
binom_out-rm	West_F_grain	no	6.03	0.32	5.41	6.64
	West_F_grain	rye	5.32	0.36	4.62	6.02
binom_full	Central_B42_grain	no	2.65	0.32	2.01	3.28
	Central_B42_grain	rye	3.62	0.32	2.99	4.25
binom_full	Central_B44_grain	no	3.45	0.31	2.84	4.06
	Central_B44_grain	rye	3.21	0.31	2.60	3.82
binom_full	Central_B44_silage	no	4.49	0.31	3.89	5.09
binom_full	Central_B44_silage	rye	3.47	0.31	2.87	4.08
binom_full	East_S_grain	no	3.42	0.36	2.73	4.12
	East_S_grain	rye	2.98	0.36	2.28	3.68
binom_full	West_F_grain	no	6.04	0.33	5.38	6.69
	West_F_grain	rye	5.76	0.34	5.09	6.43

Biomass metrics

Table 7: Cover crop biomass metrics, 10-year time frame

site_sys	nabove1	nabove2	ccbio_mean	ccbio_med	ccbio_var	ccbio_max	ccbio_stab	ccbio_2019
Boyd_grain	4	2	1.03	0.74	0.77	2.76	0.85	1.29
Boyd_silage	9	4	2.04	1.74	1.02	4.23	0.50	2.05
Funcke_grain	2	1	0.45	0.14	0.46	2.11	1.50	0.00
Stout_grain	3	2	1.32	0.43	4.89	7.30	1.68	0.30

Table 8: Cover crop biomass metrics, 5-year time frame

site_sys	nabove1	nabove2	ccbio_mean	ccbio_med	ccbio_var	ccbio_max	ccbio_stab	ccbio_2019
Boyd_grain	3	2	1.72	1.76	0.91	2.76	0.55	1.29
Boyd_silage	4	3	2.56	2.13	1.27	4.23	0.44	2.05
Funcke_grain	0	0	0.24	0.09	0.08	0.63	1.16	0.00
Stout_grain	1	1	1.73	0.36	9.71	7.30	1.80	0.30

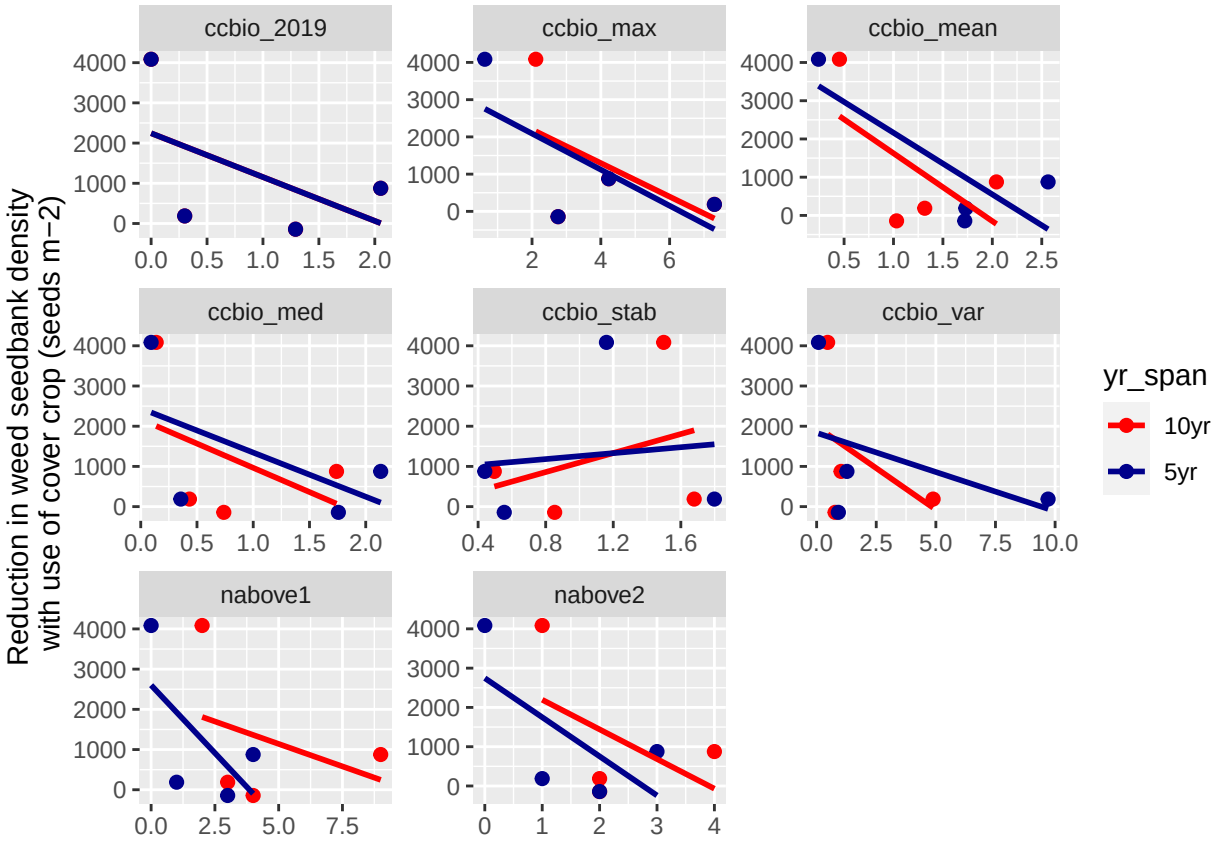


Figure 2: Absolute change in seedbank density vs. cover crop biomass metrics

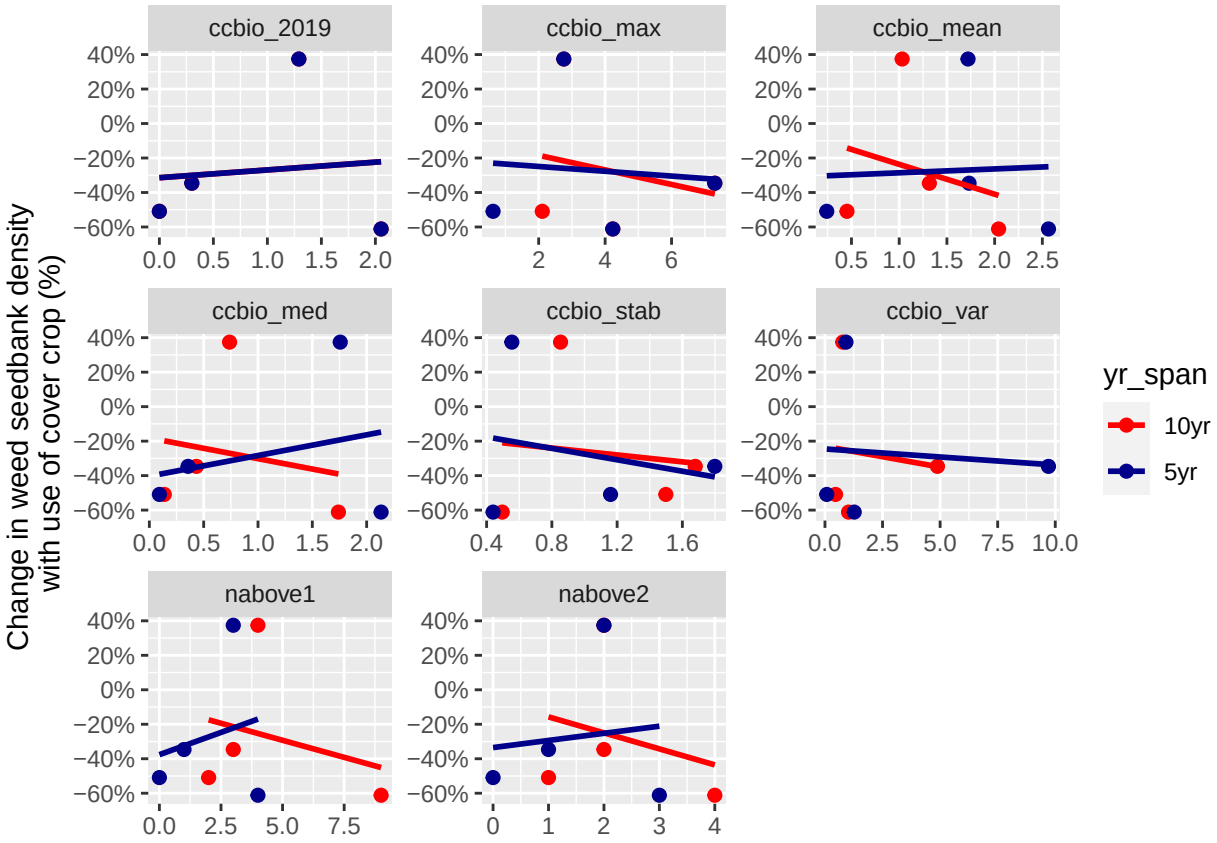


Figure 3: Relative change in seedbank density vs. cover crop biomass metrics