Supplementary Material for 'Long-term use of cover crops reduces 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	corn/soybean grain rotation, with and without rye cover crop	2009	corn	5	Y
	Boyd Farm, Boone, field 42	corn/soybean grain rotation, with and without rye cover crop	2009	soy	5	Y
Central Silage	Boyd Farm, Boone, field 44	corn silage/soybea grain rotation, with and without rye cover crop	2002	corn silage	5	Y
	Boyd Farm, Boone, field 42	corn silage/soybean grain rotation, with and without rye cover crop	2002	soy	5	N
West	Jefferson, IA	corn/soybean grain rotation, with and without rye cover crop	2008	corn	4	Y
East	Washington, IA	corn/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 corn planting, Lumax at planting
	glyphosate 1 week before corn planting, Lumax at planting	none	glyphosate 1 week before soybean planting
Central Silage	glyphosate 1 week before soybean planting	none	glyphosate 1 week before corn planting, Lumax at planting
	glyphosate 1 week before corn planting, Lumax at planting	none	glyphosate 1 week before soybean planting
West	Roundup and Cadet	none	Roundup and Cadet
East	April 15-Roundup Powermax 32 oz; April 15-Acetochlor ATZ 40 oz; May 14-Aatrex 9-0 1/2; May 14-Harness Max 40 oz; June 15-Warrant Ultra 50 oz; June 15-Roundup Powermax 22 oz;	none	3 oz Fierce XLT with 26-32 oz Roundup Powermax as burndown followed by a post emergence application of 22 oz Xtendimax plus 2 pt of Warrant

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 corn planting	15-Apr	26-Apr	Y	NA	N
	burndown, residual herbicide at corn planting	25-Apr	5-May	Y	NA	N
Central Silage	burndown, residual herbicide at corn planting	15-Apr	26-Apr	Y	NA	N
	burndown, residual herbicide at corn planting	25-Apr	5-May	Y	NA	N
West	burndown, pre-emergent herbicide	1-May	10-May	Y	chicken/turke manure	N
East	burndown, residual herbicide at planting, another application on corn at ~V6	1-May	5-May	Y	liquid swine, ~3000 gal/ac every other year to entire field	N

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
	no	2	6838.6	sampled 4/8, 12-6pm
	rye	2	5965.2	sampled 4/8, 12-6pm
	no	3	6260.4	sampled 4/8, 12-6pm
	rye	3	6136.0	sampled 4/8, 12-6pm
	no	4	5554.9	sampled 4/9
	rye	4	6312.7	sampled 4/9
	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
	rye	2	5990.0	sampled 4/16, 2-6pm
	no	2	6100.0	sampled 4/16, 2-6pm
	no	3	6245.5	sampled 4/8
	rye	3	6160.2	sampled 4/8
	no	4	6240.2	sampled 4/8
	rye	4	6007.5	sampled 4/8
	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
	rye	2	5950.5	sampled 4/9
	no	3	5885.7	sampled 4/9
	rye	3	5734.1	sampled 4/9
	no	4	6213.3	sampled 4/9
	rye	4	5968.2	sampled 4/9
	no	5	6175.8	sampled 4/9
	rye	5	6050.4	sampled 4/9
East	no	1	5349.6	sampled 4/6, 8-5pm
	rye	1	5460.6	sampled 4/6, 8-5pm
	no	2	5235.5	sampled 4/6, 8-5pm
	rye	2	5055.2	sampled 4/6, 8-5pm
	no	3	5211.1	sampled 4/6, 8-5pm
	rye	3	4991.7	sampled 4/6, 8-5pm
	no	4	5401.6	sampled 4/6, 8-5pm
	rye	4	5163.9	sampled 4/6, 8-5pm
West	no	1	6314.0	sampled 4/17, 9-2pm
	rye	1	6401.0	sampled 4/17, 9-2pm
	no	2	5841.0	sampled 4/17, 9-2pm
	rye	2	5543.0	sampled 4/17, 9-2pm
	no	3	5698.0	sampled 4/17, 9-2pm
	rye	3	5947.0	sampled 4/17, 9-2pm
	no	4	6057.0	sampled 4/17, 9-2pm
	rye	4	5989.0	sampled 4/17, 9-2pm

Statistical Results

Note: Boyd refers to the Central site, Stout to the East site, and Funcke to the West site

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	Boyd_grain	no	rye	-0.32	0.26	-1.22	0.22
	Boyd_silage	no	rye	0.95	0.35	2.66	0.01
	Funcke_grain	no	rye	0.71	0.42	1.68	0.09
	Stout_grain	no	rye	0.42	0.41	1.03	0.31
pois_full	Boyd_grain	no	rye	-0.32	0.27	-1.19	0.24
	Boyd_silage	no	rye	0.95	0.37	2.58	0.01
	Funcke_grain	no	rye	0.36	0.40	0.91	0.37
	Stout_grain	no	rye	0.43	0.43	1.00	0.32
binom_out-rm	Boyd_grain	no	rye	-0.33	0.26	-1.27	0.20
	Boyd_silage	no	rye	1.02	0.34	2.99	0.00
	Funcke_grain	no	rye	0.71	0.41	1.72	0.09
	Stout_grain	no	rye	0.45	0.40	1.12	0.26
binom_full	Boyd_grain	no	rye	-0.33	0.26	-1.23	0.22
	Boyd_silage	no	rye	1.03	0.35	2.92	0.00
	Funcke_grain	no	rye	0.28	0.39	0.71	0.48
	Stout_grain	no	rye	0.45	0.41	1.09	0.27

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	Boyd_grain	no	2.97	0.23	2.52	3.42
		rye	3.29	0.23	2.85	3.73
	Boyd_silage	no	4.30	0.30	3.72	4.88
		rye	3.35	0.30	2.76	3.95
	Funcke_grain	no	6.02	0.34	5.35	6.69
		rye	5.31	0.39	4.55	6.07
	Stout_grain	no	3.32	0.36	2.62	4.03
		rye	2.90	0.36	2.19	3.61
pois_full	Boyd_grain	no	2.97	0.24	2.50	3.43
		rye	3.29	0.23	2.83	3.74
	Boyd_silage	no	4.29	0.31	3.69	4.90
		rye	3.35	0.31	2.74	3.96
	Funcke_grain	no	6.02	0.35	5.33	6.71
		rye	5.66	0.36	4.97	6.36
	Stout_grain	no	3.32	0.37	2.60	4.05
		rye	2.90	0.38	2.16	3.63
binom_out-rm	Boyd_grain	no	3.11	0.23	2.67	3.55
		rye	3.44	0.23	3.00	3.88
	Boyd_silage	no	4.45	0.29	3.87	5.02
		rye	3.42	0.30	2.84	4.01
	Funcke_grain	no	6.03	0.33	5.37	6.68
		rye	5.32	0.38	4.58	6.06
	Stout_grain	no	3.43	0.36	2.73	4.13
		rye	2.98	0.36	2.28	3.69
binom_full	Boyd_grain	no	3.11	0.23	2.65	3.57
		rye	3.43	0.24	2.97	3.90
	Boyd_silage	no	4.44	0.30	3.85	5.04
		rye	3.42	0.31	2.81	4.02
	Funcke_grain	no	6.04	0.35	5.35	6.72
		rye	5.76	0.36	5.06	6.46
	Stout_grain	no	3.42	0.37	2.69	4.15
		rye	2.98	0.37	2.24	3.71

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

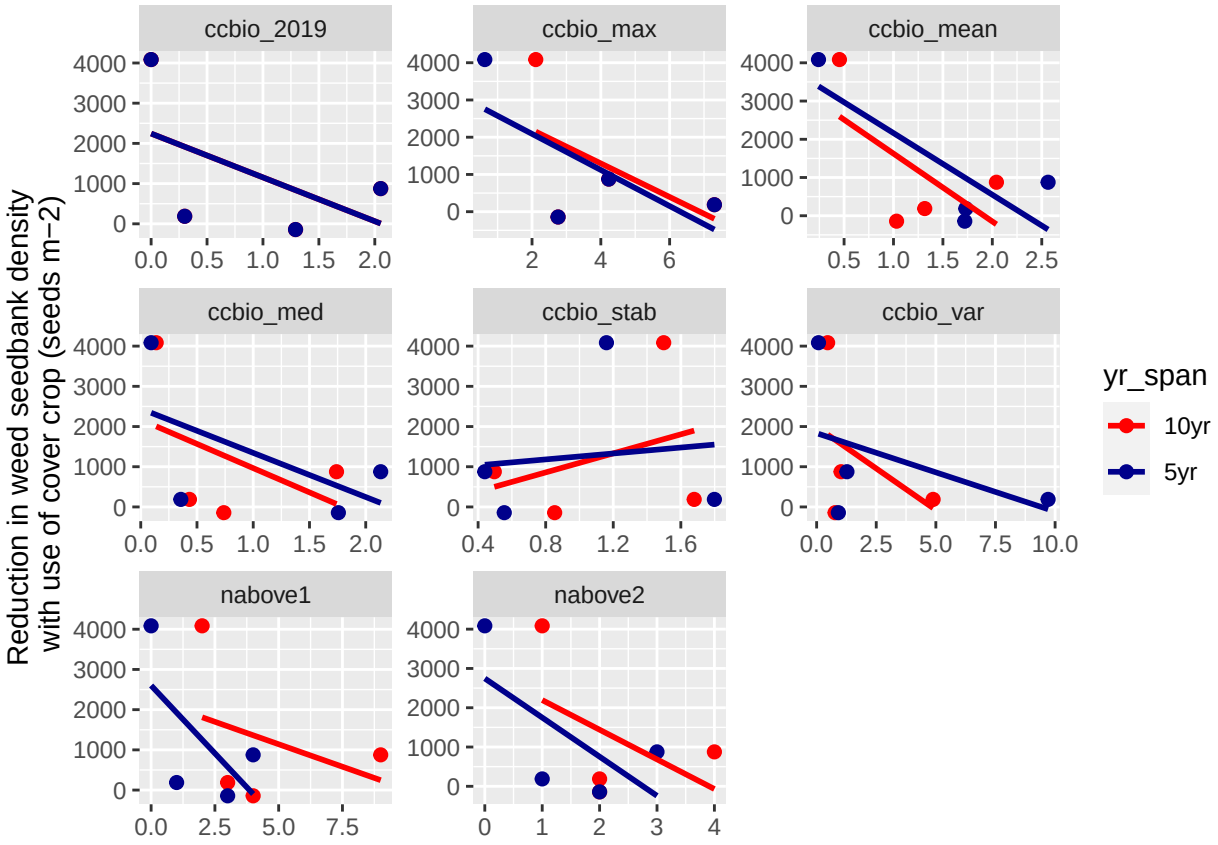

Figure 1: Absolute Change in Seedbank Density vs. Cover Crop Biomass Metrics

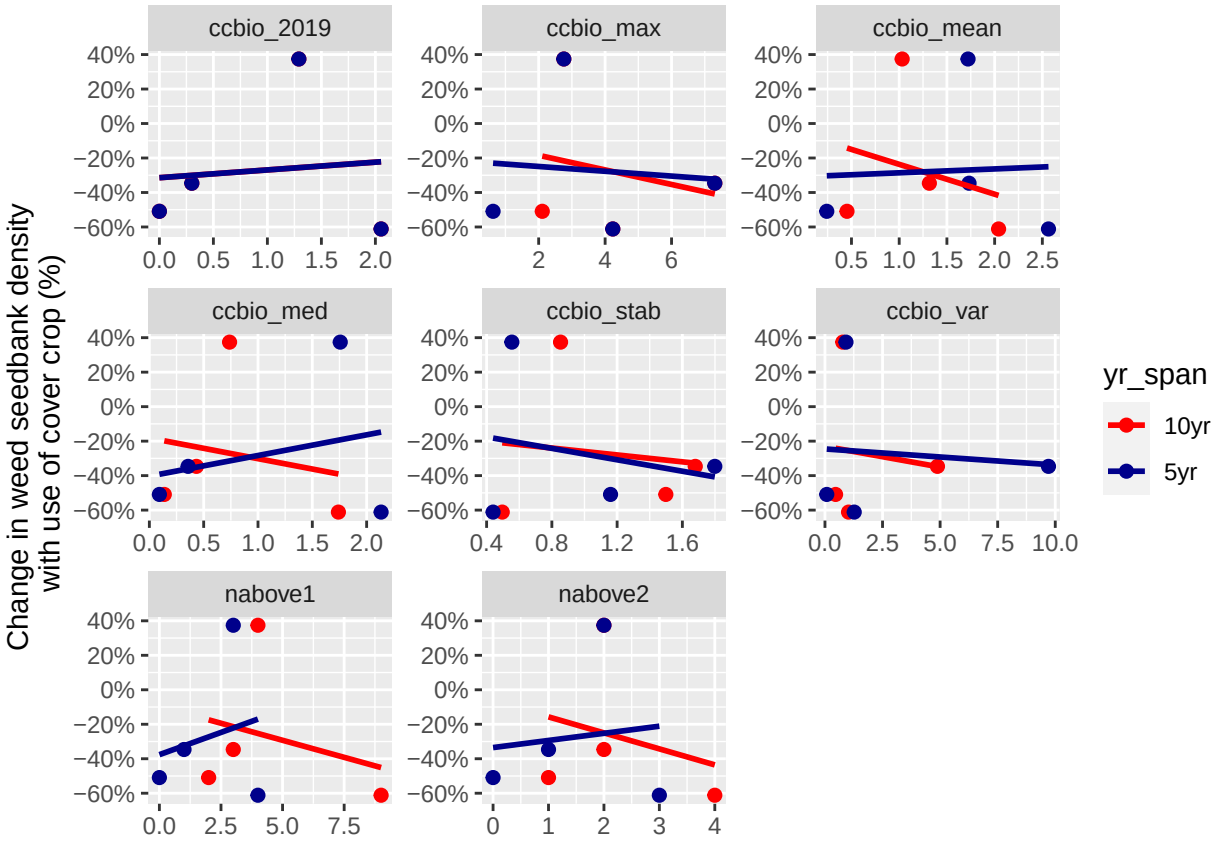

Figure 2: Relative Change in Seedbank Density vs. Cover Crop Biomass Metrics

Manuscript figures with full datasets

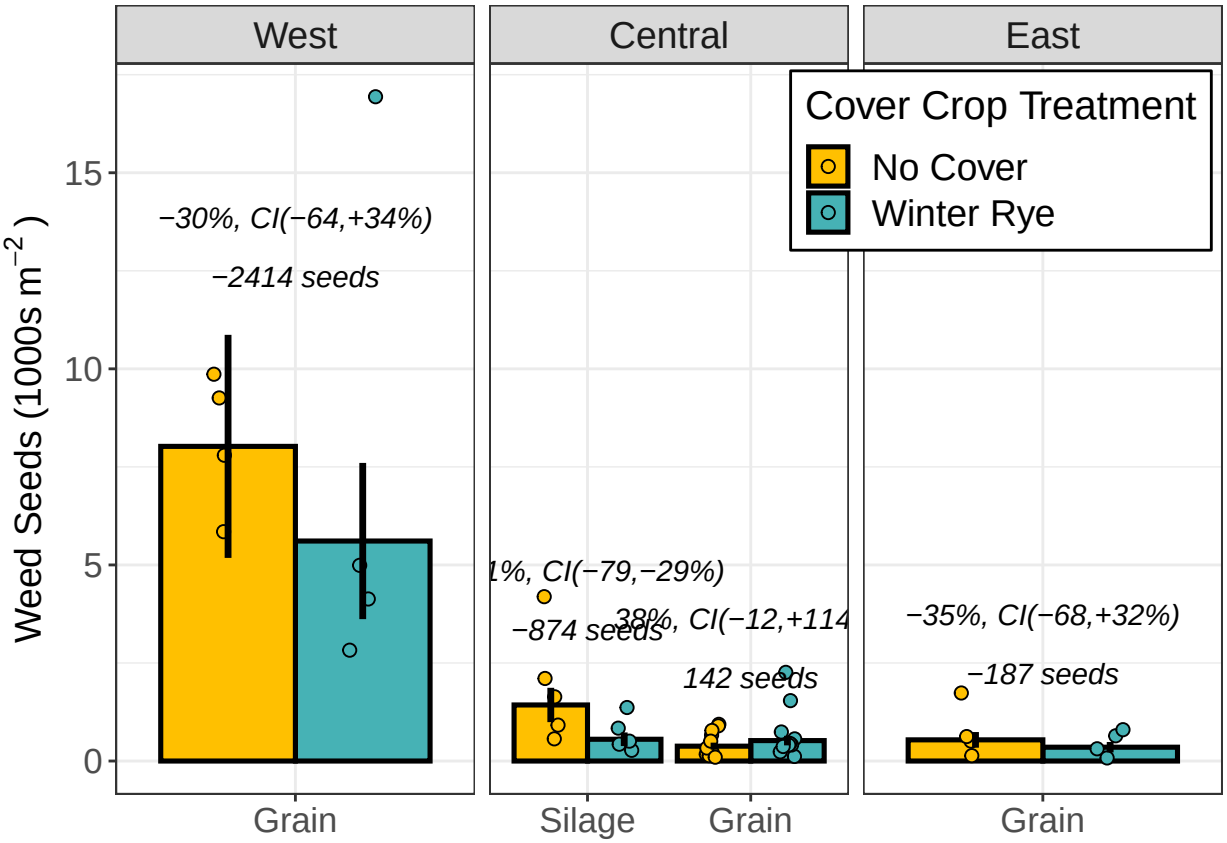

Figure 3: Manuscript Fig. 2 using full dataset

Figure 4: Manuscript fig. 4 using full dataset

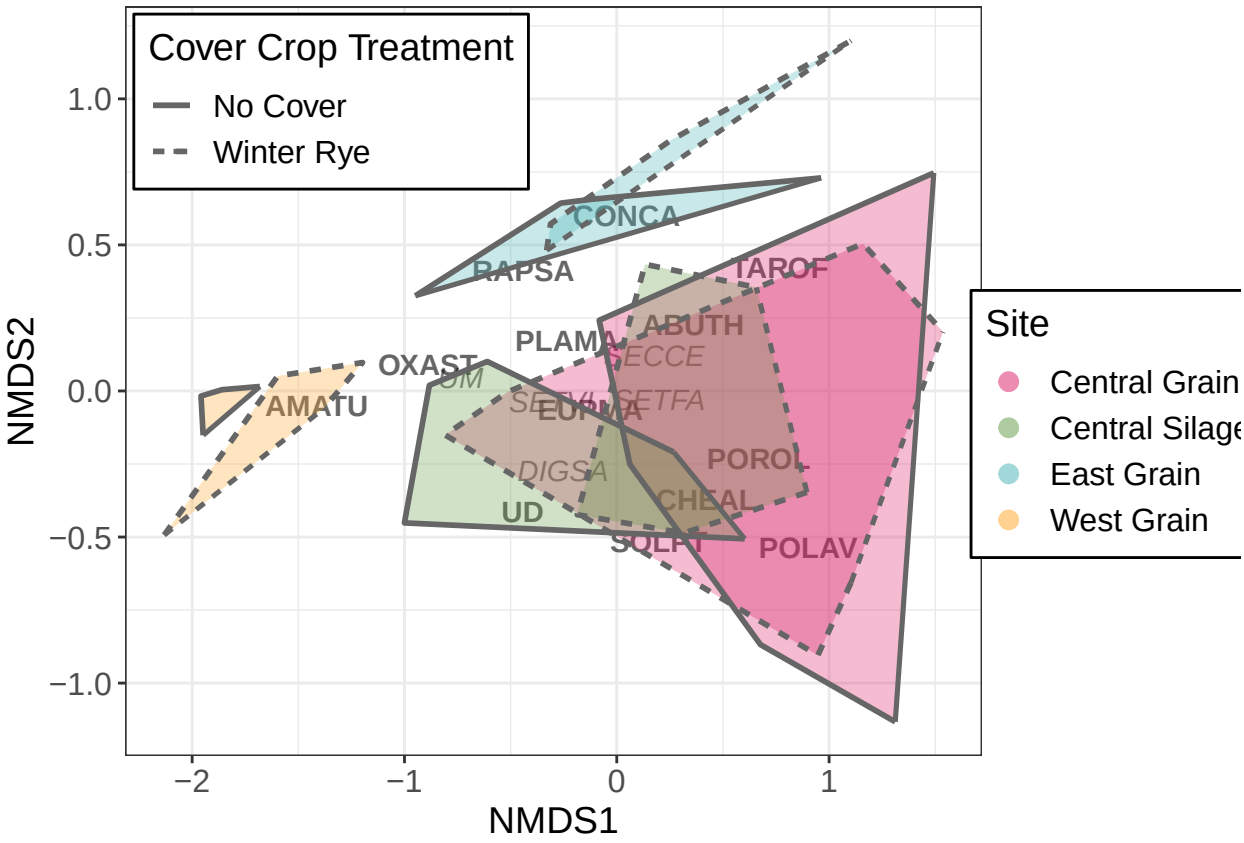

Figure 5: Manuscript fig. 4 using full dataset

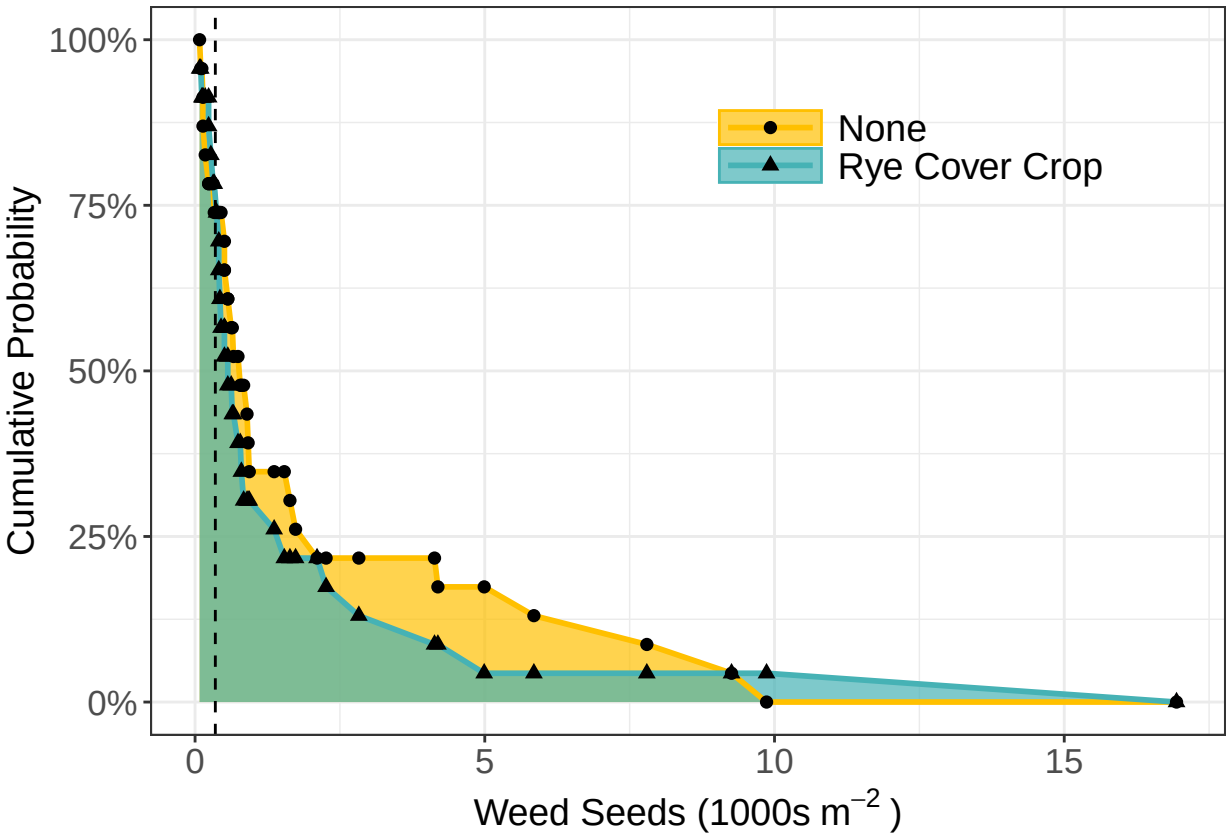

Figure 6: Manuscript fig. 5 using full dataset