Demonstrating Cover Crop Mixtures on Iowa Farmland: Management, Soil Health, and Water Quality Benefits

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Introduction

Iowa landowners and farmers increasingly are seeing the value of single species cover crops. However, in Iowa and the Upper Midwest, there has been limited research on using cover crop mixtures. In theory, cover crop mixtures have the same advantages as diverse species ecosystems like prairies. The most important advantage would be greater and more stable total plant growth. Mixing species with complimentary features can take advantage of multiple niches and environmental conditions in space, weather, time, and seasons.

The project's goal is to evaluate management techniques to increase growth, and improve the overall environmental benefits of cover crops in improving soil health and reducing nutrient losses.

Materials and Methods

Cover crop plots were established at six ISU Research and Demonstration sites in fall 2013. The project was continued at four sites in fall 2016. These four sites were seeded for the fifth year in 2017.

The plots compare three different treatments for each cash crop: single species, mixture, and no cover crop. Each treatment is replicated four times at each site, for a total of 24 plots at each farm. The plots range from 6 to 12 rows wide and all are 50 ft in length. Before corn, the single species is oats and the mixture contains hairy vetch, oats, and radish. Before soybean, the single species is cereal rye and the mixture contains rapeseed, cereal rye, and radish. For all project sites, spring and fall cover crop biomass, late spring nitrate-nitrogen, and cash crop yield data were collected to evaluate the establishment of the cover crops and potential yield impacts.

Results and Discussion

Corn grain yields were not statistically affected by the single species or mixture cover crop treatments (Table 1). In only 1 of 22 site-years was a corn yield difference found. That was Crawfordsville in 2016 where the no cover and cover crop mixture yielded more than the single species oat cover crop. Late spring nitrate levels were not statistically different within any site-year. Total fall biomass dry matter was significant in 2 of 14 site-years. These were locations in southern Iowa where the cover crop mixture had greater biomass compared with the single species oat cover crop (Table 3).

Soybean grain yields were not statistically different in 20 of 22 site-years (Table 2). June soil nitrate-nitrogen levels were significant in 7 of 16 site-years. In each of those site-years, the no cover treatment had higher soil nitrate-nitrogen. Total fall biomass dry matter was significant in 4 of 16 site-years (Table 4). In 3 of the 4 site-years, the single species cereal rye cover crop had more biomass than the cover crop mixture treatment.

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Table 1. Corn grain yield and late spring nitrate-nitrogen concentration for a no cover crop control, single species (oats), and cover crop mixture (oats, radish, hairy vetch) at multiple locations across Iowa.[1]

		Corn yield				Late spring nitrate test		
Location	**Treatment**	**2014**	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**
		bu/ac	bu/ac	bu/ac		ppm	ppm	ppm
Sutherland	No cover	187.2	228.9	235.7		40.4	8.9	
	Single	186.1	218.7	233.1		32.1	8.4	
	Mix	192.5	226.8	235.7		39.1	10.2	
	Pr > F	0.702	0.506	0.925		0.823	0.105	
Kanawha	No cover	145.1	214.0	213.1	220.8	42.0	23.9	26.7
	Single	141.9	209.4	216.6	233.6	46.6	21.0	29.6
	Mix	148.5	211.1	212.2	229.0	44.0	19.8	29.9
	Pr > F	0.605	0.698	0.789	0.246	0.797	0.497	0.216
Nashua	No cover	161.6	244.7	211.3	227.2	47.1	9.8	8.7
	Single	170.1	246.3	205.7	231.1	54.5	9.5	9.3
	Mix	167.3	246.4	208.3	224.9	45.7	9.7	8.1
	Pr > F	0.660	0.871	0.676	0.568	0.929	0.973	0.627
Lewis	No cover	227.6	238.4	212.3	223.2	5.5	14.6	12.4
	Single	216.3	245.0	219.8	208.5	6.0	21.3	12.8
	Mix	220.0	257.4	223.5	208.0	7.0	13.3	14.6
	Pr > F	0.499	0.365	0.691	0.227	0.126	0.460	0.834
Chariton	No cover	211.2	231.2	193.5		23.5	18.6	
	Single	221.2	231.6	199.0		29.6	23.2	
	Mix	232.3	234.4	195.6		34.8	28.4	
	Pr > F	0.531	0.963	0.942		0.410	0.566	
Crawfordsville	No cover	221.2	234.3	**216.1a**	156.2	64.3	9.6	9.9
	Single	212.2	239.5	**198.0b**	147.5	61.3	8.3	12.8
	Mix	209.5	237.1	**215.6a**	151.9	59.4	8.7	11.1
	Pr > F	0.506	0.395	**0.018**	0.523	0.730	0.555	0.058

[1]Statistically significant site-years are denoted by bold font. Means followed by different letters differ.

Table 2. Soybean grain yield and soil nitrate for a no cover crop control, single species (winter cereal rye), and cover crop mixture (winter cereal rye, rapeseed, radish) at multiple locations across Iowa.[1]

		Soybean yield				Soil nitrate test		
Location	**Treatment**	**2014**	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**
		bu/ac	bu/ac	bu/ac		ppm	ppm	ppm
Sutherland	No cover	**61.5a**	**70.4a**	81.8		12.8	6.7	
	Single	**57.9b**	**63.7b**	79.5		12.6	5.3	
	Mix	**58.9b**	**68.0ab**	79.3		16.3	4.9	
	Pr > F	**0.002**	**0.041**	0.419		0.197	0.093	
Kanawha	No cover	36.8	55.7	62.5	59.1	**5.5a**	**6.7a**	**6.9a**
	Single	42.1	48.9	58.9	56.6	**3.7b**	**4.4b**	**6.0b**
	Mix	44.9	53.4	63.2	59.8	**4.3ab**	**4.6b**	**5.6b**
	Pr > F	0.244	0.225	0.209	0.630	**0.047**	**0.023**	**0.012**
Nashua	No cover	70.9	75.8	69.1	64.6	7.4	**7.2a**	**8.1a**
	Single	71.4	75.4	66.2	61.7	5.3	**5.2b**	**5.4b**
	Mix	71.0	74.1	66.2	62.9	4.5	**6.4ab**	**5.6b**
	Pr > F	0.954	0.5450	0.373	0.193	0.089	**0.040**	**0.001**
Lewis	No cover	79.2	76.3	73.9	64.0	6.9	5.8	6.7
	Single	77.4	72.3	74.1	62.9	7.9	4.7	8.2
	Mix	78.7	72.5	73.1	63.4	8.3	5.6	7.5
	Pr > F	0.864	0.541	0.978	0.974	0.231	0.198	0.181
Chariton	No cover	74.6	58.9	95.4		7.9	6.1	
	Single	71.7	51.5	97.2		5.9	4.2	
	Mix	73.6	48.9	98.2		6.0	5.1	
	Pr > F	0.771	0.435	0.452		0.538	0.115	
Crawfordsville	No cover	62.9	57.9	50.0	70.4	7.4	**7.7a**	**10.6a**
	Single	63.4	57.5	47.3	60.2	4.0	**6.3ab**	**6.5b**
	Mix	62.1	59.9	41.4	65.9	4.5	**5.2b**	**6.0b**
	Pr > F	0.911	0.624	0.112	0.105	0.301	**0.037**	**0.012**

[1]Statistically significant site-years are denoted by bold font. Means at the same location and in the same column followed by different letters differ.

Table 3. Fall cover crop biomass growth for a no cover control, single species (oats), and cover crop mixture (oats, radish, hairy vetch) ahead of a corn cash crop at multiple locations across Iowa in 2015, 2016, and 2017.

		2015				2016				2017			
Location	**Treatment**	**Total biomass**	**Oat**	**Radish**	**Vetch**	**Total biomass**	**Oats**	**Radish**	**Vetch**	**Total biomass**	**Oats**	**Radish**	**Vetch**
						lb biomass/acre							
Sutherland	Single	453.3	453.3			644.4	644.4						
	Mix	575.7	490.9	53.6	31.2	623.6	426.5	125.7	71.4				
	Pr > F	0.160	0.624			0.760	0.112						
Kanawha	Single	303.9	303.9			158.9	158.9			353.4	353.4		
	Mix	272.3	225.7	24.8	21.7	127.9	93.8	16.8	17.3	311.0	270.6	11.5	28.8
	Pr > F	0.578	0.293			0.237	0.098			0.377	0.126		
Nashua	Single	267.1	267.1			372.9	372.9			593.9	593.9		
	Mix	363.2	307.4	40.8	15.1	367.6[2]	281.3	61.8	24.4	621.9	581.0	25.4	15.4
	Pr > F	0.168	0.558			0.852	0.189			0.660	0.814		
Lewis	Single	139.1	139.1			243.1	243.1			820.5	**820.5**		
	Mix	300.9	183.8	88.4	28.8	335.1	254.9	61.5	18.7	708.8	**575.8**	104.8	28.1
	Pr > F	0.102	0.528			0.178	0.852			0.371	**0.034**		
Chariton	Single					**22.7**	22.7						
	Mix					**81.5**	17.0	41.1	23.3				
	Pr > F					**0.037**	0.143						
Crawfordsville	Single					400.4[3]	**400.4**			**1,232.7**	**1,232.7**		
	Mix	35.2	7.8	10.0	17.3	286.2[3]	**196.1**	65.5	24.5	**1,662.4**	**981.5**	529.1	151.8
	Pr > F					0.088	**0.009**			**0.002**	**0.024**		

[1]Statistically significant site-years are denoted by bold font.

[2]In Nashua 2016, there was some oat (74.1 lb/ac) and vetch (173.1 lb/ac) biomass due to spring germination and growth.

[3]In Crawfordsville 2016, there was some oat (single, 43.5 lb/ac; mix, 251.6 lb/ac) and vetch (mix, 162.3 lb/ac) biomass due to spring germination and growth.

Table 4. Cover crop biomass growth for a no cover control, single species (winter cereal rye), and cover crop mixture (winter cereal rye, rapeseed, radish) ahead of a soybean cash crop at multiple locations across Iowa in 2015, 2016, and 2017.[1]

		2015				2016				2017			
Location	**Treatment**	**Total fall biomass**	**Fall brassica**	**Fall rye**	**Spring rye**	**Total Fall biomass**	**Fall brassica**	**Fall rye**	**Spring rye**	**Total Fall biomass**	**Fall brassica**	**Fall rye**	**Spring rye**
						lb biomass/acre							
Sutherland[3]	Single	102.2		**102.2**	**5,230.0**	761.4		**761.4**	2,615.8				
	Mix	120.9	65.8	**55.2**	**3,085.9**	680.0	267.8	**412.2**	2,169.2				
	Pr > F	0.627		**0.020**	**0.025**	0.156		**0.013**	0.360				
Kanawha	Single	199.7		**199.7**	8,745.3	**130.1**		**130.1**	2,186.6	**455.8**		**455.8**	**3,677.3**
	Mix	160.4	52.5	**107.9**	7,422.4	**85.0**	37.5	**47.5**	1,847.5	**327.7**	10.6	**317.1**	**4,389.2**
	Pr > F	0.089		**0.013**	0.106	**0.005**		**0.005**	0.597	**0.024**		**0.018**	**0.046**
Nashua[4]	Single	187.1		187.1	**2,197.2**	76.3		76.3	1,613.9	126.8		126.8	2,842.6
	Mix	178.5	50.6	127.9	**1,430.0**	66.8	19	47.9	876.5	124.6	32.5	92.1	2,036.8
	Pr > F	0.677		0.112	**0.002**	0.772		0.405	0.128	0.891		0.069	0.081
Lewis[2,5]	Single	471.0		**471.0**	1,647.1	**365.9**		**365.9**	1,368.9	**752.2**		**752.2**	813.0
	Mix	435.0	250.8	**184.3**	1,186.0	**244.5**	75.4	**169.1**	1,399.7	**965.2**	637.0	**328.2**	479.0
	Pr > F	0.179		**0.016**	0.159	**0.020**		**0.004**	0.928	**0.002**		**0.001**	0.055
Chariton[3]	Single	93.0		93.0	1450.3	149.3		149.3	750.3				
	Mix	85.2	0.0	85.2	868.1	187.4	140.8	46.5	596.9				
	Pr > F	0.837		0.749	0.203	0.558		0.132	0.449				
Crawfordsville[5]	Single	80.4		80.4	**850.3**	362.6		362.6	1,634.8	233.6		233.6	5,544.0
	Mix	43.1	12.5	30.6	**425.1**	286.8	75.3	211.5	1,126.1	173.2	126.4	46.8	4,382.2
	Pr > F	0.089		0.075	**0.014**	0.271		0.001	0.059	0.492		0.062	0.152

[1]Statistically significant site-years are denoted by bold font.

[2]Lewis 2015, radish 1.5 times greater than rapeseed otherwise quantities are roughly the same.

[3]Sutherland and Chariton 2016, radish 1.5 times and 2.5 times, respectively, greater than rapeseed otherwise quantities are roughly the same.

[4]Nashua 2016, had 58.2 lb/ac of spring rapeseed biomass from spring germination and growth.

[5]Lewis and Crawfordsville 2017, radish was 8.6 times and 12.5 times, respectively, greater than rapeseed whereas there was no rapeseed identified at Kanawha and Nashua.