COVER CROP ESTABLISHEMNT FOLLOWING COMMONLY APPLIED CORN AND SOYBEAN HERBICIDES IN WISCONSIN

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Introduction

Cover crops are of increasing interest to producers in Wisconsin due to many potential agronomic benefits. These potential benefits include reducing soil erosion, providing and scavenging nutrients, weed suppression, improving soil health, reducing soil moisture losses, protecting water quality, reducing production costs and increasing yield. Cover crops have been utilized for many years in crop organic production. While cover crops are of increasing interest there are often challenges with their establishment. The increasing interest is shown through results from a 2013-2014 survey conducted by the North Central Sustainable Agriculture Research and Education (SARE) program with the Conservation Technology Information Center (CTIC). This survey indicated there has been a steady increase in cover crop acres since 2009 with 415,191 acres planted in the Mississippi river basin in 2014. Of the farmers surveyed 42.5% indicated that establishing cover crops was one of the biggest challenges. (SARE/CTIC, 2014) Some of this challenge may be due to herbicide carryover issues. Herbicide persistence factors include chemical properties of the herbicide, rate of application, soil pH, organic matter content, amount of surface plant residue, temperature, rainfall, and microbial degradation (Walsh, 1993). The objective of this study was to determine if persistence of commonly used residual herbicides applied in the spring to corn and soybean crops affect the subsequent establishment of cover crops in the fall.

Materials and Methods

Field experiments were conducted at Arlington Agricultural Research Station, Arlington, WI. The experimental design was a randomized complete block with four replications. Each replication included a nontreated check where no residual herbicide was applied, but weeds were managed with POST glyphosate. The treatment structure included main plots for corn and soybean with subplots consisting of herbicide treatments and sub-subplots consisting of cover crop species. Corn and soybean plots were seeded with glyphosate-resistant cultivars on June 2, 2013 and May 22, 2014. Cover crops were directed seeded using a no-till drill. Soil type was Plano silt loam soil with 3.4 to 3.8% organic matter and pH ranging from 5.9 to 6.3.

Plots were 10 feet wide and 50 feet long. Corn and soybeans was planted in 30 inch wide rows. Corn was planted at 33,000 seeds per acre. Soybean was planted at 160,000 seeds per acre. Preemergence (PRE) herbicide treatments were applied as close to planting as possible. A burn-down application of glyphosate was applied on all plots prior to planting. Postemergence (POST) herbicides were applied at V2 corn and V3 soybean growth stages. All plots were also sprayed

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with POST glyphosate to control all weeds and limit interactions from weed competition. Herbicide treatments for corn are listed in Table 1 and soybean treatments in Table 2.

Table 1. Corn herbicide treatments.

Treatment	Trade Name	Active Ingredient	Rate	Site of action group	Timing
1	Nontreated				
2	Sharpen	saflufenacil	2 fl. oz.	14	PRE
3	Verdict	saflufenacil	15 fl. oz.	14	PRE
		dimethenamid-p		15	PRE
4	Zemax	s-metolachlor	2 qt.	15	PRE
		mesotrione		27	PRE
	Halex GT	s-metolachlor	3.6 pt.	15	LPOST
		glyphosate		9	LPOST
		mesotrione		27	LPOST
5	Fierce	flumioxazin	3 oz.	14	PRE
		pyroxasulfone		15	PRE
6	Python	flumetsulam	1 oz.	2	PRE
7	Princep 4FL	simazine	2 qt.	5	EPOST
8	Stinger	clopyralid	0.5 pt.	4	EPOST
9	Accent Q	nicosulfuron	0.9 oz.	2	EPOST
10	Resolve	rimsulfuron	1 oz.	2	EPOST
11	SureStart	acetochlor	1.5 pt.	15	EPOST
		flumetsulam		2	EPOST
		clopyralid		4	EPOST
12	Callisto	mesotrione	6 oz.	27	EPOST
13	Basis Blend	rimsulfuron	0.33 oz.	2	EPOST
		thifensulfuron-methyl		2	EPOST
14	Laudis	tembotrione	3 fl. oz.	27	EPOST
15	Impact	topramezone	0.75 fl. oz.	27	EPOST

Table 2. Soybean herbicide treatments.

Treatment	Trade Name	Active Ingredient	Rate	Site of Action Group	Timing
1	Nontreated				
2	Spartan	sulfentrazone	8 fl. oz.	14	PRE
3	Valor	flumioxazin	2.5 oz.	14	PRE
4	Sencor 75DF	metribuzin	0.5 lb.	5	PRE
5	Classic	chlorimuron-ethyl	1 oz.	2	PRE
6	Authority MTZ	sulfentrazon	12 oz.	14	PRE
		metribuzin		5	PRE
7	Gangster	flumioxazin	3.6 oz.	14	PRE
8	Zidua	pyroxasulfone	3 oz.	15	PRE
9	Firstrate	cloransulam-methyl	0.3 oz.	2	EPOST
10	Dual II Magnum	s-metolachlor	1.33 pt.	15	EPOST
11	Warrant	acetochlor	1.5 qt	15	EPOST
12	Flexstar	fomesafen	16 fl. oz.	14	EPOST
13	Pursuit	imazethapyr	4 fl. oz.	2	EPOST
14	Extreme	imazethapyr	3 pt.	2	EPOST
		glyphosate		9	EPOST
15	Cobra	lactofen	12.5 fl. oz.	14	EPOST

Corn plots were harvested as silage, and soybean plots were also harvested to simulate a forage harvest. After harvest seven different cover crop species and/or varieties were direct drilled perpendicular across all herbicide treatments. These plots were approximately 6.5 feet wide with row spacing of 7.5 inches. The cover crops included Tillage Radish® (Raphanus sp;), crimson clover (Trifolium incarnatum), cereal ryegrass 'Guardian' (Secale cereal), 70% oat 'Ogle' (Avena sativa) plus 30% peas 'Austrian winter field' (Pisum sativum) mixture, and three annual ryegrass (Lolium multifloram) varieties. The annual ryegrass varieties included 'Bruiser' and 'King', diploids, and a tetraploid. Table 3 outlines seeding population and planting depth.

Table 3. Cover crop seeding rate and depth.

Species	Winter Rye	Oats + Peas Mix	Crimson Clover	Tillage Radish®	Annual Ryegrasses
Depth(inch)	1	1	0.25	0.25	0.25
Seeding Rate (lbs./ac	120	90 oats 10 peas	10	12	32

Cover crops were evaluated for herbicide injury just after emergence, which occurred approximately two weeks after seeding. Digital images were taken at 36 inches above each sub-

sub plot weekly using methods for digital imagery analysis (DIA) data collection techniques adapted from Purcell (2000). The camera was mounted at a 70 degree angle on a 1 inch wide by 45 inch long board. This board created a stand for the camera to capture consistent photos of the plots. The camera used was a Canon PowerShot A1400 with a 16 gigabyte class 4 SDHC card (Canon USA, Inc., Melville, NY). The camera was set to auto mode with zoom set to 0. Images were resized using FastStone Image Viewer (FastStone Image Viewer). Once resized, images were analyzed using Sigma Scan Pro© 5 with the macro Turf Analysis 1-2 (SigmaScan Pro© 5, Richardson 2001, and Karcher 2005). Taking the readings at the subplot level allows for data analysis of each herbicide treatment and cover crop combination.

Biomass was collected from quarter meter squared quadrats prior to the first killing frost. According to NOAA, the average first frost date at the Arlington, WI research farm ranges from October 11 until October 20. (NCDC 2013) The biomass samples then were dried at 140°F for two weeks and weighted.

Data were analyzed using a mixed model using the pro mixed procedure in SAS statistical software (SAS Institute, Inc., Cary NC 27513). Cover crop, herbicide, and cover crop by herbicide interaction were the fixed effects. Replication was a random effect.

Results and Discussion

Winter rye was the only cover crop not adversely impacted by the herbicide treatments applied in the corn and soybean trials in 2013 and 2014 ($P<0.05$) (Table 4). All other cover crops had significantly ($P<0.05$) reduced cover (Table 4) and biomass (Table 5) for at least one of the residual herbicide treatments.

Table 4. Percent cover from cover crops in 2013. Only data which were significantly different from the nontreated check at alpha 0.05 are shown

	‘King’ Ryegrass	‘Bruiser’ Ryegrass	Tetraploid Ryegrass	Oat+Pea Mix	Tillage Radish®	Crimson Clover	Winter Rye
Nontreated	66	61	63	61	54	39	51
S-metolachor	18	29	22	54		24	
Imazethapyr	44	56	57	40	18		
Flumioxazin	38	47	35	45		24	
Pyroxasulfone	35	39	40	43			
Flumetsulam	51				41		
Sulfentrazon		46			40		
Fomesafen					22		

Table 5. Biomass from cover crops in 2013. Only data which were significantly different from the nontreated check at alpha 0.05 are shown

	'King' Ryegrass	'Bruiser' Ryegrass	Tetraploid Ryegrass	Oat+Pea Mix	Tillage Radish®	Crimson Clover	Winter Rye
Nontreated	2.8	3.0	2.9	3.5	4.5	2.0	2.9
S-metolachor	0.6	0.4	0.9	1.8		0.9	
Imazethapyr	2.0	2.3	2.3	1.5	1.6		
Flumioxazin	1.7	1.9	1.3	1.6		1.4	
Pyroxasulfone	1.1	1.2	1.6	2.2			
Flumetsulam	1.5				2.5		
Sulfentrazon		2.2			2.8		
Fomesafen					1.6		

Two varieties 'King' and tetraploid were the only cover crops to have significant ($P<0.0001$) reduction of percent cover in 2014 (Table 6). All other cover crops did not have a reduction in percent cover due to herbicide treatments.

Table 6. Percent cover from cover crops in 2014. Only data which were significantly different from the nontreated check at alpha 0.05are shown

	'King' ryegrass	Tetraploid ryegrass
Nontreated	19	25
Simazine	13	
Flumetsulam	5	
Sulfentrazone		10

Summary

Commonly used corn and soybean herbicides have the potential to reduce the establishment and green cover of many different species used as cover crops. The severity of damage will be influenced by weather, cover crop species, and the specific residual herbicide combinations previously applied. Symptoms of carryover may go un-noticed if damage is uniform across an entire field and only minor negative effects occur. More research is needed to explore these relationships and develop guidelines to help farmers avoid cover crop establishment problems associated with the persistence of residual herbicides.

Disclaimer

Herbicide trade names listed, used, and described in these trials do not imply any endorsement or recommendation related to use patterns. Always read and follow specific herbicide label recommendations.

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