Herbicide carryover evaluation in cover crops following silage corn and soybean herbicides

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Agronomy
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Crop Weed Science

Background

- Cover crops are of increasing interest to producers in Wisconsin due to many agronomic benefits.
- Cover crops have been utilized for many years in organic production.
- While cover crops are of increasing interest, there are challenges to their establishment.
- Due to previous herbicide applications?

Potential Benefits of Cover Crops

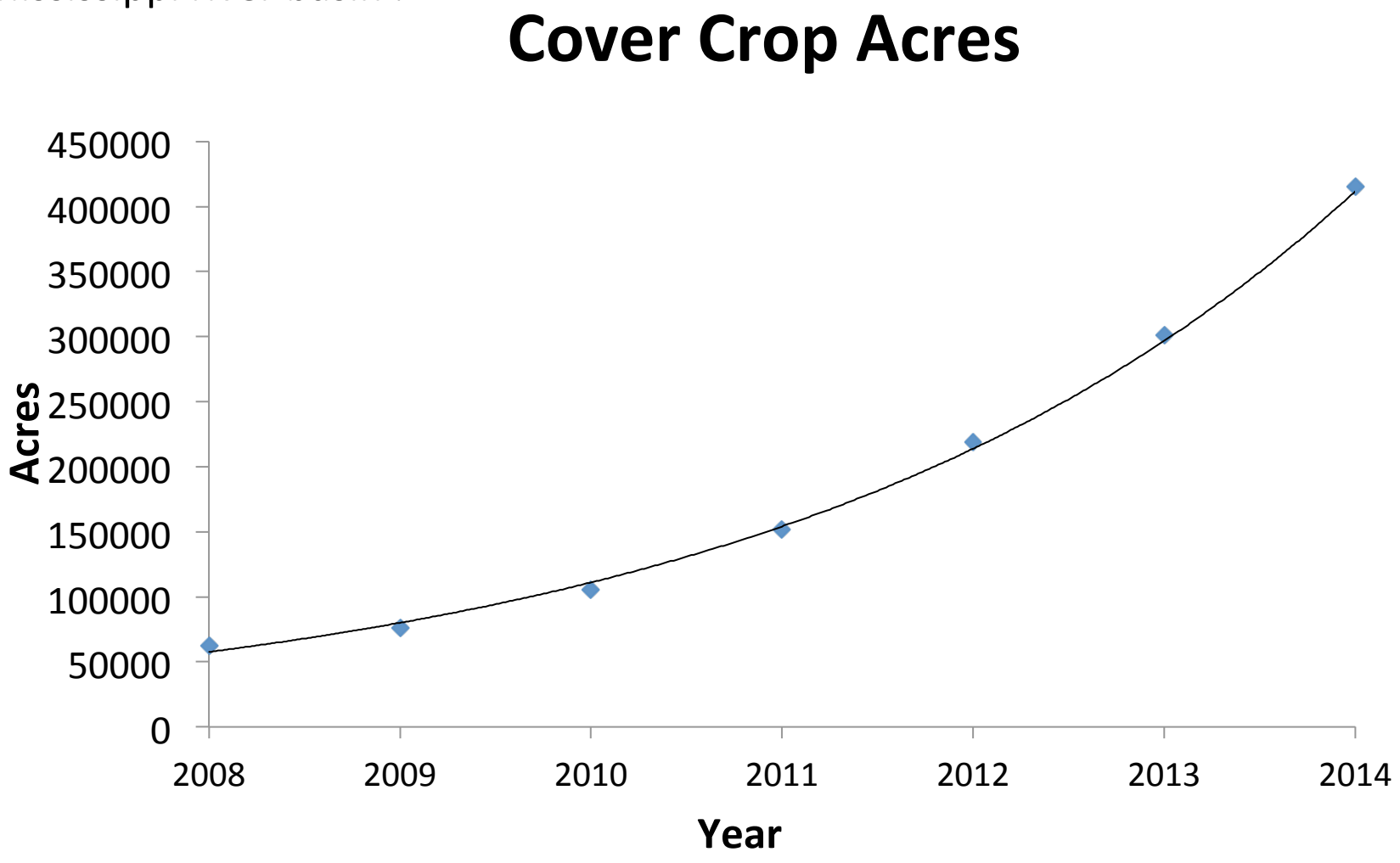
- Reducing soil erosion
- Providing and scavenging nutrients
- Weed suppression
- Improved soil health
- Reducing soil moisture losses
- Protecting water quality
- Reducing production costs
- Increased yield

Cover Crop or Forage Crop?

- Cover crops are no longer cover crops if harvested as a forage and fed to livestock. This would be classified as a forage crop and has different herbicide restrictions.
- Example: winter rye is established in the fall and harvested in the spring for forage

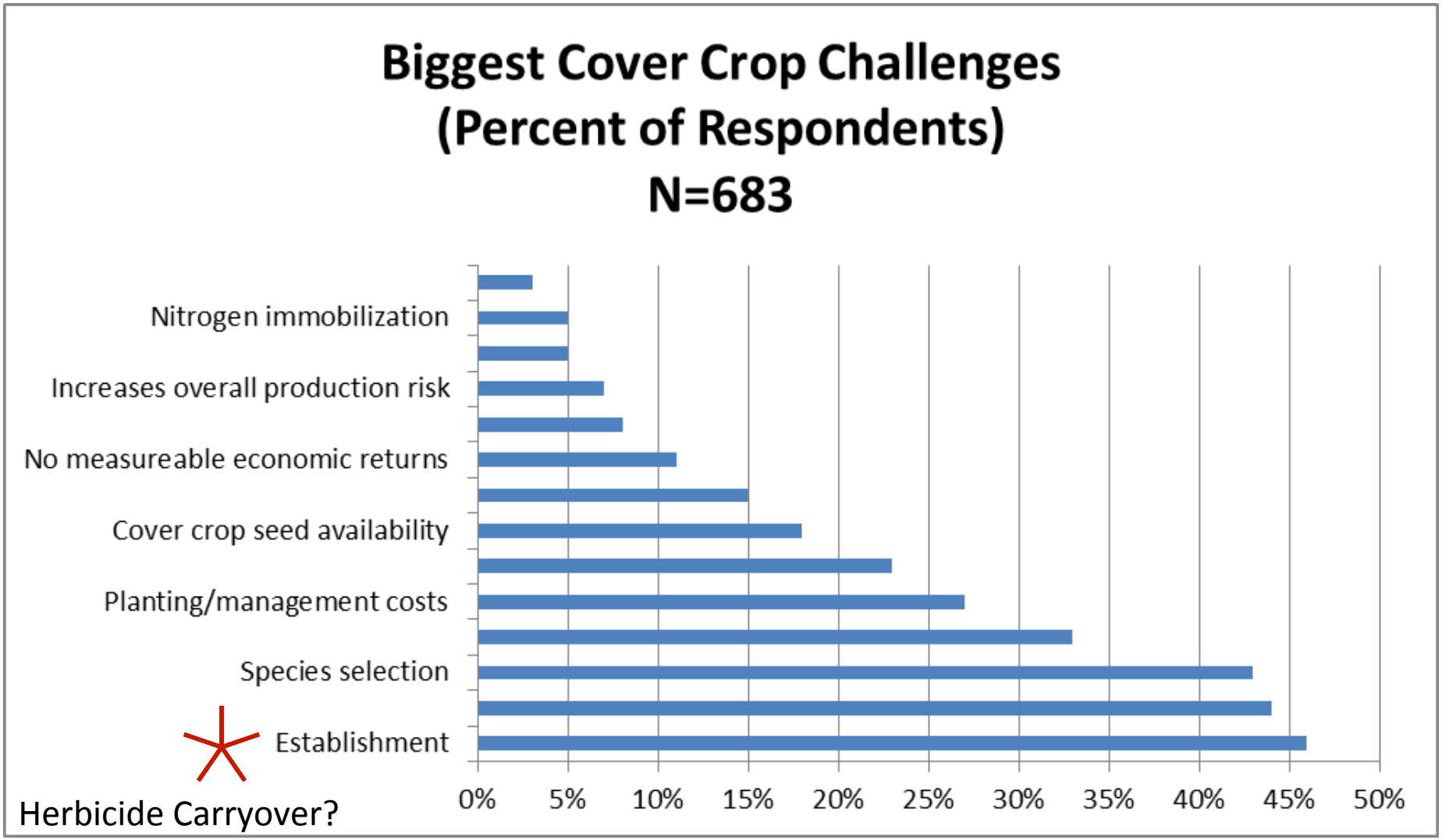
Increasing Use Trend

In Fall 2012 and Spring 2013 the North Central Sustainable Agriculture Research and Education (SARE) program with the Conservation Technology Information Center (CTIC) conducted a survey of cover crop use. The majority of farmers were from the Mississippi river basin .



Cover Crop Challenges

The SARE/CITC survey asked farmers what their biggest challenges with cover crops have been. **>45% of respondents indicated establishment biggest challenge!**



Herbicide Persistence Factors

- Chemical properties of the herbicide
- Rate of application
- Soil pH
- Organic matter content
- Amount of surface plant residue
- Temperature
- Rainfall
- Microbial degradation

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Nontreated

Example of herbicide persistence

Citation: Walsh, Joseph D., Michael S. Defelice, and Barry D. Sims. "Soybean (*Glycine Max*) Herbicide Carryover to Grain and Fiber Crops." *Weed Technology* 7 (1993): 625-32

Objective

To determine if common soil applied herbicides applied in the spring to corn and soybean crops affect the subsequent establishment of cover crops in the fall

Materials and Methods

- Corn and soybean trials with glyphosate-resistant cultivars were planted at Arlington Agricultural Research Station, Arlington, WI. on June 2, 2013 and May 22, 2014

- Soil type was Plano silt loam soil with 3.4-3.8% organic matter and pH ranged 5.9-6.3

Trial Methods

Example Treatment

50 ft.

Check
Annual Rye 3 tetraploid
Crimson Clover
Annual Rye 2 'Bruiser'
Annual Rye 1 'King'
Winter Rye
Oat + Pea Mix
Tillage Radish®

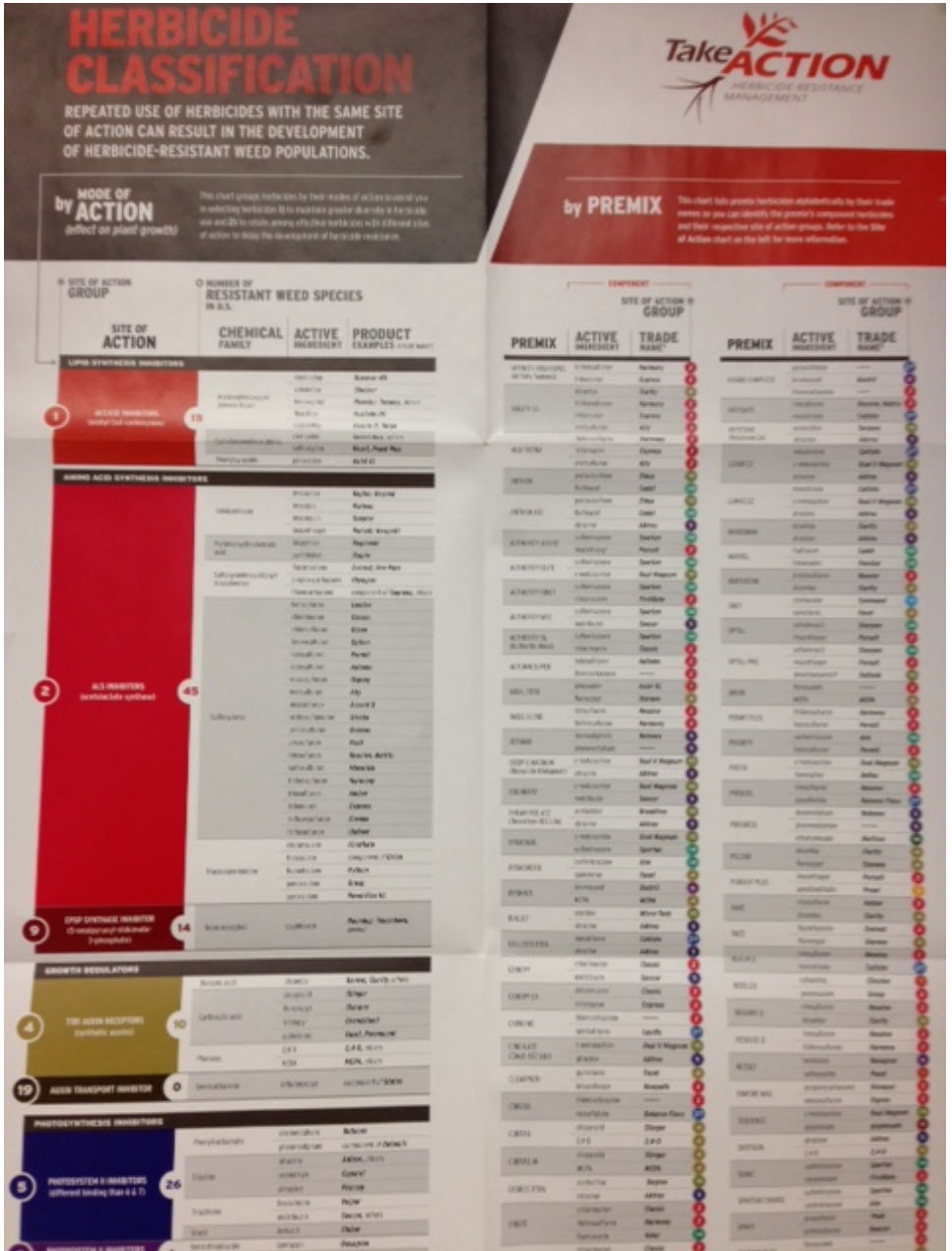
10 ft.

- RCB with 4 Reps.
- 14 Treatments per trial
- Nontreated control included

- All plots were managed for weeds with postemergence (POST) glyphosate as needed
- Corn EPOST applied at V2 and LPOST applied at V4
- Soybean EPOST applied at V2-V3 growth stage
- 9 Sites of Action Groups

Herbicide Classification

The following herbicide treatments are color coded to match the site of action from the Herbicide Classification Chart available at http://takeactiononweeds.com/



Corn Treatments

Treatment	Trade Name	Active Ingredient	App Rate	Site of action group (SOA)	Timing
1	Nontreated				
2	Sharpen	saflufenacil	2.0 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		27	EPOST

Soybean Treatments

Treatment	Trade Name	Active Ingredient	App. 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

Variety and Latin Binomial of Cover Crops

	Winter rye	Oats + peas Mix	Crimson clover	Tillage Radish®	Annual ryegrasses
Scientific name	*Secale cereale*	*Avena sativa-oat Pisum sativum-pea*	*Trifolium incarnatum*	*Raphanus spp.*	*Lolium multiflorum*
Variety	'Guardian'	'Austrian' winter field peas 'Ogle' Oats	N/A	N/A	'Bruiser' 'King' tetraploid

- Corn was chopped for silage and soybean was chopped to simulate silage harvest near the beginning of September.
- Seven different cover crop species and/or varieties were seeded uniformly across all herbicide treatments to create two split plot experiments with herbicides as whole plots

Planting Depth and Seeding Rate of Cover Crops

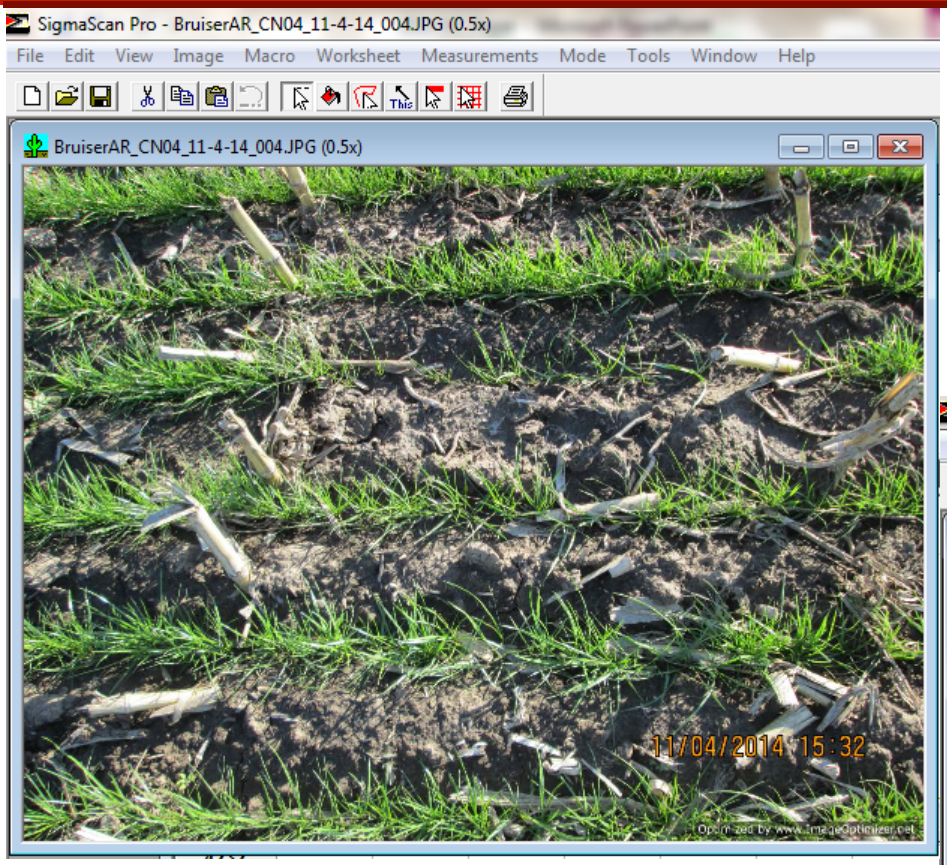
	Winter rye	Oats + peas mix	Crimson clover	Tillage Radish®	Annual ryegrasses
Depth (in)	1	1	0.25	0.25	0.25
Seeding Rate (lbs. ac $^{-1}$)	120	90 oats 10 peas	10	12	32

Materials and Methods

- Nearly two months after seeding, just before killing frost, the cover crops were evaluated for herbicide injury with digital imagery analysis for percent cover and for total dried biomass collected from a 0.25m^2 quadrat per subplot.

- Digital images were taken at 36 inches above each cover crop in every plot. The camera (Canon PowerShot A1400) was mounted at a 70 degree angle on a 1 inch by 45 inch board, set to auto mode with zoom set to 0. This board created a stand for the camera to capture consistent photos of all subplots.

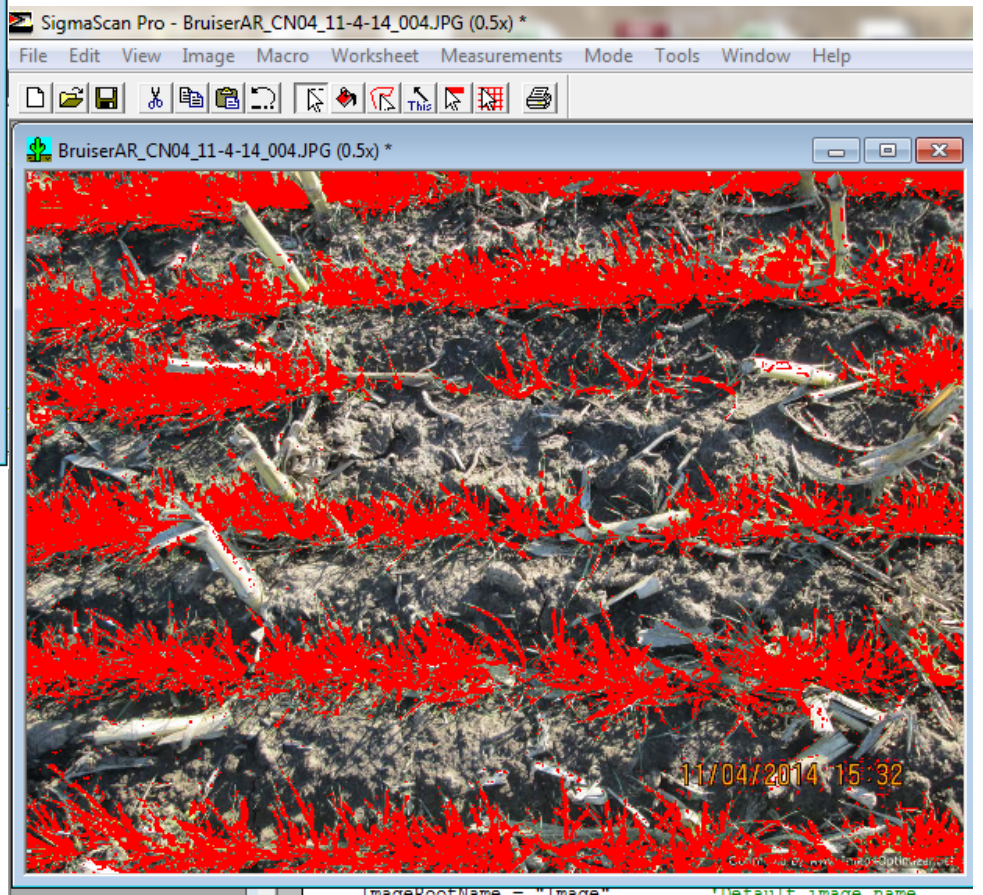
Percent Cover Calculation Procedure



Pre Software Analysis

SigmaScan Pro 5® and Turf Analysis 1-2 Macro

Percent cover is estimated using the software to turn the green pixels red and then they are counted

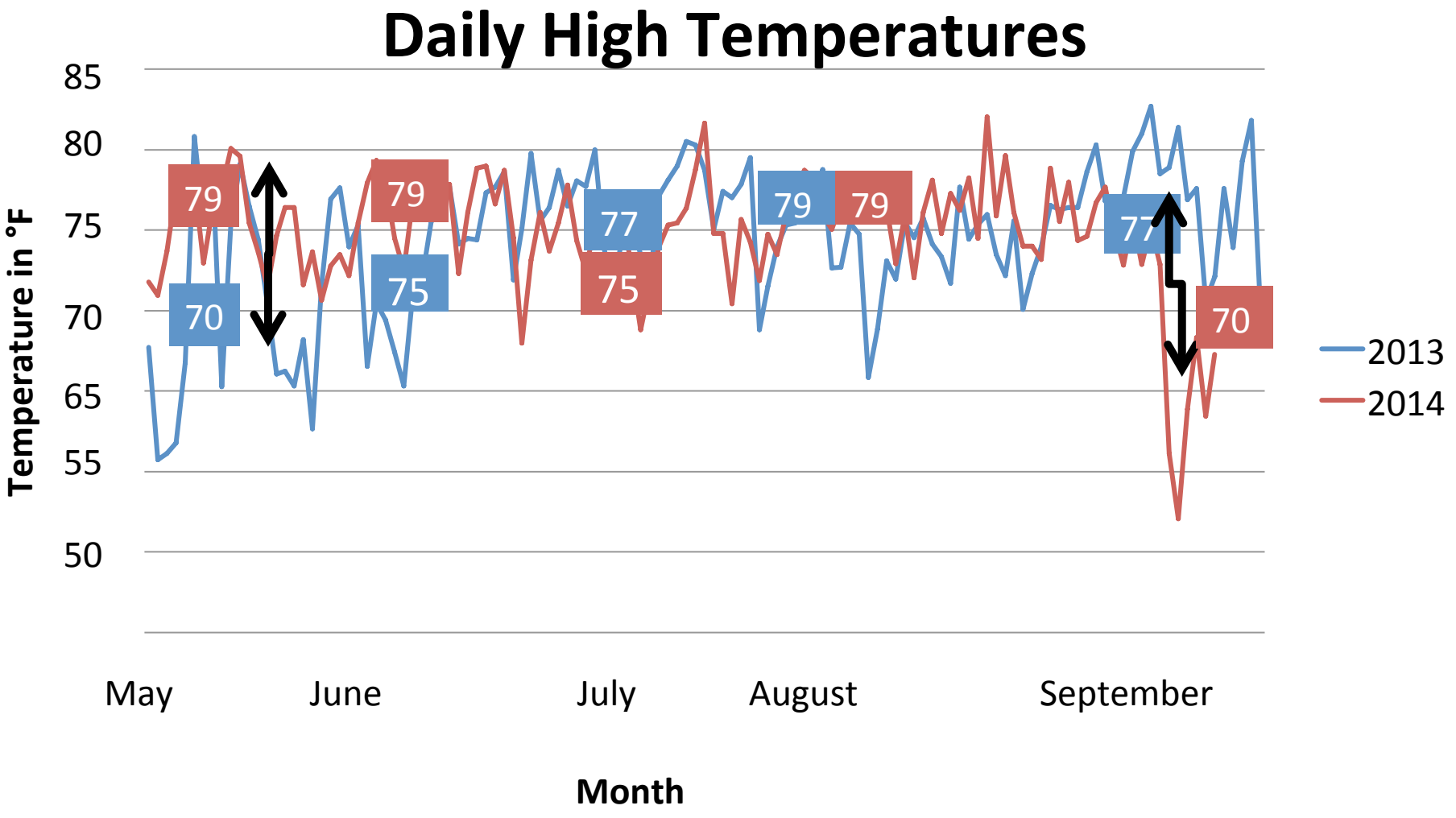


Weather- Precipitation

Month	2013 (in)	2014 (in)
May	5.5	0.6
June	7.4	9.3
July	2.7	1.5
August	1.6	2.6
September	0.1	1.2
Totals	17.3	15.2

Table shows rain fall between herbicide application and cover crop establishment.

Weather- Temperature



Temperatures shown only include days between herbicide application and cover crop establishment. Monthly average temperatures highlighted

2013 and 2014 Winter Rye

- Winter rye was the only cover crop not adversely impacted by the herbicide treatments applied in the corn or soybean trials ($P<0.05$).
- All other cover crops had significantly reduced biomass ($P<0.05$) and percent cover ($P<0.05$) for at least one of the residual herbicide treatments applied in the corn and/or soybean trial.

2013 Percent Cover Results

	'King' ryegrass	'Bruiser' ryegrass	Tetraploid ryegrass	Oat + Pea mix	Tillage Radish®	Crimson clover	Cereal rye
Nontreated	66	61	63	61	54	38	51
S-							
In							
Fl							
Py							
Fl							
SOA 2	51				41		
Sulfentrazone SOA 14		46			40		
Fomesafen SOA 14					22		

Only Significant Reduction ($P<0.05$) in Percent Cover Data Shown

2013 Percent Cover Results

	'King' ryegrass	'Bruiser' ryegrass	Tetraploid ryegrass	Oat + Pea mix	Tillage Radish®	Crimson clover	Cereal rye
Nontreated	66	61	63	61	54	38	51
S-metolachor SOA 15	18	29	22	54		24	
Imazethapyr SOA 2	44	56	57	40	18		
Flumioxazin SOA 14	38	47	35	45		24	
Pyroxasulfone SOA 15	35	39	40	43			
Flumetsulam SOA 2	51				41		
Sulfentrazone SOA 14		46			40		
Fomesafen SOA 14					22		

Data shown for all cover crop by herbicide combinations where the percent cover was reduced ($P<0.05$) at seven weeks after planting. Data is not show for cover crop by herbicide combinations with on adverse cover crop establishment effects.

2013 Percent Cover Results

	'King' ryegrass	'Bruiser' ryegrass	Tetraploid ryegrass	Oat + Pea mix	Tillage Radish®	Crimson clover	Cereal rye
Nontreated	66	61	63	61	54	38	51
S-metolachor SOA 15	18	29	22	54		24	
Imazethapyr SOA 2	44	56	57	40	18		
Flumioxazin SOA 14	38	47	35	45		24	
Pyroxasulfone SOA 15	35	39	40	43			
Flumetsulam SOA 2	51				41		
Sulfentrazone SOA 14		46			40		
Fomesafen SOA 14					22		

ALS inhibitors , PPO inhibitors and Long chain fatty acid inhibitors impacted ryegrasses and Tillage Radish®

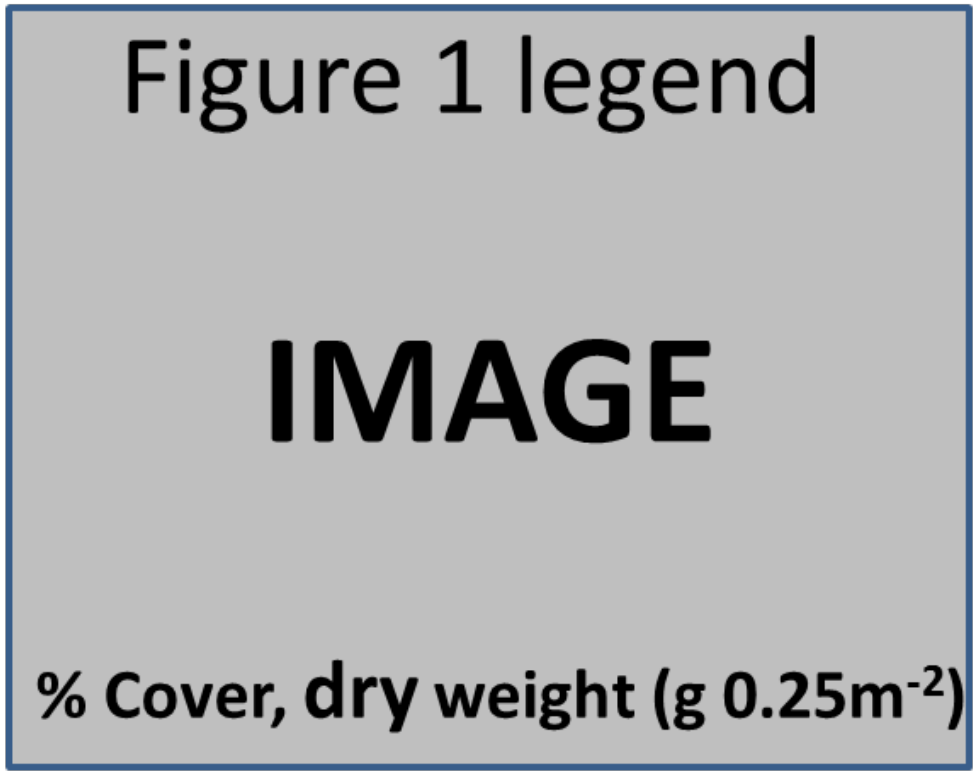
2013 Percent Cover Results

	'King' ryegrass	'Bruiser' ryegrass	Tetraploid ryegrass	Oat + Pea mix	Tillage Radish®	Crimson clover	Cereal rye
Nontreated						38	51
S-metolachor SOA 15						24	
Imazethapyr SOA 2							
Flumioxazin SOA 14	38	47	35	45		24	
Pyroxasulfone SOA 15							
Flumetsulam SOA 2							
Sulfentrazone SOA 14							
Fomesafen SOA 14							

Only two treatments had significant impact on crimson clover

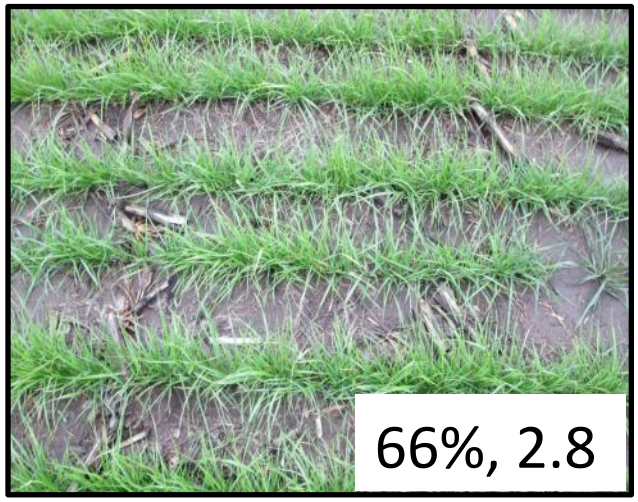
Results Photo Key

Figure 1 legend

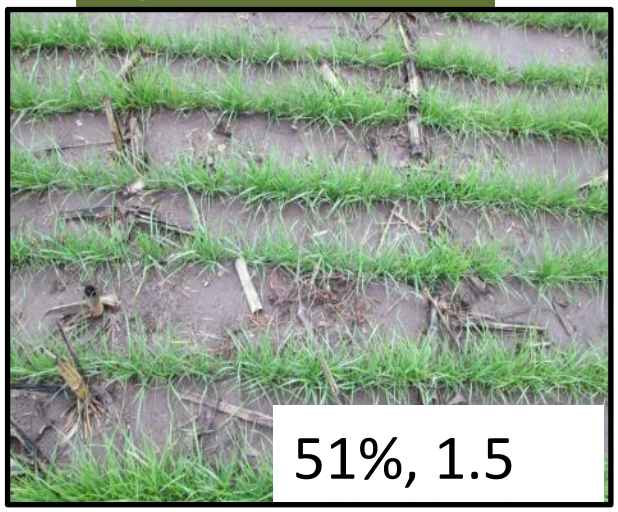


‘King’ Annual Ryegrass

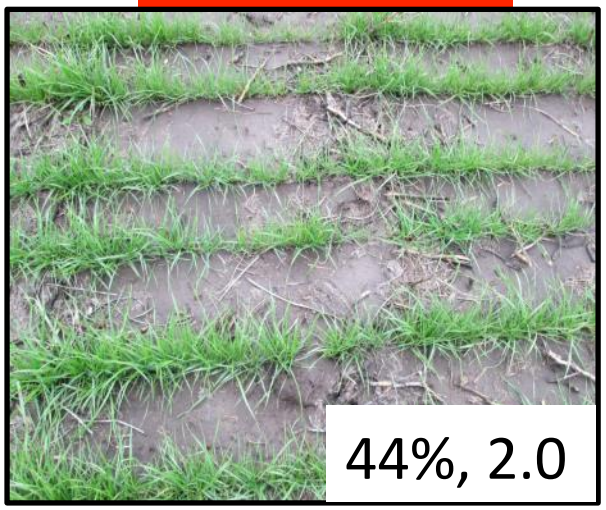
Nontreated



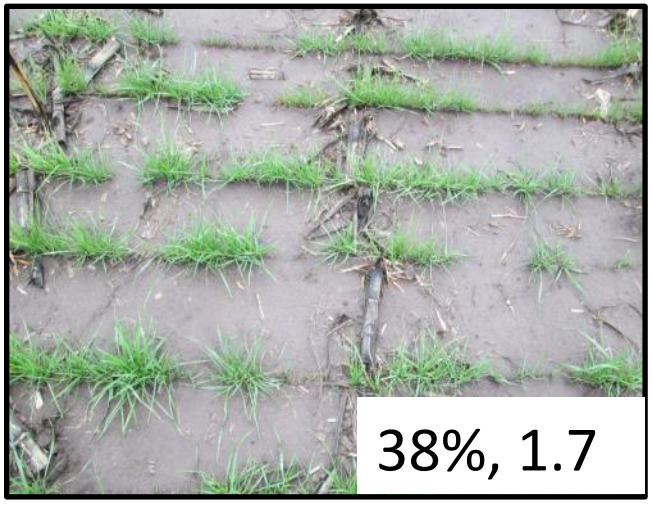
Pyroxasulfone



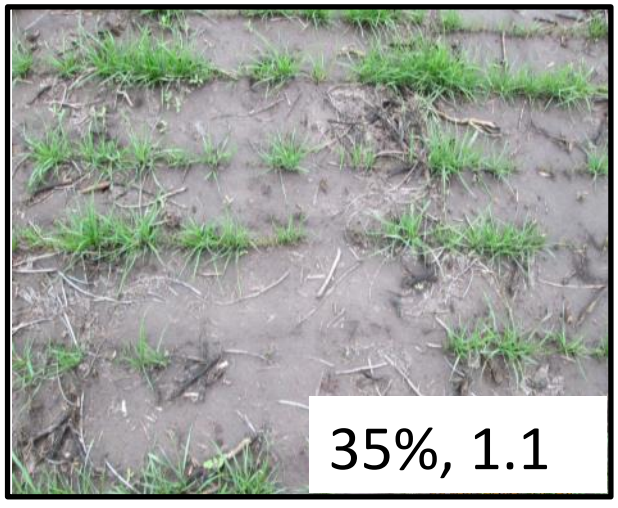
Imazethapyr



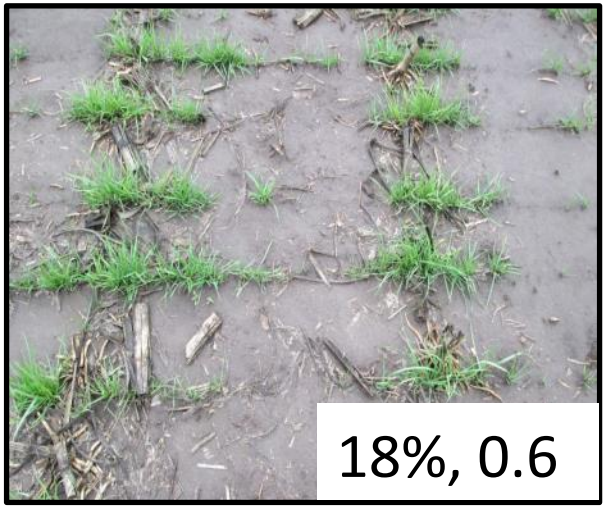
Flumioxazin



Flumetsulam

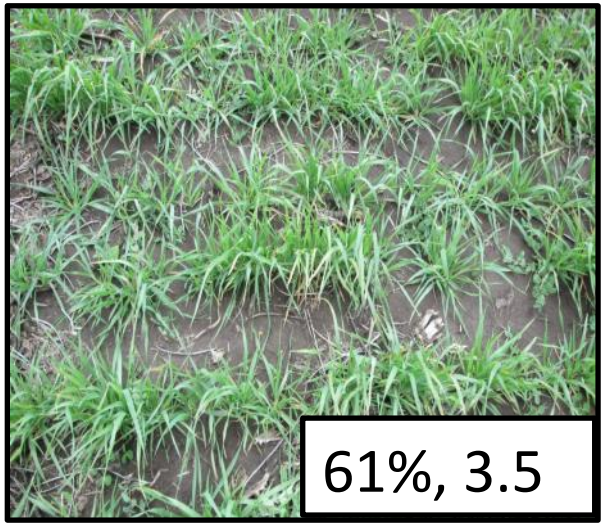


S-metolachor

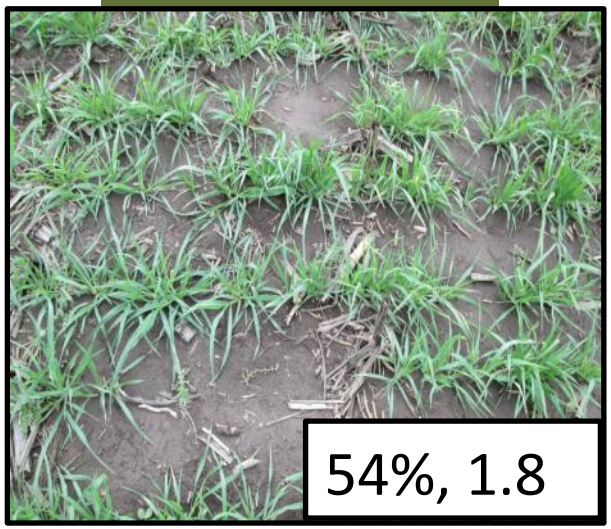


Oat + Pea Mix

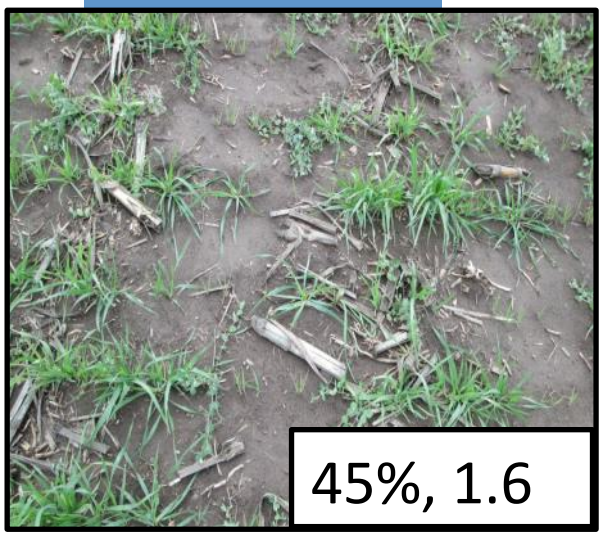
Nontreated



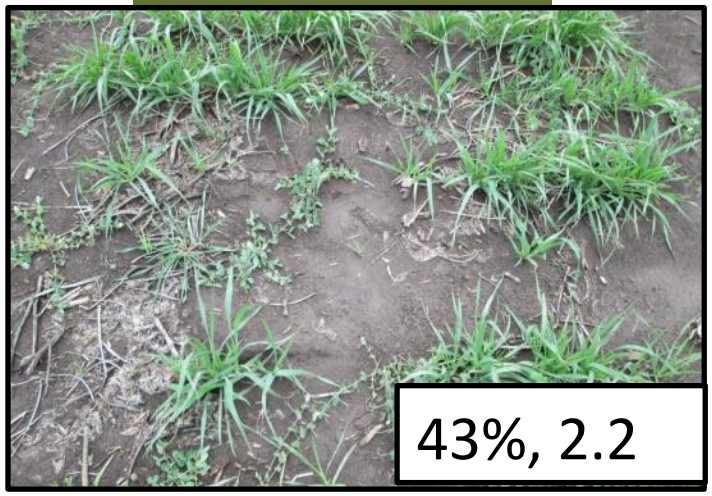
S-metolachor



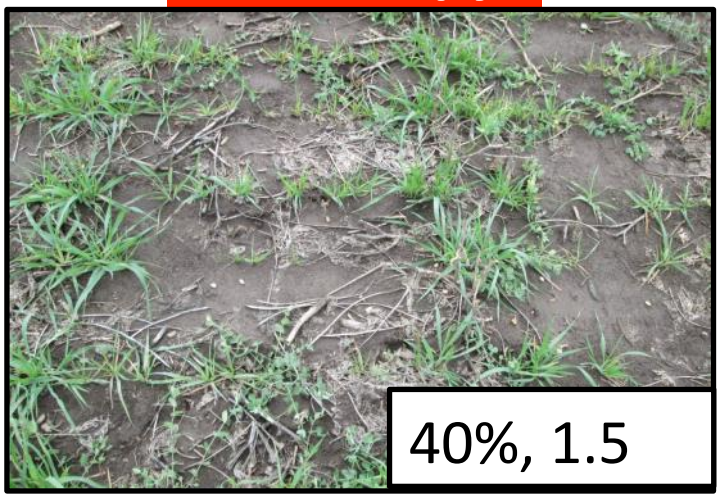
Flumioxazin



Pyroxasulfone

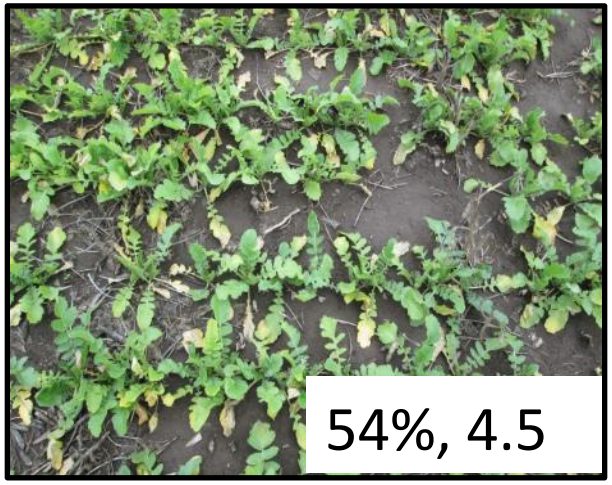


Imazethapyr

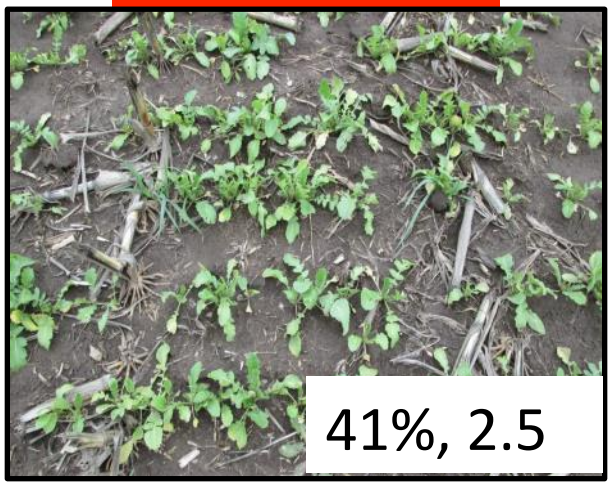


Tillage Radish®

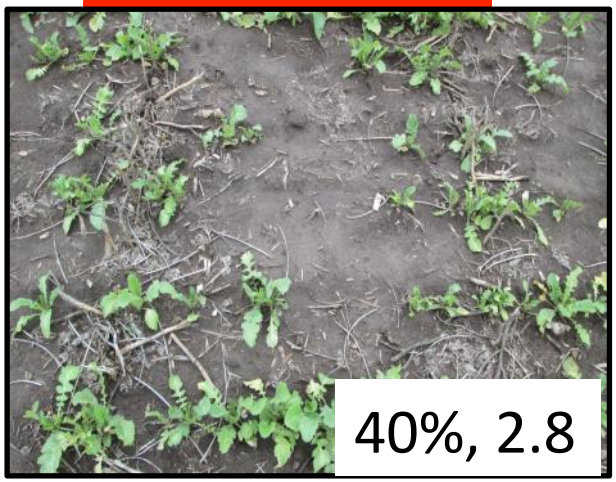
Nontreated



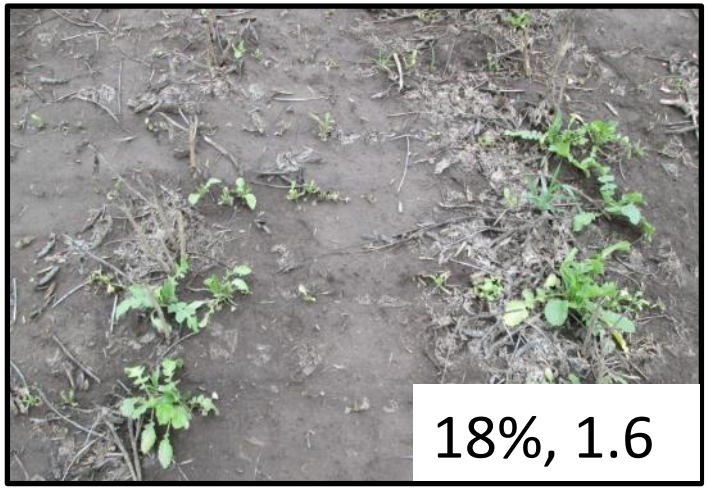
Flumetsulam



Sulfentrazone



Fomesafen



Imazethaphyr

2014 Results

- In 2014 ‘King’ and the tetraploid annual ryegrass were the only cover crops that had growth inhibition because of herbicide treatments applied in the corn or soybean trials (both p-values <0.0001).
- All other cover crops did not have significantly reduced percent cover (P<0.05) for all of the residual herbicide treatments.

Tetraploid annual ryegrass

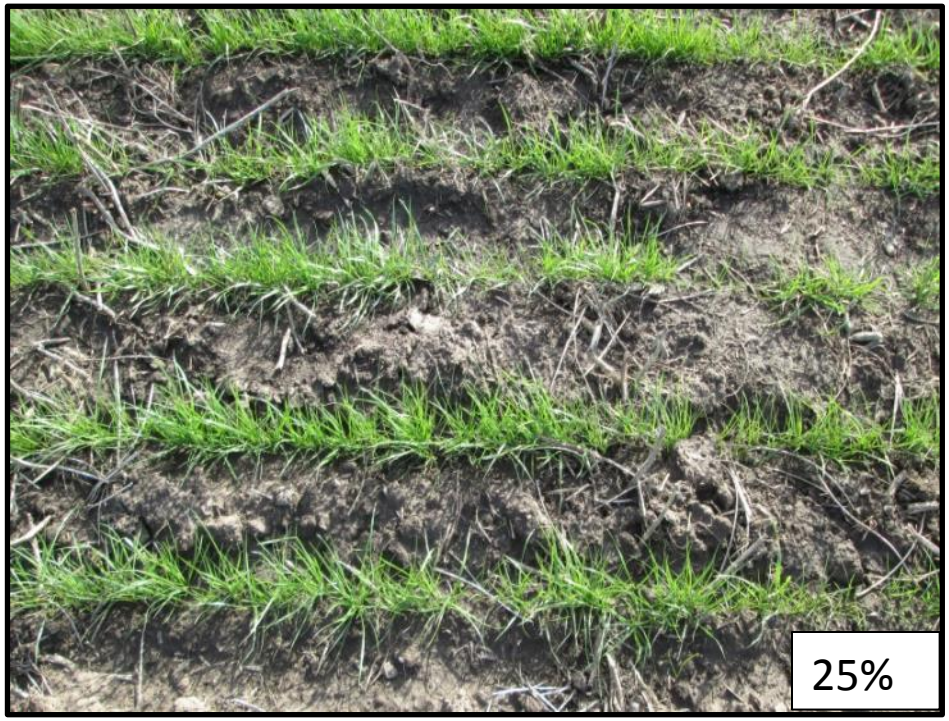
Nontreated

Simazine

Flumetsulam

‘King’ annual ryegrass

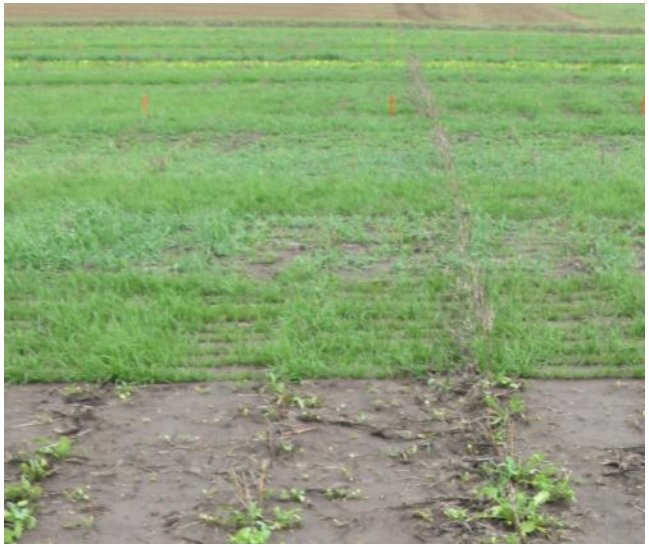
Nontreated



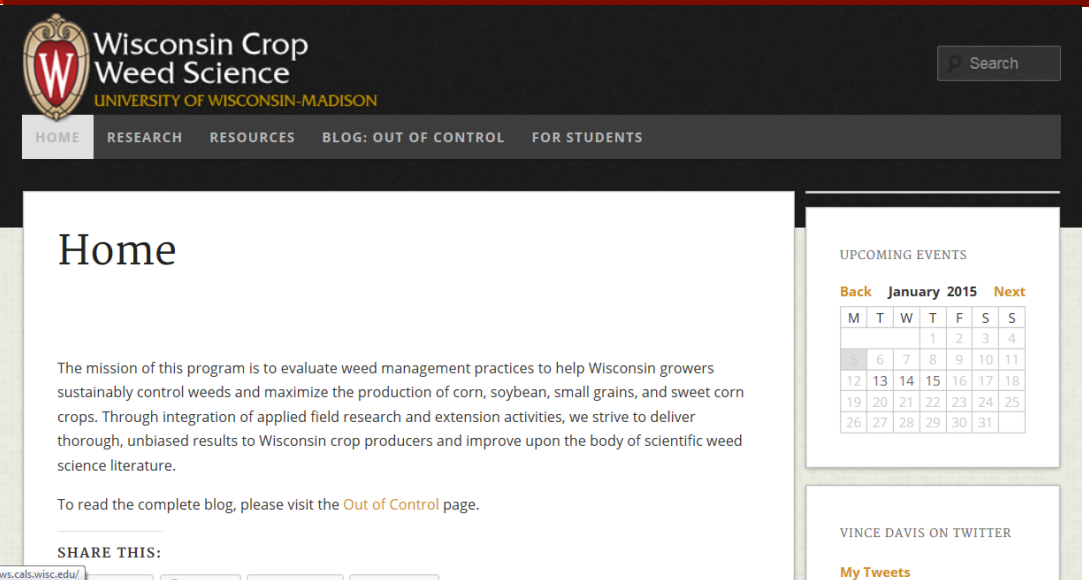
Sulfentrazone

Conclusions

- From these results we suggest several commonly used corn and soybean herbicides have the potential to reduce the establishment and green cover of many different cover crops.
- The severity of damage will be determined by weather, cover crop species, and the specific herbicide combination.



Resources



Wisconsin Crop Weed Science Website: http://wcws.cals.wisc.edu/

Herbicide Rotation Restrictions in Forage and Cover Cropping Systems Fact Sheet

Herbicide Rotation Restrictions in Forage and Cover Cropping Systems

Designing effective herbicide programs while following pesticide label restrictions can be challenging in any cropping system. With rotations that include forage and cover crops, the challenge can be increased—especially when a planned cover crop might be needed as supplemental or emergency forage. In this case, the best approach is to be aware of crop rotation restrictions ahead of time and plan the most effective solution for all possible scenarios.

Herbicide label rotational restrictions

Once a herbicide is used in a cropping system, the restrictions on that label must be followed for the original crop it is used on AND the succeeding crops until all restrictions on that label have been surpassed. These rotational restrictions exist for two reasons:

1. To protect humans and animals from herbicide residues that a succeeding crop may accumulate at elevated labels prior to entering the feed or food chain.
2. To ensure good establishment for the following crops by avoiding herbicide carryover injury.

An EPA registered pesticide label is a legal document and the instructions must be followed to avoid violating Federal law. Always check the herbicide label for crop rotational restrictions (http://www.cdms.net/LabelsMsds/LMDefault.aspx). Each crop will have a rotational planting interval stated in days or months. If a rotational restriction is not listed for a specific crop, follow the maximum interval. Pay careful attention to any listed exceptions.

What is the difference between a forage crop and a cover crop?

Simply put, a forage crop is planted for animal feed, which can be either grazed by animals or harvested from the field. A cover crop is planted for a variety of reasons—improving soil health, adding nutrients, suppressing weeds—and is not harvested. Typically, the cover crop's biomass stays in the field and may be incorporated into the soil.

In the legal sense, once the biomass of a cover crop is removed from the field for feed (grazed or harvested), it is considered a forage crop or more precisely a crop, according to the EPA registered pesticide label. It is important to note that even in situations where cover crops are allowed to be grazed or harvested within a crop insurance or cost-share program, the label restrictions must still be followed.

Conclusions

- Symptoms of carryover may go un-noticed if uniform across a entire field.
- More research will be needed to establish best management practices for farmers interested in the use of cover crops following silage harvest.

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.

Acknowledgments

- Thank you to advising committee members Francisco Arriaga, Mark Renz, and Matt Ruark
- Cover crop seed provided by Lacrosse Seed
- A special thanks to Tim Trower, the Arlington Agriculture Research Station Staff, and all graduate and undergraduate research assistants for their technical assistance


Questions?