Herbicide Carryover Evaluation in Cover Crops Following Corn and Soybean Herbicides

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Abstract

Cover Crops are a growing interest for corn and soybean producers in the North Central region due to the benefits of reducing soil erosion, providing and scavenging nutrients, and increasing soil organic matter. This study was conducted to determine whether common soil applied herbicides with residual weed control properties applied in the spring during the establishment of corn and soybean crops affect the subsequent establishment of cover crops in the fall. Corn and soybean trials with glyphosate-resistant cultivars were established at Arlington Agricultural Research Station, Arlington, WI on June 2, 2013 and May 28, 2014. Similar trials were also conducted near Lafayette, IN but only the Arlington, WI data are shown. Corn and soybean trials had fourteen herbicide treatments applied at common labeled rates and timings. Treatments were replicated four times. Each crop included a control treatment with no residual herbicide applied, but weeds were managed with postemergence (POST) glyphosate for all treatments as needed to remove any effects from weeds. Both trials were harvested for silage near the beginning of September, and seven different cover crop species and/or varieties were seeded uniformly across all herbicide treatments. The cover crops included Tillage Radish® (*Raphanus* sp;), crimson clover (*Trifolium incarnatum*), 'Guardian' winter rye (*Secale cereal*), a mixture of 70% oat (*Avena sativa*) plus 30% peas (*Pisum sativum)*, and three different annual ryegrass (*Lolium multifloram*) varieties. The annual ryegrass varieties included 'Bruiser' and 'King', both diploids, and a tetraploid. Nearly two months after seeding, the cover crops were evaluated for herbicide injury with digital image analysis for percent cover and by weighing total dried biomass collected from a 0.25m^2 quadrat. Herbicide injury included the evaluation of plant stunting and loss of plant greenness. In 2013 winter rye was the only cover crop without growth inhibition because of herbicide treatments applied in the corn or soybean trials (both p-values < 0.0001). 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 soybean trial. 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. From these results we suggest several commonly used corn and soybean herbicides have the potential to adversely affect the establishment of many different cover crops, but the severity of damage will be determined by weather, cover crop species, and the specific herbicide combination. More research will be needed to establish best management practices for farmers interested in the use of cover crops following silage harvest.

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

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Agronomy
UNIVERSITY OF WISCONSIN–MADISON

WCWS
Wisconsin
Crop Weed Science

Background

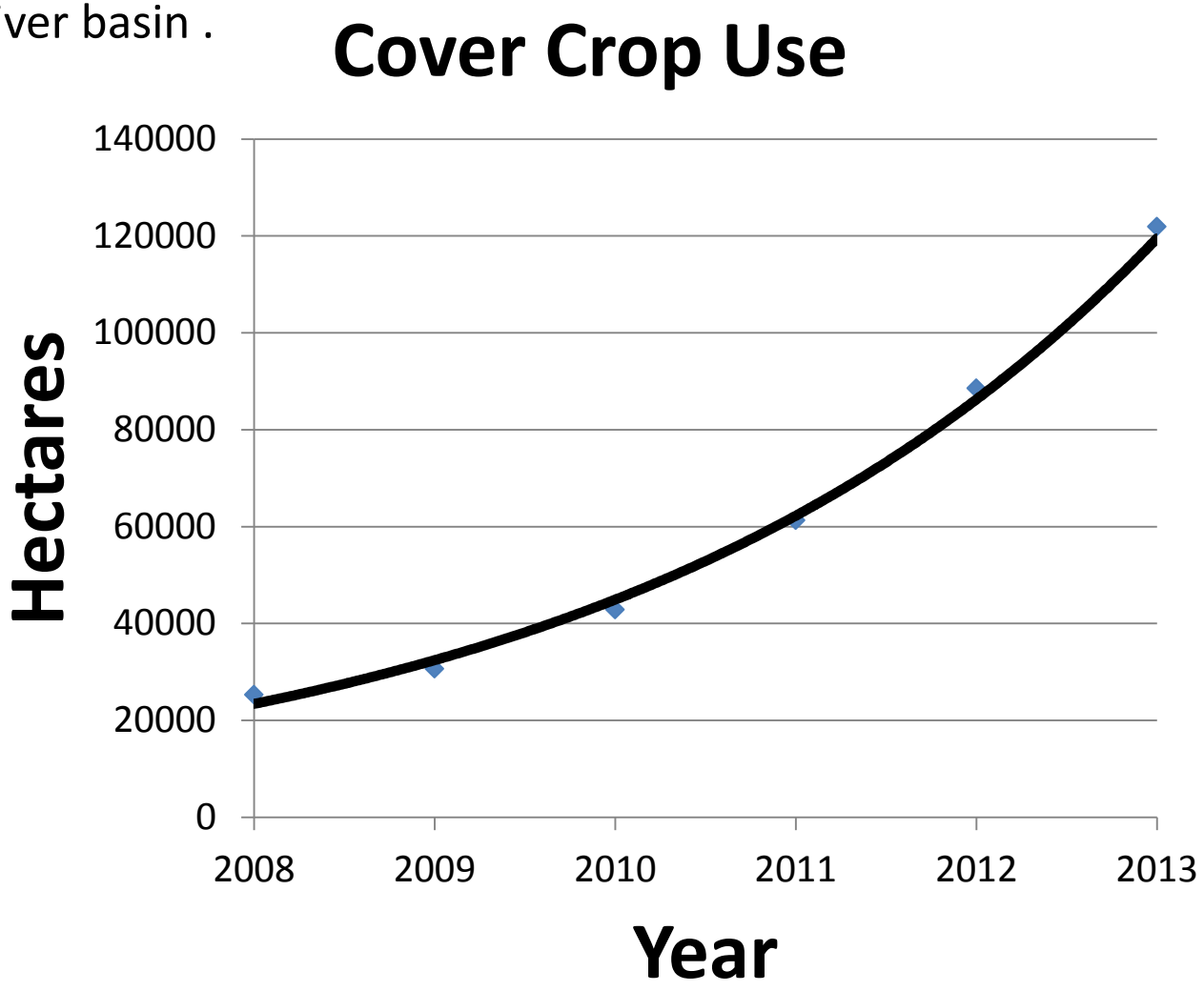
- Cover crops are of increasing interest to producers in the North central region due to many agronomic benefits.
- Cover crops have been utilized for many years in organic production.
- While cover crops are of increasing interest there are challenges to their establishment.
- Due to previous herbicide 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

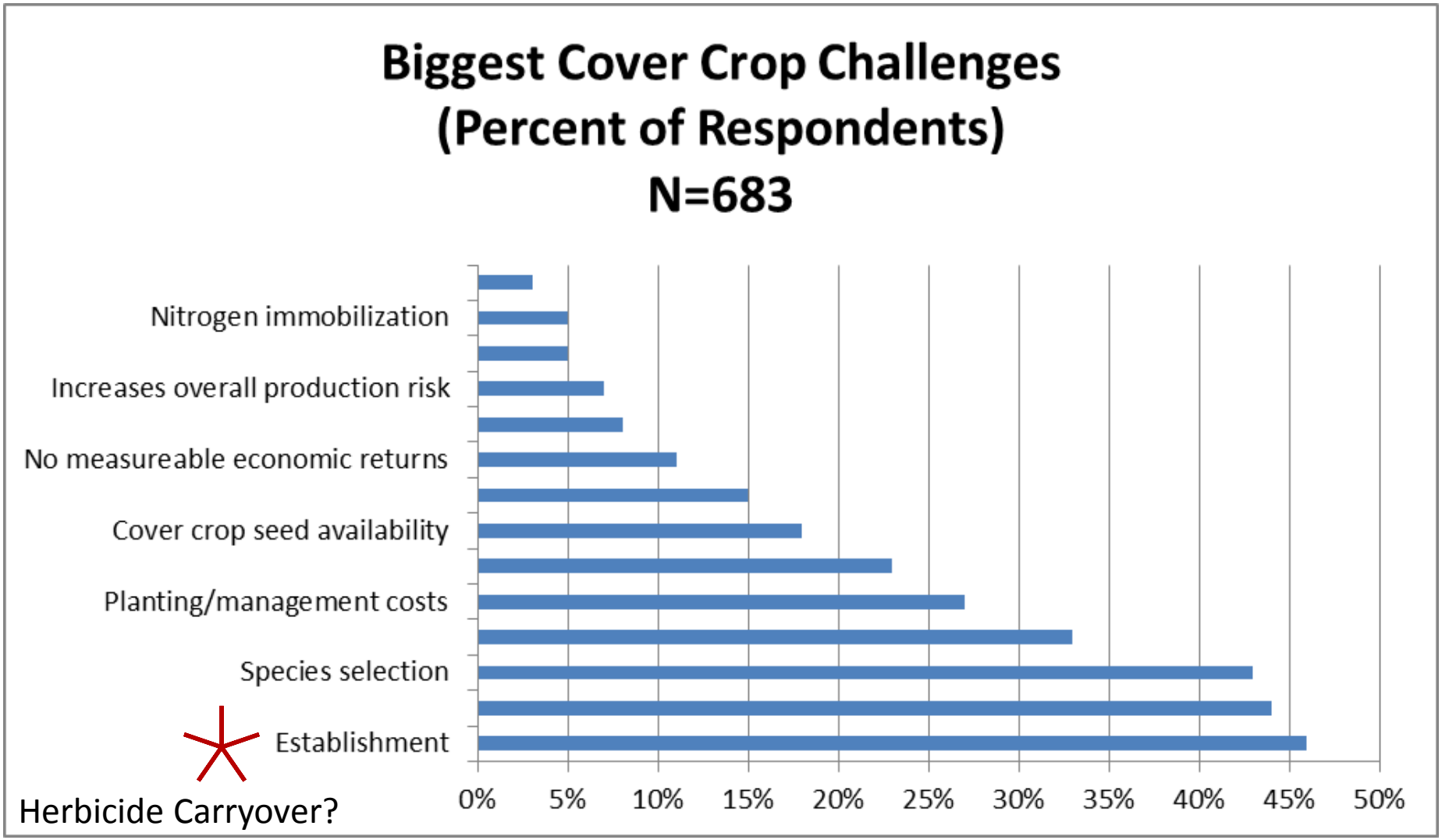
Increasing Use Trend

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

.

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

15m

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

3m

- 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
- 7 Sites of Action Groups

Corn Treatments

Treatment	Active Ingredient	Site of action group (SOA)	Timing	Rate- active ingredient (g/ha^{-1})*
1	saflufenacil	14	PRE	20
2	saflufenacil	14	PRE	30
	dimethenamid-p	15	PRE	266
3	s-metolachlor	15	PRE	758
	mesotrione	27	PRE	75
	s-metolachlor	15	LPOST	427
	glyphosate	9	LPOST	427[a] [a=] acid equivalent
	mesotrione	27	LPOST	43
4	flumioxazin	14	PRE	22
	pyroxasulfone	15	PRE	27
5	flumetsulam	2	PRE	23
6	simazine	5	EPOST	907
7	clopyralid	4	EPOST	85[a]
8	nicosulfuron	2	EPOST	14
9	rimsulfuron	2	EPOST	7
10	acetochlor	15	EPOST	319
	flumetsulam	2	EPOST	10
	clopyralid	4	EPOST	32
11	mesotrione	27	EPOST	85
12	rimsulfuron	2	EPOST	2
	thifensulfuron-methyl	2	EPOST	1
13	tembotrione	27	EPOST	32
14	topramezone	27	EPOST	7

Soybean Treatments

Treatment	Active Ingredient	Site of Action Group (SOA)	Timing	Rate- active ingredient (kg/ha^{-1})* [a= acid equivalent]
1	sulfentrazone	14	PRE	113
2	flumioxazin	14	PRE	36
3	metribuzin	5	PRE	17
4	chlorimuron-ethyl	2	PRE	7
5	sulfentrazon	14	PRE	61
	metribuzin	5	PRE	92
6	flumioxazin	14	PRE	52
7	pyroxasulfone	15	PRE	72
8	cloransulam-methyl	2	EPOST	7
9	s-metolachlor	15	EPOST	576
10	acetochlor	15	EPOST	510
11	fomesafen	14	EPOST	107
12	imazethapyr	2	EPOST	28
13	imazethapyr	2	EPOST	7
	glyphosate	9	EPOST	21^{-a}
14	lactofen	14	EPOST	89

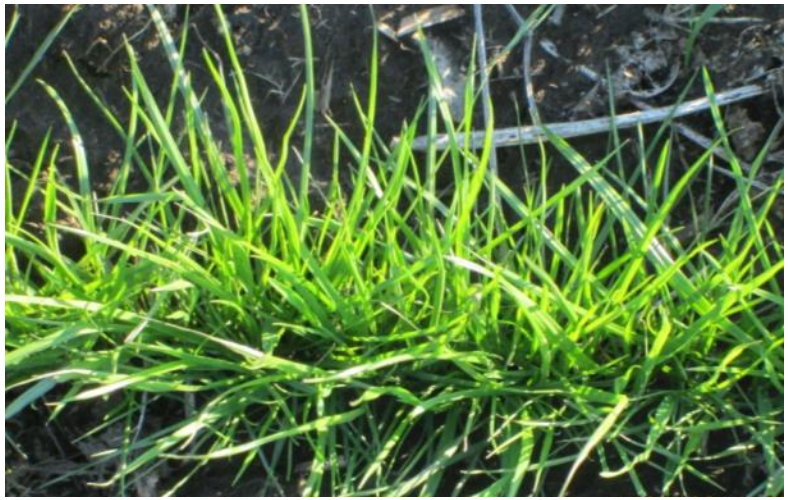
Variety and Latin Binomial of Cover Crops

	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

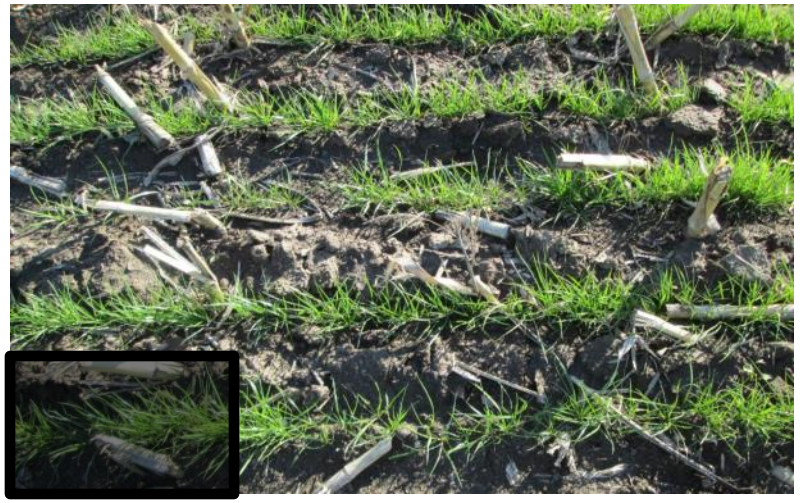
	Winter rye	Oats + peas mix	Crimson clover	Tillage Radish®	Annual ryegrasses
Depth (cm)	2.5	2.5	0.6	0.6	0.6
Seeding Rate(kg ha $^{-1}$)	134.4	100.8 Peas 33.6 Oats	11.2	12.3	37.0



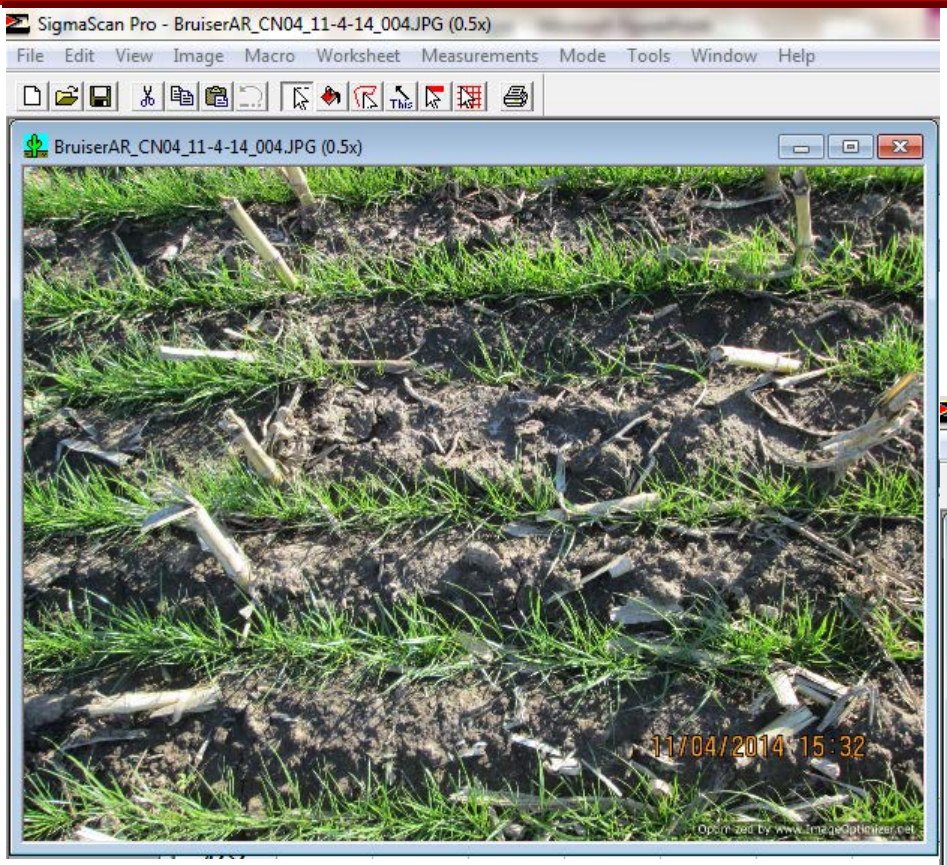
Materials and Methods

- 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 91 cm above each cover crop in every plot. The camera (Canon PowerShot A1400) was mounted at a 70 degree angle on a 2.5 cm by 114 cm 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.



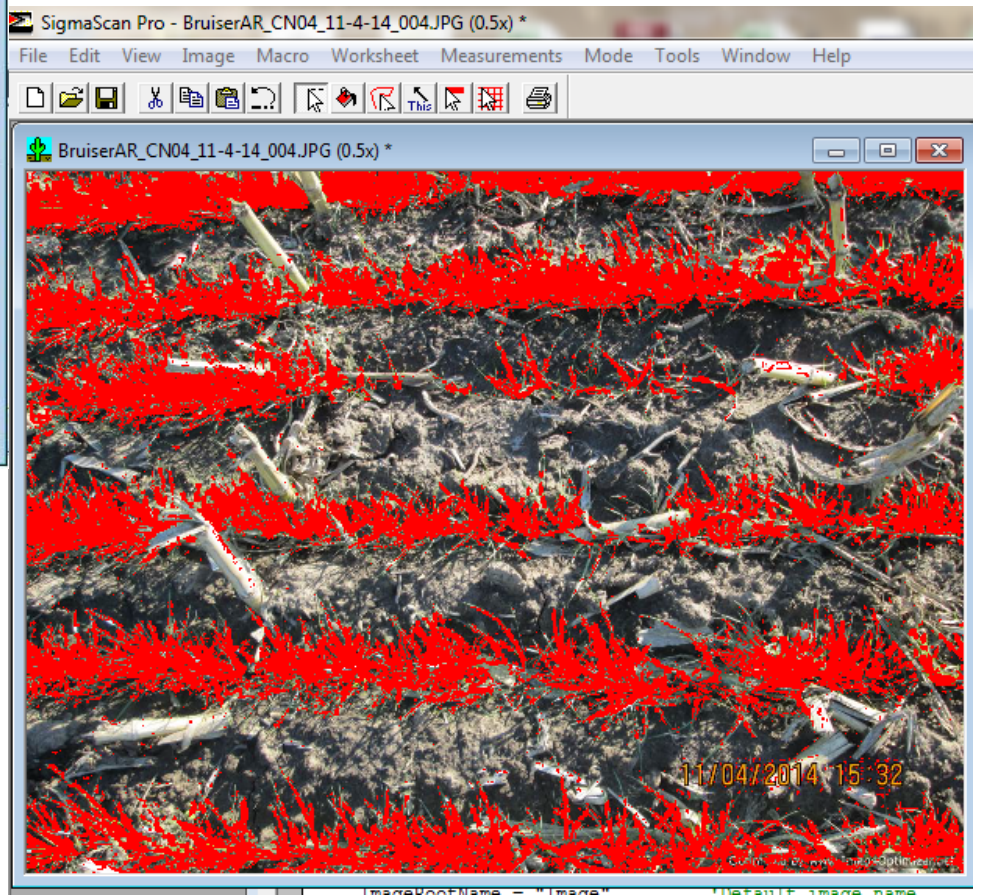
Percent Cover Calculation Procedure



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

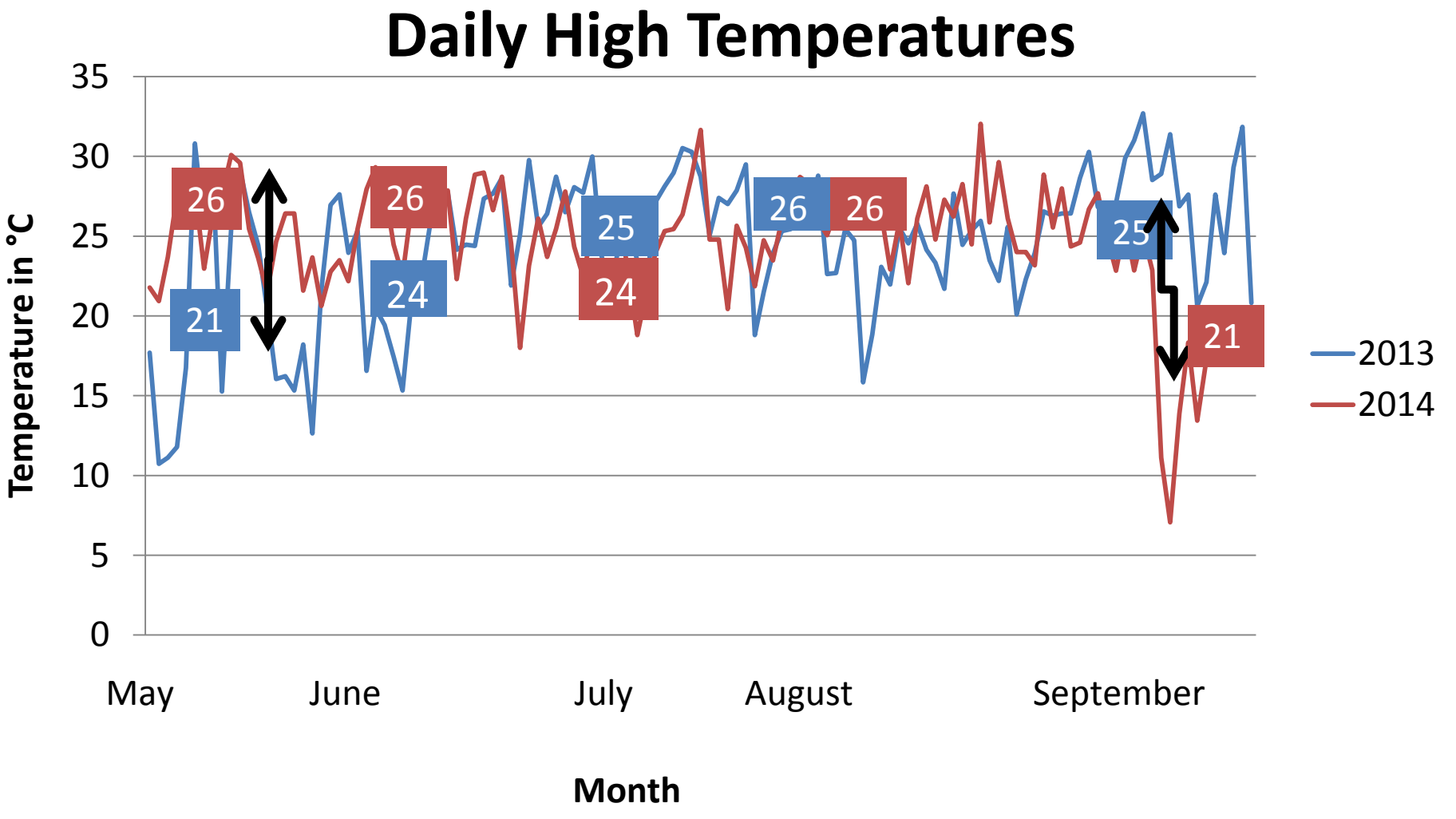


Weather- Precipitation

Month	2013 (mm)	2014 (mm)
May	140	16
June	189	238
July	69	38
August	42	65
September	0.25	31
Totals	440	389

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							
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
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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®

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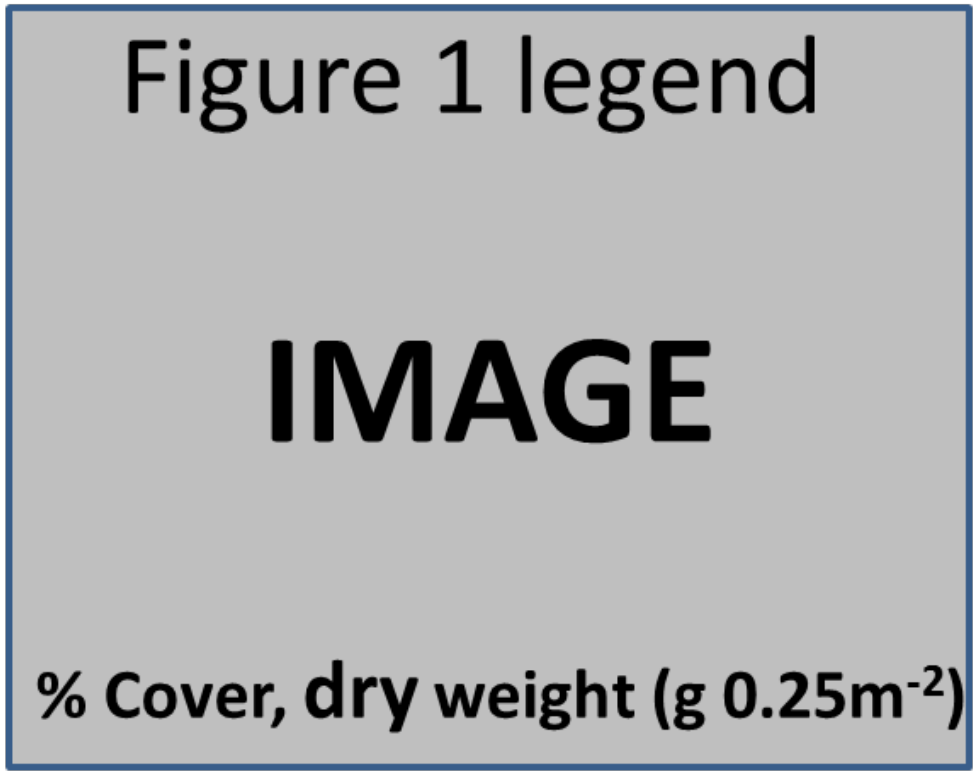
Flumioxazin SOA 14	38	47	35	45		24	
Pyroxasulfone SOA 15	35	39	40	43			
Flumetsulam SOA 2							
Sulfentrazone SOA 14							
Fomesafen SOA 14							

Only two treatments had significant impact on crimson clover

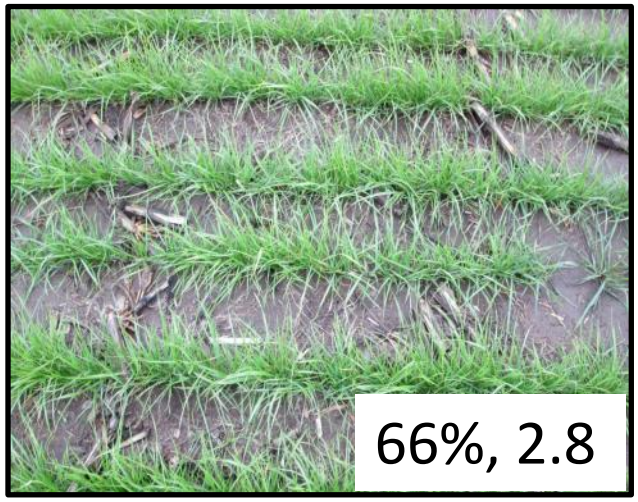
Results Photo Key

Figure 1 legend

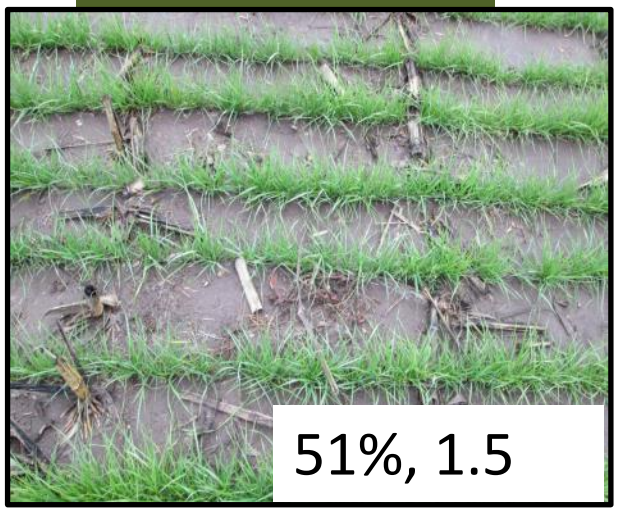


‘King’ Annual Ryegrass

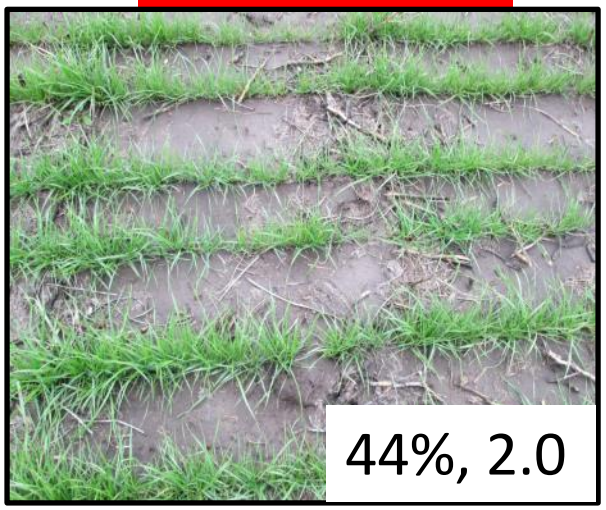
Nontreated



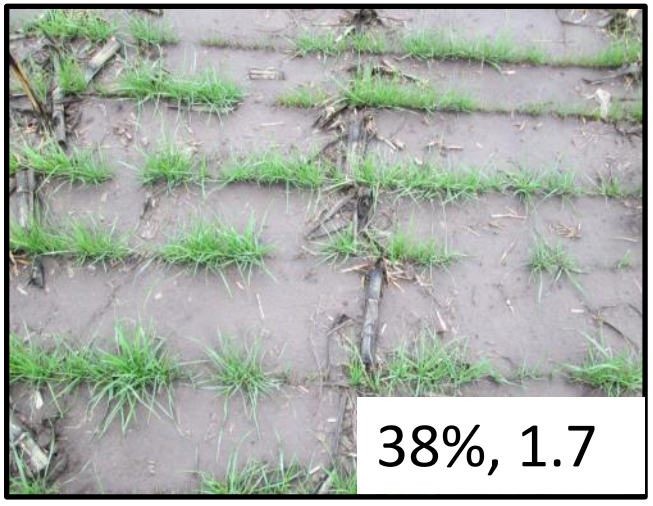
Pyroxasulfone



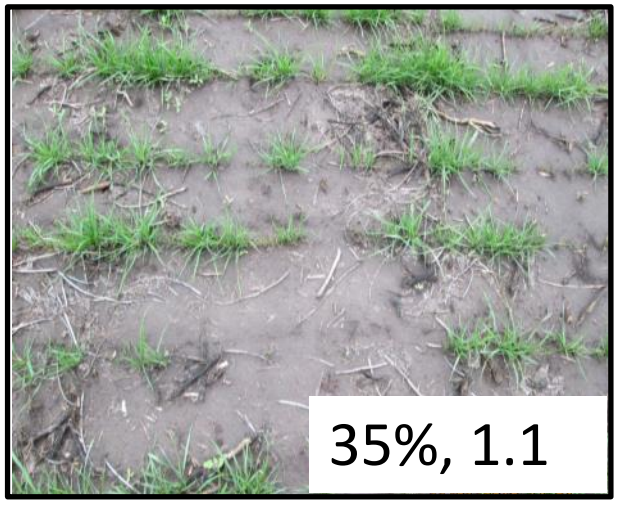
Imazethapyr



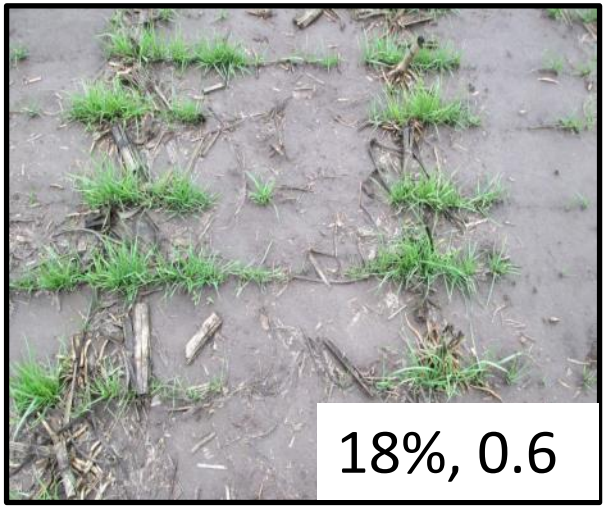
Flumioxazin



Flumetsulam

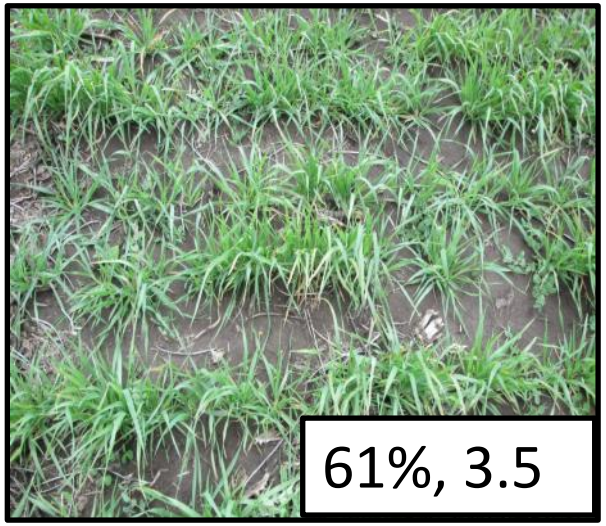


S-metolachor

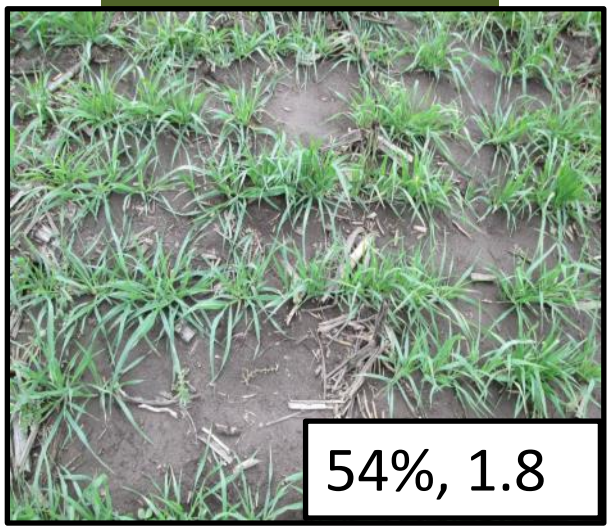


Oat + Pea Mix

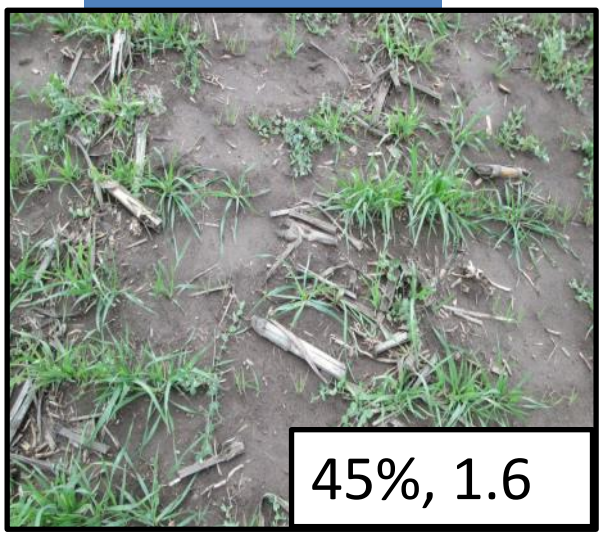
Nontreated



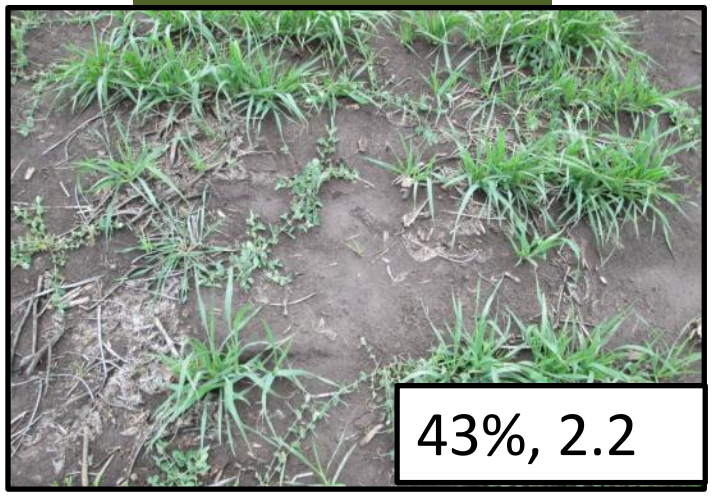
S-metolachor



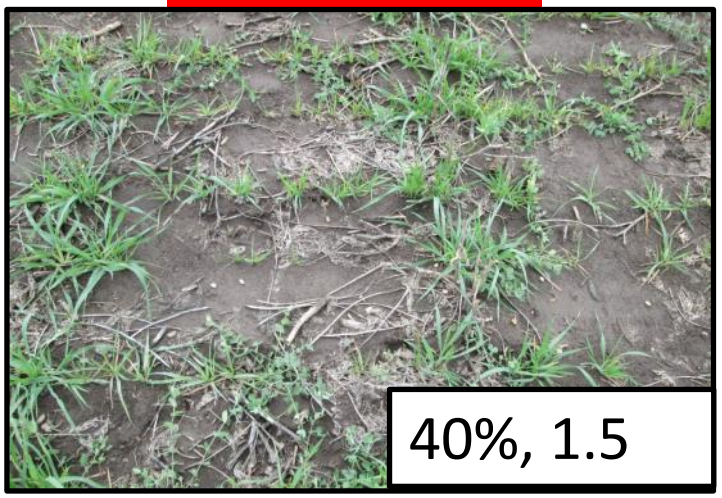
Flumioxazin



Pyroxasulfone

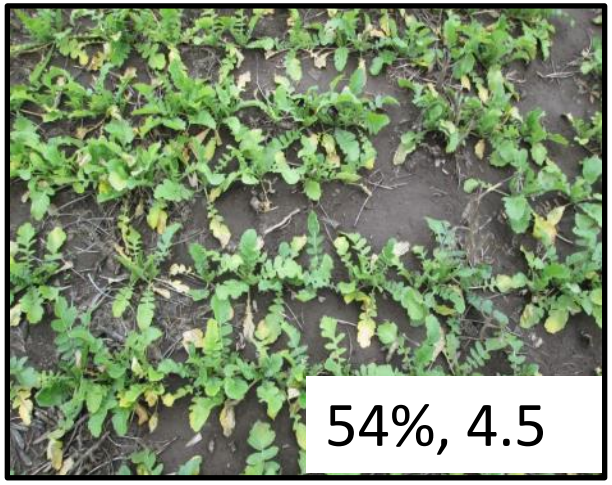


Imazethapyr

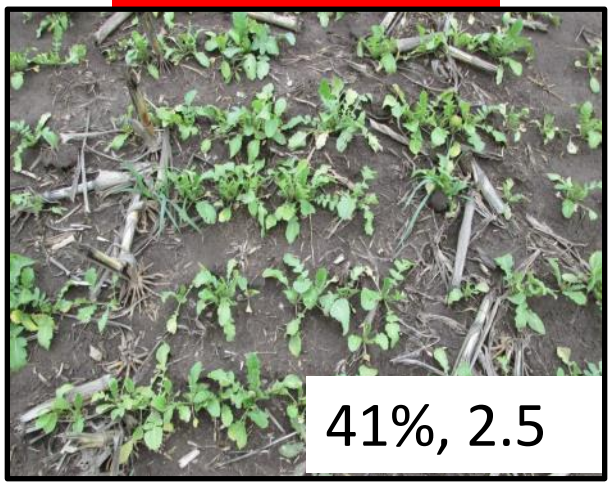


Tillage Radish®

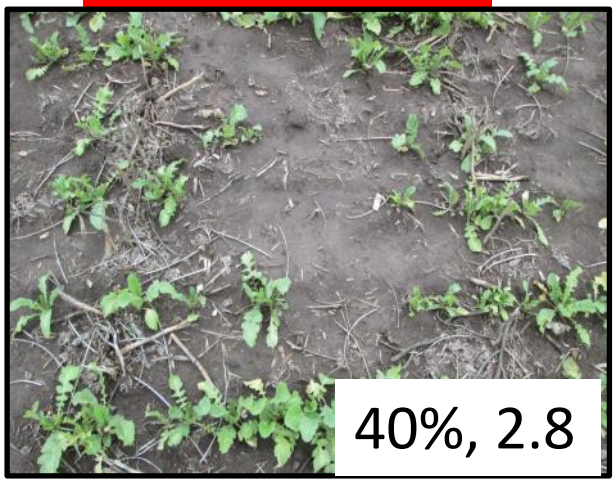
Nontreated



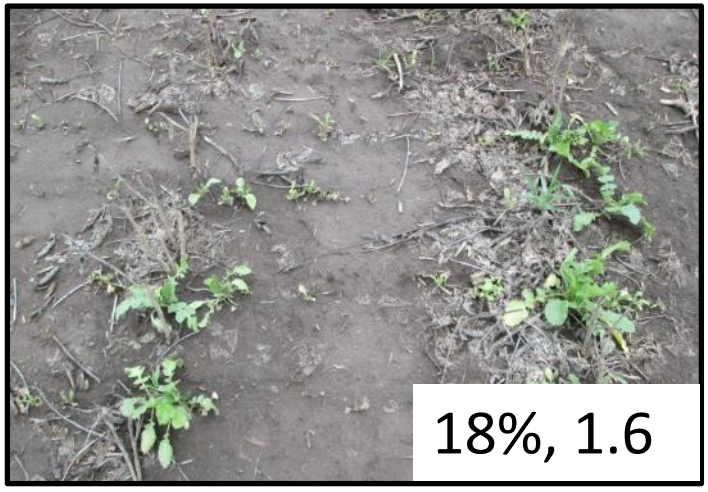
Flumetsulam



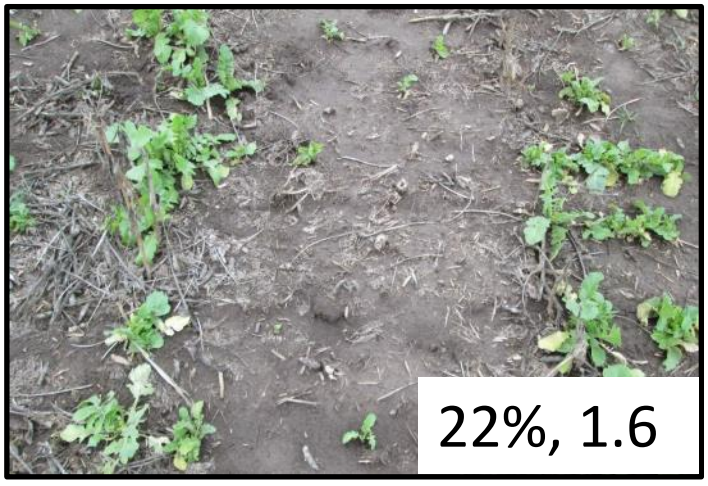
Sulfentrazone



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

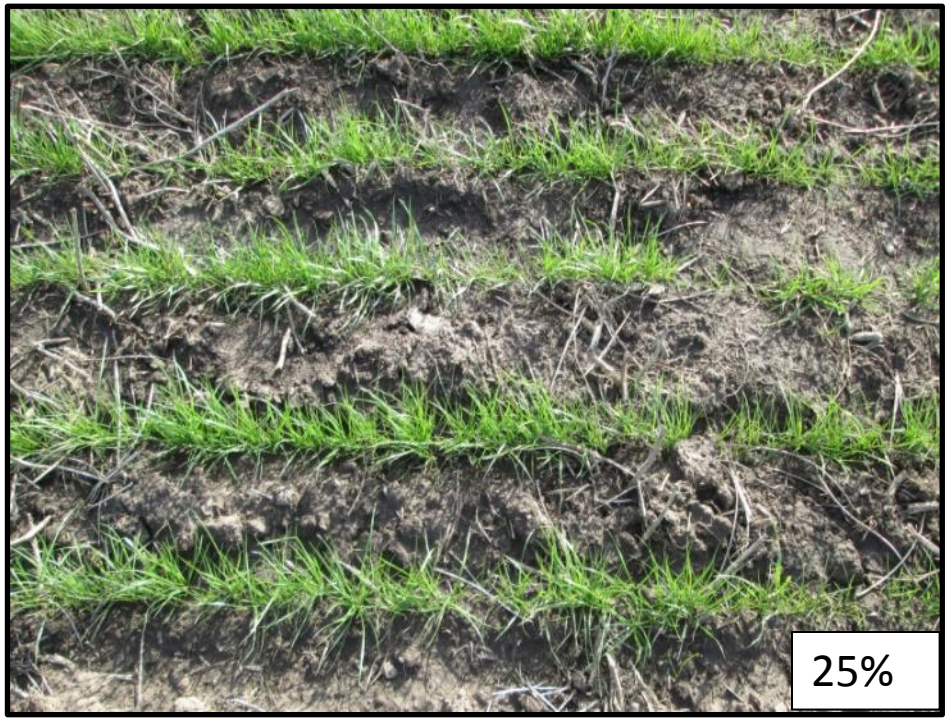
Nontreated

Simazine

Flumetsulam

‘King’ annual ryegrass

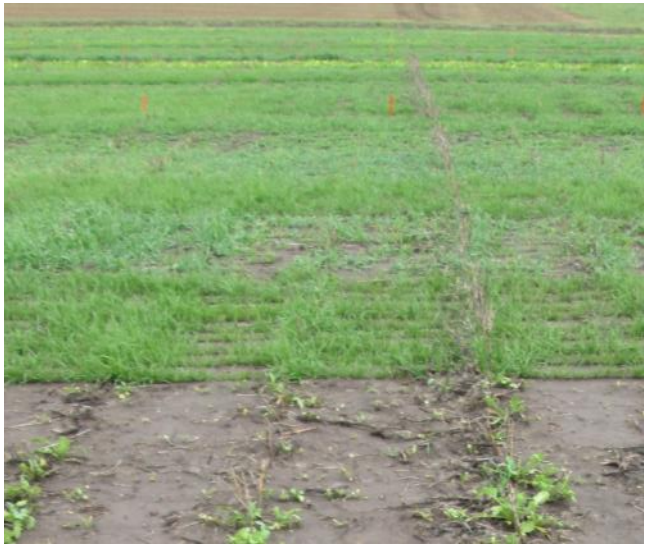
Nontreated



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.



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.

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?