

Herbicide Residual Effects on Cover Crops after Corn Silage

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According to USDA NASS, in 2019, South Dakota had 340,000 acres of corn harvested for silage. Silage is an important feed source for livestock producers in the state. However, silage harvesting removes residue and leaves soil exposed and susceptible to erosion. There are steps that producers can take to protect and improve the soil for future crops. Soil health principles that will help keep soil healthy and productive include: keeping soil covered, limiting soil disturbance, having a living root in the soil and increasing plant diversity.

In the last ten years, crop producers in South Dakota have shown increased interest in cover crops. In South Dakota, there is usually time in the season to plant a cool season cover crop after corn silage harvest. Planting a cover crop can improve soil health by providing protection to soil, increasing plant diversity and maintaining a living root for a longer timeframe.

As farmers consider whether to plant a cover crop after corn silage harvest, they often wonder what potential impact the residual activity of the herbicide(s) used in corn will have on the new cover crop. Herbicide carryover, a common problem in modern farming, is usually not uniform across a field. This can lead to uneven establishment of cover crop species. Heavy herbicide carryover areas include field entrances and edges, sprayer turnaround areas, eroded hills, and high and low pH soils depending on active ingredients. Some herbicides may show worse effects in areas with high or low moisture levels, extreme soil pH, and low organic matter. Another contributing factor could be higher herbicide rates which can lengthen the carryover time after herbicide application. However, there could be other reasons for a decreased cover

crop stand that producers need to be aware of, such as moisture deficit, high surface residue, weed pressure, and planting errors (seed depth, rate, and planting time).

Before planting cover crops, some herbicides require a field bioassay to be completed.

To perform a bioassay:

1. Collect a representative soil sample from the field or area in question
2. Mix the sample together and place it in a container (around a gallon of soil)
3. Plant seeds of desired cover crop species in the container of soil
4. As a control, plant some seeds in a container of soil from an adjacent or nearby area which did not receive the herbicide application
5. Observe each container for one week for seed germination and growth

If satisfactory growth is established, when compared to the check, then the cover crop may be planted. One critical thing to remember is that the reliability of a bioassay is only as good as the representative soil sample.

Table 1. Research shows that the following corn herbicides applied on label pre/early post, do not impact cover crops planted after corn.

SOA	Trade Name	Active Ingredient(s)
3	Prowl® H ₂ O	pendimethalin
4	Scorch™; Spitfire®; 2,4D Amine; 2, 4D LV4; 2,4D Choline; Clarity®; Starane® Ultra; Trump Card®; Kochiavore™	2,4D Amine; 2,4D Ester; 2,4D Choline; dicamba; fluroxypyr; clopyralid
6	DeadBolt®	bromoxynil
9	Roundup PowerMax®	glyphosate
10	Liberty® 280 SL	glufosinate
14	Sharpen®; Aim EC; Cadet®; Vida®	saflufenacil; carfentrazone; fluthiacet-methyl; pyraflufen
22	Gramoxone® SL 2.0	paraquat

If silage producers intend to plant cover crops they should choose herbicides that give them flexibility to do so. Due to potential herbicide carryover, the following questions need to be asked by a cover crop grower to ensure safe and productive cover crop establishment.

Will the cover crop be grazed or harvested for feed?

If Yes, then any forage restrictions listed on the label **MUST** be followed!

If No, answering the following questions can help ensure successful cover crop establishment. **The producer takes full liability for any cover crop loss.**

1. When was the herbicide applied?
2. What is the anticipated cover crop planting date?
3. How sensitive is each species in the cover crop mix to the applied herbicide?
4. How will the residual herbicide be impacted by field conditions?

For assistance with any cover crop questions, please contact the nearest SDSU Extension Regional Center.

Herbicide Residual Effects on Cover Crops after Wheat

This study was conducted during the 2018 and 2019 growing seasons at the Southeast Research Farm near Beresford and on-farm locations near Redfield and Groton, South Dakota.

RESULTS:

Research has shown that soil pH over seven and lack of microbial breakdown are the leading causes for herbicides used in this study to cause carryover to rotational crops. Microbial breakdown of herbicides are increased in an environment favorable to microbial growth, which includes generally warm temperatures and sufficient soil moisture.

For this study, 28 herbicides were applied before corn emergence (Pre) or after corn emergence (Post) according to label recommendations. After corn silage harvest, cover crops were drilled across all herbicide treatments at full seeding rates. Treatments were repeated four times at each study site. Data was collected eight weeks after cover crop planting from each treatment plot by counting cover crop stands in a five square foot area. Statistical analysis (Analysis of Variance, SAS 9.4) showed that the herbicides used in the study did not have significant impact on cover crop species stand across all three locations.

Results in **Table 2** and **Table 3** show the highest percent loss of cover crops after pre-applied or post-applied corn herbicides across all locations and years following corn silage in South Dakota. Depending upon field conditions, cover crop stand ranged from zero to highest percent loss (stated in Table 2 & Table 3). At some locations, stand counts varied quite significantly across replications.

Some herbicide labels clearly state the planting interval for various cover crop species. **Table 4** gives the label restrictions for cover crop planting dates after application of several common corn herbicides. If the cover crop is planted before the label stated time frame, then the cover crop grower takes full responsibility for any cover crop loss.

Table 2. Highest percent loss of cover crops after pre-applied corn silage herbicides across all locations and years.

Trade Name	SOA	Active Ingredient(s)	Mustard		Winter Pea		Winfred		Radish	
			Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture
1 lb Atrazine 4L	5	atrazine	25	25	17	0	29	42	0	29
1/2 lb Atrazine 4L	5	atrazine	17	34	17	11	12	20	17	8
Acuron®	15+5+27	S-metolachlor + atrazine + mesotrione + bicyclopyrone	0	29	16	12	19	56	11	30
Anthem® Maxx	15+14	pyroxasulfone + fluthiat methyl	26	25	0	20	24	10	22	30
Armezon®	27	topramezone	33	22	16	0	24	41	0	18
Armezon® PRO	15+27	topramezone + dimethenamid-p	13	41	16	12	14	62	17	20
Balance® flexx	27	Isoxaflutole	0	23	17	50	11	15	0	22
Callisto®	27	mesotrione	22	35	16	30	43	18	22	27
Cinch®	15	S-metolachlor	0	28	16	10	27	9	17	20
Corvus®	27+2	isoxaflutole + thiencazone	17	25	16	20	27	18	17	32
Glory®	5	metribuzin	25	32	17	14	24	34	17	7
Intrro™	2	alachlor	17	0	33	11	5	10	27	36
Lumax® EZ	15+27+5	S-metolachlor + mesotrione + atrazine	20	35	16	50	19	21	40	33
Outlook®	15	dimethenamid-p	25	35	33	20	7	47	28	30
Parallel®	15	metolachlor	20	44	16	50	24	29	17	42
Permit®	2	halosulfuron	33	32	16	14	19	20	17	20
Pruvin®	2	rimsulfuron	22	21	33	11	24	20	17	10
Python® WDG	2	flumetsulam	17	39	33	50	12	23	33	10
Resicore®	15+27+4	acetochlor + mesotrione + clopyralid	13	21	16	20	27	47	0	36
Sharpen®	14	saflufenacil	22	22	33	50	47	41	17	10
Surestart® II	15+2+4	acetochlor + flumetsulam + clopyralid	0	32	17	23	24	49	17	30
Valor® EZ	14	flumioxazin	17	28	17	20	47	22	11	42
Verdict®	14+15	saflufenacil + dimethenamid	33	28	16	11	29	25	17	14
Warrant®	15	acetochlor	17	21	17	20	41	13	22	45
Zidua®	15	pyroxasulfone	13	29	0	20	15	17	17	25
Low Moisture = 10 to 11 inches and High Moisture = 17 to 21.5 inches from herbicide application to cover crop planting										

Table 2. Highest percent loss of cover crops after pre-applied corn silage herbicides across all locations and years, continued.

Trade Name	SOA	Active Ingredient(s)	Flax		Rye		Annual Rye		Oat	
			Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture
1 lb Atrazine 4L	5	atrazine	33	18	22	17	37	35	15	20
1/2 lb Atrazine 4L	5	atrazine	25	22	15	18	40	19	31	27
Acuron®	15+5+27	S-metolachlor + atrazine + mesotrione + bicyclopyrone	20	13	23	26	37	41	7	20
Anthem® Maxx	15+14	pyroxasulfone + fluthiat methyl	10	23	0	24	63	22	14	29
Armezon®	27	topramezone	8	29	22	18	42	11	36	20
Armezon® PRO	15+27	topramezone + dimethenamid-p	33	7	17	18	32	32	15	15
Balance® flexx	27	Isoxaflutole	20	27	0	32	42	27	14	24
Callisto®	27	mesotrione	12	25	0	29	26	34	29	7
Cinch®	15	S-metolachlor	13	23	22	21	25	10	14	7
Corvus®	27+2	isoxaflutole + thiencazone	13	17	17	18	26	13	29	35
Glory®	5	metribuzin	13	32	15	53	45	54	38	7
Intrro™	2	alachlor	33	29	11	15	45	9	7	20
Lumax® EZ	15+27+5	S-metolachlor + mesotrione + atrazine	6	9	22	18	30	32	23	13
Outlook®	15	dimethenamid-p	40	38	18	9	40	44	29	24
Parallel®	15	metolachlor	33	24	17	24	37	55	23	20
Permit®	2	halosulfuron	25	22	17	9	42	8	7	15
Pruvin®	2	rimsulfuron	20	19	23	14	45	34	39	29
Python® WDG	2	flumetsulam	37	10	23	21	16	23	14	13
Resicore®	15+27+4	acetochlor + mesotrione + clopyralid	30	29	22	31	37	41	36	20
Sharpen®	14	saflufenacil	26	22	12	27	50	23	27	24
Surestart® II	15+2+4	acetochlor + flumetsulam + clopyralid	21	32	17	24	47	22	9	47
Valor® EZ	14	flumioxazin	10	11	17	5	40	19	23	12
Verdict®	14+15	saflufenacil + dimethenamid	25	15	13	18	45	15	29	19
Warrant®	15	acetochlor	20	7	16	35	42	26	24	20
Zidua®	15	pyroxasulfone	0	36	0	45	26	26	18	24
Low Moisture = 10 to 11 inches and High Moisture = 17 to 21.5 inches from herbicide application to cover crop planting										

Table 3. Highest percent loss of cover crops after post-applied corn silage herbicides across all locations and years.

Trade Name	SOA	Active Ingredient(s)	Mustard		Winter Pea		Winfred		Radish	
			Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture
Accent® Q	2	nicosulfuron	17	19	0	17	12	23	17	20
Beacon®	2	primisulfuron	0	35	16	0	28	33	17	30
Laudis®	27	tembotrione	0	41	0	22	29	30	28	18
Spirit®	2+2	prosulfuron + primisulfuron	0	25	0	20	19	42	17	11
Low Moisture = 8.5 to 9.5 inches and High Moisture = 14 to 19 inches from herbicide application to cover crop planting										

Trade Name	SOA	Active Ingredient(s)	Flax		Rye		Annual Rye		Oat	
			Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture	Low Moisture	High Moisture
Accent® Q	2	nicosulfuron	26	15	15	8	45	37	15	8
Beacon®	2	primisulfuron	20	21	6	0	21	27	15	27
Laudis®	27	tembotrione	40	32	12	0	42	45	14	27
Spirit®	2+2	prosulfuron + primisulfuron	33	33	17	11	35	32	15	24
Low Moisture = 8.5 to 9.5 inches and High Moisture = 14 to 19 inches from herbicide application to cover crop planting										

Table 4. Label plant-back restrictions for cover crops.

Trade Name	Cool Season							
	Grass			Legume	Broadleaf			
	Oat	Annual Ryegrass	Rye	Winter Pea	Mustard	Radish	Winfred	Flax
Accent® Q	4	10 ¹	4	10	10 ¹	10 ¹	10 ¹	10 ²
Acuron®	18 ³	18 ³	4	18 ³	18 ³	18 ³	18 ³	18 ³
Anthem® Maxx	11	11	11	18	18	18	18	18
Armezon®	3	3	3	9 ⁴	18	18	18	18
Armezon® PRO	4	4	4	9 ⁴	18	18	18	18
Atrazine 4L	2 CS ⁵	NCS ⁵	NCS ⁵	2 CS ⁵	NCS ⁵	NCS ⁵	NCS ⁵	NCS ⁵
Balance® flexx	4 ⁷	18 ^{6&7}	4 ⁷	18 ^{6&7}	18 ^{6&7}	18 ^{6&7}	18 ^{6&7}	18 ^{6&7}
Beacon®	18	18	3 ⁸	8 ⁸	18	18	18	18
Callisto®	AT	AT	4	10	18	18	18	18
Cinch®	4.5	12	4.5	12	60 D ¹⁰	60 D ⁹	60 D ⁹	12
Corvus®	4 ^{7&12}	17 ^{11&7}	4 ^{7&12}	17 ^{11&7}	17 ^{11&7}	17 ^{11&7}	17 ^{11&7}	17 ^{11&7}
Glory®	18 ¹³	18 ¹³	18 ¹³	8	18 ¹³	18 ¹³	18 ¹³	18 ¹³
Laudis®	4 ⁷	18 ⁷	4 ⁷	10 ⁷	18 ⁷	18 ⁷	18 ⁷	18 ⁷
Lumax® EZ	NCS	NCS	4.5	18	18	18	18	18
Outlook®	4 ¹⁴	4 ¹⁴	4 ¹⁴	4 ¹⁴	4 ¹⁴	4 ¹⁴	4 ¹⁴	4 ¹⁴
Parallel®	4.5	NCS	4.5	NCS	NCS	NCS	NCS	NCS
Permit®	2 ¹⁵	36 ¹⁵	2 ¹⁵	9 ¹⁵	36 ¹⁵	12 ¹⁵	36 ¹⁵	36 ¹⁵
Pruvin®	9	18	18	10	18	18	18	10/18 ⁴
Python® WDG	4	9	4	4	9	9	9	9
Resicore®	10.5 ¹⁶	18 ¹⁶	10.5 ¹⁶	18 ¹⁶	18 ¹⁶	18 ¹⁶	18 ¹⁶	18 ¹⁶
Sharpen®	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶
Spirit®	3 ¹⁷	18 ¹⁷	3 ¹⁷	10 ¹⁷	18 ¹⁷	18 ¹⁷	18 ¹⁷	18 ¹⁷
Surestart® II	26 ¹⁸	26 ¹⁸	NCS	NCS	26 ¹⁸	26 ¹⁸	26 ¹⁸	26 ¹⁸
Valor® EZ	4/10 ¹⁹	4/10 ¹⁹	3	3	4/10 ¹⁹	4/10 ¹⁹	4/10 ¹⁹	3
Verdict®	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶	4 ¹⁶
Warrant®	ACC ²⁰	ACC ²⁰	ACC ²⁰	ACC ²⁰	ACC ²⁰	ACC ²⁰	ACC ²⁰	ACC ²⁰
Zidua®	18 ⁴	18 ⁴	18 ⁴	11 ⁴	18 ⁴	18 ⁴	18 ⁴	8 ⁴
All in months unless otherwise noted. D=Days, ACC=After cash crop; CS=Cropping Season; NCS=Next cropping Season								

Reference guide for Table 4.

Reference Number	Label Restriction Reference Guide
1	It is pH dependent, pH greater than 6.5 requires 18 month rotational interval.
2	Rotational interval is extended during drought to 18 months.
3	Cover crop is allowed to be planted after cash crop, but not allowed to be grazed or fed as livestock feed. Perform a field bioassay before planting a cover crop.
4	Depends upon rate, refer to label.
5	Depends upon rate, soil pH, geographic location and cover crop.
6	All cover crops can be planted after successful field bioassay has been completed. Requires 15 inches of cumulative precipitation.
7	Cover crops may be planted within 90-120 days after application, although injury may occur. A field bioassay is required before planting cover crop.
8	Injury may occur if dry weather is prominent from application until cash crop harvest.
9	May be planted 60 days after application if less than 1.33 pt/acre was applied.
10	May be planted 60 days after application if less than 2.0 pt/acre was applied.
11	30 inches of cumulative precipitation required from application to planting cover crop.
12	When soil pH is 7.5 or above, plant back should be delayed from 17 to 24 months depending upon cover crop.
13	Cover crops for soil building or erosion control may be planted any time, but do not graze or harvest for food or feed. Stand reductions may occur in some areas.
14	Cover crops may be planted after application of Outlook either inter-seeded into the current crop before harvest or after harvest of the current crop. Cover crop stand establishment may be reduced.
15	Rotation intervals below may need to be extended if drought or cool conditions prevail.
16	Depends upon rate. If cover crops are planted after corn silage, depending upon the sensitivity of the sown cover crop, stand establishment may be reduced. If cover crops were sown less than 4 months after sharpen application, DO NOT harvest cover crops as food or feed crop or allow livestock to graze cover crops.
17	Depends upon geographic region and pH levels in the soil.
18	Must complete a successful field bioassay.
19	Depends on if applied to a tilled field or no-till field, rate and sensitivity to herbicide.
20	Non-food or feed cover crops may be planted after cash crop harvest. DO NOT graze or harvest cover crops for food or animal feed for a minimum of 18 months following last application of Warrant.

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