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BEST MANAGEMENT PRACTICES

CHAPTER 15

Cover Crops in Rotations Including Corn

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Cover crops are noncash crops grown with or after a cash crop. Benefits from cover crops may include: 1) reduced wind and water erosion, 2) reduced nitrate leaching, 3) increased soil organic matter and water infiltration, 4) improved nutrient recycling, 5) improved water quality, 6) improved soil health, 7) enhanced weed suppression, 8) remediation of saline and sodic soil problems, and 9) increased forage for livestock and wildlife. Establishing cover crops in the region's semi-arid, frigid soils can be challenging. Viable options for planting cover crop seed include: planting after wheat harvest, planting in-season after the critical weed-free period (see Chapter 44), and in the fall, following corn harvest. When deciding to plant cover crops, *caution must be used to ensure that cover crops do not void your crop insurance* and that your weed-control and cover-crop objectives are aligned. The purpose of this chapter is to discuss the strengths and weaknesses of including cover crops in South Dakota cropping systems.

Figure 15.1 Brassicas (radishes and turnips) planted into spring wheat stubble in mid-August harvest. Photo taken in November, about 10 weeks after planting. This cover-crop mix provided fall forage for livestock and helped reduce soil compaction. (Courtesy: Cheryl Reese, SDSU)

Table 15.1 Steps for integrating cover crops into your rotation:

1. Identify specific objectives and agronomic requirements the desired cover crop.
   a. Determine the season(s) when cover crops are desired and fit the rotation.
   b. Determine if the cover crop will exacerbate pest problems.
   c. Determine if herbicides used during the cropping season allow establishment and growth of the choosen cover crops.
2. Select a cover-crop mixture (cocktail) and seeding rates, planting date, and seeding method that are compatible with the applied herbicides and landscape position to obtain the greatest benefits with no loss to the cash crop.
3. Determine costs (e.g., seed, planting, future control, if needed) and expected returns.

If carefully chosen, cover crops will not overwinter and cause problems in the following spring. Herbicides, application timing,and labor costs must be considered if the cover crop does overwinter or produces viable seed.

Identify Cover-crop Goals

Successful cover crops require planning and a clear identification of goals (MCCC, 2012; Table 15.2). For example, if the purpose is to utilize excess nutrients, then a cover crop should be established after the cash crop has met most of its nutrient needs. However, if the purpose is to provide cattle forage or increase water filtration, then the cover crop should be seeded as early as possible in the season to maximize fall growth.

Table 15.2 Matching the cover-crop objective to the plant species. (Modified from Hoffbeck et al., 2008)

Objective	Cover-crop species
Grazing	turnips, lentils, canola, radish, rye, oat
Reducing compaction	radish, canola, sugar beets, sunflower, turnip
Soil moisture management	canola, clover, winter wheat, rye
N fixation	clovers, vetches, lentils, cowpeas, chickling vetch
Residue cycling	brassicas (canola, radish, turnips, mustards)
Nutrient cycling	sunflower, sugar beets, brassicas, small grains
Salinity remediation	sugar beets, barley, winter or spring canola

Cover Crops and Compaction

Cover-crop cocktails that include brassicas (grazing radish) can be used to reduce soil compaction. These plants produce a taproot that can penetrate soils down to 2 feet or more. The plant roots can rapidly decompose leaving large pores in the soil. These old root channels aid in water infiltration and soil aeration, and provide root pathways for following crops.

Cover Crops and Soil Health

Cover-crop mixtures can help provide food for beneficial soil organisms such as earthworms, bind the soil together, and speed up the mineralization of crop residues (Fig. 15.2, Ketterings et al., 1997). Crop residues with high C to N ratios such as wheat straw or corn stover generally mineralize slowly, whereas those with low C to N ratios, such as brassicas (e.g. turnips and radishes), peas or soybeans, generally mineralize rapidly. The mineralization rate influences how much of the nitrogen contained in residue will be available to the following crop.

Figure 15.2 Beneficial isopods associated with a decomposing radish root. (Courtesy: Cheryl Reese, SDSU)

Soil Residue Cover, Trapping Nutrients and Managing Salts

When determining a cover-crop blend to plant, consideration should be made for the current soil-residue cover. If the desired outcome is crop-residue retention, cover crops with high C:N ratios should be considered. However, if the goal is to improve soil nutrient recycling from one crop to the next, then crops with low C:N ratios should be seeded. The decomposition rate of surface residues will increase if brassicas are used in the cover-crop mixture.

Cover crops can be useful in salt management by increasing water loss through transpiration instead of evaporation, and reducing capillary movement of water and salts into surface soil. In South Dakota, barley, sugar beets, rape, rye, canola, and western wheatgrass can be seeded into salty soil zones.

Cover Crops and Rotational Sequences

Selecting the appropriate cover-crop species and seeding rates is critical for achieving your goals. Mixing multiple species allows for several goals to be addressed by a single planting, and often enhances the opportunity for successful establishment. Care must be taken not to plant at too high a rate, as cover crops can use water needed for the following crop and act as a weed that limits cash-crop yield. If many species are planted together, the rate of each must be evaluated because competition among these plants can impact survival.

In South Dakota, considerable success has been achieved by seeding a cover crop after winter or spring

wheat wheat harvest (typically early to mid-August) that allows for fall growth. In this system, the cover crop is planted after the short-season crop and before next season's corn planting. Care in selecting the cover crop should be taken. Crops such as winter rye or hairy vetch are often suggested, as these plants usually overwinter. However, roller crimping or herbicide application may be required to kill them before corn planting. Another risk is that seed shattering from cover crops that matured in the fall or spring may behave as weeds in the next crop.

Figure 15.3 An example of cover crop drilled into the interrow area of a cornfield. Cover-crop mix (forage radish, winter wheat) was planted at V3 and photo taken at V6 of corn at Aurora, SD. (Courtesy: Graig Reicks, SDSU)

Other opportunities for seeding cover crops include following a failed crop (e.g., late spring frost, early fall frost, or hail damage) or after corn's weed-free period (V6). Our research at SDSU indicates that if cover crops are planted at or just before corn planting, the cover crop can be an ideal weed (Vos, 1999). In this example, even though the cover crop was a legume (annual medic), this species at this planting time outcompeted corn for N, resulting in N-deficiency and a corn-yield loss at the end of the season. However, if a cover crop was planted during the middle or near the end of corn's critical weed-free period (V6 or later), the cover crop did not reduce the corn yield (Figs. 15.4 and 15.5; Bich et al., 2014).

Figure 15.4 Crimson clover drilled into corn at V6 on June 30, 2011, with photo taken Sept. 15, 2011, near Trail City, SD. (Courtesy: Alex Bich, SDSU)

Planting Cover Crops

In SDSU research, drilled and broadcast planting techniques were compared. Drilling the cover crop into the interrow of corn had superior stand establishment and growth compared with any type of broadcast seeding (Figs. 15.3, 15.4, 15.5). Even if rains followed the broadcast application of seed, the seed remained on the soil surface, sprouted, and most died before establishment. Drilled seeds, on the other hand, became well-established and provided green forage in the fall, even though planted in July. In addition, if drilled between rows, the distance from the corn can be maximized to lessen the cover crop's impact as a weed, whereas broadcast applications are imprecise and may negatively influence corn growth and development.

Figure 15.5 An example of cover crop broadcast into a crop at Aurora, SD. Note many seeds on the soil surface did not germinate. (Courtesy: Alex Bich, SDSU)

Cover-crop Composition: Warm- vs. Cool-Season Plants

The ideal cover-crop mixture is dependent on the cover-crop goals, weed-control program, planting time, and soil characteristics (Tables 15.4 to 15.8). Cover-crop mixtures need to be developed for each unique situation. For example, cool-season grazing blends often consist of turnips, radishes, and grasses, whereas cowpeas, millet, and sudangrass can be used for warm-season grazing.

Selecting an appropriate seeding mixture is critical. Cover-crop cocktail composition could be warm- or

cool-season plants or a mixture depending on when the cover crop is seeded. Cool-season plants grow best in cool temperatures. Cool-season species start growth when air and soil temperatures are cool and will continue to grow during the spring and fall but go dormant or quickly die when temperatures are warm (>80°F). Cool-season broadleaves can be divided into (1) brassicas, and (2) legumes. Cool-season grasses include barley, oats, winter wheat, and rye. In a South Dakota fall, a cool-season cover-crop mixture is often blended with broadleaf and grass species.

Warm-season plants grow best in warm temperatures (soil temperatures > 50°F). Warm-season species typically start growth in late spring when soil and temperatures are warm. These plants thrive during the warm summer weather. Examples of warm-season plants are big bluestem, corn, and sorghum. Warm-season species typically do not tolerate frost and will die quickly as fall temperatures decrease.

Match Herbicides and Cover Crops

The use of pre-emergence herbicides with residual activity reduces the germination and growth of cover-crop seeds and seedlings (Table 15.3). For example, if grass herbicide was broadcast-applied in May, it may be difficult to establish hearty stands of rye in August. The solution is planning. Many herbicides have activity for a relative long period of time (Table 15.3). For example, Roundup® (glyphosate) has no residual soil activity and no restrictions to planting any crop after application. In comparison, Maverick (sulfosulfuron) has a long residual activity (22 months), and planting to anything except small-grain crops is not recommended. Matching the herbicide rotation to the desired cover crop is critical for cover-crop success.

Table 15.3 Examples of rotational crop restrictions; see individual product label for full details. Trade names are provided for the reader's convenience; products with other trade names may contain the same or similar active ingredients. Always read and follow label directions. (Adapted from University of Minnesota Applied Weed Science Research, www.appliedweeds.cfans.umn.edu., accessed 12/14)

Herbicide active ingredient	Trade name or premix name	Examples of rotational crop restrictions
Atrazine	Aatrex Premix products with similar restrictions as atrazine: Buctril + atrazine; Bullet; Degree Extra; Expert; Field Master; Fultime; Guardsman; Harness Xtra; Keystone Premix types; Lumax; Marksman; Shotgun	Second cropping season after application alfalfa, barley, canola, beans, wheat, flax, lupines, oat, peas, rye, sugar beet
Clopyralid; flumetsulam; nicosulfuron; rimfulsuron	Accent Gold	26 months – canola, lupines, flax, sugar beet 18 months – sunflower 10 months – alfalfa, bean, pea 8 months – barley, spring wheat, oat, rye 4 months – winter wheat
Rimfulsuron; nicosulfuron	Basis	18 months – alfalfa, canola, flax, pea, sugar beet 10 months – bean, sunflower 9 months – barley, spring wheat, oat 4 months – rye, winter wheat
Rimfulsuron; nicosulfuron; atrazine	Basis Gold	18 months – alfalfa, barley, canola, bean, wheat, flax, lupines, oat, pea, rye, sugar beet
Atrazine; s-metolachlor	Bicep Lite II Magnum	Second cropping season – alfalfa, barley, bean, lupines, oat, pea, rye, spring wheat, sugar beet 15 months – canola, flax, winter wheat
s-metolachlor; mesotrione	Camix	Next cropping season – barley, oat, rye 18 months – alfalfa, canola, bean, flax, lupine, pea, sugar beet 4.5 months – winter and spring wheat

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Diflufenzopyr; dicamba; nicosulfuron	Celebrity Plus	Dependent on soil pH and rainfall; generally 10 to 18 months for crops
Diflufenzopyr; dicamba	Distinct	One month – alfalfa, barley, canola, bean, flax, lupine, oat, pea, rye, sugar beet
Foramsulfuron; iodosulfuron	Equip	18 months – alfalfa, canola, bean, flax, lupine, pea, rye 8 or 9 months – barley, wheat, oat, spring wheat, sugar beet 2 months – winter wheat
acetochlor	Harness (see atrazine restrictions)	
Clopyralid; flumetsulam	Hornet (see Accent Gold above)	
Acetochlor; atrazine	Keystone premixes (see atrazine restrictions)	
Bentazon; atrazine	Laddok (see atrazine restrictions)	
Imazethapyr; imazapyr	Lightening	40 months – canola, sugar beet[a] 18 months – oat 9.5 months – alfalfa, barley, bean, lupine, pea 4 months – rye, wheat [a]other restrictions apply, see label for details
s-metolachlor; mesotrione; atrazine	Lumax (see atrazine restrictions)	
Dicamba; atrazine	Marksman (see atrazine restrictions)	
Primisulfuron; dicamba	Northstar	18 months – canola, flax, lupine, sugar beet 8 months- alfalfa, barley, oat, pea, spring wheat 3 months – rye, winter wheat
Atrazine; 2,4-D	Shotgun (see atrazine restrictions)	
Nicosulfuron; rimfulsuron	Steadfast	10 months – alfalfa, canola, bean, lupine, pea 8 months – barley, spring wheat, oat, rye 4 months – winter wheat
Nicosulfuron; rimfulsuron; atrazine	Steadfast ATZ	18 months – barley, canola, bean, flax, lupine, oat, pea, rye, spring wheat, sugar beet 10 months – alfalfa, winter wheat
Halosulfuron; dicamba	Yukon	36 months – sugar beet 15 months – canola 9 months – alfalfa, lupine, pea 2 months – barley, bean, oat, spring wheat, winter wheat

Table 15.4. Cover-crop blends for grazing. (Revised from Jason Miller, NRCS, Pierre, SD)

Grazing blend	Type	Full rate	Option 1		Option 2		Grazing warm	Season	Grazing compaction	
Species		lbs/a	%	lbs/a	%	lbs/a	%	lbs/a	%	lbs/a
Lentils	Cool/broad	30	30	9	40	12				
Turnip	Cool/broad	4	30	1.2	30	1.2			20	0.8
Radish	Cool/broad	8	10	0.8					20	1.6
Rapeseed	Cool/broad	5			30	1.5				
Oat	Cool/broad	70	30	21						
Copea	Warm/broad	30					40	12	30	9
Millet	Warm/broad	25					60	15	20	5
Sudangrass	Warm/broad	25							20	5

Table 15.5 Cover crops that may aid in reducing compaction. (Revised from Jason Miller, NRCS, Pierre, SD)					
Grazing blend	**Type**	**Full rate**	**Compaction**	**Grazing/comp.**	**Residue/comp.**
Species		lbs/a	lbs/a	lbs/a	lbs/a
Lentils	Cool/broad	30	9	12	
Radish	Cool/broad	8	4.8		
Canola	Cool/broad	5	0.5		1.5
Cowpea	Warm/broad	30			12
Millet	Warm/broad	25			15
Sudangrass	Warm/broad	25			
Turnip	Cool/broad	4	1.2	1.2	

Table 15.6 Cover crops that may enhance residue-cycling compaction. (Revised from Jason Miller, NRCS, Pierre, SD)				
Grazing blend	**Type**	**Full rate**	**Residue cycling**	**Compaction present**
Species		lbs/a	lbs/a	lbs/a
Lentils	Cool/broad	30	15	9
Canola	Cool/broad	5	2.5	2
Radish	Cool/broad	8		2.4

Table 15.7 Cover crops that may potentially germinate under saline conditions. (Revised from Jason Miller, NRCS, Pierre, SD)					
Grazing blend	**Type**	**Full rate**	**Option 1**	**Option 2**	**Option 3**
Species		lbs/a	lbs/a	lbs/a	lbs/a
Sugar beet	Cool/broad	4	2	2.4	1.2
Barley	Cool/broad	50	25		20
Canola	Cool/broad	5		2	1.5

Table 15.8 Cover crops that may reduce soil moisture and enhance nitrogen cycling. (Revised from Jason Miller, NRCS, Pierre, SD)					
Grazing blend	**Type**	**Full rate**	**Option 1**	**Option 2**	**Option 3**
Species		lbs/a	lbs/a	lbs/a	lbs/a
Hairy vetch	Cool Broad	15	7.5	7.5	
Canola	Cool Broad	5			2.5
Rye	Cool grass	100	50		50
Triticale	Cool grass	60		30	

Other Considerations

The cover crop should be matched to the drainage characteristics of the soil. For example, annual rye is a cool-season grass that grows under wet soil conditions and tends to grow better in heavy clay soils than cereal rye, whereas cereal rye grows better in well- to moderately well-drained sites.

Figure 15.6 Fungi (not mycorrhizae) decomposing a corn root. (Courtesy: Cheryl Reese, SDSU)

Cereal and annual rye overwinter like winter wheat. The major problems with cereal rye are that if excessive spring growth is not controlled: 1) soil moisture can be depleted, and 2) it can produce stands up to 6 feet tall, which may be too much biomass for no-till planting. Typically, herbicide is used in spring to burn down annual rye when its growth is 8 to 16 inches tall. However, during cool spring weather, glyphosate may have limited effectiveness against annual rye. Under these conditions, annual rye seeds can become a future weed problem.

Cover crops may reduce available moisture for the cash crop, but they also increase water infiltration and snow catch. Depending on the situation, our research suggests that they can reduce or increase available moisture for the row crop. Cover crops increase plant diversity, which can in turn increase soil biological diversity. Depending on which species is seeded, cover crops may increase or decrease mycorrhizae (Fig. 15.6).

Cost share programs may be available for cover-crop seeding from county USDA-NRCS offices. EQIP and CSP are programs that typically allow some cost-share benefits for cover crops. The best way to take advantage of the programs is to check early with your county NRCS office for applications and deadlines.

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