CHAPTER SEVEN

Cover Crops Following Wheat

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Cover crops can provide forage for livestock, improve soil quality, and help manage excess water. This chapter provides an overview of cover crops and basic information needed to determine what and when to plant.

Cover Crop Rules of Thumb

- The smaller the seed size, the longer it will take for the plant to put on substantial growth. Clovers will take much longer to put on growth than peas, lentils or vetches.
- When selecting species and planting densities, be sure to consider disease issues for the following crop.
- Most cool and warm season grasses (including oats, barley, rye, sorghum and corn) can act to varying degrees as secondary hosts for the wheat curl mite.
- Choose cover crops that are broadly different from the next cash crop.
- To decrease surface residue plant cover crops high in N (legumes), or low in fiber (Brassicas).
- To increase residue, plant cover crops high in C and fiber (millet or sorghum).
- Plant as soon as possible.
- Buy seed with an objective of minimizing seed cost.

Figure 7.1. Cover crop planted into wheat stubble.

In South Dakota an opportunity exists for cover crops to be planted following the harvesting of small grains in July and August. Cover crops capture energy from sunlight that would otherwise be lost from the ecosystem. Benefits of cover crops may include: reduced erosion, decreased compaction, potential for reducing N losses and reduced N fertilizer requirements, increased trapping of snow, improved traffic ability, increased production of game birds, improved nutrient recycling, and improved management of excess water.

Like any tool, cover crops can have a negative impact, if not used wisely. For example, cover crops have the potential to use soil moisture that otherwise might be available to the following crop. They can also reduce the following yield in the cash crop, if they do not winterkill. For cover crops that winterkill, the effect on soil moisture is dampened by the recharge of soil moisture over the winter. Cover crops that grow into the following spring will use more moisture, and legumes will fix more N than those that winterkill.

Depending on the circumstances, overwintering cover crop may be a positive or a negative factor. In a wet spring, the use of moisture and improved traffic ability, associated with the over-wintering cover crop, may be an asset. In a dry spring the overwintering cover crop may be a liability. Obviously, the dryer the environment, the more likely that water use by the cover crop can have a negative impact on the following year crop yields. In many situations the water used by the cover crop can be replaced by increased snow capture.

Planting date and composition

Delaying planting reduces the amount of generated biomass (Fig. 7.2). This reduction is attributed to a decrease in heat units. Cover crops can be planted as solid stand of a single species or a mixture of plants. For solid stand, planting rates, planting depths, and salt tolerances are provide in Table 7.1 and for mixtures selected seeding rates are provided in Table 7.2. Many growers, who use cover crops, plant a mixture because:

1. A mixture is more broadly adapted to varying soil conditions.
2. A mixture helps manage climate and soil variability.
   a. When N is limiting, legumes, which fix N, will be favored.
   b. When N is plentiful, grasses and brassicas can “soak up” the extra N.
3. A mixture enhances cropping system diversity and increases the rotation benefits.

Table 7.1. Seeding depth, salt tolerance, and full seeding rate of selected cover crops. To determine seeding rates of mixtures, multiple the full rate times the desired composition (see salinity and other compositions in Table 7.2).

Plant	Composition %	Rate lbs/acre
Canola	30	5×0.3=1.5
Sugar beet	30	4×0.3=1.5
Barley	40	40×0.4=20

Plant	Seeding depth	Salt tolerance	Seeding rate
	inch	rating	lbs/acre
Canola	0.25-0.75	good	5
Turnip	0.25-0.5	poor	4
Radish	0.25-0.5	poor	8
Barley	0.75-2	good	50
Rape	0.25-0.75	fair	5
Oat	0.5-1.5	fair	70
Lentil	1-1.5	poor	30
Sugar beet	0.25-0.5	good	4

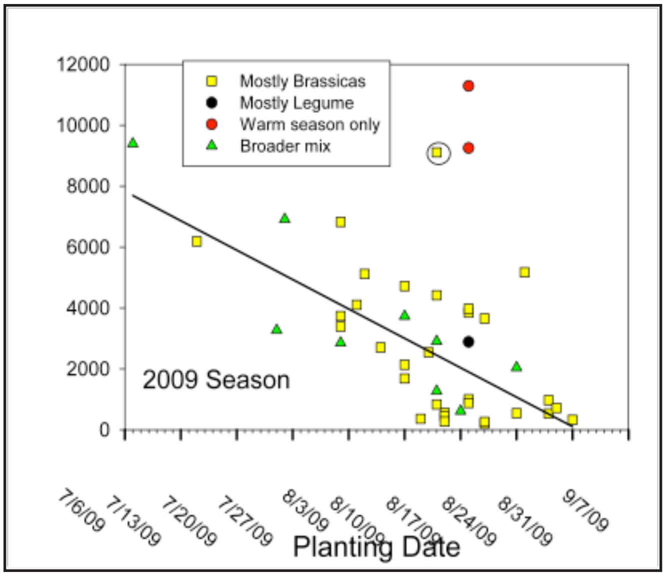

Figure 7.2. On-farm observations of dry matter production relative to planting date in 2009. The warm season only points and the circled point were not included in the trend line analysis for the 2009 season. (Jeff Hemenway, USDA-NRCS)

General categories of cover crops

Brassicas (e.g. radish, turnips, and canola) are well adapted to cool fall conditions. Brassicas have relatively low seeding rates, and will help alleviate soil compaction (especially forage radish). A disadvantage with Brassicas is that they that do not form mycorrhizal associations. There is also some concern that Brassicas may act as a host for white mold, which can be a disease problem in soybeans. Usually infection by the white mold fungus occurs at flowering, so Brassicas that don't flower before winterkill are less of a concern.

Warm-season grasses (e.g., sorghum, millets, sudangrass, and corn) have the greatest potential for rapid accumulation of dry matter under warm conditions, tolerate drought stress better than many other species, and have roots that form associations with mycorrhizal fungi. Mycorrhizal associations help plants take up water and nutrients. N contained in the residue may not be readily available to the subsequent crop.

Table 7.2. Some cover crop mixes suggested by the NRCS for different grazing and soil improvement purposes. (from Jason Miller, USDA-NRCS)			
Purpose	**Species**	**Percent**	**Seed Rate in Mixture (lb/ac)**
Grazing	Lentil	*30%*	9
	Turnip	*30%*	1.2
	Oat	*30%*	21
	Radish	*10%*	0.8
Salinity	Canola/Rape	*30%*	1.5
	Sugar beet	*30%*	1.2
	Barley	*40%*	20
Compaction	Canola/Rape	*10%*	0.5
	Lentil	*25%*	7.5
	Radish	*55%*	4.4
	Flax	*10%*	2
Warm- season Grazing	Pearl Millet	*60%*	15
	Cowpea	*40%*	12
Residue Cycling & Compaction	Canola/Rape	*30%*	1.5
	Radish	*30%*	3.2
	Lentil	*40%*	9
Use of Spring Moisture & N Fixation	Winter Rye	*50%*	30
	Hairy Vetch	*50%*	7.5
Warm-season Grazing & Compaction	Cowpea	*20%*	6
	Pearl Millet	*20%*	5
	Sorghum-sudan	*20%*	5
	Turnip	*20%*	0.8
	Radish	*20%*	1.6
Residue Cycling	Canola/Rape	*50%*	2.5
	Lentil	*50%*	15

Cool-season grasses (e.g., oats and barley) are frost tolerant and adapted for growth in cool fall conditions. If the plant tissue becomes fibrous, N contained in the residue may not be readily available to the following crop. These residues may decompose slower than Brassicas. This group of plants will also form mycorrhizal associations.

Cool-season legumes (e.g., peas, lentils, hairy vetch, and chickling vetch, and clovers) tolerate cool conditions and resist frost. Some members of this group, such as hairy vetch, may overwinter. Cool-season legumes:

1) produce high quality forage,
2) can fix N,
3) produce residue with a low C:N ratio, and
4) have slower growth rates than many grasses.

It is noteworthy to point out that chickling vetch seeds contain toxins that may injure livestock, particularly horses, if consumed. Residues from cool-season legumes are generally rapidly mineralized, allowing the N contained in their biomass to be partially available to the following crop. This group of plants forms mycorrhizal associations.

Warm-season legumes (e.g., cowpea, mungbean, and soybean) are relatively heat tolerant, but not frost tolerant, and therefore they will not have a long fall growing period. This group of plants:

1) fixes N under the proper circumstances,
2) has growth rates that are slower than many grasses, and
3) forms mycorrhizal associations.

Sunflower, flax, buckwheat, and sugar beets are broadleaved plants that have unique characteristics. Sunflower is well adapted to warm temperatures and has roots that elongate faster than many other crops. Flax is shallow rooted and forms a high level of mycorrhizal associations. Buckwheat develops a canopy very rapidly, sets seeds quickly, but is not frost tolerant, and it is an efficient P scavenger. Sugar beets are tolerant of frost and salinity, but do not appear to form mycorrhizal associations.

Selecting a cover crop mixture

There are several important factors to consider in selecting a cover crop mixture. Most important are the objectives you have in mind: forage production, reduce residue, increase residue, ameliorate soil compaction, among others. Table 7.2 provides information on seed rates for a number of cover crop mixes developed for different purposes. When selecting species and planting densities, farmers should consider their impact on diseases for the following crop. Cover crops that share diseases or pests with whatever comes next in the rotation cycle should be avoided. If the next crop is corn (a warm-season grass), then cool-season legumes and Brassicas might be a good choice. If the next crop is wheat, it is advised to avoid grasses altogether in order to deny the wheat curl mite entry to the field.

Most cool and warm season grasses (including oats, barley, rye, sorghum and corn) can act to varying degrees as secondary hosts for the wheat curl mite (Wegulo et al. 2008). Wheat curl mite acts as a disease vector that carries the wheat streak mosaic virus. The mite prefers wheat and will multiply most rapidly on wheat; therefore, control of volunteer wheat is most important for controlling this disease and preventing its spread to nearby wheat crops. Selection of cover crops that do not act as hosts for the mite also will help to limit mite populations in fields that will be seeded back into wheat.

Generally it is a good idea to choose a cover crop that is completely different than the next crop. Using this approach will maximize the rotation benefits and avoid disease problems. For example, some legumes such as hairy vetch and cowpeas can act as hosts for soybean cyst nematode, while rye can become a contaminant in wheat. In this regard, Brassicas are often a valuable component in cover crop mixes because they differ from many cash crops grown in South Dakota (except for canola). They require a low seed rate and decompose quickly; their volunteers are easy to control with herbicides. However, as noted earlier, Brassicas can act as a host for white mold, particularly if they produce flowers.

To decrease residue on the soil surface, cover crops that are high in N, such as legumes, or those that produce succulent growth, such as radishes, are a good choice. To increase residue, cover crops that are high in C and fiber, such as millet or sorghum, may be good choices. Water use by the cover crop also needs to be considered. Cover crops will use some moisture in the fall, but they may also help trap snow to recharge the profile. The impact on soil moisture depends upon soil type, rainfall patterns, and the relative need for moisture in the following crop.

Another consideration is the potential of the cover crops to overwinter, for example winter rye, winter triticale, and hairy vetch. A cover crop that overwinters can provide more forage in the spring and will use more soil moisture, compared to cover crops that winterkill.

Cover crops ahead of wheat and wheat on wheat rotations

When considering cover crops in a wheat-following-wheat rotation, disease pressure and water use must be considered. With winter wheat following spring wheat, there is not enough time between the spring wheat harvest and the winter wheat seeding for a cover crop to put on much growth. However, when spring wheat follows winter wheat there is enough time for the cover crop to produce biomass. By avoiding grasses in this rotation, disease problems (Chapter 23) such as crown rot and wheat streak mosaic virus (carried by the wheat curl mite) may be lessened.

Cover crops can also impact populations of beneficial microbes such as mycorrhizae. Figure 7.3 shows partial data from a study conducted in Australia looking at effects of previous crops on mycorrhizae populations in the following wheat crop. Even cover crops that are not hosts to mycorrhizae, namely, canola and mustard in this study, showed increased infection in the following wheat crop.

Soil moisture is another consideration in wheat on wheat rotations. Some judgment is needed to consider effects of a cover crop on soil moisture for the following wheat crop. On the plus side, one would expect cover crops to help catch snow and contribute to improved soil structure, which would mean better infiltration rates and root growth for the following crop. On the negative side, the water use by the cover crop could lead to a drier seed bed.

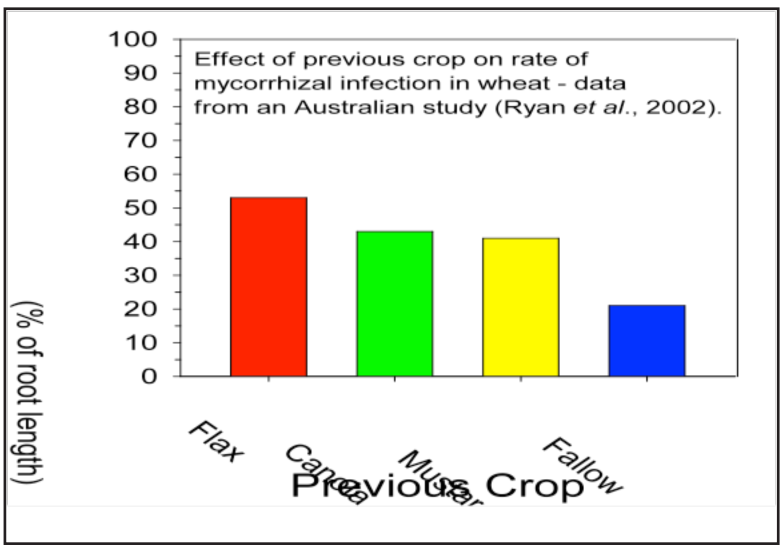

Figure 7.3. Mycorrhizal infection in wheat as influenced by prior crop.
(Modified from Ryan et al., 2002)

N cycling

Composition of the cover crop mix, N uptake by the cover crops, total biomass produced, along with climate conditions the following season, all influence residue decomposition and how much N will be released for the following crop. Legumes and Brassicas tend to breakdown quickly and release a larger portion of their N than do grasses. For some systems, additional N fertilizer is required for the following crop. For example, for immature grasses, 25% of the N in the grass may be released to the following crop; whereas with more mature grasses, an extra 20 to 30 lb of N per acre may be required to compensate for N tied up in the residue.

The potential for leaching of N out of the soil profile is another factor to consider when weighing the value of cover crops. Cover crops, particularly cool season grasses and Brassicas that grow well into the fall, will take up soil N and prevent its loss through leaching or denitrification. In denitrification, nitrogen is lost from the soil to the atmosphere as nitrous oxide (N_2O) or nitrogen gas (N_2). Both nitrate leaching and denitrification generally occur under high moisture conditions. Cover crops can reduce these losses by taking up the inorganic N from the soil (Chapter 11). Research to determine the N credit from cover crops is currently being conducted. Data from around the region suggests that:

1. A legume cover crop mix might produce a 20 to 25 lbs N per acre credit.
2. Radish cover crop might have a credit of 10 to 15 lb N per acre.
3. Grasses might require an additional 15 to 30 lb extra N/acre.
4. When the following crop is a small grain, it may be better not to assign an N credit because the more rapid maturity of the small grain means there is less time for the cover crop residue to decompose before the grain crop matures.

As more research data becomes available, these estimates may be changed.

Grazing can also have an impact on the rate of N release. Grazing will accelerate tissue decomposition and nutrient release. Data on the effect of grazing on yield of the following grain crop is scarce. Work done in the southeastern U.S. with grazed and ungrazed grass plots indicates that, while grazing caused small increases in soil compaction, it increased yields of the following grain crop due to more rapid nutrient cycling (Jim Marois, University of Florida, personal communication). Given the uncertainty and the consequences of under-applying N, farmers are advised to keep good records of cover crop growth and changes in soil N before and after the following crop to help guide their decisions over time.

Residue decomposition

The N concentration of the crop residue, along with temperature and moisture, has a large impact on the rate of residue breakdown. Cover crops reach down into the soil and pull N up through their root systems to support top growth. When the cover crop dies and decomposes, N is released at or near the soil surface. If the cover crop decomposes rapidly, as is typical of Brassicas and legumes, then it appears this N may contribute to accelerated decomposition of previous crop residues, so that in the following growing season there may be less residue. On the other hand, if the cover crop is slow to decompose, the N it takes up will be sequestered in the cover crop residue and the decomposition of the cover crop may tie up N, rather than release it. In this situation the cover crop will contribute to increased residue on the surface as well as increase the N requirement of the following crop. This is more likely to occur with non-legumes and non-Brassicas, especially if they have a high C:N ratio or are fiberous/stemy in growth.

Salinity

Soil salinity is an increasing problem in South Dakota. Salt tolerances of selected cover crops are provided in Table 7.1. This topic is discussed further in Chapter 19.

Herbicide carryover

Carryover of herbicide activity can injure cover crops. Refer to the product label for plant back restrictions for cover crops of interest. A partial listing of several compounds used in wheat production with estimated plant back restrictions in months for different cover crop groups is given in Table 7.3. Chapter 25 discusses herbicide recommendations in wheat.

Table 7.3. Partial listing of several herbicides that may have carryover effects on cover crops. This list is provided to give a preliminary estimate of potential for herbicide carryover. It is not exhaustive or complete, so refer to the label or consult with your herbicide retailer for more specific information on individual cover crop species. If uncertain, conduct a bioassay to see if there is residual activity of the herbicide in question.

	Cover Crop Group		
Herbicide	**Brassicas**	**Legumes**	**Warm-season Grasses**
		Months	
Olympus® *Propoxy-carbazone*	12 to 24	12 to 24	12
Maverick® *Sulfosulfuron*	22	22	22
PowerFlex® *Pyroxsulam*	9	9	9
Everest® *flucarbazone*	9 to 24	9 to 24	11 to 24
Ally® *metsulfuron*	22	22	12

Additional information and references
http://www.mccc.msu.edu/

http://www.sdnotill.com/Field_Facts_wheat_cover_crop.pdf

Managing cover crops profitability. Published by SARE.
Available at http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

Potential cover crop seed suppliers. Available at http://attra.ncat.org/attra-pub/covercrop.html and http://www.sdnotill.com/Potential%20Cover%20Crop%20Seed%20Suppliers.pdf

South Dakota No-Till Association web site. Available at www.sdnotill.com

South Dakota NRCS home page. Available at http://www.sd.nrcs.usda.gov/technical/CoverCrops.html

Wegulo, S.N., G.L. Hein, R.N. Klein, and R.C. French. 2008. Managing wheat streak mosaic. EC1871, University of Nebraska-Lincoln, Lincoln, NE.

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