

Soil Management and Fertilizer Use: Cover Crops

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Excerpt from Agronomy Guide for Field Crops (Chapter 2)

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Introduction

Cover crops play an important role in Ontario by providing ground cover to reduce erosion and by adding organic matter to improve the soil. They can also perform a number of other functions.

Cover Crop Functions

Reduce Soil Erosion

Cover crops can do exactly what their name implies; cover the soil. A cover crop such as rye is commonly used to cover and protect the soil surface from wind and water erosion. The top growth covers the soil surface while the roots bind and stabilize the soil particles. Cover crops may be planted over a whole field for erosion protection or they may be selectively planted in the most erosion-prone areas, such as sandy knolls for wind erosion, water runs or low areas for water erosion.

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Add Organic Matter

Cover crops do add organic matter, but the amount really varies depending upon the cover crop species and the conditions under which it is grown. [Table 2-6, Cover Crop Dry Matter Production](#), gives dry matter levels (aboveground residues only) for some common cover crops established in late summer and early fall. The numbers were collected from cover crop plots in Southwestern Ontario.

Table 2-6. Cover Crop Dry Matter Production

Common Cover Crops ¹	Dry Matter Produced	
	kg/ha	lb/ac
Red clover (plow-down)	2,700 - 4,500	2,403 - 4,005
Oats	1,000 - 5,500	890 - 4,895
Rye	1,000 - 4,000	890 - 3,560
Oilseed radish	2,000 - 7,500	1,780 - 6,675

¹Dry matter production can vary greatly due to a number of production factors.

These may not show as great an organic matter return as some of the cover crop work from the United States, however, it is important to consider climatic differences and how the cover crop is incorporated into the crop rotation.

Reduce Nutrient Losses

Some cover crops fix nitrogen, but many more require nitrogen to grow. Grass cover crops (such as rye) and brassicas (such as oilseed radish) are excellent scavengers of nitrogen left behind by the main crop or from manure applications. Cover crops that take up nitrogen can help to reduce nitrogen losses due to leaching. This reduces the potential for the movement of nitrates to shallow aquifers. When the cover crop is killed, the nutrients held in the plant tissues are returned to the soil and can be used by the following crop.

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Improve Soil Fertility

Legume cover crops can fix nitrogen for a subsequent crop. Organic growers often include this type of cover crop in order to produce nitrogen for the rest of the crop rotation. Some cover crop species are credited with making more phosphorous available to other crops through the action of the roots. Deep-rooted cover crops can bring nutrients up from deep in the soil profile.

Reduce Pest Populations

Some cover crop species may be a non-host for a pest or may release materials that are toxic to the targeted pest. For example, many common cover crops have been rated for their ability to support root lesion and other nematode populations (see [Table 2-7, Characteristics of Cover Crops Grown in Ontario](#)). Cover crops like marigolds and pearl millet do not support or allow the nematode to reproduce. Other cover crops, such as some mustards, particularly those with high glucosinilate and euricic acid levels in the plant tissue can create a "natural fumigant" through the chemical breakdown of these materials. The amount of green plant material that must be tilled into the soil for this to be effective is often difficult to achieve under field conditions. Weeds are often alternate hosts for the nematodes. Good cover crop establishment, adequate plant stand and excellent weed control within the cover crop are critical for these methods of nematode reduction/suppression to be effective.

Table 2-7. Characteristics of Cover Crops Grown in Ontario

Species	Normal Seeding Time	Seeding Rate Kg/ha ¹	Nitrogen Fixed ²	Overwintering Characteristics	Potential Weed Problem From Volunteer Seed	Supports Nematodes ³	
						Lesion	Root-knot
Grasses							
Ryegrass	April-May or August-early September	12-18	No	Annual, Italian partially survive: Perennial overwinters	No	-	-
Spring cereals	Mid-August-September	100-125	No	Killed by heavy frost	No	+	-
Sorghum	June-August	50	No	Killed by frost	No	0	-

sudan							
Pearl millet	June-August	4	No	Killed by frost	No	-	-
Winter wheat	September-October	100-130	No	Overwinters very well	No	+	-
Winter rye	September-October	100-125	No	Overwinters very well	No	+ ⁴	-
Legumes							
Hairy vetch	August	20-30	Yes	Overwinters	No	++	+
Red clover	March-April	8-10	Yes	Overwinters	No	++	+++
Sweet clover	March-April	8-10	Yes	Overwinters	No	-	-
Soybeans	August	40-50	Yes	Killed by frost	No	-	-
Field peas	August	100-150	Yes	Killed by heavy frost	No	-	-
Non-Legume Broadleaves							
Buckwheat	June through August	50-60	No	Killed by first frost	Yes	+++	0
Oilseed radish	Mid-August-early September	10-14	No	Killed by heavy frost	Yes	0	0

Nematode Rating Codes: - = poor or non-host
+ = ability to host
0 = some cultivars are non-hosts

¹100 kg/ha = 90 lb/ac

²Oilseed radish, buckwheat and the grasses do not fix nitrogen from the air but are scavengers of nitrogen from soil and manure applications.

³Varietal differences in cover crop species may affect nematode reaction.

⁴Rye: full season rating would be higher (+++)

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Reduce Compaction and Improve Soil Structure

Cover crops can help reduce compaction and improve soil structure. The addition of the plant top and especially root matter helps to improve water infiltration and holding ability. It can also decrease soil bulk density. Deep-rooted cover crops can help decrease the impact of soil compaction. If deep tillage is used to combat compaction, the seeding of a cover crop can help stabilize the cracks and fissures that were created in the soil profile by the deep tillage. Growing cover crops and working in the residues improves soil structure.

Water Management

Cover crops can be grown and the residues used to mulch the crop and help reduce moisture loss.

Emergency Forage

Under adverse conditions and a shortage of forage due to drought or winterkill, some cover crop species can make quite acceptable hay or pasture. See [Annual Forages](#).

Information on the most commonly used cover crops is provided below. See also [Table 2-7, Characteristics of Cover Crops Grown in Ontario](#).

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Choosing a Cover Crop

Consideration	Comment
Growth habits	<ul style="list-style-type: none"> • What kind of growth habit is needed? • When is the growth required, e.g., lots of vigorous late fall growth or rapid early spring growth? • Is deep rooting important?

Overwintering	<ul style="list-style-type: none"> • Does the cover crop need to survive overwinter? • Would it suit the cropping schedule and soil type if the cover crop winter killed and dried out by spring ?
Control Options	<ul style="list-style-type: none"> • Will the cover crop become a weed concern? • How is it controlled? • What options are there for control?
Sensitivity to herbicides	<ul style="list-style-type: none"> • How sensitive is the cover crop to herbicide residues from other crops in the rotation?
Seed cost and availability	<ul style="list-style-type: none"> • What is the seed cost and is the seed available in your area?
Establishment	<ul style="list-style-type: none"> • What is the best way to plant the seed? • Is different equipment required? • How easy is it to establish? • Will it create a solid cover? • Good establishment is critical to the success of the cover crop?
Nutrient Management	<ul style="list-style-type: none"> • Is it a nitrogen producer or does the cover crop require nitrogen to grow well? • Does it scavenge well for nitrogen?
Pest Management	<ul style="list-style-type: none"> • What crop family is the cover crop in? • Is it related to other crops in the rotation? • Are there pest concerns?

Grass Crops

| [Ryegrass](#) | [Spring Cereals](#) | [Sorghum Sudan](#) | [Pearl Millet](#) | [Winter Rye](#) | [Winter Wheat](#) |

Grasses have fine, fibrous root systems that are well suited to holding soil in place and improving soil structure. Suitable grass species for cover crops are fast growing and relatively easy to kill, either chemically, mechanically or by winter weather. Grasses do not fix any nitrogen out of the atmosphere but can accumulate large quantities from the soil.

Ryegrass (Annual, Italian or Perennial)

Direct seed in spring or from August to mid-September, or seed with a nurse crop in spring. It has also been broadcast into corn in late June to early July with some success. Annual ryegrass gives the most top growth in the seeding year, often heading 6-8 weeks after seeding. Italian ryegrass (a biennial) does not head in the seeding year, so top growth is considerably less. However, it has the largest, densest root system of the three types. Annual and Italian ryegrasses usually suffer considerable winterkill, but part of the stand may survive. Perennial ryegrass normally survives the winter.

Cautions: Establishment and growth of ryegrasses can be poor during very hot, dry weather. It can be difficult to kill overwintering ryegrass with only cultivation or disking. The nitrogen tied up in ryegrass releases more slowly than from other cover crops. Thus corn after ryegrass often requires an extra 20-30 kg/ha (18-27 lb/ac) of nitrogen.

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Spring Cereals

Spring cereals are usually seeded for plowdown. Stands seeded from mid-August to mid-September will have 20-40 cm (8-16 in.) of growth by freeze-up. The stand is generally killed by late hard frosts.

Volunteer spring cereals are sometimes left to grow until freeze-up as a cover crop. Stands may not be very uniform. There may be up to 70 cm (28 in.) of growth by freeze-up, resulting in a heavy mat that keeps the soil wet the following spring. On erosion-prone knolls, spring cereals often have little growth and have been observed to "blow off" by spring, possibly opening the whole field to more erosion.

Cautions: Early seeding may result in considerable growth by freeze-up. If left unplowed in the fall, the mat of dead residue will slow soil drying and warming in the spring, which can cause problems in

the mat of dead residue will slow soil drying and warming in the spring, which can cause problems in early-seeded crops.

Sorghum Sudan

Sorghum sudan is an excellent choice for growing as a green manure crop for soil improvement. The root growth is extensive and the top growth lush. A pre-plant herbicide treatment is recommended for crop establishment. Plant after all threat of frost has passed - mid-June. The crop will benefit from the warm temperatures of early to midsummer. Approximately 50 kg/ha (45 lb/ac) of N will help the crop achieve maximum top growth.

Cautions: Sorghum sudan should be mowed before it reaches a height of 1 m (3.28 ft), to encourage tillering and ensure that stalks are not woody and will break down readily.

Pearl Millet

Pearl millet is a cover crop that has similar growth and other characteristics to sorghum sudan.

Winter Rye

Winter rye is seeded from September into mid-October. It grows until freeze-up, then commences growth again in late March-early April (slightly earlier than winter wheat). Growth rate is very rapid during May. The stand is generally killed in late April or early May by tillage or herbicide use.

Winter rye can be seeded later than any other crop and still survive over winter. For good ground cover and erosion protection, it should be seeded at least a month before freeze-up. Winter rye is one of the most consistent, flexible and economical cover crops available.

Cautions: Rye will grow very rapidly under warm temperatures in early spring. Monitor growth to kill it at an appropriate time. It can deplete soil moisture, and incorporation can be difficult if it is allowed to grow too tall.

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Winter Wheat

Winter wheat can be seeded in late August through October. It can be seeded outside this time, however, similar to spring cereals, weather conditions may reduce top growth. Wheat will survive over winter and begin growing in April. The stand can be killed through tillage or herbicide application. The plant shuts down earlier in the fall and begins to grow later in the spring than rye.

Cautions: Generally winter wheat does not provide the same amount of green material to return to the soil or the level of weed competition that rye provides.

Legume Crops

| [Hairy Vetch](#) | [Red Clover](#) | [Sweet Clover](#) | [Soybeans](#) | [Field Peas](#) |

Legume cover crops can fix nitrogen from the air, supplying nitrogen to the succeeding crop. Legumes also protect the soil from erosion and add organic matter. The amount of nitrogen fixed varies between species, although generally, more top growth equals more nitrogen fixed. Some legume species have aggressive tap roots that can break up subsoil compaction, but this requires more than one year's growth.

Nitrogen release from legumes can be inconsistent. This must be accounted for when calculating fertilizer needs.

Hairy Vetch

To provide good ground cover over the winter, hairy vetch must be seeded by mid-August. It grows slowly until freeze-up and establishes an extremely vigorous, fibrous root with moderate top growth. Hairy vetch may also be drilled into winter wheat when the wheat is about 20 cm (8 in.) tall. Seeding at this later stage prevents the hairy vetch from causing a problem with wheat harvest, but results in much more vetch growth by freeze-up than does an August seeding.

The vines resume growth early in the spring (similar time to winter wheat) and may reach 150 cm (60 in.) in

length if left to maturity. Plowdown stands are usually killed in the spring by tillage or herbicide application. Vetch's fibrous root system improves soil structure, and large amounts of fresh organic matter are added to the soil.

Cautions: Competition from volunteer cereals can lead to poor stands of hairy vetch. On droughty soils, hairy vetch left alive until early May can deplete soil moisture. Glyphosate is not effective in killing hairy vetch. If hormone-sensitive crops are following, apply hormone sprays in the fall to avoid injury.

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Red Clover

Red clover is commonly broadcast into winter wheat in March or early April or seeded with spring cereals. Early seeding gives best stands. Double-cut red clover produces considerably more top growth than single cut (60 cm versus 25 cm, respectively). For plowdown, common seed produces equal results to pedigreed seed, although it may contain more weed seeds.

Major growth takes place from grain harvest until a heavy frost. Red clover can be killed in the fall or the spring by tillage or herbicide application. Unless herbicides are also applied, chisel plowing will not kill the stand completely.

Red clover plowdown improves soil structure and adds large amounts of fresh organic matter. Nitrogen is fixed and released slowly to the following crop. It gives excellent erosion protection when left unplowed until spring or killed in the fall with a herbicide.

Cautions: Glyphosate alone is often not effective in killing red clover. If hormone-sensitive crops are following, apply hormone sprays in the fall to avoid injury.

Sweet Clover

Sweet clover is most commonly seeded into winter wheat in March or early April or seeded with spring cereals. Either the yellow or white blossom type may be used. The white-blossom type produces somewhat taller top growth. Major growth takes place after the grain is harvested until heavy frost. Top growth will usually be 30-40 cm (12-16 in.) tall, but not dense. A strong taproot is produced, often 30 cm long and 1 cm across at the crown. If allowed to grow the following spring, sweet clover will flower in July at a height of about 180 cm (72 in.), set seed and die. Plowdown stands may be killed in the fall or the following spring by tillage or with herbicides.

Cautions: Sweet clover is very sensitive to many herbicides and will not tolerate any phenoxy herbicides.

Soybeans

Soybeans can be drilled in following spring or winter cereal harvest. With adequate moisture they will produce 20-40 cm (8-16 in.) of top growth before being killed by frost. Inoculation should not be necessary unless the soybeans are being grown in virgin ground.

Cautions: Soybeans need more moisture to germinate than small seeded crops, so results may be disappointing in dry years. Since soybeans are a warm season crop, growth will slow or stop as the weather cools in the fall.

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Field Peas

Field peas will produce 60-90 cm (24-36 in.) of top growth before frost if drilled in following cereal harvest. They are adapted to cool, damp conditions, so will grow vigorously until well into the fall. The main drawback to field peas as a cover crop is the volume and cost of seed required.

Cautions: A heavy mat of residue from a vigorous stand of field peas may delay soil drying in the spring, delaying tillage or planting.

Non-Legume Broadleaf Crops

Non-Legume Broadleaf Crops

These broadleaf crops cannot fix nitrogen out of the air but may absorb large quantities from the soil. Neither of these crops is winter-hardy, so additional control measures are not normally required. They should not be allowed to go to seed, as the volunteer seed can become a significant weed problem.

| [Buckwheat](#) | [Oilseed Radish](#) |

Buckwheat

As a cover crop, buckwheat is most commonly seeded in late June-early August. It grows very rapidly, reaching the flower stage and a height of 45-75 cm (18-30 in.) in about 6 weeks. It has a relatively small fibrous root system and is completely killed by the first frost.

Buckwheat provides rapid soil cover, gives good erosion protection during the growing season, smothers annual weeds and suppresses perennial ones. Moderate amounts of fresh organic matter are returned to the soil. Buckwheat does not fix nitrogen.

Cautions: Late summer seedings may be killed by an early frost before providing significant growth.

Oilseed Radish

Oilseed radish is commonly seeded in August or very early September. It is unaffected by early frosts and can grow to a height of 50-90 cm (20-36 in.) and bloom in October. The plant has a thick but short taproot, varying between carrot- and turnip-shaped. It is killed by severe frosts in late November or December. It gives a reasonably rapid soil cover and excellent erosion protection over winter and returns moderate amounts of organic matter to the soil. For good growth, this crop must have a large amount of available nitrogen, either from a recent manure application or from nitrogen left from a previous crop.

Cautions: Growth will be poor if soil nitrogen levels are low. Scattered volunteer plants usually appear in subsequent crops.

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Tillage Systems After Cover Crops

Cover crops reduce soil erosion potential by keeping the ground covered between crops, by improving soil structure and, in conservation tillage systems, by increasing surface residue cover.

Management factors to consider when reduced tillage follows cover crops are:

- Some regrowth of winter annual, biennial or perennial cover crops will occur in the following crop year. Usually this is easily controlled with normal herbicide treatments in the following crop. A controlled amount of regrowth can provide some spring wind protection.
- The first mulch tillage operation with overwintering cover crops should occur at least 2 weeks prior to planting to allow the breakdown of the residue to start.
- It may be difficult to prepare a seedbed if persistent cover crops are not tilled until spring and are allowed to grow too large.
- Cover crops that do not survive over winter may be an option, especially on more poorly drained soils or for crops that are planted very early in the spring.
- Burn-down herbicides should be considered before mulch tillage of overwintering cover crops such as rye. Careful timing and application of herbicides can help to keep enough residue on the surface to prevent wind damage to tender crops while allowing crop establishment.