Cover crops

Dale R. Mutch and Todd E. Martin

Key concepts and questions

- What are cover crops?
- How do cover crops influence carbon and nitrogen cycles?
- How do cover crops influence pest management?
- How do cover crops influence weed management?
- Which cover crops can be used in each part of a corn-corn-soybean-wheat rotation in Michigan?
- How economical are cover crops?
- What are the long-term benefits of using cover crops?

Additional reading

Sustainable Agriculture Research and Education Program. Managing Cover Crops Profitably. Sustainable Agriculture Publications - USDA, Washington, D.C. 20250-2200.

What are cover crops?

A cover crop is a crop that is not harvested but is grown to benefit the soil and / or other crops in a number of ways. Cover crop benefits include: reduced soil erosion; improved soil quality; reduced weed pressure; reduced insect, nematode and other pest problems. Cover crops are grown during or between primary cropping seasons. They are versatile and easily adapted to conventional, low-input and organic field crop ecosystems.

There are many cover crop species. **Legume** cover crops fix atmospheric nitrogen into a form plants and microorganisms can use. **Non-legume** species recycle existing soil nitrogen and can reduce the risk of excess nitrogen leaching into groundwater.

Cover crop species

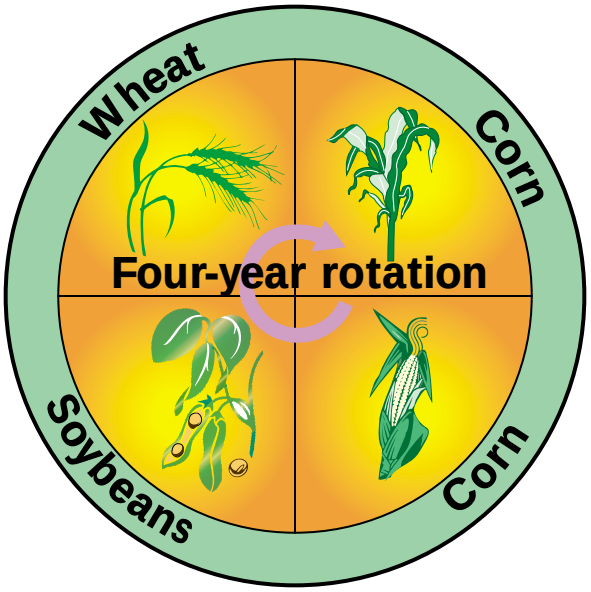
Species	Life cycle[a]	Nitrogen value[b] (lb / A)	Seeding rate (lb / A)	Seeding depth (inches)
Legumes				
Annual medic	SA	40 - 100	10 - 39	1 / 4 to 1 / 2
Berseem clover	SA	60 - 90	9 - 20	1 / 4 to 1 / 2
Crimson clover	SA	50 - 60	12 - 20	1 / 4 to 1 / 2
Field peas	SA	30 - 100	70 - 150	1 to 2
Hairy vetch	WA	60 - 180	25 - 40	1 / 2 to 2
Mammoth red clover	B	60 - 70	8 - 15	1 / 4 to 1 / 2
Sweetclover (SW)[c]	B	70 - 90	8 - 15	1 / 4 to 1 / 2
Alfalfa	P	50 - 150	9 - 25	1 / 4 to 1 / 2
White clover	P	60 - 100	5 - 7	1 / 4 to 1 / 2
Medium red clover (RC)	P	60 - 70	10 - 15	1 / 4 to 1 / 2
Alsike clover	B / P	60 - 70	4 - 10	1 / 4 to 1 / 2
Birdsfoot trefoil	P	40 - 100	5 - 10	1 / 4 to 1 / 2
60 / 40 mix (RC / SW)	B / P	60 - 90	8 - 15	1 / 4 to 1 / 2
Non-legumes				
Buckwheat	SA	NA	36 - 60	1 / 4 to 1 / 2
Forage turnips	SA	NA	3 - 5	1 / 4 to 1 / 2
Oats	SA	NA	34 - 68	1 to 2
Oilseed radish	SA	NA	15 - 25	1 / 4 to 1 / 2
Rape	SA	NA	3 - 8	1 / 4 to 1 / 2
Annual ryegrass	WA	NA	15 - 25	1 / 4 to 1 / 2
Barley	WA	NA	48 - 96	1 to 2
Rye	WA	NA	28 - 112	1 / 2 to 1
Triticale	WA	NA	60 - 120	1 / 2 to 1
Wheat	WA	NA	60 - 120	1 / 2 to 1

[a] Life cycles: P = perennial; WA = winter annual; SA = summer annual; B = biennial
[b] Nitrogen values vary depending on cover crop densities
[c] Yellow-blossom sweetclover

Source: Managing Cover Crops Profitably, Sustainable Agriculture Publications - USDA.

Cover crops and crop rotation

Because every aspect of farm management is linked to other aspects, it is important to consider the entire system when planning a field crop scheme. Rotating crops is an important practice that has repeatedly proven to be an excellent pest management tool. Rotation also provides an opportunity for seeding cover crops. The corn-corn-soybean-wheat rotation many Michigan farmers use offers several possibilities for using cover crops.



Common field crop rotation in Michigan

Growers can incorporate cover crops into their cropping systems by overseeding, frost seeding, aerial seeding or spreading.

Aerial seeding.

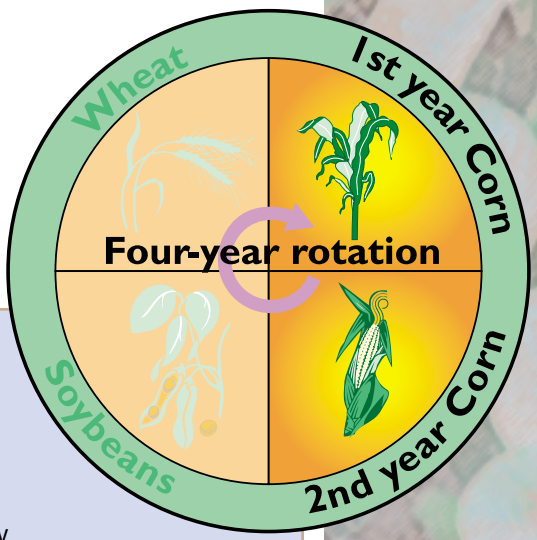
Source: Howell, NRCS.

Overseeding (above), bulk spreading (below).

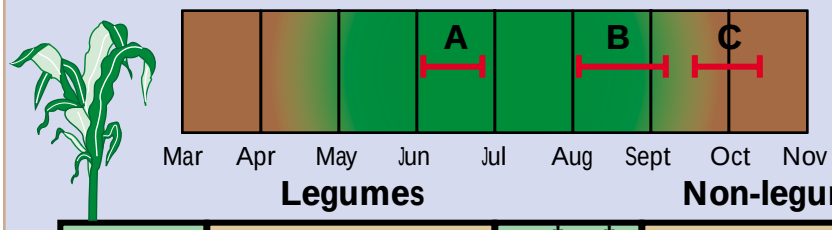
Frost seeding.

Cover crops in corn

Researchers at KBS have adopted a corn system that includes a 10-inch band herbicide treatment followed by two cultivations. Cover crops are overseeded at the second cultivation. Several cover crop species have been successfully established this way, including crimson clover, mammoth red clover, annual ryegrass, hairy vetch and a 60 percent red clover / 40 percent sweet clover plowdown.

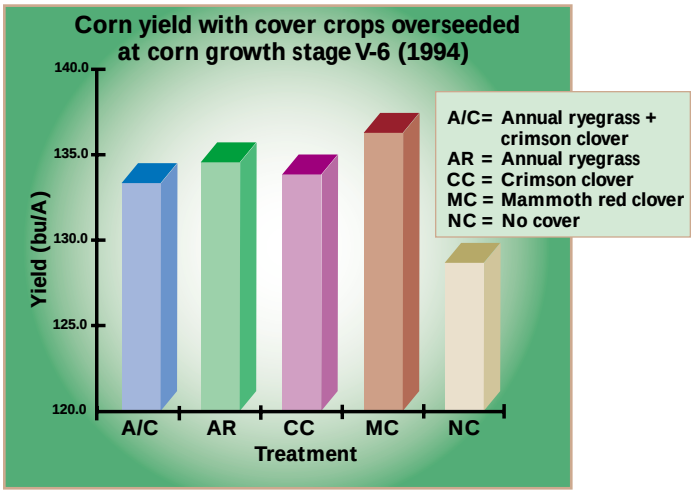


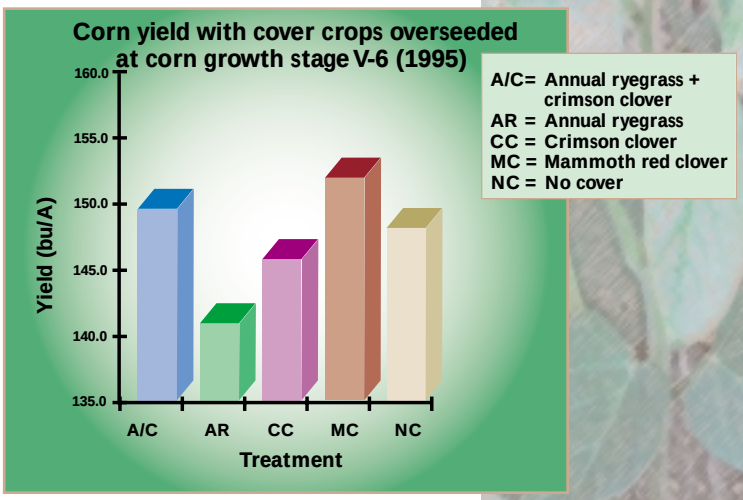
Cover crop options for corn



Legumes		Non-legumes	
A	Berseem clover	A†, B†	Annual ryegrass
A, B	Crimson clover	C	Barley
A, B	Mammoth red clover	A, B	Buckwheat
A, B	Medium red clover	B	Oats
A, B	Sweet clover	B	Oilseed radish
A, B	White clover	B	Rape/Turnip
A, B	60/40 mix	C	Rye
A†, B†	Hairy vetch	C	Triticale
A	Medic annual	C*	Wheat

A = Overseed corn at vegetative stages V4 - V8
B = Overseed corn by air or highboy
C = Overseed corn by air or highboy
* = After Hessian fly-free date
† = Not recommended if being planted to wheat





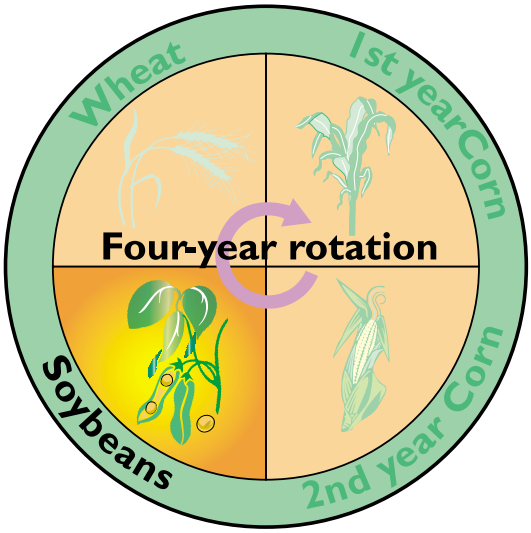
Timing is very important to successfully establishing a cover crop by overseeding. It is extremely important to seed when there is enough light to germinate and establish the cover crop, yet late enough so it will not compete with the corn crop for water, nutrients or light. Two years of research data have shown that legume covers should be seeded between corn growth stages V-4 and V-6, while annual ryegrass should be seeded at V-6 to V-8. With good weed control, cover crops overseeded between the corn rows have not shown a corn yield reduction compared to a broadcast / no cultivation herbicide treatment. For best ground cover after corn harvest, adequate rainfall must occur during the growing season.

Crimson clover and annual ryegrass in corn stubble.

Hairy vetch in corn.

Many Michigan producers apply broadcast herbicide treatments without cultivation. These farmers can still use cover crops by seeding cover crops aerially or with highboy applicators. These seedings can begin when the corn crop begins drying. As the plant dries, sunlight penetrates to the soil, allowing cover crops to germinate and establish. Farmers have been very successful seeding cereal grains, particularly cereal rye.

Annual ryegrass in corn stubble.

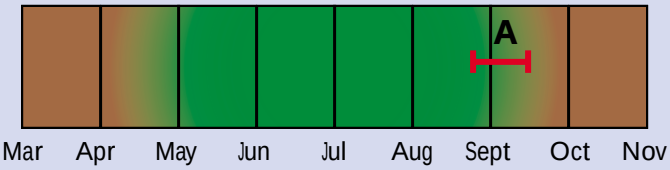


Cover crops in soybeans

Soybeans leave very little residue following harvest, thus following soybeans with wheat is an environmentally beneficial rotation. Not only will the wheat benefit from the nitrogen produced by the soybeans, but seeding after soybean harvest generally offers a good seedbed for drilling wheat. Wheat also provides farmers perennial weed control. Michigan soybeans are often harvested following the Hessian fly-free date providing a nice fit in the crop rotation scheme.

One alternative to rotating to wheat is to follow soybeans with cover crops planted at soybean leaf drop. KBS cover crop researchers have successfully overseeded red clover, wheat, cereal rye and forage rape into soybeans.

Cover crop options for soybeans



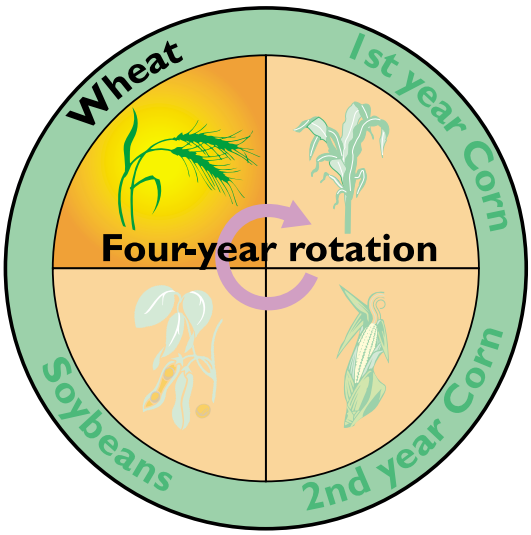
Legumes		Non-legumes	
NR	Berseem clover	A†	Annual ryegrass
A	Crimson clover	A	Barley
A	Mammoth red clover	NR	Buckwheat
A	Medium red clover	A	Oats
A	Sweet clover	A	Oilseed radish
A	White clover	A	Rape/Turnip
A	60/40 mix	A	Rye
A†	Hairy vetch	A	Triticale
NR	Medic, annual	A*	Wheat

A = Overseeding at leaf drop
NR = Not recommended
† = Not recommended if being planted to wheat
*** = After Hessian fly-free date**

Wheat seedlings emerging in soybean stubble (corn stubble from previous year).

Rye seeded into soybeans.

Red clover seeded into soybeans.

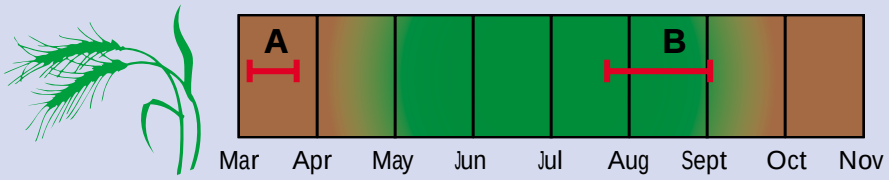


Cover crops in wheat

Wheat offers several cover crop seeding alternatives. Mammoth red clover can be successfully frost-seeded into wheat when spring nitrogen fertilizer is applied. This usually occurs mid-March to mid-April, depending on location. Nitrogen is not necessary for the cover crop, but combining activities reduces the number of trips across the field.

After wheat harvest, farmers have a large window of time for establishing cover crops and managing perennial weed problems. Several cover crops can be successfully drilled into wheat stubble.

Cover crop options for wheat



Legumes		Non-legumes	
B	Berseem clover	B	Annual ryegrass
B	Crimson clover	B	Barley
A, B	Mammoth red clover	B	Buckwheat
A, B	Medium red clover	B	Oats
B	Sweet clover	B	Oilseed radish
B	White clover	B	Rape/Turnip
A, B	60/40 mix	B	Rye
B	Hairy vetch	NR	Triticale
B	Medic, annual	NR	Wheat

A = Frost seed
B = Seed after harvest
NR = Not recommended

Red clover in wheat.

Oilseed radish in wheat stubble.

Cattle grazing oats in an early harvested potato field.

Oats and forage rape in harvested seed potato field.

Once farmers begin incorporating cover crops into their farming systems, they will discover innovative cover cropping strategies. Cover crops fit well with short-season specialty crops (early harvest potatoes, carrots, cucumbers, snap beans, sweet corn and seed corn). In southwest Michigan, farmers have shown that early harvested potato fields can be seeded to cover crops and grazed by livestock.

Economics

What are the economics of using cover crops in field crop systems? Initial studies conducted at KBS compared continuous corn to first-year corn following frost-seeded red clover in wheat. These studies have shown a $40/A gross return minus costs when cover crops were incorporated into a crop rotation.

Costs and returns of first-year corn in a rotation compared with continuous corn*

First-year corn following wheat and red clover cover crop

	Yield or quantity	Price ($)	Dollars/A
Gross returns yield @ 15 percent moisture	158 bu	2.35/bu	371.30
Variable costs			
Seed Corn	26,000 seeds/A		24.00
Ryegrass	25 lb	0.30/lb	7.50
Red clover	15 lb	1.00/lb	15.00
Fertilizer	409 lb	0.11/lb	43.28
Bladex 4L	0.5 qt	3.10/qt	1.55
Dual II	0.5 pt	7.01/pt	3.50
Atrazine	0.25 pt	3.05l/pt	0.76
Drying			10.00
Fuel	5.42 gal	0.9/gal	4.88
Repairs			6.01
Operating interest			10.00
Total variable costs			126.48
Gross margin (gross return minus costs)			244.82

Continuous corn (no cover crop)

	Yield or quantity	Price	Dollars/A
Gross returns yield @ 15 percent moisture	139 bu	2.35/bu	326.65
Variable costs			
Seed Corn	26,000 seeds/A		24.00
Fertilizer	596 lb	0.105/lb	61.78
Bladex 4L	0.5 qt	3.10/qt	1.55
Dual II	0.5 pt	7.01/pt	3.50
Atrazine	0.25 pt	3.05/pt	0.76
Drying			10.00
Fuel	5.42 gal	0.9/gal	4.88
Repairs			6.01
Operating interest			10.00
Total variable costs			122.48
Gross margin (gross return minus costs)			204.17

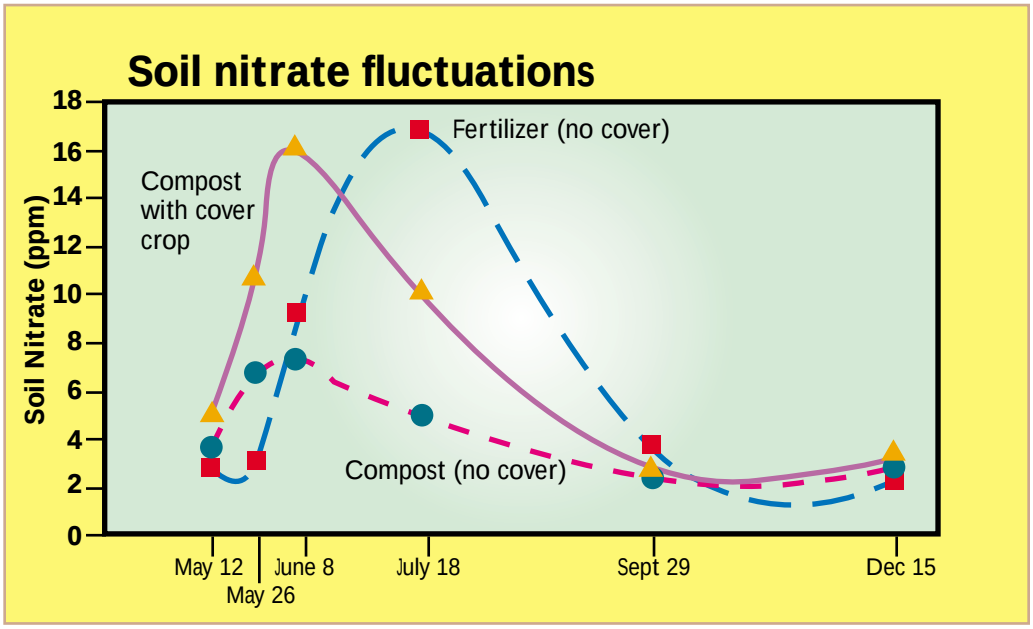
* Third year of rotation study, KBS,.1995

Source: Jones, M., 1996, Ph.D. dissertation, MSU.

KBS studies on corn showed no yield differences between banded herbicide with two cultivations and overseeded cover crops versus broadcast herbicide and no cultivation. The reduced herbicide system requires two cultivations and is more labor intensive, but it also decreases herbicide costs by 67 percent. These savings can often compensate for the added cost of cover crop seed. The long-term economic benefits of cover crops have not yet been calculated, but the value of increased soil biotic diversity, soil quality, soil organic matter, soil erosion control, insect and nematode biodiversity, soil water-holding capacity, aeration and water percolation is certainly important.

Cover crops, soil nitrogen and soil quality

Recent KBS research has shown a dramatic influence of cover crops on soil nitrate dynamics when used in conjunction with composted dairy manure.



Source: Living Field Laboratory, KBS, 1995.

This figure shows that when synthetic **fertilizer** was applied according to PSNT recommendations, a sharp increase in soil nitrate levels followed. Corn yields were 152 bu / A. Adding a clover cover crop to this system resulted in a slightly earlier increase in soil nitrate and only a slight increase in yield (158 bu / A, curve not shown). When **composted dairy manure** was the sole added nitrogen fertility source, nitrate levels peaked earlier in the season, but maximum levels were much lower than with synthetic fertilizers, and corn yields were similarly lower (140 bu / A). When **cover crops** and compost were the only nitrogen sources added to the manure treatment, maximum nitrate levels were much higher than with manure alone, and equal to those with fertilizer, but peak nitrate concentration occurred five weeks earlier. Corn yields were also higher (169 bu / A).

This effect was not just due to nitrogen since adding fertilizer earlier in the season does not result in this type of yield increase. The earlier nitrate peak, resulting from **mineralization** of manure and cover crop nitrogen, may be an indication of soil quality. The cover crop's active roots may have provided a "**priming effect**," in which microorganisms growing on or near live roots increased manure and soil nitrogen mineralization more than without a cover crop. This possibility is currently being investigated by MSU researchers.

Further progress toward increasing nitrogen efficiency in Michigan row crop ecosystems will require more research on integrated systems, and will involve cooperative efforts between farmers, MSU Extension and research scientists. Incorporating cover crops will undoubtedly be an important component of high-production, nitrogen-efficient agricultural systems in Michigan.

Crimson clover and oats, the first of December.