Indiana Cover Crop Tool

NRCS 340 Implementation Requirement (IR)

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Name	Example
Location	
Tract(s) / Field(s)	
Year(s)	

Total Area Summary	
Total Area of All Mixes (sqft)	500
Total # (No) of 1000sqft	1
Total acres, rounded up	0.1

Mixes

Create mixes using the tables below. Mixes 1 to 5 are built by choosing cover crop species and their desired rates. Pre-Made Mixes 1 to 3 are for diverse pre-made mixes obtained from a seed provider. If using pre-made mixes for USDA-NRCS programs, contact your conservation planner to verify mix compatibility with programs and the NRCS Check-a-Mix calculator.

Seeding Rates	
Low - L	Normal rate ÷ 2
Normal - N	100% canopy for a single species
High - H	Normal rate x 2

Divisor

Use the divisor column to reduce the rates of multiple same-typed species (grass, legume, etc.) in a mix by the number of species of that type.

Pure Live Seed - PLS %

Pure Live Seed (PLS) is the % of viable seed that is capable of developing into seedlings. Find on seed tag or inquire with seed provider. PLS = % Purity x % Germination / 100
Ex: If PLS is 80%, the tool will increase the rate by 20% to achieve a full seeding rate.

Notes

EXAMPLE MIXES

The following mixes are examples, all planned for 100 square feet, to highlight common mixes and seeding rates. They do not reflect the amount of seed needed for your area. Please work with your conservationist to fill out this tool with your areas and the mixes that are suitable to your operation.

MIX 1		Notes					
Area of Bed (sqft)	100	Winterkill Cover Crop Mix					
# of Beds	1						
Total Area (sqft)	100						
Cover Crop Species	**Type**	**Rate L - N - H**	**Divisor**	**Rate PLS Oz/100sqft**	**PLS %**	**Amount of Seed per bed**	**total**
Oats	Grass	Normal		2.3	100	0 lb 2.3 oz	0 lb 2.3 oz
Pea, Field	Legume	Normal		2.2	100	0 lb 2.2 oz	0 lb 2.2 oz
					100		
					100		
					100		
					100		
					100		
			Total	4.5	-	0 lb 4.5 oz	0 lb 4.5 oz

Planting Method(s)	Termination Method(s)	Planned Next Crops	Cost Estimate	
Direct Seed	Winterkill	Early spring crops		

MIX 2		Notes					
Area of Bed (sqft)	100	Overwintering Legume Cover Crop					
# of Beds	1						
Total Area (sqft)	100						
Cover Crop Species	**Type**	**Rate L - N - H**	**Divisor**	**Rate PLS Oz/100sqft**	**PLS %**	**Amount of Seed per bed**	**total**
Oats	Grass	Low		1.2	100	0 lb 1.2 oz	0 lb 1.2 oz
Vetch, Hairy	Legume	High	2	1.8	100	0 lb 1.8 oz	0 lb 1.8 oz
Clover, Crimson	Legume	High	2	0.5	100	0 lb 0.5 oz	0 lb 0.5 oz
					100		
					100		
					100		
					100		
			Total	3.4	-	0 lb 3.4 oz	0 lb 3.4 oz

Planting Method(s)	Termination Method(s)	Planned Next Crops	Cost Estimate	
Direct Seed	Mow or Cut	Crops with high nitrogen needs		
	Tarp	Sweet corn, multiple crops		

MIX 3		Notes					
Area of Bed (sqft)	100	Overwintering High Biomass Cover Crop: To terminate, mow or crimp and tarp for 25 days or until fully terminated.					
# of Beds	1						
Total Area (sqft)	100						
Cover Crop Species	**Type**	**Rate L - N - H**	**Divisor**	**Rate PLS Oz/100sqft**	**PLS %**	**Amount of Seed per bed**	**total**
Rye, Winter Cereal	Grass	Normal		2.0	100	0 lb 2 oz	0 lb 2 oz
Clover, Crimson	Legume	Normal	2	0.2	100	0 lb 0.2 oz	0 lb 0.2 oz
Vetch, Hairy	Legume	Normal	2	0.9	100	0 lb 0.9 oz	0 lb 0.9 oz
					100		
					100		
					100		
					100		
			Total	3.1	-	0 lb 3.1 oz	0 lb 3.1 oz

Planting Method(s)	**Termination Method(s)**	**Planned Next Crops**	**Cost Estimate**	
Broadcast + Incorporation	Crimp	Transplanted or larger seeded late crops (May, June) - Squash, Tomatoes, Sweet Potato		
	Tarp			

MIX 4		Notes					
Area of Bed (sqft)	100	Summer High Biomass					
# of Beds	1						
Total Area (sqft)	100						
Cover Crop Species	**Type**	**Rate L - N - H**	**Divisor**	**Rate PLS Oz/100sqft**	**PLS %**	**Amount of Seed per bed**	**total**
Sorghum-sudangrass	Grass	Normal		1.5	100	0 lb 1.5 oz	0 lb 1.5 oz
Hemp, Sunn	Legume	Normal		1.8	100	0 lb 1.8 oz	0 lb 1.8 oz
					100		
					100		
					100		
					100		
					100		
			Total	3.3	-	0 lb 3.3 oz	0 lb 3.3 oz

Planting Method(s)	**Termination Method(s)**	**Planned Next Crops**	**Cost Estimate**	
Direct Seed	Mow or Cut	Fall brasiccas, fall cover crops, or winterkill mulch cover		
	Tarp			

MIX 5		Notes					
Area of Bed (sqft)	100	Summer Low Biomass Cover Crop					
# of Beds	1						
Total Area (sqft)	100						
Cover Crop Species	**Type**	**Rate L - N - H**	**Divisor**	**Rate PLS Oz/100sqft**	**PLS %**	**Amount of Seed per bed**	**total**
Buckwheat	Nonlegume Forb	High		2.0	100	0 lb 2 oz	0 lb 2 oz
					100		
					100		
					100		
					100		
					100		
					100		
			Total	2.0	-	0 lb 2 oz	0 lb 2 oz

Planting Method(s)	**Termination Method(s)**	**Planned Next Crops**	**Cost Estimate**	
Direct Seed	Mow or Cut	Fall crops or fall cover crops		
	Tarp			

Indiana Cover Crop Seeding Windows

Plant Species	March		April		May		June		July		August		Sept.		Oct.		Nov.		Dec-Feb.	
Barley, Winter											N	IN	IN	IN	IN	IN	R			
Buckwheat					S	IN	IN	IN	IN	IN	IN	IN	R							
Clover, Balansa	R-2	IN	IN								IN	IN	IN	IN						
Clover, Berseem							IN	IN	IN	IN	IN	S								
Clover, Crimson					S	IN	IN	IN	IN	IN	IN	IN	IN	R						
Clover, Red	R-2	S	IN	IN	IN														F-2	F-2
Collards		R	S	IN	IN	IN	IN	IN	M	M	M	IN	IN	IN	R					
Cowpea/Soybeans					S	IN	IN	IN	IN	M	3									
Flax		R	IN	IN						M	IN	IN								
Kale		R	S	IN	IN	IN	IN	IN	M	M	M	IN	IN	IN	IN	IN	R			
Millet, Japanese/Pearl					S	IN	IN	IN	IN	IN	3									
Oats, (Spring & Black)	R-2	S	IN	IN	IN	IN	IN	M	M	M	M	IN	IN	3						
Pea, (Field/Spring/Winter)	R-2	S	IN	IN	N						N	IN	IN	IN	R					
Phacelia		R	IN							M	IN	IN	IN	R						
Radish, Oil Seed											M	IN	IN	R						
Rapeseed										M	IN	IN	IN	IN	IN	IN	R			
Rye, Winter Cereal	R-2										N	IN	IN	IN	IN	IN	IN		F-2	F-2
Ryegrass, Annual	R-2	S	IN	IN	IN	N					N	IN	IN	IN	R				F-2	F-2
Sorghum-Sudangrass						IN	IN	IN	IN	IN	IN	IN-3	S-3							
Sudangrass / Milo						IN	IN	IN	IN	IN	IN	IN-3	S-3							
Soybean, (Forage & Field)					S	IN	IN	IN	IN	IN	IN-3	S-3								
Sunflowers				S	IN	IN	IN	IN	IN	IN	S									
Sunn Hemp					S	IN	IN	IN	IN	S										
Teff (Coated Seed)					S	IN	IN	IN	M	M	S-3									
Triticale, Winter											N	IN	IN	IN	IN	IN	IN			
Turnips/Pasja	S-4	IN-4	IN-4						M	IN	IN	IN	IN	R						
Vetch, Hairy		S	IN							IN	IN	IN	IN	IN	S					
Wheat, (Winter & Spelt)											R-1	R-1	R-1	R-1	IN	R				

Legend

IN	Suitable seeding dates for all of Indiana
S	Additional suitable seeding dates for Southern IN (~South of I-70)
N	Additional suitable seeding dates for Northern IN (~North of I-70)
R	Riskier Establishment (Season/Weather/Variety Dependent)
F	Frost/Dormant Seeding
M	If sufficient moisture
-1	Risk for Hession fly-free dates recommended
-2	Dormant/Frost/Early seeding December thru March. Increase rates by 25%.
-3	Expect lower biomass and production
-4	Bolting risk

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

MARION COUNTY SOIL AND WATER CONSERVATION DISTRICT

INDIANA SMALL FARMS CONSERVATION

This document can be found at:
marionswcd.org/soilhealth/
& the NRCS Indiana Field Office Technical Guide

NOTE: Northern and southern Indiana seeding dates are divided on a general line along US 36 from Illinois to Indianapolis and US 40 from Indianapolis to Ohio.There is built-in adjustment according to site specific weather, season, soil conditions, and/or high tunnel micro-climates as observed by the planner.

December 2025

Indiana Cover Crop Table for Small Farms and Gardens

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Species	Type	Life Cycle	Winter Survival	Termination Methods					Growth Height	C:N at Maturity
				Freeze	Tillage	Mow	Crimp[2]	Tarp		
Barley	Grass	Winter Annual	Expected		•	•	•	•	Medium-Tall	30:1
Buckwheat	Nonlegume Forb	Summer Annual	Never	•	•	•		•	Medium	20:1
Clover, White/Ladino	Legume	Short-Lived Perennial	Expected		•			•	Short	15:1
Clover, Balansa	Legume	Cool Season Annual	Expected		•	?	•[2]	•	Short	15:1
Clover, Berseem	Legume	Summer Annual	Never	•	•			•	Short	15:1
Clover, Crimson	Legume	Winter Annual	Expected		•			•	Short	15:1
Clover, Red	Legume	Short-Lived Perennial	Expected		•			•	Short	15:1
Flax	Nonlegume Forb	Summer Annual	Rarely	?	•	?	?	•	Short	19:1
Hemp, Sunn	Legume	Summer Annual	Never	•	•	•	?	•	Tall	20:1
Kale	Brassica	Cool Season Annual	Seldom or Expected[1]		•			•	Medium	19:1
Millet, Japanese	Grass	Summer Annual	Never	•	•			•	Tall	48:1
Millet, Pearl	Grass	Summer Annual	Never	•	•			•	Tall	48:1
Oats	Grass	Cool Season Annual	Seldom	•	•	•		•	Medium-Tall	30:1
Pea, Field	Legume	Winter Annual	Rarely	•	•	•		•	Medium-Tall	25:1
Pea, Winter	Legume	Winter Annual	Seldom		•	•		•	Medium-Tall	25:1
Pea, Cow	Legume	Summer Annual	Never	•	•	•		•	Medium-Tall	20:1
Phacelia	Nonlegume Forb	Cool Season Annual	Seldom	•	•	?	?	•	Medium	25:1
Radish (Oil Seed)	Brassica	Cool Season Annual	Seldom	•	•			•	Medium	19:1
Rapeseed	Brassica	Winter Annual or	Seldom or Expected[1]		•			•	Medium	19:1
Rye, Winter Cereal	Grass	Cool Season Annual	Expected		•	•	•	•	Medium-Tall	37:1
Ryegrass, Annual	Grass	Winter Annual	Seldom or Expected[1]		•			•	Medium	25:1
Sorghum-sudangrass	Grass	Summer Annual	Never	•	•			•	Tall	52:1
Soybean	Legume	Summer Annual	Never	•	•	•		•	Medium	35:1
Sudangrass	Grass	Summer Annual	Never	•	•			•	Medium	50:1
Sunflower	Nonlegume Forb	Summer Annual	Never	•	•	•		•	Tall	35:1
Triticale, Winter	Grass	Winter Annual	Expected		•	•	•	•	Medium-Tall	35:1
Turnips / Pasja	Brassica	Cool Season Annual	Seldom	•	•			•	Medium	19:1
Vetch, Hairy	Legume	Winter Annual or	Expected		•	•	•[2]	•	Medium	11:1
Wheat, Winter	Grass	Winter Annual	Expected		•	•	•	•	Medium-Tall	35:1

? Data undetermined
[1]Variety dependent
[2]Crimping only may not fully terminate legumes
If using chemical termination, ensure proper use and species compatability

Indiana Cover Crop Table for Small Farms and Gardens

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Species	Min. Germ Temp[3]	Optimum Depth (inches)	Surface Broadcast Potential	Seeding Rate (Oz/100 sq.ft.)		
				Low	Normal	High
Barley	35F	¾-1½	+	1.5	3.0	6.1
Buckwheat	50F	½-1	-	0.5	1.0	2.0
Clover, White/Ladino	42F	¼-½	+	0.8	1.5	3.0
Clover, Balansa	42F	¼-½	+	0.1	0.1	0.3
Clover, Berseem	42F	¼-½	+	0.2	0.5	1.0
Clover, Crimson	42F	¼-½	+	0.2	0.4	0.9
Clover, Red	41F	¼-½	+	0.1	0.2	0.5
Flax	?	?	?	0.2	0.3	0.7
Hemp, Sunn	68F	½-1½	-	0.9	1.8	3.7
Kale	40F	¼-½	-	0.1	0.1	0.3
Millet, Japanese	65F	½-¾	-	0.1	0.1	0.1
Millet, Pearl	65F	½-1	-	0.1	0.1	0.2
Oats	38F	½-1	+	1.2	2.3	4.7
Pea, Field	41F	1-1½	-	1.1	2.2	4.4
Pea, Winter	41F	1-1½	-	1.1	2.2	4.4
Pea, Cow	58F	1-1½	-	0.9	1.8	3.5
Phacelia	37F	¼-½	?	0.1	0.1	0.2
Radish (Oil Seed)	45F	½-¾	+	0.1	0.3	0.5
Rapeseed	41F	¼-½	+	0.1	0.1	0.3
Rye, Winter Cereal	34F	¾-1½	+	1.0	2.0	4.1
Ryegrass, Annual	40F	⅛-½	+	0.3	0.6	1.2
Sorghum-sudangrass	65F	½-1½	-	0.7	1.5	2.9
Soybean	50F	1-1½	-	1.7	3.4	6.8
Sudangrass	65F	½-1	-	0.4	0.7	1.5
Sunflower	65F	1-1½	-	0.3	0.7	1.4
Triticale, Winter	38F	¾-1½	+	1.1	2.3	4.6
Turnips / Pasja	45F	¼-½	+	0.1	0.1	0.3
Vetch, Hairy	50F	½-1½	+	0.9	1.7	3.5
Wheat, Winter	38F	¾-1½	+	1.2	2.4	4.9

General Guidelines for Seeding Rates and Mixes

Rates are based on the broadcast seeding method and provided in ounces (weight) per 100 square feet. Normal rate is based on a single species 100% canopy cover in optimum/average conditions. Low rate is half and high rate is double the normal rate.

Best practices for rates

1. Increase rates if using a seeding method that is less assured of good seed to soil contact.
2. Increase rates if a primary purpose is weed control.
3. Increase rates as you reach the end of the optimum seeding window.
4. Increase rates if you plan to terminate a cover crop earlier than maturity.
5. Decrease rates as you increase soil fertility.
6. Decrease rates within a more diverse seed mix.
7. Certain species such as oilseed radish, oats, sorghum-sudangrass, and cereal rye are highly competetive against other species in a mix. Use low rates of these species to prevent them from dominating a balanced mixture.
8. Legume components of a mixture, which tend to be weak competitors, are more safely kept near normal or high rates to ensure establishment.
9. Seeding rates for multiple same-type species in a mix should be reduced by the number of species of that type.

[3]Minimum soil germination temperature

Marion County SWCD Demo Garden Cover Crop Strategies

Cover Crop Mix	Rate L-N-H	Suitable Next Crop
Winterkill Cover Crop		**Early spring crops - transplanted or direct seeded**
Oats	N	*Beets, Carrots, Lettuce, Peas, Spinach, Various crops*
Field Peas	L	Plant in fall - Cover crop winterkills.
Lacy Phacelia (optional)	L	Remove weeds or tarp for 6 weeks in March.
Oilseed Radish (optional)	L	Rake CC mulch into pathway before planting crop.
		Mulch up with compost before or after planting crop.
		Furrow with pointed hoe and plant crop.
		Direct seed or transplant crop
Overwintering Legume Cover Crop		**Direct seeded crops**
Oats	L	*Sweet corn, Various crops*
Hairy Vetch	H	Plant in fall - Legumes overwinter.
and/or		Weed whack in spring and leave residue on bed.
Crimson Clover	H	Tarp for 2 weeks or until fully terminated.
		Lightly rake aboveground residue from planting rows.
		Furrow with pointed hoe and plant crop.
		Mulch up with compost for 100% soil cover before or after planting.
Overwintering Legume Cover Crop		**Transplanted crops**
Oats	L	*Brassicas, Tomatoes, Peppers, Various crops*
Hairy Vetch	H	Plant in fall - Legumes overwinter.
and/or		Weed whack 10 days before planting spring crop.
Crimson Clover	H	Mulch up with layer of newspaper and straw or compost.
		Wait 10 days to ensure cover crop termination.
		Open spaces in mulch and transplant crop.
Overwintering High Biomass Cover Crop		**Transplanted or large seeded late crops (May, June)**
Cereal Rye	H	*Tomatoes, Peppers, Melons, Sweet Potato, Squash*
Crimson Clover	L	Plant in fall to late fall - Cover crop overwinters.
Hairy Vetch	L	Scout and spot weed in fall and spring.
Add diversity (optional)	L	Weed whack or crimp in mid-April to early June.
		Tarp for 25 days or until fully terminated.
		Broadfork if needed to alleviate compaction or ease planting.
		Mulch up for 100% soil cover before or after planting crop.
		Transplant or make space in mulch for direct seed.

Refer to the Indiana Cover Crop Table for Small Farms and Gardens for rates (Low-Normal-High) in Oz/100 square feet.

Results may vary based on soils, climate, and weed pressure.

For all mixes and strategies, scout for weeds often and spot weed.

If cover crop plots become too weedy to effectively spot weed, terminate early with tarp.

Broadfork before planting cover crop or crop if soil is compact or to ease planting.

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Marion County SWCD Demo Garden Cover Crop Strategies

Cover Crop Mix	Rate L-N-H	Suitable Next Crop
Spring Cover Crop		**Transplanted or large seeded late crops (June, July)**
Oats	N	*Late beans, squash, melons, peppers*
Field Peas	N	Plant in early spring (early April).
Flax (optional)	L	Crimp or weed whack in late spring or early summer.
Lacy Phacelia (optional)	L	Tarp for 25 days or until fully terminated.
		Make space in mulch for transplants or direct seed.
Summer High Biomass Cover Crop		**Fall crop or fall cover crop**
Sorghum Sudangrass	N	Plant in summer after spring crop harvest
Sunn Hemp	N	Allow to grow tall or weed whack down to 1' and allow to regrow
Add diversity (optional)	L	The mix often winterkills in October
		If planting fall crops, crimp or weedwhack and tarp until terminated.
		Make space in mulch for transplants or direct seed.
Summer Low Biomass Cover Crop		**Fall crop or cover crop**
Buckwheat	H	Plant in summer after spring crop harvest.
Cowpeas (optional)	N	Buckwheat flowers in approximately 6 weeks.
		Crimp or weed whack and tarp for 1 to 2 weeks to full terminate.
		Allow 20 days after termination before planting small seeded crops.

Refer to the Indiana Cover Crop Table for Small Farms and Gardens for rates (Low-Normal-High) in Oz/100 square feet.

Results may vary based on soils, climate, and weed pressure.

For all mixes and strategies, scout for weeds often and spot weed.

If cover crop plots become too weedy to effectively spot weed, terminate early with tarp.

Broadfork before planting cover crop or crop if soil is compact or to ease planting.

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Cover Crops Overview
For Small Farms and Gardens

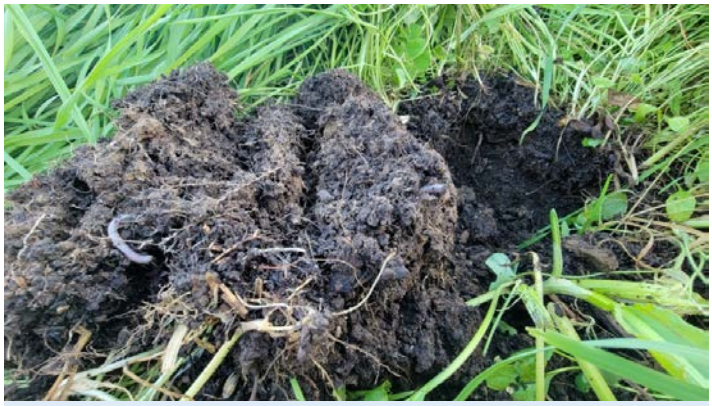
Purpose

Cover crops are grasses, legumes, and forbs planted for seasonal vegetative cover. In most cases, each of the following benefits are maximized when they are planted as early as possible and terminated as late as feasible.

- Reduce erosion
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation by utilizing excessive soil nutrients
- Suppress weeds and break pest cycles
- Improve moisture use efficiency
- Minimize soil compaction
- Grow in situ mulch

Cover crops in a garden

Oats and field peas



Cover crops increase soil health

Soil Health and Organic Matter

Cover crops have the potential to increase soil organic matter and increase the biodiversity of soil organisms in the soil. Increase the diversity of cover crops (ex. mixtures of several plant species and plant families) to promote a wider diversity of soil organisms, and thereby promote increased organic matter. Increased populations of beneficial organisms such as earthworms and arbuscular mycorrhizal fungi greatly increase nutrient use efficiency, water retention, aeration and improved soil structure.

The cover crops should be managed as a part of a conservation cropping system. Soil health is a product of a combination of practices, including crop rotation, cover crops, no-till, reduced tillage, mulching, and compost.

Erosion Control

Cover crops reduce soil erosion in several ways. They protect the soil surface from raindrop or irrigation water impact, increase water infiltration, secure crop residues and compost applications, improve soil aggregate stability and provide a network of roots which protect soil from flowing water.

Minimize Soil Compaction

To minimize soil compaction, select and manage cover crop species that will produce deep roots and large amounts of surface and or root biomass to penetrate or prevent compacted layers, increase soil organic matter, improve soil aggregate stability, and increase water infiltration. Tillage can increase compaction, especially in wet soils. Prevent compaction by utilizing cover crops in a no-till or reduced till system. If grazing, limit to only times with ideal soil conditions. When appropriate for the crop production system, mowing certain grass cover crops (ex. sorghum-sundagrass, pearl millet) prior to heading out and allowing the cover crop to regrow can enhance rooting depth and density, thereby increasing their subsoiling and nutrient-recycling efficiency.

Oilseed radish breaks up compaction

Weed Suppression

Growing cover crops provide competition for sunlight, nutrients, water, and space. Once terminated, the mulch cover creates a weed barrier by blocking sunlight or by producing natural chemicals which suppress weed growth. If greater weed suppression is needed, seed a higher density cover crop stand to promote rapid canopy closure. High seeding rates and good seed to soil contact for quick germination can improve weed competitiveness.

Oats and crimson clover

Break Pest Cycles

Cover crops can be selected to help break pest cycles or suppress plant pests or pathogens. Select cover crop species that do not harbor pests or diseases of subsequent or preceeding crops in the rotation, but rather provide food or habitat for natural enemies of pests. Cover crops may be selected that release bio fumigation compounds that inhibit soil-borne plant pests and pathogens. Regularly scout for pests and disease.

Spring cover crops on a small farm

Bed Preparation

It is very important to plant cover crops into a weed

Fall cover crops on a small farm

free seedbed. Pay particular attention to noxious and potentially invasive species. Many of these species are perennials that spread through seed and roots, and may have rhizomatous root systems that will persist and negatively impact the planting. Common methods include stale seedbeds, mechanical or hand weeding, and/or tarping.

Seeding

Use seed that has been cleaned, tested, and labeled according to Indiana Seed Law. Use of cover crops with stated varieties is encouraged for quality assurance, as opposed to seed listed as "variety not stated" or VNS.

Select a species or a mix that is adaptable to the desired planting date with ample time to germinate and reach an acceptable growth stage prior to a killing freeze or achieve adequate root growth to survive the winter. Utilize *USDA-NRCS Indiana Seeding Windows* for suitable seeding dates and the *Indiana Cover Crop Tool for Small Farms and Gardens* for appropriate seeding rates. The document provides further information on seeding methods, including broadcast, broadcast with incorporation, and direct seed (i.e. row seeders).

Termination

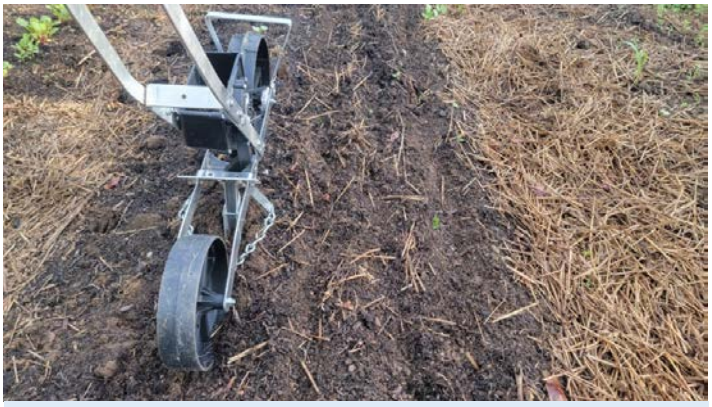
Living cover crops improve soil health, but in most cases, they need to be terminated before planting vegetables for crop plantability and to not outcompete the crop for nutrients, water, and sunlight.

Some cover crop species die in the winter, or "winterkill." Some species survive the winter and have a growth spurt in the spring before producing grains or flowers. For most cropping systems, it is not desirable to allow the cover crop to produce seed. There are multiple ways to kill a cover crop, and sometimes a combination of methods is best. Options include winterkill, mow or cut, crimp, tarp, solarization, mulch, tillage, and chemical. Refer to *Cover Crop Termination for Small Farms and Gardens* for further information.

Time the termination of the cover crops to meet nutrient release goals. Though mulch production may be reduced, terminating at early vegetative stages may cause a more rapid release compared to a more mature stage. Some cover crop species have potential allelopathic effects that can inhibit the growth of weeds and potentially the establishment of following crops. Follow a wait period especially with small-seeded crops.

Nitrogen Fixation

Legume cover crops can typically produce most or all of subsequent crop nitrogen needs. Many legumes require Rhizobium Bacteria to fix nitrogen. In many cases these are specific strains to individual species



Seeding cover crops with a row seeder

Winterkilled oats cover crop

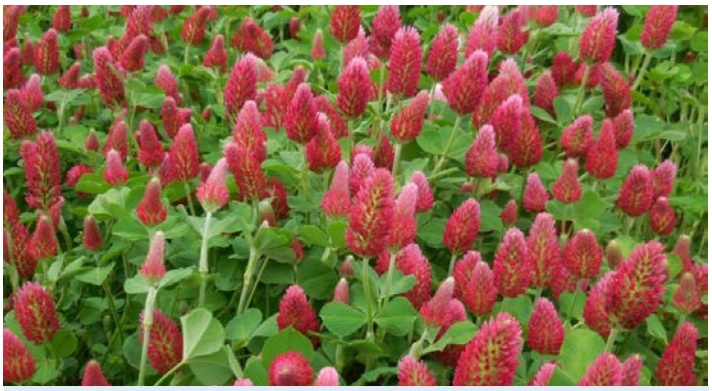
of legumes. Assure the proper inoculant is applied to the seed just before planting and use only fresh inoculant. Legumes add the most plant-available nitrogen if terminated when the cover crop is in early bloom.

Choose a cover crop species or mixture, and timing and method of termination, that will maximize efficiency of nitrogen utilization by the following crop. Consider soil type and conditions, season and weather conditions, cropping system, C:N ratio of the cover crop at termination, and the anticipated nitrogen needs to the subsequent crop.

Improve Moisture Efficiency

Increased soil organic matter and improved soil structure will result in enhanced water infiltration and water holding capacity. As soil health improves, the soil develops a better relationship with water. The soil will have an increased capacity to retain moisture in droughts and regulate water in intensive rainfalls. In areas with limited soil moisture, a cover crop can be terminated sufficiently early to conserve soil moisture for the subsequent crop. If a cover crop matures in a dry season and utilizes soil moisture reserves, be prepared to irrigate. Cover crops established for moisture conservation should be left on the soil surface after termination. In areas with potential excess soil moisture, a cover crop can be allowed to grow as long as possible to maximize soil moisture removal.

Nitrogen fixing bacteria nodes on legume root



Crimson clover legume cover crop

Cover crops at a garden

References

- Indiana Cover Crop Tool, Table, Cover Crop Seeding Windows, Cover Crop Seeding Methods, and Cover Crop Termination Methods for Small Farms and Gardens: Marionswcd.org/soil-health-guide/

- Managing Cover Crops Profitably, 3rd Edition. SARE 2007.

Cover Crop Seeding Methods

For Small Farms and Gardens

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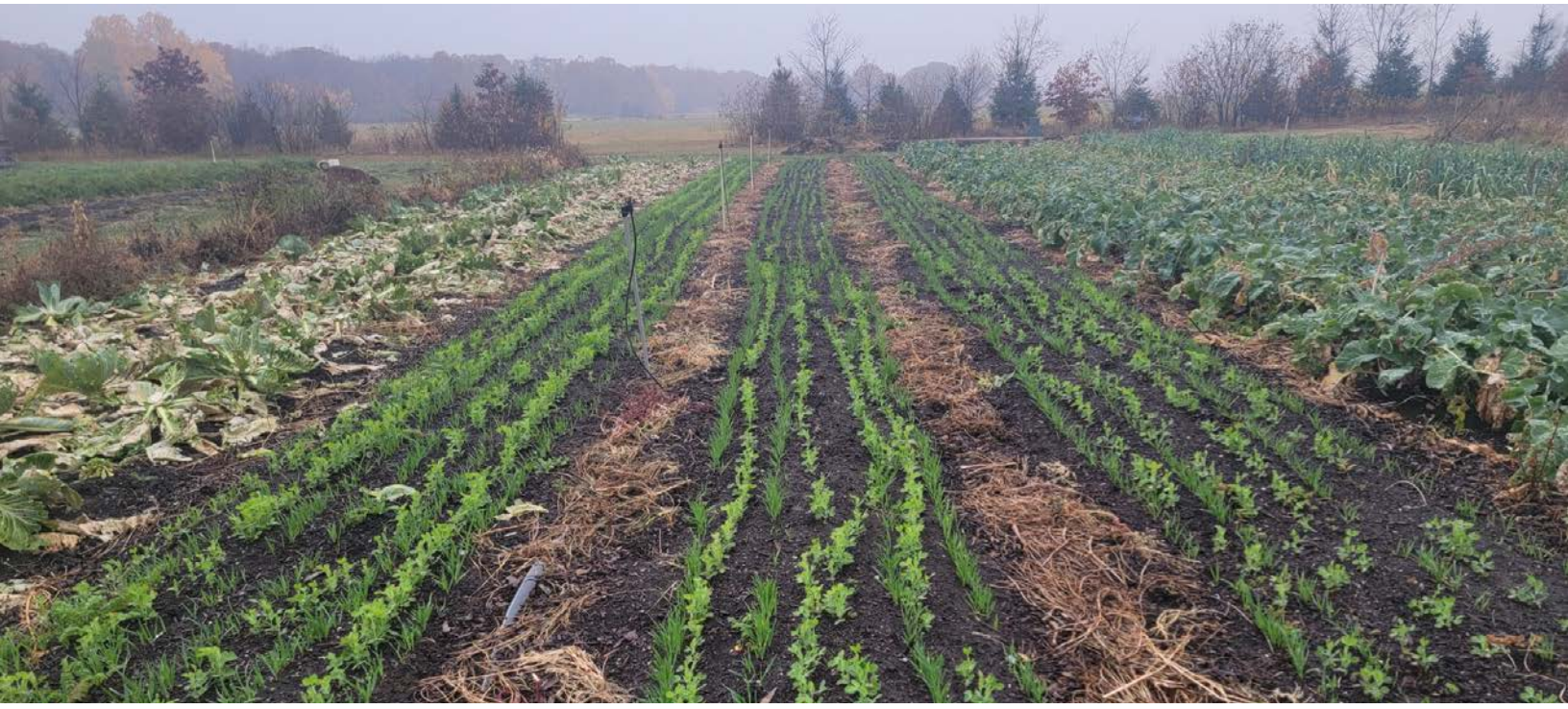


Produced in partnership by:

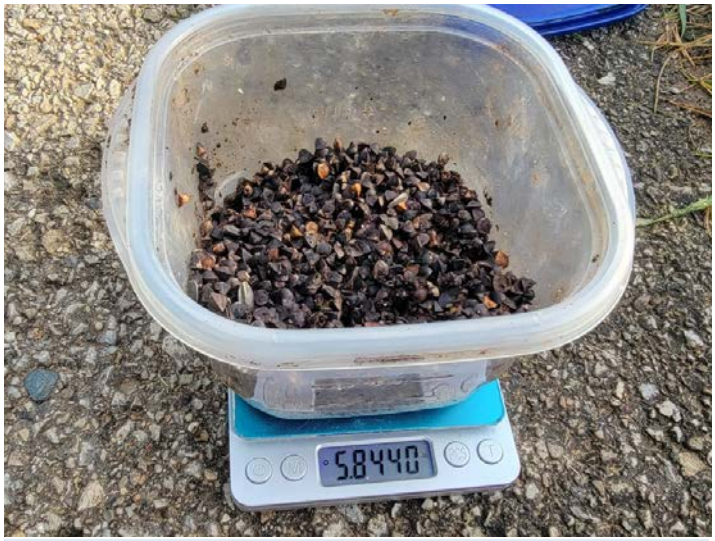
Marion County Soil and Water Conservation District
Indiana's Natural Resources Conservation Service

Introduction

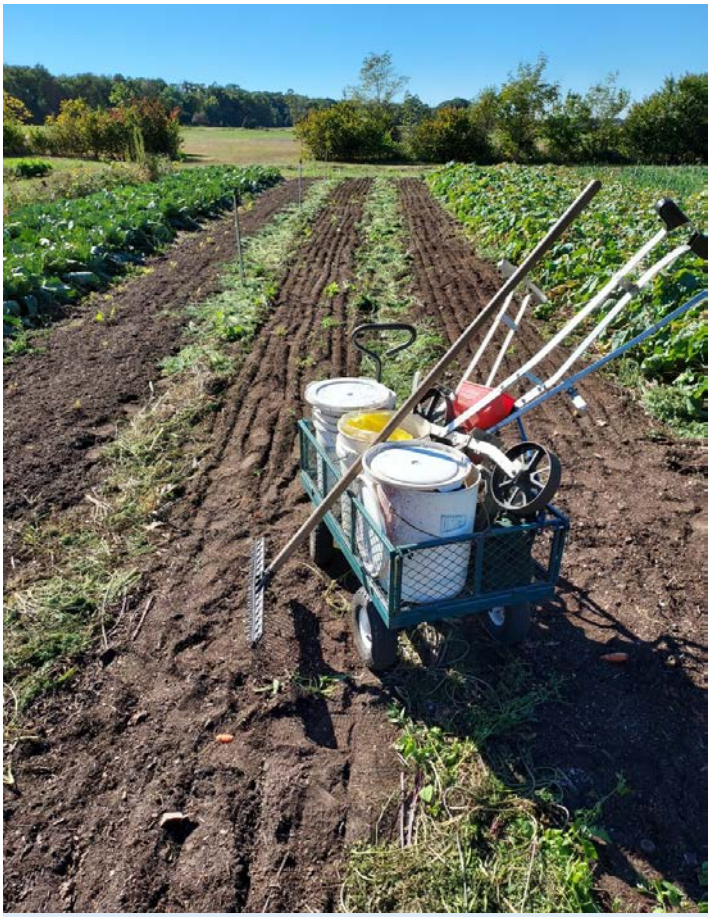
The most common seeding methods for cover crops in small-scale agriculture include:

- Broadcast seeding
- Broadcast with incorporation
- Direct seeding
- Interseeding

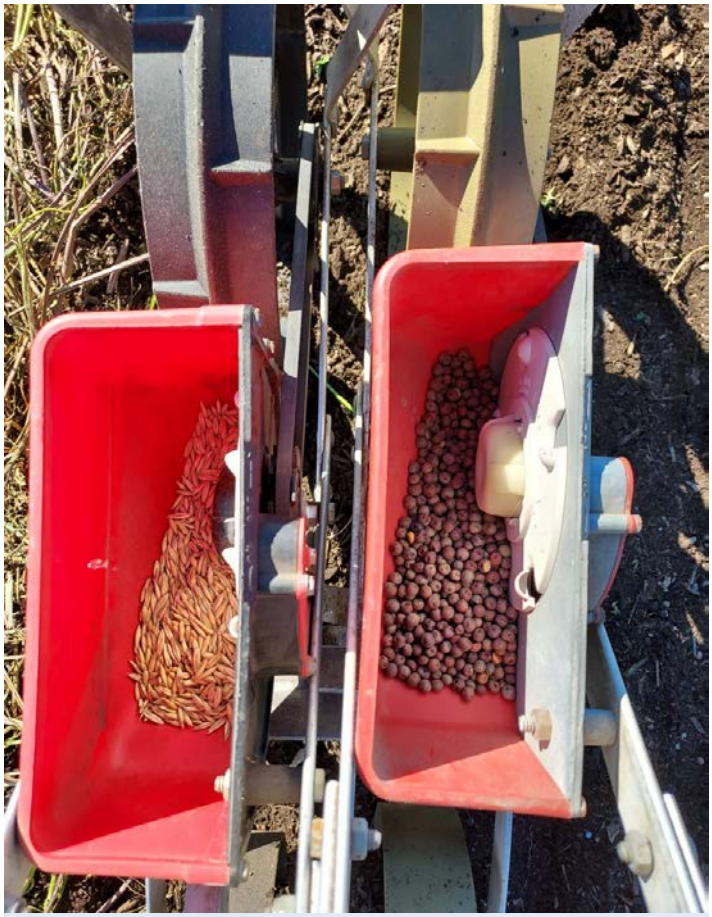
This document covers each method as well as considerations for soil moisture, fertilization, inoculation, and weed management.



Weigh seed to achieve a desired seeding rate



Ready with all the needed equipment and seed



Oats and field peas in row seeder hoppers

Broadcast Seeding

Broadcast seeding is accomplished by spreading the cover crop seed over an area (i.e. by hand or with a seed spinner).

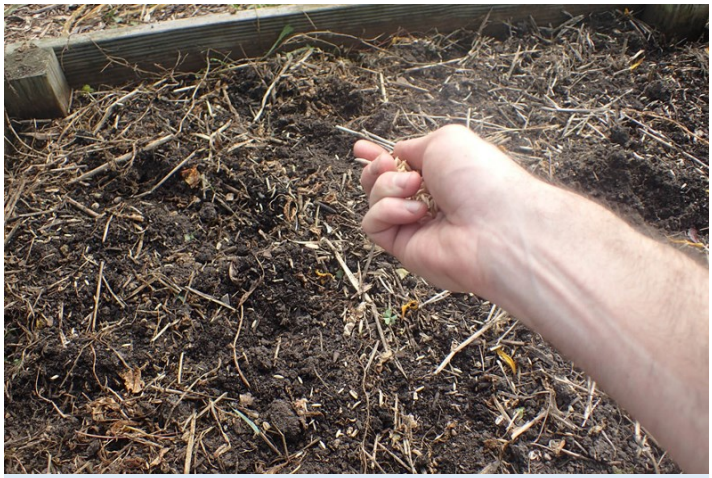
Potential for low seed to soil contact can result in patchy and uneven germination. Increasing seed to soil contact and moisture availability can improve results. Helpful methods include firming the soil surface after seeding, irrigation, and/or adding a light layer of mulch or compost.

Broadcasting is an alternative to incorporation or direct seeding when high residue makes it difficult to bury the seed to optimal depths (i.e. with a rake or row seeder).

Some species are better adapted to broadcast seeding, especially smaller seeds. Refer to the "Surface Broadcast Potential" column on the **Indiana-NRCS Cover Crop Table for Small Farms and Gardens** for broadcast potential for each cover crop species.

Species	Type	Min. Germ Temp[4]	Optimum Depth (inches)	Surface Broadcast Potential
Barley	Grass	35F	¾-1½	+
Buckwheat	Nonlegume Forb	50F	½-1	-
Clover, White/Ladino	Legume	42F	¼-½	+
Clover, Balansa	Legume	42F	¼-½	+
Clover, Berseem	Legume	42F	¼-½	+
Clover, Crimson	Legume	42F	¼-½	+
Clover, Red	Legume	41F	¼-½	+
Flax	Nonlegume Forb	?	?	?
Hemp, Sunn	Legume	68F	½-1½	-
Kale	Brassica	40F	¼-½	-
Millet, Japanese	Grass	65F	½-¾	-
Millet, Pearl	Grass	65F	½-1	-
Oats	Grass	38F	½-1	+
Pea, Field	Legume	41F	1-1½	-
Pea, Winter	Legume	41F	1-1½	-
Pea, Cow	Legume	58F	1-1½	-
Phacelia	Nonlegume Forb	37F	¼-½	?
Radish (Oil Seed)	Brassica	45F	½-¾	+

Excerpt from Cover Crop Table



Broadcasting by hand

Broadcasted seed into sweet corn residue plus compost mulch

Broadcast with Incorporation

Broadcast with incorporation is spreading the seed over an area and then using a tool to bury the seed to a desired depth. Refer to the **NRCS Cover Crop Table for Small Farms and Gardens** for optimum seeding depths for cover crop species.

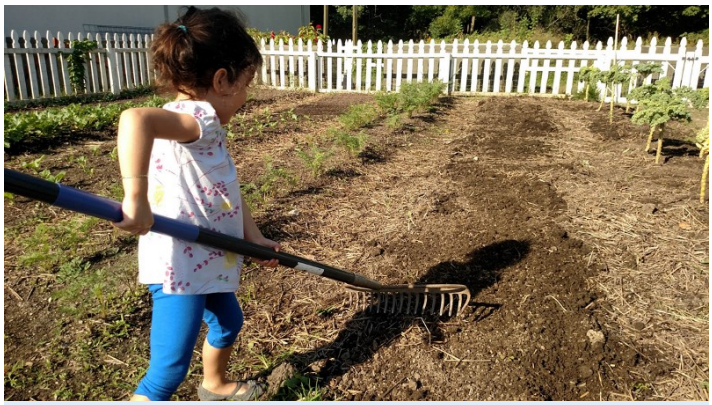
Good seed to soil contact and moisture availability results in more consistent germination. Methods include firming the soil surface after seeding, irrigation, and/or adding a light layer of mulch or compost.

Adding a light layer of compost to the area prior to seeding and incorporation may decrease the depth of native soil disturbance and may reduce weed seed emergence.

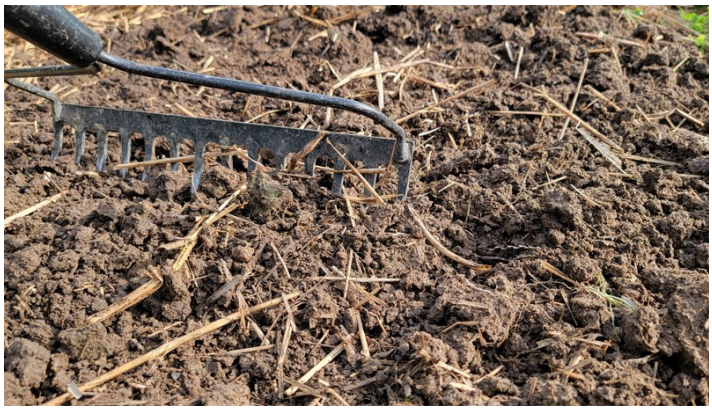
Common tools for incorporation include a rake, rotary cultivator, tilther, and a power harrow or tiller with bed rollers or rolling baskets for depth control and to firm the bed.

Tilther Photo Johnnyseeds

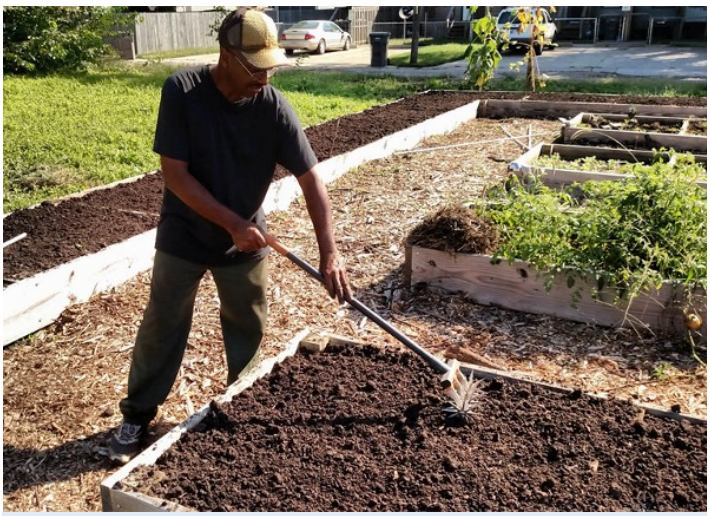
Power Harrow ⅔ Bed Roller Photo BSCAmerica



Seed incorporation with a rake



Firming and mulching



Rotary cultivator

Direct Seeding

Direct seeding in rows is accomplished by using row seeders or tools to create a furrow, plant the seed, and cover the furrow with soil.

Refer to the NRCS Cover Crop Table for Small Farms and Gardens for optimum seeding depths for cover crop species.

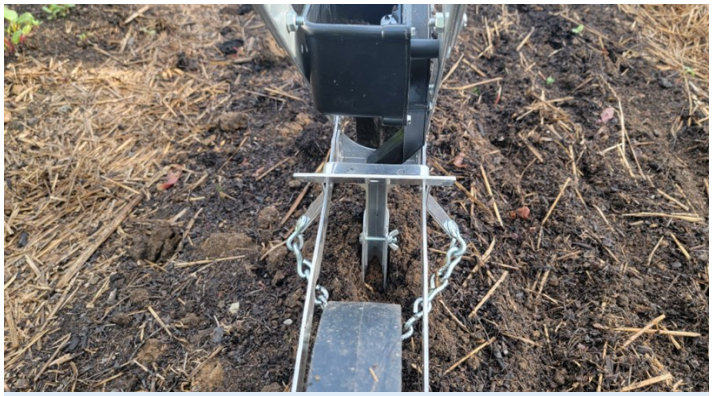
Good seed to soil contact and moisture availability results in more consistent germination. Methods include firming the soil surface after seeding, irrigation, and/or adding a light layer of mulch or compost.

Refer to "Using Manually–Operated Seeders for Precision Cover Crop Plantings on Small the Small Farm" document or manufacturer standards for planter setup recommendations.

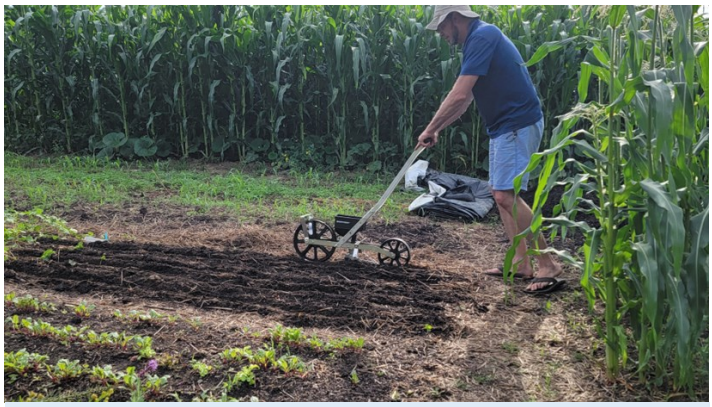
One technique is to broadcast small seed and then direct seed large seed on the same bed (i.e. Broadcasted oats followed by a one row seeder with field peas).

Row seeders and hand tools can be inefficient in hard or compacted soils. Shallow seedbeds or furrows can be prepared prior to direct seeding to facilitate the seeder's ability to move through the soil (i.e. rake, harrow, tilther, wheel hoe). An empty row seeder can also be used in less compacted soil to create furrows which then creates less resistance when planting in those furrows with seed.

Adding a light layer of compost can allow for direct seeding without disturbance. Soil moisture from prior irrigation or rain also allows for easier direct seeding without disturbance.



Direct seeding with a one row seeder



Direct seeding with a one row seeder

Direct seeded alternating rows of oats and field peas

Interseeding

Interseeding is accomplished by seeding the cover crop during crop growth.

A cover crop can be seeded early in the crop's growth stage or towards the crop's maturity depending on crop growth habit and cover crop growth habitat.

Growing cover crops simultaneously with crops can have poor results for certain crops due to impacts on air flow, water and nutrient availability, sunlight, and spacing.

Good cover crop candidates for interseeding include species that are tolerant of shade, low moisture, and low fertility.

Consider how an interseeded cover crop will impact harvesting techniques. A cover crop growing under spinach may not affect a home gardener who is carefully harvesting individual leaves. However, in a market farm situation, fast harvesting may collect unwanted cover crop vegetation along with the harvested crop.

Remove weeds under growing crops prior to interseeding cover crops for better success.

Interseeded cover crops can be broadcasted or direct seeded in rows between growing crops.

Cover crop interseeded under mature kale

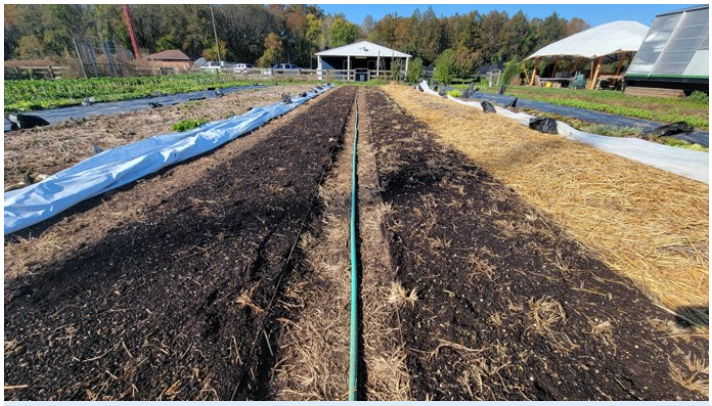
Cereal rye and crimson clover interseeded in spinach

Crimson clover interseeded under mature tomatoes

Moisture Management

The best practice is to keep the soil moist through cover crop germination.

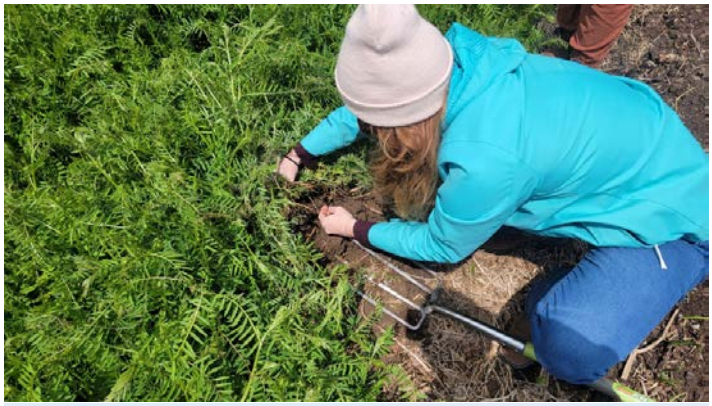
Seed to soil contact improves moisture availability and germination. A light layer of straw or other mulch on top of the cover crop seeding can help conserve moisture. A good rain or irrigation is advantageous. If seeding the cover crop into a layer of compost mulch, pay special attention to ensure that moisture is maintained.



Maintaining moisture

Fertilization

Typically there is no need to fertilize a cover crop. If the purpose is to scavenge excess nutrients, do not add more nutrients. Added nitrogen will actually decrease the effectiveness of legumes to produce nitrogen. Consider fertilization if the purpose is to grow a cover crop for biomass for weed suppression or forage. If the next crop needs fertilization or pH adjustments, it is possible to add the fertility during cover crop establishment or active growth, especially phosphorus and potassium.



Cover crops activate biology and enhance nutrient cycling; Examine legumes for nitrogen fixing bacteria nodes;

Legume Inoculation

Legume cover crops add nitrogen to the soil if the compitable nitrogen-fixing bacteria is present. Inoculate legume seeds with the rhizobial bacteria that is specific to the legume species before planting. A little water can help the bacteria stick to the seed. Keep the inoculant refrigerated before use to prolong its viability.

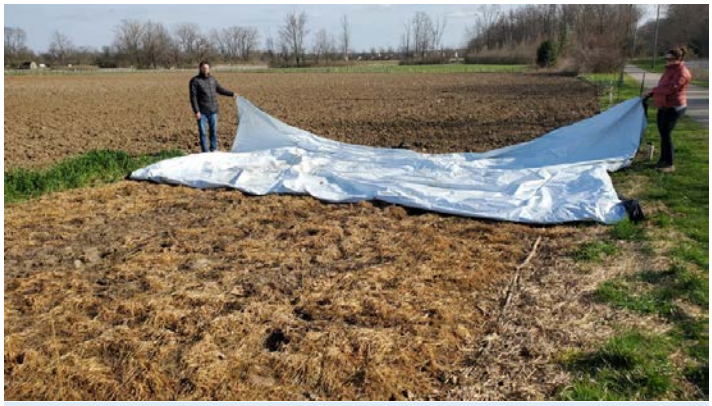
Nitrogen-fixing bacteria on legume nodules; Pinker nodules means more nitrogen;

Weed Management

Cover crops may not suppress 100% of weeds. Proactive measures for weed control include:

- Ensure a weed-free seed bed before planting cover crops.
- Scout for weeds during cover crop growth.
- Perennials can often be pulled. Low lying annuals can often be lightly hoed at the soil surface or carefully flame weeded.
- Patch bare spots with mulch or reseed.
- If weeds are a major issue and cannot be sufficiently removed, consider terminating the cover crop early to prevent the development and spreading of weed seeds.
- Tactics such as stale seed bedding, tarping, zero seed rain, and other weed management methods can pair with cover crops to more fully manage weeds.
- Weed pressure should improve over time with cover crop use, especially when combined with additional weed suppressing practices such as no-till, reduced tillage, mulching, and strategic use of tarping.

Weed growth in a fa@over crop



Tarp to he@terminate weeds

Increased cover crop biodiversity often increases weed suppression

MARION COUNTY SOIL AND WATER CONSERVATION DISTRICT

This publication was compiled by:
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Cover Crop Termination

For Small Farms and Gardens

Produced in partnership by:

Marion County Soil and Water Conservation District

Indiana's Natural Resources Conservation Service

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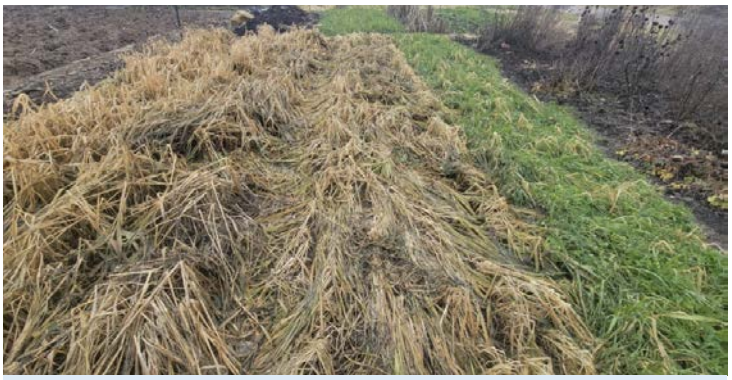
Introduction

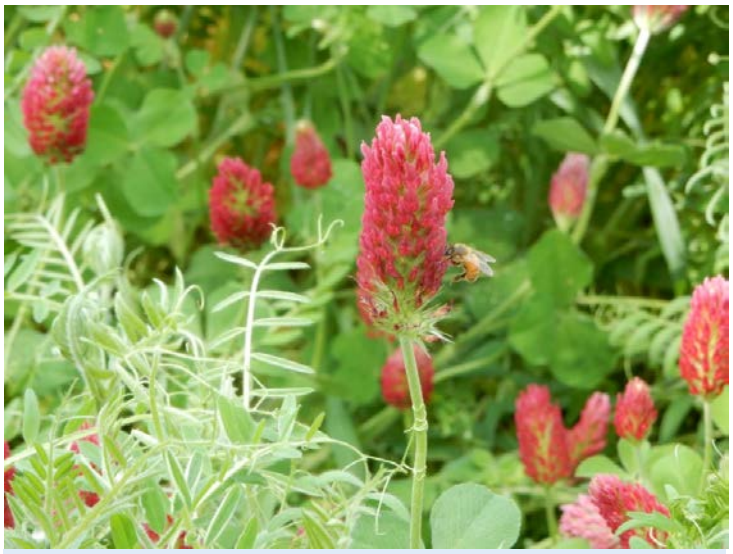
Living cover crops improve soil health, but in most cases, they need to be terminated before planting vegetables or subsequent crop as to not outcompete the crop for nutrients, water, and sunlight. Terminated cover crops also benefit the garden. Their nutrients return to the soil and become available for future crops. Their biomass can be used as mulch to suppress weeds and retain soil moisture. If managed well, they can create favorable planting conditions for crops and facilitate gardening with little or no soil disturbance, thus keeping weed seed buried and soil health thriving.

This document covers a diversity of ways to kill or terminate a cover crop. Methods discussed include winterkill, mow or cut, crimp, tarp, solarization, mulch, tillage, and chemical. Sometimes a combination of methods is best. When choosing a cover crop or mix, it is important to know how to terminate it and imagine how the garden bed will look after termination in order to best prepare for planting crops. While this guide provides a foundation, growers and conservationists are continually learning and advancing cover crop management.

The type, size, maturity, and nature of the cover crop can all factor in to how a cover crop is terminated. Some species die in the winter or "winterkill". Some survive the winter and have a growth spurt in the spring before producing grains or flowers, which is a great time to terminate before they set seed. Some produce a high amount of biomass and others do not. If allowed to mature, species like cereal rye or sorghum sudangrass grow tall and rigid, which invokes termination methods that are different than smaller, more tender cover crop like oats, field peas or oilseed radish.



Winterkilled oats vs. overwintering mix

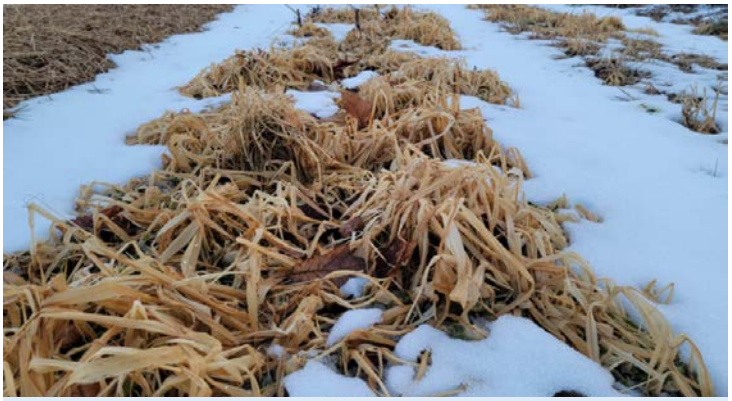


Crimson clover blooming in spring

The **USDA-NRCS Indiana Cover Crop Table for Small Farms and Gardens** (excerpt below) indicates which termination methods work best for each cover crop in Indiana's climate.

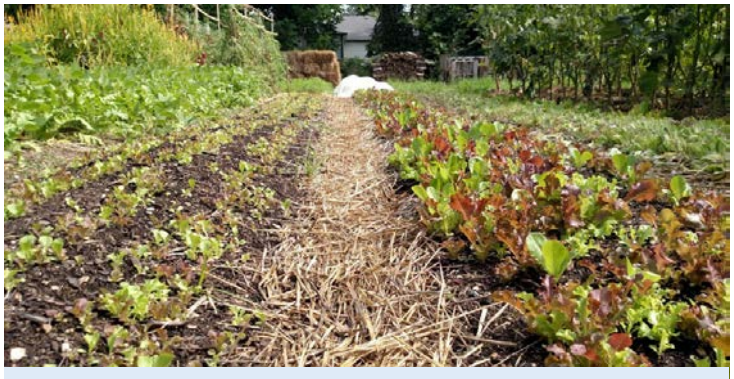
Species	Type	Life Cycle	Winter Survival	Termination Methods					Growth Height	C:N at Maturity
				Freeze	Tillage	Mow Cut	Crimp	Tarp		
Barley	Grass	Winter Annual	Expected		•	•	•	•	Medium-Tall	30:1
Buckwheat	Nonlegume Forb	Summer Annual	Never	•	•	•		•	Medium	20:1
Clover, White/Dutch/Ladino	Legume	Short-Lived Perennial	Expected		•	•		•	Short	15:1

Fall planted oats and field peas



Winterkilled cover crop mix

Cover crop residue raked into the pathway and beds prepared with a layer of compost



Cover crop residue covering the pathway between lettuce beds

Winterkill

Winterkilled cover crop species are not expected to survive freezing temperatures or frost. Many of these species, such as oats, field peas, and oilseed radishes, can be planted in the fall to provide soil health benefits and soil coverage through winter. A suite of summer cover crops also winterkill, including buckwheat, sorghum sudangrass, sunn hemp, and more.

In the spring, the brown residue of the dead cover crops can be left in place, raked into the pathways, or composted. Weed whacking, mowing, and/or tarping can facilitate raking. Leave the decomposing roots and soil undisturbed for soil health benefits. Raking away the top growth can allow for more efficient seeding or planting.

A winterkilled cover crop can greatly diminish the amount of weeds in a garden bed, especially if planted early enough to gain good growth before they die. Scout for and control the weeds that do persist to create a weed-free planting bed for the next crop. Options for weed control include but are not limited to a scuffle hoe, trowel, tine weeder, and/or a tarp in late winter.

If a warm Indiana winter does not fully terminate the cover crop, resort to other termination methods such as mowing or tarping. Late-planted winterkilled cover crops may have an increased chance of surviving. Some summer cover crops and early planted oats may try to set seed before winter sets in. To avoid this, terminate them with other options such as mowing or tarping.

A winterkilled cover crop is an excellent choice for beginner cover croppers and equally as useful for experienced growers.

Cover Crop Termination

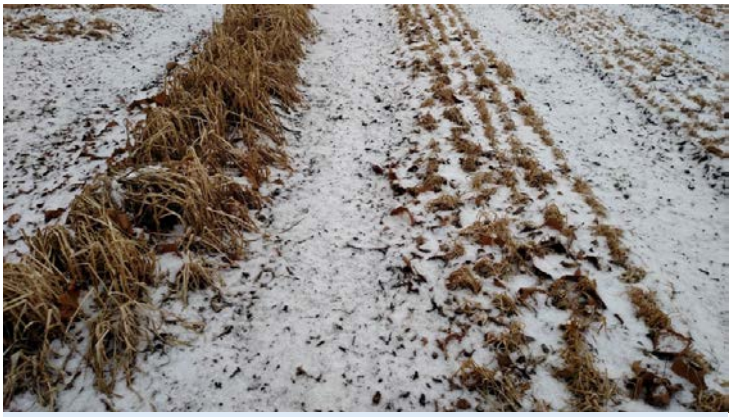
Oats in fall

Oats in early spring

Oilseed radishes in fall

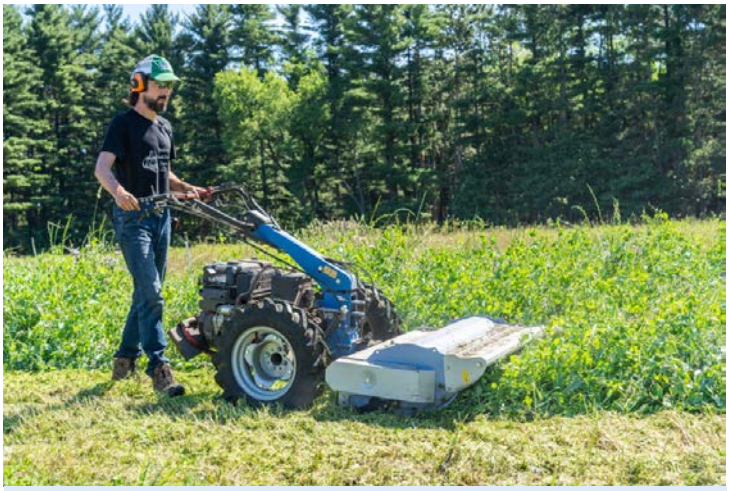
Oilseed radishes in early spring

The species, rates, and growth duration of cover crops in a winterkill mix will impact the type of mulch left behind. Species with higher carbon to nitrogen ratios such as oats will generally produce longer lasting residues that protect the soil further into spring. Field peas or radishes have lower carbon to nitrogen ratios and decompose more quickly, which could lead to bare and unprotected soil if planted alone. Mixing them with oats is a great option. Note that tall sorghum sudangrass can have a very high carbon to nitrogen ratio and produce a lot of residue. In general, it is harder to rake off a bed than a more tender mix like oats and field peas.

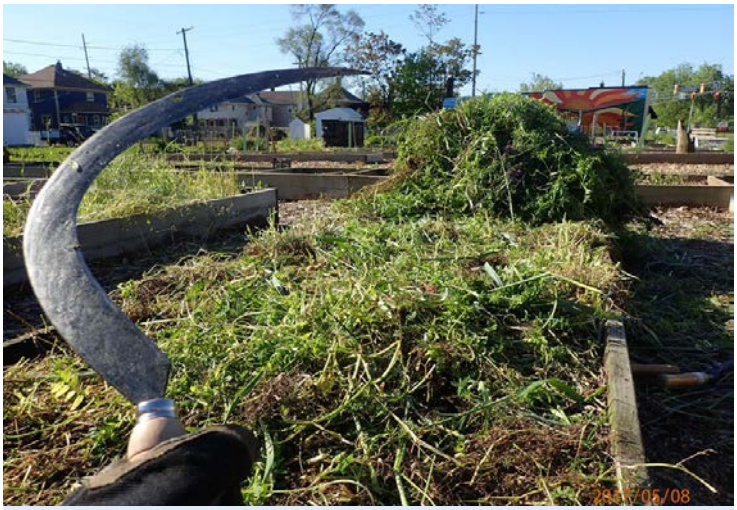


Biomass from early (left) vs. late (right) plantings

Winterkilled cover crops planted earlier in their seeding windows have more time to grow and often produce more biomass and mulch.



Flail mower on walk-behind tractor



Chop and drop with a sickle

Cereal rye anthesis (foreground) and hairy vetch flowering (background)

Mow or Cut

Mowing or cutting is a viable termination method for several species of cover crops. Also referred to as “chop and drop” in a no-till garden, the crop residue can be left on the soil surface as a mulch or raked off to facilitate direct seeding. The smaller pieces can also facilitate tillage by making the vegetation easier to incorporate into the soil.

Termination success is dependent on timing. Cutting at flower or anthesis is the most effective time to terminate. Cutting early can result in cover crop regrowth. Cutting late may allow the cover crop to have set seed and potentially become a weed itself.

There are steps that one can take to increase effectiveness of mowing or cutting, especially if it is not possible to wait until the cover crop is at the optimal flowering stage before attempting termination. Mowing the cover crop once and then again a week later can help. Tarping over the chopped cover crop for a period of time is very effective in ensure full termination of the cover crop and any weeds. Adding a thick mulch on top of the chopped cover crop can also work, as long as it blocks the light from reaching the cover crop in order to prevent regrowth. See sections on tarps and mulch for more details.

Whether you plan to use a flail mower, sickle, weedwhacker, or sheers, ensure that you and your equipment can handle cutting through thick biomass. Tender cover crops such as oats and legumes are easier to cut through than bulky, rigid ones like a mature, cereal rye. For thick stands, some growers make a high pass with a flail mower or weedwhacker and a second, lower pass to finish the job. It is advantageous to mow or cut just above the soil surface.

Crimp

Crimping entails knocking down the cover crop flat to the ground to provide a mulch and soil protection for the next crop. Preferably, the method pinches the stem in multiple locations to prohibit water flow through the plant in order to best terminate it. Like cutting, the optimal time to crimp a cover crop is at flower or anthesis.

High biomass mix of cereal rye and legumes

High biomass mix of cereal rye and legumes

Crimped

Cereal rye and similar grasses are the most conducive cover crop species to crimp. Legumes are often noted as “crimpable” but heavy equipment is sometimes needed to truly break their stems. In human-scale agriculture, legumes are difficult to terminate through crimping alone. If crimping a cereal rye cover crop mix with legumes, anticipate the need for additional termination measures such as tarping.

Tarping can help ensure termination of a crimped cover crop and weeds. If crimped prior to anthesis, a cover crop like cereal rye may continue to grow. Tarping for 25 days is often enough to fully terminate it. If crimped at anthesis, with high temperatures, it will take less time. If crimping without a tarp, pay special attention to optimal timing and scout for weeds.

Terminated cereal rye residue

Crimping Methods

Methods to crimp a cover crop are diverse. In a small garden, a tool could be as simple as one's foot. T-posts or angle irons attached to a board with ropes on each end can be used to stomp a cover crop over. Weighted rollers, walk-behind tractor implements, and even the bucket of a tractor are all methods that could be employed to crimp a cover crop.

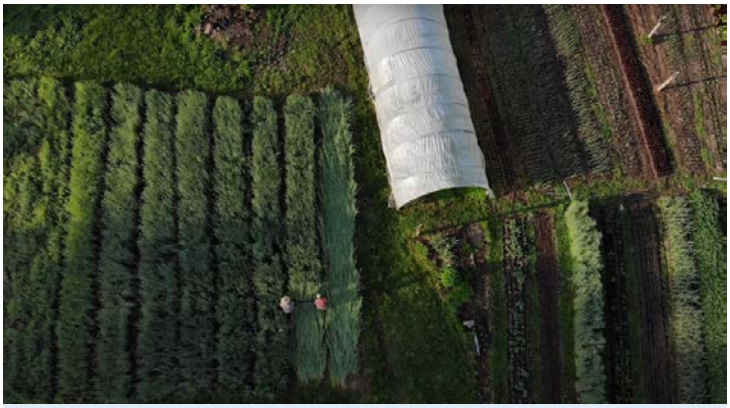
If the crimped cover crop will be tarped, pressing the cover crop over to the ground may be sufficient. Without additional measures, extra care should be taken to crimp at anthesis.

If there is a need to terminate early, a young cereal rye cover crop that is less than two feet tall may not be rigid enough to crimp. In this situation, mowing or cutting and then tarping may be favorable. Pressing the cover crop over enough to cover with a tarp can also work, though the young, vigorous plants may push up against the tarp until they begin to lose energy.

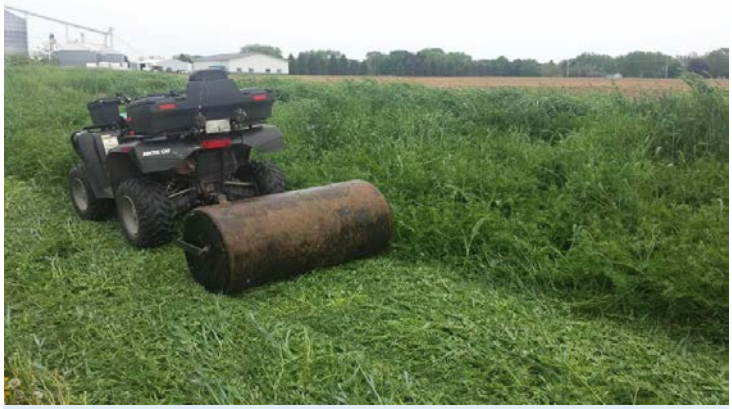
As a general rule of thumb, pushing the cover crop down in one direction can help leave a more manageable mulch when planting a crop.

Crimping by foot

"T-Post foot stomper"



"T-post foot stomper" Photo by NoTillGrowers



Rolling cover crops

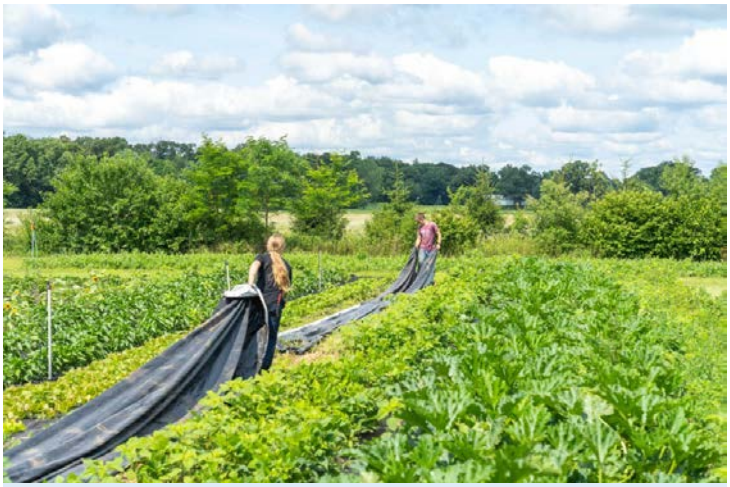
Tarps

Tarps can be used to supplement mowing, cutting, or crimping to ensure a fuller termination of the cover crop and weeds. After the cover crop is mowed or crimped, an opaque tarp is placed on top of the cover crop residue to block sunlight and prevent regrowth. The tarp can then be removed once the cover crop is dead. This process is also referred to as occultation. Bulletin #1075, Tarping in the Northeast: A Guide for Small Farms is an excellent resource for additional information and grower case studies.

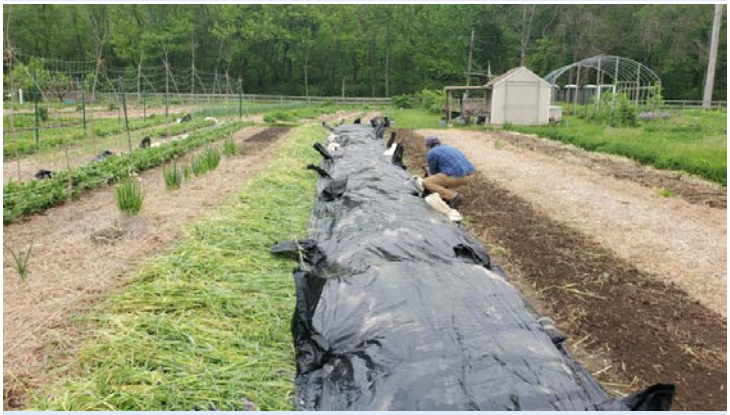
Common materials include black silage tarps or thick landscape fabric. Tarps can be susceptible to high winds, so anchors such as sandbags, tires, cinder blocks, or step-in fence posts are used to hold them in place.

Tarps are especially useful when a cover crop mix contains species with different bloom times or if the cover crop needs to be terminated before it reaches the flowering stage. For example, if a target planting date for a crop is May 15, a tarp can be placed a month prior to fully terminate the stand in time for crop planting. The amount of mulch may be reduced if tarped early, but the bed will be ready. Mowing and tarping very young vegetative cover crops can also accelerate termination but produce less mulch.

In general, a tarp will fully terminate a cover crop in approximately 25 days in spring. The duration needed varies based on many factors. Less time is needed when temperature is higher, and more time when the temperature is cooler. Duration is also species specific. Legumes take less time than cereal rye. Some perennial weeds take longer. If the cover crop is mowed or crimped at flower or anthesis and then tarped, the duration needed should be less than if done prior to the optimal growth stage.



Tarping



Tarping

Getting there

Terminated and planted to tomatoes

Tarps and Weeds

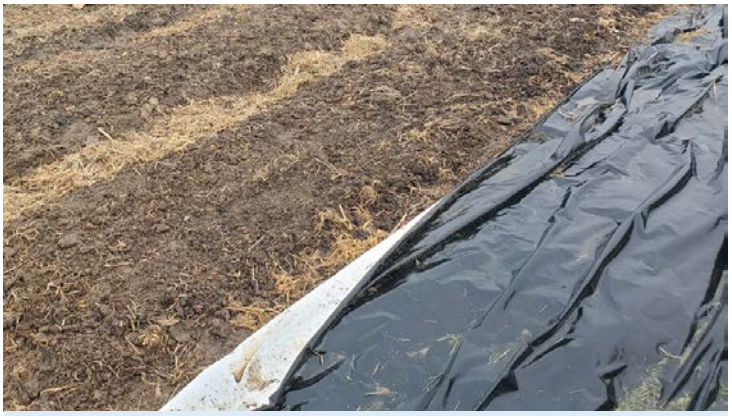
Cover crops are excellent at smothering weeds, but consistent 100% control is not the norm. A tarp not only ensures that the cover crop will be fully terminated, but it also helps terminate weeds that do not winterkill or cannot be terminated by cutting or crimping. The strategic combination of cover crops and tarps can provide long-lasting weed suppression in a vegetable rotation.

Note that some perennial weeds may need longer tarping periods to completely terminate. Perennials such as dandelions, burdock, thistle, bindweed, and rhizomatous grasses may not be terminated at all. After removing the tarp, persistent perennial weeds may be more visible in contrast to the other dead, brown residue and can be dug out of the bed.

Weed seeds may also germinate under the tarp and terminate, except for some species that need light to germinate such as crabgrass and purslane. Remember that tillage after tarp removal may bring weed seeds closer to the soil surface and encourage germination.

If the goal is to mow or cut an overwintered high biomass cover crop in spring, scout for weeds in the months leading up to termination and spot weed where necessary. If there is a substantial amount of weeds within a cover crop and spot weeding is not feasible, consider tarping the bed before the weeds set seed in order to prevent future issues.

Keep in mind that extended periods of tarping may have negative impacts on soil organic matter. Tarping dry soil can also have negative impacts on soil life. Irrigate or allow for a rain prior to tarping to ensure adequate moisture.



Early spring tarping of a winterkilled cover crop to terminate remaining weeds

Perennial weed after tarping

Perennial weeds removed after tarping

For helpful information on tarping, visit: https://smallfarms.cornell.edu/projects/reduced-tillage/tarping/

Solarization

Solarization can be used to supplement mowing or cutting in order to accelerate the termination of certain cover crops. After the cover crop is cut or mowed, clear plastic can be placed on top of the crop residue to intensify the heat to burn the plant. The plastic can then be removed once the cover crop is dead.

Common materials include clear sheets of plastic, such as used high tunnel covers or large sheets of 4 mil. construction plastic.

In general, solarization is more effective on tender crops like oats and legumes, as opposed to vigorous grasses like cereal rye, sorghum sudangrass, or annual ryegrass.

The effectiveness of solarization depends on the air temperature and intensity of sunlight. Typically, two to three sunny days in June to August is used to kill cover crops. Check roots and stems to ensure no new growth has occurred. Cool, cloudy days may not be sufficient.

Solarization attempts in early spring when the weather is cool can result in a greenhouse effect and actually accelerate cover crop or weed regrowth. This could potentially be used as a stale seed bed tactic if followed with tarping or another form of weed management.

Intense heat can kill microorganisms and therefore damage soil health. If using this technique, be conscientious to not overheat the soil for long periods. Growers advise that 14 days can severely damage biology but that negative soil health effects can occur with even less time. Keeping the edges of the plastic sealed can help prevent moisture loss.

Solarization of mowed oats and field peas

Solarization of mowed oats and field peas

Mulch Up

Mulch can be used as a supplemental tool for cover crop termination. After mowing, crimping, or tarping, mulches like straw, hay, compost, leaf mold, or others can be applied to provide enhanced weed suppression. Materials like cardboard and newsprint can also be added to the mulch layer to enhance termination. The idea is to block light from reaching the soil and cover crop residue in order to prevent weed seed germination and decrease the chance of cover crop regrowth via photosynthesis.

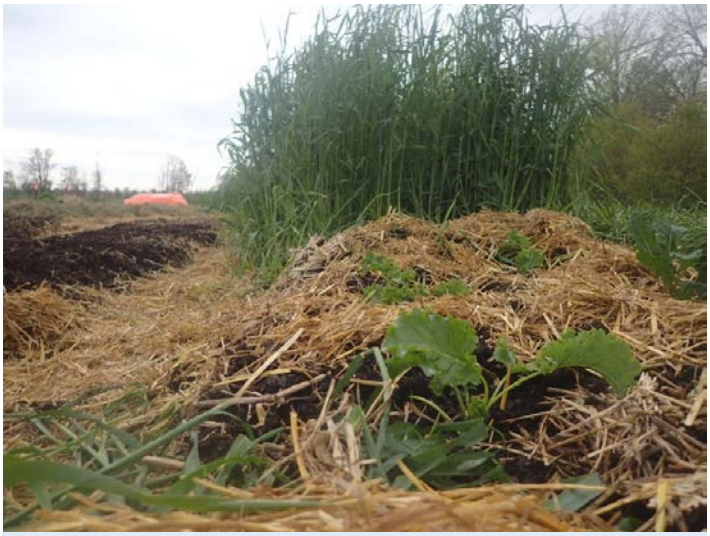
Like a tarp, mulching can also be used to terminate a cover crop earlier than the anthesis stage. However, the thickness of the mulch and its ability to block light will determine its effectiveness.

The vigor of the cover crop species is also a factor. Cereal rye and other grass cover crops can continue growing if mowed or crimped before flower. A thick layer of straw might be able to stop the growth but is not considered a dependable tactic. On the other hand, the same technique can prove effective with tender cover crops like hairy vetch or crimson clover, especially with an added layer of newspaper below the straw. It is beneficial to wait 10 or more days after implementing this method before opening transplant holes through the mulch, as the cover crop may not have fully terminated and can regrow via the introduced light.

Scale is also a consideration. Weeding any regrowth is more feasible in a smaller garden than in a large market garden. Mulching methods can be favorable on constructed raised beds if tarps are not practical due to issues with anchoring.

Newspaper and hay over cut crimson clover

Straw over cut hairy vetch



Compost and straw over cereal rye that was mowed before anthesis (foreground)

Tillage

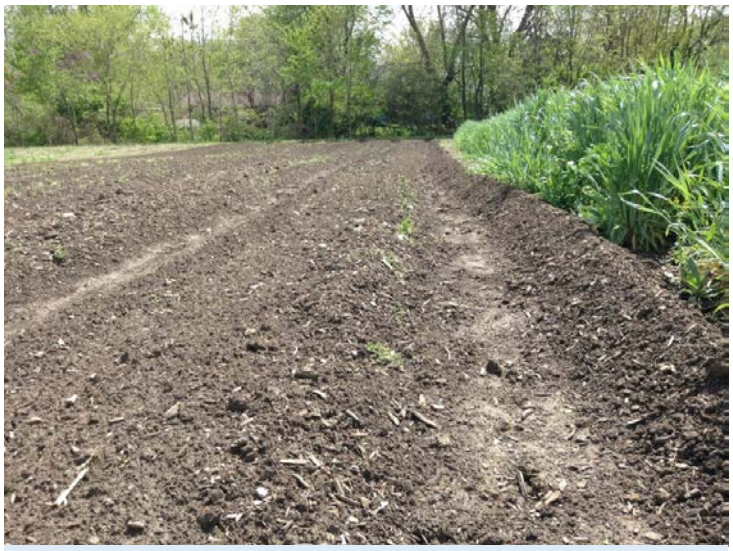
Tillage is a termination method in which the cover crop is incorporated into the soil, commonly referred to as "green manure."

Tillage may need to be repeated multiple times in order to fully terminate a cover crop. The growth state of a cover crop can also affect the ability for the cover crop to regrow after tillage. Cereal rye, for example, has a greater tendency to regrow if tilled when it is less than 12 inches tall.

Mowing a cover crop first produces smaller pieces of vegetation which facilitate tillage. Some growers with smaller tillage equipment mow the cover crop, tarp for a period of time to allow for the material to further breakdown, and then till. Some growers rake the cover crop top growth off the bed before tillage. Note that mowed cover crops, especially if mature, can wrap in a tiller.

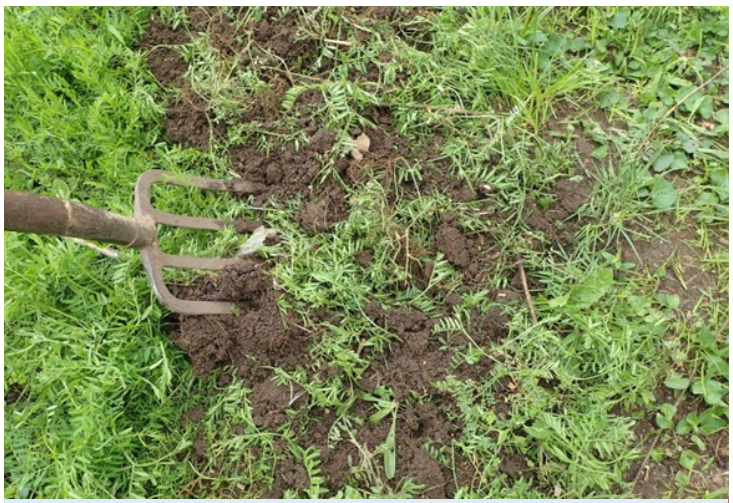
SARE's Managing Cover Crops Profitably guide, table 4B "Potential Disadvantages" has information on each cover crop's ability to be terminated through tillage. Consult this table as well as each cover crop's individual chapter for additional guidance on tillage.

Note that if soil conditions are too moist or too dry, tillage can cause damage and compaction.



Mowed and tilled cover crop

Cover crop mix cut with a string trimmer and incorporated with a pitchfork



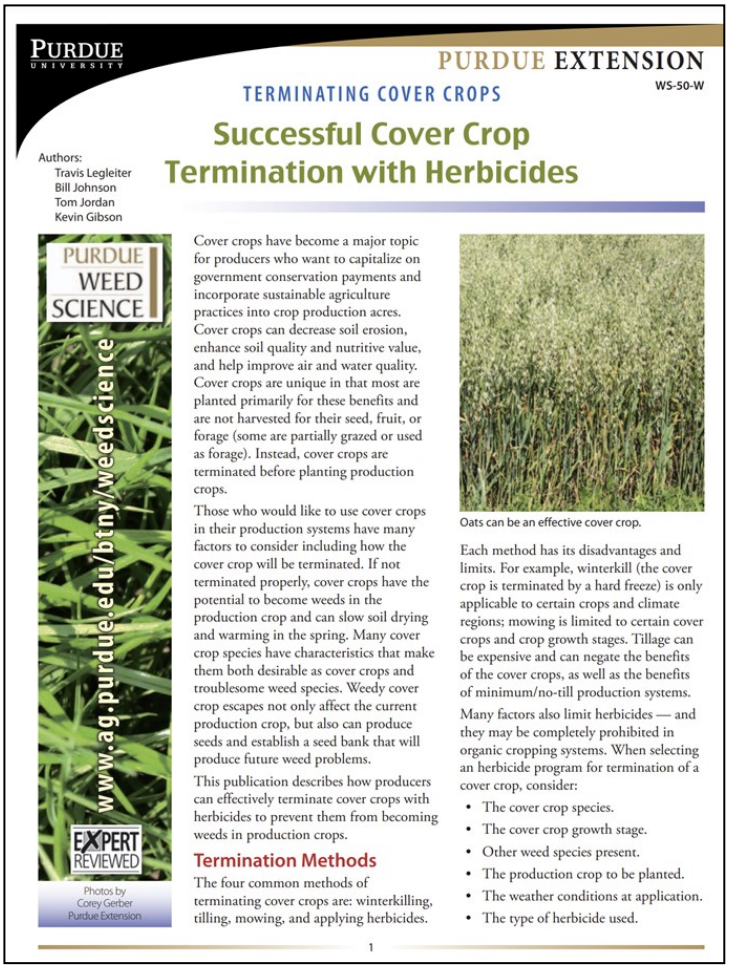
Incorporating a cover crop like hairy vetch with a pitchfork only once may not fully terminate it

Chemical

For chemical termination, consult Purdue Extension's guidance entitled:

"HO-50-W: Terminating Cover Crops, Successful Cover Crop Termination with Herbicides"

or contact Purdue Extension for additional assistance.



PURDUE UNIVERSITY

PURDUE EXTENSION

WS-50-W

TERMINATING COVER CROPS

Successful Cover Crop Termination with Herbicides

Authors:
Travis Legleiter
Bill Johnson
Tom Jordan
Kevin Gibson

PURDUE WEED SCIENCE

www.ag.purdue.edu/btny/weedscience

EXPERT REVIEWED

Photos by Corey Gerber Purdue Extension

Cover crops have become a major topic for producers who want to capitalize on government conservation payments and incorporate sustainable agriculture practices into crop production acres. Cover crops can decrease soil erosion, enhance soil quality and nutritive value, and help improve air and water quality. Cover crops are unique in that most are planted primarily for these benefits and are not harvested for their seed, fruit, or forage (some are partially grazed or used as forage). Instead, cover crops are terminated before planting production crops.

Those who would like to use cover crops in their production systems have many factors to consider including how the cover crop will be terminated. If not terminated properly, cover crops have the potential to become weeds in the production crop and can slow soil drying and warming in the spring. Many cover crop species have characteristics that make them both desirable as cover crops and troublesome weed species. Weedy cover crop escapes not only affect the current production crop, but also can produce seeds and establish a seed bank that will produce future weed problems.

This publication describes how producers can effectively terminate cover crops with herbicides to prevent them from becoming weeds in production crops.

Termination Methods

The four common methods of terminating cover crops are: winterkilling, tilling, mowing, and applying herbicides.

Oats can be an effective cover crop.

Each method has its disadvantages and limits. For example, winterkill (the cover crop is terminated by a hard freeze) is only applicable to certain crops and climate regions; mowing is limited to certain cover crops and crop growth stages. Tillage can be expensive and can negate the benefits of the cover crops, as well as the benefits of minimum/no-till production systems.

Many factors also limit herbicides — and they may be completely prohibited in organic cropping systems. When selecting an herbicide program for termination of a cover crop, consider:

- The cover crop species.
- The cover crop growth stage.
- Other weed species present.
- The production crop to be planted.
- The weather conditions at application.
- The type of herbicide used.

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Techniques for Walk-Behind Tractors

Growers are continually making advancements in how to effectively terminate cover crops.
Here are some grower-tested methods to consider.

Flail Mow

- Make a high pass
- Make a low pass close to the soil surface
- Tarp
- If no tarp, wait a week, and mow again to improve termination

Flail Mow and Rotary Plow

- Flail mow growing bed
- Rotary plow walkway soil onto beds
- Tarp

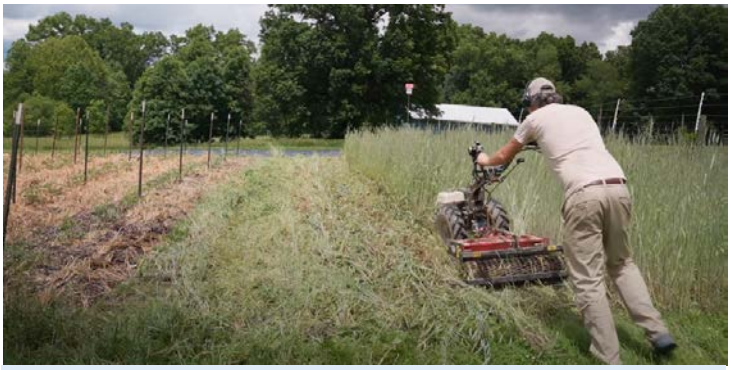
Crimp

- Knock cover crop over with unengaged flail mower or unengaged power harrow
- Tarp

Clobber Method

- Knock cover crop over with power harrow with PTO engaged and tines set several inches above the soil
- This method pinches the stems to increase termination effectiveness
- Tarp

Flail mowed cover crop



Check out this YouTube video by No-Till Growers that demonstrates different methods that can be used to terminate cover crops with walk-behind tractors and their attachments.
https://youtu.be/O6-IYSxbbuE

High Biomass Residue

The cover crop species and method of termination both impact the type of mulch left behind. Knowing the desired amount and type of residue can drive the decision on what species or mix of cover crop to plant and how best to terminate it.

Cover crops with higher carbon to nitrogen ratios will produce longer lasting residues that are slower to decompose. Great examples are maturing cereal rye and sorghum sudangrass. These cover crop species can produce a lot of biomass. Species with low carbon to nitrogen ratios will produce residues that will decompose more quickly. Great examples are legumes such as hairy vetch and crimson clover. Cover crop species within a mix may contain a diversity of C:N ratios. Upon removing a tarp from a mix of crimped cereal rye and hairy vetch, the cereal rye's sturdy stems may be abundant, whereas the hairy vetch's brittle plant matter is well on its way in the decomposition process.

A mowed cover crop creates smaller pieces of vegetation which are more readily decomposed into the soil. A crimped cover crop stays intact and often decomposes more slowly.

As soil health increases, the biology of the soil becomes more active. Increased activity from decomposer microorganisms can result in quicker decomposition of cover crop residue and mulches. Higher temperatures and sufficient moisture will also increase decomposition rates.

Crop planting and weeding strategies and techniques should be adapted to high residue mulches. Weed suppression can be significant in these systems, but for weeds that do arise, tools like tine rakes or hoes are not viable when the soil is covered with hardy mulches. Anticipate scouting for weeds and manually pulling.

Cut vs. crimped cereal rye

Mowed vs. crimped cereal rye

Wheedwhacked planting strips after a crimped and tarped cereal rye with compost added for fertility and soil warming

Soil Moisture

A maturing cover crop, especially a vigorous one like cereal rye, needs water to grow and produce grains or flowers. The cover crop can be terminated in a way to manage soil moisture. In areas with limited moisture, one can terminate growth of the cover crop sufficiently early to conserve soil moisture for the subsequent crop. In areas with potential excess soil moisture, allow the cover crop to grow as long as possible to maximize soil moisture removal. If too dry, a soil depleted of moisture can be replenished through irrigation.

Tarping dry soil over extended periods of time can be detrimental to soil life. Irrigate or allow for rain before tarping to ensure adequate soil moisture.

Though cover crops can at times draw moisture out of the soil, the cumulative impact of conservation practices like cover crops, mulching, and minimizing disturbance improve soil health, water infiltration, and water holding capacity. A garden bed with a terminated cover crop mulch will retain soil moisture as compared to a hot, bare soil.

Cover crops in raised beds

Nutrient Management

Nutrient management should be considered when using cover crops. Legumes provide nitrogen to the following crop, yet high biomass covers like a mature cereal rye can reduce short-term nitrogen availability in the soil. Consider crop needs when planting into high biomass residue or adjust fertilization accordingly. Contact your local Soil and Water Conservation District for more information.

Allelopathy

Some cover crops produce allelopathic compounds that are capable of acting as a natural herbicide towards other plants. This phenomenon can benefit gardens by inhibiting the germination or growth of weeds.

Cover crop species known to produce allelopathic effects include but are not limited to cereal rye, sorghum sudangrass, and buckwheat. Varieties within these species, as well as their growth states, may also impact the potency of the chemical.

While of benefit to reducing weeds, allelopathy can also impact small-seeded vegetables. Wait 20 days after incorporating a cover crop with tillage before seeding small-seeded vegetables. Transplants, larger seeds, and legumes are less susceptible.

Timing of Flower and Anthesis

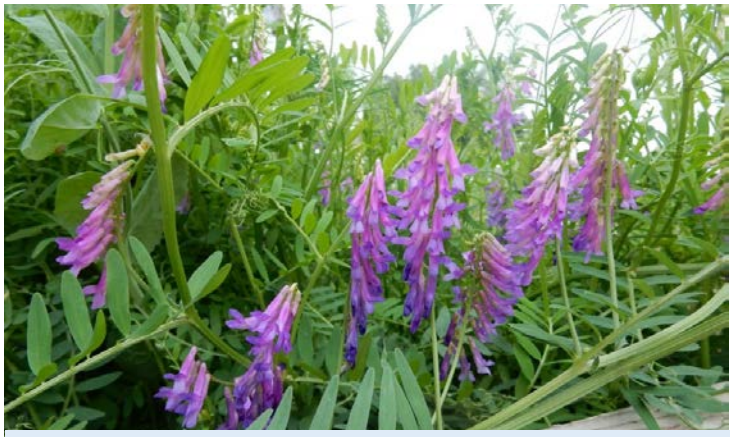
The sections on mowing, cutting, and crimping refer to "flower" or "anthesis" as the optimal growth stage to terminate the cover crop. At this stage, the plant is using its energy for the reproductive process and less energy for vegetative growth. This makes plants less likely to regrow if terminated at this stage. Again, if attempting to terminate early, the cover crop might regrow. If late, the cover crop may undesirably set seed.

These pictures show examples of cover crops in their anthesis or flowering stage. Hairy vetch is most effectively mowed during full flower after the first legume pods appear. For a cereal grain like cereal rye, the best time for termination is when pollen is shedding on the grain head.

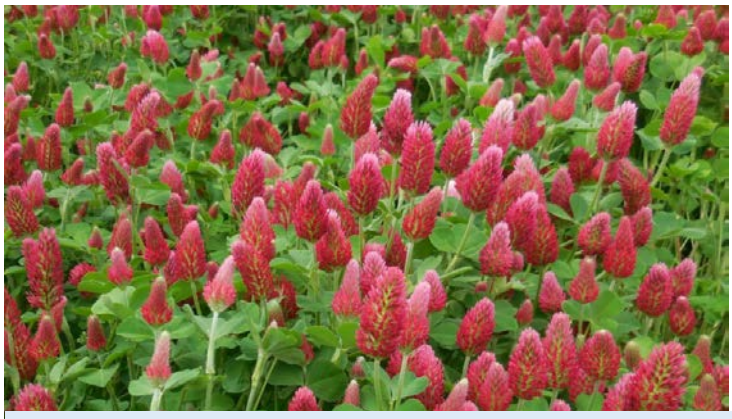
The timing of this stage can vary according to climate and even cover crop variety. Cereal rye tends to undergo anthesis in late May or early June but can certainly occur earlier. Crimson clover often flowers in early or mid May, and hairy vetch a little later. Choosing species that have similar bloom times is helpful in order to be able to terminate all the species in a mix at the optimal time.

As discussed in this document, additional measures such as tarping or mulching up can help growers overcome these timing obstacles and provide more flexibility in the crop plan.

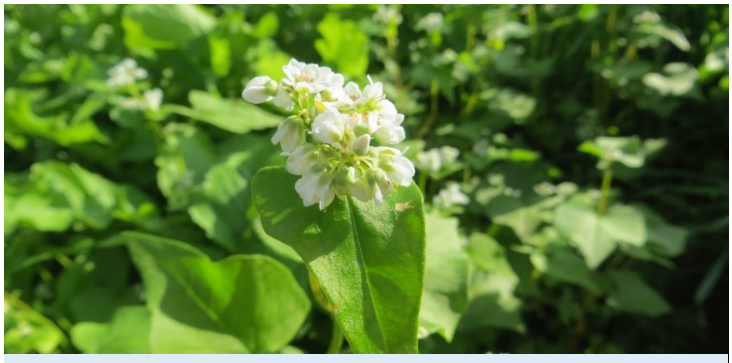
Cereal rye anthesis



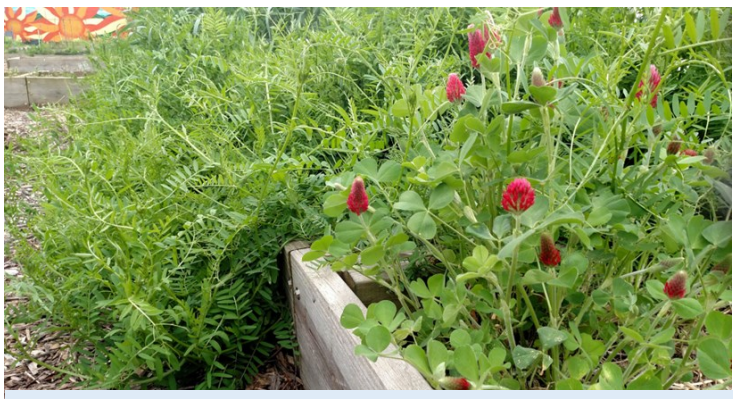
Hairy vetch flower



Crimson clover flower



Buckwheat flower



Hairy vetch (left) and crimson clover (right)

Cover Crop Termination

Typical termination stages for common fall-planted cover crops in Indiana.					
Cover Crop	Winter	March	April	May	June
Oats	Winterkill				
Field Peas	Winterkill				
Oilseed Radish	Winterkill				
Crimson Clover			Flower		
Hairy Vetch				Flower	
Cereal Rye					Anthesis