Cover Crop Termination

For Small Farms and Gardens

Produced in partnership by:
Marion County Soil and Water Conservation District
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MARION COUNTY SOIL AND WATER CONSERVATION DISTRICT

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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.

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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.

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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.

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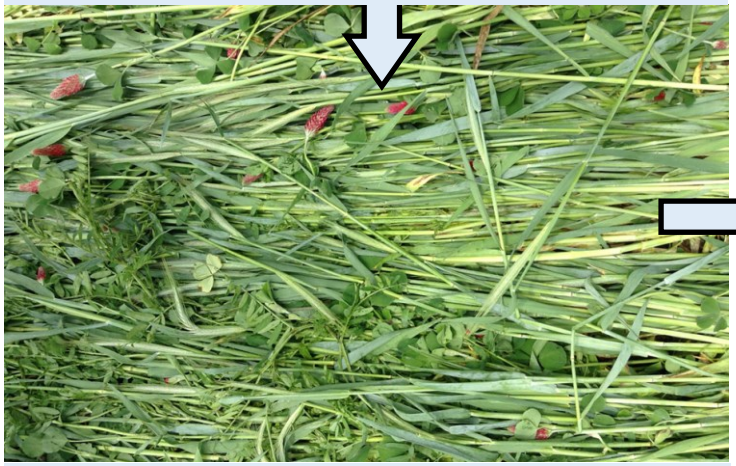
Crimp

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

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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

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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

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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)

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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.

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WS-50-W

TERMINATING COVER CROPS

Successful Cover Crop Termination with Herbicides

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PURDUE WEED SCIENCE

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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

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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.

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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)