COVER CROP TERMINATION

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Developing a termination strategy for cover crops is an essential part of the planning process to ensure there is no interference with the planting or management of the subsequent cash crop. Depending on the cover crop species there are up to three termination options; including winter kill, mechanical methods, and herbicides.

Winter Kill

Whether or not a cover crop will survive the winter or "winter kill" is determined by the innate hardiness of the plant (i.e. physiological capability to withstand cold temperatures), the weather, and the stage of plant growth prior to freezing temperatures. For cover crops that are marginal in their hardiness, mild winters and prolonged snow cover will increase the chances of survival. The winter annual cover crops crimson clover and annual ryegrass will typically survive Michigan winters. However, if these species flower prior to freezing they are not likely to survive a typical winter. Expected winter kill of select species is rated in Table 1, splitting Michigan into 4 regions (Figure 1).

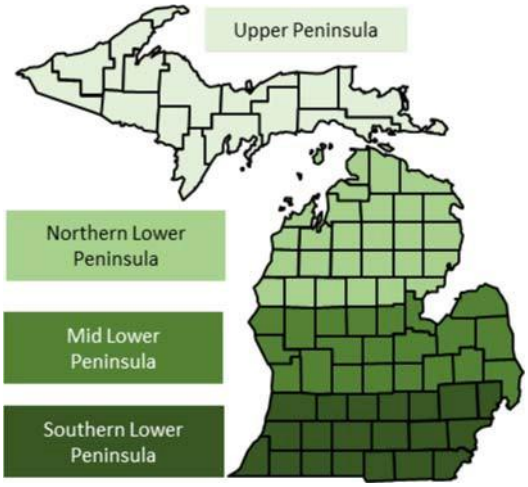

Figure 1. Regions of Michigan used for distinguishing cover crop winter kill.

Mechanical methods

In systems that include tillage, or are managed organically, mechanical soil disturbance can be a reliable method of cover crop termination. A moldboard plow is the most effective tool to manage dense stands of overwintering cover crops. Chisel plowing is also an effective method for termination of most cover crops. However, multiple passes may be required if large amounts of cover crop biomass are present. Rototillers can also terminate cover crops when biomass levels are low enough to avoid clogging. Vertical tillage tools are not reliable for cover crop termination. Mowing is also not a reliable method of terminating most cover crops (Figure 2).

Figure 2. Flowering regrowth in buckwheat shortly after failed termination by mowing (Photo credit: Erin Hill).

For mowing to be effective, the cut must be below all growing points on the plants. In grasses, the growing point is often below ground during the vegetative stage and in broadleaf species, there are usually multiple growing points. However, under high biomass conditions mowing can be used to reduce cover crop biomass prior to tillage. Using a roller crimper to terminate cover crops can be effective under select conditions, particularly with crops that have later planting

dates. Examples of cover crops that have been successfully terminated using the roller crimper include cereal rye (Figure 3) and hairy vetch. Success is dependent on the stage of the cover crop, with these two species required to reach the point of flowering (Feeke's 10.5/Zadoks 60, for cereal rye). Crimping prior to flowering may result in continued growth. However, waiting until the time of flowering adds the risk that viable seed could be produced, resulting in volunteer plants emerging in the future. Utilizing the roller crimper in combination with herbicides increases the likelihood of successful termination.

Figure 3. Roller crimping cereal rye (Photo credit: Dale Mutch).

Herbicides

The use of herbicides can be highly effective for cover crop termination; however, there are several important points to consider.

Herbicide selection. It is important to choose a herbicide or herbicide combination that will effectively terminate the cover crop and weed species that are present at the time of cover crop termination. Glyphosate, for example, is a popular choice for cover crop termination due to its lack of residual activity; however, it may not be the best choice for legume cover crops such as medium red clover or hairy vetch. Dicamba and/or 2,4-D would be more effective in terminating these species.

Many legume cover crops are grown with a grass cover crop species (i.e., cereal rye or annual ryegrass) so combinations of glyphosate and 2,4-D or dicamba would be the most effective in terminating these cover crop mixtures. The effectiveness of burndown herbicides for cover crops is displayed in Table 1. A more extensive listing of herbicides used before corn and soybean for terminating rye, wheat, clover, and hairy vetch is available in Tables 1J and 2P of the MSU Weed Control Guide for Field Crops (E-434), see link in the references.

Herbicide crop rotation restrictions. It is important to know what the herbicide crop rotation restrictions are for the herbicide programs used for termination to ensure safe planting of the subsequent cash crop. For example, if 2,4-D ester is used as part of the termination strategy, the application needs to be made at least 30 days prior to soybean planting at 1 qt/A or 7 days or more before planting soybean at the 1 pt/A rate. If dry beans are to be planted, 2,4-D should not be used. Review the rotation restriction information provided in Table 1 or consult the herbicide label or Table 12 of the most recent MSU Weed Control Guide for Field Crops (E-434).

Adjuvants and/or additives. Several herbicides are only effective if an appropriate adjuvant is included in the spray tank. The footnotes of Table 1 and the herbicide label should be consulted to determine the appropriate additives recommended to increase the effectiveness of the herbicide. For example, with glyphosate it is important to add ammonium sulfate (AMS) at 17 lbs/100 gal of spray solution. The AMS counteracts the effects that hard water has on glyphosate and helps with glyphosate uptake into plants for more effective control.

Active cover crop growth. Many herbicides are systemic, meaning they need to be moved within the plant to maximize their effectiveness; therefore plants that are dormant or not growing much may not be successfully terminated. This is particularly important for glyphosate and synthetic auxin herbicides (Group 4, e.g. 2,4-D and dicamba).

Termination prior to flowering. Plants that have started to flower (reached the reproductive stage) may be difficult to control as the movement of photosynthates change in the plant, thereby altering the movement of herbicides that are translocated (Figure 4).

Figure 4 Glyphosate terminated the cereal rye (left), but failed to control bolting rapeseed (right) in this two-species mix-ture (Photo credit: Erin Hill).

Also, older vegetative tissue often absorbs less herbicide compared with younger more actively growing tissue due to thicker cuticle development. Control prior to flowering will also prevent seed production that can lead to volunteer cover crops that become weeds in subsequent years. This is particularly the case with buckwheat as there is a relatively short timeframe between flowering and viable seed production.

Weather conditions. Cool, cloudy, and drought conditions can all negatively affect herbicide activity. Herbicide absorption into the plant can be reduced under adverse conditions. In addition, these conditions limit plant growth, photosynthesis, and transpiration, therefore limiting the movement of the herbicides within the plant. For glyphosate and other systemic herbicides, it is recommended that the air temperatures be a minimum of 45°F or greater for several days, with warmer temperatures resulting in increased uptake and faster activity.

Simultaneous control of emerged weeds, including herbicide-resistant weeds. When terminating a cover crop it is important to also control weeds that are present. These weeds need to be controlled to ensure that there is no interference with planting or growth of the cash crop. In the event that herbicide-resistant weeds are present, be sure that the herbicide program chosen will effectively control the resistant weed population. For example, if a farmer is terminating a cereal rye cover crop prior to planting soybean and glyphosate-resistant horseweed (i.e. marestail) is present, a herbicide like Sharpen® (PPO inhibitor, Group 14) plus a methylated seed oil (MSO) should be added to glyphosate.

Sharpen® alone will not terminate cereal rye cover crop, but the combination of Sharpen® plus MSO with glyphosate will terminate the cereal rye cover crop and control the glyphosate-resistant horseweed population. Keep in mind that dense cover crop stands can impede residual herbicides from reaching the soil surface and reduce activity. To maximize the activity of residual products, consider early cover crop termination, prior to dense canopy formation, or application after the cover crop has dried down.

Termination timing in the event another application or different method is required. Occasionally multiple herbicide applications will be required to successfully terminate a cover crop (Figure 5). Early termination allows for flexibility should a second application be needed.

Figure 5. Failed control of annual ryegrass prior to corn planting resulting in crop competition and seed production (Photo credit: Bruce MacKellar).

Resources:

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Loux M, Doohan D, Dobbels A, Johnson W, Young B, Hagar A (2017) Weed control guide for Ohio, Indiana, and Illinois. Ohio State University Extension. Pub#WS16. Available online at: https://u.osu.edu/osuweeds/files/2016/12/2017-Weed-Control-Guide-tnkpfi.pdf

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Table 1. Effectiveness of cover crop termination methods and crop rotation restrictions. Herbicides are rated for spring application*.

Termination method/ Herbicide (rate/ A)	Site of action group(s)	Effectiveness of cover crop termination method												Rotation restrictions (in months)							
		Alfalfa[1]	Crimson clover	Red clover	Hairy vetch[2]	Buckwheat	Oilseed radish	Rapeseed	Annual ryegrass	Cereal rye	Winter wheat	Triticale	Oats	Alfalfa	Corn, field	Dry bean	Potato	Small grains[3]	Soybean	Sugar beet	Vegetables[3]
Winter kill (S. L.P. MI)[4]		N	P	N	N	E	E	N	N	N	N	N	E	.	.	.	.	.	.	.	.
Winter kill (Mid. L.P MI)[4]		N	F	N	N	E	E	N	N	N	N	N	E	.	.	.	.	.	.	.	.
Winter kill (N. L.P. MI)[4]		N	G	N	N	E	E	P	N	N	N	N	E	.	.	.	.	.	.	.	.
Winter kill (U.P. MI)[4]		N	E	N	N	E	E[4]	F	P	N	N	P	E	.	.	.	.	.	.	.	.
Moldboard plow		G	E	G	G	E	E	E	E	E	E	E	E	.	.	.	.	.	.	.	.
Chisel plow[5]		G	G	G	G	E	E	E	G	E	E	E	E	.	.	.	.	.	.	.	.
Disking/Vertical tillage		P	P	P	P	P	P	P	P	P	P	P	P	.	.	.	.	.	.	.	.
Glyphosate (0.75 lb a.e.)[5,6]	9	F	P	P	P	E	E	F	F	E	F	E	E	0	0	0	0	0	0	0	0
Glyphosate (1.13 lb a.e.)[5,6]	9	G	F	F	F	E	E	E	G	E	G	E	E	0	0	0	0	0	0	0	0
2,4-D ester (1 pt)	4	G	F	F	F	-	-	-	N	N	N	N	N	FS	0	FS	FS	FS	7d	FS	FS
2,4-D ester (2 pt)	4	E	G	G	G	-	-	P	N	N	N	N	N	FS	0	FS	FS	FS	1	FS	FS
Dicamba (0.25 lb a.e)	4	G	G	G	G	-	P	P	N	N	N	N	N	4	0	4	4	½	4[10]	4	4
Dicamba (0.5 lb a.e.)	4	E	E	E	E	-	P	P	N	N	N	N	N	4	0	4	4	1	4[10]	4	4
Gramoxone (2.0 pt)[7]	22	-	P	P	P	-	-	-	P	F	F	F	F	0	0	0	0	0	0	0	0
Gramoxone (3 pt)[7]	22	-	F	F	F	-	-	-	F	G	G	G	G	0	0	0	0	0	0	0	0
Liberty (32-43 oz)[7]	10	-	P	P	G	-	-	-	-	P	F	P	F	6	0	6	2.5	2.5	0	0	6
Atrazine (1 lb a.i.)[8]	5	-	-	P	-	P	-	-	-	P	P	P	P	15	0	21	10	21[7]	10	21	21
Extreme (3 pt)[6]	2,9	-	P	P	P	-	-	-	-	G	G	G	G	4	8.5	4	26	18	0	40	40
Select Max (16 oz)[6,7]	1	N	N	N	N	N	N	N	G	E	E	E	E	0	1	0	0	1	0	0	0
Glyphosate (0.75 a.e.) + 2,4-D ester (1 pt)	9,4	E	G	F	E	E	E	F	F	E	E	E	E	FS	0	FS	FS	FS	7d	FS	FS
Glyphosate (0.75 a.e.) + dicamba (0.5 lb a.e.)	9,4	E	G	E	E	E	E	F	F	E	E	E	E	4	0	4	4	1	4[10]	4	4
Glyphosate (0.75 a.e.) + Select Max (9 oz)[6,7]	9,1	F	F	F	F	E	E	E	G	E	E	E	E	0	1	0	0	1	0	0	0
Glyphosate (0.75 lb a.e.) + Sharpen (1 oz)[9]	9,14	-	F	F	P	E	E	P	G	E	E	E	E	4	0	4	4	0	0	4	4
Glyphosate (1.13 lb a.e.) + Sharpen (1 oz)[9]	9,14	-	G	G	F	E	E	F	E	E	E	E	E	4	0	4	4	0	0	4	4
Gramoxone (3 pt) + 2,4-D ester (1 pt)	22,4	G	G	F	G	-	-	-	G	G	F	G	G	FS	0	FS	FS	FS	7d	FS	FS

Footnotes for Table 1 on page 5

Footnotes to Table 1

*P=Poor; F=Fair; G=Good; E=Excellent; N=None; -= Not enough information to rank, FS= following spring, d=day(s).
[1] Glyphosate susceptible (non-Roundup Ready) alfalfa.
[2] Survival of hairy vetch following termination in the spring may be due to new emergence from hard seed and not the result of failure of the control method.
[3] Rotation restrictions vary somewhat within the diversity of species considered small grains and vegetables. This represents the most conservative interval; check product labels to be certain.
[4] See county designations in Figure 1. Expected winter kill under 30-yr average winter conditions. Mild winters or rapid snow cover may result in unexpected survival.
[5] May require multiple passes/applications for cover crops marked as "Fair" or "Good."
[6] Always include 8.5-17 lbs/100 gal of ammonium sulfate (AMS); 2.5 lbs/A for Select Max.
[7] Always add either a non-ionic surfactant (0.25%) or a crop oil concentrate (1%).
[8] Always add crop oil concentrate at 1qt/A to maximize foliar activity.
[9] Must be applied with a methylated seed oil (MSO) at 1% and ammonium sulfate (17 lbs/100 gal).
[10] If there has been 1" of rainfall following the application of dicamba the rotation restriction can be reduced to 14 days. No rotation restriction is necessary if Roundup Ready 2 Xtend® (dicamba-tolerant) soybeans are used.
[11] To combat weed resistance it is important to rotate herbicide sites of action utilized for cover crop termination and in season weed control. For more information on herbicide resistance in weeds please visit https://iwilltakeaction.com/weeds .

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