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Herbicide Options to Terminate Winter Cover Crops

Kara Pittman, Extension Associate, School of Plant and Environmental Sciences, Virginia Tech
Michael Flessner, Extension Weed Science Specialist, School of Plant and Environmental Sciences, Virginia Tech
Charlie Cahoon, Extension Weed Specialist, Department of Crop & Soil Science, North Carolina State University
Kevin Bamber, Senior Research Specialist, School of Plant and Environmental Sciences, Virginia Tech

Why is cover crop termination important?

The focus of cover crops often revolves around the benefits of using them and how to grow the cover crop to achieve those benefits. But something as equally important to consider is how to kill the cover crop. Cover crops that aren't completely killed, or terminated, prior to cash crop planting can interfere with planting, compete with the cash crop, or set seed and become weedy in subsequent seasons. Cover crops are typically terminated prior to planting corn, soybean, or other cash crops. Alternatively, "planting green" is when a cash crop is planted into a growing cover crop and then cover crop termination occurs, usually about two weeks after planting. Regardless of termination timing, growers should plan for cover crop termination before planting the cover crop to know how and when the cover crop should be terminated to achieve desired benefits while not creating problems for next season.

What methods are used to terminate cover crops?

There are three main ways to terminate cover crops: the species naturally winterkills, they are terminated mechanically, or they are terminated chemically with herbicides. Termination method and timing will vary depending on the type of operation, equipment available, cover crop species planted, and the goals for the cover crop.

Winterkill

Some cover crops are not able to survive through the winter. The temperature threshold needed to winterkill will vary based on cover crop species. The benefit of selecting a cover crop that will winterkill is that it won't have to be terminated prior to cash crop planting. However, some species might not always winterkill in Virginia or the effect might vary across the state. Growers should have a contingency plan if winter weather conditions don't completely kill the cover crop. Some of these species include forage radish, mustard, spring pea, and oats (Anonymous 2015) (Figure 1). However, the full benefits of

Figure 1. Winterkilled forage radish in Blacksburg, Virginia.

cover crops are often lost when the cover crop winterkills, especially when weed suppression is the main goal of the cover crop.

Mechanical Methods

Mechanical methods of managing cover crops include mowing, tillage, or roller crimping. Each method has its own purpose. Mowing and tillage will remove or incorporate the cover crop biomass making it ineffective for weed management, but may be required for biofumigation or other goals. Roller crimpers are implements that both roll the standing cover crop and crimp the vascular tissue, which restricts water and nutrient flow and kills the plant (Figure 2). Many roller crimpers look like a drum with fins. For successful termination, crimping is essential and not all implements crimp well in all conditions. This method is often used when the goal of a cover crop is for weed suppression because it will create a residue "mulch".

One difficulty in using mechanical methods for termination is the potential for an ineffective kill resulting in regrowth and seed set. Seeds produced by the cover crop can then germinate in later seasons becoming weeds.

Figure 2. Cover crop being terminated with a roller crimper. This specific roller crimper has a roller followed by three spring-loaded crimpers.

Growth stage of the cover crop at the time of termination is critical for successful termination. Mechanical methods are most effective for cereal rye and other cereal grains when they are flowering (Mirsky et al. 2009). These methods are most effective for hairy vetch at late flowering through pod set (Mischler et al. 2010). Cover crops might not reach this ideal stage before typical planting time for the following cash crop in Virginia. Recent studies show that hairy vetch will produce pods beginning in late May, which is past the typical burndown time for corn or soybean planting (Pittman, unpublished data). Selecting the optimal timing for mechanical termination becomes difficult when growing cover crop mixtures as the various species likely will not mature at the same time.

Chemical Methods

Herbicides are the most popular method used to terminate cover crops on conventional farms because of the ease and ability to kill cover crops across a range of growth stages (Cornelius and Bradley 2017; Westgate et al. 2005). Some considerations to be aware of when using herbicides to control a cover crop species beyond making the best herbicide choice are to ensure the best coverage of the herbicide into the thick stand or residue layer, and to check rotation restrictions to the following cash

crop. For some broadleaf species, 2,4-D and dicamba are good options for control but require a delay in planting to corn, soybeans, or cotton for crop safety (Bond 2014).

Now with greater cover crop biomass as the goal for weed suppression, our cover crops are growing larger, which can make them more difficult to control with herbicides (Mirsky et al. 2013). The goal of the research described below was to determine which herbicides and herbicide combinations are the most effective at terminating various cover crop species.

Research Results

In Blacksburg and Holland, VA, studies were conducted to determine which herbicides or combinations of herbicides are most effective at terminating various cover crop species. Two rows of nine different cover crop species, listed in Table 1, were planted in early to mid-September. These plants grew through the winter without any additional inputs, such as fertility. In late March to mid-April, herbicides were sprayed across the rows of cover crops with a handheld boom at 15 gallons per acre (GPA) (Figure 3). Herbicide treatments and cover crop heights and growth stages at termination are included in Tables 1 and 2. Visible control ratings were taken at 4 weeks after application (WAA).

Figure 3. Field layout for the termination study in Blacksburg, Virginia. The cover crop species were planted in strips and then herbicide treatments were sprayed perpendicular to the rows.

Table 1. Cover crop species planted, varieties, seeding rates, as well as height and growth stage at termination. These seeding rates are based on the Virginia NRCS Cover Crop Planting Manual.

Cover Crop Species	Cultivar	Seeding Rate (lbs per acre)	Height at Termination (inches)	Growth Stage at Termination
Winter Wheat	Gore Soft Red	120	17	Jointing
Winter Barley	P919	120	21	Jointing to boot
Cereal Rye	Elbon	120	39	Boot to heading
Winter Oats	Bob	120	13	Tillering to jointing
Austrian Winter Pea	VNS	50	13	Vegetative
Crimson Clover	Dixie	20	14	Vegetative to early flowering
Hairy Vetch	TNT	25	15	Vegetative to early flowering
Annual Ryegrass	Winterhawk	20	16	Tillering
Rapeseed	Trophy	6	39	Floweirng to immature pods

Table 2. Herbicide treatments applied to the cover crop species.

Herbicide	Trade Name	Rate
2,4-D	Shredder™ 2,4-D LV4	16 fl oz/a
Dicamba[1]	Banvel®	8 fl oz/a
Halauxifen-methyl[2]	Elevore™	1 oz/a
Glyphosate[3]	Roundup Powermax®	32 fl oz/a
Saflufenacil[25]	Sharpen®	1.5 fl oz/a
Paraquat[4]	Gramoxone®	48 fl oz/a
Glufosinate[3]	Liberty®	43 fl oz/a
2,4-D + Glyphosate[3]	Shredder™ 2,4-D LV4 + Roundup Powermax®	16 fl oz/a + 32 fl oz/a
Dicamba + Glyphosate[3]	Banvel® + Roundup Powermax®	8 fl oz/a + 32 fl oz/a
Halauxifen-methyl + Glyphosate[3]	Elevore™ + Roundup Powermax®	1 oz/a + 32 fl oz/a
Saflufenacil + Glyphosate[3]	Sharpen® + Roundup Powermax®	1.5 fl oz/a + 32 fl oz/a
Glufosinate + Glyphosate[3]	Liberty® + Roundup Powermax®	43 fl oz/a +32 fl oz/a
2,4-D + Paraquat[4]	Shredder™ 2,4-D LV4 + Gramoxone®	16 fl oz/a + 48 fl oz/a
Dicamba + Paraquat[4]	Banvel® + Gramoxone®	8 fl oz/a + 48 fl oz/a
Halauxifen-methyl + Paraquat[4]	Elevore™ + Gramoxone®	1 oz/a + 48 fl oz/a
Saflufenacil + Paraquat[4]	Sharpen® + Gramoxone®	1.5 fl oz/a + 48 fl oz/a

[1] includes non-ionic surfactant at 0.25% volume by volume
[2] includes methylated seed oil at 1% volume by volume
[3] includes ammonium sulfate at 13.6 oz per gallon
[4] includes crop oil concentrate at 1 qt/a
[5] includes UAN at 2 qts/a

Winter wheat, winter barley, cereal rye, and winter oats were grouped together as cereal grains because they responded similarly to the herbicide treatments. Annual ryegrass was analyzed separate from these four species. Roundup was the most effective single product applied to the grass species, providing 98 and 94% control 4 weeks after application for cereal grains and annual ryegrass, respectively (Figure 4). Gramoxone followed by Liberty were the next best products to control cereal grains or annual ryegrass. The auxin herbicides, 2,4-D, dicamba, and Elevore, had no effect on the grass species and are not included in Figure 4. Sharpen was also excluded from Figure 4; cereal grains and annual ryegrass showed injury to Sharpen 2 weeks after application but recovered by 4 weeks.

The broadleaf cover crop species showed varied responses to the single active ingredient product herbicides (Figure 5). This highlights the importance of planning ahead and knowing what herbicides will be the most effective to kill the cover crop species planted. Roundup was the most effective herbicide to use on Austrian winter pea, 92% control, followed by Liberty and Gramoxone. Crimson clover was best controlled by Liberty, 92%. All other treatments had less than 80% control. Out of the four broadleaf cover crop species, hairy vetch was the only species that was adequately controlled by the

auxin herbicides, greater than or equal to 80% control. Liberty provided similar control to the auxin herbicides on hairy vetch with 81% control.

Rapeseed was not controlled by any products used in this experiment with the best option being Roundup (58% control). This is likely due to the size of the rapeseed at termination and that the plants were flowering. Other research conducted in Virginia has shown that 2,4-D + glyphosate and 2,4-D + paraquat provided over 80% control on 20-inch rapeseed, which is half the size of the plants that we sprayed in our experiment. On smaller 5-inch tall rapeseed, 2,4-D + glyphosate provided 96% control (Askew et al. 2019). Rapeseed should be terminated when small or with additional mechanical means to achieve an effective kill.

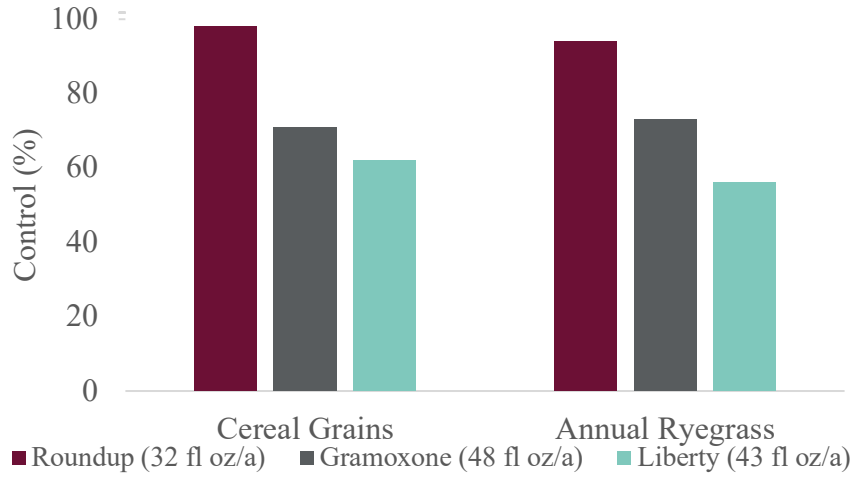

Figure 4. Control of cereal grains (wheat, barley, cereal rye, oats) and were not included because they have no activity on grasses.

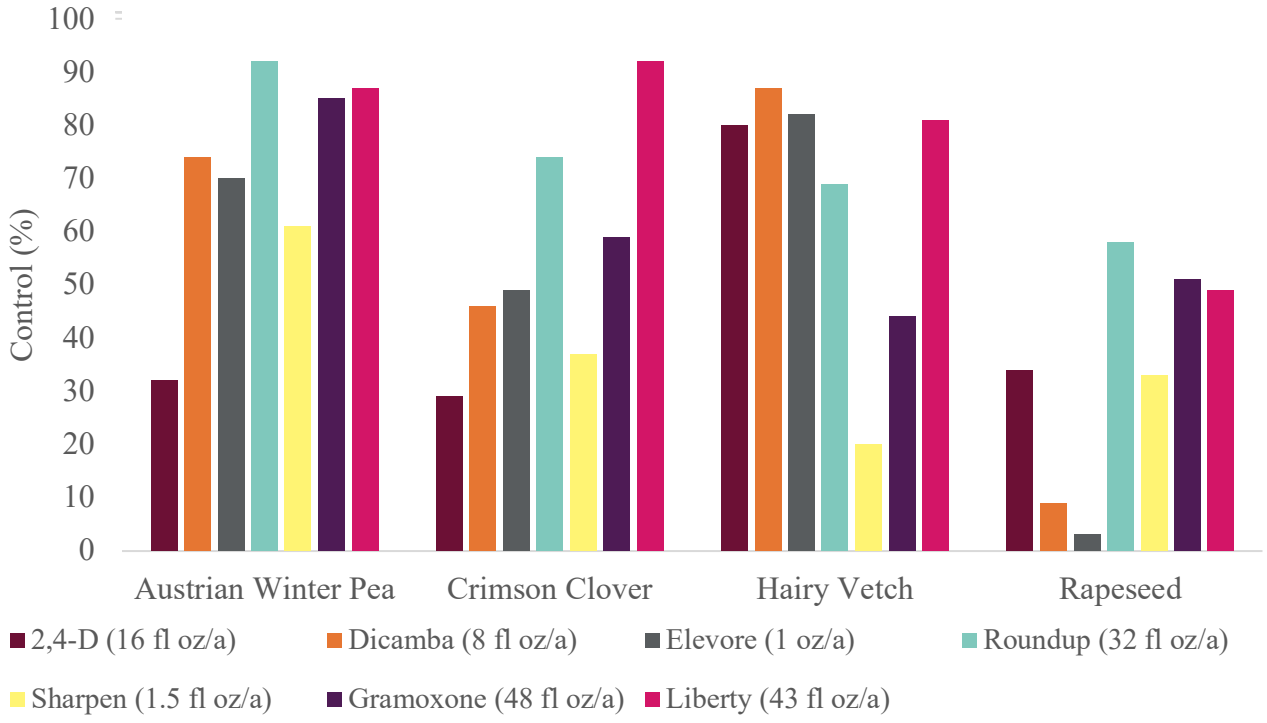

Figure 5. Control of broadleaf cover crop species from single active ingredient herbicides 4 weeks after application.

Comparisons were used to determine if tankmixes would be more effective than single active ingredient herbicides at terminating cover crop mixtures. To make this determination, the control from all single products were averaged and compared to the average in control for the tankmixes including Roundup and the tankmixes including Gramoxone (Table 2). The average control from each of the groups of treatment: single products, tankmixes with Roundup, and tankmixes with Gramoxone are shown in Figure 6.

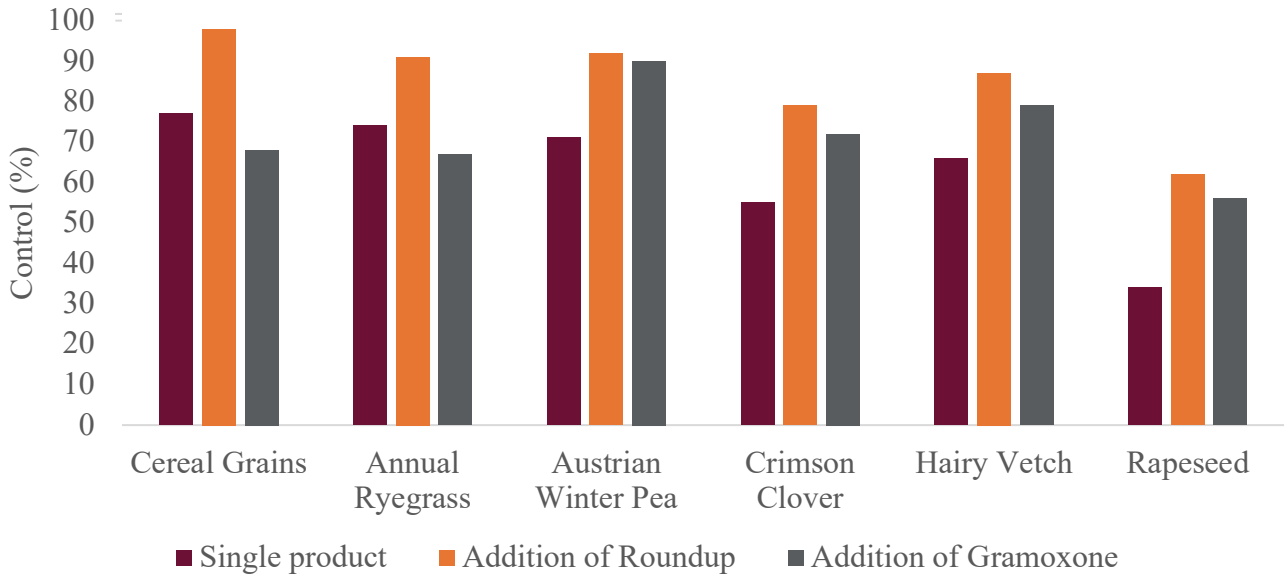

Figure 6. Comparison of control from single active ingredient products, tankmixes including Roundup, and tankmixes including Gramoxone 4 weeks after application. Cereal grains include wheat, barley, cereal rye, and oats.

Cereal grains and annual ryegrass were best controlled with Roundup and tankmixes containing Roundup. Tankmixes including Gramoxone were not as effective for control as the single active ingredient products and tankmixes including Roundup. For all broadleaf cover crop species, adding Roundup or Gramoxone increased control compared to the single active ingredient products. In almost all instances, except for Austrian winter pea, the addition of Roundup was more effective than the addition of Gramoxone. Crimson clover, hairy vetch, and rapeseed control had smaller gain between the two with a 6 to 8% increase in control by adding Roundup compared to adding Gramoxone to a tankmix.

This testing resulted in less control of broadleaf cover crops than listed in the Pest Management Guide: Field Crops (Tables 5.13 and 5.47) due to larger cover crop size at herbicide application.

Management Recommendations

Cover crops have many benefits but must be managed appropriately to gain these benefits but not negatively impact following crops. For weed suppression, large amounts of biomass are important to create the mulch layer to suppress weeds. Larger plants are more difficult to control with herbicides and growers should have a plan in mind to effectively terminate their cover crop. Based on the results from this study, cereal grains, such as wheat, barley, cereal rye, and oats, and annual ryegrass will be

adequately controlled by glyphosate. Herbicides needed to control the broadleaf cover crops vary by species and tankmixes with glyphosate or paraquat increase efficacy. Common cover crop mixtures in Virginia often include a grass cover crop species and a legume cover crop species. For these mixtures, tankmixes including glyphosate will provide the best control. When cover crops become too large or would be too difficult to terminate with herbicides, alternative mechanical methods should be used to ensure an adequate kill to prevent competition and seed set that will interfere with future crops.

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