Cover Crop Weed Suppression in Annual Rotations

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Cover crops usually are not grown for harvest, but they serve many other functions in crop production systems. For example, they enrich soil with organic matter, they cycle nutrients, and they protect soil from water and wind erosion. They also can be part of an integrated system to control weeds. Cover crops often accomplish several of these purposes at once.

Cover crops in annual rotations generally are planted in early to mid fall, grow throughout winter and early spring, and are killed 3 weeks or more before the summer crop is planted.

Weed suppression varies with cover crop type and management, residue and tillage management, and weed populations. A particular combination of cover crop and management may suppress, have no effect, or even stimulate the emergence of a particular weed. Shifts in weed populations like those caused by herbicides often are observed when cover crops are used in annual rotations.

As cover crops grow, they suppress weed growth and reduce seed production by competing directly for light and nutrients. Most affected are *winter weeds* that grow during cool weather in fall, winter, and early spring; they include redstem filaree, wild geranium, sowthistle, deadnettle, and mustards. A competitive cover crop can nearly eliminate many winter annual weeds (Figure 1). Also, glyphosate-susceptible cover crops such as small grains replace glyphosate-tolerant weeds, thus improving herbicide efficacy.

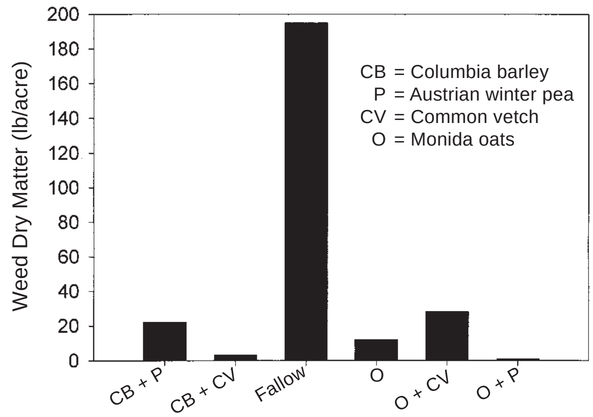

Figure 1.—Winter weed suppression by cover crops in the Willamette Valley. Cover crops were planted in the fall of 1994, and weed dry matter was measured April 18, 1995. All cover crops significantly reduced weed dry matter. Cover crop dry matter was 1 to 2 tons per acre by April 18 (Luna, McGrath).

Summer weed emergence depends to a large degree on how cover crop residues are managed. Any sort of spring tillage, including cover crop incorporation, brings buried viable weed seeds to the soil surface and increases summer weed emergence. Therefore, summer weed emergence is minimized in no-till and strip-till systems because cover crop residues remain on the soil surface.

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The effect of an incorporated cover crop on summer weed emergence depends on species, management, and growth conditions. Although many incorporated cover crops decrease or have no effect on summer weed emergence, others have been observed to increase weed emergence.

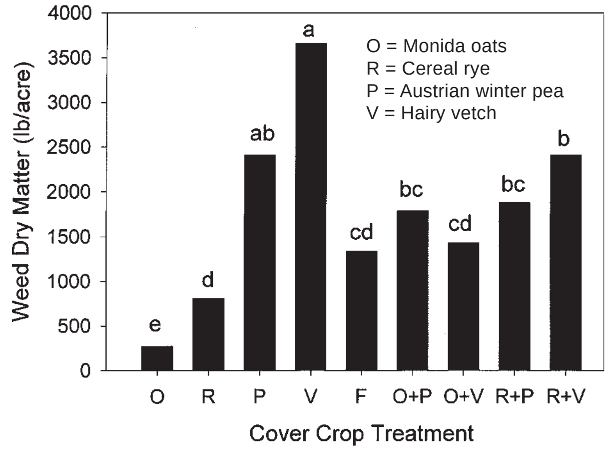

Figure 2.—Effect of incorporated *cover crops on* summer *weed dry matter accumulation measured July 11, 1994 in broccoli. Cover crops were planted the previous fall and incorporated May 2; broccoli was planted May 24. Bars with different letters above indicate significant differences (F-protected LSD, $\alpha = 0.05$).*

Winter and spring weed suppression

Cover crop growth rate and stature

Cereal grains and grasses do the best job of suppressing fall and winter weeds because they establish quickly in the fall, cover the soil, and grow throughout the winter. By contrast, although brassicas may grow throughout the winter, soil coverage usually is not adequate for weed control. Legumes generally grow too slowly during cold weather to effectively suppress winter weed growth. On the other hand, the rapid spring growth of most cover crops (cereals, grasses, brassicas, and legumes) is ideal for spring weed suppression.

Management factors

Planting date A vigorous cover crop in an even stand does the best job of suppressing weeds. Fall cover crop growth depends to a large degree on planting date. Generally, early planting is desirable because the cover crop can grow during warm fall weather. There are exceptions, however. See *Using Cover Crops in Oregon*, EM 8704, available through the OSU Extension Service, for information about specific crops.

Planting method Drilling cover crops generally speeds germination and early establishment and creates an even stand. Narrow rows are better than wide ones because the cover crop canopy

Table 1.—Effects of *incorporated* cover crops on the percent reduction of *summer* weeds in broccoli in the Willamette Valley. Cover crops were planted in the fall of 1993 and incorporated May 2, 1994. Broccoli was planted May 24; weeds were measured July 5. Negative values indicate the cover crop stimulated weed emergence.

	Reduction of weeds relative to fallow (%)				
Cover crop(s)	Nightshade	Groundsel	Shepherdspurse	Misc.	Total
Monida oats	59	82	97	63	74
Cereal rye	48	64	95	-16	51
Austrian peas	33	5	-18	-4	7
Hairy vetch	13	4	-45	-21	-10
Fallow	0	0	0	0	0
Oats + peas	30	18	68	-65	17
Oats + vetch	52	66	36	13	44
Rye + peas	23	37	68	-60	21
Rye + vetch	77	49	29	-8	42

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

closes faster, resulting in fewer bare spots that weeds can colonize.

Broadcasted seed can be distributed more evenly over the soil surface than drilled seed and may result in earlier canopy closure. However, germination is less consistent, and because seed mortality rates are higher, seeding rates should be increased for broadcasting.

Seeding rate When winter weed suppression is a primary goal, cover crop seeding rates should be increased to provide faster and better soil coverage. A general rule of thumb is that cereal grain seeding rates should be increased as much as 50 percent over normal cover cropping rates for improved weed control. Grains that normally would be planted at 80 to 100 lb/acre are planted at 120 to 150 lb/acre.

Another approach for small-grain cereals is to plant 45 viable seeds per square foot. The advantage of using this method is that it accounts for differences in seed size and germination rate.

Mixtures A mixture of several cover crops may fill more niches than a single cover crop, resulting in increased weed suppression. Planting a mixture also spreads the risk of plant failure.

When legumes and cereal grains are planted together, the cereal grains provide winter weed suppression, and both grains and legumes suppress spring weeds. Seeding rates should be balanced so that the legume is not suppressed by the grain but will have room to grow in early spring.

Effects of cover crops on summer weeds

Incorporated cover crops

A replicated field trial was conducted in the mid-Willamette Valley to determine the effect of incorporated winter cover crops on summer weed emergence (Nova, 1995). Cover crops were planted in the fall of 1993. They were flailed and then incorporated with a cover crop disk on May 2, 1994. A seedbed was prepared with a roterra, and broccoli was planted May 24. Weed density was measured on July 5, and weed dry-matter accumulation was measured on July 11.

The results are summarized in Table 1 and Figure 2. Note that cover crop–weed interactions are specific to the cover crop and the weed species. Monida oat and cereal rye as sole crops significantly reduced weed emergence and total weed dry matter when compared to the fallow control. However, hairy vetch and Austrian winter pea, both legumes, appeared to stimulate shepherdspurse emergence. The legumes also produced the greatest amount of weed dry matter.

Cover crop mulches

The tillage required to incorporate a cover crop enhances summer weed emergence by bringing buried seeds to the surface and exposing them to light. If summer weed suppression takes precedence over other objectives, the cover crop residue can be left on the soil surface as mulch. Summer weed emergence can be reduced by as much as 95 to 99 percent when corn or beans are planted directly into undisturbed soil and cover crop mulch.

The degree of weed suppression depends on soil coverage, residue characteristics, residue management, weed species, amount of disturbance at planting, and, possibly, soil type.

Although cover crop residues can contribute to summer weed suppression, simply eliminating spring tillage usually reduces summer weed emergence significantly.

Summer annual broadleaf weeds are affected most by cover crop residue mulches and undisturbed soil. Table 2 and Figure 3 show how tillage and cover crop mulches affected summer weed emergence in Willamette Valley sweet corn in 1995.

Eliminating tillage greatly reduced broadleaf weed emergence, even in the fallow plots. Barley, rye, and oat cover crop residue mulches suppressed nightshade emergence further, nearly eliminating it. Pigweed also was sensitive but not to the extent that nightshade was.

When residues were tilled into the soil, pigweed and nightshade emergence did not differ significantly from the tilled fallow plots except for the plot that had monida oat residues; there, nightshade emergence was significantly greater.

Heavy residues and undisturbed soil may dramatically shift the emerging species to groundsel and other wind-dispersed weeds. Perennials also survive well, but survival may depend on the herbicide used to kill the cover crop.

Herbicides and cover crops in conservation tillage systems

Cover crops and weeds in no-till and strip-till systems usually are killed with herbicides. All herbicides must be applied according to label instructions and restrictions.

Increased efficiency of preplant herbicide

The efficiency of preplant herbicides can be increased by planting cereal grain cover crops. Cereal grains suppress winter weeds, including redstem filaree, wild geranium, deadnettle, and mustards, which quickly predominate when fields are left fallow over winter. As much as 2 lb/acre of glyphosate ai (active ingredient), applied preplant, may be needed to kill these winter annual weeds. Some, such as redstem filaree, are tolerant to glyphosate. On the other hand, cereal grains are relatively easy to kill with herbicides. Typically, 0.5 lb/acre of glyphosate ai is enough to kill them.

The amount of herbicide that actually reaches weeds under the cover crop canopy is critical. Higher application rates, higher spray pressures,

Table 2.—Summer weed emergence response to cover crop residues and tillage in sweet corn in the Willamette Valley (1995). Conventional tillage is indicated by a plus sign, and elimination of spring tillage is indicated by a minus sign. Means in the same column followed by an asterisk differ significantly from the fallow treatment receiving conventional tillage.

		Number of plants/sq yd		
Cover crop	**Spring tillage**	**Pigweed**	**Nightshade**	**Total broadleaf weeds**
Micah barley	–	8*	1*	9*
Micah barley	+	89	28	120
Wheeler rye	–	19*	0*	21*
Wheeler rye	+	67	58	125
Monida oats	–	13*	0*	13*
Monida oats	+	71	80*	162
Winter fallow, no cover crop	–	18*	6*	26*
Winter fallow, no cover crop	+	66	43	129

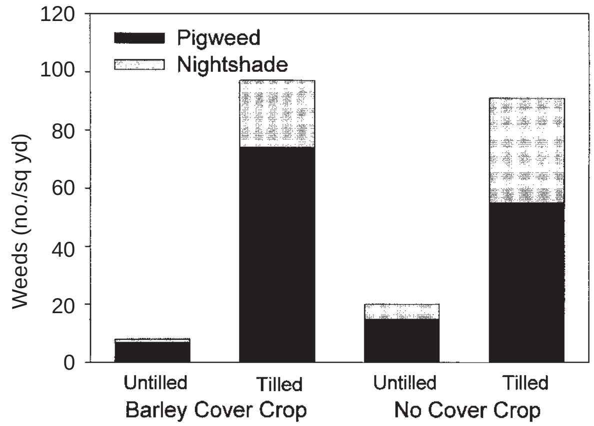

Figure 3.—Cover crop residue and tillage effects on summer weed emergence in sweet corn in the Willamette Valley (1995). Using a cereal grain cover crop and eliminating tillage greatly reduced pigweed and nearly eliminated nightshade.

and adding surfactants increase herbicide contact and potential activity on understory plants. If the canopy has an open structure, lower rates may be used.

Adding a nonionic surfactant improves the effectiveness of many glyphosate products.

Glyphosate is not as effective in killing legumes as it is in killing cereals. Adding a small amount of 2,4-D improves effectiveness, although you must wait at least 30 days to plant broadleaf crops after a 2,4-D application. Check the herbicide label for other restrictions that may apply.

Paraquat can be used as a burn-down treatment for cover crops. The same generalities apply to paraquat as to glyphosate. However, because paraquat activity is not systemic, some cover crops may regrow, especially legumes. Paraquat is less expensive than glyphosate but more difficult to handle because of its toxic properties.

Splitting spring applications

Splitting a glyphosate application may be useful and may reduce costs when using cereal grain cover crops. Apply a lower rate first (0.25 to 0.5 lb ai/acre) to kill the cereal cover crop and expose surviving weeds. Then reapply glyphosate plus a preemergence herbicide immediately after planting the summer crop to kill surviving weeds and to supplement the weed suppression of the mulch. Caution: Glyphosate *must* be applied before the crop emerges, or the crop will be damaged. Check the herbicide label for restrictions on cucurbits and other crops that may have limitations on applying glyphosate after planting.

Interaction of cover crop residues with herbicide effectiveness

When cover crop residues remain on the soil surface, early-season weed suppression can be as high as 90 to 99 percent. However, surviving and emerging weeds may need to be controlled with herbicides or with postemergence cultivation. A high-residue cultivator such as the Buffalo cultivator may be essential.

Preemergence herbicides may be less effective if cover crop residues intercept them. Residue type, amount, and management determine how much herbicide is lost. For example, flailing an upright cover crop may reduce the amount of herbicide that contacts the soil.

A field trial replicated in the mid-Willamette Valley in 1995 and 1996 compared the effects of tillage, cover crop residues, and preemergence herbicide on weed control and sweet corn yield. Cover crops were planted in the fall and killed in the spring. Two fallow plots without cover crops were included. Cover crop and winter weed dry matter accumulation are listed in Table 3 (page 6).

Cover crops and weeds in fallow plots were killed with glyphosate 3 to 4 weeks before planting corn. The roller on a flail (with the flail turned off) was used to roll residues on the soil surface before planting. One of the fallow plots was plowed, tilled with a roterra, and rolled to prepare a seedbed. The other fallow treatment was left undisturbed. Sweet corn was planted with a no-till planter in late May 1995 and mid-June 1996. Weed control treatments on subplots of the main cover crop plots included dimethenamid (Frontier), metolachlor (Dual), and a check plot with no herbicide. Weed control was estimated visually 8 weeks after planting by comparing with weed emergence and survival in the conventionally tilled plot. Results appear in Table 4 (page 7).

Cover crop residues left undisturbed on the soil surface without the use of preemergence herbicides suppressed summer weeds from 60 to 97 percent compared to the conventionally tilled plot. The magnitude of the effect depended on cover crop variety and weed species. Cover crop residues were better at suppressing nightshade and purslane emergence than pigweed emergence. Common purslane control was improved by the cover crop residues and was near 100 percent in the triticale and crimson clover plots. However, simply eliminating tillage in the spring also significantly reduced weed emergence compared to conventional tillage.

Herbicides improved weed control in all treatments. Dimethenamid and metolachlor gave about the same degree of control, but results varied depending on weed species and cover crops. Pigweed control with dimeththenamid was somewhat lower in cover crop residues than in the conventionally tilled plots, whereas metolachlor's control of pigweed was about the same. Both herbicides' control of purslane always was better when cover crop residues were present than when plots were conventionally tilled. Cover crop residues did not interfere with herbicide control of nightshade. There were no significant differences in corn yield between treatments, but yields were more variable in cover-cropped plots.

Allelopathy

A few cover crops (e.g., cereal rye) may have an allelopathic effect on weeds. That is, their roots or decomposing residues release compounds in the soil that are toxic to weeds. Simply incorporating large amounts of residue, especially if succulent, often causes a sharp increase in soilborne pathogen populations, especially damping-off fungi (e.g., *Pythium*), which attack seeds as they germinate. A similar effect is noted after glyphosate applications even when residues are not incorporated. This may account for some of the reduced weed and crop germination observed shortly after killing and/or incorporating cover crops. Wait 3 to 4 weeks after incorporating cover crop residue before planting the summer crop to minimize disease incidence on crop seeds.

Table 3.—Cover crop and winter weed dry matter accumulation during the winters of 1994–95 and 1995–96 for the Willamette Valley tillage/herbicide trial. Above-average precipitation resulted in relatively low cover crop dry matter accumulation. Summer weed control results are in Table 4.

		Dry matter (ton/acre)			
Cover crop	Winter weeds	Cereal	Legume	Total cover crop	Ratio of cereal to legume
1996					
Micah barley	0.02	0.9	0	0.9	–
Micah barley and common vetch	0.002	0.5	1	1.5	0.5
Hesk barley and common vetch	0.01	1.5	0.7	2.2	2.2
Triticale and crimson clover	0.01	1.1	1	2.1	1.2
Fallow	0.19	0	0	0	–
1995					
Micah barley	0.1	1.6	0	1.6	–
Micah barley and common vetch	0.11	1.7	0.9	2.6	1.9
Hesk barley and common vetch	0.17	0.8	1.4	2.2	0.6
Triticale and crimson clover	0.17	1.8	0.2	2	10.1
Fallow	0.89	0	0	0	–

Conclusions

Cereal grains or grasses are best for winter weed suppression. Cover crop type, planting date, seeding rate and method, weather, and other factors influence the weed-suppressive effect of the cover crop.

Many legumes, cereal grains, and grasses are effective for early spring weed suppression because of their rapid spring growth. Leaving cover crop residues on the soil surface as a mulch and eliminating tillage suppresses many summer annual weeds. However, herbicide applications must be planned to fit the system.

Some cover crops, especially legumes, may stimulate summer weed emergence when tilled into the soil.

References

Nova, Segundo. Impact of cover crops on weed abundance and nitrogen contribution in broccoli production systems in the maritime Pacific Northwest. M.S. thesis (Oregon State University, Corvallis, 1995). 92 pp.

Luna, J.M., and D.G. McGrath. 1996. Evaluation of winter annual cover crops for western Oregon vegetable production. *Proceedings of the Oregon Horticultural Society* 87:100–104.

Table 4.—Cover crop, tillage, and herbicide effects on weed control at 8 weeks after planting in sweet corn in the Willamette Valley. Pigweed and purslane control is the average of 1995 and 1996 trials; nightshade data are from the 1996 trial only because there was not enough nightshade in the 1995 trial.

		Control (%)		
Cover crop	**Herbicide**	**Pigweed**	**Purslane**	**Nightshade**
Conventional tillage	Dimethenamid	100	83	100
	Metolachlor	95	73	88
	None	0	0	0
Fallow (direct seed)	Dimethenamid	95	86	100
	Metolachlor	97	84	99
	None	58	68	73
Micah barley	Dimethenamid	93	96	100
	Metolachlor	94	96	98
	None	73	89	96
Micah barley + common vetch	Dimethenamid	82	94	99
	Metolachlor	96	95	99
	None	60	69	80
Hesk barley + common vetch	Dimethenamid	90	88	99
	Metolachlor	87	94	99
	None	66	85	91
Triticale + crimson clover	Dimethenamid	93	98	100
	Metolachlor	96	99	100
	None	70	97	92

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