

Direct Seeding

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Perennial Weed Control in Direct Seeding Systems

Perennial weeds live for at least two years and often many more. They reproduce and/or spread by underground creeping rootstocks, rhizomes or tubers as well as by seed.

These reproductive strategies are one of the reasons these weeds are difficult to control in conventional and reduced tillage systems. Perennial weeds are very competitive, and if they are not controlled, they reduce crop production.

In recent years, there has been a dramatic increase in the incidence of perennial weeds in Alberta (Table 1). For example, in the Alberta Weed Survey (1987 - 89), Canada thistle was ranked twelfth, occurring in 35 per cent of fields. By 2001, it was ranked fourth and occurred in 41 per cent of fields (Thomas et al 1997).

This change in the relative abundance ranking in that 14-year time period may be due to the adoption of reduced tillage practices, continuous cropping, weather and diversified crop rotations. The objective of this factsheet is to discuss ways to manage perennial weeds in reduced tillage systems using integrated pest management techniques.

Common Perennial Weeds

Based on reproductive strategies, perennial weeds can be simple or creeping. Simple perennials spread by seed alone. They have large and fleshy taproots that produce a new plant if cut. Creeping perennials reproduce by underground spreading rootstocks, rhizomes or tubers. They also reproduce by seed. Commonly occurring perennial weeds, regardless of the tillage systems on the Canadian prairies, are as follows (Table 2).

Table 1. Perennial weed population shifts in Alberta

Weeds	Frequency of occurrence (%)			Relative abundance rank			Change in relative abundance rank since 1987 - 1989
	1987 - 1989	1997	2001	1987 - 1989	1997	2001	
Canada thistle	35	53	41	12	5	4	+ 8
Dandelions	22	32	23	18	12	10	+ 8
Field horsetail	32	17	14	8	9	12	- 4
Quackgrass	15	18	15	22	16	14	+ 8
Perennial sow-thistle	24	25	17	16	15	18	- 2
Foxtail barley	0.4	3	4	99	40	31	+ 68
Yellow toadflax	2	2	1	50	33	49	+ 1

Adapted from Alberta Weed Surveys – Thomas et al 1997; Leeson et al 2001



Table 2. Common perennial weeds of western Canada

Simple perennial	Creeping perennial
Common dandelion*	Leafy spurge
Foxtail barley*	Perennial sow-thistle*
Canada thistle*	Quackgrass*
Common milkweed	Smooth bromegrass*
Field bindweed	Yellow toadflax*
Field horsetail*	Wild rose*

* Common in Alberta

Perennial Weed Control in Reduced Tillage Systems

Successful management of perennial weeds in conventional and reduced tillage requires several key steps:

- Knowing the weed species present, their density, extent of the weed populations and their biological characteristics (Table 3) to help formulate appropriate weed control strategies.
- Evaluating the weed infestations in question, whether the weeds are in patches (patch infestation) or throughout the field (field-scale infestation).
- Patch control program: if the perennial weed infestation occurs in small distinct patches, patch treatment may be adequate. However, a successful patch control program requires two steps:
 - Patrolling fields, including field margins, isolating and marking patches, and destroying these weed patches.
 - Monitoring the patches for at least three years to check for re-infestation and further control if necessary.

- For field-scale infestation, use an integrated weed management approach, which involves the following:
 - Controlling weeds in surrounding non-crop areas such as fence-rows and headlands.
 - Developing a multi-year control program approach that includes specific crop rotations to provide diversity in weed control and herbicide options.
 - Planting weed-free seed and using high seeding rates to provide a competitive crop stand that suppresses weed growth.
 - Seeding early – most perennial weeds emerge in mid to late spring. Earlier seeded crops have a distinct competitive advantage over weeds that emerge after planting.
 - Improving the fertilizer use efficiency of the crop – most weeds respond well to fertilizer, so place the fertilizer with seed or band fertilizer (side band or mid-row banding).
 - Repeating applications of appropriate herbicides, systemically or annually, for heavier infestations, to reduce the weed populations to a manageable level.
 - Ensuring tillage and harvest equipment are free of weed seeds and roots and/or rhizome fragments.
 - Checking the results in the spring and following up with in-crop treatment if necessary.
- Implementing a successful seedling control program. Most perennial weeds produce seeds and seedlings that can re-infest the fields. Left uncontrolled, these seedlings quickly mature and become perennial plants.



Table 3. Growth cycle, seed and root characteristics of commonly occurring perennial weeds in reduced tillage systems

Weed biology	Canada thistle	Dandelion	Field horsetail	Quackgrass	Perennial sow-thistle	Foxtail barley	Yellow toadflax
Growth cycle	Emerges from the root system in mid to late spring and forms rosettes. Flower buds appear 4 - 6 weeks after emergence and flowering can continue until harvest.	New shoots emerge from root crown and from seedlings in early spring. Flowers appear throughout the growing season, but they are most abundant in spring and late summer.	Fertile stems emerge in early spring from rhizomes and tubers. Sterile stems appear in late spring after the fertile stem emerges. Only fertile stems produce spore. Plants never flower or produce seed.	Seedlings germinate and rhizomes start growth at soil temperature >5°C. Growth continues throughout the growing season. Flowering and seed production occurs in June and July.	New shoots emerge from the root system or seeds in late spring and start to flower in June. Flowering and seed production continue from June to September.	Shoots appear from the crown buds in early spring. Seed-heads are produced in late spring to early summer. At maturity, seed-heads break off, encouraging wind dispersal over great distances.	New shoots and seedlings emerge when soil temperature is 5 to 10°C (mid-spring). They start to flower June through August. Seeds start to ripen in August. Growth and development is limited by drought.
Seed	Prolific seed production – up to 5,000 seeds/plant. Seeds can germinate 10 days after maturity or can remain dormant for many years. Seeds can live in water for up to 4 years.	Prolific seed producers (>23,000 seeds/plant). Seeds germinate on the soil surface at 10 - 20°C. Buried seeds will not germinate but remain viable for up to 3 years in soil.	Spores are viable for about 48 hours after release and germinate only in damp soils. Seedlings emerging from spores are easy to kill with tillage or herbicide.	Low viable seed production. Seeds may remain dormant in soil for 3 or more years.	Prolific seed production (4,000 seeds/plant). Seeds germinate late in spring and continue to germinate until fall. Seeds may germinate 7 - 9 days after flowering or remain dormant.	A single plant can produce >200 seeds. Seeds germinate from the top 3 cm of soil and germinate mainly in the fall, although some seeds can germinate in the spring.	Prolific seed producers. Seeds have no dormancy and can germinate as soon as they are shed. Seeds are dispersed mainly by wind over long distances.

continued



Table 3. Continued

Weed biology	Canada thistle	Dandelion	Field horsetail	Quackgrass	Perennial sow-thistle	Foxtail barley	Yellow toadflax
Vegetative	Mainly spread by adventitious root buds that form on horizontal rootstocks. Roots can grow to a depth of 6 m and can produce a total root length of 50 m in 1 year. An 8 cm root fragment can produce an 18 m diameter patch in 3 years.	Dandelions mainly propagate by seed but also reproduce vegetatively from pieces of taproot if cut by tillage operations.	Field horsetail propagates by spores and rhizomes. Rhizomes can grow to a depth of 2 m and can send up above-ground shoots. Tubers, if removed from the rhizomes, can regenerate new shoots.	Rhizomes are the main mode of spread for this weed. In one year, a plant grown from a single bud can spread to 3 m in diameter and produce 154 m of new rhizomes. Temperatures from 5 - 15°C favor rhizome growth.	Reproduces vegetatively from deep horizontal creeping root systems. Roots are easily broken and give rise to new buds. Root buds have a natural dormancy that inhibits shoot emergence of root buds in the fall.	Reproduces vegetatively from buds, which are located in the crown slightly below the soil surface.	Reproduces by seeds and rhizomes. A 10 cm tall shoot is capable of generating a large number of new rhizomes. Most rhizomes grow in the upper 5 - 10 cm of soil. Rhizomes have a large number of buds and each is capable of initiating new shoots.

Control Options

There are four time periods for controlling perennial weeds within any cropping year:

1. pre-seed burndown application
2. early spring in-crop application
3. pre-harvest application
4. post-harvest application

1. Pre-seed burndown application

Pre-seeding burndown applications in the spring usually burn down the top growth of perennial

weeds. Early emerging quackgrass and dandelion can be adequately controlled using glyphosate-based products (Table 4). However, this method of application has little or no impact on Canada thistle, perennial sow thistle or yellow toadflax; these weeds usually emerge after planting, or they have only partially emerged by that time.



Table 4. Pre-seed or post-harvest control of quackgrass and dandelion

Product	Weed controlled	Weed stage	Rate	Remark
Credit, Factor, Glyphos, Maverick, Renegade, Roundup Original, Roundup Transorb, Touchdown iQ, Vantage, Vantage Plus, Victor	Quackgrass	3 - 4 green leaves or more and 20 cm tall	1.0 L/ac	Season-long control of light to moderate infestation. Apply in 20 - 120 L/ac water volume.
Roundup Dry			0.53 kg/ac	
Roundup WeatherMax			0.67 L	
Touchdown 600			0.8 L/ac	
Credit, Factor, Glyphos, Maverick, Renegade, Roundup Original, Roundup Transorb, Touchdown iQ, Vantage, Vantage Plus, Victor	Quackgrass	3 - 4 green leaves or more and 20 cm tall	1.0 - 2.8 L/ac	Long-term control on heavy infestations. Use the higher rate for sod bound quackgrass.
Roundup Dry			0.8 - 1.06 kg/ac	
Roundup WeatherMax			0.67 - 1.89 L	
Touchdown 600			0.8 - 2.24 L/ac	
Credit, Factor, Maverick, Renegade, Roundup Original, Roundup Transorb, Vantage, Vantage Plus, Victor	Dandelion	Less than 15 cm in diameter	1.0 L/ac	Apply up to and including dandelion bloom for best results. Glyphosate: allow 7 or more days after treatment before tillage. Amitrol: allow 10 - 14 days after treatment before tillage.
Roundup Dry			0.53 kg/ac	
Roundup WeatherMax			0.67 L	
Amitrol 240		<10 cm	1.7 L	
Credit, Factor, Maverick, Renegade, Roundup Original, Roundup Transorb, Vantage, Vantage Plus, Victor	Dandelion	Greater than 15 cm diameter	1.5 - 2.0 L/ac	
Roundup Dry			0.8 - 1.06 kg/ac	
Roundup WeatherMax			0.67 - 1.34 L	
Touchdown iQ			1.82 - 2.83 L/ac	
Touchdown 600			1.38 - 2.24 L/ac	

2. Spring in-crop applications

Season-long control of perennial weeds – A number of herbicides are available for use in cereal, oilseed and pulse crops that provide good in-crop top growth control of Canada thistle, dandelion and perennial sow thistle (Table 5).

Clopyralid-based products such as Curtail M, Lontrel, Prestige and Prevail are unique in their ability to move to the root system and provide good season-long control of Canada thistle in cereal. Other products such as DyVel, DyVel DS, Refine Extra, Express Pack and Sundance can

also provide good suppression of perennial weeds in cereal. Assure II, Poast Ultra, Select and Venture are good grass killers in broad-leaf crops, and they provide good suppression of quackgrass in oil-seed crops.

None of the herbicides listed in Table 5 provides any long-term impact on perennial weed populations because at this time of application, weeds are transporting sugars and nutrients to the above-ground parts (shoots and flowers), and there is little or no translocation down to the roots.



Table 5. Spring in-crop applications of herbicides for top growth control of Canada thistle, dandelion, perennial sow thistle, quackgrass and foxtail barley in cereal, oil-seed and pulse crops

Products	Crops								Canada thistle*	Dandelion*	Perennial sow-thistle*	Quackgrass*	Foxtail barley*
	Barley	Corn	Oat	Wheat	Flax	Canola	Pea	Lentils					
Assure II					•	•						S	
Attain	•			•					6.8				
Champion Extra	•								7.1				
Curtail M	•		•	•					8.1				
DyVel	•			•					7.3				
DyVel DS	•	•		•					7.5				
Lontrel	•		•	•	•				7.2				
Express Pack	•			•					6.9				
Frontline	•		•	•					6.4	6.6	7.5		
Frontline 2,4-D	•		•	•					S	S	S		
Muster Gold II						•						S	
Poast Ultra					•	•	•	•				S	S
Prestige	•			•					8.5	8.0			
Prevail	•			•					8.0	S	S		
Refine Extra	•		•	•					7.0		6.7		
Select						•	•	•				S	
Sundance				•					S	S	S	S	C
Target/Sword	•		•	•					6.6		S		
Venture L					•	•	•	•				S	

* Herbicide performance ratings are based on data from the Expert Committee on Weeds (Western Section) Research Reports: 0 = no control, 7= commercial control, 9 = complete control. These numbers are not absolute and, therefore, not a guarantee of expected performance. When a number is not included, there is not sufficient data to provide a rating.

Abbreviations: C = season-long control; S = suppression. This information is based on the pesticide label of the relevant product.

**Spring in-crop suppression of perennial weeds**

– Post-emergence applications of 2,4-D, Ally, Banvel II, Buctril M, Estaprop, MCPA and other herbicides (Table 6) can provide varying degrees of top growth suppression of Canada thistle in cereals.

From the long-term control standpoint, however, these herbicides are inadequate. While they do provide suppression of top growth, there is no effect on the root-kill, and by harvest time, there is significant re-growth.

In a system where more than one application is needed for perennial weed management, the chemicals listed in Table 6 can be successfully utilized for initial in-crop suppression of weeds such as Canada thistle, dandelion and perennial sow thistle; then, before harvest, these weeds can be controlled with pre-harvest glyphosate.

Perennial weed control in herbicide tolerant crops – Herbicide tolerant crops offer a new option for in-crop control of perennial weeds. This technology allows perennial weeds to be sprayed later in the season than previously possible, allowing fair to excellent season-long control (Table 7). Single or repeated post-emergence applications of glyphosate can be applied to Roundup Ready canola, corn and soybean for the control or suppression of quackgrass, foxtail barley, Canada thistle, perennial sow thistle and dandelion.

Similarly, in Liberty Link crops, post-emergence applications of glufosinate (Liberty) can be made for the control of dandelion and perennial sow thistle, and the suppression of quackgrass and Canada thistle. In CLEARFIELD canola, post-emergence application of Absolute will provide good control of Canada thistle.



Table 6. Spring in-crop applications of herbicides for top growth suppression of Canada thistle, dandelion, perennial sow thistle, field horsetail and yellow toadflax in cereals, flax and peas

Products	Crops							Canada thistle*	Dandelion*	Perennial sow-thistle*	Quackgrass*	Foxtail barley*
	Barley	Corn	Oat	Rye	Wheat	Flax	Pea					
2, 4-D	•	•		•	•			5.0	3.0	S	S	S
2,4-D B	•	•	•		•			5.4	S	5.4	S	
Achieve Extra Gold	•			•	•			4.9				
Achieve Liquid Gold	•			•	•			4.9				
Afolan F		•									S	
Ally	•				•			S				
Banvel II	•	•	•	•	•			S				
Basagran/Basagran Forte		•			•	•	•	4.7				
Buctril M/Mextrol	•	•	•	•	•	•		4.9		S		
Champion Plus	•							S				
Crossfire	•				•			S				
Estaprop	•				•			5.6		S		S
FlaxMax						•		S	S	S		
Horizon BTM					•			S				
K2					•			S		S		S
Laser DF					•			S				
MCPA	•	•	•	•	•	•		5.8	S		S	
MCPB + MCPA	•	•	•	•	•		•	S		S	S	
Triumph Plus					•			S				

* Herbicide performance ratings are based on data from the Expert Committee on Weeds (Western Section) Research Reports: 0 = no control, 7= commercial control, 9 = complete control. These numbers are not absolute and, therefore, not a guarantee of expected performance. When a number is not included, there is not sufficient data to provide a rating.

Abbreviations: S = suppression. This information is based on the pesticide label of the relevant product.



Table 7. Perennial weed control in herbicide resistant canola, corn and soybean

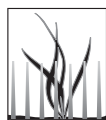
Products	Rate/acre	Herbicide resistant canola			Canada thistle	Dandelion	Perennial sow-thistle	Quackgrass	Foxtail barley
		Roundup Ready	Liberty Link	CLEAR-FIELD					
Absolute	Odyssey: 17 g Lontrel: 170 mL			•	C				
Eclipse	Eclipse A: 113 mL Eclipse B: 506 mL	•			C	S	S	C	
Liberty	1.08 L		•		S	C	C	S	
Roundup Original	0.5 L	•			S	S	S	C	
Roundup Original	0.75 L	•			C	S	C	C	
Roundup Original	0.5 + 0.5 L (sequential)	•			C	S	C	C	C
Roundup Transorb	0.5 L	•			S	S	S	C	
Roundup Transorb	0.75 L	•			C	S	C	C	
Roundup Transorb	0.5 + 0.5 L (sequential)	•			C	S	C	C	C
Roundup WeatherMax	0.33.	•			S	S	S	C	
Roundup WeatherMax	0.33+0.33 L (sequential)	•			C	S	C	C	C
Vantage	0.5 L	•			S	S	S	C	
Vantage	0.5 + 0.5L (sequential)	•			C	S	C	C	
Vantage Plus	0.5 L	•			S	S	S	C	
Vantage Plus	0.5 + 0.5 L (sequential)	•			C	S	C	C	
Touchdown iQ	0.5 L	•			S	S	S	C	
Touchdown iQ	0.5 + 0.5 L (sequential)	•			C	S	C	C	

Roundup Ready corn and soybean

Products	Rate/acre	Field bindweed	Common milkweed	Perennial sow-thistle	Canada thistle	Yellow nutsedge
Factor, Glyfos*, Roundup Original, Roundup Transorb, Vantage, Vantage Plus, Touchdown iQ*	1.0 + 1.0 (sequential)	C	C	C	C	C
Roundup WeatherMax	0.67 + 0.67 (sequential)	C	C	C	C	C

Abbreviations: C = season-long control; S = suppression.

* Not registered for use in Roundup Ready corn.



3. Patch treatments

Post-emergence applications of glyphosate can be made in cereals, oil-seed, pulse, forage, pasture and on summerfallow for the control of quackgrass, Canada thistle, dandelion, foxtail barley and toadflax (Table 8).

4. Pre-harvest application

Just before harvest is the most appropriate time for the control of perennial weeds. At this time, perennial weeds are actively growing, and plants are transporting the nutrients and photosynthates to the root system.

Glyphosate is a systemic herbicide that is rapidly translocated from foliage to roots, rhizomes and apical tissues of the treated plants. This translocation results in the death of “hard to kill” perennial weeds. Pre-harvest glyphosate can be applied to barley bean (dry), canola, field pea, flax (including solin), lentils, oat, soybean, wheat and forage crops and will provide good to excellent control of quackgrass, Canada thistle, perennial sow thistle, common milk weed, yellow toadflax and dandelion.

Table 8. Patch treatments of perennial weeds in wheat, oats, barley, corn, soybean, forage legumes and forage grasses

	Rate per acre						
	Quackgrass	Canada thistle		Dandelion		Foxtail barley	Toadflax
	20 cm tall	Bud or beyond	Rosette summer-fallow	<15 cm	>15 cm	Seedling to heading	Vegetative summer-fallow
Credit, Factor, Glyphos, Maverick, Renegade, Roundup Original, Roundup Transorb, Touchdown iQ, Vantage, Vantage Plus, Victor	1.0 - 2.8 L	1.9 - 2.8 L	1.0 L	1.0 L	1.5 - 2.0 L	1 - 2 L	1 L
Roundup Dry	0.53 - 1.5 kg	1.0 - 1.5 kg	0.53 kg	0.53 kg	0.8 - 1.1kg	0.53 - 1.1 kg	0.53 kg
Touchdown 600	0.8 - 2.24 L	1.6- 2.4 L	0.8 L	0.67 L	1 - 1.34 L	0.67 - 1.34 L	
Roundup WeatherMax	0.67 - 1.89 L	1.28 - 1.89 L	0.67 L	0.67 L	1 - 1.34 L	0.67 - 1.34 L	0.67 L
Banvel II			0.5 - 1.0 L				
2,4-D (fall fallow/stubble)			0.31 - 1.3 L				

Table 9. Pre-harvest weed controls in barley bean (dry), canola, field pea, flax (including solin), lentils, oat, soybean and wheat

Product	Weeds controlled	Rate/acre	Remarks
Credit, Factor, Glyphos, Maverick, Renegade, Roundup Original, Roundup Transorb, Touchdown iQ, Vantage, Vantage Plus, Victor	Quackgrass Canada thistle Perennial sow-thistle Milk weed Toadflax Dandelion	1.0 L	Do not apply to crops grown for seed. Not all glyphosate products are registered for preharvest applications in certain crops. Please consult specific labels for application recommendations.
Roundup Dry		0.53 L	
Roundup WeatherMax		0.67 L	
Touchdown 600		0.8 L	



6. Post-harvest application

Under good growing conditions, post-harvest applications of glyphosate provide good to excellent control of many perennial grasses (e.g. quackgrass) and broad-leaved weeds, e.g. dandelion (Table 3). In the fall, weeds are translocating sugars to roots and rhizomes, and leaf-absorbed glyphosate moves rapidly with the sugars to the underground storage organs for an effective kill. However, on the Canadian prairies this method of application is a risky proposition for several reasons: there may be inadequate weed regrowth at that time, a late harvest and/or an early onset of frost.

Summary and Conclusions

Perennial weeds are the most persistent and hard-to-kill weeds in reduced tillage systems. The successful management of perennial weeds requires an integrated weed management strategy involving good crop health and crop rotations that allow in-crop weed management. Within any given crop year, there are four opportunities to control perennial weeds with herbicides:

1. before seeding
2. in-crop
3. pre-harvest
4. post-harvest

Pre-seeding burndown applications in the spring usually burn down the top growth of perennial weeds. Early emerging weeds such as quackgrass and dandelion can be adequately controlled using glyphosate-based products. However, this method of application has little or no impact on Canada thistle, perennial sow thistle and yellow toadflax.

In-crop treatments are good in providing suppression of the top growth of weeds such as Canada thistle and quackgrass; however, these treatments do not provide root kill, and these treatments should be best used in combination with a pre-harvest glyphosate application.

Herbicide resistant crops (Roundup Ready, Liberty Link and CLEARFIELD) represent a unique opportunity for in-crop perennial weed control. For example, single or repeated post-emergence applications of glyphosate can be made to Roundup Ready canola, and the herbicide will provide good control of quackgrass and foxtail barley as well as suppression of many broad-leaved perennials.

Pre-harvest is the most appropriate time for the management of perennial weeds in reduced tillage systems using a glyphosate-based product.

Glyphosate, Amitrol and Dicamba are registered for post-harvest control of many perennial weeds. However, in western Canada, the results are generally inconsistent.

Glyphosate plays an important role in the management of perennial weeds: it can be applied before seeding, in Roundup Ready crops, pre-harvest and post-harvest. To keep glyphosate as an important weed management tool, producers should make it only part of an integrated weed management program and not the sole weed control option.

References

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