Emerging Weed Issues –Here to Stay?

Denise Maurice
Manager, Agronomic Information Extension
Westco

Weeds are part of a dynamic ecosystem that includes the crop species, the natural environment and the production practices that are imposed upon the system (Aldrich and Kremer 1997). In fact, the production practices employed within the agro-ecosystem creates the selection pressure that will influence the weed species that are present within the system. In the last several years' farmers have been under greater pressure to undertake practices that are sustainable and environmentally sound, while still ensuring the economic viability of crop production. Farmers have responded by increased efforts towards directseeding and reduced tillage. The latest survey results (P. Gamache, RTLinkages, personal communication) shows a significant increase in the number of farmers practicing reduced tillage, Of the total annually seeded acres in Alberta, 30% were high disturbance directseeded and 39% were low disturbance directseeded. This change in production practice in itself is significant, however other parallel production practices have also changed. There are more diverse rotations many include, legume crops, winter cereals and herbicide tolerant crops. The inclusion of chemical fallow as part of a moisture conservation initiative has also increased over the last 10 years. The implementation of herbicide rotation, and the wide range of timings for the weed control options such as pre-seed, in-crop, pre-harvest post-harvest and fall applications, all these factors will influence the weed spectrum.

Farm size has also increased and as a result producers are implementing and /or utilizing field scouting services that allows for the assessment of the weed species composition and their associated densities. This intimate knowledge on a field to field basis provides early detection of new weed problems and ensures that the appropriate interventions can be taken. Farmers are managing more complex cropping systems and with these changes come the shift in weed population dynamics. Species presence and abundance is determined by dispersal, disturbance, environment, management factors and species interaction (Booth and Swanton, 2002).

So the question remains, how have these changes in production practices impacted on the weed species presence and abundance in the field?

Recent weed survey results show a shift in the ranking of various weeds species in addition to changes in population size (Leeson, Thomas and Hall, 2003). The most significant change has been in the frequency of field samples that showed no weeds….In late 1980's, 43 % of the fields were documented to have no weeds present. In 1997, the percentages of weed-free quadrants rose to 60.8% (Thomas et al 1998), and in 2002 the number climbed to 66.7% (Leeson, Thomas and Hall 2002). This shift in the percentage of weed-free samples indicates that the intervention and weed management practices utilized by producers across Alberta has had a significant impact on weed densities in the field.

The examination of the weed population data and their relative ranking also reveals some very interesting trends. The top ten weed species remain the same over the last 2 survey periods, with only a shift in their relative ranking. Of particular interest is the observed decrease in the frequency in all the top ten species; with the exception of cleavers which continued to occupy 11% of the fields surveyed.

Wild oats ranked second over the survey period 1997-2003, however previous survey results from 1988 –1997 showed an overall increase in the frequency of wild oats. This increase in frequency in earlier surveys, may in part be due to the development of resistant wild oat biotypes. In 2003, the occurrence of wild oats decreased from 56% to 45% of field infested. This change in frequency may be attributed to the ability to manage herbicide resistant wild oats with new herbicide groups in-crop. Herbicide tolerant crops provided a "just in time" solution to manage wild oat resistance in the crop rotation.

Alberta Weed Survey Results 1997 and 2003

Weed Species	2003			1997		
	Rank	Frequency %	Density (pl/sq.m)	Rank	Frequency %	Density (pl/sq.m)
Wild buckwheat	1	54.3	7	4	59.2	5
Wild oats	2	45.6	10	2	56.1	9
Chickweed	3	21.2	31	1	30.7	33
Canada thistle	4	40.7	3	5	53.4	3
Stinkweed	5	30.6	6	3	43.9	12
Cleavers	6	18.4	8	7	18.0	11
Lamb s-quarters	7	23.7	5	8	27.6	5
Hempnettle	8	18.8	7	10	22.8	5
Green foxtail	9	11.4	18	18	16.4	4
Dandelion	10	22.7	2	12	31.6	2

Although it is generally believed that wild buckwheat populations are increasing as a result of the extensive use of glyphosate, the survey results indicate that the frequency remains around 50% and the density has only slightly increased.

The weed species of particular concern are those that have shown a significant movement in temrs of relative ranking. These species shifts and changes are due to changing in the selection pressure as a result of a change in production practices or more likely the creation of biological niche that favour these specific species.

Alberta Weed Survey Results 1997 and 2003

Weed Species	2003			1997		
	Rank	Frequency %	Density (pl/sq.m)	Rank	Frequency %	Density (pl/sq.m)
Annual sowthistle	15	8.2	13	28	6.0	3
Volunteer canola	16	13.1	5	21	8.3	8
Kochia	20	8.8	4	27	5.6	5
Foxtail barley	31	4.1	2	40	2.5	1

These species include dandelion, annual sow-thistle, volunteer canola, kochia and foxtail barley. Not only have all these species increased in their relative ranking but they have also extended their range as indicated by their field frequency. The one exception is dandelion, which decreased in the percent of field infested.

Examining the biology of these species can provide some insight to the increase in their distribution. All these weed species have the ability to germinate on the soil surface, some can survive both in disturbed and undisturbed conditions. Another common trait of these species is the optimum timing of a herbicide application falls outside the normal window for spraying. For example, the most opportune time for dandelion

control is post-harvest and not every year are farmers able to take advantage of the post-harvest application timing.

Kochia has significantly extended it range. It is a weed adapted to hot dry conditions however its diverse genetic makeup has allowed for the adaptation to a wider range of environments. In 2003, a sample from the Vegreville and Peace River areas were submitted for identification. The sample sent in from the Peace River area was found along the railway tracks near an AgRetail office. Soft thick hairs cover most of the leaf surface of kochia protecting it from excessive drying, this characteristic can vary with biotype and moisture conditions. Kochia will develop many leaves at once making it difficult appropriately time a herbicide application and obtaining good coverage can be a challenge with this species. Maintaining high water volumes for adequate coverage is critical for the control of this weed. Kochia seed has a short viability period so if control measures are successful, in two years the population can be significantly reduced.

Foxtail barley a simple perennial is better controlled in the fall or very early spring. The preseed burnoff will not provide complete control of foxtail barley since it is likely too advanced for complete control and the glyphosate rate maybe too low.

Volunteer canola has become a common weed in western Canada. Seed losses range from 3.3-10%, providing ample source of seed to establish a weed seedbank. Losses of 3000 viable seeds sq.meter are common (Shirtliffe, 2003). Shirtliffe indicates that these seed losses amount is 9-56 times the normal seeding rates of canola. He further indicates that these losses occur even if good harvest management practices are followed, since it seems to be a result of the shattering nature of canola. To further complicate the issue, Shirtliffe's research team found that in some canola varieties the seed has the ability to develop secondary dormancy . This adaptation is advantageous as it allows seeds not germinate at a time of year when chances of reproduction are low. From a production perspective it means that volunteer canola can be a weed problem several years after the year of production. The secondary dormancy appears to be genetically controlled as there are canola varieties that consistently show high potential to be induced into dormancy. So varietal selection maybe a means of managing this new weed problem in addition to early swathing, proper combine operation and the use registered herbicides for control in-crop Interestingly these researchers observed that most of the volunteer canola emerged prior to the appropriate timing of an in-crop herbicide application. Producers should explore the tank mixes in a preseed application to ensure the control of all canola varieties including all herbicide tolerant varieties.

Directseeding systems provide an opportunity for effective pre-seed weed control in addition to the traditional windows of opportunity provided by more conventional tillage systems. An effective pre-seed burnoff ensures a weed-free seedbed, enhancing the competitive advantage of the seeded crop. Recent registrations provide a greater number of options for cost-effective solutions to weed control pre-seed.

WEED SPECIES IN THE PRE-SEED ENVIRONMENT

Many different types of weed species appear in early spring prior to seeding. Winter annuals, annuals, biennials and perennials can all be present in the pre-seed environment. Proper identification allows for the selection of the appropriate herbicide(s), herbicide rate, and tank mix partner for the most cost-effective solution. Weed spectrums in the pre-seed window change from season to season and over the years. Recent field scouting reports indicate an increase in winter annuals such as shepherd's purse, peppergrass and Narrow-leaved hawk's-beard, in addition to the biennial species, American dragonhead, and several perennial species such as white cockle pasture sage, absinth and foxtail barley.

Winter annuals - are the most common life cycle in the pre-seed environment. These weed species emerge in the fall, overwinter as rosettes, and set seed in the spring of the following year. Most of the winter annuals prefer undisturbed conditions, and flowering is dictated by temperature. To maximize herbicide performance, applications need to be performed prior to flowering.

Common winter annual species:

Broadleaf species:

- stinkweed
- flixweed
- Narrow-leaved hawk's-beard
- peppergrass
- cleavers
- stork's bill
- scentless chamomile
- Canada fleabane

Grass species:

- downy brome

Annuals - germinate in the spring, flower, and set seed within the same season. Annual weed species that have the ability to germinate in undisturbed, cooler conditions are more likely to appear in the pre-seed environment. The early spring appearance of annuals will be determined by moisture and temperature conditions prior to seeding. Managing Roundup Ready canola volunteers has become routine, so matching the appropriate tank mix partner is critical to ensuring maximum crop safety and performance.

Broadleaf weeds:

- hempnettle
- lamb's-quarters
- kochia
- wild buckwheat
- Redroot pigweed
- Russian thistle
- Volunteer canola
- Smartweed
- goat's beard

Grass weeds:

- Wild oat
- Green foxtail
- annual bluegrass
- Volunteer cereals

Biennials - complete their life cycle in two seasons. The first season they remain in a rosette, in the second season they flower after a full summer season. These weeds can be more challenging to control in a pre-seed environment due to their well-established rosette and root system. Excellent coverage and early control combined is the best strategy for these species.

Common biennials:

- American dragonhead
- Biennial wormwood

Perennials - persist for more than two growing seasons. They can be simple perennials that reproduce by seed, or creeping perennials that reproduce by seed and vegetative parts such as rhizomes.

Common perennial species:

Broadleaf weeds:

- Dandelion
- Canada thistle
- perennial sow-thistle
- curled dock
- absinth
- scentless chamomile
- pasture sage
- toadflax

Grass species:

- quackgrass
- foxtail barley

TIMING

Timing of the pre-seed burnoff application is determined by weed species present and their relative staging. **Optimum timing just prior to seeding.** Research conducted by Eric Johnson, Agriculture and Agri-Food Canada (AAFC) illustrated that regardless of the type of seeding system, glyphosate just prior to seeding resulted in the greatest yield response both for wheat and barley. This yield response is a result of minimizing the weed competition factor and injury to the crop.

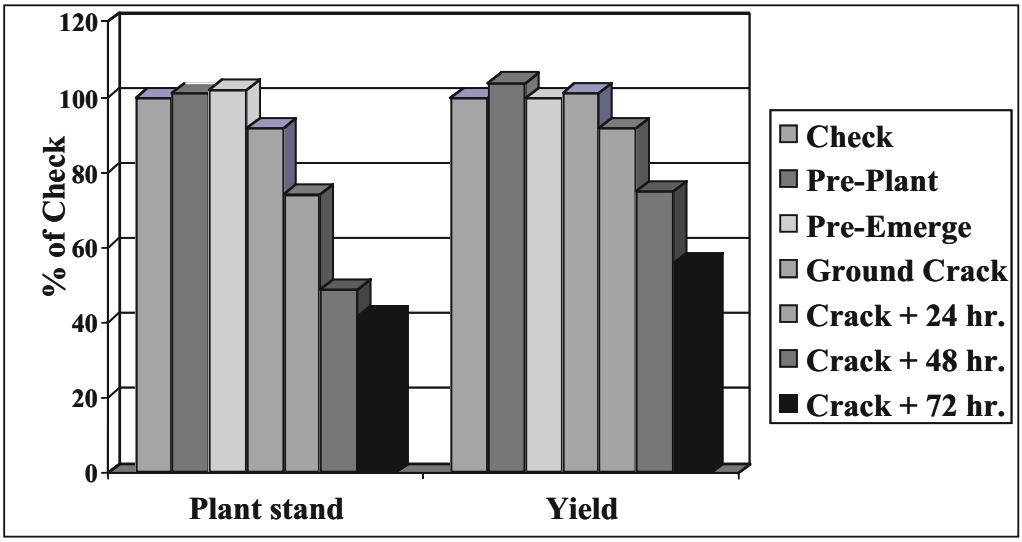
Grain yield and weed fresh weight in Directseeding System (Melfort and Scott, SK 1997 & 1998)

Glyphosate timing	*Narrow hoe-direct*			*Sweep direct*		
	Weed fresh weight (g m^{-2})		Grain yield	Weed fresh weight (g m^{-2})		Grain yield
	Grasses	Broadleaf	(Bu/acre)	Grasses	Broadleaf	(Bu/acre)
Wheat						
2-3 wk prior	520	-	26.4	390	-	30.1
1 d prior	280	-	36.7	420	5	30.5
3-4 d after	180	20	30.1	420	-	26.0
Barley						
2-3 wk prior	250	-	27.3	180	40	20.0
1 d prior	100	-	28.0	140	10	25.0
3-4 d after	90	-	27.4	120	10	20.3

Source: E.N. Johnson et al. 2001.

Further research conducted by Ken Sapsford, University of Saskatchewan (U of S), and Eric Johnson (AAFC) shows that delaying the pre-seed glyphosate application after ground crack can result in both a crop stand and yield reduction in wheat and barley.

Wheat Response to Timing of Glyphosate Application



Source: Ken Sapsford, U of S and Eric Johnson, (AASFC)

Weed species emergence will also dictate timing of the pre-seed application. When temperatures are warm, winter annuals and biennials can advance through their growth stages more quickly than under cooler conditions. Once the winter annual or biennial weed has started to bolt, the flowering stage is eminent, and weed control operations will require higher rates for optimum performance. Warm springs can compress the pre-seed season from 3 – 4 weeks to 1 – 2 weeks.

CROP ROTATION

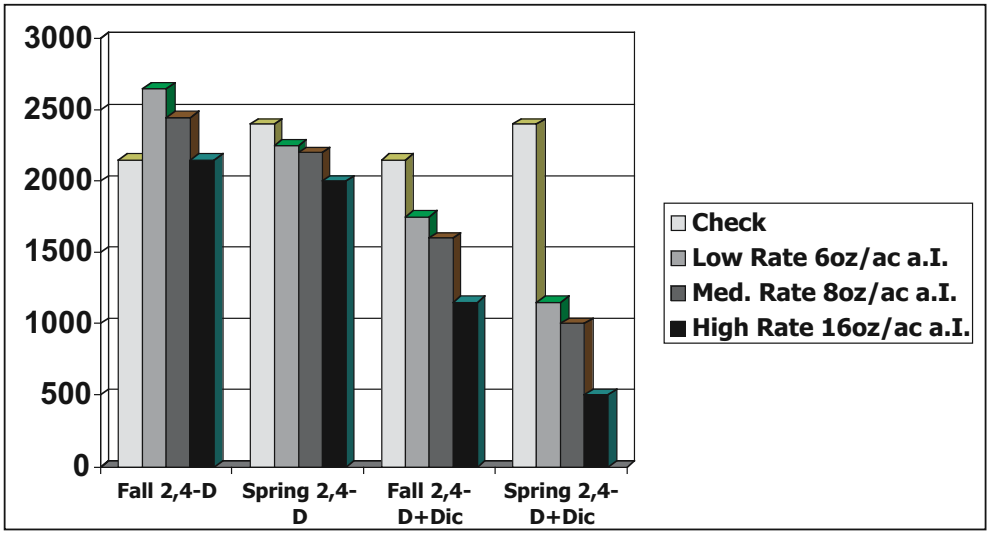
Some of the new herbicide options available for pre-seed burnoff have cropping restrictions. In order to minimize injury to sensitive crops due to residual activity of the herbicide, plant back guidelines should be followed.

Herbicides for Use Before Seeding or After Seeding but Prior to Crop Emergence

HERBICIDE	RATE L/acre	pre seeding	pre emergent	barley	canaryseed	canola	corn, field	corn, sweet	dry beans	field pea	forage grasses	flax	oats	soybean	wheat	rye
Amitrol	1.7	✔		✔		✔	✔		✔	✔				✔	✔	
Glyphosate	0.3-1.0	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Glyphosate + Pardner	0.5 + 0.405	✔	✔	✔									✔		✔	
PrePass	40 acres / case	✔		✔									✔		✔	
Roundup + 2,4-D	0.5-0.8 + 0.23-0.58	✔	✔	✔											✔	✔
Roundup + Buctril M	0.5-0.8 + 0.2-0.4	✔		✔	✔		✔	✔			✔	✔	✔		✔	✔
Roundup + Express (Agral)*	0.3-0.5 + 4g/ac	✔	✔	✔									✔		✔	
Roundup + MCPA	0.5-0.8 + 0.2-0.28	✔		✔			✔	✔		✔		✔	✔		✔	✔
Roundup + MCPA	0.5-0.8 + 0.2-0.4	✔		✔			✔	✔				✔	✔		✔	✔
Rustler	1.0-1.3	✔		✔			✔						✔		✔	✔

Field peas for example, are very sensitive to 2,4-D and dicamba residues. As a result, MCPA is the herbicide of choice for controlling Roundup Ready canola volunteers.

The effects of pre-seeding, 2,4-D and 2,4-D + dicamba on pea yield (1989)



Source: Ken Sapsford, U of S and Eric Johnson, (AAFC)

WEED CONTROL

For grassweed control, glyphosate is a key component to the pre-seed burnoff tank mix. Where the tank mixes differ in performance is in the control of harder to control broadleaf weed species. For example, Roundup Transorb 500ml/ac plus Express will control shepherd's purse and kochia, while a full liter of Roundup would have been required.

Weed Control Before Seeding of After Seeding but Prior to Crop Emergence

			Broadleaf weeds															Grass					
HERBICIDE	Herbicide Group	RATE L/acre	Buckwheat, Wild	Dandelion	Flixweed	Hempnettle	Kochia	Lady's-thumb	Lamb's-quarters	Mustard, Wild	Narrow-leaved Hawk's-Beard	Pigweed, Redroot	Russian Thistle	Shepherd's Purse	Stinkweed	Volunteer Canola (including Roundup Ready varieties)	Volunteer Flax	Brome, Downy	Foxtail Barley	Foxtail, Green	Quackgrass	Volunteer Cereals	Wild Oats
Amitrol 240	11	1.7		•																			
Glyphosate + Pardner	9,4	0.4 + 0.45	•				•	•	•	•			•		•	•				•		•	•
Glyphosate	9	0.3 to 1.5	•	S	•	•	•	•	•	•	•	•	•	•	•		•	•	S	•	•	•	•
PrePass	9,2	40 acres / case	•	S	•	•	•	•	•	•	•	•	•	•	•	•		•		•		•	•
Roundup + 2,4-D	9,4	0.5-0.8 + 0.23-0.58	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•	•
Roundup + Buctril M	9,6,4	0.5-0.8 + 0.2-0.4	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•	•
Roundup + Express	9,2	0.4-0.5 + 4g/ac	•	S		•	•	•	•	•	S	S	•	•	•	•	•	•		•	•	•	•
Roundup + MCPA	9,4	0.5-0.8 + 0.2-0.4	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•	•
Rustler	9,2	1.0 to 1.3	•		•		•	•	•	•		•	•		•			•		•		•	•

• - Controlled S - Suppression

Field observations (Westco trial 2003) indicate suppression of dandelions with several tank mixes: Roundup Transorb 500ml/ac plus Express 4g/ac; RoundupTransorb 500ml/ac plus 2,4-D 600 (400ml/ac) and PrePass. The pre-seed application used in conjunction with an in-crop application of a clopyralid-based herbicide (e.g., Curtail M)can reduce dandelion populations significantly.

Herbicide Group rotation needs to be a consideration with these new tank mix or premix options. PrePass and tank mixes with Express represent active ingredients from Herbicide Group 2. Ensuring the integration of these Herbicide Groups from a herbicide rotation perceptive will delay the development of resistance. In Alberta for example, Group 2 herbicides have been used extensively in-crop, resulting in over eight broadleaf weed species becoming resistant to this Group. Further, Glyphosate is an extremely valuable tool that has revolutionized directseeding and needs to be preserved. So in choosing the best weed control option, herbicide rotation, crop rotation and weed spectrum all need to be considered.

VOLUNTEER CANOLA CONTROL

Many recent registrations are geared to controlling Roundup Ready canola in the pre-seed environment. In most cases they include a Group 4 or Group 2 herbicide which is safe to use in cereals, but can cause injury to sensitive broadleaf crops. Roundup plus the low rate of MCPA can be used in peas and flax, but the presence of phenoxy at this rate only controls the Roundup Ready canola volunteer, and does not add any additional weed control benefit. PrePass and the use of Express or the higher rates of 2,4-D will widen the weed spectrum controlled, and allow in some cases, the lowering of the glyphosate rate (cereals only).

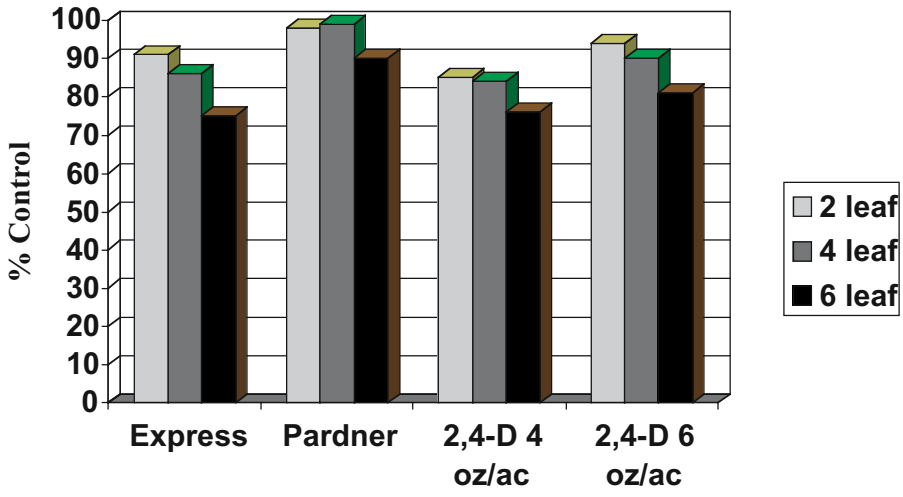
Pre-seeding control of Roundup Ready canola volunteers: Tank-mixing with Roundup or Roundup Transorb.

Tank Mixture	Rate (per acre)	Registered Crops	Control volunteer Roundup Ready canola
Roundup + 2,4-D amine or LV Ester 600*	0.5-0.75 L + 0.24-0.36 L	Winter Wheat, Wheat, Barley and Rye	1- to 4-leaf stage
Roundup + 2,4-D amine or LV Ester 600*	0.5-0.75 L + 0.48-0.6 L	Winter Wheat, Wheat, Barley and Rye	4- to 6-leaf stage
Roundup + MCPA amine or Ester 500	0.5-0.75 L + 0.2-0.28 L	Wheat, Barley, Rye, Corn, Oats, Flax and Field Peas**	1- to 4-leaf stage
Roundup + MCPA amine or Ester 500	0.5-0.75 L + 0.2-0.4 L	Wheat, Barley, Rye, Corn, Oats and Flax	1- to 4-leaf stage
Roundup + Buctril M	0.5-0.75 L + 0.2-0.4 L	Wheat, Barley, Rye, Corn, Oats, Flax, Canary Seed and seedling grasses	1- to 4-leaf stage
Roundup + Express	0.3-0.5 L + 4 g/ac	Wheat, Barley and Oats	1- to 4-leaf stage
Roundup + Pardner	0.4 + 0.45	Wheat, Barley and Oats	1- to 4-leaf stage
PrePass	40 ac/case	Wheat, Barley and Rye	1- to 4-leaf stage

*** Adjust rates accordingly for other 2,4-D formulations**
**** MCPA amine only prior to Field Peas**

Controlling the volunteer Roundup Ready canola early is the key to maximizing performance. Recent research conducted at Scott Research Station indicates the 1- to 4-leaf stage is optimum. After the 4-leaf stage, reduced control can be a concern regardless of the herbicide used.

RR Canola Control at Different-leaf Stages



In some years we receive inquiries about post-seed burnoff where the wheat is emerging, but volunteer canola has already emerged over the past several days. Growers are concerned the canola may get a jump on the wheat. So what are our options?

Give the crop and the weeds another week and re-assess (especially if canola is only in the cotyledon stage).

It is important to assess the volunteer canola population. If volunteer canola is in patches and overall, the volunteer canola didn't amount to more than 1 plant per square foot. For these fields, waiting until in-crop application is probably not unreasonable, but the situation would have to be monitored (especially if more canola is still emerging). In fields where populations are at moderate levels, an herbicide application may be required before the normal in-crop application of herbicide.

The option for control in a wheat crop that is in the coleoptile to 1-leaf stage is very limited. Most broadleaf products suggest at least 2-leaf stage before applying herbicide. At this stage, the crop is able to safely metabolize the herbicide. Most growers will want to go with a cost-effective option. If the wheat is emerged at all, avoid 2,4-D unless the wheat is in the 3- to 4-leaf stage (minimum). Significant injury with 2,4-D can show up at crop heading (distorted heads; blank florets). The MCPA label suggests waiting until at least the 3-leaf stage. 1960's research suggests some injury similar to 2,4-D, but generally MCPA is not as harsh as 2,4-D. Other suggestions include Buctril M, and while it is relatively safe on cereal crops, it does contain about 225ml of MCPA equivalent per acre, and remember that the bromoxynil needs good growing conditions for optimum activity. **Bottom line, MCPA may be the preferred choice by growers, but try to hold out until at least the 3-leaf stage of wheat if possible.** Previous research suggests up to 10% damage can occur in the way of blank florets and distorted heads when applying prior to the 3-leaf stage. To control volunteer canola effectively, a rate of 300ml/ac is preferred.

References

Aldrich, R.J. and R.J. Kremer (1997). *Principles in Weed Management*, second edition. Iowa State University Press, Ames, Iowa.

Booth, B.D. and C.J. Swanton (2002). *Assembly Theory Applied to Weed Communities.* Weed Science 50: 2-13.

Brenzil, C. (2003). *Control of Tumble Weeds: Managing Kochia and Russian Thistle.* Saskatchewan Agriculture, Food and Rural Revitalization, Regina SK. LSSN0840-6447CD.

Buhler, D.D. (1999). *Expanding the Context of Weed Management.* Journal of Crop Production, Volume 2, Number 1 (#3).1.

Holt, J.S. (1994). *Impact of Weed Control on Weeds: New problems and Research Needs.* Weed Technology 8: 400-402.

Lesson, J.Y., A.G. Thomas and L.M. Hall (2002). *Alberta Weed Survey of Cereals, Oilseed and Pulse Crops in 2001.* Weed Survey Series Publication 02-1 Saskatoon, SK. Agriculture and Agri-Food Canada, Saskatoon Research Centre.

Radosevich, S.R. and C.M. Ghersa (1992). *Weeds, Crops and Herbicides: A Modern Day "Neckriddle".* Weed Technology 6: 788-795.

Shirtliffe, S.(2003) *Controlling Volunteer Canola as a Weed.* Final Report Project #19990104, Department of Plant Science, University of Saskatchewan, Saskatoon.

Thomas, A.G., B.L. Frick and L.M. Hall (1997). *Alberta Weed Survey of Cereals and Oilseed Crops 1997.* Weed Survey Series Publication 98-2, Saskatoon, SK. Agriculture and Agri-Food Canada, Saskatoon Research Centre.

Wicks, G.A. et al. (2003). *Survey of Winter Wheat (Triticum aestivam) Stubble Fields Sprayed with Herbicide in 1998: Cultural Practices.* Weed Technology 17: 467-474.

Wyse, D.L. (1992). *Future of Weed Science Research.* Weed Technology 6: 162-165.