Herbicide Resistance: Dealing with a New Weed Problem

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ABSTRACT

In recent years, resistance to commonly used herbicides has developed in several weed species in Saskatchewan. The first examples were weeds resistant to herbicides in the sulfonylurea family (e.g., Glean, Ally, Amber) and included kochia and Russian thistle. Next came green foxtail (wild millet) resistant to dinitroaniline herbicides (e.g., Treflan, Rival, Edge). In the past two years wild oat and green foxtail samples have been identified that are resistant to many of the newer postemergence herbicides, including Hoe-Grass, Triumph Plus, Laser, Poast and Achieve. In all cases resistance has developed in individual fields after repeated use of the same herbicide or herbicides with the same mode of action. For some growers, the development of resistant weed biotypes significantly restricts the choice of herbicide available for their weed control program. Growers need to become aware of the modes of action of the different herbicides that are available to them, and to ensure that they use an appropriate rotation of herbicides so that resistance does not increase in their fields. In addition, the use of non-chemical weed control methods should be encouraged, so that growers avoid the repeated use of herbicides.

INTRODUCTION

Herbicide resistance in weeds refers to the development of weed biotypes that survive the typical herbicide application rates used to control that weed. Although the phenomenon of herbicide resistance has been known for approximately 20 years, it is only in the past 4 years that it has appeared as a weed problem in western Canada. A listing of some of the major occurrences of herbicide resistance in common weeds in the prairie provinces is shown in Table 1. The first weed species to show resistance was kochia, which developed resistance to Glean and related herbicides within 5 years of the introduction of these products. At first it was believed that the long soil residual activity of these products was a major component of the selection for herbicide-resistant individuals. However, the development of resistance to non-residual herbicides (e.g., Hoe-Grass, Poast) indicates that soil residual activity is not necessary for the selection of resistant biotypes in all instances.

Table 1. Examples of species in which herbicide resistance has developed in the Canadian prairie provinces.

Weed species	Herbicides	Locations
Wild oat	Hoe-Grass, Poast, etc	N-W Manitoba, E. Sask
Wild oat	Avadex, Difenzoquat	Central Alberta
Green foxtail	Hoe-Grass, Poast, etc	N-W Manitoba
Green foxtail	Trifluralin, etc	S-W Manitoba, Sask Parkland
Green foxtail	HoeGrass, Poast, etc + trifluralin, etc	W. Manitoba
Kochia, Russian thistle	Glean, Ally, etc	S. Saskatchewan
Chickweed		Central Alberta
Wild Mustard	2,4-D, Banvel	W Manitoba

Although it is difficult to assess the number of sites in which each herbicide-resistant weed occurs, and the total acreage affected, it is estimated that there are over 400 trifluralin-resistant green foxtail sites (Group 3 herbicides), over 100 "fop and dim" resistant wild oat sites (Group 1 herbicides), approximately 50 sulfonylurea-resistant kochia sites (Group 2 herbicides), and smaller numbers of other herbicide-resistant weed sites. However, it is impossble to predict at present if these numbers will continue to increase or if they will stabilize close to their present level.

DEVELOPMENT OF RESISTANCE

Herbicide resistance occurs through the selection of naturally resistant individuals by repeated herbicide application. It appears that in many weed species a very small proportion of individuals possesses a resistance mechanism that allows them to survive normal herbicide application rates. After repeated use of the same herbicide, or herbicides with the same mechansim of action, the susceptible weeds are controlled, but the resistant ones survive and increase in number to the point where they become the majority in the field. Thus a resistant weed may initially occur at 1 in 1,000,000 in the population, but after repeated selection by the herbicide it can become the predominant type in the population. Unfortunately, there is no way at present of predicting in which species

resistance is likely to arise, how fast it might arise, or to which herbicides. We learn this the hard way - by experience in the field.

Several examples of herbicide use histories in fields in which resistance has developed are shown in Tables 2 and 3. Resistance to green foxtail (wild millet) to dinitroaniline herbicides has arisen in many fields after repeated use of herbicides such as Treflan, Rival, Edge, etc. (Table 2). Similary, resistance to postemergence grass herbicides in wild oat has arisen following repeated use of these herbicides (Table 3).

Table 2. Herbicide history of two fields in which trifluralin-resistant green foxtail has developed.

	Field 1		Field 2	
Year	Crop	Trifluralin rate (L/ac, 500g/L EC)	Crop	Trifluralin rate (kg/ac, 5% gran.)
1980			Lentil	11.3
1981	Wheat	0.45	Wheat	0
1982	Canola	1.05	Lentil	11.3
1983	Wheat	0	Wheat	0
1984	Wheat	0.45	Flax	11.3
1985	Canola	1.05	Wheat	0
1986	Wheat	0	Canola	11.3
1987	Wheat	0.45	Wheat	0
1988	Canola	1.05	Lentil	11.3

PATTERNS OF RESISTANCE AND CROSS-RESISTANCE

It is important to know which herbicides a "resistant" weed is resistant to, and which herbicides can still be used to control it. To assist in this, herbicides can be grouped according to their mode of action (Table 4). Generally, we find that if a weed develops resistance to one member of a particular group, it will be resistant to all other members of that group. For example, willd oats resistant to Hoe-Grass will probably be resistant to Poast, Triumph Plus, and other "Group 1" herbicides. (I say "probably" here because, as with everything else, there can be exceptions; however, this is true in the majority of cases.)

Table 3. Herbicide histories of two fields in Manitoba in which herbicide-resistant wild oat has developed.

	Field 1		Field 2	
Year	Crop	Herbicide	Crop	Herbicide
1981	---	---	Barley	Hoe-Grass
1982	Wheat	Hoe-Grass	Wheat	---
1983	Barley	Hoe-Grass	Wheat	Hoe-Grass
1984	Wheat	Hoe-Grass	Flax	Poast
1985	Barley	Hoe-Grass	Wheat	Hoe-Grass
1986	Wheat	Hoe-Grass	Canola	Poast
1987	Flax	Poast	Wheat	---
1988	Barley	Hoe-Grass	Flax	Poast
1989	Flax	Poast	Wheat	Hoe-Grass
1990	Wheat	Triumph Plus	Wheat	Triumph Plus

Table 4. Herbicide groups based on their mechanism of action.

Group	Member herbicides
Group1	Excel, Fusilade II, Hoe-Grass, Hoe-Grass II, Laser, Triumph Plus, Assure, Puma, Poast, Achieve, Select
Group 2	Ally, Assert, Amber, Glean, Muster, Refine, Triumph Plus
Group 3	Edge, Fortress, Treflan, Rival, Triflurex
Group 4	2,4-D, MCPA, Banvel, Buctril M, Dyvel, Estaprop, Kil-Mor, Target, Tordon 202C, Lontrel
Group 5	Bladex L, Blagal, Sencor, Lexone
Group 6	Buctril M, Hoe-Grass II, Laser, Pardner
Group 7	Afolan, Lorox
Group 8	Others - Avenge, Avadex BW, Carbyne, Mataven, Eptam, TCA, Stampede

The basis for categorizing herbicides into these groups is that herbicides kill plants by interfering with particular biochemical processes, and all of the herbicides within each

group affect the same process. Thus although the crop selectivity of Hoe-Grass and Poast are very different, they kill wild oat plants in exactly the same way. Wild oat plants that are resistant to Hoe-Grass, therefore, are likely to be resistant to Poast, also - and to all the other herbicides listed in Group 1 in Table 4. Note that some herbicides in Table 4 appear in more than one group, because they contain more than one active ingredient.

IDENTIFICATION/CONFIRMATION OF HERBICIDE RESISTANCE

It is important to establish as quickly as possible whether or not weed "escapes" are truly herbicide-resistant or are just random escapes. To do this, a grower can ask several questions:

Are other weeds listed on the label controlled satisfactorily?
Is herbicide failure patchy with no reasonable explanation?
Has the same herbicide failed here before?
Has the same herbicide, or one from the same group, been used repeatedly in the same field?
Was there a possible water quality problem in the spray tank?

The answers to these questions should provide a strong indication of the nature of the problem - misapplication, possible weather-related factors, etc. If resistance is still suspected, seed samples should be collected and tested by a lab that offers this service.

STEPS TO AVOIDING HERBICIDE RESISTANCE

The best management practice for dealing with herbicide resistance starts with the use of all possible means to avoid the problem in the first place. These can include the following:

Use herbicides only when needed; no cosmetic weed control.
Rotate among herbicide groups as much as possible (i.e. use herbicides with different modes of action).
Use other weed control methods where appropriate (tillage, etc).
Do not double-spray or use higher rates for "problem patches."

Growers should be aware that weeds respond to selection presssure in any way they can, and that application of the same selection pressure (e.g., use of the same herbicide year after year) will accelerate the development of resistance in a weed poulation. This means that it is very important to be aware of the modes of action of the different herbicides available, and in particular which groups different products belong to (Table 4). Growers have to make a conscious effort to use all possible means of weed control at their disposal, including non-chemical means, so that the potential usefulness of herbicides is maintained.