HERBICIDE RESISTANCE

It can't be ignored!

BATTLE RIVER IMPLEMENTS

AGRONOMY UPDATE
NOVEMBER 2016

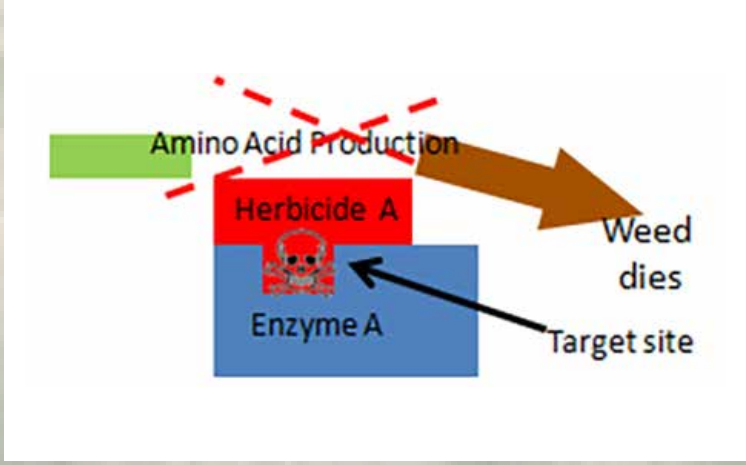
Over 30 years ago I stood in a field late in the fall near Harris, Saskatchewan – a town north east of Rosetown in the dark brown soil zone, and puzzled over a strange phenomenon. Glean herbicide (a highly effective and extremely residual herbicide for those not familiar with it) had been applied to a wheat crop that spring. The soil was low in organic matter and high in pH. Under these conditions I was used to seeing Glean control broadleaf weeds for two or even three years after an application. Yet, here I was looking at trails of kochia plants randomly winding across the field, looking happy and healthy wherever the "tumbleweeds" had dropped seed as the wind blew the dried up plants across the field.

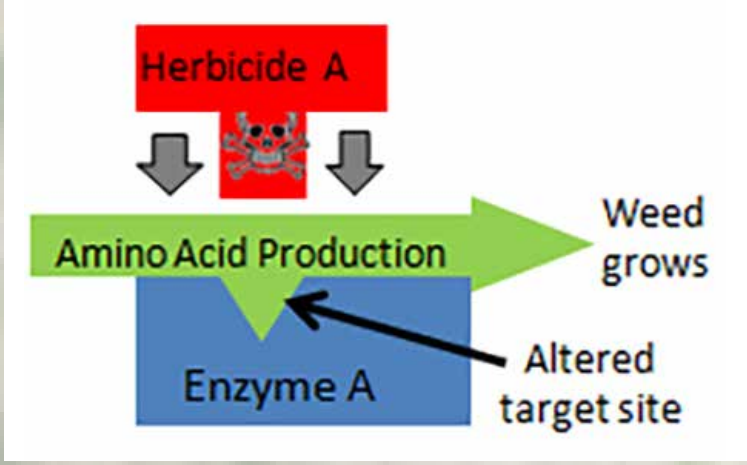
I remember looking at a scene similar to the one shown in this picture and being totally baffled by what I was seeing. It was not until almost a year later that I realized that I had just seen my first example of herbicide resistance.

Since then, our understanding of resistance has grown incrementally, mostly driven by the growing problem of wild oat resistance to Group 1 and Group 2 herbicides.

Some weeds, such as the Group 2 example on kochia below or Group 1 wild oat resistance are examples of "**target site resistance**". The herbicide targets certain sites in the plant and binds to them, interfering with the plant's metabolic processes. Plants with a different shape or structure at this site can avoid the herbicide binding to them. These "point mutations" are common and we select for them when we apply these kinds of herbicides.

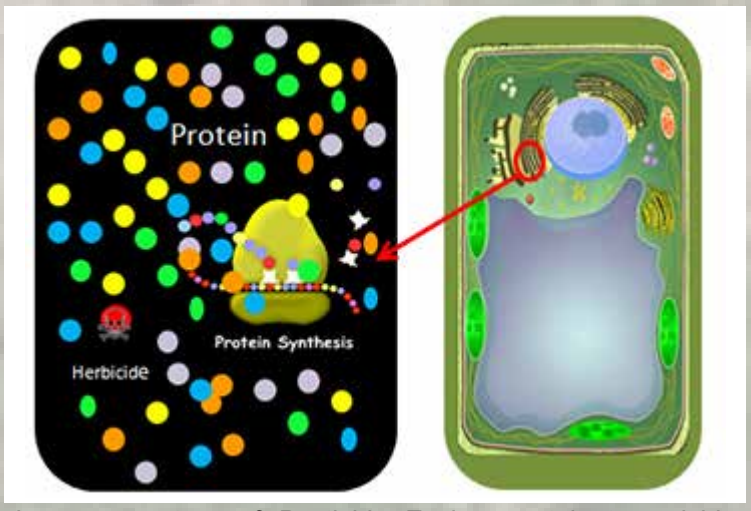
Picture courtesy of Robert Blackshaw - weed control research scientist at the Agriculture and Agri-Food Canada–Lethbridge Research Centre





Images courtesy of Pesticide Environmental stewardship Website

Most of us are familiar with this type of resistance, and it has largely shaped the management practices we have adopted to deal with resistant weeds, but we are now seeing other types that we will need to learn how to deal with. The one most prominent in the news today deals with glyphosate resistant kochia, which is generally the result of something called "**target site amplification**". In this scenario, the plant does not exhibit altered target sites – it simply has the ability to make more and more target sites. The herbicide binds as it should to the target site (in this example below a protein), but once all the herbicide is "used up", the plant still has sites that



Images courtesy of Pesticide Environmental stewardship Website

are not bound by herbicide, so the metabolic processes of the plant will continue and the plant will live to produce seed. With target site resistance, the more effective the herbicide is on the general population, the more quickly a resistant population is selected for; with amplification, lower application rates allow plants with the ability to replicate the target sites to survive and pass their trait on to the next generation. Lab studies have shown that we can "create" predominantly resistant populations in as few as 4 generations by applying rates of herbicides that do not effectively control the population.

There are other ways that resistance can develop. Some plants have the ability to increase their metabolism so that they can detoxify the herbicide before it can kill the plant. Others can "sequester" the chemical, either by physically removing it from the parts of the cell where metabolic activities take place and storing it in the cell wall for example, or by binding it with sugar molecules – making it inert.

So to summarize a somewhat complex and confusing issue – there are many ways that weeds can develop resistance and we need to be aware of what is happening in our fields. Learn to look for the early warning signs and act on them. Too often we look at a questionable result from herbicide applications, attribute them to environment or spraying conditions and go back to the product one more time in the field. If the true problem was weed resistance, the results can be an issue that you will deal with for years. The pictures below show what happens when "we go to the well" one too many times with the same herbicide.

SO WHAT DO YOU NEED TO KNOW?

The Scope of the Problem

- It is estimated that over half of the land in Western Canada produces resistant biotypes of at least one weed species in the field.
- Group 1 resistant wild oats are the number one problem.
- Multiple types of resistance (stacking) is an emerging problem – about 1/3 of the Group 1 resistant wild oats are also resistant to Group 2 herbicides.
- Group 2 resistant cleavers are the fastest spreading problem in Western Canada.
- There is an increase in glyphosate resistant weeds world wide – kochia is the only one recorded to date in Western Canada, but others such as Canada Fleabane can be expected.
- There has not been a new group of herbicide registered in over twenty years – and even if a new one were discovered today **IT WOULD NOT SAVE YOU**!

What people need to understand is that repeating the same practice over and over again on the same land puts selection pressure on a weed population. Whether it is cultivation, hand weeding or herbicides, the population will eventually adapt to what you are doing and find a way around it. A good example of this is in the Philippines where rice paddies that have been hand weeded for over a hundred years have developed genotypes of a close relative to barnyard grass that mimic the characteristics of rice plants; they are often missed when hand weeding and live to set seed. So while a new herbicide group may gain a few more years of weed control without changing management methods, it will not address the long term issue.

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How do we proceed?

Dr. Hugh Beckie, who runs the Saskatchewan Crop Protection Laboratory where they test for resistant weeds, gave the following advice at a conference on Weed Resistance in March of 2016. First and foremost – there is no silver bullet! No new chemistry or single solution is going to appear and make the problem go away. It's too complex and biodiversity in the target population means no one solution will work. With that in mind, here are Dr. Beckie's "Top 10 Best Management Practices" to manage resistance.

- Sound record keeping for herbicides and weeds – monitoring is the key to staying ahead of resistance.
- Strategic tilling – not a popular option these days, but there is a place for it as a management practice.
- Field and site specific weed management - problems usually begin in a field where a few resistant biotypes manage to produce seed and pass on the trait for future years. Irregular shaped "patches" of weeds should not be allowed to set seed if possible.
- Weed sanitation – clean equipment to avoid spreading resistant weeds to new fields and dispersing them there.
- In-crop herbicide rotation.
- Using a mixture of herbicides in sequence in a field. Pay attention to the groups being used pre-seed, in crop, pre-harvest, and post-harvest.
- Scouting prior to spraying to ensure the best herbicide is being used and again after to measure the effectiveness of the application.
- Use crops and practices that help out the herbicide by promoting a competitive field situation that makes it harder for the weeds to thrive.
- Crop rotation diversity – ideally a mixture of spring seeded and fall seeded crops or, alternatively crops with early removal from the field makes it harder for any one type of weed to establish and flourish.

The main thing to remember about managing resistant weeds going forward is that the biggest danger is in providing a stable environment for the weeds in your field. Repeating the same practices over and over allows the population to quickly adapt to the environment. Change up that environment. Do whatever you are able to in order to create a variety of selection pressures on the weeds in the field. This will help maintain genetic diversity in the weed population and slow down the selection pressure caused by herbicides on the population.

Change up that environment.

We are in a unique position in western Canada. We have all the information available to us from the SE United States; where an unvarying rotation of soybeans and corn using glyphosate as the major source of weed control has led to disaster. Dr Jason Noseworthy from the University of Arkansas stood in front of an audience in Saskatoon last winter and told us that he starts most talks to farmers these days with "Roundup was the best weed management tool we used to have". In large swaths of land they are now unable to grow their traditional crops because they have no way left to control the weeds economically. We are still in a position in western Canada to make changes to our management practices that can preserve many of the herbicides we depend upon as useful tools well into the future. However

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that will require the ability and willingness to make changes in how we handle weed control in the future. Unfortunately, human nature dictates that people generally make changes only when forced into them. The example of the southern United States shows us where that path leads as well.

(Yes, there is a corn crop under all that Giant Ragweed!)

Glyphosate Resistant Giant Ragweed (Ambrosia trifida) infesting Roundup Ready Corn. Photo: Dr. Bill Johnson

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