

Weed Resistance to Herbicides

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Since the turn of the century, weed management has been accomplished through the use of mechanical, cultural, biological and chemical means. During the 1940's after World War II, extensive use of the herbicide 2,4-D ushered in the age of selective weed control. Over the past fifty years, herbicide use on cropland and other sites has increased dramatically. The selectivity and activity characteristics of herbicides developed over the past several years has been no less dramatic. We now have herbicides that can effectively remove grass or broadleaf weeds from either grass or broadleaf crops. What is even more phenomenal is that they achieve this at fractions of an ounce per acre. While these advances in chemical weed control are quite beneficial economically and environmentally, there is sometimes a price to pay with regard to weed resistance to herbicides.

Weed resistance may be defined as the inherent ability of a weed to survive a herbicide application to which the original population was susceptible. In other words, plants of a given specie may look exactly alike, however, some plants may have genetic or physiological traits that make them resistant to a given herbicide or herbicide family. The term **biotype** is often used to describe a group of plants within a species that has biological traits uncommon to the population as a whole. These plants can be weeds, as described earlier, or they may be crops, where herbicide resistance has been achieved through selection or genetic transformation techniques.

Many of today's herbicides are effective enough to eliminate entire populations of a given weed specie infesting a field. When this happens, a competitive advantage can be gained by any biotype of this specie that may not be susceptible to the herbicide. Once you remove the "resistant" biotype's competition, by controlling it with an effective herbicide, the resistant biotype will flourish. This concept of competitive advantage is often referred to as "**selection intensity**". Selection intensity is helped by herbicides with long soil residual where susceptible plants are controlled for months.

How does herbicide resistance get started?

In situations where highly effective herbicides have been used, particularly year after year at the same location, there is a possibility of weed resistance showing up. Selection for a resistant biotype may or may not happen, depending upon many factors such as cropping sequence, herbicide use intensity, and herbicide selection. There is not a clear explanation as to where the genetic differences in weed biotypes come from, however, herbicide use itself has not been shown to cause this. It is the general assumption that a small percentage (probably less than 1%) of resistant weeds are present in natural populations. If the selection pressure remains intense, and no other herbicides are used, then these small populations will eventually reproduce and thrive. The result of this is a total lack of control over this specie in the subsequent seasons (*Figure 1*).

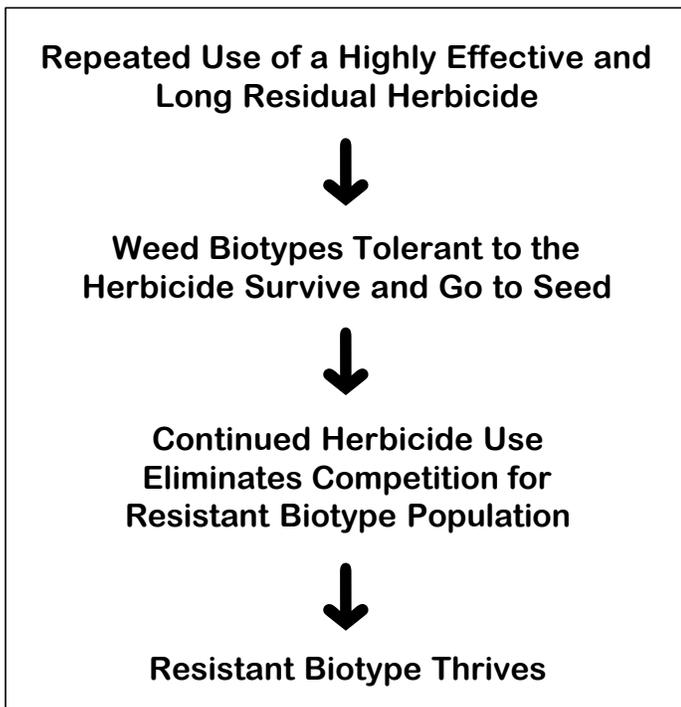


Figure 1. Development of Weed Resistance

Herbicide activity

Herbicides act at different “sites” within the plant to disrupt normal plant processes. The way in which herbicides accomplish this disruption is often referred to as their “**mode of action**”¹. Most herbicides will fall into one of several modes of action, however, they may have many or a single “**site of action**”. In addition, several herbicides may have the same site of action. For some herbicides, however, the exact site or mode of action is still unknown. Herbicides may also have similar chemistry (chemical structure) and therefore similar activity on susceptible plants. Herbicides with these characteristics are often referred to as being in the same **herbicide family**.

If different herbicides acting at the same site of action are used repeatedly, herbicide resistance development may occur quite rapidly. **Herbicide cross-resistance** refers to a weed biotype that has gained tolerance to more than one herbicide. This tolerance can occur with herbicides in the same or different families, and with the same or different site of action.

Herbicide multiple resistance refers to weeds that have developed resistance to more than one herbicide, brought about by separate selection processes. For example, when a weed develops resistance to a particular herbicide, another herbicide is used to control it. If

the weed then develops resistance to the second herbicide, then we can say it has multiple resistance.

After considering the factors previously discussed, we can now draw some conclusions regarding herbicide use characteristics that are often associated with weed resistance development.

Herbicide characteristics conducive to development of weed resistance

- ✓ Herbicides that act on a single site of action.
- ✓ Herbicides that are applied multiple times during the growing season, or that have long soil residual activity, keeping selection pressure high.
- ✓ Herbicides that are used for several consecutive growing seasons.
- ✓ Repeated use of herbicides with the same site of action to the same or different crops.
- ✓ Use of herbicides as the only weed control measure.

Now that we know the circumstances that might result in weed resistance to herbicides, here are some practical approaches for preventing or managing this problem.

Strategies for avoiding and managing herbicide resistant weeds

- ✓ Employ integrated weed management strategies. Use herbicides only when necessary, and combine their use with mechanical, cultural, or biological methods.
- ✓ Rotate herbicide use, utilizing herbicides with different modes of action.
- ✓ If possible, rotate crops where herbicide rotation is also feasible.
- ✓ When planting herbicide resistant crops, limit herbicide applications and employ other weed control methods.
- ✓ Scout fields regularly to determine if resistant weed populations may be present and also to assess the need for herbicide treatment.
- ✓ Clean tillage and harvesting equipment to help eliminate the spread of resistant species.

¹Refer to B-6081 Herbicides: How They Work and the Symptoms They Cause