

# TOP TEN REASONS why your herbicide did not work as expected

By Dr Charlie Reinhardt

**D**espite the best efforts of manufacturers or registration holders of herbicides to provide the best possible products, cases of poor weed control and even injury to crops occur from time to time.

The discussion points in this article are not arranged in order of importance, but number 10 is at the basis of human responsibility, and number 1 is arguably the main natural (biological) reason why we struggle to control weeds effectively.

## 10. You neglected to read the product label, or to apply recommendations/instructions correctly.

Effective weed management begins with the reading, studying, understanding and correct implementation of recommendations and instructions conveyed on product labels. Many complaints and even court cases have resulted from inadequate and wrongful implementation of label prescriptions.

Failure to give the herbicide label proper attention and credibility, can lead to significant economic loss. Regard the product label as a legally binding contract between the manufacturer and/or registration holder of a product and the user.

## 9. Following its application, the herbicide is not where it is supposed to be.

Herbicides can be grouped based on how they are taken up (absorbed) by plants: Application directed at the soil surface intended to make herbicides accessible for uptake by roots of target plants (weeds), and application on plant foliage to allow herbicide uptake through leaves and green stems.

Irrespective of how they are applied, all herbicides sooner or later end up in one or more of the three environmental



compartments – air, soil and water. Numerous natural factors in these compartments influence the herbicides to such an extent, that the prognosis of herbicide activity (herbicidal effect) and persistence of herbicide residues in the environment is complicated.

For any herbicide to be effective, it needs to reach the 'site-of-action' within the target plant. Here the herbicide has one or more 'mechanisms-of-action' through which the target plant (weed) is injured or, at best, killed.

For example, the herbicide glyphosate is taken up through the green or living tissue of plants and translocated to all parts (foliage and roots) where it binds to, and blocks the functioning of, the critically important EPSPS enzyme, thus resulting in injury and death of affected plants.

## 8. Herbicide resistance has evolved over time.

Weeds have the natural ability to gradually evolve or develop resistance to herbicides. Two types of resistance have been identified.

Metabolic resistance is when a herbicide's uptake by certain plants in a particular weed population is less than that of other plants of the same species, and/or herbicide

translocation following uptake is reduced. Another form of metabolic resistance is accelerated neutralisation or inactivation of the herbicide within the plant system.

Site-of-action resistance happens when there is spontaneous (natural) genetic change (mutation) of the target enzyme, e.g. the EPSPS enzyme (the target of glyphosate), with the result that the herbicide can no longer inhibit the enzyme, and consequently the weed with this genetic adaptation survives.

Since poor weed control can be confused with real herbicide resistance, confirmation of resistance can only be done through research conducted under controlled conditions (e.g. glasshouse trials). Main drivers of resistance development are the type of weed and herbicide, use of the same herbicide or herbicide mechanism-of-action without alteration of the latter, and both under- and over-dosing.

## 7. The herbicide or herbicide mixture is not suited for the weed spectrum on a field.

Mistaken identity of weeds can result in inappropriate choice and use of herbicide products, and subsequently

poor weed control. Weeds are sometimes wrongly identified, and in South Africa certain weed species are not listed on any herbicide label, albeit that they occur widely and are serious weeds.

Species within a particular genus can differ significantly in terms of their susceptibility towards herbicides. For example, recent research by Dr Elbé Hugo (2014) revealed that *Digitaria sanguinalis* is confused with *Digitaria nuda*, which has gradually surpassed the former as important grass weed in certain areas of the main maize production region.

She found that *Digitaria nuda* is more difficult to control with grass herbicides than *Digitaria sanguinalis*, which explains why the former tends to dominate on crop fields where they occur together.

#### 6. Environmental factors weakened herbicidal activity.

Several environmental factors influence the amount and rate at which a herbicide reaches its site-of-action within the plant system. For post-emergence applied herbicides, air temperature not only determines spray droplet size and distribution on the target, but also the ability of target plants to absorb the herbicide.

Hot conditions (>30°C) are neither favourable for ideal spray droplet size, nor for optimal uptake through plant foliage. Extremes in temperature, i.e. both low and high, can impede herbicide uptake through both leaves and roots.

Extremes in soil moisture content have a similar effect on soil-applied herbicides. Low soil moisture content reduces the uptake of herbicides by plant roots, whereas overly wet soil can result in excessive herbicide uptake, to the extent that crop injury might occur. Weed plants that suffer environmental stress are likely to respond less to herbicides than unstressed plants that are growing actively.

#### 5. The dosage was cut to save pennies.

The herbicide dosage (litres or kilograms product per hectare) you select only determines the potential amount of herbicide that will reach the site-of-action inside the plant. Dosages appearing on product labels are the result of many years of research and development, and

disregard of dosage recommendations is therefore a seriously perilous human trait!

Under-dosing is likely to result in poor weed control, and over-dosing can cause crop injury and result in carry-over of herbicide residues to a following season. Both promote herbicide resistance.

#### 4. Herbicide application was delayed for too long.

Actively growing weeds are generally more susceptible to herbicides, and young plants are likely to respond more and quicker than older plants. Besides older plants not taking up as much herbicide as younger plants, the herbicide is also subject to greater dilution in bigger (higher biomass) plants compared to smaller/younger plants.

Therefore, weeds that are at an advanced growth stage, in particular at flowering, are more likely to survive treatment compared to plants treated timeously and in accordance with label recommendations. The dilution factor in plants having high biomass is equitable with under-dosing.

#### 3. New cropping practices affected herbicide activity.

Conservation agriculture (CA) has made sustainable agriculture achievable. However, we should be cognisant of how CA, particularly zero-tillage practices, changed soil characteristics that determine the behaviour and fate of pesticides, including herbicides.

A key attribute of zero-tillage is increased carbon content of soil, specifically the humic fraction. This colloidal fraction (particle size <1 micron) of soil is far more important than clay content in determining the strength of herbicide retention on soil particles, and thus the amount of herbicide available for uptake by plant roots.

Therefore, soil-applied herbicides are likely to be less efficient in soil in which organic carbon content has increased significantly, with clay content remaining stable. In South Africa, soil-applied herbicide dosage recommendations are generally based on soil clay content alone.

Increased soil organic matter content

also stimulates microbial activity. Most soil-applied herbicides are prone to microbial breakdown, therefore high microbial activity will contribute further to the reduction of herbicide uptake and activity in zero-tillage systems.

Furthermore, dense 'trash blankets' (organic mulch) on the soil surface can, temporarily at least, trap soil-applied herbicides that must reach the soil in order to be activated.

#### 2. Your herbicide sprayer is not in good working order.

No matter how expensive and modern the spraying equipment is, it is delivery of the optimal herbicide dosage in ways that allow a critical concentration to reach the site-of-action within the target plant that ultimately determines whether weed control is effective or not. Obviously, all parts of spraying equipment must be in good working order, and not only certain parts of it.

#### 1. Weed pressure is high due to high seed numbers.

Weeds are especially adept in the ways their seeds are distributed and able to survive under extreme conditions for months, years and even decades. Be mindful of the fact that with high numbers of weed seeds in the soil seed bank, even 90% weed control may appear as if the herbicide was ineffective, because the 10% of plants not controlled represent unacceptably high weed numbers.

Ten million weed seeds per hectare in the soil seed bank represents 1 000 seeds per square meter. If 90% of those fail to develop into plants due to herbicidal action, the remaining 100 seeds (10%) can produce 100 weed plants per square meter, which is a very conservative estimate of the real situation on most crop fields. Hence, best practice is to prevent weeds from setting seed. 🌱

Dr Charlie Reinhardt is dean of the Villa Academy and extraordinary professor of weed science at both the University of Pretoria and Stellenbosch University. Contact him at [creinhardt@villaacademy.co.za](mailto:creinhardt@villaacademy.co.za) or 011 396 2233.