

## **Herbicide Crop Injury Mechanisms and Routes of Exposure.** *Brad Hanson, UC Cooperative Extension Specialist, UC Davis*

Herbicides can provide an amazing level of weed control in many situations; however, they can also cause unexpected crop injury in some cases.

A great deal of research goes into developing herbicide uses for labeled crops to ensure rates and use patterns will allow good crop safety and performance. In labeled crops this may be due to an inherent tolerance, timing or placement of the herbicide relative to the crop, or herbicide safeners. In non-labeled crops, safety is usually achieved through separation in time (e.g. rotation crop restrictions) or in space by using buffer zones or application techniques to mitigate drift.

When crop injury occurs, it typically is due to either a foliar route or a root uptake route. The effects of foliar exposure can be very dramatic when applied directly to a sensitive crop (wrong herbicide, wrong field) or from mixer/loader errors such as a rate miscalculation or sprayer miscalibration. In situations with lower margins of safety, injury can also occur from excessive spray overlaps or use of “hot” surfactants. In-field foliar exposure problems can also be less dramatic and variable such as in the case of low doses due to sprayer contamination or drift from poorly set up spray booms. Usually, these scenarios don’t have a clear pattern in the field or may be associated with sprayer tank loads if a loading mistake.

Foliar exposure can also happen from drift onto a sensitive crop from an adjacent field, field margin, or neighboring area. This can be dramatic or subtle and is due to direct movement of spray droplets out of the targeted area before they ever reach the soil or foliage. A few herbicides are somewhat volatile and can move in the vapor phase after deposition on the target. This is more common under moist warm conditions and is generally limited to only a few herbicide active ingredients. Importantly in most cases of drift, either as droplets or volatiles, there will be some sort of pattern in the field. Because the dose will be higher nearest the source of the drift, often a gradient of injury is visible and gets less dramatic further from the source area.

Herbicide injury from root uptake is usually due to something done in that field, not due to neighboring field operations. Herbicides can be in the soil due to an application in a preceding crop persisting at too high of a level for the next crop in the rotation. Planting a sensitive crop too soon after a long-residual herbicide is one factor that can contribute to this type of exposure. Excessive application rates or slower-than-expected dissipation rates can also contribute to injury in this scenario. Another route of crop injury caused by herbicide soil exposure is from herbicides used in that crop but being incorporated too deeply, either mechanically or by excessive downward movement with irrigation or rain water. Depending on the situation, this type of injury can range from patchy and sporadic to fairly uniform across the field and have a wide range of severity. When patterns of injury are noted, it sometimes can be associated differences in soil, water, or application rates in areas of the field.

When trying to diagnose herbicide symptoms on any crop, it's important to think about how they work (mode of action), how they move in soil or plant tissue. This information can provide important clues as to expected symptoms, timeline, and duration of injury. Remember that symptoms can vary widely depending on the crop species, part exposed to the herbicide, the dose/rate of exposure, and the time since exposure. Additionally, many biotic and abiotic disorders can be confused with herbicide injury so it's important to avoid jumping to conclusions.

When in the field, take good photos of the symptoms and include both overviews and close-ups. Describe the timeline of events and symptom development on crop and non-crop plants. Question the growers and advisors about herbicides and other practices used at the site in question as well as think about the weed control practices used in surrounding areas. Look for patterns in the field – these can be especially important in diagnosing application errors or soil issues and may reveal other cultural practices that can cause crop damage.

Finally, symptomology can never be fully diagnostic of herbicide injury – when in doubt, collect leaf and tissue samples and freeze in case it becomes necessary to confirm herbicide exposure through laboratory analyses.