

Integrating Weed Management in California

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RR cotton was the first genetically engineered herbicide tolerant crop used in California. The acreage of herbicide tolerant cotton has increased dramatically in the United States. They account for approximately 95 percent of the cotton in other cotton-producing states; whereas, in California RR cotton is grown on approximately 50 percent of the upland and 85 percent of California Pima cotton. The acreage of herbicide tolerant cotton will likely continue to increase as higher yielding varieties are developed with these traits and as genetically engineered crops with resistance to more than one herbicide are developed.

RR technology has provided growers with an excellent tool for managing most annual and perennial weeds, including weeds such as nightshades, annual morningglory, and nutsedge. Before the adoption of RR cotton, purple and yellow nutsedge were widespread problems in California cotton fields and existing control measures were only marginally effective at best. Using a combination of glyphosate and cultivation, now nutsedge is seldom a serious problem. Additional advantages of this system include the following: Glyphosate can be applied post emergence so growers can delay application to observe the weeds present and their density. There are no plant-back restrictions. This technology has allowed growers to reduce tillage operations and experiment with ultra-narrow row systems. Cost savings from RR technology typically range from \$25 to \$200/acre.

Concerns have already surfaced in California regarding reduced control of barnyardgrass, sprangletop, pigweed, and lambsquarter with continual use of RR systems. Amaranth species (pigweed) is becoming more difficult to control. Volunteer RR corn in RR cotton is now a major problem. Resistance management will become a greater part of our production systems. Sprangletop, palmer amaranth, horseweed, and hairy fleabane have now infested most canals, roadsides, and field edges throughout the San Joaquin Valley. In some cases these weeds are beginning to encroach into cotton fields. Liberty Link systems that use Rely 280 (glufosinate) are being used on a limited basis on upland seed fields.

Even if growers use an herbicide tolerant system, it is still advisable to use a preplant incorporated herbicide in cotton. The cost is low (\$6-\$8/A) and these herbicides control most annual grasses and many broadleaves. Rotating glyphosate or tank mixing with ET, Chateau, Diuron, Shark, or Rely is an effective way to control annual morningglory at layby. Ultimately the decision of which herbicide tool(s) to use and how to integrate different herbicides into the weed management system will depend on their cost and effectiveness. The solution is to avoid using a single approach.

When RR cotton was the only glyphosate tolerant crop in California, crop rotation in itself was usually enough to avoid problems with weed shifts or resistant weeds. However, now with the commercialization of other glyphosate-tolerant crops like RR corn, cotton, and alfalfa the potential for the evolution of herbicide resistant weeds is greater. The more crops relying on glyphosate for weed control the greater is the selection pressure. A major concern for an increase in GR weeds is that cotton is often rotated with RR corn and often RR volunteer corn becomes a problem in RR cotton or vice versa. In addition, there has been considerable interest in reduced tillage corn, a system that relies on glyphosate for weed control. A crucial component of no-till corn production should be effective weed management.

Corn growers have access to a variety of different herbicide programs due to the sheer number and effectiveness of herbicides registered for use in corn. Despite the abundance of available herbicides for conventional corn, the RR system continues to gain popularity because it is the easiest to use in terms of weed management, especially when tillage is completely eliminated or reduced. Most no-till corn growers who use the RR system do not use a pre-emergence herbicide, preferring instead to rely on over-the-top applications of glyphosate, often alone but sometimes in tank mixes with 2,4-D, dicamba, halosulfuron (Sempra) or in conjunction with separate treatments of these herbicides. As a result in RR corn where glyphosate-alone is used GR jungle rice, pigweeds, and RR alfalfa is becoming a common problem. Corn growers using dairy manure to fertilize fields need to be particularly diligent to stay on top of weed control. Some tillage once in a while, combined with use of herbicides with a different mechanism of action, may be necessary for effective weed control especially where dairy manure is applied to fields.

Effective Farmstead Weed Management

Sound stewardship practices to avoid weed shifts and the evolution of herbicide-resistant weeds is not restricted to weed control practices within the actual crop fields. As mentioned earlier, many of the GR weeds did not evolve in agronomic crop fields themselves. Instead many evolved in non-crop areas or orchards and vineyards and subsequently invaded crop fields. Many of these annual weed species are dispersed by wind and/or water and can therefore easily move from field borders and fence-lines into cropland. For example, sprangletop, horseweed, and hairy fleabane have now infested most canals, roadsides, and field edges throughout the San Joaquin Valley and in many cases these weeds are now encroaching into crop fields. Growers should be more diligent in their weed control practices and be sure to control weeds along field edges and border areas using mechanical practices or other effective control measures. It is imperative for growers to have a lower tolerance threshold and control weeds around fields so that these herbicide-resistant biotypes don't get a foothold in crop fields.

Summary

A sound approach to resistance management must incorporate crop and herbicide rotation and control of weed escapes through tillage or hand weeding. An integrated weed

management system supplements an existing transgenic or conventional weed control program and uses a variety of the available pre-plant, selective over-the-top and layby herbicides along with tillage. Although herbicide tolerant crops provide an easy-to-use and effective tool, it will continue to be necessary to use a range of weed management strategies in the future to economically and effectively control weeds and prevent to the greatest degree possible weeds from building up in the seed bank to infest future crops.