

## Weeds in Paradise: The View from the Farm

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This topic is not an easy one to address for several reasons. First, what is *Paradise*? Is California *Paradise*, or for that matter has California ever really been a *Paradise*? Secondly, presenting “the view from the farm” from a statewide perspective is challenging, especially for someone who lives at the very northern edge of the state. Without a doubt California has the most diverse (and the most productive) agriculture in the country. In fact, greater diversity exists within California alone than occurs in most other countries. Evaluating the status of agriculture in relation to weeds for the entire state is a daunting task.

A logical first step to present this topic is to consider the meaning of the word *paradise*. The Merriam-Webster dictionary defines *paradise* as: **1 a : EDEN 2 b : an intermediate place or state where the souls of the righteous await resurrection and the final judgment c : HEAVEN 2 : a place or state of bliss, felicity, or delight.**

While California is probably one of the better places to live and farm from many people’s perspective, the word *paradise* is not an accurate description—especially taking into account current conditions California farmers confront. However, the truth is California probably never was *paradise*. On the other hand, it is undeniable that California has a nearly ideal combination of weather and soils that make it the leading state in the nation for agricultural production. With these favorable environmental conditions, weed populations thrive as well and weed control is a continual battle for crop producers. Are we making headway in the battle with weeds or are the weeds getting the upper hand?

When Program Chair Carl Bell asked me to make this presentation, the specific questions he wanted addressed were:

- 1. What is the status of weeds in crop Ag? Are they getting better or worse?**
- 2. How is the crop Ag business doing overall?**
- 3. Is there a crisis ahead or just more of the same?**
- 4. Is CA still paradise even with the weeds?**

To answer these questions from a broader perspective, I contacted several UC colleagues from throughout the state. I wish to acknowledge the assistance I received from Oleg Daugovich, Steve Fennimore, Kurt Hembree, Tom Lanini, Richard Smith, Rob Wilson and Steve Wright.

Weed science is a constantly evolving discipline and major advances continually surface to better enable farmers to manage weeds in crops. Whether weed problems are being resolved or getting worse depends to a large degree on the commodity and the availability of herbicides. Regardless, weeds are amazingly adaptive. It seems we solve one problem and another arises. No new technology is a panacea and typically comes with some kind of a price. The initial problem may be solved but oftentimes another one is created. This is apparent in some of the advances described below.

### **Weed Management Status in Agronomic Crops**

Generally speaking most weed problems in agronomic crops have lessened. Several herbicides were released over the last decade that have either broadened the spectrum of weed control or made weed control easier to achieve. Just a few of the relatively recent advances are described below. Raptor (imazamox) has had a major impact on weed control in seedling alfalfa. It is broader spectrum than the previous standard treatments controlling a wide array of both broadleaf and grassy weeds. Previously registered herbicides for use in seedling alfalfa typically controlled broadleaf weeds or grasses but not both. Fiddleneck has long been a significant problem in small grains. A relatively new herbicide, Shark (carfentrazone), has provided an economical and effective way of controlling broadleaf weeds in small grains. In addition, registrations for Puma and Osprey have made it possible to control problematic grassy weeds such as wild oats, canarygrass and ryegrass in cereal crops. Nightshade is much easier to control cotton now with Staple herbicide significantly reducing hand labor. Corn has had a large arsenal of herbicides with Eradicane, Duel, and Lasso controlling most weeds as a preplant incorporated treatment, and dicamba and 2,4-D controlling most broadleaves post-plant directed. Two new corn herbicides have improved control of some troublesome weeds; Sempra (halosulfuron) for control of nutsedge and Accent (nicosulfuron) for control of Johnsongrass.

Without a doubt the most significant breakthrough in weed control in agronomic crops in the past decade has been the development and commercialization of transgenic herbicide-resistant crops. Glyphosate resistant cotton, corn and now alfalfa are commercially available. Roundup resistant corn and more recently alfalfa are also now available. These crops have already or are expected to have an enormous impact. The adoption rate for this technology has surpassed expectations. In most cases it has simplified weed management and improved broad-spectrum control of both annual and difficult-to-control perennial weeds—all while virtually eliminating crop injury. In addition to improved weed control, this technology has made it possible to grow ultra narrow-row crops and has facilitated reduced-till and no-till systems. This technology has resulted in less tillage, with a concomitant fuel savings, and a significant reduction in costly hand labor. For example, hand weed labor in crops like cotton has gone from \$100-200 per acre down to approximately \$50 per acre.

As mentioned above, there are some risks or downsides to some of these technological advances. For example widespread damage from Shark drift occurred in the Central Valley resulting in application restrictions. Some of these new herbicides are so effective that many growers rotate less, an example being an endless rotation of small grain forage and corn. The fields often receive considerable applications of non-composted manure and now have serious problems with stinging nettle and canary grass. Because of the effectiveness of current small grain herbicides, grain growers in some dryland areas grow grain continuously and have moved away from sound cultural practices resulting in new weed problems.

Herbicide resistant crops are believed by many to be the silver bullet when it comes to weed management. Even though these are cost effective tools and a great benefit to growers, this technology is not without risks. The primary concern is the occurrence of weed shifts and weed resistance. The Roundup Ready weed control system is so effective and easy that it can make growers complacent in their weed control practices facilitating the evolution of weed shifts and resistance. Two weed species already have documented resistance to Roundup in California—annual ryegrass and marestail. Neither of these cases is the result of growing a transgenic crop but increased continual use of Roundup with transgenic herbicide-resistant crops increases the likelihood of weed shifts and resistance. Roundup-resistant ryegrass was first found in California orchards where there was a long history of continual Roundup use. Roundup resistant marestail originated in the southern San Joaquin Valley of California in orchards, vineyards, and ditch banks where tillage was no longer used and Roundup was used continuously for several years, oftentimes with multiple applications per season. Roundup-resistant crops have provided growers with an easy-to-use, low-cost, and effective weed management program but its effectiveness may be reduced in the long term if it is not used wisely. The key is to reduce selection pressure by not relying on a single herbicide repeatedly for weed control.

### **Weed Management Status in Vegetable Crops**

With a lower tolerance for weeds and fewer herbicide registrations, weed control in vegetable crops has been more challenging compared with agronomic crops. Matrix (rimsulfuron) in tomatoes and Sandia (halosulfuron) in tomatoes, peppers and cucurbits has improved control of nightshades and nutsedge. Overall, however, new herbicide registrations for vegetable crops have been few and far between because of limited market potential and higher risk of liability. In fact, most of the new registrations are not new chemistry—rather a new use for old chemistry. For example, there is a 24(c) for Prowl H20 (pendimethalin) in onions and a 24(c) registration is expected for GoalTender (oxyflurofen) for onions at the one leaf stage. This early application will help growers significantly with early-season weed control. GoalTender has other new uses as well such as over-the-top applications on broccoli and other cole crops. It has also proven useful in strawberries to control mallow, filaree and at the highest use rates clover—all weeds with hard seed coats typically not controlled by soil fumigation. Another older herbicide, Stinger (clopyralid), has received registration for use on cole crops. A 24(c) was also granted for the

use of Kerb (promamide) via chemigation for mustard control in fall lettuce in Fresno, Imperial and Riverside Counties. Work is underway to develop data for coastal vegetable production areas. Dual Magnum (s-metolachlor) has been beneficial in spinach, celery and tomatoes, especially for nutsedge suppression.

One of the most significant advances, or at least changes, has been the shift to buried drip irrigation in vegetable crops (tomatoes primarily). It has resulted in reduced weed emergence, since there is less surface soil moisture. The downside of this change is that herbicides that require irrigation for incorporation are rendered ineffective (or only partially effective).

Fumigants play a large role in weed control in many high value vegetable crops. There has also been a move toward 80 inch beds for some vegetable crops, which presents additional challenges for weed control and greater reliance on preplant fumigation. However, the phasing out and use restrictions imposed on methyl bromide are going to have a major effect on weed control in some crops. Strawberries are a prime example, and weeds like yellow nutsedge will be far more difficult to control. Use of other fumigants is expected to become more problematic as well due to VOC restrictions, buffer zone requirements, and the fact that some neighbors will no longer tolerate them.

Organic food, primarily produce, is an ever increasing market. The organic food market has grown by approximately 20 percent each year from 1997 to 2005. While this is still a relatively small share of the entire market (organic production accounts for only about 1-2 percent of total food sales in the US in 2003), it is becoming increasingly important. Weed control in an organic system is especially difficult to achieve and costly. A shortage of labor for hand weeding, tighter restrictions on hand weeding, and increased cost (minimum wage increases) has made hand weeding even less attractive.

The time may be ripe for the adoption of precision guidance systems for cultivators and intelligent sensing systems for precise application of herbicides. There could be significant developments in computer assisted weeders (such as split knife system for tomatoes and the weed recognition system developed by Dave Slaughter with UC Davis Biological & Agricultural Engineering Department). Although this technology will be expensive, the lack of herbicides and increased cost for hand weeding may make this technology a viable option. The move to transplants may also open options for other herbicides or weeding techniques.

### **Weed Management Status in Tree and Vine Crops**

There have been more new herbicide registrations for trees and vines than for vegetables. Chateau (flumioxazin) has made major inroads in the tree and vine market and has been effective for controlling some of the more difficult to control weeds in these perennial crops including fleabane, maretail and malva (cheeseweed). Visor (thiazopyr) also gained registration for

nonbearing bearing orchards and for bearing citrus. Rely (glufosinate) received registration for grapes and many orchard crops and, like Chateau, controls marestalk. Shark (carfentrazone) was the most recent new herbicide registered for bearing and nonbearing trees and vines.

Weed management in trees and vines seems to be largely dictated by commodity prices. When the prices are profitable, weed management improves, but when commodity prices are poor weed management becomes a lower priority. This creates a buildup of the weed seed bank thus causing future problems. Many growers rely primarily on postemergent sprays with Roundup. This often results in less than perfect weed control. Timing is important but is often problematic in wet years. Hairy fleabane has been one of the most difficult weeds to control. Ground Water Protection Area (GWPA) regulations with limitations due to soil type have prevented some of the important preemergent herbicides (simazine, diuron, bromacil) from playing a stronger role like have in the past.

### **Agricultural Profitability**

One of the issues Program Chair Carl Bell asked each of us to address in this series on Weeds in Paradise was an overall assessment of the profitability of the industry we represent. This is nearly an impossible task with the diversity of commodities represented in the agricultural sector. Profitability is extremely crop specific.

As always, there have been tough times in some markets while other commodities have fared well. The standouts have probably been almonds and walnuts. Grape prices are still fairly low and peaches and nectarine prices have been mediocre. Cotton, sugarbeets and beans have all lost acreage over the last few years. Alfalfa has remained at over a million acres as prices, while not the record prices we saw the previous year, have still been strong. Vegetable markets continue to be volatile with the biggest news being the food safety concerns related to E. coli and the devastating effect it had on the spinach market. The state's \$258.3 million spinach industry came to a screeching halt, as growers plowed under fields and worked with health officials to determine the source for the contamination.

There is no doubt that weeds are a significant problem and keeping them under control is a major cost for producers. I do not wish to minimize their importance, but frankly in my opinion there are other issues that are far more threatening to the future viability of farming in California than weeds. The increasing costs of farming in California make it difficult to compete. Imports from China and other countries are, and will likely remain, an issue. The availability of labor and the cost of labor with the increase in minimum wage are major concerns. High fuel costs and their effect on the cost of other inputs greatly increase the cost of doing business. Because of the slim profit margins for most agricultural enterprises, "start-up" farms rarely survive past 2 or 3 years. Family farms are consolidating and getting bigger to remain competitive. Even the big farming companies are consolidating into bigger ones. High value crops push out the lower

values crops as land becomes more expensive. Farm acreage continues to be devoured by urban sprawl as profits from selling the land far exceed the potential income from farming.

Existing and pending regulations and how they are enforced are major concerns for farmers. At times the list seems endless. The Endangered Species Act can affect all aspects of farming and resulted in complete withdrawal of irrigation water in the Klamath Basin in 2001. Water availability in the future is tenuous and farmers fear the next drought year and what it might bring in terms of water for agricultural production. The federal Clean Water Act and Ground Water Protection Area Regulations can have a significant impact on farming practices and how we control weeds. Similarly, air quality regulations related to drift, agricultural dust (especially particulate matter of less than 2.5 microns in size), and required reductions in Volatile Organic Compound (VOC) Emissions will have a major impact. The major pesticide contributors of VOC's are fumigants and pesticides with emulsifiable concentrate (EC) formulations. These regulations will shape how we do business and control weeds. The degree to which these regulations will impact profitability, production practices and specifically weed management has yet to be seen.

### **A Crisis Ahead?**

Is there a crisis ahead in the crop agriculture industry when it comes to our ability to control weeds? It depends on what you consider a crisis. Crisis is probably too strong a word, but there is absolutely no question that there are significant challenges ahead. The rate of herbicide development has slowed markedly since the golden era of herbicide discovery in the 70's and early 80's. The cost to bring a new herbicide to market has been quoted by some to be \$187 million (research and development, regulatory costs, toxicology studies, residue and soil dissipation studies, etc.).

The development and overwhelming popularity of herbicide tolerant crops, primarily the Roundup Ready technology, has stifled research and development on new herbicide chemistry. With herbicide development costs so high, there is little incentive for manufacturers to develop truly new products when the remaining market share is so small. This is especially a problem for vegetable crops where it is questionable whether herbicide tolerant crops will ever be commercialized and the industry relies on chemistry developed for the major agronomic crops eventually trickling down to the vegetables. With fewer herbicides available and a greater reliance on single herbicides (like glyphosate), weed shifts and weed resistance will become increasingly prevalent. When the profit margin declines, so does a grower's willingness and ability to spend for weed control. Growers cut cost by using less expensive herbicides and/or reducing hand weeding.

Weeds have always been and will continue to be a challenge for farmers and crop protection professionals. Through the development of improved technologies and diligence on the part of

farmers we have dealt with weeds in the past and will continue to do so in the future. There are still growers willing to take risks, and to remain profitable they will take higher and higher risks. We, as crop protection professionals, researchers and educators, need to be right there with them. I am reminded of a quote by Lou Holtz, one of the winningest college football coaches. Life is ten percent what happens to you and ninety percent how you respond to it. A lot is going to happen to us in agriculture over the coming years. We need to be proactive and innovative in our approach to the challenges that await us.