

Avocado Weed Management

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Glyphosate, the active ingredient in RoundUp® herbicide has been an avocado grower's go-to weed management tool for decades. However, to quote Bob Dylan, "the times they are a-changin'." The court of public opinion, as well as several courts of law, have decided that RoundUp® is public enemy number one. At least 34 California cities – including ag powerhouses like Fresno and Watsonville, and avocado producing areas like Irvine and Carlsbad – have taken some level of action against RoundUp®, from outright bans on city-managed property to reviews of the chemical's safety.

That said, RoundUp® is not the product it used to be. When it was first introduced in 1974, the common belief was that plants could never develop resistance to the unique mode of action of RoundUp®. But every grower knows that isn't the case, and many weed species have developed some tolerance, if not outright resistance, to RoundUp®.

One of the authors had a weed science professor at Cal Poly San Luis Obispo many years ago who was apparently close to retiring and didn't want to write a new exam to address products coming to market. Instead, he wrote on the chalk board, "RoundUp® is not the answer to any of these questions." And he was known for telling his students, "No matter what you kids think, RoundUp® is not always the answer." His warnings proved prophetic!

California's arid climate guarantees only the strongest of weeds survive. If a weed is tolerant to glyphosate and its neighbors are not, the tolerant weed becomes the dominant weed due to the lack of competition. We have always had mareastail and pig weed, but as these species have developed glyphosate resistance, they are now all you see in some groves.

Although there has been no action taken officially at the California state level to withdraw the registration for glyphosate, growers need to be prepared for that eventuality. So, let's review your weed management options.

Mechanical Weed Control

If you are lucky enough to be on relatively level ground, mowing is an option. Make sure the ground is dry enough so you do not move disease (e.g., *Phytophthora* root rot) or cause soil compaction. Be cautious, as mowing can be difficult to do without disturbing leaf litter that is so important as mulch to our shallow rooted trees. "Weed eating" is also an option but is slow and labor intensive, and cut weeds grow back. There are various flame weeders on the market as well, but they are generally not recommended in our dry climate.

Mulching can be considered a means of mechanical weed control because the thick layer of mulch keeps most weed seeds from germinating. The key to a good mulch cap is to keep it thick enough to keep sunlight off the soil – 3 to 4 inches is the standard recommendation – and never pile mulch up against the trunk of trees, keep it back at least 6 to 12 inches, especially on young trees. Be sure you are getting your mulch from a reputable source to ensure it is disease free. Use mulch that is screened and that has been piled to generate heat and kill weed seeds. Note that mulch is not compost. Mulch should be composed of relatively large chunks that will allow air and water to penetrate through to the soil surface and feeder roots. Avoid the "free" yard waste available from many municipalities that is mostly lawn clippings. This mulch breaks down quickly and is often loaded with weed seeds and lawn chemicals you do not want in your grove. See "Dispelling the Myths of Mulch" (Californiaavocadogrowers.com/cultural-management-library/dispelling-myths-mulch) for more information.

Chemical Weed Control

Currently, there are 143 herbicide products registered in California for use in avocado groves; 54 of which are some form of glyphosate. Another 18 products contain paraquat (Gramoxone®) or diquat (Diquat 2L®), which will be dis-

cussed later in this article. In total, the 143 registered herbicide products represent 18 different active ingredients (see accompanying table). Of these 18 active ingredients, eight are for use only in non-bearing groves, which we will not discuss in this article. Take out glyphosate and paraquat, and you are left with eight active ingredients that can be used in bearing avocado groves, two of which are organic products, and two of which, although labeled, are impractical.

Glyphosate is the only systemic herbicide that is registered for food crops. Once glyphosate is inside the weed it is only a matter of time until the weed dies from the roots up. But to be effective, glyphosate must be absorbed by the plant. A plant like mustard – with its tiny little waxy leaves, prickly trunk and yellow flowers – does not absorb anything. Standard applications of glyphosate do not work for this type of plant. You spray it this year, next year you have more yellow mustard. This is one of the reasons weeds that do not take up glyphosate are now taking over groves. Statewide we have different species of weeds that are becoming “super weeds” because of overuse of glyphosate.

Thus, the remaining post-emergence herbicides are contact “burn down” products, such as paraquat. These products do exactly what the name implies, they chemically burn any part of the weed that the product contacts. These were commonly used before glyphosate became the go-to cost-effective tool. Burn downs often will kill a young weed that is not well established but only will knock back an established weed. Think of these products as “chemical mowers.” Knock the weed down, get some rain and it’s back.

As an industry, we need to re-learn how to apply burn downs; there’s an

Herbicide active ingredients registered for use in avocados in California.^a

| Active Ingredient | Trade Name ^b | REI/PHI ^c | Signal Word ^d | Comments |
|---|-------------------------|----------------------|--------------------------|--|
| Ammonium nonanoate | Axxe | 4 hr/0 day | Warning | Organic |
| Prodiamine | Barricade | 12 hr/0 day | Caution | Non-bearing only |
| Sodium salt of bentazon | Basagran | 48 hr / 1 yr | Caution | Non-bearing only |
| Flumioxazin | Chateau | 12 hr/1 yr | Caution | Non-bearing only; do not apply within 2 months of planting; trees < 1-year-old must be protected with non-porous wraps |
| Diquat dibromide | Diquat | 24 hr/1 yr | Warning | Non-bearing only |
| Fluazifop-P-butyl | Fusilade | 12 hr/1 yr | Caution | Non-bearing only |
| Isoxaben | Gallery | 12 hr/1 yr | Caution | Non-bearing only |
| Oxyfluorfen | Goal | 24 hr/0 day | Warning | |
| Paraquat | Gramoxone | 24 hr/0 day | Danger | Restricted use |
| Sethoxydim | Poast | 12 hr/1 yr | Warning | Non-bearing only |
| Simazine | Princep | 12 hr/0 day | Caution | Do not apply within 1-year of planting; 1 application per year max |
| Glyphosate | RoundUp | 4 hr/14 day | Caution | |
| Pelargonic acid and related fatty acids | Scythe | 12 hr/24 hr | Warning | |
| Carfentrazone-ethyl | Shark | 12 hr/0 day | Caution | Apply at least 1-day pre-planting |
| Trifluralin & Isoxaben | Snapshot | 12 hr/1 yr | Caution | Non-bearing only |
| Norflurazon | Solicam | 12 hr/60 day | Caution | Do not apply within the first 6 months after planting; do not replant within 12 months of application |
| Caprylic acid | Suppress | 24 hr/0 day | Warning | Organic |
| Oryzalin | Surflan | 24 hr/0 day | Caution | ½-1-inch of rain/irrigation required for activation |

^a Data are based on a search of the Agrian database on May 14, 2019 and are accurate as of that date. Growers are reminded that the label is the law and all label guidelines must be followed when using any ag chemical.

^b Trade names are provided as examples only and do not constitute an endorsement of any product.

^c REI = Restricted-entry interval is the period of time after application when entry into the treated area is restricted; PHI = Preharvest interval is the wait time between when a product is applied and when the crop can be harvested.

^d Signal words are found on product labels and they describe the acute (short-term) toxicity of the formulated product. CAUTION means the product is slightly toxic, WARNING means the product is moderately toxic, and DANGER means the product is highly toxic.



Hairy fleabane.

entire generation of growers and farm managers who've never known a world without glyphosate. When discussing ag chemical efficacy, you often hear the phrase "coverage is key," but with glyphosate about 30 percent coverage of a susceptible weed provided good kill because it's a systemic product. In comparison, contact herbicides need good coverage and higher volumes than glyphosate, maybe as much as 250 gallons per acre for good control.

In addition to the downfall of glyphosate, paraquat is impractical to use. The chemical is extremely toxic to humans with no known antidote and is a restricted use chemical. New regulations will be going into effect no later than November 1, 2019, that will further restrict paraquat's use. These new restrictions include the requirement that anyone applying paraquat be a certified applicator; applicators no longer will be allowed to work under the supervision of a certified applicator. In addition, paraquat applicators will need to take the Environmental Protection Agency's paraquat training and exam, passing the exam with a 100 percent score. Retraining and examination will be required every three years. Paraquat also is required to be mixed in a closed mixing system. Although these changes take effect November 1, some changes may start to appear on product labels sooner, so if you use

paraquat be sure to review the product label and follow all restrictions.

Norflurazon (Solicam®) is another herbicide that is impractical in avocados due to the 60-day preharvest interval (PHI). Oryzalin (Surflan®) is likewise impractical because it requires ½ to 1 inch of rain or irrigation for activation. In a wet winter like the one we just had, you may be able to make the timing work, but in most years that won't be the case. And irrigating oryzalin in is impractical since microsprinklers only irrigate the area under a tree's canopy, where weeds tend to be shaded out, and not the row middles where the weeds grow.

This leaves a total of six herbicides for use on bearing avocados: ammonium nonanoate (Axxe®), Oxyfluorfen (Goal 2XL®), sethoxydim (Poast®), pelargonic acid and related fatty acids



Sow thistle.



Marestalk (horseweed, left) and hairy fleabane (right) rosettes.

(Scythe®), carfentrazone-ethyl (Shark EW®) and caprylic acid (Suppress®).

Ammonium nonanoate and caprylic acid are both organic certified broad-spectrum contact herbicides. They have no residual activity and are relatively expensive to apply because they are applied at higher concentrations (up to 15 percent for ammonium nonanoate, and 9 percent for caprylic acid) compared with many conventional herbicides. Pelargonic acid is a similar product to the previous two chemistries, but never received organic certification.

Oxyfluorfen is primarily effective against broadleaf weeds, such as marestalk and pigweed, but also has efficacy against some grass species. Sethoxydim is only effective against annual and perennial grass species.

Carfentrazone-ethyl is a broadleaf specific herbicide that some growers are finding good success with. Timing is critical with this product; it is only effective if weeds are sprayed at the right stage of growth. Some growers are finding good success with a tank mix of carfentrazone-ethyl and glyphosate. However, you must keep in mind when tank mixing that the restricted entry interval (REI) and PHI will be for the chemi-

cal with the greatest restriction, so a tank mix of carfentrazone-ethyl and glyphosate will have a 12 hour REI and a 14 day PHI.

No matter how many options we review in this article your weed problem is specific to your grove. Young trees, old trees, high density, low density, yellow mustard, Russian thistle, pigweed, marestalk, we all have different challenges that need different solutions.

The Future of California Avocado Weed Control

Your California Avocado Commission Production Research Committee has been looking for alternatives to glyphosate. We have been working with weed scientists to give us some safe economical options that work well. This includes seeking proposals for screening trials to look at new chemistries as well as possible tank mixes of existing chemistries to improve efficacy.

The old professor was right, RoundUp® is not the answer to everything. 🍌

All photos by Lynn M. Sosnoskie, University of California.