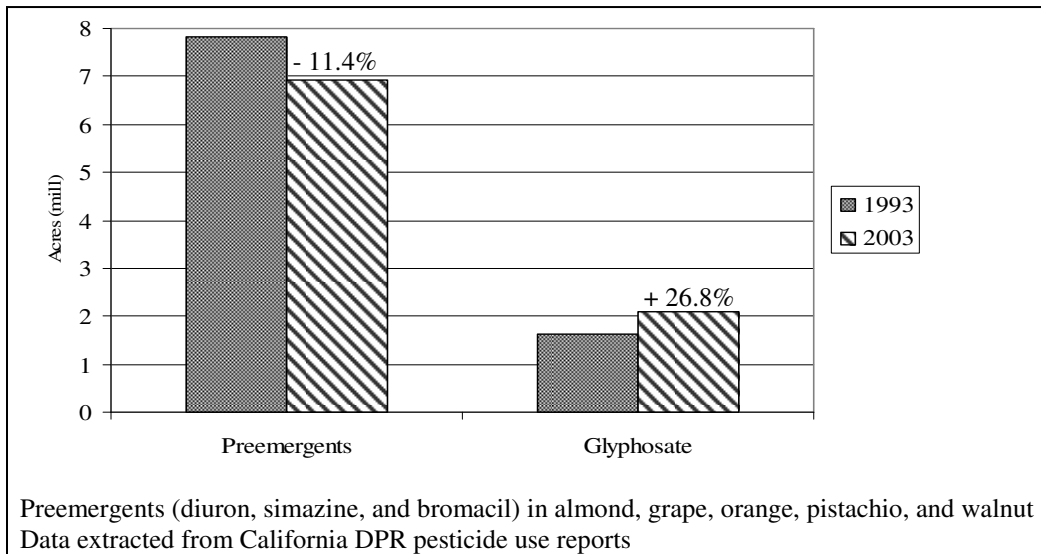


## Control of Glyphosate-Resistant Marestalk in Orchards and Vineyards

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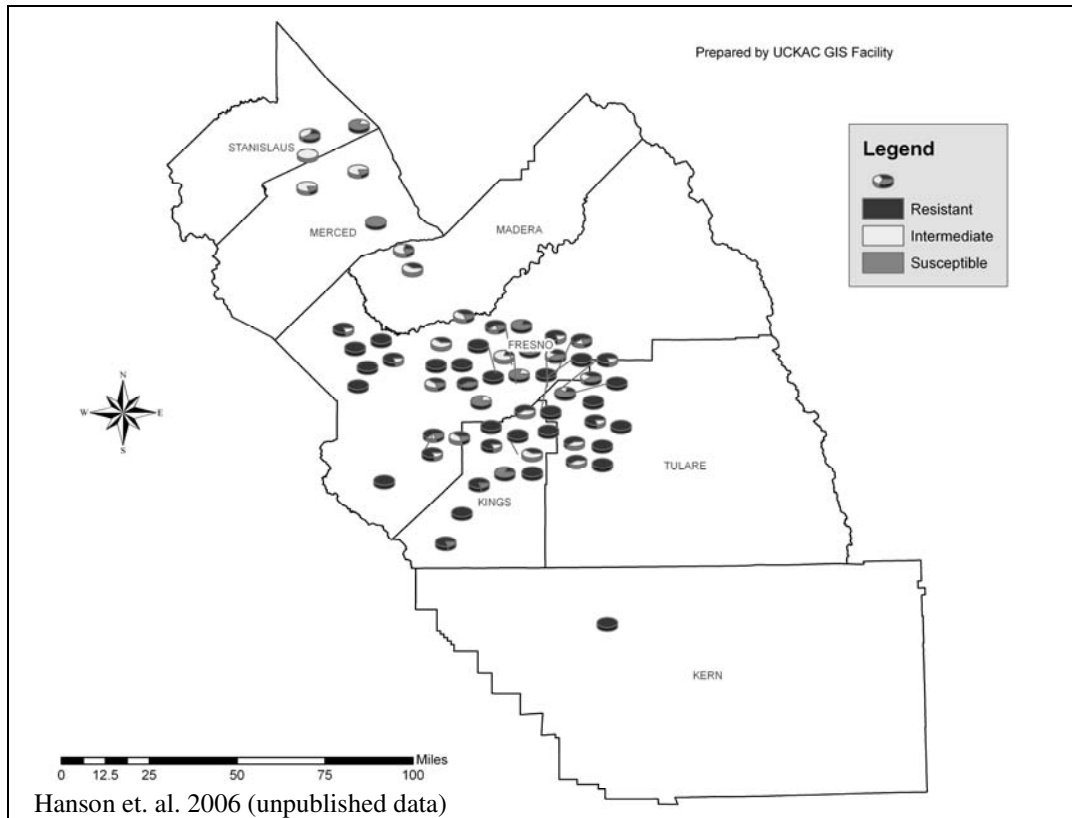
Horseweed or marestalk (*Conyza canadensis*) is a major weed pest in California. It is an annual weed commonly found infesting perennial orchard and vineyard crops, right-of ways, irrigation ditch banks, and other non-crop areas in the southern San Joaquin Valley. Historically, marestalk has been managed in orchards and vineyards with combinations of preemergent and postemergent herbicides. However, with adoption of regulated groundwater protection areas (GWPA), declining crop prices (particularly raisins) since about 2000, and the potential for crop injury when some of these preemergent herbicides are used on lighter soil types, many people began relying more on repeated sprays of postemergent herbicides for weed control. Since generic glyphosate brand products could be bought for less than \$20/gal, it became the herbicide of choice for many growers during this time (figure 1).

Figure 1. Preemergent and postemergent herbicide use in California in 1993 and 2003



By 2004, large populations of marestalk were readily observed in the region which had not been previously seen. In 2005, a glyphosate-resistant horseweed biotype was documented in California along an irrigation canal system that ran through Fresno and Tulare counties. Including California, there are now 12 states that have horseweed populations resistant to glyphosate in the USA. Preliminary studies in 2006 estimate 85% of the marestalk populations tested in the area have some degree of glyphosate resistance (figure 2). The primary reason for marestalk evolving resistance to glyphosate in this area is thought to be due to repeated applications of glyphosate to the same areas over a number of years.

Figure 2. Marestalk populations thought to be resistant to glyphosate in the southern San Joaquin Valley



Managing populations of glyphosate-resistant marestalk requires changing the current control strategy. To be successful, growers should use diverse control tactics and not rely on a single herbicide approach for control. An integrated approach to weed control will undoubtedly eliminate, or at least delay the risk of weed resistance. Three important steps for managing resistant (or non-resistant) marestalk populations include: 1) diversify control with the use of both pre- and postemergent herbicides and timely cultivation, 2) apply timely postemergent applications, and 3) use appropriate nozzle or pre- and postemergent herbicides.

Preemergent herbicides registered in orchards and vineyards in California are seen in table 1. When using these herbicides, treatment should begin before marestalk seeds germinate. In the southern San Joaquin Valley, marestalk emerges in fall following rainfall or post-harvest irrigation water and in late-winter/early-spring (February-April). Products containing bromacil, diuron, norflurazon, and simazine require a permit from the county agricultural commissioner if they are being used in a state GWPA (refer to [www.cdpr.ca.gov](http://www.cdpr.ca.gov) at the California Department of Pesticide Regulation for additional information). Additionally, to reduce the risk of marestalk or other weeds becoming resistant to these herbicides, rotate herbicides with different mode of actions (MOA) and/or use tank-mix combinations.

Table 1. Preemergent herbicides registered in California in orchards and vineyards for marestalk control.

Herbicide	Lb ai/acre	Control	MOA Group	Notes
bromacil (Hyvar X®)	3.2	Excellent	C1	GWPA permit required
diuron (Direx®, etc)	2.5	Good	C2	GWPA permit required
bromacil + diuron (Krovar®)	3.2	Excellent	C1 + C2	GwPA permit required
eptc (Eptam®)	3.0	Excellent	N	Short residual, primarily nut crops
flumioxazin (Chateau SW®)	0.375	Excellent	E	Good coverage of soil surface
isoxaben (Gallery T&V®)	1.0	Excellent	L	Non-bearing only
norflurazon (Solicam®)	2.0	Fair	F1	GWPA permit required
oxyfluorfen (Goal 2XL®)	2.0	Fair	E	Good coverage of soil surface
Simazine (Princep®)	2.5	Good	C1	GWPA permit required
Simazine + diuron	1.5 + 1.5	Excellent	C1 + C2	GWPA permit required
Thiazopyr (Visor®)	1.0	Fair	K1	Split the rate in fall and winter

Refer to the pesticide label for crops labeled and follow all label recommendations. Other effective products may be available but not listed here.

Postemergent herbicides registered in orchards and vineyards in California are shown in table 2. Rotating to alternative herbicides like glufosinate, paraquat, and 2,4-D can provide effective control of marestalk resistant to glyphosate. When several species of weeds are present and are not controlled by these other products alone, tank mixing with glyphosate can work as long as the alternate product is effective on marestalk and is allowed on the pesticide labels. Effective control can be achieved as long as treatments are made when the weeds are small and not stressed for moisture. Like with the preemergents, rotate postemergent herbicides with a different MOA. Do not continue to use the same product year-after-year, or resistance could evolve.

Table 2. Postemergent herbicides registered in California in orchards and vineyards for marestalk control.

Herbicide	Lb ai/acre	Control	MOA Group	Notes
carfentrazone (Shark EW)	0.031	Good	E	Marestalk <21 leaves
glufosinate (Rely®)	1.0-1.5	Excellent	H	Marestalk <4" tall
glyphosate (Roundup Weathermax®, etc.)	2.0	Good	G	Marestalk <21 leaves
paraquat (Gramoxone Inteon®, etc.)	2.0	Excellent	D	Marestalk < 4" tall
2,4-D (Dri-Clean®, etc.)	1.4	Excellent	O	Marestalk < 4" tall

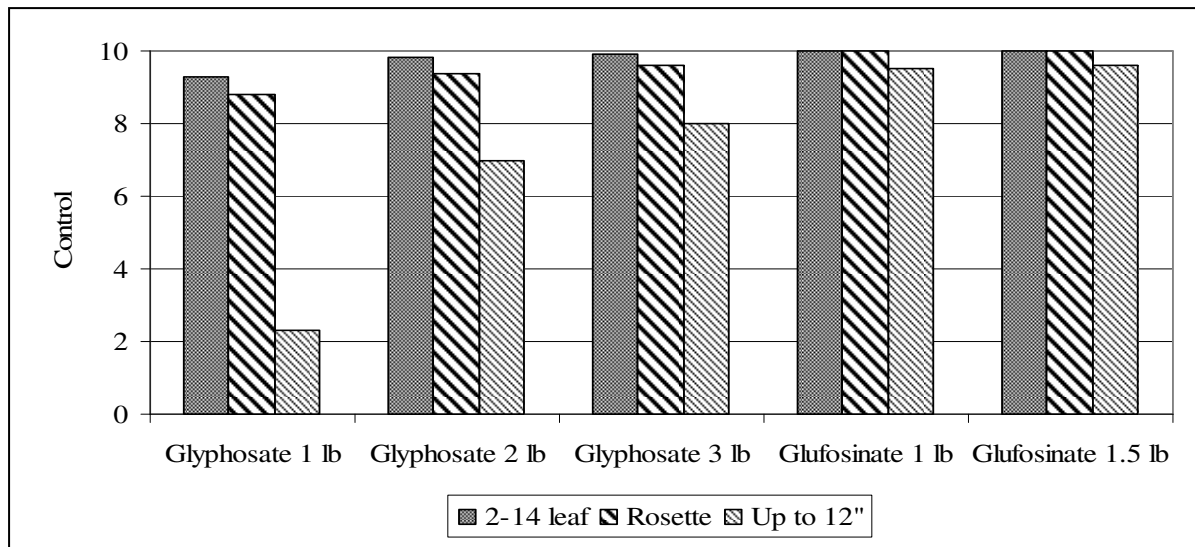
Refer to the pesticide label for crops labeled and follow all label recommendations. Other effective products may be available but not listed here.

Cultivation is also an effective option for managing resistant marestalk populations. Marestalk plants less than 4" tall are very sensitive to tillage. Numerous types of equipment are available that can be used for cultivating both in- and between-row in orchard and vineyard systems. Shallow disking of row middles two to three times a year can effectively remove weeds between the trees. In grapes, specialized in-row cultivators can be used as long as irrigation tubing is suspended high off the soil surface. Specialized in-row cultivation equipment includes the French plow, Clemens, Weed Badger, Bezzerides, and others. When the soil is slightly moist, young weeds can be easily killed, while protecting the grape vines. Most of the other tree and vine crops are only cultivated during the establishment years. As tree nut and fruit trees mature,

cultivation is usually limited to the middles. In this case, combinations of middle cultivation and pre- and postemergent herbicide strip-sprays can be effective for eradicating marestalk. In addition to cultivating emerged weeds, lightly disturbing the soil surface before marestalk seed germinates may inhibit weed emergence. Most marestalk seed does not emerge from depths of 2 mm or more, so burying seed may be an option (lightly disking or scraping the soil surface in October – December). Mowing is not an effective tool for marestalk management. The use of propane flamers can work, but the marestalk needs to be in the seedling stage and multiple applications may be needed. A permit may be required for such a technique.

Postemergent herbicide efficacy on marestalk seems to be influenced by the stage of marestalk growth at time of treatment. Figure 3 shows a comparison of glyphosate and glufosinate on marestalk (not resistant to glyphosate) control, when treated at three different stages of growth in a trial conducted in a grape vineyard in Fresno County in 2006 (unpublished results). What is apparent from this, and other work is that marestalk needs to be relatively small (rosette stage or less) to be effectively controlled with most of the postemergent products. Therefore, treat marestalk plants before they become too large and escape treatment. Since “contact-type” herbicides (like paraquat, carfentrazone, and glufosinate) require thorough wetting of the weed foliage to be effective, early timing of treatment is especially critical. If weeds become large, the spray nozzles may be set to low to cover the entire weed and regrowth can occur. To improve wetting of the weed foliage, consider using twinjet or similar nozzles, rather than “standard” flat-fan spray nozzles, which are better suited for preemergence herbicides. Increasing weed cover will improve wetting of the weed foliage, including the entire stems, and will require additional water to be carried in the spray tank.

Figure 3. Efficacy of glyphosate and glufosinate at different stages of marestalk growth in Fresno County 2006.



Since a single maretail plant can produce more than 200,000 seeds per plant, which can be dispersed in air currents ¼ mile or more, it is imperative that growers, pest control consultants, and others be diligent in their efforts to prevent the escape of this weed, particularly glyphosate-resistant biotypes. To help resolve this problem, diversify the approach to weed control by incorporating preemergent herbicides (like simazine, bromacil, flumioxazin, or others where appropriate) into the program at least every 2<sup>nd</sup> or 3<sup>rd</sup> year. If you farm in a GWPA and want to use some of the products currently regulated in California, obtain a permit from the agricultural commissioner. Also, time preemergent treatments in the fall and the late-winter where multiple periods of emergence may occur. When using postemergence herbicides, treat when maretail plants are at the rosette stage or sooner. Alternative herbicides that can control glyphosate-resistant maretail include glufosinate, paraquat, 2,4-D, and carfentrazone. If you must use glyphosate, tank-mix one of these other effective postemergence products and remove those plants escaping treatment. Thorough coverage of the foliage is important for maretail control. Additionally, implementing similar control practices along field margins, fence lines, road sides, and canal banks are essential components for eradication. Practicing good integrated approaches to control and routinely monitoring fields for escapes will help to resolve the situation and help maintain glyphosate as an important tool for weed control in California.

### **Suggested references**

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International Survey of Herbicide Resistant Weeds at [www.weedscience.org](http://www.weedscience.org)