

Evaluating Herbicide Drift on Dried Plum Early Growth and Vigor

B.D. Hanson

Extension Weed Specialist, UC Davis

Herbicides are an important part of orchard floor management in dried plum orchards as well as in nearby cropping systems. Dried plum growers occasionally observe tree injury from inadvertent exposure to herbicides drifting from adjacent crop fields or from within-orchard applications. With support of the California Dried Plum Board from 2009-2011 we have been conducting research to evaluate the effects of propanil, glyphosate, and other herbicide drift on established plums. During the initial trials conducted on established and fruit-bearing trees, no statistical differences in various yield parameters (buds, fruit set, harvestable fruit, and individual fruit weight) were observed over three years (see previous reports for details).

It was suggested that the lack of clear response to simulated propanil and glyphosate drift in 2009-11 may have been due to the age (~15 yr) of the prune trees tested. In response to this in 2010, we proposed conducting a follow up experiment on younger trees. With support of the California Dried Plum Board and the cooperation of a local grower, we initiated a new field experiment in spring 2011 to evaluate the cumulative effects of annual simulated drift applications of propanil, glyphosate and several other common herbicides on young dried plum trees and this project is ongoing.

Additionally, in 2013-14, a new set of objectives was proposed to address questions about glyphosate soil residues in the soil. Although glyphosate is generally considered to have little to no soil activity and few negative impacts on the soil environment, there have recently been questions raised about whether high use rates and frequent applications of glyphosate herbicide are having unexpected effects on orchard crops. These questions are usually along the lines of either 1) can glyphosate be taken up by tree roots close to the soil surface? Or 2) does glyphosate in the soil affect micronutrient availability as rumored in some trade magazines?

ONGOING OBJECTIVES (2011-14)

1. Evaluate the symptoms associated with sub-lethal doses of glyphosate, propanil, penoxsulam, glufosinate, and oxyfluorfen on young French prune trees.
2. Determine the long term effects of these herbicides on dried plum yield parameters over three years.

NEW OBJECTIVES (2013+)

1. Evaluate the visual symptoms and growth effects of repeated applications of glyphosate on young orchard trees.
2. Determine how soil type and irrigation regime affects potential glyphosate exposure to young trees via root uptake.
3. If unusual symptoms are noted, future research will address the environmental fate of glyphosate and physiological effects on tree performance.

PROCEDURES

Winters site: A field trial was initiated in spring 2011 at Martinez Orchards, Winters, CA to evaluate the effects of several low-rate (simulated drift) applications of glyphosate, propanil, penoxsulam, and oxyfluorfen on canopy injury, flower and fruit set, fresh yield, and prune dry weight. Bare root French prune nursery stock was planted March 9, 2011 as “interplants” in a new orchard planted by the cooperating grower. The test trees will be removed when they grow large enough to interfere with the commercial orchard trees.

Each year, herbicide treatments are applied above the tree canopy by research personnel using a CO₂-powered backpack sprayer, with 80015 nozzles, delivering 10 gal/A total spray volume. Individual plots are a single tree and each treatment is replicated five times. Glyphosate (Durango), propanil (Stam 80 EDF), penoxsulam (Tangent), glufosinate (Rely 280), and oxyfluorfen (Goal 2XL) are applied at 0, 1/20, 1/10, and 1/5 of the herbicide use rates. The reference 1x herbicide rate is 1.5 lbs ae/A for glyphosate and 4.0, 0.03, 1.0, and 1.25 lbs ai/A for propanil, penoxsulam, glufosinate, and oxyfluorfen, respectively. Treatments were applied in August 2011, July 2012, and July 2013 and will repeated a final time in July 2014.

Data collection in the experiment includes annual trunk diameter measurements and visual estimates of foliar injury several times during the growing season. Beginning in 2014 (no flowering was observed in 2012 or 2013), the number of flower buds will be counted on each tree (or representative portion thereof) prior to the first herbicide application and fruit set will be evaluated in mid-summer. Once fruit production begins, fruit on each tree will be counted and weighed and, if appropriate, a subsample will be dried and weighed to determine final prune yield and quality.

Davis site: This research is envisioned as a three year project. In 2013, an experimental orchard was established at UC Davis. Half of the French prune trees were planted in the soil native to the field in Yolo County (eg Rincon silty clay loam) and half were planted in soil imported from Merced County (eg. Delhi sandy loam). Prior to planting dormant nursery stock in February 2013, the tree sites were prepared by augering and a tree site with a 30-inch auger and refilling with either the native soil or the imported sandy agricultural soil. The test orchard contains 64 prune trees planted in a 10 by 20 spacing and irrigated with microsprinklers at each tree.

No herbicide treatments were imposed in 2013 in order to ensure good tree establishment. Beginning in 2014, the orchard will be subjected to various treatment combinations of glyphosate and irrigation regimes. The experimental design will be a factorial arrangement of 2 soils, 4 glyphosate rates, and 2 post-treatment irrigation regimes (Table 1) and each treatment will replicated four times in single-tree plots.

Glyphosate will be applied by research personnel using CO₂-pressurized backpack sprayer and a 2-nozzle boom calibrated to deliver 20 GPA spray solution. Immediately after each herbicide application date, the post treatment drench treatment will be imposed by applying an equivalent of one acre-inch of water in the immediate area of the tree. Water will contained with a plastic ring or earthen berm in order to force percolation into soil surrounding the tree.

In the first year of the trial, data collection will include visual assessments of injury and tree vigor and physical growth (trunk caliper, height) parameters. These evaluations will occur

monthly during the growing season in each year of the trial. If glyphosate injury, reduced vigor, or other symptoms of poor growth are noted, glyphosate analyses and other laboratory evaluations will be added to future proposals. These will depend on the symptoms observed but may include tissue level glyphosate analysis, micronutrient analyses, shikimate assays to test for glyphosate activity in the leaves, etc. A new postdoc, Bahar Kutman, was hired in December 2013 to direct the micronutrient aspects of this dried plum research as well as related orchard projects being conducted in partnership with Dr. Patrick Brown.

Table 1. Proposed glyphosate treatments to address the effect of glyphosate in the soil on young orchard trees at the Davis site.

trt	soil	Glyphosate rate (lb ae/A)*	post treatment irrigation
1	clay loam	0	no extra
2	clay loam	1	no extra
3	clay loam	2	no extra
4	clay loam	4	no extra
5	clay loam	0	post trt drench
6	clay loam	1	post trt drench
7	clay loam	2	post trt drench
8	clay loam	4	post trt drench
9	sandy loam	0	no extra
10	sandy loam	1	no extra
11	sandy loam	2	no extra
12	sandy loam	4	no extra
13	sandy loam	0	post trt drench
14	sandy loam	1	post trt drench
15	sandy loam	2	post trt drench
16	sandy loam	4	post trt drench

* One lb ae/A is in the mid-range of glyphosate application rates in orchard crops.

RESULTS AND DISCUSSION

Similar to the results in the first two years of the study, one month after application (MAA), slight to moderate canopy injury were observed from all treatments in 2013. The injury symptoms most often noted were chlorosis of newly emerged leaves (glyphosate), yellowing or dying leaves (propanil), necrotic spots of varying sizes (oxyfluorfen), and chlorosis and necrosis of new and old leaves (penoxsulam) (data not shown). The greatest injury was observed in propanil and glufosinate simulated drift; however, by three months after treatment, only the propanil treated trees still had moderate injury ratings. Despite early season injury, trunk diameter measurements did not differ statistically among treatments after three applications (data have not yet been collected after the 2013 season). These trees were heavily pruned in winter 2011/12 and no yield parameters (flowers, fruit, etc) were collected in 2012. In 2013, the orchard also did not flower well and no meaningful flower or fruiting data were collected.

The Winters site will be monitored again in 2014 to evaluate the effects of simulated herbicide drift in 2011, 2012, and 2013 on bud and flower initiation. Treatments will be reapplied in 2014 and similar data will be collected. The trial is expected to continue through the 2014 growing season before being terminated. Results of this work will be presented to dried plum producers at Cooperative Extension meetings and field days as appropriate. If results warrant, scientific presentations and publications will be prepared. Additionally, photos of herbicide symptomology will be used in training of farm advisors as well as proving useful in diagnosing herbicide drift in prunes and other tree crops.

The Davis test orchard was established in 2013 and a postdoc hired to work on the project, particularly any potential interactions between glyphosate and micronutrient status in the soil and plants. This work will continue for several years and dried plum board funding will be used to leverage additional support from other sources to support the necessary soil and tissue analyses (glyphosate and micronutrient status).

WEED SCIENCE PROGRAM:

Support from the dried plum board complements our statewide research and extension program that focuses on weed management in orchard and vineyard cropping systems. Our research covers several broad areas applicable to most California tree and vine systems: methyl bromide alternatives in nursery and orchard replant situations, chemical and non-chemical weed control in orchards and vineyards, biology and management of herbicide resistant weeds, and herbicide fate in plants and the environment. Results are routinely presented to growers and industry stakeholders in extension presentations, field days, and scientific meetings as appropriate as well as extended through the cooperative extension network.

<http://ucanr.org/brad.hanson>

<http://ucanr.org/blogs/UCDWeedScience>

<http://wric.ucdavis.edu/>