Determining the Yield Effect of Herbicide Drift on Dried Plum Trees

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Introduction:

Dried plums were first introduced to North America in 1856, when cuttings from France were planted in California (CA). In 2010, 63,000 acres in the US, almost 100% in CA, were devoted to dried plum production; 125,000 tons of prune-variety plums were harvested with an estimated crop value of $153 million.

Recently, dried plum growers have observed instances of leaf spotting, mottling, poor tree growth and poor flower set that are suspected to be the result of off-target herbicide drift. In previous work conducted by the California Dried Plum Board, glyphosate and propanil were found in measureable amounts in dried plum leaf tissue. While the source of propanil was, most likely, aerial applications made to nearby rice fields, the origin of the glyphosate contaminant was not immediately evident. Glyphosate is a commonly applied herbicide in both non-crop and cropping systems, including prunes and other perennial production environments. Regardless of the source, it is not clear what effects sub-lethal rates of these, and other, herbicides are having on dried plum production. If one or both of these products are impacting dried plum productivity, it may be necessary to modify 1) the way they are applied or 2) the timing of the application.

In 2009, a research project, supported by the California Dried Plum Board (CDPB) was initiated to evaluate the effects of simulated propanil and glyphosate drift on the performance and fruit yield of established trees (~15 years old). An additional experiment was begun in 2011 to describe and compare injury symptomology and subsequent yield effects of sub-lethal doses of glyphosate, propanil, penoxsulam, glufosinate, and oxyfluorfen on newly established French prune trees over time.

Materials and Methods:

2009-2011 Wolfskill Farms Experiment

This experiment was conducted (2009 to 2011) in an established French prune orchard (Wolfskill Farms) near Winters, CA, to evaluate the cumulative effects of yearly, low-rate (simulated drift) applications of propanil (Stam 80 DF at 0.002, 0.01, and 0.1X labeled rate) and glyphosate (Roundup WeatherMax 0.01, 0.1, and 0.5X labeled rate) at three application timings (June, July, and August) on fruit set and fresh yield. The reference 1X herbicide rates are 1.5 lbs ae/A for glyphosate and 4.0 lbs ai/A for propanil. Both herbicides were applied to the tree canopies by researchers on an orchard ladder. Trees were sprayed with two-passes of a 3-nozzle spray boom from opposite sides of the tree resulting in approximately 80% of the upper canopy being treated. Applications were made using a CO_2-pressurized backpack sprayer, with 80015 nozzles, delivering 10 gal/A total spray volume. Individual plots consisted of a single tree, each; treatments were replicated up to three times. Visual observations of herbicide injury were recorded throughout the course of the study. Each year, two mid-canopy branches per tree were selected and the number of buds and fruit (set and harvested) per branch and fruit (set and harvested) per bud were counted. Fresh fruit weights were also recorded and the individual fruit weights determined. Several trees were left untreated at the site for the purpose of comparison.

2011-2013 Martinez Farms Experiment

With support of the CDPB and the cooperation of a local grower, a new field experiment was established 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 in a new French prune planting (1-leaf trees). Bare root French prune nursery stock was planted March 9, 2011 as "interplants" in a new commercial orchard planted by the cooperating grower; test trees will be removed when they are large enough to interfere with the commercial orchard trees. Herbicide treatments were applied above the tree canopies by research personnel using a CO_2-powered backpack sprayer, with 80015 nozzles, delivering 10 gal/A total spray volume. Glyphosate (Durango), propanil (Stam 80 EDF), penoxsulam (Tangent), glufosinate (Rely 280), and oxyfluorfen (Goal 2XL) will be applied at 0, 0.05, 0.1, and 0.2X 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. Non-treated trees have been included in the study as negative controls. Individual plots consist of a single tree, each; all treatments are replicated five times. In 2011, treatments were applied on August 10 due to late planting and slow initial growth; however, treatments in 2012 and 2013 will be applied earlier in the spring. Data collection for the experiment includes: annual trunk diameter measurements, as well as visual estimates of foliar injury. Beginning in 2012, 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.

Results and Discussion:

2009-2011 Wolfskill Farms Experiment

When it occurred, visual injury was minor (7 to 18%) and transient, as well as consistent with the typical symptoms associated with each herbicide. Glyphosate is both translocated and slow to metabolize, and physical injury symptoms (yellowed tissues and shortened internodes or "witches brooms") were often not observed until the season following the herbicide treatments. Leaves directly exposed to propanil, a photosynthesis inhibitor, exhibited interveinal chlorosis soon after treatments were applied. Over three fruiting years (2009, 2010, and 2011), no statistical differences were observed with respect to French prune bud and fruit set, as well as fresh fruit weight, in response to herbicide type, rate, or application timing (data not shown). Results from this trial suggest that visual injury from both propanil and glyphosate may not significantly affect fruit yield on established prune trees. If injury does occur, it may be difficult to measure given the variability among trees within an orchard, or among orchards, due to widely varying horticultural practices.

2011-2013 Martinez Farms Experiment

One month after application (MAA), slight to moderate canopy injury was observed for all herbicide treatments applied in 2011. 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) (Figure 1). The greatest injury occurred in those treatments that received the highest rates of each herbicide (Figure 2). Injury ratings at 2 MAA were considerably less severe as compared to the 1 MAA observations, indicating plant recovery (data not shown); however, some degree of injury was still evident for the highest herbicide rates. Despite early season injury, final trunk measurements were not greatly affected by herbicide treatments, except those that were treated with propanil and oxyfluorfen (data not shown). Yield parameter data were not collected in 2011 because the trees were in their first growing season. The Martinez Farm site will be monitored in 2012 to evaluate the effects of simulated herbicide drift in 2011 on both bud and flower initiation. Treatments will be reapplied in 2012 and 2013 and similar data will be collected. The trial is expected to continue through the 2013 growing season before being terminated.

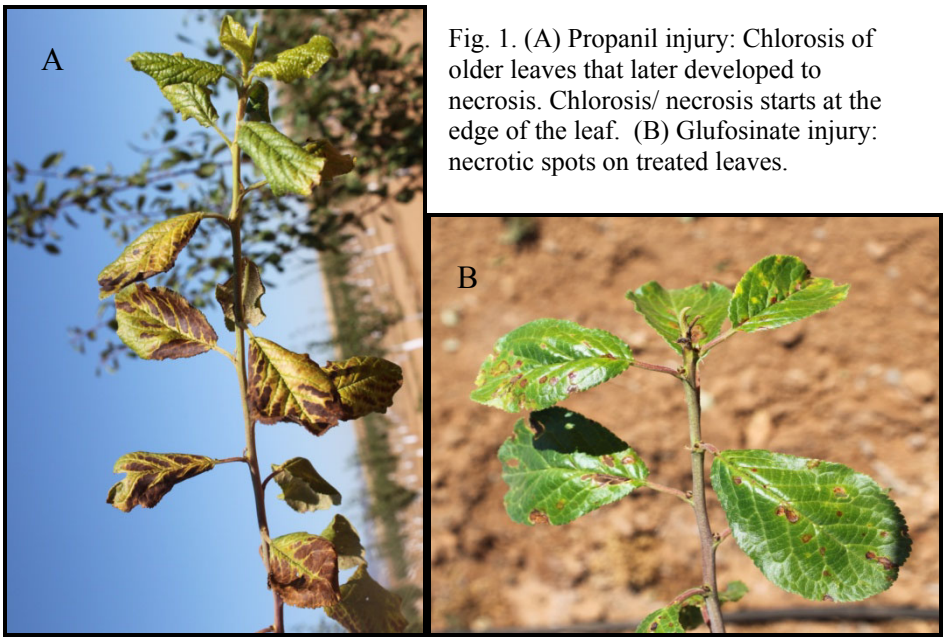

Fig. 1. (A) Propanil injury: Chlorosis of older leaves that later developed to necrosis. Chlorosis/ necrosis starts at the edge of the leaf. (B) Glufosinate injury: necrotic spots on treated leaves.

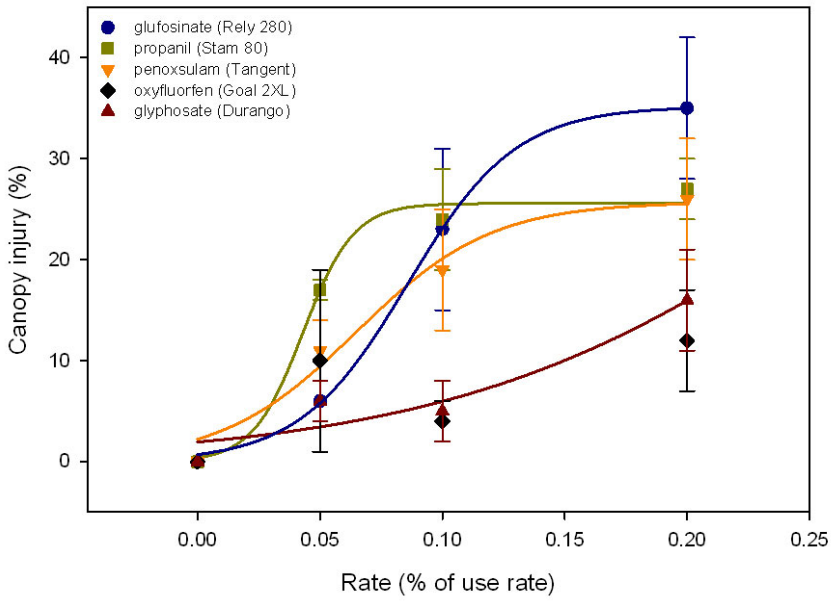

Fig. 2. Effect of simulated herbicide drift on young dried plum trees 1 MAA. Data are means (n=6) plus or minus standard error. A regression could not be fit to oxyfluorfen (Goal 2XL) data.