Project ID: HORT12

Research and Extension to Improve Orchard Weed Management

- Research team and collaborators include UC academics, postdoctoral researchers, graduate students, undergraduate assistants:

Brad Hanson[1,2], Seth Watkins[1], Guy Kyser[1], Caio Brunharo[1,3], Katie Martin[1], Steven Haring[1], Drew Wolter[1,2], Matt Fatino[1] , Mariano Galla[1,2], Dani Lightle[2,3], John Roncoroni[2], and Franz Neiderholtzer[2]

[1]Department of Plant Sciences, University of California, Davis; [2]University of California Cooperative Extension, [3]Oregon State University

The conventional almond production system relies heavily on herbicides for full-season weed control. Our program addresses a number of herbicide efficacy, crop safety, weed biology/genetics, and educational needs related to vegetation management in almond and other tree cropping systems.

Program Goals

The overall goals of the tree and vine weed science research and extension program at UC Davis (http://hanson.ucdavis.edu) is to provide information on weed management and herbicide issues to California growers, Pest Control Advisors, and the UC Cooperative Extension network. Nearly all of the more than 3 million acres of tree and vine crops in the state have moderate to intensive levels of weed management each year. To effectively manage weeds, the industry needs science-based information that spans from immediate weed management solutions to basic biology, genetics, and chemistry that enhances our understanding of weeds, and the tools used to control them.

To remain effective and relevant, yet true to the Cooperative Extension mission, an applied research and extension program often includes a mix of traditional outreach efforts as well as modern communication platforms. Likewise, research efforts can span the from in-field demonstration projects to fundamental basic science all of which can be used to inform the range of stakeholders in the state.

Objectives

The primary objectives of the current project include:

- Evaluation and testing of newly registered herbicide materials, tank mix partners, and application techniques for control of weeds in almond orchards
- Sequential herbicide programs for management of summer grass weeds.
- A special focus on threespike goosegrass and other summer grasses which are becoming a growing orchard problem

In addition, related research and outreach efforts include:

- Understanding the genetics and biochemistry of herbicide-resistant weeds with a particular focus on glyphosate resistance.
- Evaluating herbicide injury symptoms in tree crops and developing training tools.
- Herbicide fate in the soil environment with regard to herbicidal performance and environmental impacts.
- Weed control aspects of integrated pest management and orchard sustainability systems research.
- Supporting UCIPM outreach efforts through subject matter expertise in online tools, publications, and other content.
- Supporting registration of pest control chemicals in a broad range of specialty crops as a field location of the Western Region USDA-IR4 program.

In-field research provides scientifically valid and locally-relevant data that is the foundation of a cooperative extension program. Including graduate student training increases the volume of research that can be done and also develops future extension talent.

Program support

Our research and extension work is regularly supported by:

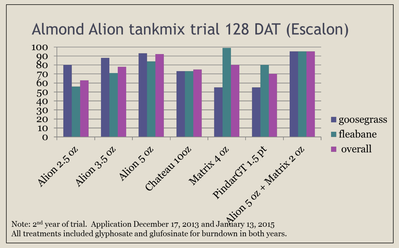
- The Almond Board of California (18.HORT12Hanson)
- Other commodity boards such the California Walnut Board, CA Rice Research Board, California Tomato Research Institute, and others;
- competitive grant programs including USDA-NIFA, California Department of Agriculture Specialty Crop Program;
- the crop protection industry (Bayer Crop Science, Dow AgroSciences, Syngenta Crop Protection, Nichino USA, UPI, BASF, etc);
- graduate student fellowships and scholarships from various sources,
- and the USDA-IR4 Program.

Herbicide performance

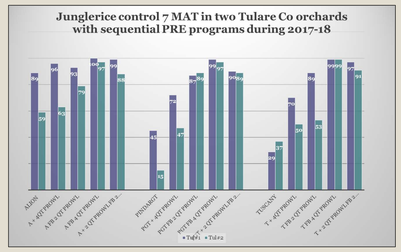
Each year, a dozen or more field trials are conducted in grower fields and at UC research facilities to evaluate weed control efficacy to generate data for our extension programs as well as baseline knowledge for extension personnel. In these experiments, research personnel (often the grant-funded staff, postdocs, or graduate students) apply replicated, small-plot treatments using CO2 pressurized backpack or ATV-mounted spray equipment. Weed control is visually assessed several times during the growing season and, in some cases, biomass or other quantitative data are collected. A few representative data sets are shown below and most of these can also be found online at the UCANR Weed Science Report Database (http://ucanr.edu/sites/UCWeedReports/Weed_Science_Database/) or have been extended through outlets such as the UC Weed Science blog (http://ucanr.edu/blogs/UCDWeedScience/index.cfm). Much of this research is also used to support registration of new herbicides or label additions and updates in partnership with the crop protection industry and regulatory agencies

Glyphosate-paraquat resistant hairy fleabane in an almond orchard.

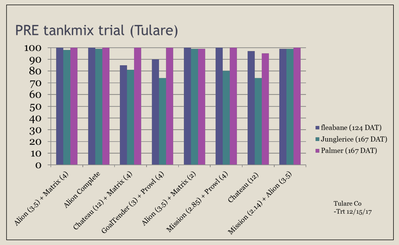
Above: Evaluation of herbicide injury and grower/PCA discussions of weed management strategies in young orchards.



A two-year evaluation of preemergence herbicides for control of threespike goosegrass and other orchard weeds in the San Joaquin Valley.



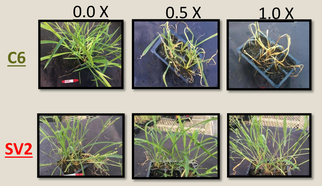
Above: evaluation of sequential PRE programs for control of summer grasses:



Above: preemergence herbicide performance in a tree nut orchard in Tulare County.

Identification and verification of herbicide-resistant weeds

Weed management in California tree and vine crops is currently dominated by problems with glyphosate-resistant and glyphosate–tolerant species. To date, six species resistant to glyphosate have been confirmed: hairy fleabane, horseweed (aka marestail), Italian and rigid ryegrass, and junglerice, and annual bluegrass. Several other species of concern have been identified and are under evaluation; these include threespike goosegrass, Palmer amaranth and a suite of summer annual grasses.



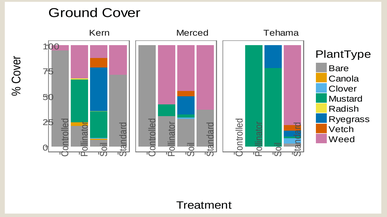
Above right is a threespike goosegrass seed head. Above middle is a goosegrass plant that survived a 16x glyphosate treatment. Above right is two junglerice populations treated with glyphosate as part of a temperature response experiment.

A graduate student researcher, Drew Wolter, is currently conducting field and greenhouse research on this challenging species. Former postdocs Sarah Morran and Caio Brunharo conducted research on the genetics and physiology of herbicide-resistant orchard weeds.

Outreach

- Extension presentations and field days: Each year, members of the T&V weed group make around 40 presentations at UCCE- and industry-sponsored meetings and field days. Involving students and postdoctoral researchers increases our extension footprint and develops future extension talent.
- Online formats include: participation and contributions to the UC Weed Research and Information Center, the UC Weed Science Blog, the UC IPM Pest Management Guides, the UC IPM Herbicide Susceptibility Database, The UC Weed Research Report Database, and others.
- Consultations: Like other disciplinary specialists in the UCCE Network, the weed science team is regularly consulted by phone, email, tweet, and any number of communication platforms for weed control advice, crop injury troubleshooting, and weed identification. Support to the UCCE network and the agricultural industries remains a core mission of this program.

Orchard systems and complex interactions

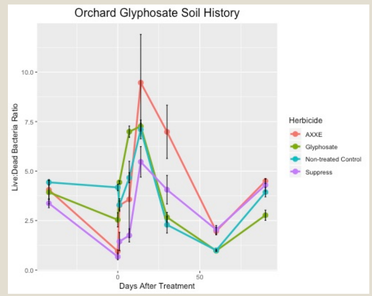


Above: Relative orchard floor cover at each of three experimental sites, as observed in the spring following cover crop establishment. Bare ground is shown in gray, weeds in pink, and each cover crop group is in a separate color. Cover crop establishment varies inversely with weed cover.

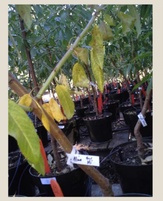
Graduate student Steven Haring, supports orchard covercrop systems project led by A. Gaudin.

Graduate student, Katie Martin, is evaluating soil chemical, physical, and microbial interactions on orchard herbicide fate.

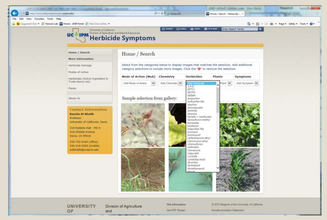
Below: evaluations of the impacts of synthetic and organic herbicides on microbial community activity in almond orchard soils with different glyphosate use histories



Herbicide injury and crop safety



Above and right: Field and greenhouse herbicide symptomology demonstrations use to help troubleshoot crop injury issues (left and center).



Images are also being used to in online support tools such as the UC-IPM Herbicide Symptoms database http://herbicidesymptoms.ipm.ucanr.edu/index.cfm and during a two-day Diagnosing Herbicide Symptoms shortcourse.

Recent Publications

- Brunharo, C.A.C.G., H.K. Takano, C.A. Mallory-Smith, F.E.Dayan, and B.D. Hanson. 2019. Role of glutamine synthetase isogenes and herbicide metabolism in the mechanism of resistance to glufosinate in Lolium perenne. JAFC 67:8431-8440
- Galla, M.F., B.D. Hanson, and K. Al-Khatib. 2018. Detection of bispyribac-sodium residues in walnut leaves following simulated drift. HortTechnol. 29:25-29.
- Brunharo C.A.C.G. and B.D.Hanson. 2018. Multiple-resistant Italian ryegrass (Lolium perenne) in California perennial crops: characterization, mechanism of resistance and chemical management. Weed Science 66:696-701.
- Brunharo, C.A.C.G, S. Morran, K. Martin, M.L. Moretti, and B.D. Hanson. 2019. EPSPS duplication and mutation involved in glyphosate resistance in the allotetraploid weed species Poa annua L. Pest Man Sci 75:1663-1670.

Acknowledgments:

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