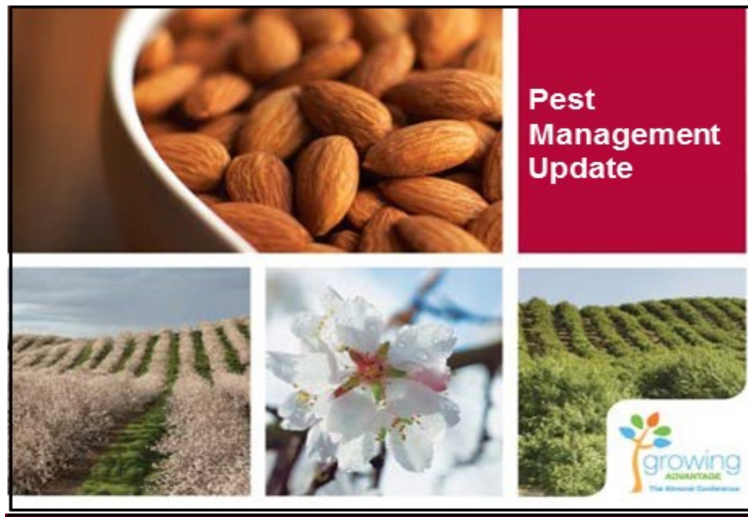
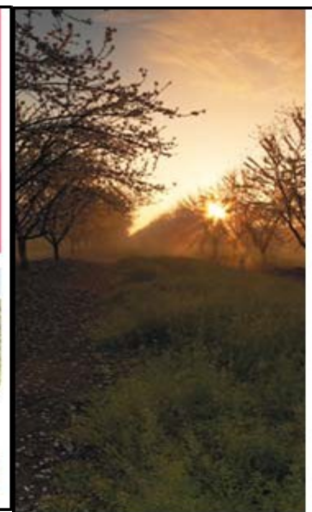


Pest Management Update



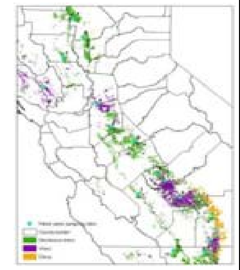
Orchard Weed Management Update

Brad Hanson
Extension Weed Specialist
UC Davis

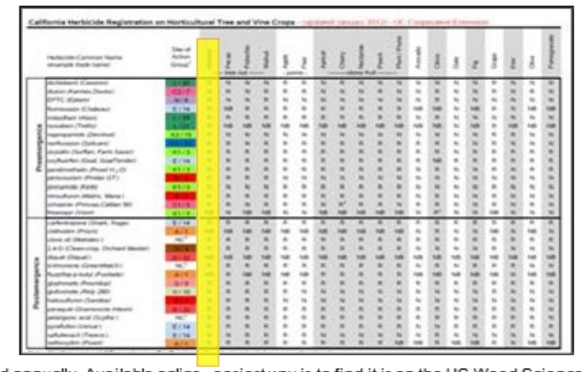
T&V weed science program focus

Almond research centers on:
- Weed control efficacy
- Herbicide resistant weeds
- Crop safety and herbicide injury
- Fumigant and non-fumigant alternatives

- Significant support of the California Almond Board and other commodity groups and industries



T&V herbicide registrations



Updated annually. Available online - easiest way is to find it is on the UC Weed Science blog

CA almond herbicide use

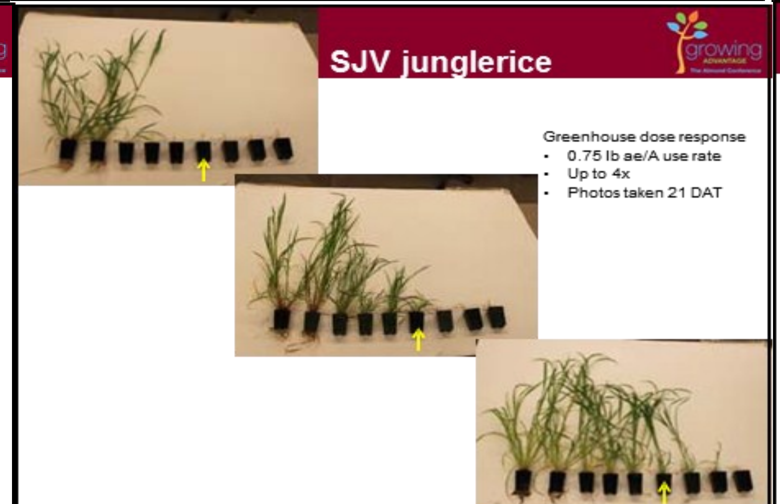
	Top 10 active ingredients	2009 treated acreage
1	glyphosate	1,300,394
2	oxyfluorfen (Goal, Goaltender)	723,524
3	glufosinate (Rely)	271,135
4	paraquat (Gramoxone Inteon)	250,156
5	pendimethalin (Prowl)	167,689
6	2,4-D	152,455
7	oryzalin (Surflan, etc)	99,220
8	simazine (Princep, etc)	92,220
9	flumioxazin (Chateau)	90,718
10	carfentrazone (Shark)	68,360
11	rimsulfuron (Matrix)	52,577

740,000 A bearing almond (2010)

Confirmed glyphosate resistance

(grouped by genus)	USA	CA	WA	OR
Palmer amaranth and com. waterhemp				
Giant and common ragweed				
Australian fingergrass				
Hairy fleabane and horseweed				
Sourgrass				
Junglerice				
Goosegrass				
Wild poinsettia				
Italian and rigid ryegrass				
Ragweed parthenium				
Buckhorn plantain				
Johnsongrass				
Liverseedgrass				

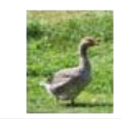
SJV junglerice



Greenhouse dose response
- 0.75 lb ae/A use rate
- Up to 4x
- Photos taken 21 DAT

Other species of concern - goosegrass

Eleusine spp.
- Goosegrass and threespike goosegrass



C190-05 C190-07

Other species of concern - pigweeds

e.g. Palmer amaranth

What might we be in for?

2011-12 GR weed training sessions

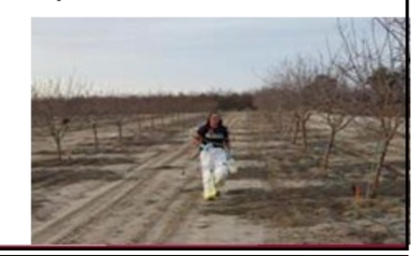
7 workshops in CA, OR, and WA
- University, Extension, and USDA-ARS presenters

Resulted in a series of UC IPM publications
- Selection Pressure, Shifting Populations, and Herbicide Resistance and Tolerance
- Glyphosate Stewardship: Keeping an Effective Herbicide Effective
- Preventing and Managing Glyphosate-Resistant Weeds in Orchards and Vineyards
- Managing Glyphosate-Resistant Weeds in Glyphosate-Resistant Crops

http://www.ipm.ucdavis.edu/IPMPROJECT/glyphosateresistance.html

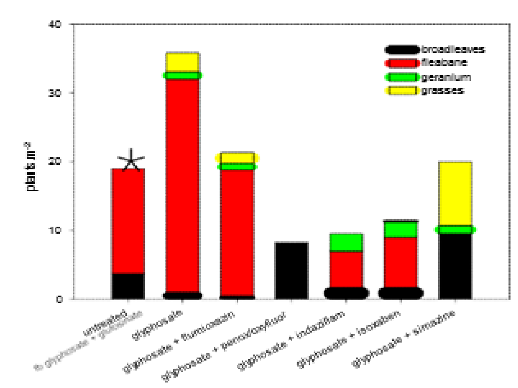
Herbicide evaluations

Recent focus on residual herbicides
- Several new products
  - Additional MOA for resistance management
- Tank mixes and sequential applications
- Also burn down partner comparisons

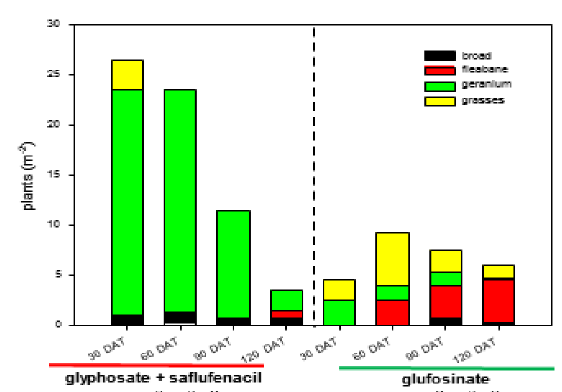


Glyphosate + penoxsulam/oxyfluorfen

Weed density 120 DAT



Glyphosate vs glufosinate (w/resid)



New (er) herbicides

PRE
- Indaziflam
- Penoxsulam
- Rimsulfuron
- Isoxaben

POST
- Glufosinate
- Saflufenacil
- Pyraflufen

Herbicide injury research

- Addressing Farm Advisor and industry questions
- Training tools for herbicide injury symptoms

Other weed management issues

VOC regulations
- EC formulations of oxyfluorfen

Crop safety of newer herbicides or use patterns

Glufosinate shortfall in 2013 (and 2014?)

What else? Questions? Comments?

T&V weed science team

Brad Hanson - Cooperative Extension Weed Specialist
- Chemical weed control, herbicide resistance, herbicide fate, methyl bromide alts

Lynn Sosnoskie, Ph.D. (Project Scientist)
- Weed biology, ecology and resistance management

Sorkel Kadir, Ph.D. (Visiting Scientist)
- Herbicide fate in plants and soil

Seth Watkins, B.Sc. . (Research Technician)
- Orchard and vineyard herbicide efficacy and crop safety evaluations

Marcelo Moretti, M.Sc. (PhD Student)
- Mechanisms of resistance in glyphosate- and paraquat-resistant Conyza, herbicide field performance, control of herbicide resistant biotypes

Andrew (Bob) Johnson, B.Sc. (MS Student)
- Non-fumigant approaches for orchard re-plant issues, herbicide performance

UCCE and industry cooperators

Thanks!

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UC Davis Weed Research and Information Center
http://wric.ucdavis.edu/
http://ucanr.org/blogs/UCDWeedScience/

UC Davis Statewide Integrated Pest Management Program
http://www.ipm.ucdavis.edu/

Postemergence Control Options for Glyphosate-Resistant Junglerice in tree-nut Orchards

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UC DAVIS
UNIVERSITY OF CALIFORNIA

INTRODUCTION

Junglerice (*Echinocloa colona*) is an annual summer weed found in vineyards and orchards of the Central Valley of California. Its management on orchards relies on post-emergence herbicides like glyphosate, but recently a glyphosate-resistant (GR) junglerice population was documented in northern areas of the state (Alarcón-Reverte et al., 2012). A survey conducted in important orchard and vineyard production areas also identified GR junglerice populations in Colusa, Madera, and Kern Counties (Moretti et al., 2013). This indicates that GR junglerice is rapidly spreading around the state, thus rapid management options are needed to minimize further spread. The objective of this study was to evaluate junglerice control with herbicide combinations registered in tree nut orchards.

MATERIALS AND METHODS

- Seedlings of confirmed glyphosate-resistant (R) and susceptible (S) populations of junglerice were used (Moretti et al., 2013)
- Plants at 2- to 3-tiller stage (6 to 8 inch height) were treated with post-emergence herbicides using a spray chamber calibrated to deliver 250 L ha^{-1} with a flat fan 8002E nozzle.
- Herbicide rates and adjuvants were based on label recommendations for almonds (Table 1).
- Visual injury & biomass were evaluated 28 DAT.
- Experimental design was a randomized complete design with six replicates per biotype. The experiment conducted during August-September 2012 at the University of California, Davis.
- Data were subjected to ANOVA analysis indicating a significant effect of populations. Means separated by Tukey's test at $P \leq 0.05$.

Table1. List of herbicide treatments combinations tested. All treatment included manufacture's recommended adjuvants.

active ingredient	trade name	rate per acre (commercial formulation)
1 untreated	n/a	
2 glyphosate	Roundup Powermax	1 lb ae (28 fl oz)
3 glyphosate	Roundup Powermax	1.55 lb ae (44 fl oz)
4 glufosinate	Rely 280	0.87 lb ai (48 fl oz)
5 glufosinate	Rely 280	1.5 lb ai (82 fl oz)
6 paraquat	Gramoxone SL	0.3 lb ai (1.25 pt)
7 paraquat	Gramoxone SL	1 lb ai (3 pt)
8 rimsulfuron	Matrix	0.03 lb ai (2 oz)
9 rimsulfuron*	Matrix	0.03 lb ai (2 oz)
10 oxyfluorfen/penoxsulam	Pindar GT	0.015 / 0.74 lb ai (1.5 pt)
11 oxyfluorfen/penoxsulam*	Pindar GT	0.015 / 0.74 lb ai (1.5 pt)
12 flumioxazin	Chateau	0.023 lb ai (6 oz)
13 flumioxazin*	Chateau	0.023 lb ai (6 oz)
14 fluazifop	Fusilade II	0.18 lb ai (12 fl oz)
15 clethodim	Selectmax	0.12 lb ai (16 fl oz)
16 sethoxydim	Poast	0.28 lb ai (12 fl oz)

* Addition of glyphosate 1 lb ae/A

RESULTS

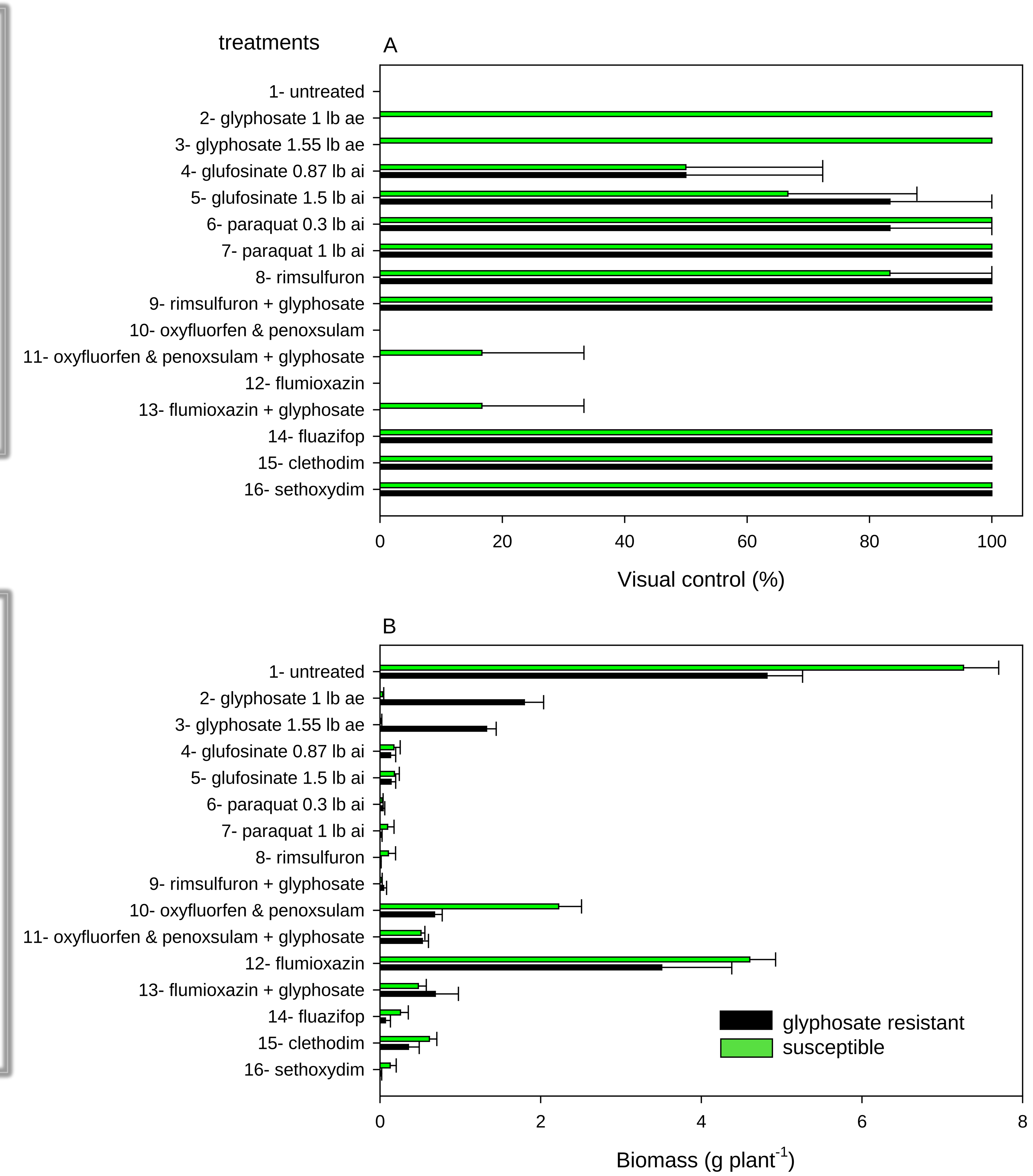

Fig 1. Junglerice glyphosate-resistant (black) and susceptible (green) populations visual injury (a) and biomass reduction (b) 28 DAT with single postemergence herbicides and tank mixes.

- Paraquat, rimsulfuron, fluazifop, clethodim & sethoxydim successfully controlled both populations of junglerice (fig 1A & B)
- All treatments significantly reduced plant biomass production when compared to untreated control (fig 1B)
- Glyphosate treatments controlled only the susceptible population (fig 2A & B).
- Flumioxazin or penoxsulam/oxyfluorfen did not control junglerice regardless of tank mixes with glyphosate. Nonetheless, addition of glyphosate significantly reduced plant growth (fig 1B & 3A)
- Glufosinate at 1.5 lb ai provided better control of both junglerice populations when compared to 0.87 lb ai, but no differences in plant biomass were observed (fig 1B & 3b)

Fig 2. Glyphosate-resistant (A) and susceptible (B) junglerice response to different post-emergence herbicide treatments.

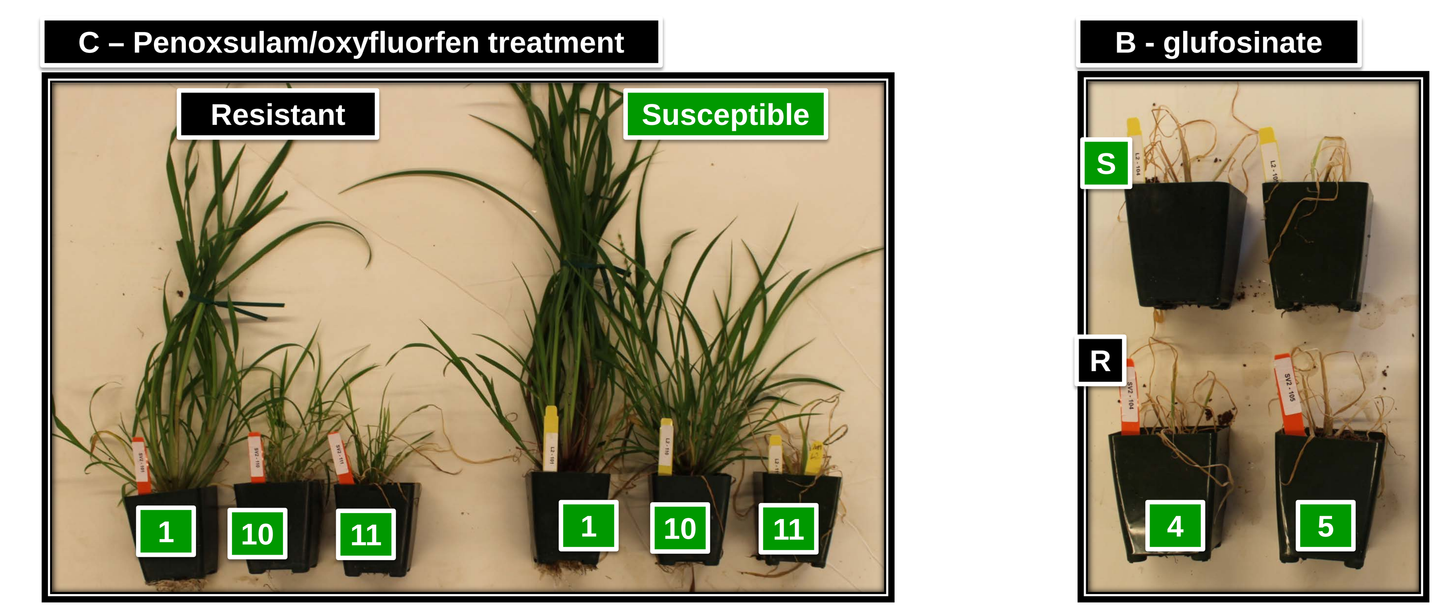

Fig 3. Glyphosate-resistant and susceptible junglerice response to penoxsulam/oxyfluorfen (A) or glufosinate (B) treatment.

CONCLUSIONS

Paraquat, rimsulfuron, fluazifop, clethodim and sethoxydim are effective herbicides at controlling both populations of junglerice and can be used as post-emergence management options. Field research is ongoing to validate these results in commercial tree nut orchards.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of Seth Watkins, Rolando Mejorado and Dr. Tom Lanini.

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- Moretti, M L, Garcia, A., Fischer, A.J, Hanson, B D. 2013. Distribution of glyphosate-resistant junglerice (*Echinocloa colona*) in perennial crops of the Central Valley of California. Proc. of the 66th Annual Conference of the Western Weed Science Society. San Diego, CA.

Evaluation of ^{14}C-Glufosinate Translocation in Young Almond (*Prunus dulcis*) Trees

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University of California, Davis

Introduction

In California, there are approximately 323,750 hectares of almonds; most of these orchards are treated one or more times each year with herbicides (California DPR 2011). Over the past four years since its registration in the California tree nut crops, use of glufosinate has increased substantially due to glyphosate-resistant weeds in these cropping systems.

Glufosinate is a non-selective, contact herbicide (Senseman et al. 2007). Crop safety to glufosinate in almonds is based upon applications directed below the trees' foliage. Recently, growers, pest control advisors, and extension agents have expressed concerns about injuries to young (2-4 year old) almond trees, suspected to be caused by glufosinate contact with the basal bark. Injury symptoms noted are gummosis on the lower trunks (Figure 1) as well as occasional reports of shoot tip dieback.

Figure 1: Gummosis injury on green bark, scion, and old bark caused by glufosinate in field trial.

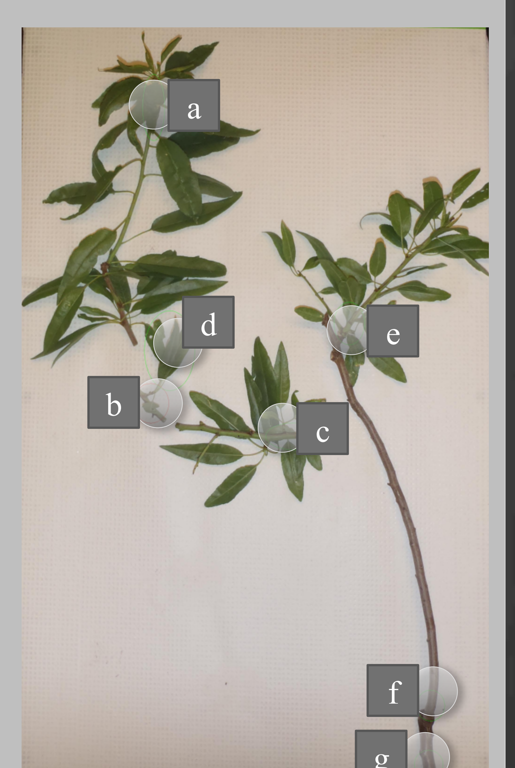

Figure 2: Almond tree at time of harvest, with indication of sectioned areas.

Objective

Quantify absorption and translocation of ^{14}C-glufosinate as a function of time and type of plant tissue treated.

Materials and Methods

- Second-year Nonpareil almond scions grafted on peach rootstock were treated with ^{14}C-radiolabeled glufosinate (1833 bq) and non-ionic surfactant. Ten microliters of solution were applied using a micro syringe to leaf tissue, green bark (scion), or to old bark (rootstock).
- Plants were destructively harvested 1, 3, and 7 days after treatment (DAT) with three replicates per treatment and harvest time combination.
- Each tree was divided into 8 sections: (a) upper branch 1, (b) middle branch 1, (c) lower branch 1, (d) middle leaf, (e) lower branch 2, (f) scion, (g) old bark, and (h) roots, Figure 2. Each section was subdivided into 3 cm sections and all plant parts were oven dried at 50ºC for 72 hours and biomass recorded. A 0.02 to 0.60 mg representative sub-sample of each section was combusted in a Perkin Elmer biological oxidizer and trapped in a 50/50 mixture of Carbosorb and PermaFluor. ^{14}C-glufosinate content was measured using a Tri-Carb Liquid Scintillation Analyzer.
- Unabsorbed glufosinate was determined by rinsing the surface of each treated section with 10 mL of 75% ethanol. Rinsate was collected and radioactivity measured using liquid scintillation analysis. Absorbed glufosinate was calculated by subtracting unabsorbed radioactivity from total applied radioactivity. Percent of total ^{14}C-glufosinate recovered is presented in Figure 4.
- Results are displayed as a percentage of corrected disintegrations per minute (DPM). Biomass of each sample was used to standardize DPM on a dry weight basis. Data were subjected to ANOVA and, because there was no significant effect of sample time, the data were combined over the three sample times.

Results

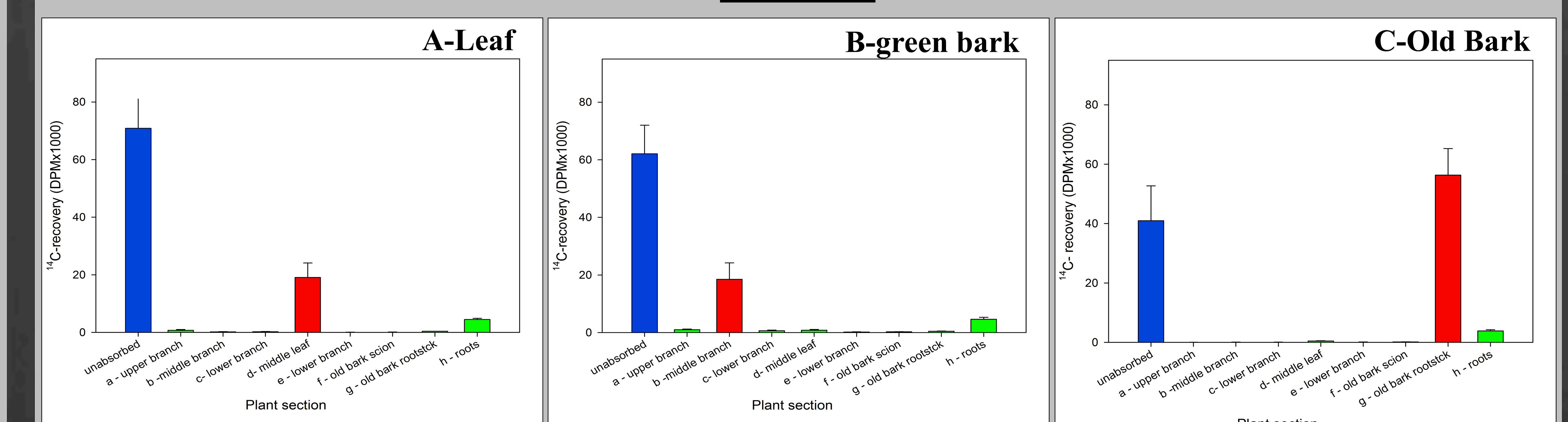

Figure 3: Recovery, in DPM and standard error, of ^{14}C-glufosinate when applied to (A) leaf, (B) green bark, and (C) old bark. Red bar indicates treated section and green bars sampled sections.

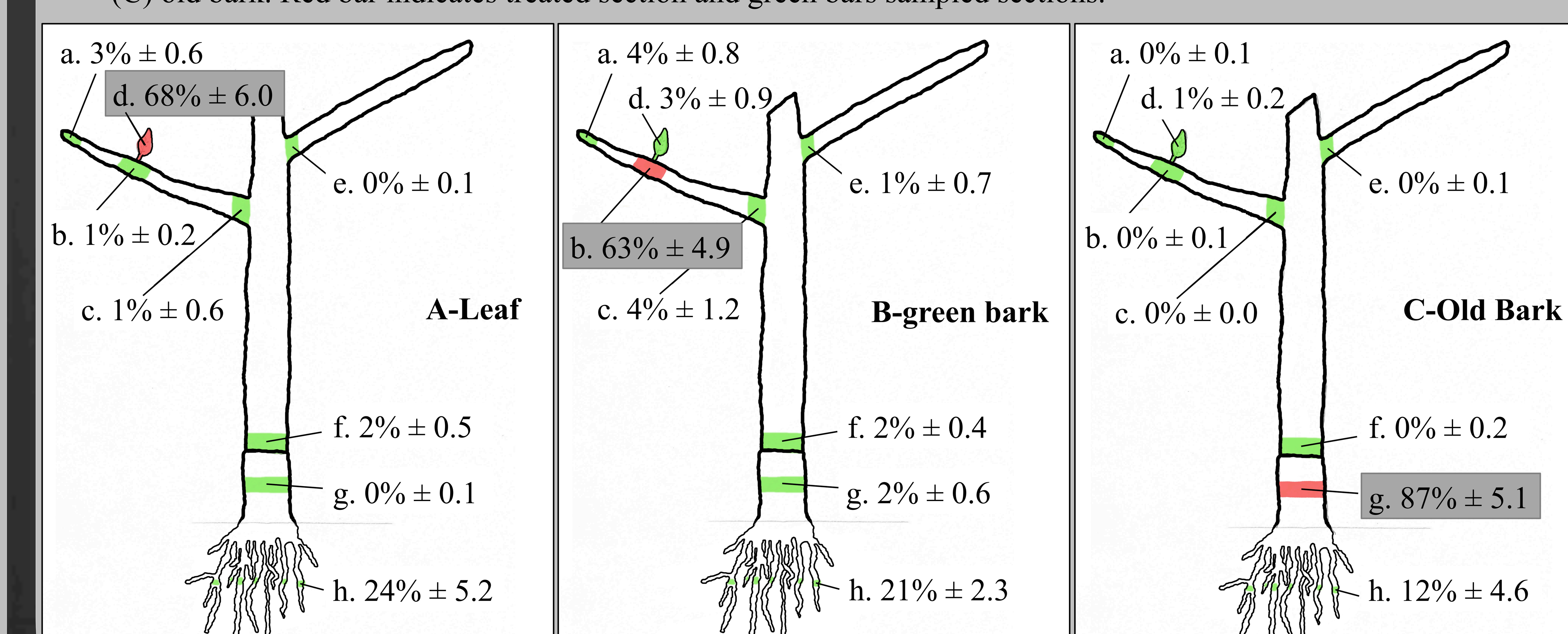

Figure 4: Distribution of ^{14}C-glufosinate, shown as a percentage of recovered material and standard error, from application to leaf (A), green bark (B), and old bark (C). Treated section is highlighted in red and sampled sections in green.

Discussion

- From the sections of the almond tree sampled and oxidized, approximately 80% of the total amount of ^{14}C applied was recovered in the rinsate or in oxidized plant tissues (Figure 3 and 4). The remaining 20% is presumed to be distributed through the sections not sampled.
- When applied to leaves, only 19% of ^{14}C-glufosinate was absorbed. Of the amount absorbed, the majority (68%) remained in the treated leaf (Figure 4-A). However, 24% of the recovered material was in the root tissue, which may indicated substantial long-distance phloem transport. Smaller amounts of ^{14}C were distributed through the other sampled areas.
- Similar to leaf applications, ^{14}C-glufosinate applied to green bark resulted in about 17% absorption. Of the herbicide absorbed, 63% remained in the treated area and around 21% moved to roots (Figure 4-B).
- When applied to older bark, 52% was absorbed. Over 87% glufosinate absorbed remained within the treated area of bark and did not move to the pith; only 12% translocated to roots (Figure 4-C).

Conclusion

- There was no difference in glufosinate absorption among plants sampled 1, 3, and 7 DAT, which indicates that most of the absorption occurs within the first 24 hours after treatment.
- Regardless of where ^{14}C-glufosinate was applied, most ^{14}C absorbed remained in the treated area. However, a substantial amount (12-24%) of the recovered ^{14}C was located in root tissue. Translocation of ^{14}C was greatest when applications were made to green (non-suberized) tissue.
- This experiment did not address the form of the ^{14}C-glufosinate recovered in almond tissues. Further studies using high performance liquid chromatography techniques are needed to determine whether the recovered radioactivity is in the form of glufosinate or a metabolic degradation product.

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California DPR. 2011. Pesticide use reporting. http://www.cdpr.ca.gov/docs/pur/purmain.htm.

Senseman, Scott A (ed.). *Herbicide Handbook*. 9th ed. Lawrence, KS: Weed Science Society Of America, 2007. Print.

Acknowledgments

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