Investigating reports of glufosinate injury on young almond trees

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Introduction

Each year, almond growers in California spend a considerable amount of management effort and financial resources to manage weeds on the orchard floor. Many growers use an integrated weed management approach that includes mechanical weed control in the middles (tillage and/or mowing) combined with strip herbicide applications within the tree rows. However, the vast majority of California's approximately 800,000 acres of almonds are treated at least once each year with a broad spectrum "burn down" herbicide such as glyphosate, paraquat, or glufosinate (Table).

These herbicides do not have any inherent selectivity in almond – their safety to the crop is based upon applications directed below the foliage, minimal exposure to green bark (often through the use of milk cartons during early establishment years), and the use of other application techniques to minimize tree exposure. However, each year almond growers and pesticide consultants and researchers observe cases of injury due to drift, misapplication, or unknown causes.

Table. Herbicide use in California almond orchards (2009)

	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

Resistance management

Overreliance on one herbicide mode of action has led to the selection of resistant weed biotypes in many cropping systems. In the last decade, almond growers have experienced this with the selection of glyphosate-resistant biotypes of rigid ryegrass, Italian ryegrass, horseweed, and hairy fleabane becoming very problematic in many parts of the Central Valley. One relatively new postemergence product being promoted for the control of weeds including glyphosate-resistant biotypes is glufosinate (Rely branded products from Bayer Crop Sciences).

Glufosinate is generally considered to be somewhat intermediate between the other two commonly used postemergence herbicides (table below). Glufosinate does not translocate as well as glyphosate but it is somewhat more mobile in the plant than paraquat. Paraquat has much faster burndown activity than either glyphosate or glufosinate. Paraquat and, to a lesser extent glufosinate, are generally considered to be less effective than glyphosate against grasses and perennial weeds because the weeds can regrow from below ground tissue after the application.

Thumbnail comparison of three common burndown herbicides used in almond.

Chemical name	*Glyphosate*	*Glufosinate*	*Paraquat*
Trade name(s)	Roundup, Durango, Honcho, etc	Rely, Rely 200, Rely 280	Gramoxone, Gramoxone Inteon
Mode of action	Inhibits EPSP synthase (EPSPS) enzyme	Inhibits glutamine synthetase enzyme	Photosystem I inhibitor
Selectivity	Non-selective	Non-selective	Non-selective
Soil activity	Essentially none	Essentially none	None
Translocation	Very good	Limited	Very limited
Coverage needed	Less critical	Critical – especially on larger weeds	Critical – especially on larger weeds
Broadleaf weed control	Broad spectrum. Good control of small to medium plants but can vary with large weeds.	Broad spectrum. Good control of small weeds, less effective on large weeds or dense stands due to coverage.	Broad spectrum. Good control of small weeds, less effective on large weeds or dense stands due to coverage.
Grass weed control	Broad spectrum. Usually good control of vigorously growing grasses	Broad spectrum. Control can vary by size - seedling grasses often controlled, small established grasses may be burned down but regrow, some success with medium-sized grasses nearing maturity	Broad spectrum activity but control varies. Seedling grasses often controlled, but established grasses usually burned down but regrow
Perennial weed control	Good – can vary depending on plant size and time of year	Poor – burns tops; however plants often regrow from roots/rhizomes	Poor – burns tops; however plants often regrow from roots/rhizomes
Resistance reported	Yes, in California – ryegrass, horseweed, hairy fleabane, others suspected. 19 species worldwide.	Not in California. Ryegrass in Oregon, goosegrass in Malaysia.	Yes, in California – hairy fleabane, horseweed, 3 other in USA, 25 species worldwide

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Suspected glufosinate injury on an almond tree near Arbuckle, CA

Occasional crop injury

Because of the increasing problems with glyphosate resistant weeds and the desire to minimize selection pressure for more resistant biotypes, use of glufosinate in almonds has increased substantially in recent years. In the period since Rely was registered in almond, PCA's, researchers, and University extension personnel have received a number of calls about injury to young (2-4 yr-old) almond suspected to be related to glufosinate applications. The injury symptoms most often noted is gummosis or gum balls on the lower trunks but other symptoms including tip die-back have also been alleged. It is important to note that reports of injury suspected to be from Rely are fairly rare and often sporadic within the same orcahrd. Thus far, evidence has been largely anecdotal because these symptoms have been somewhat difficult to recreate in the field.

With funding from the Bayer Crop Science and the California Almond Board, this research was initiated to provide almond growers and industry advisors more information on the causes and long-term effects of tree injury occasionally associated with glufosinate treatments

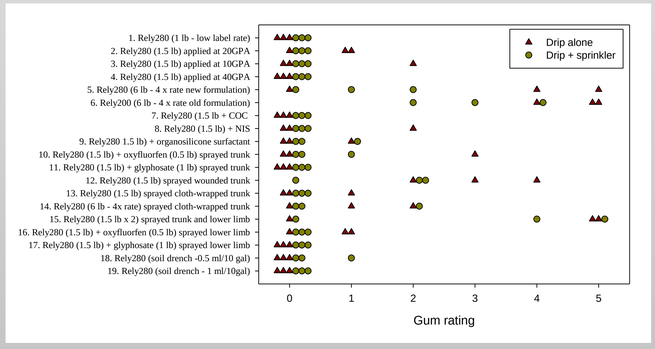
Objectives

- Determine if bark injury observed in young almond trees can be replicated under experimental conditions with glufosinate applications.
- Determine factors contributing to this sporadically observed injury in order to develop mitigation techniques.

Materials and Methods

This project was initiated in 2011 to confirm the cause of the alleged glufosinate injury on young almond trees and to determine factors contributing to the sporadically observed symptoms. A preliminary trial was initiated in a second leaf almond orchard near Parlier, CA and two new experimental orchard were planted near Davis and Arbuckle CA in spring 2011 for treatments in 2012 and 2013.

Trunk injury (gumming) was rated on a 0-5 scale six weeks after treatment with various glufosinate combinations in a trial near Parlier.
-Unless otherwise noted, Rely 280 was applied directly to the lower 18 inches of the trunk at 1.5 lb ai/A (high label rate) in 20 GPA water with ammonium sulfate at 10 lb/100 gal spray solution.
-Six trees were sprayed with each treatment. Following treatment half were irrigated with drip tubing and half were irrigated with drip tubing plus microsprinklers that wetted the treated trunk.



Results

Preliminary results from 2011 suggest that trunk exposure to glufosinate can result in localized lesions. While there does not appear to be a strong correlation to glufosinate formulation, a strong rate response was observed. At normal (high label) use rates (1.5 lb ai/A) injury symptoms were somewhat variable among replicates within the same treatment and among sprinkler and drip-irrigated trees. Interestingly, although several treatments had severe trunk gumming six weeks after treatment, symptoms were greatly reduced by subsequent ratings 10 weeks after treatment. It is too early at this time to make determine the long term effects, if any, from these trunk symptoms.

These treatments will be repeated in a second set of 2nd and 3rd leaf almonds as well as the new test orchards established in 2011. These experiments are expected to continue through 2013.

Conclusions

- Glufosinate can cause trunk gumming in young almond trees under experimental conditions.
- No obvious effect of tankmix partners or surfactants were observed.
- Very strong rate response suggests that calibration and careful applications will minimize potential injury.
- It is too early to determine whether the injury will have a long-term impact on tree health and productivity.
- Studies will be repeated and expanded upon in 2012-1013.

Trunk injury (gumming) related to a 4x rate of Rely 280 (treatment #5).

Trunk injury related to a Rely 280 treatment (#10). Young tissue is clearly much more sensitive than more mature bark.

Acknowledgments
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