Alternatives to Glyphosate: Efficacy and Trade-offs in the Landscape

Karey Windbiel-Rojas

Area Urban IPM Advisor -- Sacramento, Yolo, and Solano counties

UC Cooperative Extension

UC IPM | University of California Agriculture and Natural Resources | Integrated Pest Management Program

Audiences interested in controlling weeds naturally or organically

- Residential audiences/homeowners
- School and child care staff and parents
- Municipalities, parks and recreation
- Landscape professionals, utilities, ROW
- Universities and colleges

FDA Scientist Finds Weed Killer on Many Foods

Air Date: Week of May 18, 2018

0:00 / 9:23

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IUSD 2018-19 Pesticide/Herbicide List

GROUNDS

me of Hebacide (Organic)	Active Ingredient(s)	Purpose
Halo (25b exempt)	Eugenol and Clove Oil	Weeds
Preem (25b exempt)	Soybean Oil	Weed
Avenger	d-Limonene	Weed
Fiesta	Iron HEDTA	Broadleaf
Scythe	Pelargonic Acid	Weed
Suppress Herbacide	Caprylic Acid	Weed
Weed Pharm	Acetic Acid	Wee
Name of Pesticide (Organic)	Active Ingredient(s)	Purp
Why Spray (25b exempt)	Lemongrass and Clove Leaf Oil	Wasps a
ProVerde (25b exempt)	Geranoil	
Eco Via EC (25b exempt)	Thym Oil, 2--Phenyl	

15 Health Problems Linked to Monsanto's Roundup

By Guest Contributor | Jan. 23, 2015 11:44AM EST

enterprise

YOLO COUNTY NEWS

Local News

City considering a ban on use of weed killers

By Felicia Alvarez

A Davis ban on neonicotinoids and glyphosate — the active ingredients in weed killers like Roundup — could be on the horizon, after three city commissions and local residents are calling for a re-evaluation of the

CITY OF IRVINE

Public Works Department
Maintenance Operations
Policies and Procedures

INTEGRATED PEST MANAGEMENT PROGRAM

PURPOSE: To establish criteria for an Integrated Pest Management (IPM) Program.

POLICY: The City of Irvine will focus on long-term prevention or suppression of pest problems with minimum impact on human health, the environment, and nontarget organisms with the limited use of pesticides in accordance with direction provided by the City Council (2/23/16) for Parks, Fields and Playgrounds; City-wide Pest Management Guiding Principles, and an annual update:

Parks, Fields and Playgrounds

When pesticides are needed, use the following prioritized approach: (1) organic pesticides; (2) Water Quality Act Allowed Pesticides; and (3) EPA Level III "caution" labeled pesticides only when deemed necessary to protect public health and economic impact by a licensed pest control adviser.

Management Guiding Principles

KILLS THE ROOTS!

WeedKillerCrisis

Organization Tracking The Unfolding Legal & Health Crisis Surrounding Exposure to Weed Killer Products

Herbicides | Weed Killer | Glyphosate | Health Risks | Food Supply | Lawsuits & Claims | ALERT: Breaking News

ome / Lawsuits / Roundup Lymphoma Cancer Lawsuits Settlements & Payouts

Roundup Lymphoma Cancer Lawsuits Settlements & Payouts

By Michael Bennett - November 4, 2018

lore than 11,000 lawsuits are now pending against Bayer AG and Monsanto over their contro-versial weed-killer products, according to the German company's own 2018 financial reports.

Those thousands of cases come on the heels of a blockbuster jury verdict last fall in California and were disclosed just after a second California trial got underway in late February

Views: 5273

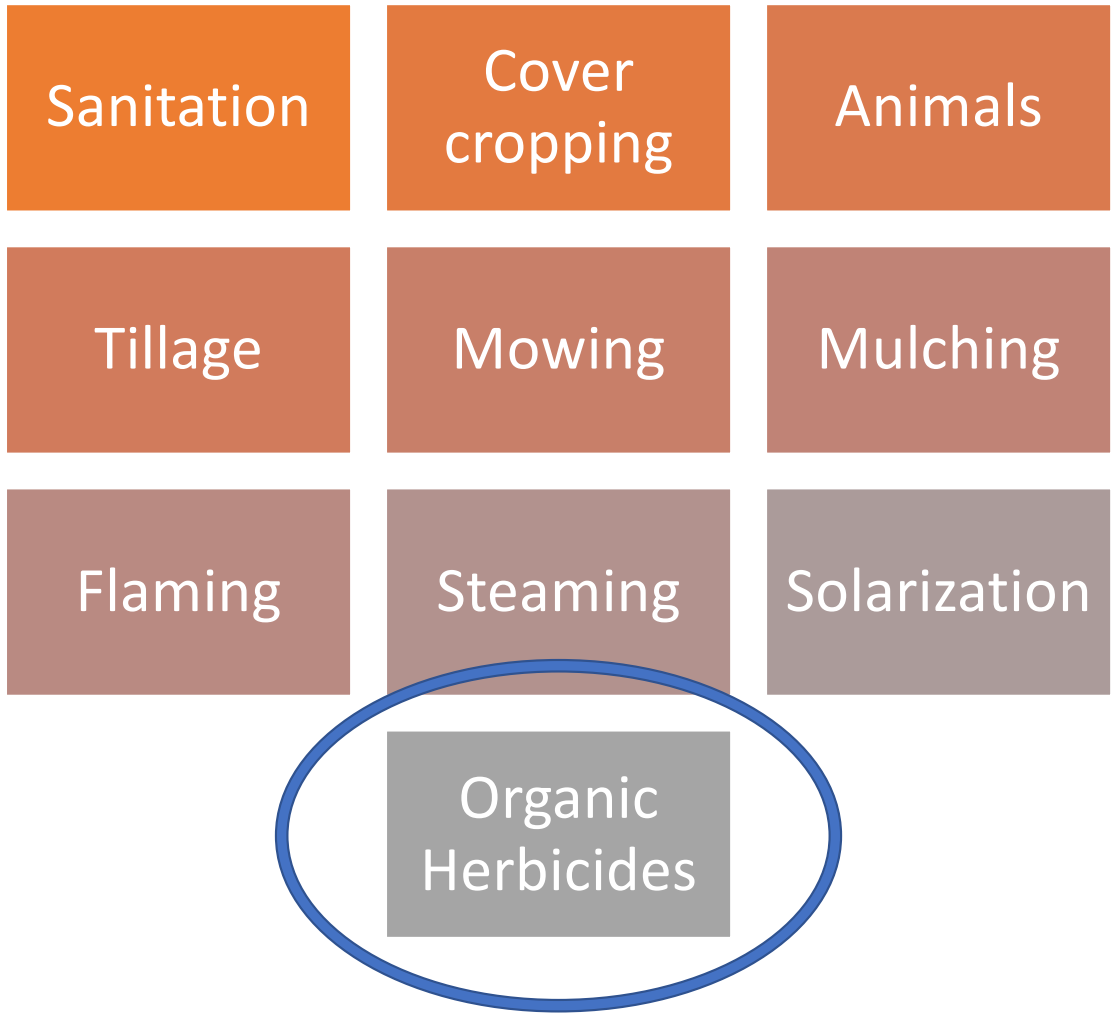
LAWSUIT

MONSA

Used Roundup? Have Cancer?

Jury Returns $2 Billion Verdict Against Monsanto for Couple with Cancer -- File Your Lawsuit Claim Now!

Organic Weed Control Options



Research on Alternatives to Glyphosate

- Until recently, little research had been conducted in turf and ornamental for alternatives and organic products
- Research is catching up with public demand changes in policy
- Important to communicate understanding weeds, reasons for weed control, herbicides and how they are work.

Are There Alternatives to Glyphosate for Weed Control in Landscapes?

NC STATE EXTENSION

Introduction

Glyphosate is the most widely used postemerge... reasons.

in landscape plantings for several

(translocated) herbicide that moves ...ots. In this way, glyphosate kills

...an be used to control most weeds

...lay particles in the soil rendering ...d trees without damaging the ...ds and off of the shrubs.

...des.

...xic and environmentally

...been questioned, And, ...t glyphosate does not ...directions, many ...e asking is: "what can I ...e weeds you are trying ...er herbicides and ...l weeds, established ...hod or product

UC WEED SCIENCE

Weed control, management, ecology, and minutia

Update on "organic" herbicide test for landscapes

Author: Cheryl A. Wilen
Posted by: Gale Perez

Published on: December 11, 2016

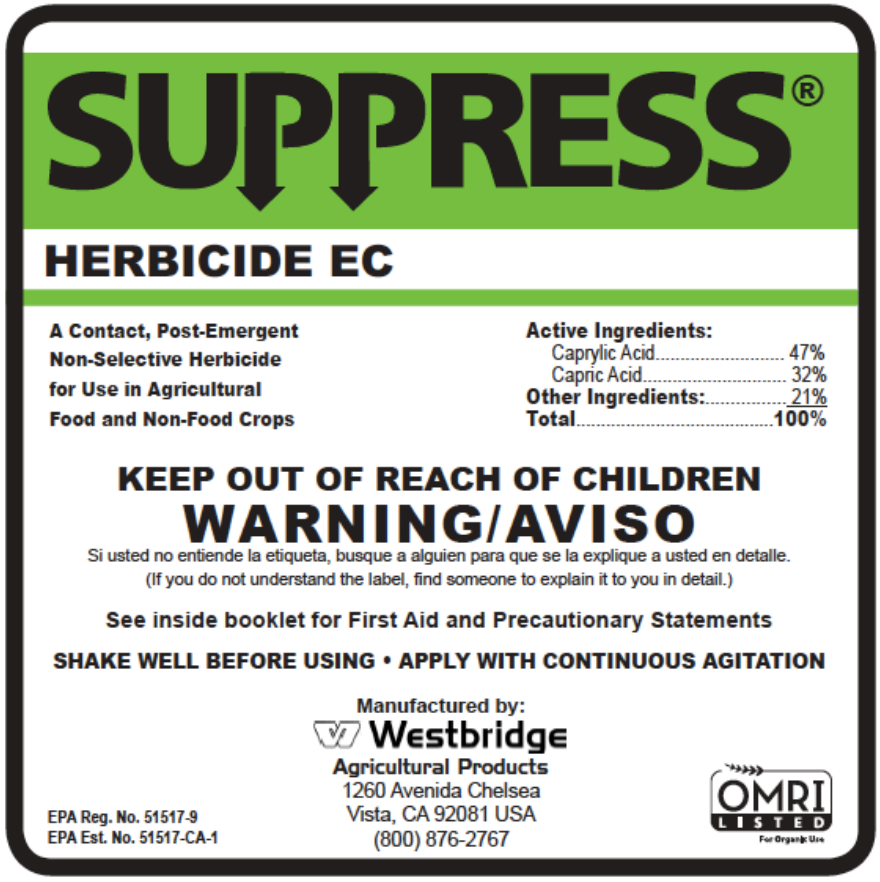
A few months ago I wrote about starting some tests looking at various postemergence herbicides for non-crop use. This project was initiated due to new ordinances some cities in southern California were considering or adopted that limited the use products containing glyphosate on city owned property. I changed up some of the products from the original test I did and repeated some others.

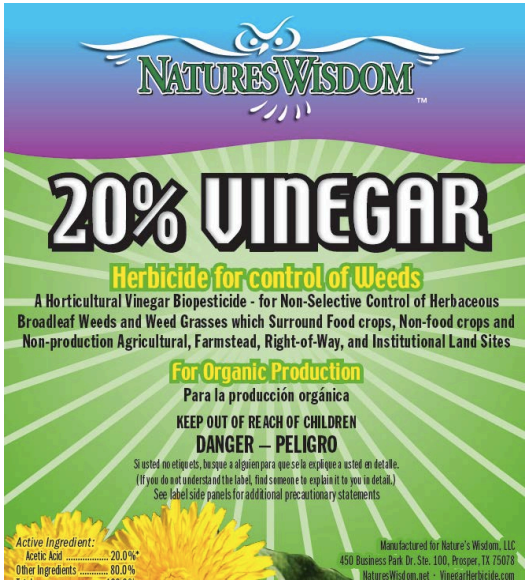
Some are listed as organic and some are organic but not be organically approved by a certifying agency e.g. OMRI. One is listed as a biopesticide (Fiesta). One is a synthetic pesticide (Finale) that may be a good replacement in certain situations.

Product	Signal word	Active ingredient(s)	$	Unit (gal)	$/1000ft² 1 application, herbicide only
	25 (b)	45% Clove Oil	124.35	1	12.84
		48.7% glyphosate (included for comparison)	69.99	2.5	0.87
		45% Cinnamon Oil	157.26	2.5	18.53
			250.95	2.5	8.15
			150.00	2.5	7.46
				2.5	2.17
				2.5	4.84

How Do Organic Herbicides Work?

- All are contact herbicides- grasses and perennials
- Good spray coverage is essential
- Work best on clear sunny days
- Usually work better in warm weather (80º F or above)
- Organic surfactants improve weed control
- Repeat applications are needed for larger weeds or very weedy areas

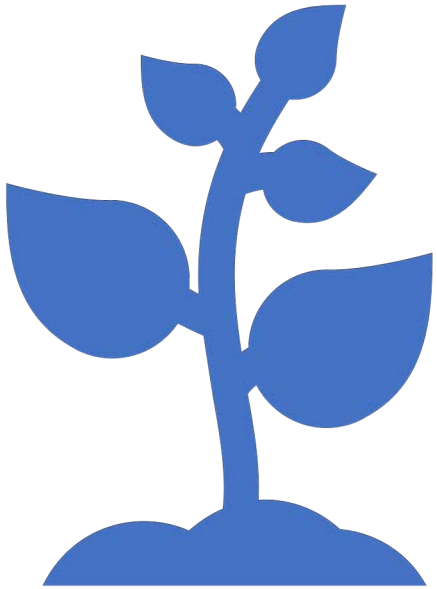




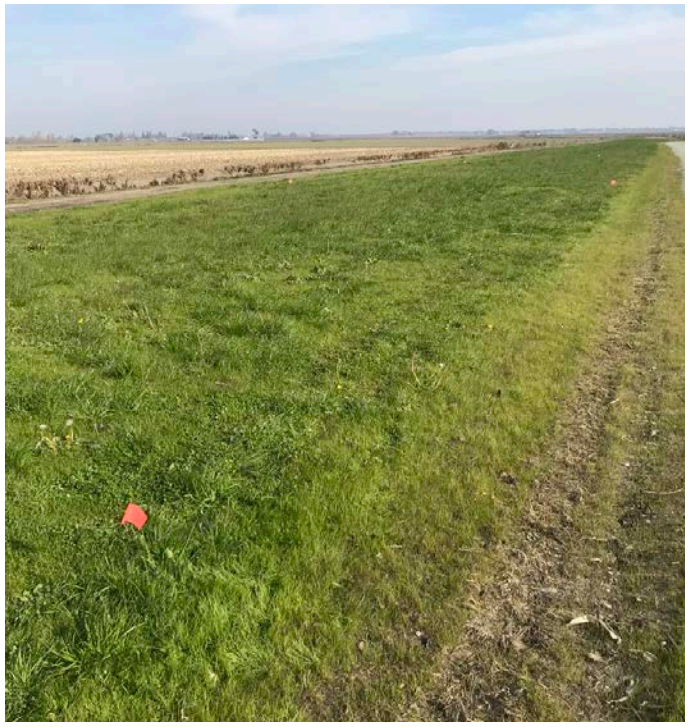
Plants oils, soaps, derived from natural sources. All organic?

Products tested in our trials

Product name	Active Ingredients	Signal Word	Organic?
Avenger AG	70% d-limonene	Caution	Yes
AXXE	40%, ammonium nonanoate	Warning	Yes
Burnout	8% citric acid, 2 % clove oil	Danger	Yes
Fiesta	Iron HEDTA	Caution	No
Finale	glufosinate-ammonium	Warning	No
Finalsan	22% ammoniated soap of fatty acids	Warning	Yes
Nature's Wisdom	20% acetic acid	Danger	Yes
Ranger Pro	41% glyphosate	Caution	No
Scythe	57% pelargonic acid; 3% fatty acids	Warning	No
Suppress + BioLink	47% caprylic acid, 32% capric acid	Warning	Yes
Weed Slayer (Part A & B)	6% eugenol; 35% Rhamnolipid biosurfactant	Caution	Yes
Weed Zap	45% clove oil, 45% cinnamon oil	Caution	Yes



Efficacy
(preliminary studies)

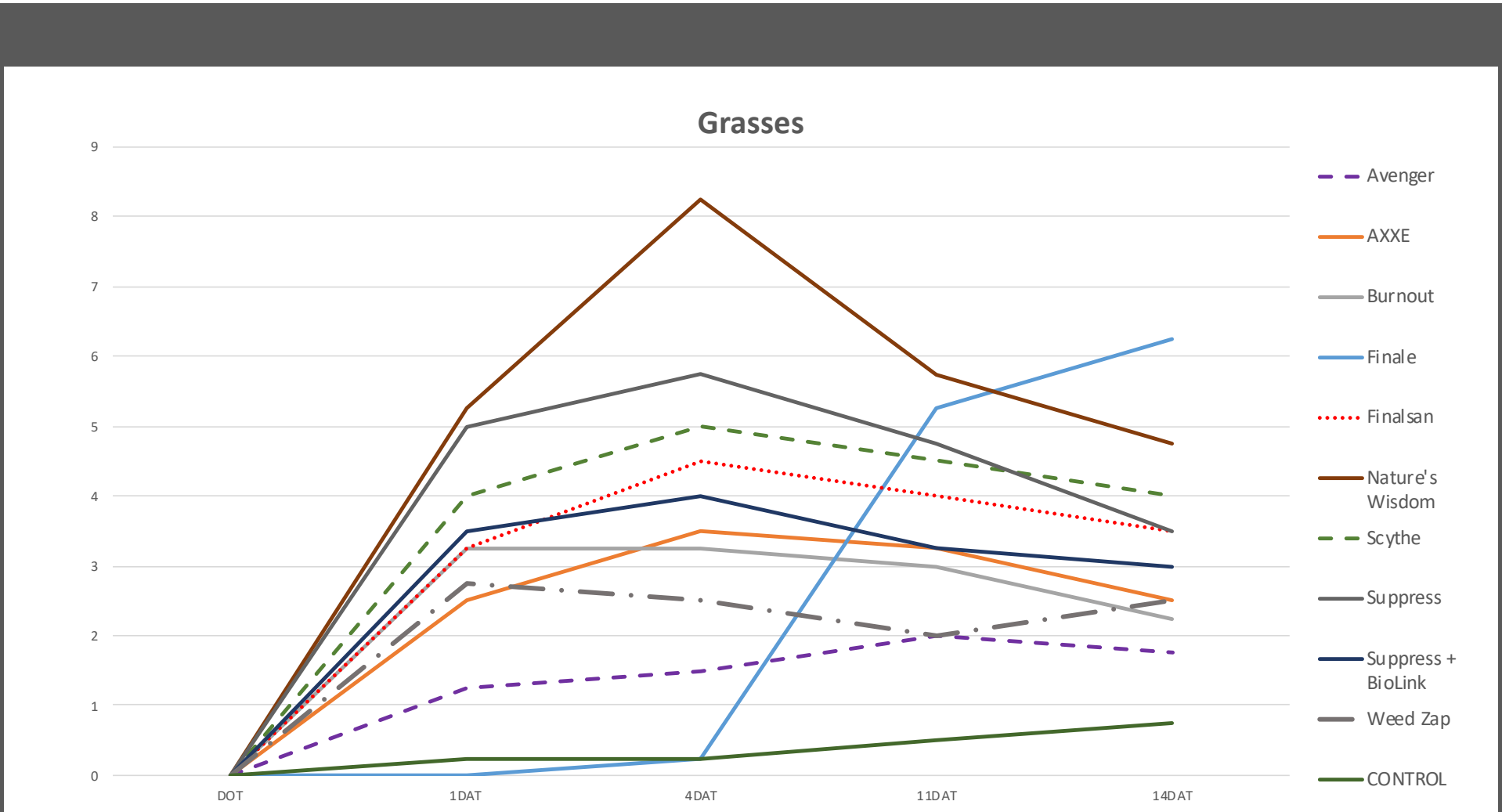

Sacramento Delta site, 2019

- Major weeds at this site included clovers, bristly oxtongue, dandelion, mallow, various grasses

Sacramento Delta region, February-March 2019

- Plots were 5 x 10 ft
- Three nozzle, flat fan; 100 GPA
- 12 plots per rep; 4 reps
- Temperature range 50-65º F

Product	Formulation	Rate
Avenger	70% d-limonene	6%
AXXE	40% ammonium nonanoate	10%
Burnout II (concentrate)	24% citric acid, 8% clove oil	25%
Fiesta	Iron HEDTA	4%
Finale	Glufosinate-ammonium	1%
Finalsan	22% Ammoniated soap of fatty acids	17%
Nature's Wisdom	20% acetic acid	Full
Scythe	57% pelargonic acid; 3% fatty acids	6%
Suppress	47% caprylic acid, 32% capric acid	6%
Suppress + BioLink	47% caprylic acid, 32% capric acid + biosurfactant	6% + 1%
Weed Zap	45% clove oil, 45% cinnamon oil	6%
CONTROL		


Grasses
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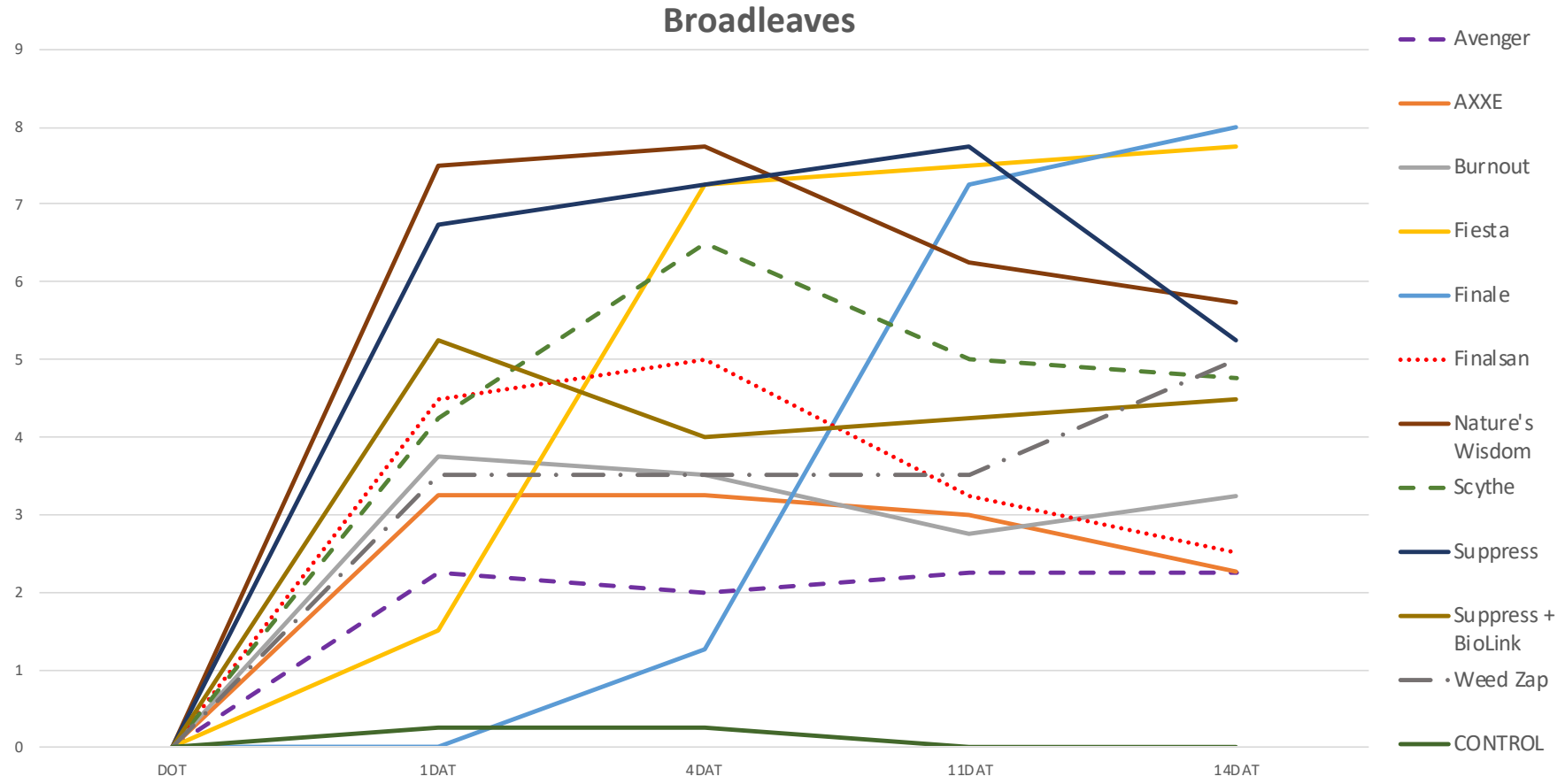
Avenger
AXXE
Burnout
Finale
Finalsan
Nature's Wisdom
Scythe
Suppress
Suppress + BioLink
Weed Zap
CONTROL


Broadleaves
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Avenger
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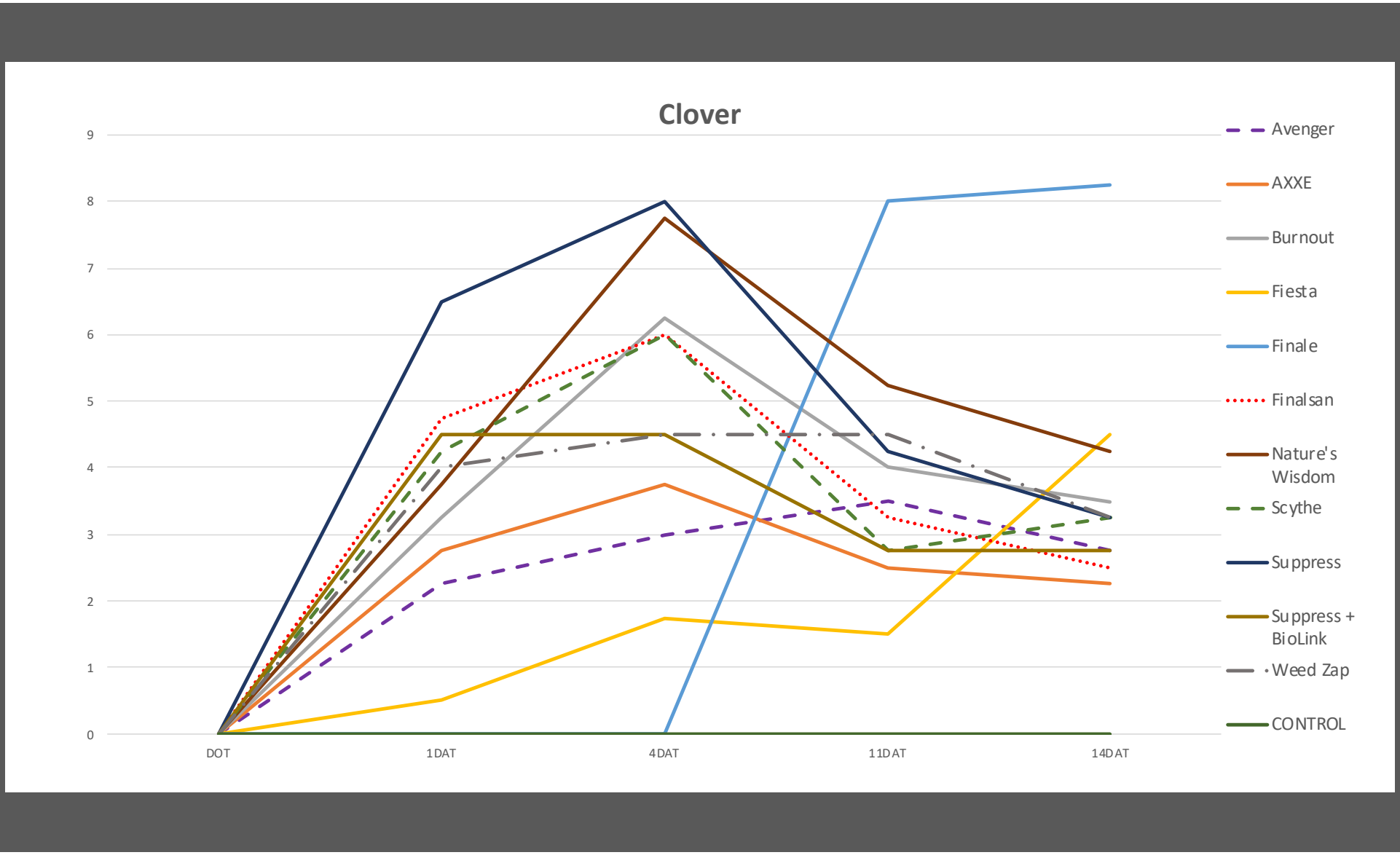
Burnout
Fiesta
Finale
Finalsan
Nature's Wisdom
Scythe
Suppress
Suppress + BioLink
Weed Zap
CONTROL


Clover
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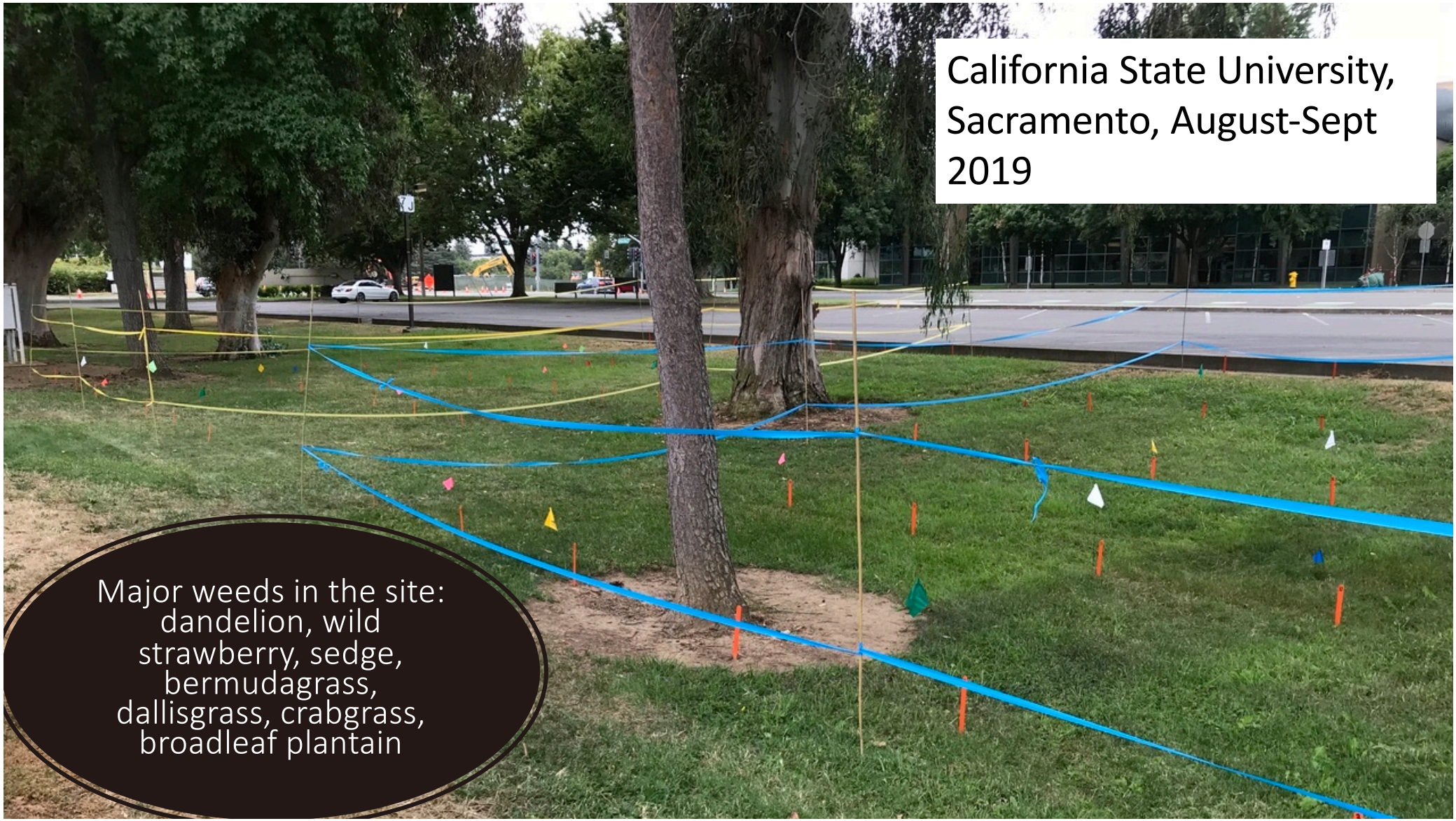
Suppress + BioLink
Weed Zap
CONTROL

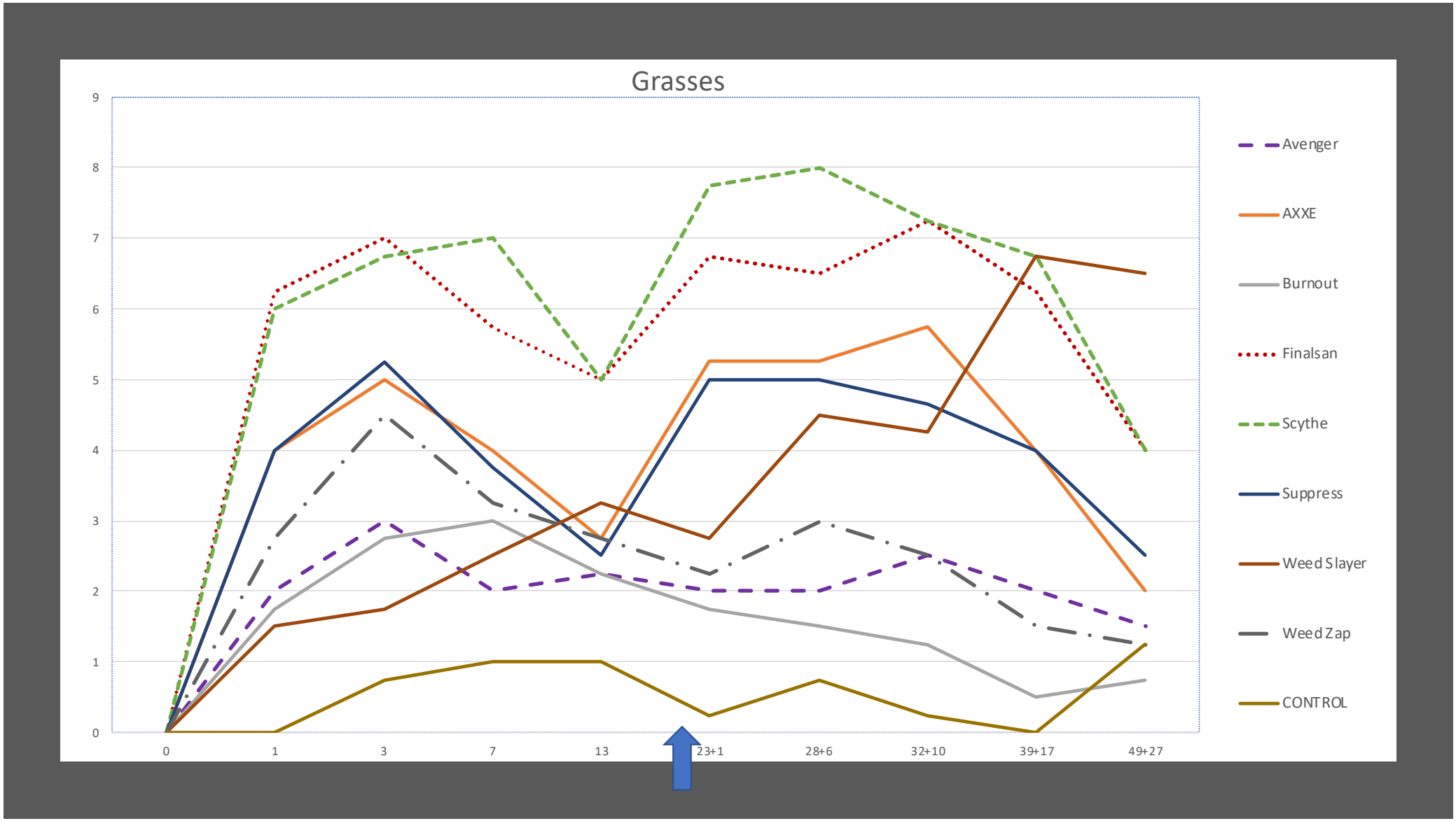

California State University, Sacramento, August-Sept 2019
Major weeds in the site: dandelion, wild strawberry, sedge, bermudagrass, dallisgrass, crabgrass, broadleaf plantain


College Town Dr

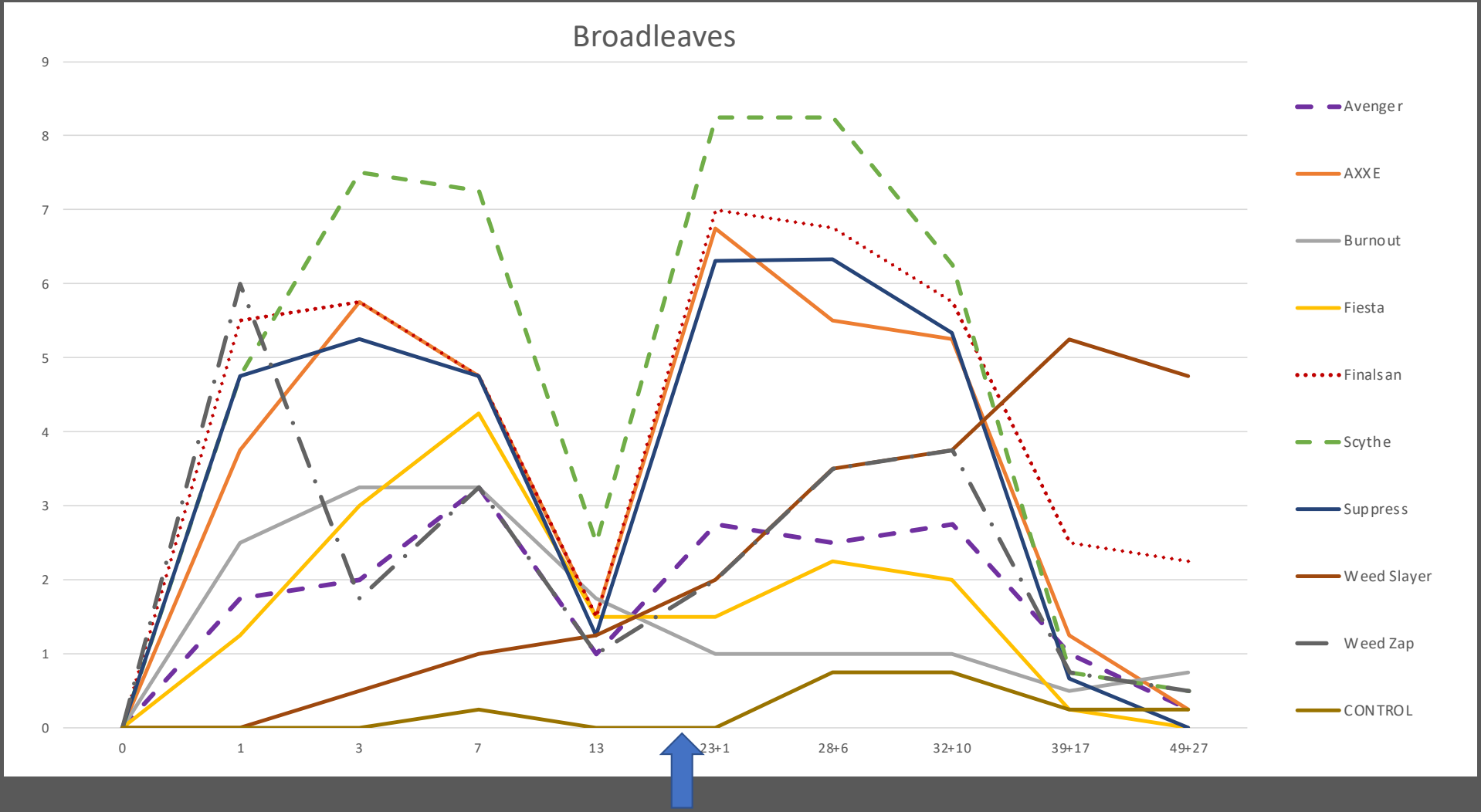
CSU Sacramento, August-Sept 2019

- Almost same materials as Sac Delta
- Plots were 5 x 10 ft
- Three nozzle, flat fan; 50 GPA
- 12 plots per rep; 4 reps
- Temperature range 70-104º F

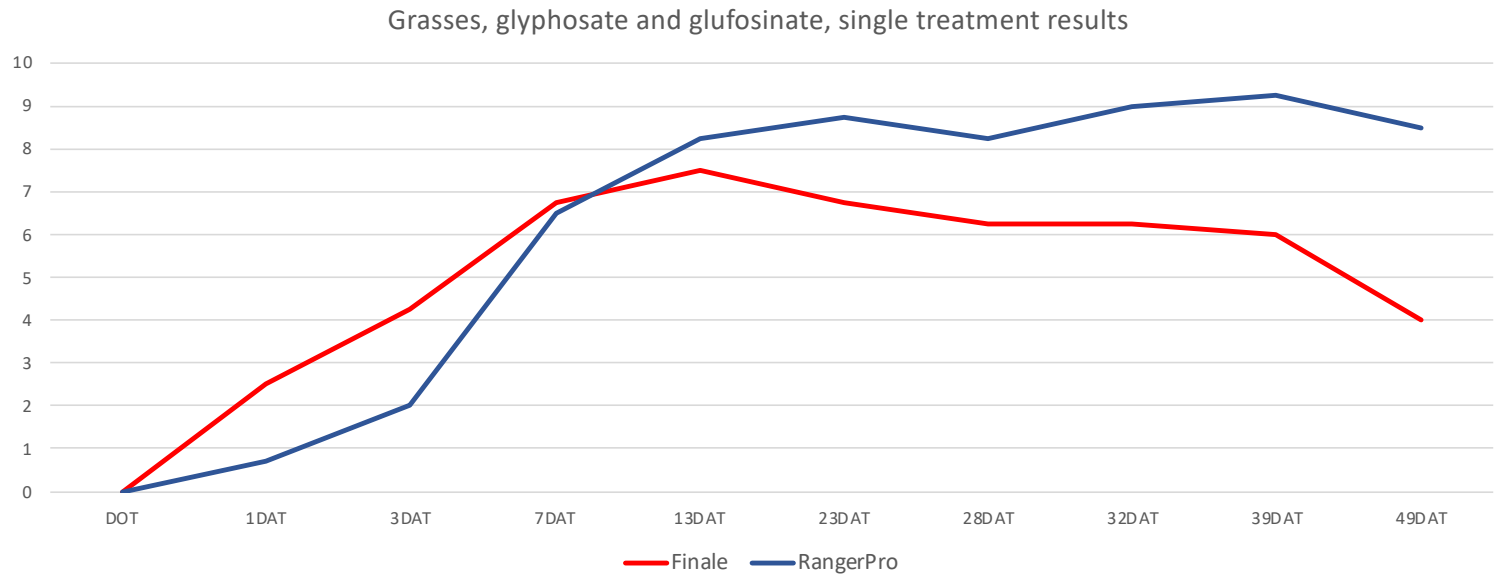
Product	Active Ingredients	Rate
Avenger AG	70% d-limonene	6%
AXXE	40%, ammonium nonanoate	10%
Burnout	8% citric acid, 2 % clove oil	25%
Fiesta	Iron HEDTA	4%
Finale	glufosinate-ammonium	1%
Finalsan	22% ammoniated soap of fatty acids	17%
Ranger Pro	41% glyphosate	1%
Scythe	57% pelargonic acid; 3% fatty acids	6%
Suppress + BioLink	47% caprylic acid, 32% capric acid	6% + 1%
Weed Slayer (A & B)	6% eugenol; 35% Rhamnolipid biosurfactant	1 qt/acre (treatment 1); 3 qt/ac (treatment 2)
Weed Zap	45% clove oil, 45% cinnamon oil	6%
CONTROL		



2nd treatment



2nd treatment


Grasses, glyphosate and glufosinate, single treatment results
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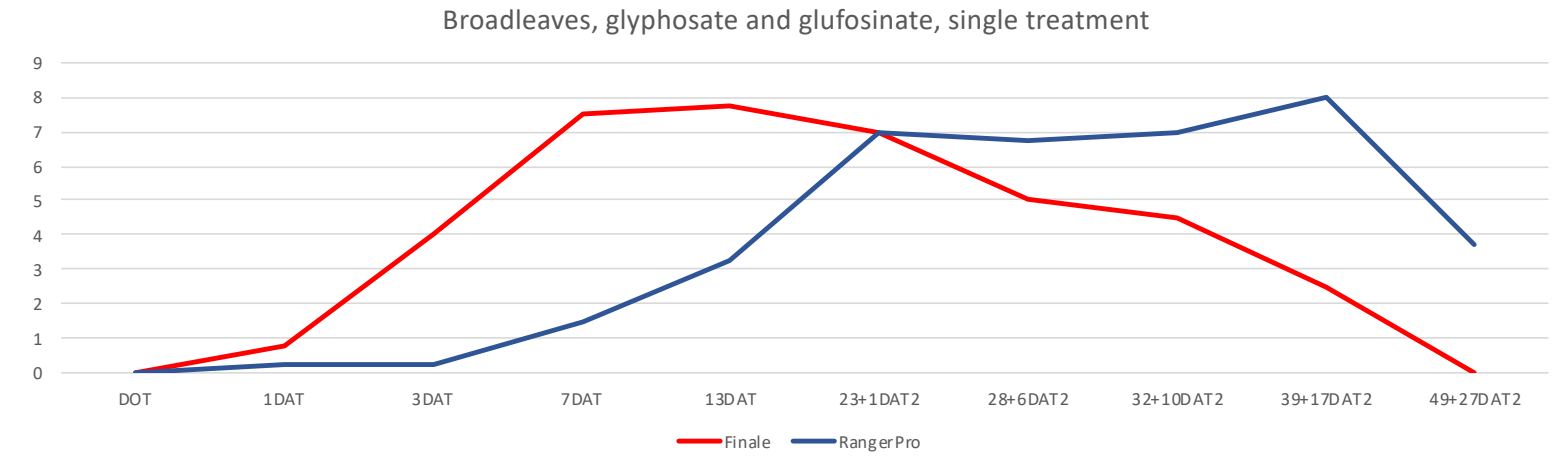
Finale
RangerPro


Broadleaves, glyphosate and glufosinate, single treatment
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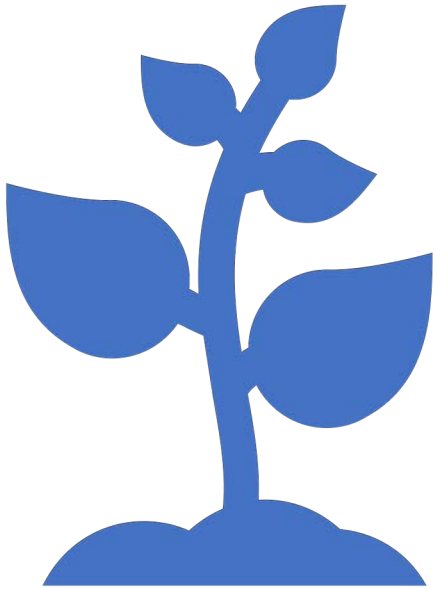
28+6DAT2
32+10DAT2
39+17DAT2
49+27DAT2
Finale
RangerPro



Tradeoffs

Tradeoffs associated with conventional glyphosate products or a nonselective organic alternative.

	Conventional glyphosate product[1]	Organic nonselective herbicide
Mode of action	Systemic	Contact
Signal word	Caution	Variable depending on product: Caution, Warning, or Danger
Personal Protective Equipment (PPE)	California minimum PPE (long-sleeved shirt, long pants, shoes plus socks, protective eyewear, and chemical-resistant gloves)	Variable depending on product, may include: California minimum PPE, chemical-resistant footwear, coveralls, or respirator
Rate of observable weed injury	Visible injury in 4 to 20 days	Visible injury in hours to days
Reapplication frequency for broadcast spray	Lower reapplication frequency	Higher reapplication frequency
Active ingredient volume	Lower volume of active ingredient	Higher volume of active ingredient
Cost per application area	Lower cost per application area	Higher cost per application area

[1]Information for a standard glyphosate-containing product

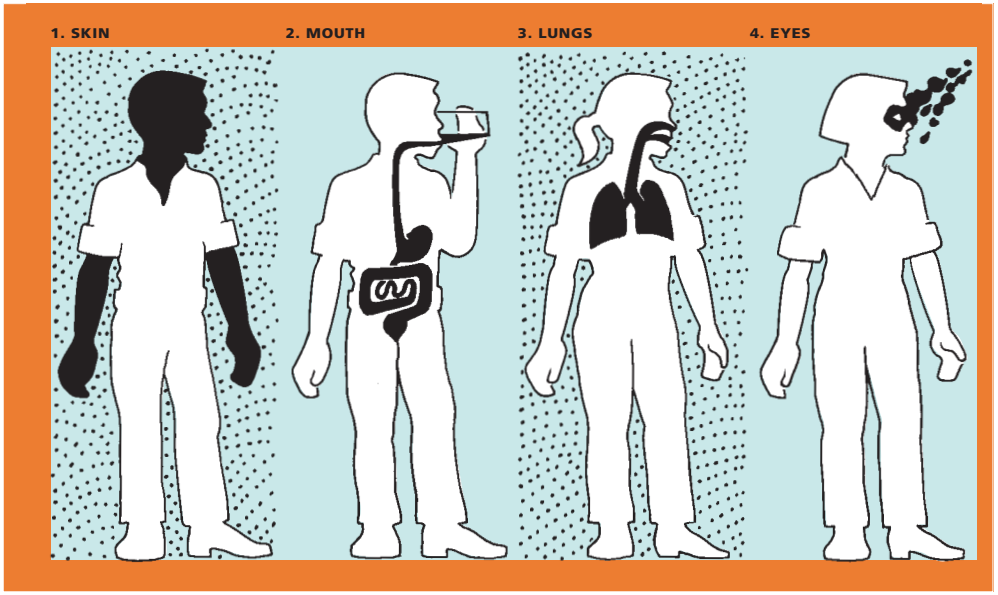
Products used in 2019 trials

Product name	Active Ingredients	Signal Word	Organic?
Avenger AG	70% d-limonene	Caution	Yes
AXXE	40%, ammonium nonanoate	Warning	Yes
Burnout	8% citric acid, 2 % clove oil	Danger	Yes
Fiesta	Iron HEDTA	Caution	No
Finale	glufosinate-ammonium	Warning	No
Finalsan	22% ammoniated soap of fatty acids	Warning	Yes
Nature's Wisdom	20% acetic acid	Danger	Yes
Ranger Pro	41% glyphosate	Caution	No
Scythe	57% pelargonic acid; 3% fatty acids	Warning	No
Suppress + BioLink	47% caprylic acid, 32% capric acid	Warning	Yes
Weed Slayer	6% eugenol; Bacillus megaterium	Caution	Yes
Weed Zap	45% clove oil, 45% cinnamon oil	Caution	Yes

NOTE from KR: some of these may not be considered organic due to carrier ingredients, even if the active ingredient would be considered organic.

Signal Words indicate acute toxicity

SIGNAL WORD	Toxicity	Approx Human lethal dosage
DANGER-POISON	Highly toxic	Drop to a teaspoon
DANGER	Highly hazardous	Pesticide-specific
WARNING	Moderately toxic	1 teaspoon-1 oz
CAUTION	Low toxicity	1 oz to relatively nontoxic



Plot 31
FinalSan

by day 13, weeds are regrowing

by day 22, they are filling in; a second spray was applied

SUPPRESS®

HERBICIDE EC

KEEP OUT OF REACH OF CHILDREN

WARNING/AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

Active Ingredients:

Caprylic Acid	47%
Capric Acid	32%
Other Ingredients:	21%
Total	**100%**

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for Category C on an EPA chemical-resistance selection chart.

Applicators and other handlers must wear:

- Protective eyewear
- Coveralls worn over short-sleeved shirt and short pants
- Shoes plus socks
- Chemical resistant gloves such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride or viton

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE items separately from other laundry.

Protective eyewear
Coveralls over long sleeved shirt and long pants
Socks plus shoes
Chemical resistant gloves – category and specific glove materials

Causes substantial but temporary eye injury

OMRI LISTED
For Organic Use

Personal Protective Equipment

Is that all he needs?

Personal Protective Equipment (PPE) Applicators and other handlers (other than Mixers and Loaders) must wear:

- Long-sleeve shirt and long pants
- Shoes plus socks
- Protective eyewear
- Chemical-resistant gloves – Category A (e.g. barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinyl chloride (PVC), or Viton®)
- A dust/mist NIOSH-approved respirator with any N, R, P, or HE filter. The respirator should have a NIOSH approval number prefix TC-84A.

Cost per 1000 sq. ft.

Product name	Active Ingredients	Signal Word	Organic?	Price/btl	Size	price/ 1000 ft2
Avenger AG	70% d-limonene	Caution	Yes	$200	2.5 gal	$5.50
AXXE	40%, ammonium nonanoate	Warning	Yes	$207	2.5 gal	$9.45
Burnout	8% citric acid, 2 % clove oil	Danger	Yes	$100	2.5 gal	$11.41
Fiesta	Iron HEDTA	Caution	No	$180	2.5 gal	$3.31
Finale	glufosinate-ammonium	Warning	No	$175	2.5 gal	$0.80
Finalsan	22% ammoniated soap of fatty acids	Warning	Yes	$81	2.5 gal	$6.29
Nature's Wisdom	20% acetic acid	Danger	Yes	$75	2.5 gal	$34.24
Ranger Pro	41% glyphosate	Caution	No	$70	2.5 gal	$0.32
Scythe	57% pelargonic acid; 3% fatty acids	Warning	No	$180	2.5 gal	$4.95
Suppress + BioLink	47% caprylic acid, 32% capric acid	Warning	Yes	$190	2.5 gal	$5.22
Weed Slayer	6% eugenol; Bacillus megaterium	Caution	Yes	$185	1 gal	$2.64
Weed Zap	45% clove oil, 45% cinnamon oil	Caution	Yes	$175	2.5 gal	$4.81

What's Next?

- Finish analyzing data
- Continue trials in other sites in Sacramento & Yolo County
- Testing products at different rates/tank mix?
- Trials in different weather conditions
- Publish results

Organic herbicides and glyphosate for weed control: results of coordinated experiments in urban landscapes

Maggie Reiter, Environmental Horticulture Advisor and Affiliate IPM Advisor, UC Cooperative Extension, Fresno County
Karey Windbiel-Rojas, Area IPM Advisor, UC Cooperative Extension, Sacramento, Yolo, & Solano County and UC Statewide IPM Program

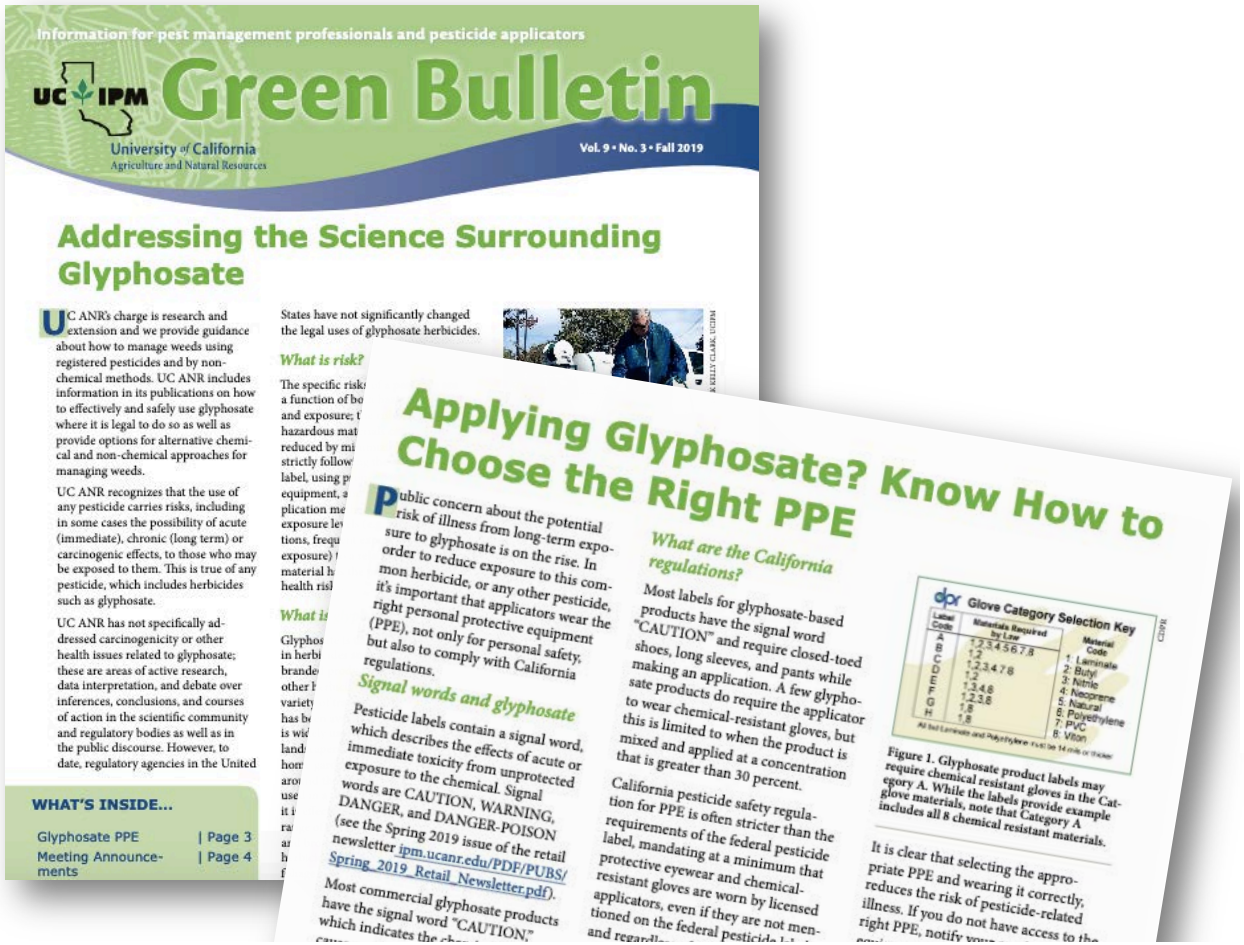
Introduction

Weeds in urban landscapes can be detrimental since they compete with native and desirable plants, contribute to wildland fire fuels, reduce functions of recreational areas like turf and pavement, hinder visibility in transportation networks, impact human health via allergen exposure, and promote other pests like rodents. While integrated pest management (IPM) provides many nonchemical options for controlling weeds—tools, steaming, flaming, weed-eating animals and others—situations may still require the application of herbicides. For several decades, glyphosate has been used to control weeds in both agricultural and nonagricultural areas. Glyphosate is relatively inexpensive, effective on a wide range of weeds, and has a low risk of offsite movement (Henderson et al. 2010).

One approach is to use other conventional or organically acceptable herbicides. This approach may be easiest for pest management practitioners; swapping herbicide formulations does not require new application equipment or knowledge of how to use new equipment. Despite contemporary interest, there is little research on organic/alternative herbicide efficacy in urban landscape systems. We designed experiments to address this need and provide information about organic herbicides. Our trials build on previous work examining natural herbicides in California landscapes by Wilen (2012, 2016).

The objective of our experiments was to compare herbicides certified by the Organic Material Review Institute (OMRI) as

Green Bulletin e-newsletter



Information for pest management professionals and pesticide applicators

UC IPM Green Bulletin

University of California Agriculture and Natural Resources

Vol. 9 • No. 3 • Fall 2019

Addressing the Science Surrounding Glyphosate

UC ANR's charge is research and extension and we provide guidance about how to manage weeds using registered pesticides and by non-chemical methods. UC ANR includes information in its publications on how to effectively and safely use glyphosate where it is legal to do so as well as provide options for alternative chemical and non-chemical approaches for managing weeds.

UC ANR recognizes that the use of any pesticide carries risks, including in some cases the possibility of acute (immediate), chronic (long term) or carcinogenic effects, to those who may be exposed to them. This is true of any pesticide, which includes herbicides such as glyphosate.

UC ANR has not specifically addressed carcinogenicity or other health issues related to glyphosate; these are areas of active research, data interpretation, and debate over inferences, conclusions, and courses of action in the scientific community and regulatory bodies as well as in the public discourse. However, to date, regulatory agencies in the United States have not significantly changed the legal uses of glyphosate herbicides.

WHAT'S INSIDE...

Applying Glyphosate? Know How to Choose the Right PPE

Public concern about the potential risk of illness from long-term exposure to glyphosate is on the rise. In order to reduce exposure to this common herbicide, or any other pesticide, it's important that applicators wear the right personal protective equipment (PPE), not only for personal safety, but also to comply with California regulations.

Signal words and glyphosate

Pesticide labels contain a signal word, which describes the effects of acute or immediate toxicity from unprotected exposure to the chemical. Signal words are CAUTION, WARNING, DANGER, and DANGER-POISON (see the Spring 2019 issue of the retail newsletter ipm.ucanr.edu/PDF/PUBS/Spring_2019_Retail_Newsletter.pdf).

Most commercial glyphosate products have the signal word "CAUTION," which indicates the

What are the California regulations?

Most labels for glyphosate-based products have the signal word "CAUTION" and require closed-toed shoes, long sleeves, and pants while making an application. A few glyphosate products do require the applicator to wear chemical-resistant gloves, but this is limited to when the product is mixed and applied at a concentration that is greater than 30 percent.

California pesticide safety regulation for PPE is often stricter than the requirements of the federal pesticide label, mandating at a minimum that protective eyewear and chemical-resistant gloves are worn by licensed applicators, even if they are not mentioned on the federal pesticide

dpr Glove Category Selection Key

Label Code	Materials Required by Law	Material Code
A	1,2,3,4,5,6,7,8	1: Laminate
B	1,2	2: Butyl
C	1,2,3,4,7,8	3: Nitrile
D	1,2	4: Neoprene
E	1,3,4,8	5: Natural
F	1,2,3,8	6: Polyethylene
G	1,8	7: PVC
H	1,8	8: Viton

All but Laminate and Polyethylene: if 50 to 14 mils or thicker

Figure 1. Glyphosate product labels may require chemical resistant gloves in the Category A. While the labels provide example glove materials, note that Category A includes all 8 chemical resistant materials.

It is clear that selecting the appropriate PPE and wearing it correctly, reduces the risk of pesticide-related illness. If you do not have access to the right PPE, notify your

Questions?

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