
UC
CE
University of California
Agriculture and Natural Resources
Cooperative Extension
Weed Control Options and Strategies from Local Research
Mick Canevari
Paul Verdegaal
UCCE San Joaquin Co

Allied Industry/Cooperators

- John Kautz Farms:
- Delicado Vineyards:
- Aberlee Acres
- Klein Farms
- Lagorio Farms
- Sutter Home
- Joe Valente
- Nick Bokitas
- Ernie Dozio
- Don Lutz
- Don Colbert
- Randall Witte
- Kurt Hembre
- Paul Verdegaal
- Anil Shestra
- Brad Hanson
- Crop Production Service
- Simplot
- Mid Valley
- Wilbur Ellis
- Bayer
- FMC
- Syngenta
- Dupont
- BASF

Are all Weeds Bad ?

Short lived annuals
Shallow rooted
Low water use
Suppress weed germ
Improves soil tilt

Are all Weeds Bad ?

High water consumption
Tough to control
Prolific seed producer
Herbicide resistance
Harvesting issues
Disease & insect host


Weeds were left to grow for 0, 3, 6, 9, 12, and 24 months after planting.
Kurt Hembree, UCCE, Fresno County – May 4, 2011
Hembree & Vasquez , UCCE, Fresno County

Effect on trunk growth:

Hembree & Vasquez , UCCE, Fresno County

Vine damage

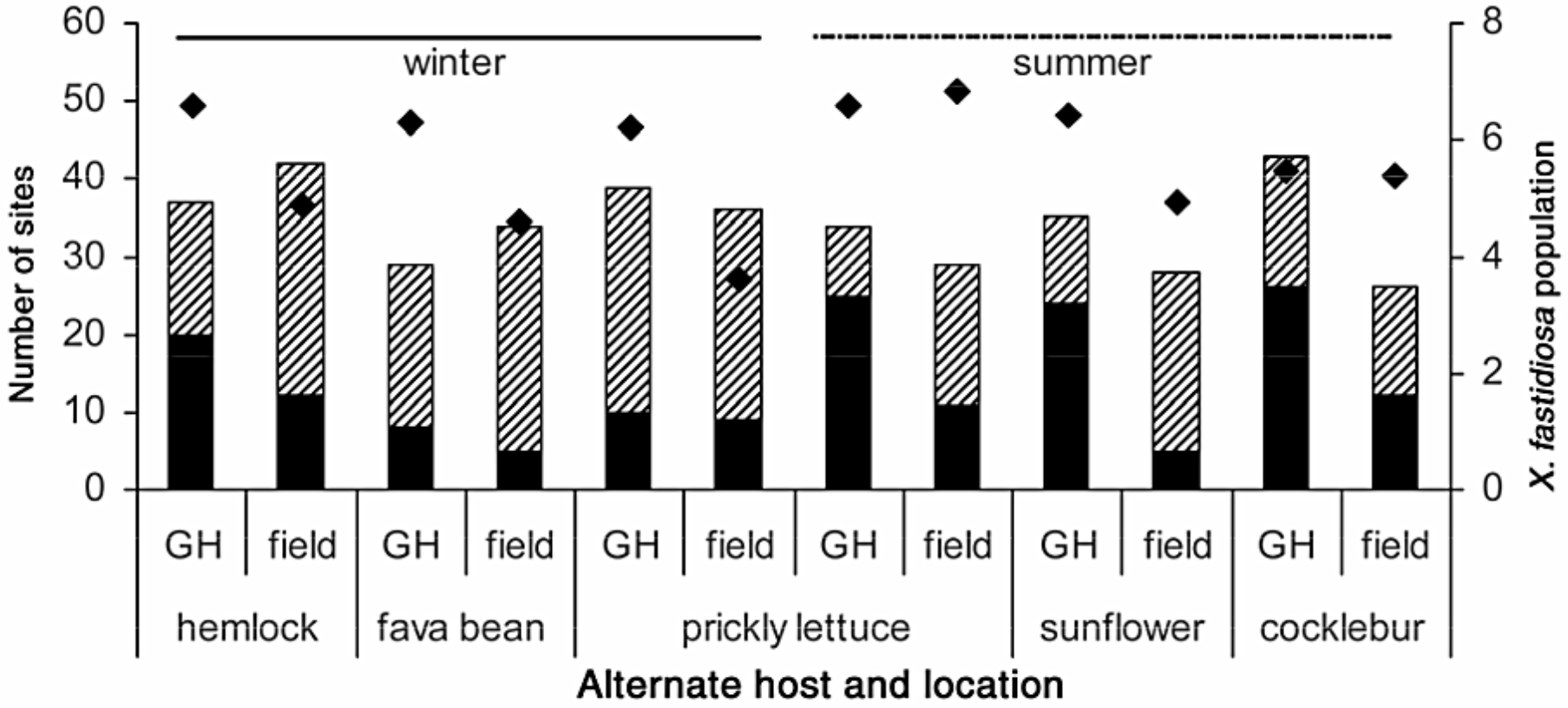
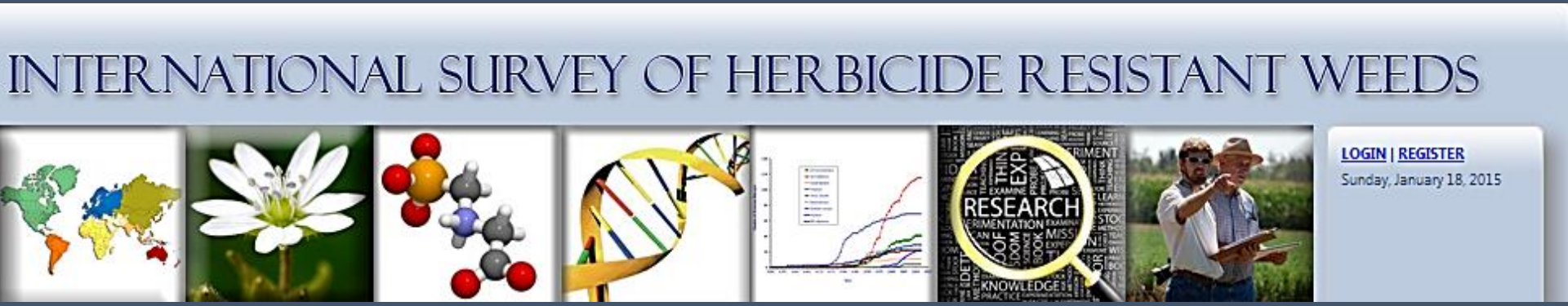


Fig. 2. *Xylella fastidiosa* infection at the caged insect feeding site in five alternate host species grown in the greenhouse (GH) and field in winter (November 2001 to March 2002) and summer (July to November 2002). Black area represents the number of inoculation sites with *X. fastidiosa* recovery; striped area is the number of bacteria-free inoculation sites. Diamonds (secondary y-axis) represent median *X. fastidiosa* populations in $\log_{10}$ CFU/g.

Herbicide Resistance- *Around the World*

- **442 Resistant Biotypes 240 Species (140 dicots and 100 monocots)**
- **about 22 of the 25 herbicide sites of action**
- **85 crops in 65 countries**
- ***- same time last year 417***



Source: Heap, I. The International Survey of Herbicide Resistant Weeds (www.weedscience.org)
January 20, 2015

Possibility of replacing the failed herbicide with a new one?

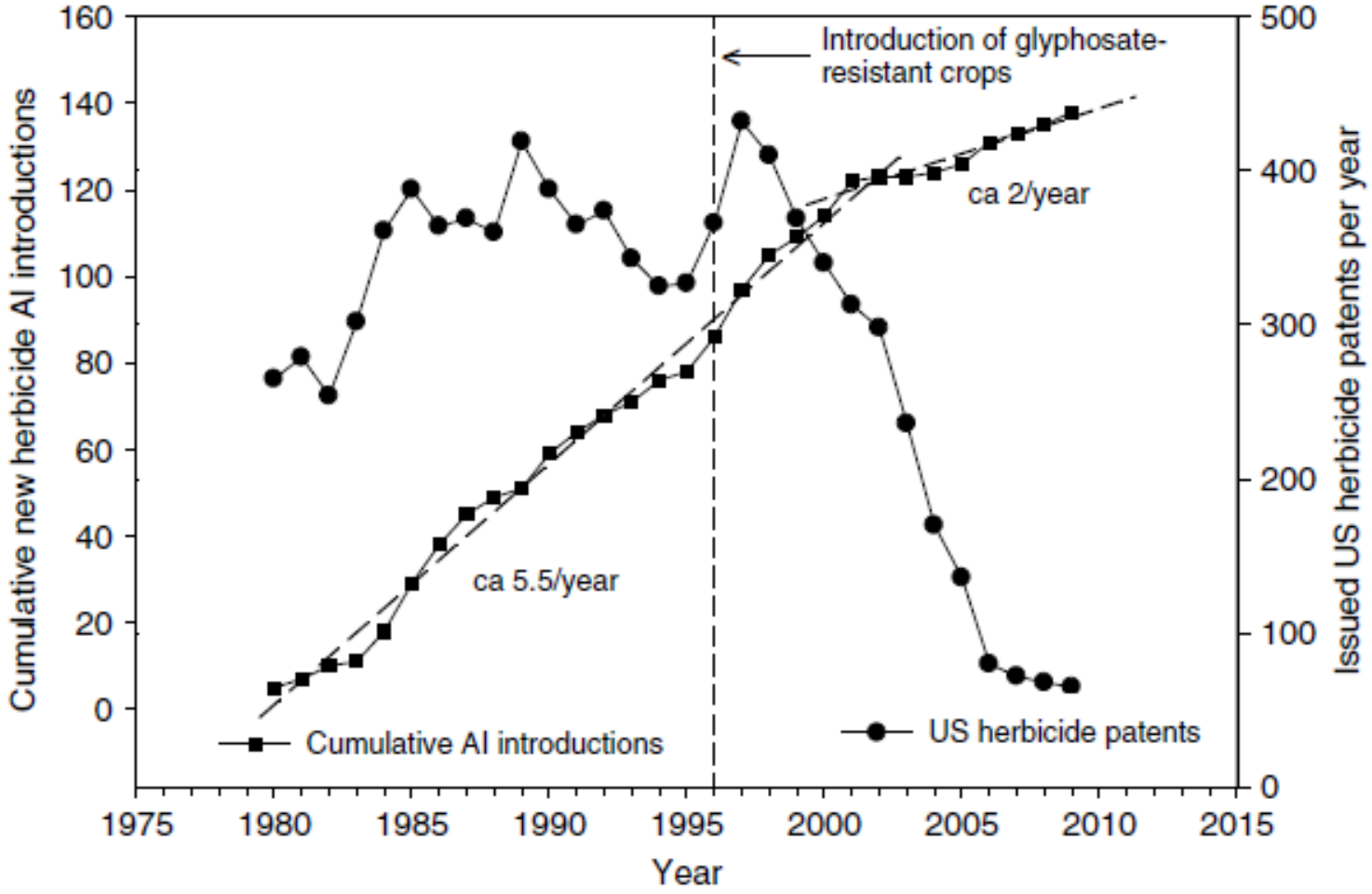
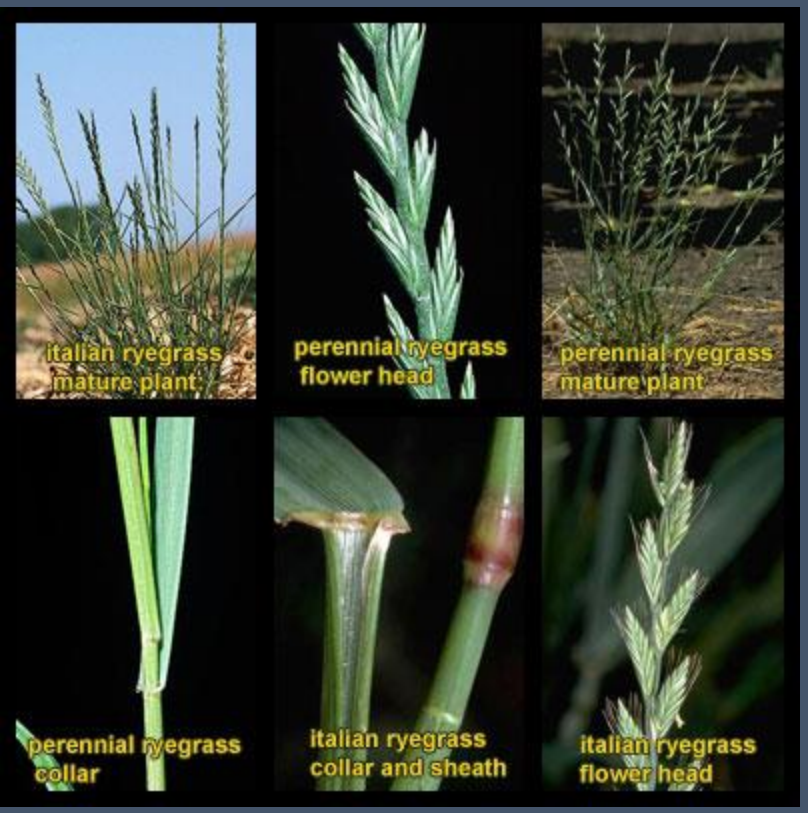


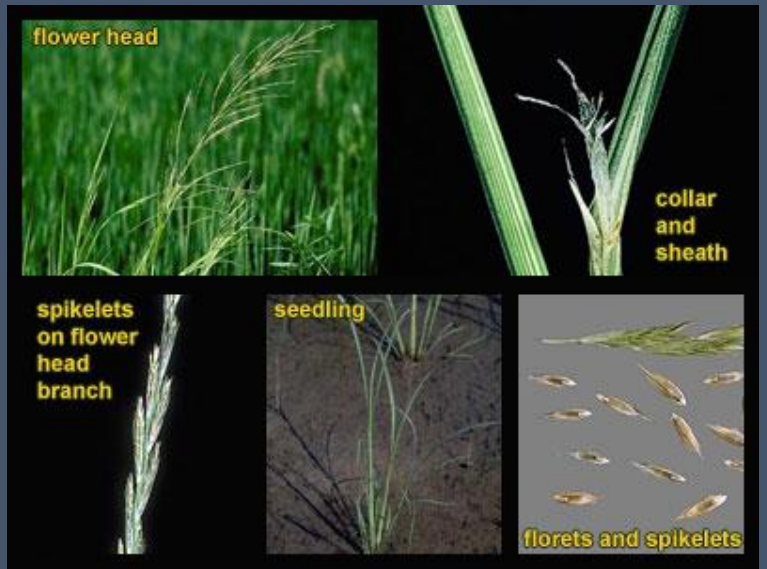
Figure 1. US herbicide patents and new active ingredient introductions over the past 30 years. Redrawn from Gerwick.[4]

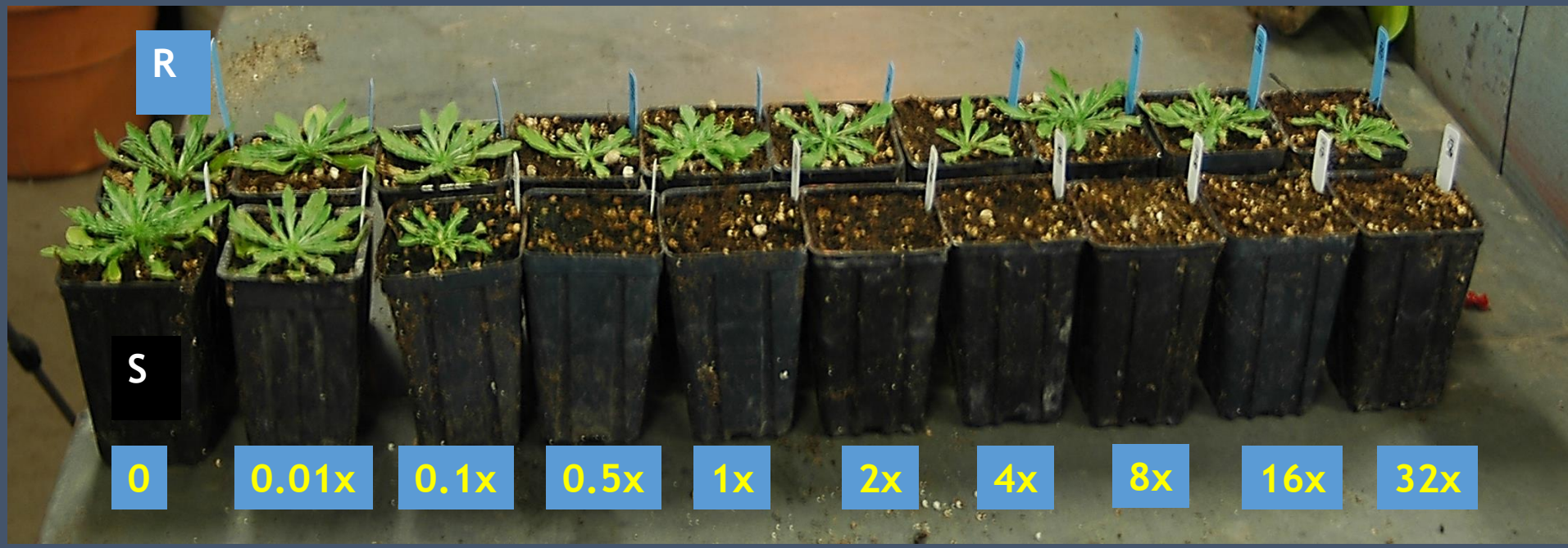
Roundup Resistant in Calif

HORSEWEED & FLEABANE



Multiple Resistant





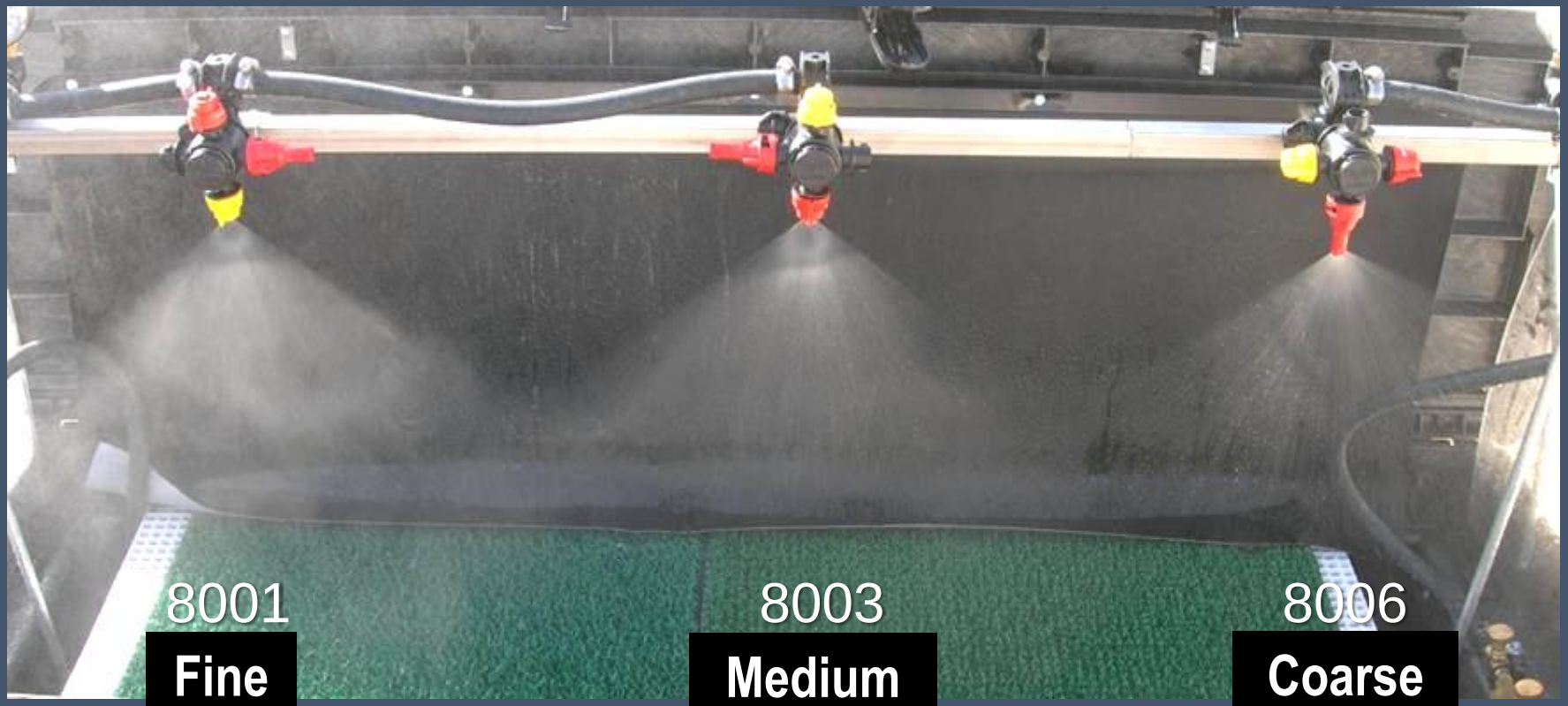
Hairy Fleabane
Resistant to both
Glyphosate & Paraquat

Moretti et al. 2013

Factors that contribute to weed control failure

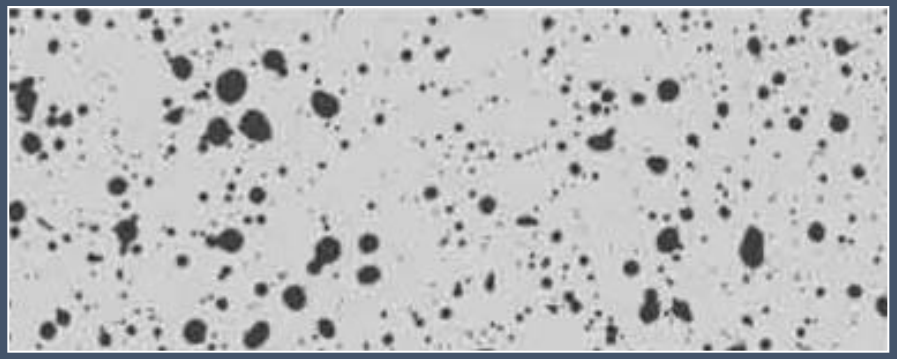
1. Spray volume
2. Spray coverage
3. Weed Size
4. Calibration
5. Soil conditions
6. Weed debris and leaves
7. Wind and drift
8. Adjuvants & Surfactants
9. Environmental conditions
10. Right herbicide

VOLUME, COVERAGE, DRIFT

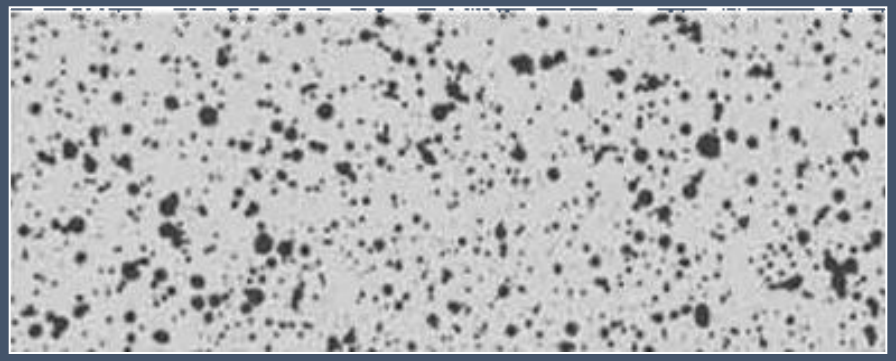


Droplets <200 μm drift more

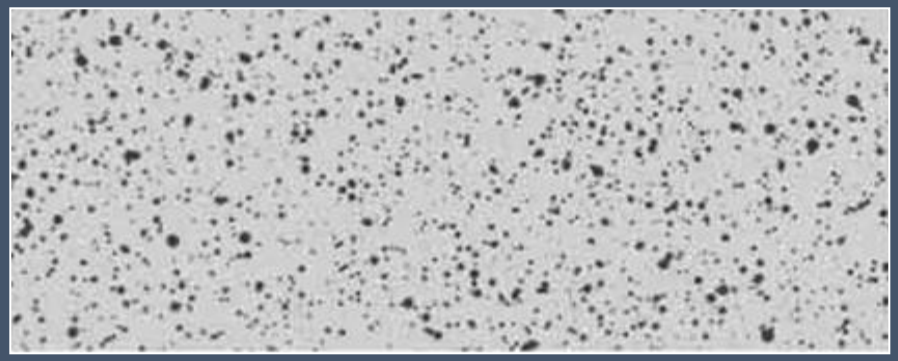
410 microns



340 microns



235 microns



Less Drift

More Drift

Herbicide + Application + Environmental Factors = Drift

New Vineyard Herbicides

Trellis® *isoxsaben.* Was recently registered for bearing and non-bearing grapes. It is strictly a pre-emergent broadleaf herbicide controlling weeds at germination. Ideally suited to be applied in late fall to early spring. Weed control has lasted 4-5 months under most conditions. It has controlled horseweed/fleabane, henbit, sowthistle and other weeds listed on the label. It is safe on young vines.

Mission® *flazasulfuron*. Is a sulfonylurea herbicide. The mode of action is an ALS, inhibitor the same mode of action as (Matrix). It's primarily a pre-emergent herbicide controlling broadleafs and grasses. It has post emergent activity on small weeds including horseweed.

New Vineyard Herbicides

Zeus® *sulfentrazone.* Is a triazolinone herbicide applied pre-emergent for broadleaf weeds, and has shown suppression of yellow nutsedge. It should be tank mixed with a post herbicides (Rely, Roundup etc) if weeds have already emerged. In grape trials, Zeus provided the best control of weeds was in combination Alion, Matrix, and Chateau, & Prowl. We have seen both excellent and marginal nutsedge results depending on soil type and enough water. This herbicide has potential for controlling some of our more challenging weeds like nutsedge but will take specific management to maximize its potential.

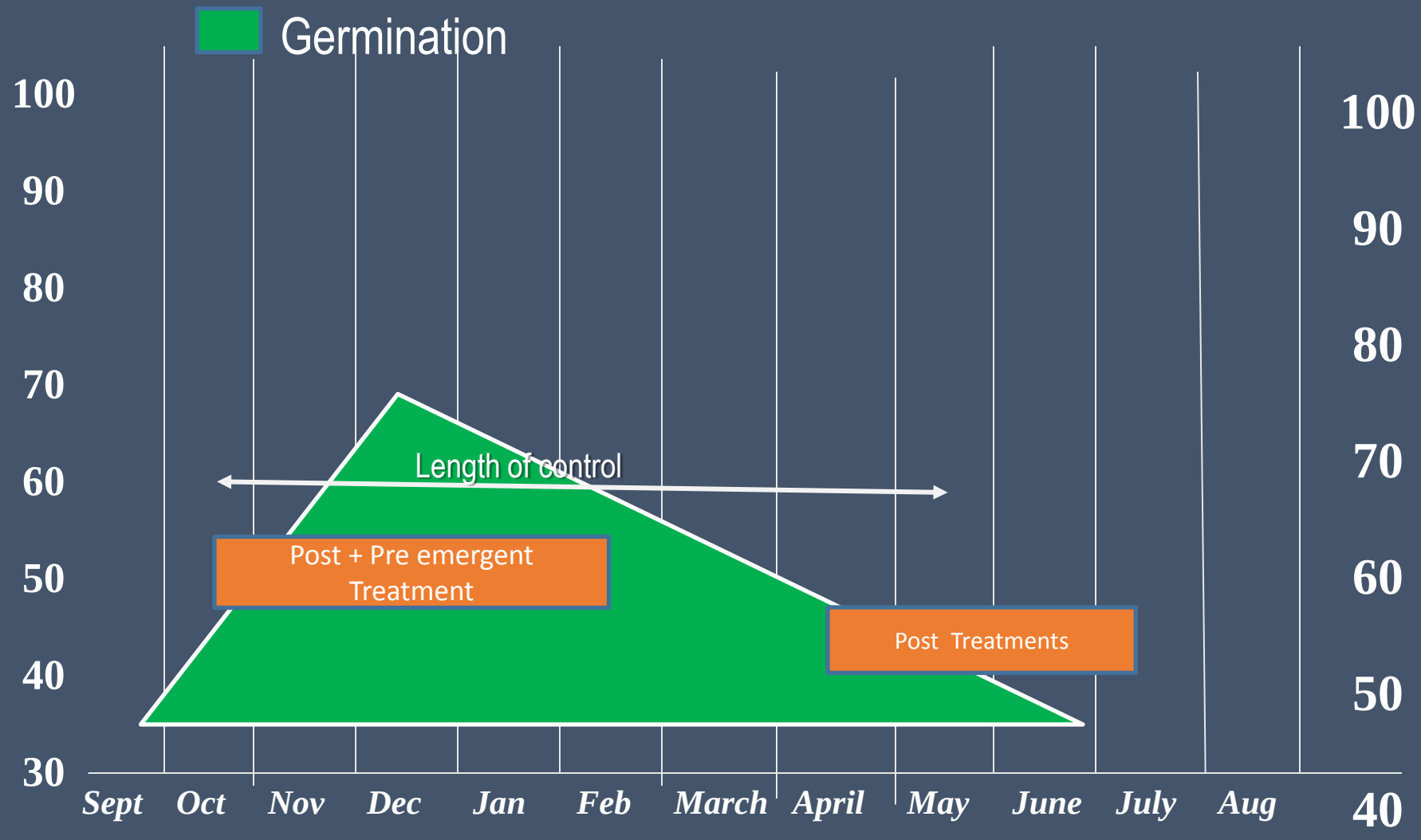
Suppress® *caprylic acid*
Suppress is OMRI approved herbicide for organic production
They are currently working out some details regarding the label with CDPR and the EPA Registration will hopefully be granted in December.


2014 Research focus
Horseweed /Fleabane
Yellow Nutsedge
Summer Grasses

Horseweed/Fleabane

- Can germinate from fall to spring and may live as an annual or biennial.
- 60-80% of new seeds can germinate immediately upon rainfall.
- Fall germinated plants grow during the winter, plants start to bolt in April/May, begin to flower in July, set and disperse seed from August to November.
- Seed Production: A large Horseweed plant can produce 200,000 seeds.
- Both have developed multiple herbicide resistant's.

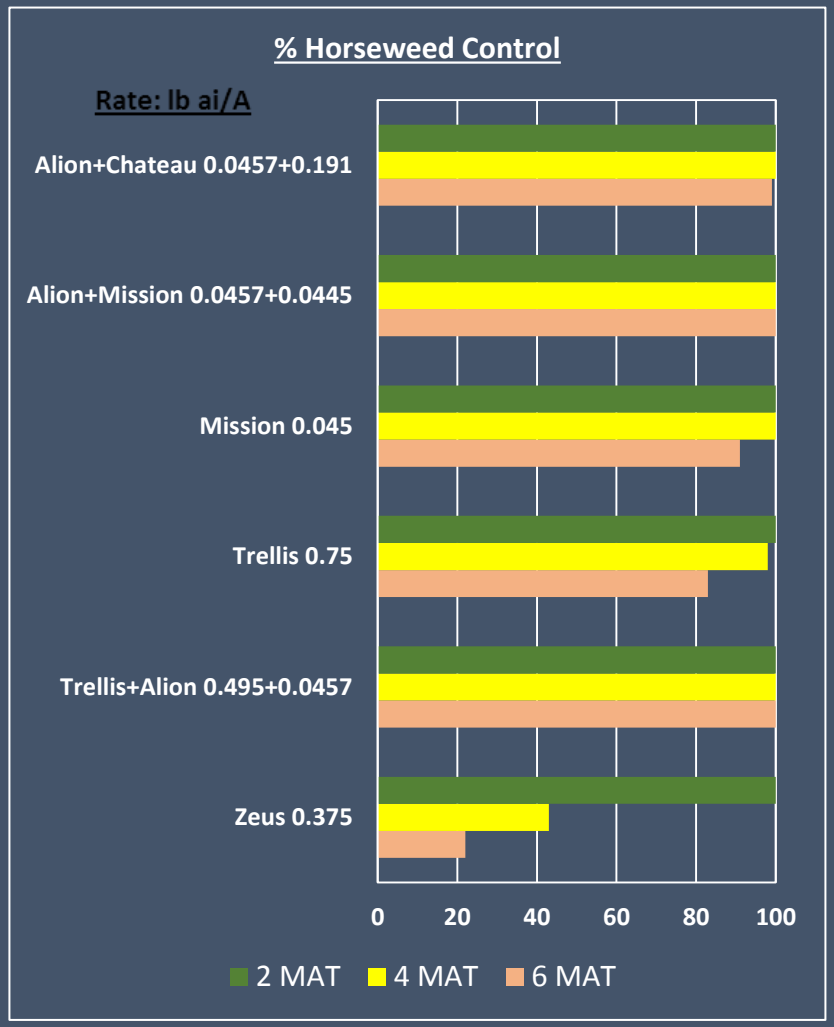
Herbicide Timing for Horseweed Control

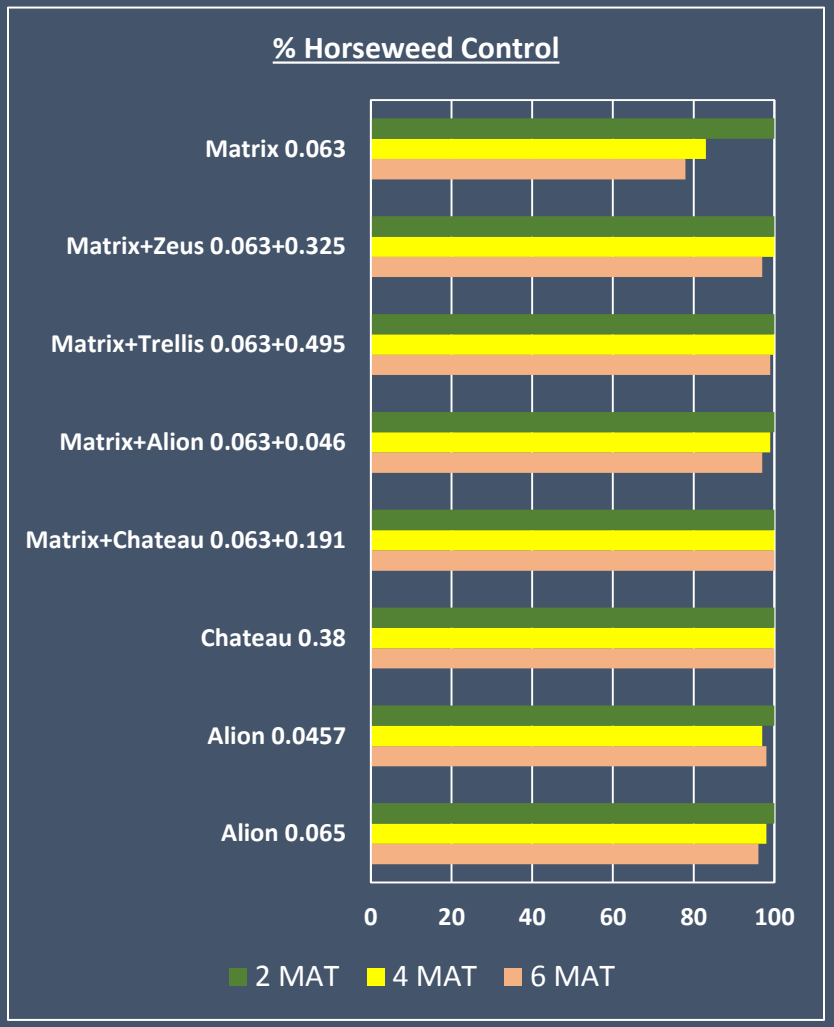


Grape Horseweed Preemergence Trial

Lodi Ca 2014

Application 11-17-13






11/17/13
150 DAT
4-24-2014
Untreated


Roundup PM 3 pts


Chateau 10 oz


Mission 2.85 oz


Trellis + Alion 0.66 + 3.5oz


Trellis 1.0


Alion 3.5oz


Matrix 4oz


Goal 3 pts

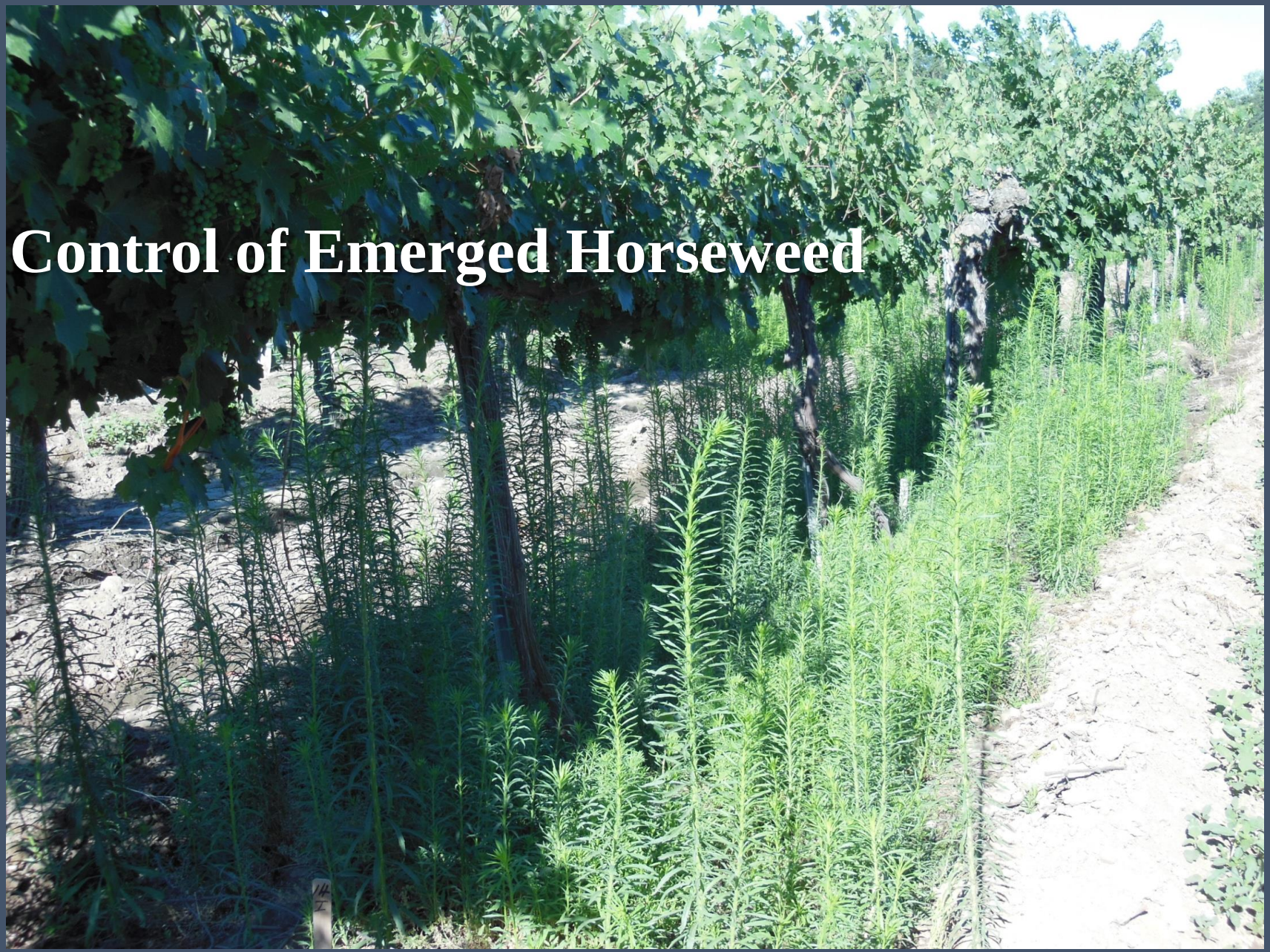

5
Trellis + Matrix 4oz +0.66 lb


13
Alion + Zeus 3.5oz + 12oz


3
Trellis + Surflan 1.0 + 3 qts

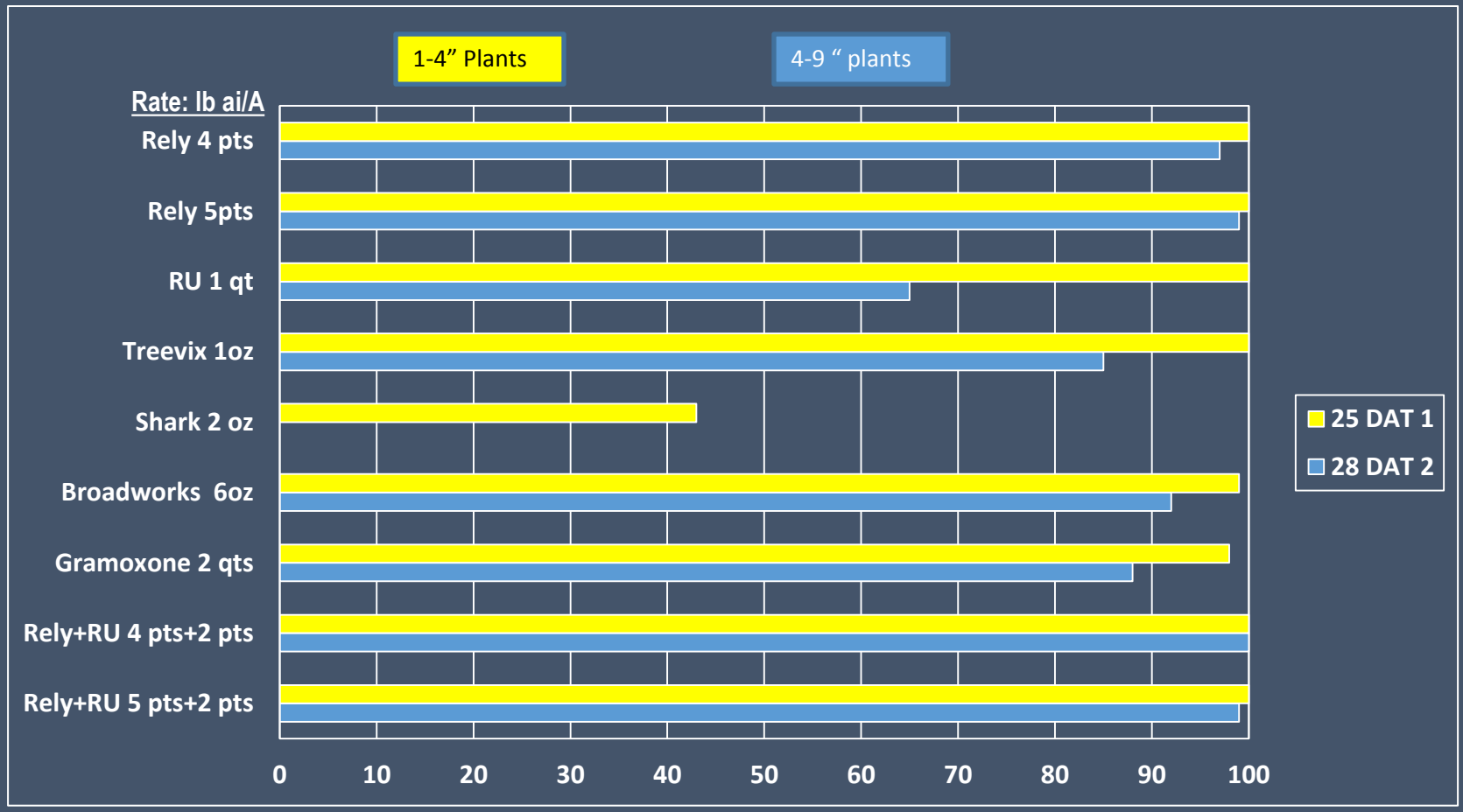

14
Matrix + Alion 2oz + 5 oz

Control of Emerged Horseweed



Burn down of Horseweed at different Growth Stages

COMPARING POST HERBICIDES ON DIFFERENT SIZE HORSEWEED



Application: Feb & 12 Mar 17, 2014 45 gal/A

MICK CANEVARI
UCCE EMERITUS
SAN JOAQUIN COUNTY


Rely 1.5 2.5 qts


Gramoxone 2 qt/A

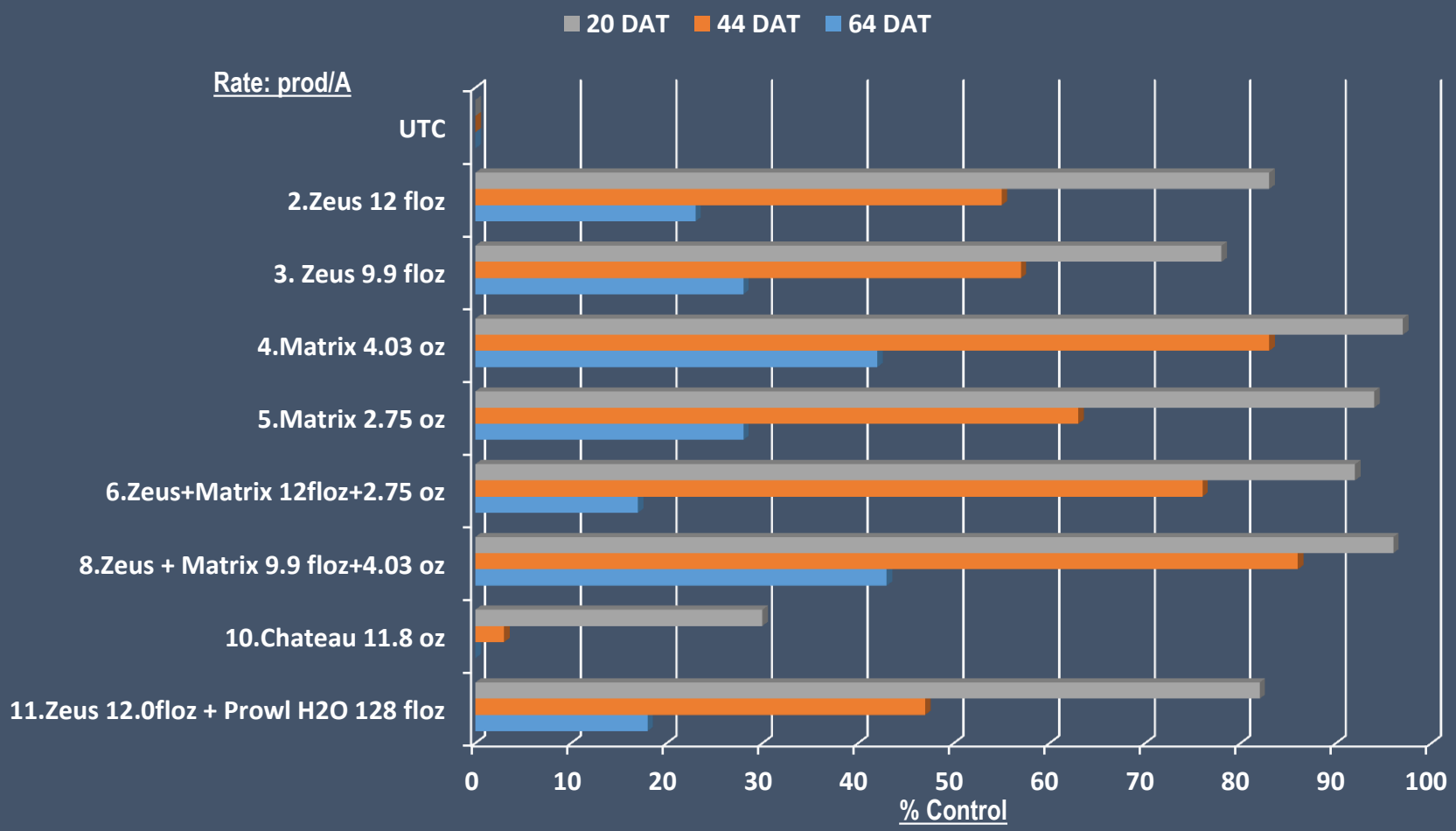

Roundup 2 qt/A


Rely + Roundup 2 qt + 1qt


Yellow Nutsedge

Grape Nutsedge Control

Lodi Ca, 2014



Appl: 2-25-14; Rely @ 2.0 qts/A. and Activator 90 @ 0.25% V/V added to all treatments. Rainfall following application = 1.85".

MICK CANEVARI
UCCE EMERITUS
SAN JOAQUIN COUNTY

Nutsedge Trial

20 Days following application

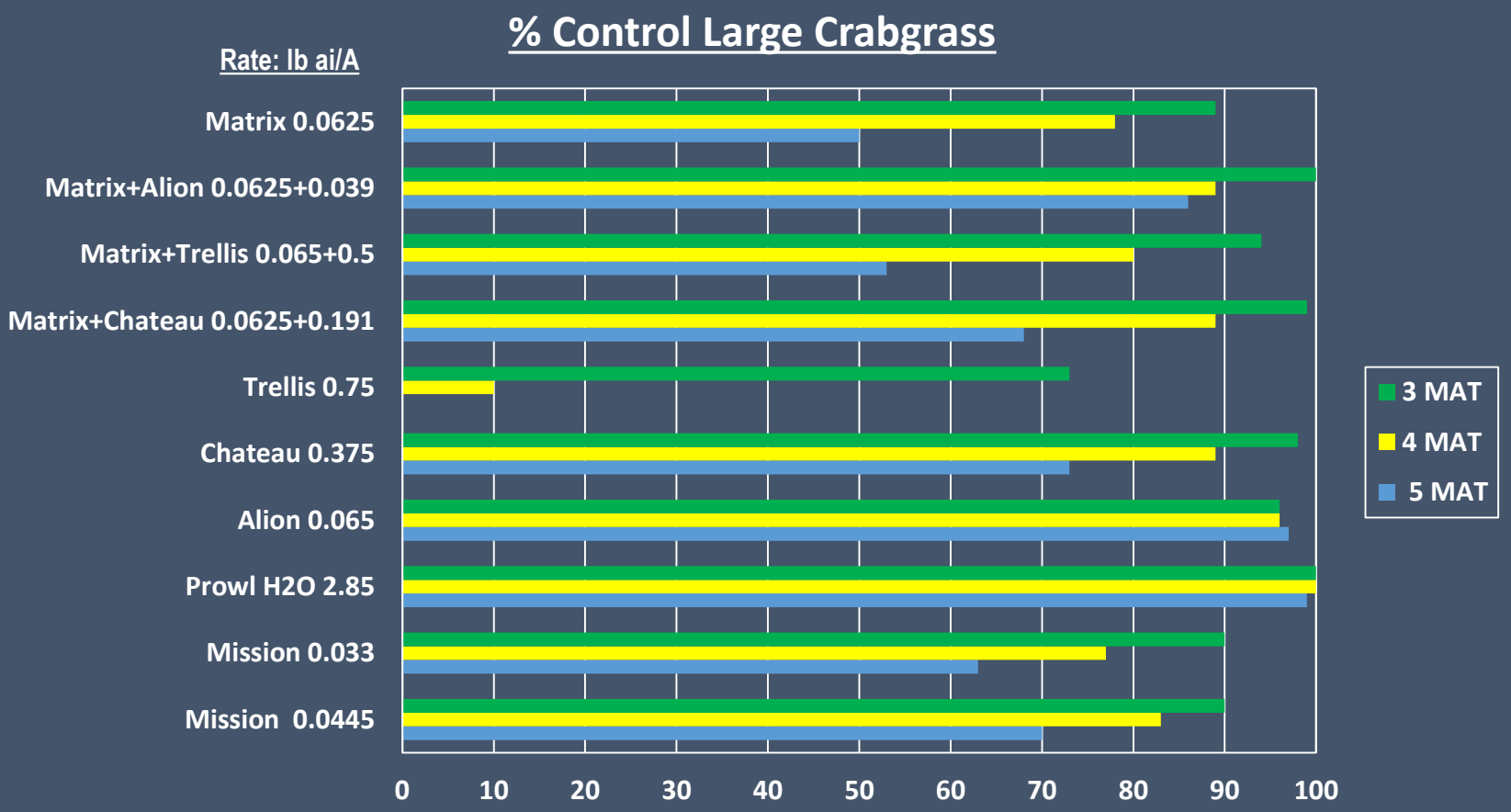
Summer annual Grasses

Crabgrass, SW Cupgrass
Barnyard grass, Green Foxtail

Pre-Emergent Summer Grass Control

Lodi Vineyard

2013



All treatments applied Jan 21, 2014 in 36 gpa water; Rely 280 + Phase @ 1.45 lbai/A + 0.25% V/V added to each treatment to control existing winter weeds.

MICK CANEVARI
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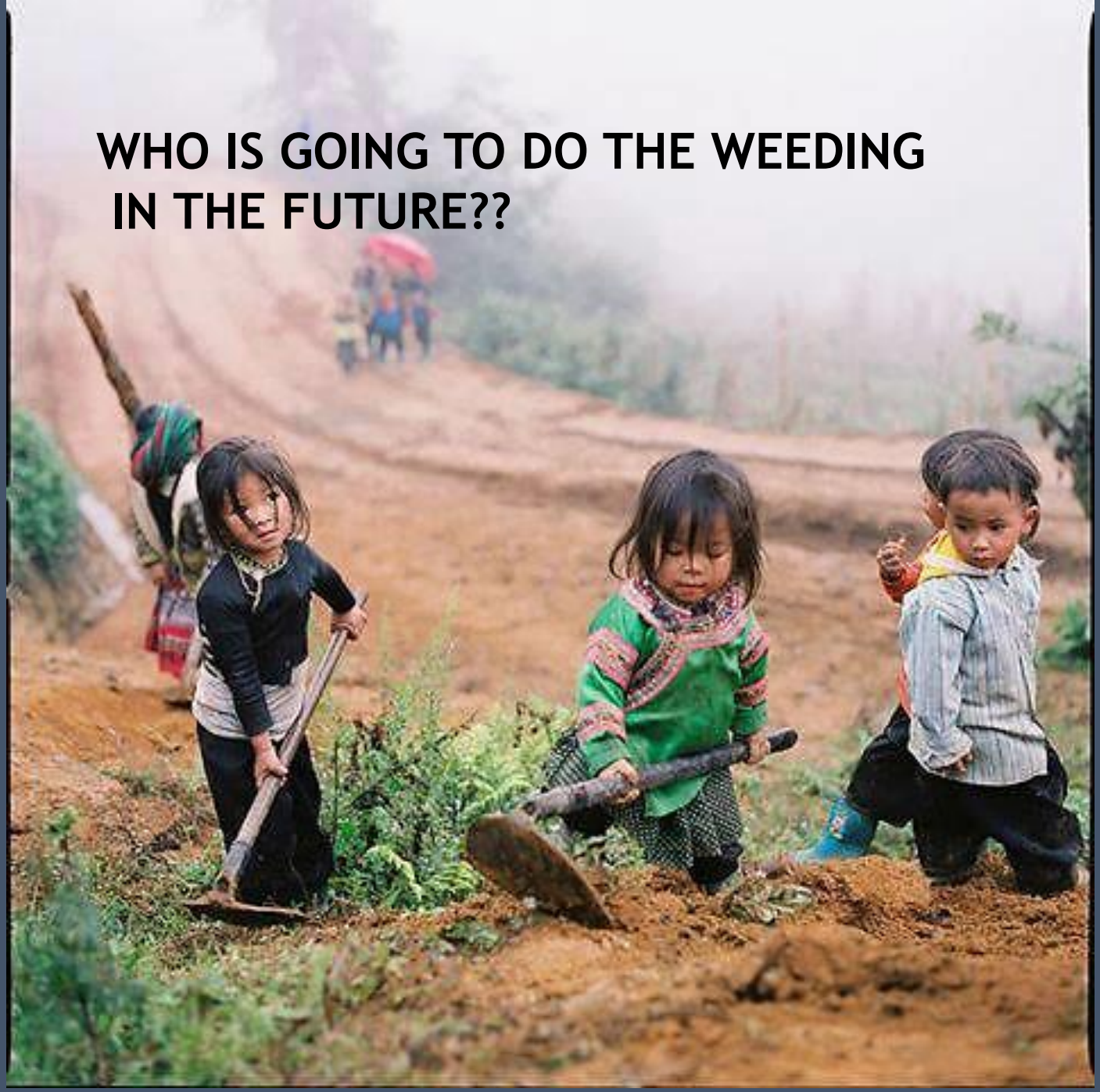
SAN JOAQUIN COUNTY


START CLEAN

Stay Ahead of the Weeds

KEEP IT CLEAN


WHO IS GOING TO DO THE WEEDING
IN THE FUTURE??


THANK YOU

A Systems Approach to Weed Management

INTEGRATED WEED MANAGEMENT (IWM)

- weed control requires multiple components!
- The use of “many little hammers” (Liebman and Gallandt)
- Be timely & vigilant

Major Herbicide Mechanism of Action
Weed Science Society of America

Group	Site of Action	Group	Site of Action
1	ACCase inhibitor	14	PPO inhibitor
2	ALS inhibitor	17, 25, 26	Potential nucleic acid inhibitor or non-descript
3, 15, 23	Mitosis inhibitors	18	DHP inhibitor
4	Synthetic auxin	19	Auxin transport inhibitor
5, 6, 7	Photosystem II inhibitors	20, 21, 28, 29	Cellulose inhibitor
8, 16	Lipid synthesis inhibitor	22	PS I inhibitor
9	EPSP inhibitor	24	Oxydative phosphorylation uncoupler
10	Glutamine synthetase inhibitor	NC	Not classified
11, 12, 13, 27	Carotenoid synthetase inhibitor		

	1st - winter strip spray	2nd - spring strip spray	Cost ($/Acre)	EI/Acre
Recommendation (wine grapes)	Oryzalin, Oxyfluorfen, Glyphosate	Glyphosate	133	114
Alternative Treatments				
Alternative 1	Oryzalin, Oxyfluorfen, Glufosinate	Glyphosate	161	119
Alternative 2	Oryzalin, Oxyfluorfen, Glufosinate	Glufosinate	189	123
Alternative 3	Flumioxazin, Glyphosate	Glufosinate	110	39
Alternative 4	Rimsulfuron, Pendimethalin, Glyphosate	Glufosinate	154	124

Photo: Navarro Vineyards, Mendocino

Herbicides Registered for use in CA Vineyards

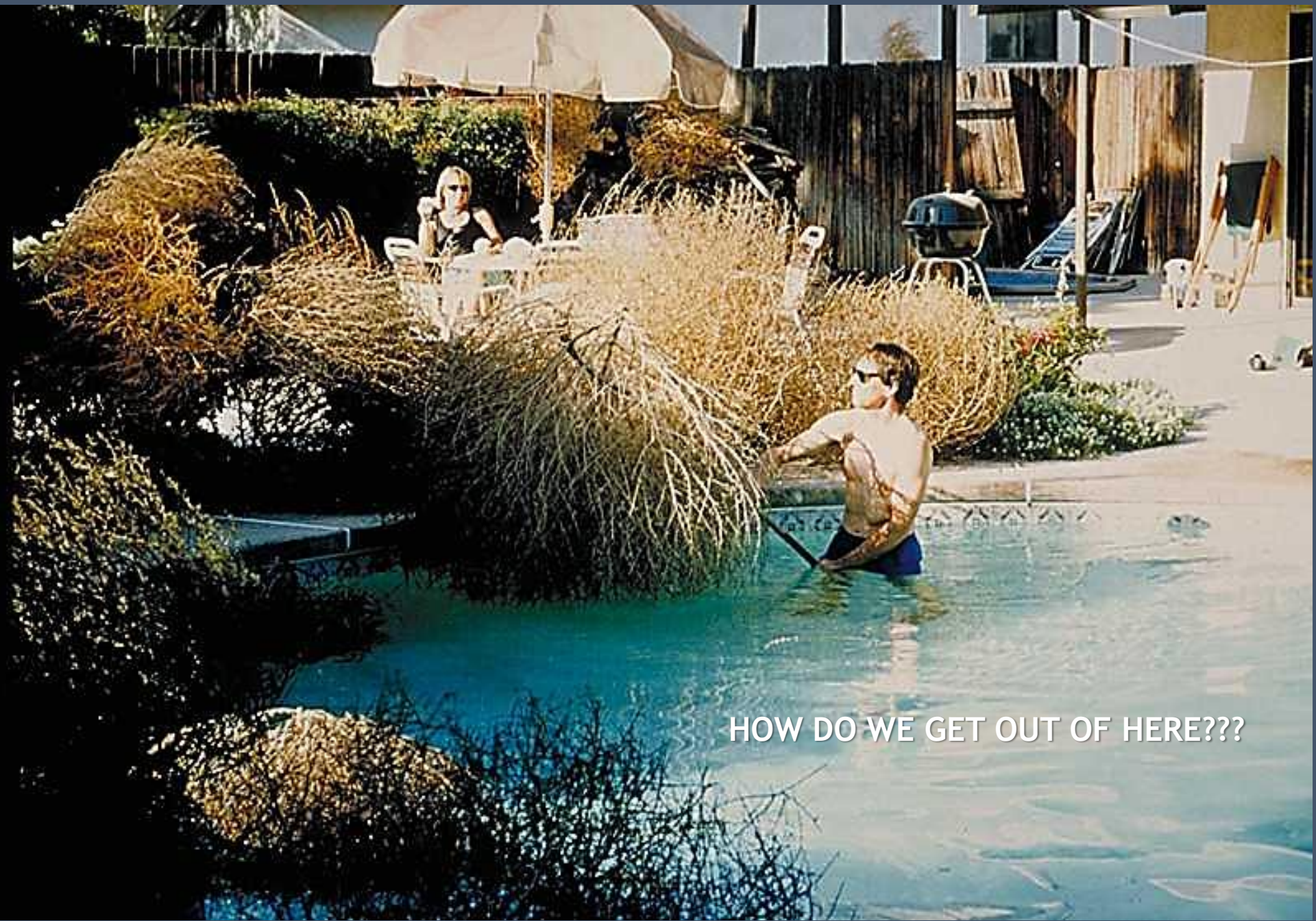
Preemergent Products	Almond	Apple	Apricot	Cherry, sweet	Citrus	Grape
bromacil (Hyvar X®)	N	N	N	N	R48	N
bromacil + diuron (Krovar®)	N	N	N	N	R36	N
dichlobenil (Casoron®)	N	R	N	R	N	R
diuron (Karmex, Direx®)	N	R12	N	N	R	R36
eptc (Eptam®)	R	N	N	N	NB	N
flumioxazin (Chateau SW®)	R	R	R	R	NB	R
isoxaben (Gallery T&V®)	NB	NB	NB	NB	NB	NB
napropamide (Devrinol®)	R	R	R	R	R	R
norflurazon (Solicam®)	R18	R	R18	R18	R	R24
oryzalin (Surflan®, etc.)	R	R	R	R	R	R
oxyfluorfen (Goal®, etc.)	R	R	R	R	NB	R
pendimethalin (Prowl H_2O®)	R	R	R	R	NB	NB
pendimethalin (Prowl 3.3 EC®)	NB	NB	NB	NB	NB	NB
pronamide (Kerb®)	N	R12	R12	R12	N	R12
rimsulfuron (Matrix FNV®)	R12	R12	R12	R12	R12	R12
simazine (Princep®)	R36	R12	N	N	R12	R36
thiazopyr (Visor®)	NB	N	NB	N	R	NB
trifluralin (Treflan®, etc.)	R	R	R	R	R	R
Postemergent Products						
clethodim (SelectMax®)	NB	NB	NB	NB	NB	NB
carfentrazone (Shark EW®)	R	R	R	R	R	R
diquat (Reglone®)	NB	NB	NB	NB	NB	NB
fluazifop-p-butyl (Fusilade DX®)	NB	NB	R	R	N	NB
glufosinate (Rely 200®)	R	N	N	N	N	R
glyphosate (Roundup®, etc.)	R	R	R	R	R	R
msma (MSMA®, etc.)	NB	NB	NB	NB	R	N
paraquat (Gramoxone Inteon®)	R	R	R	R	R	R
pyraflufen (Venue®)	R	R	R	R	N	R
sethoxydim (Poast®)	R	R	R	R	R	R
2,4-D amine (Dri-clean®, etc.)	R12	R12	R12	R12	N	R12

N = not registered for use
NB = registered for use in non-bearing only (at least 365 days before harvest)
R = registered for bearing and non-bearing
R12, R18, R24, R36, R48 = registered for use after the crop has been planted fo

Dichlobenil - Group 20
Diuron - Group 7
Flumioxazin - Group 14
Indaziflam - Group 29
Isoxaben (NB) - Group 21
Napropamide - Group 15
Norflurazon - Group 12
Oryzalin - Group 3
Oxyfluorfen - Group 14
Pendimethalin (NB) - Group 3
Pronamide - Group 3
Rimsulfuron - Group 2
Simazine - Group 5
Thiazopyr (NB)- Group 3
Trifluralin - Group 3
Clethodim (NB) - Group 1
Carfentrazone - Group 14
Diquat (NB) - Group 22
Fluazifop (NB) - Group 1
Glufosinate - Group 10
Glyphosate - Group 9
Paraquat - Group 22
Pyraflufen - Group 14
Sethoxydim - Group 1
2, 4-D - Group 4

Groups
1*
2*
3*, 15*
4*
5*, 7*
9*
10*
12*
14*
20*, 21*, 29*
22*

While In The US We are asking, ‘how did we get here’?



Many developing countries are asking ‘Isn’t there a better way than hand weeding?’.... A chemical for weed control?

Children and Old People Left to Farm

Center for Global Food Issues

Growing More Per Acre Leaves More Land for Nature

← UN TRAPPED IN CLIMATE TURMOIL, BY: DENNIS T. AVERY

WASHINGTON POST CONVERTS TO CONSERVATION? BY DENNIS T. AVERY →

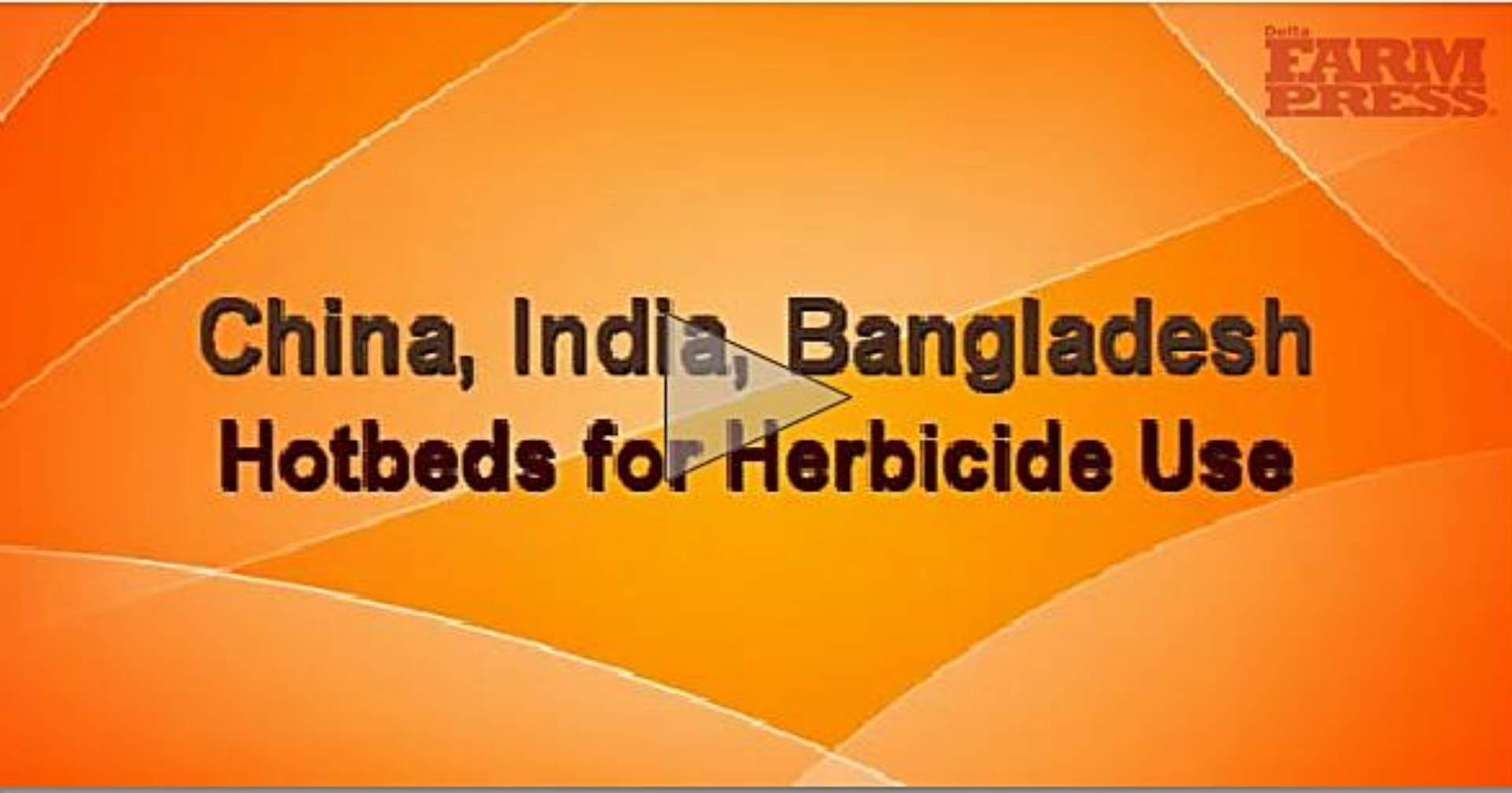
ADD HERBICIDES TO AFRICA'S RESCUE PLAN, BY DENNIS T. AVERY

Posted on November 27, 2011 by CGFI

Search

Archives

- July 2013
- June 2013
- May 2013
- April 2013
- March 2013



India – herbicide market grew by 35% in 2012 because of lack of labor

Glyphosate

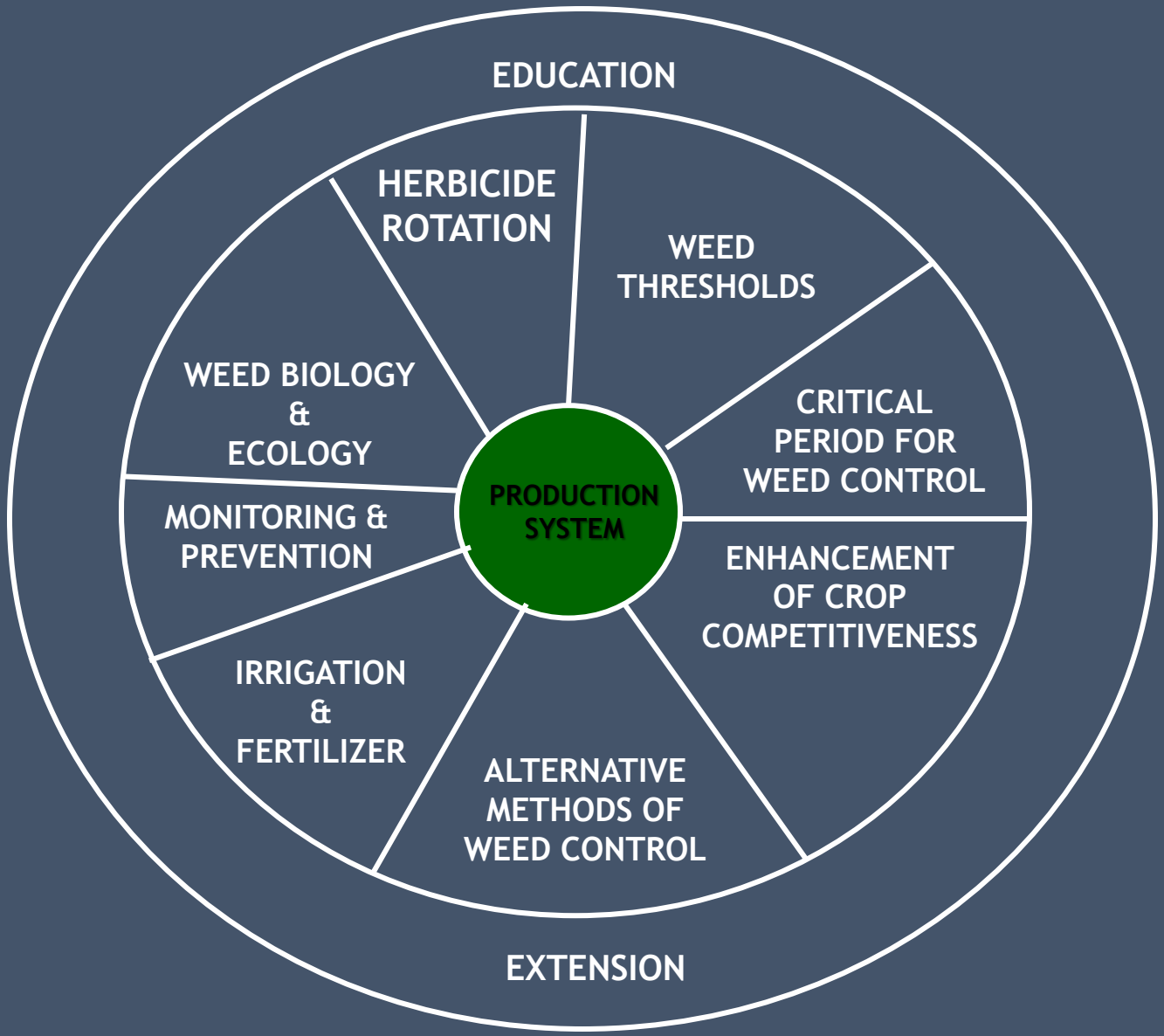
Paraquat

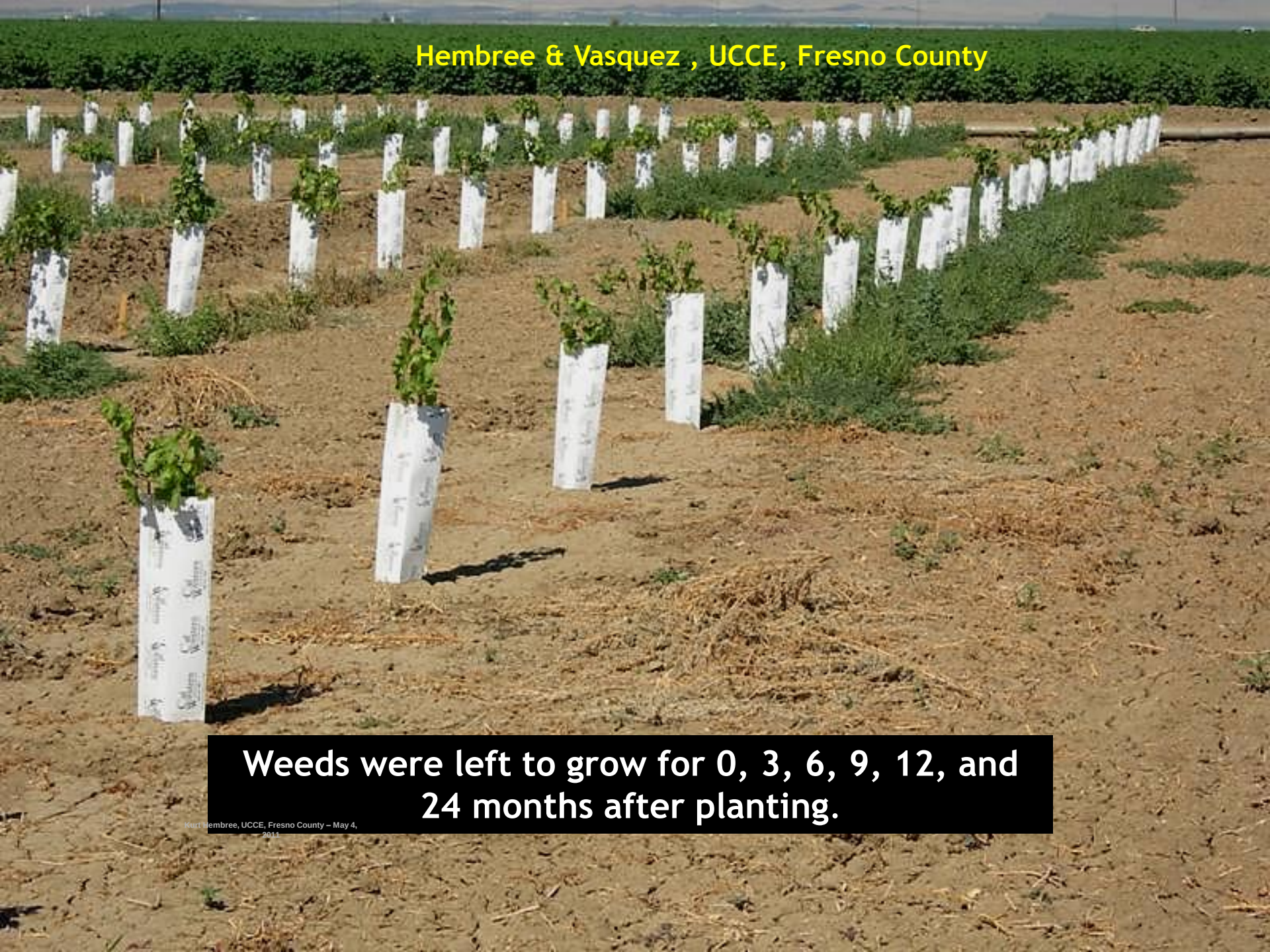
How do we manage weeds in vineyards?

Integrated Weed Management options

- Chemical
- Physical
- Cultural
- Biological
- Mechanical

COMPONENTS OF IWM IN A VINEYARD




Hembree & Vasquez , UCCE, Fresno County
Weeds were left to grow for 0, 3, 6, 9, 12, and 24 months after planting.
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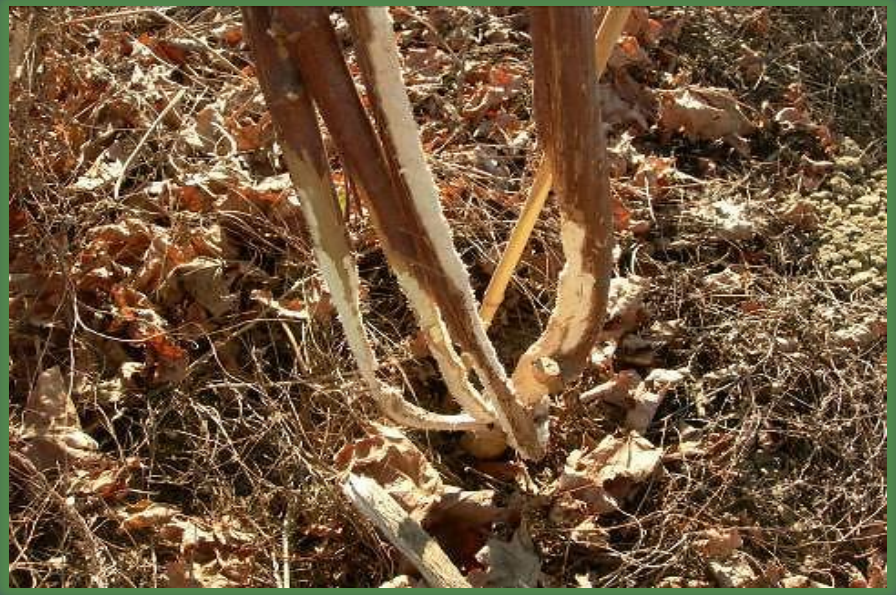
Effect on vine damage



Hembree & Vasquez , UCCE, Fresno County

The bottom line according to Kurt Hembree:

It's critical to maintain a weed-free environment around young vines for at least 12 weeks after planting to aid growth and production.

Weed Seed Production

Examples of seed production by various weed species

Weed species	No. of seeds produced/plant
Barnyardgrass	700,000
Horseweed	200,000
Eastern blacknightshade	825,000
Common lambsquarters	72,450
Common purslane	1,800,000
Shepherdspurse	150,000
Redroot pigweed	229,175
PunctureVine	100,000
Velvetleaf	48,000
Wild radish	1,875

Weed seed longevity

Species	Years
Barnyardgrass	5
Common purslane	20-25
Velvetleaf	15-40
Puncturevine	15-20
Shepherd’spurse	15-35
Black nightshade	40+
Cheeseweed	200
Burclover	200


Crop competitiveness in vineyards can be enhanced by:
Good canopy management
Shade out the weeds
Competitive rootstocks?

Is weed science in the crossroads in the 21st century???

We are looking at IWM because of resistance issues

Developing countries are looking at herbicides because of labor issues


Callisto/Broadworks
24 DAT
4
3

‘Half the fields in Africa don’t get planted because of weeds’

Enhancement of crop competitiveness

- Effect of vineyard row direction on weed growth (East-West vs North-South oriented rows)

'Selma Pete' in an open-gable trellis system

Row direction	Berries No/plant	Seeds No/berry	Total seed return No/plant
East-West	155	47	7151
North-South	184	51	8976

Almost 25% more seeds/plant in the North-South plants


HORSEWEED ROOTS
E-W ROW
FULL SUN


Frequent wetting of the soil promotes more rapid herbicide degradation in the soil

Alternative weed management

- In the last decade, more publications - on mulching and cover cropping than on cultivation and herbicide use, suggesting stronger interest in cover cropping and mulching practices for vineyards (Guerra and Steenwerth, 2012).

- Mechanical control will still have a major role to play in areas where erosion and slope is not a problem because of efficacy of weed control and lower costs

- “Physical weed control tools and integrated programs are why we do not have any herbicide resistance problems in lettuce, tomato and most vegetable crops. I sincerely believe that California should lead the way in the US in developing innovative physical weed control tools"

  - Steve Fennimore


Cultivators

Vineyard floor management

Tourte et al. (2008) Smith et al. (2008)

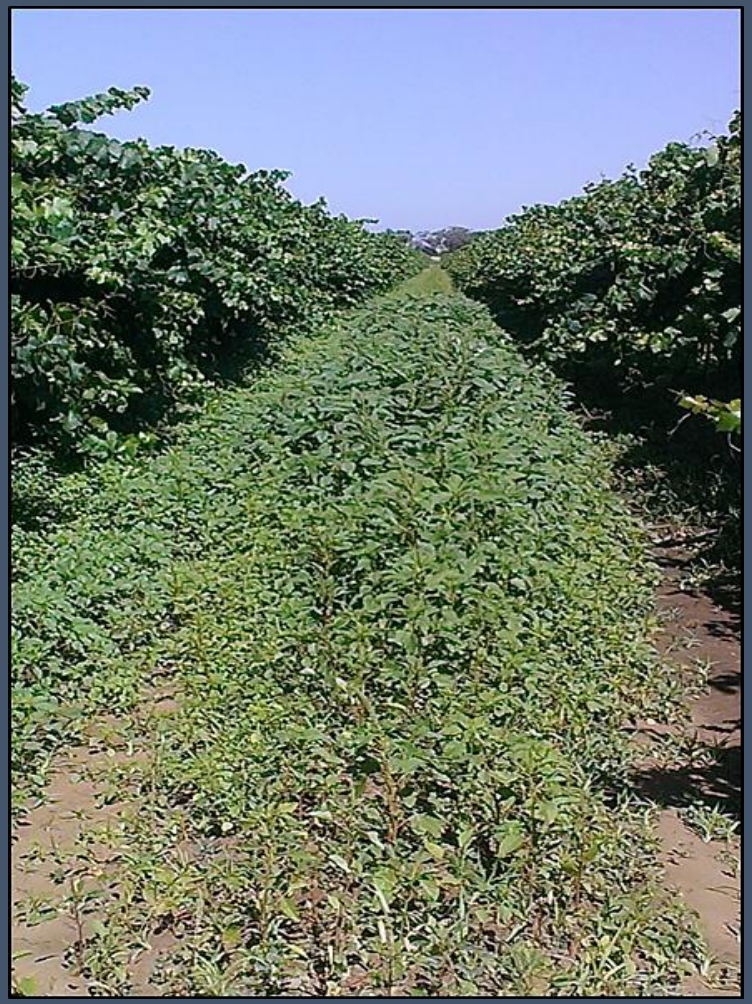
Cover crops increased juice soluble solids, anthocyanins, and other phenolic components and decreased titratable acidity and pH

Organic mulches reduced pest pressure (Guerra and Steenwerth, 2012)

Increasing prevalence of Palmer amaranth in the vineyards of the SJV
However, it is not known if these are cases of GR populations

OR

if these are cases of escapes due to glyphosate applications being made later at more tolerant stages of the weed - Poor application?



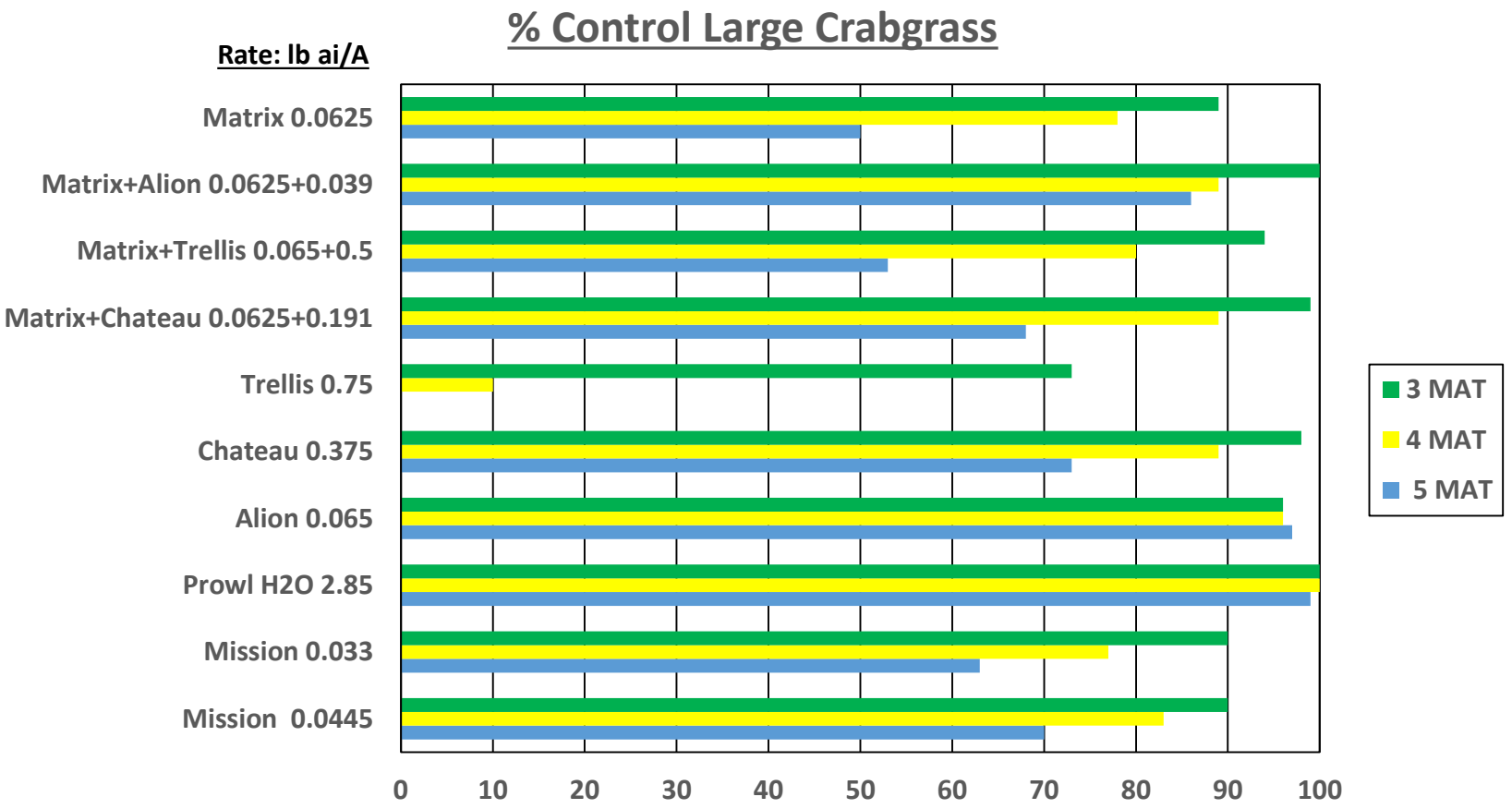
Fresno County (2013)


YOU!
Aloha Nui

Pre-Emergent Summer Grass Control

Aberle Acres Vineyard

2013



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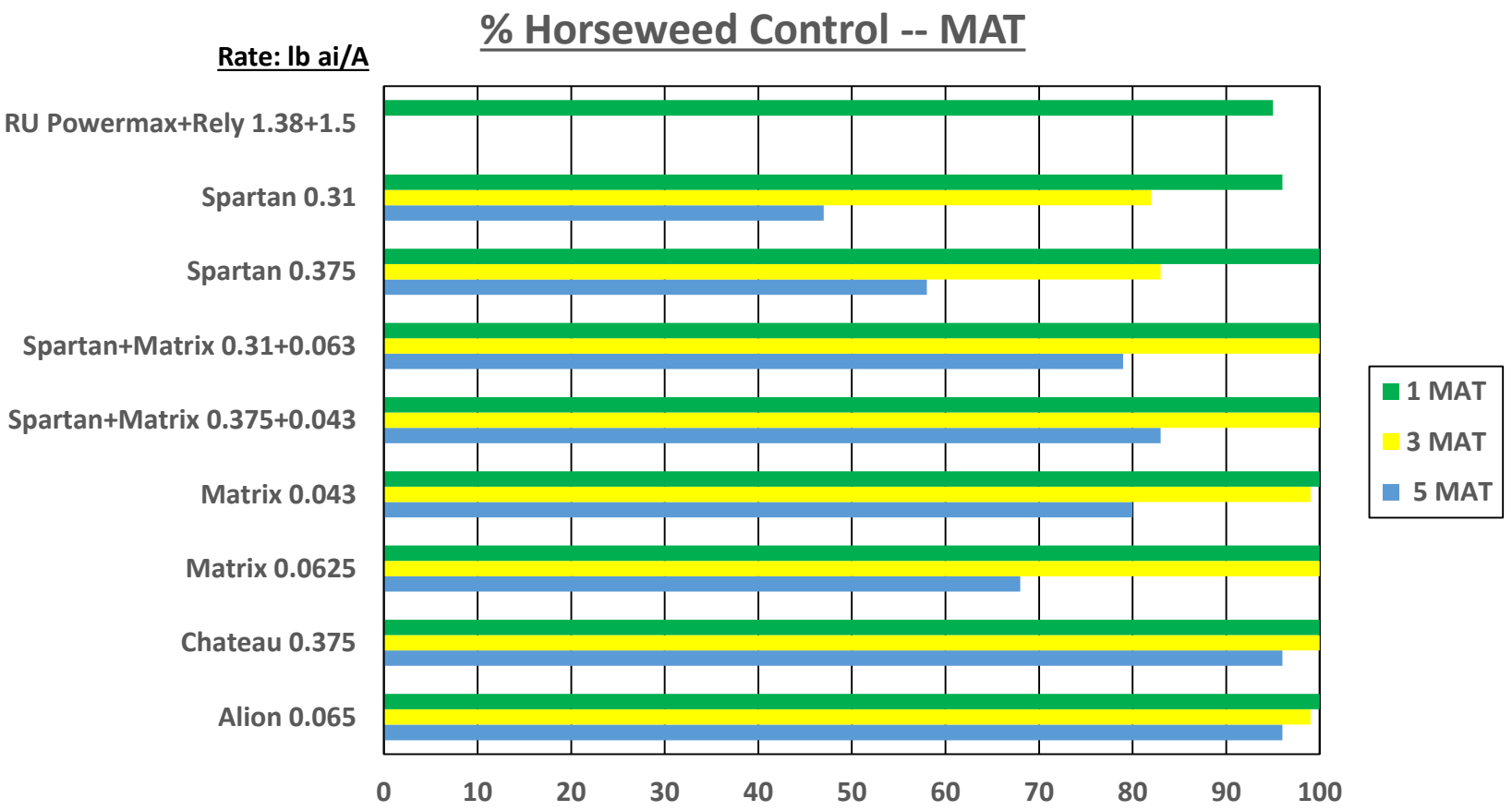
SAN JOAQUIN COUNTY

Horseweed Control in Established Vineyard

Bokitas Vineyard

2014



All treatments applied Jan 6, 2014 in 32 gpa water; Horseweed = 0.5-4" dia.; RUPM 1.38 lbai + Rely 280 1.5 lbai + Activator 90 0.25% V/V added to each treatment.

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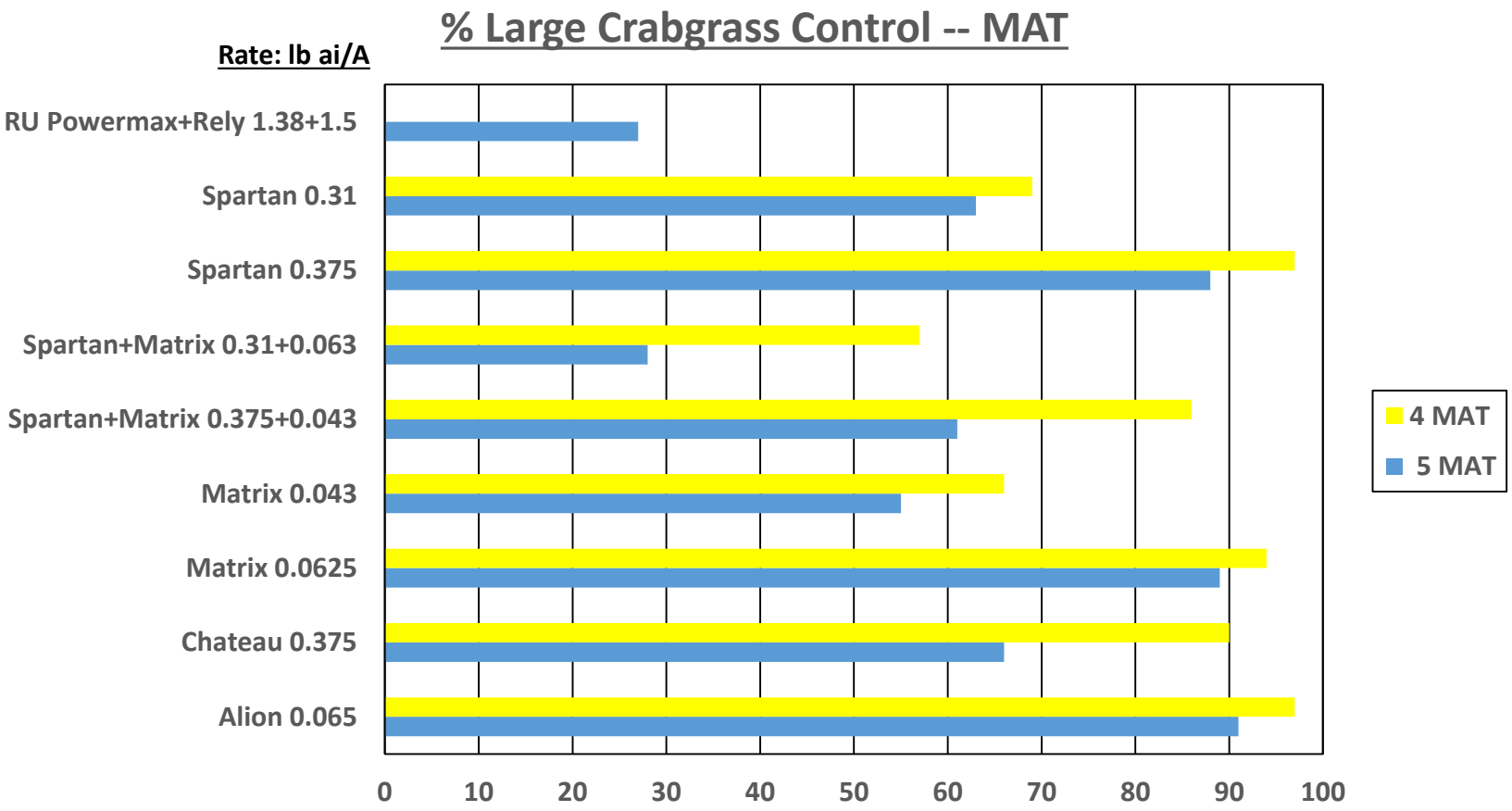
SAN JOAQUIN COUNTY

Grass Control in Established Vineyard
Bokitas Vineyard
2014



All treatments applied Jan 6, 2014 in 32 gpa water; Large Crabgrass = pre; RUPM 1.38 lbai + Rely 280 1.5 lbai + Activator 90 0.25% V/V added to each treatment.

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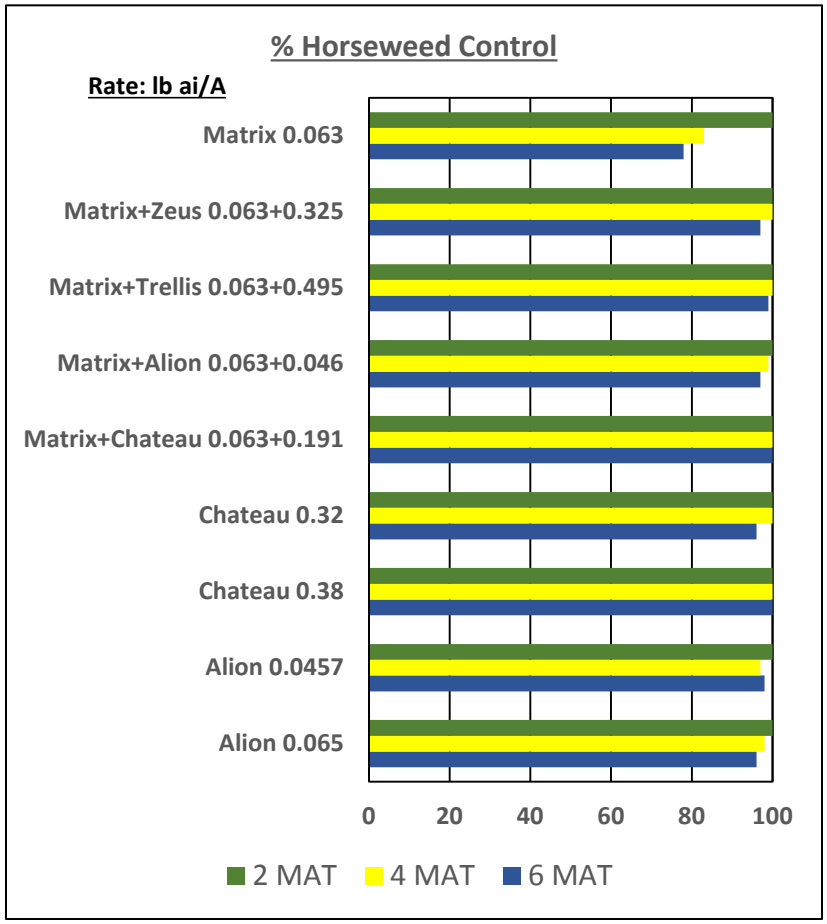
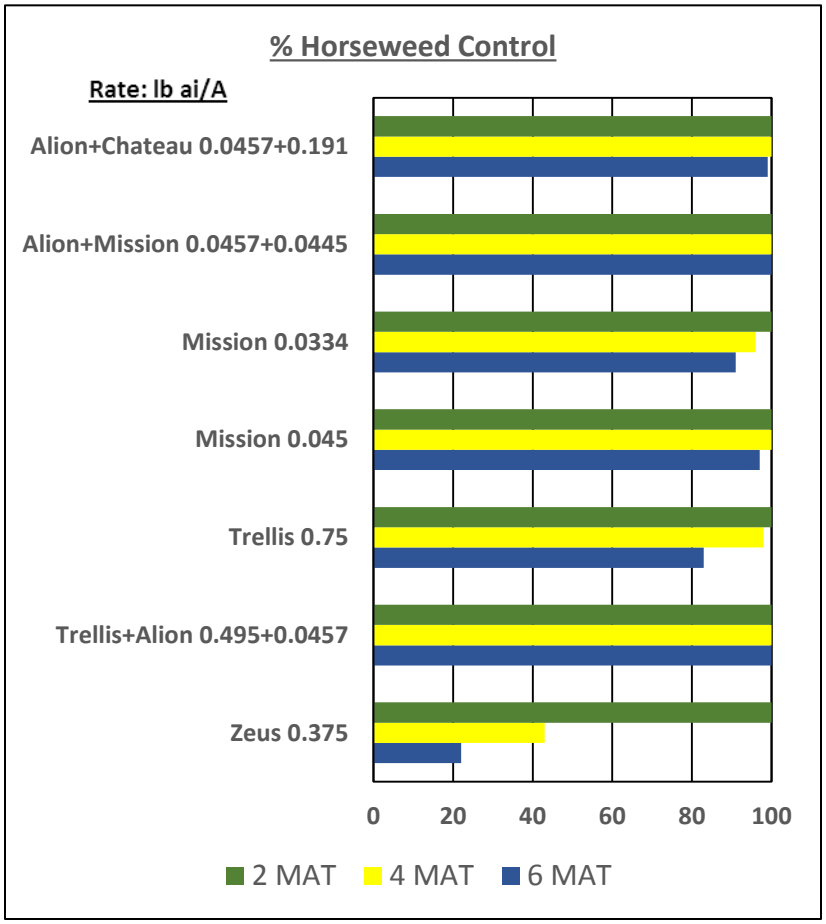
Grape Horseweed Preemergence
Kautz Vineyard
2014





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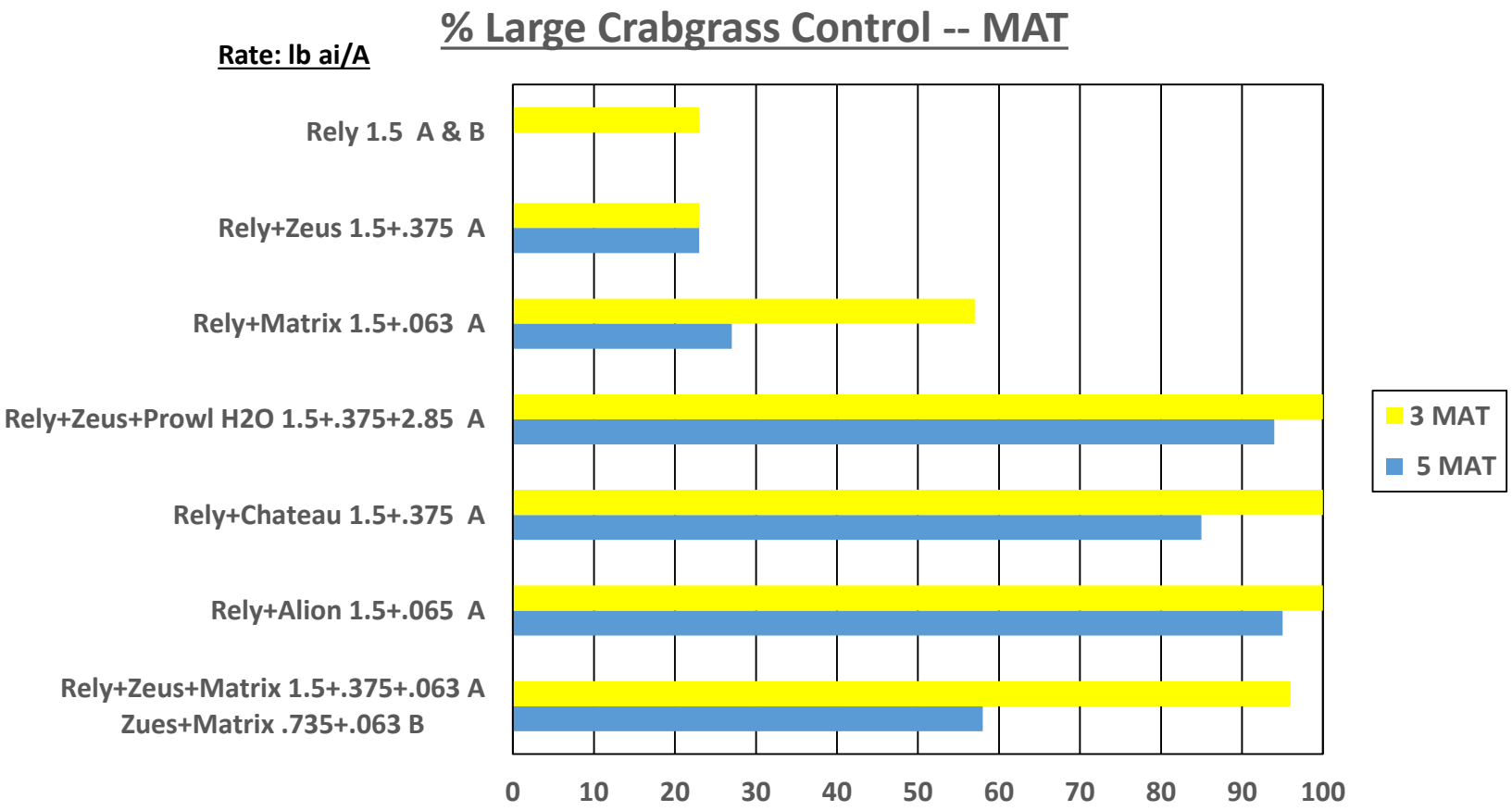
Post-emergence Winter Herbicide Applications

Soil Residual Activity Controlling Large Crabgrass

Aberle Vineyard - 2014



Applications: A = Jan 6, B = Feb 24, 36 gpa water; Large Crabgrass = Pre at both application dates.

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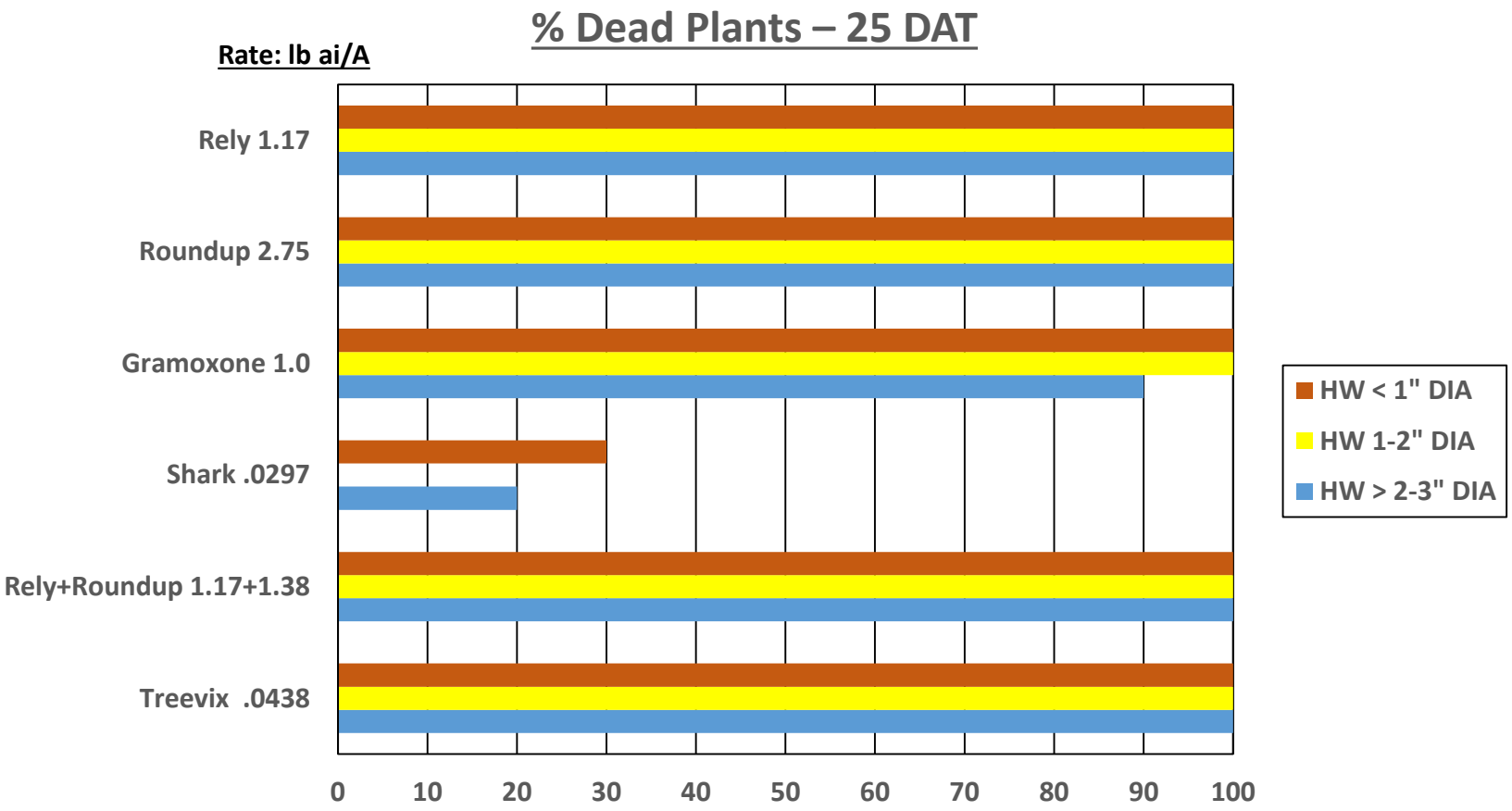
Post-Emergence Herbicide Horseweed Growth Stage
Phase I
Aberle Vineyard - 2014



Application: Feb 17; Added Hasten @ 1% V/V + ammonium sulfate @ 85 lb/100 gal to each treatment. Rely 280; Roundup Powermax; Gramoxone Inteon; Shark EW; Treevix WDG.

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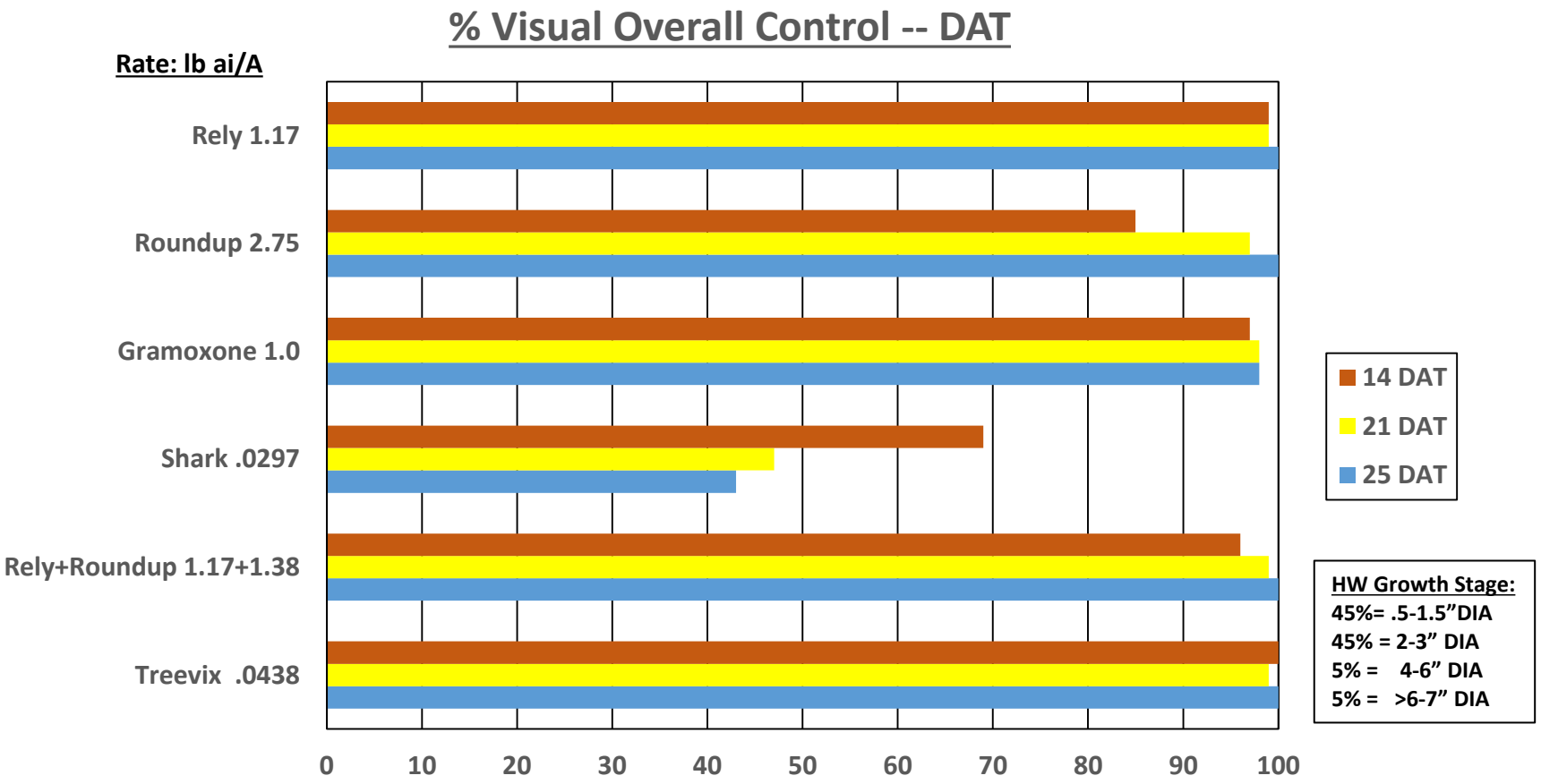
Post-Emergence Herbicide Horseweed Growth Stage
Phase I (Cont.)
Aberle Vineyard - 2014



Application: Feb 17, 36 gal/A ; Added Hasten @ 1% V/V + ammonium sulfate @ 85 lb/100 gal to each treatment. Rely 280; Roundup Powermax; Gramoxone Inteon; Shark EW; Treevix WDG.

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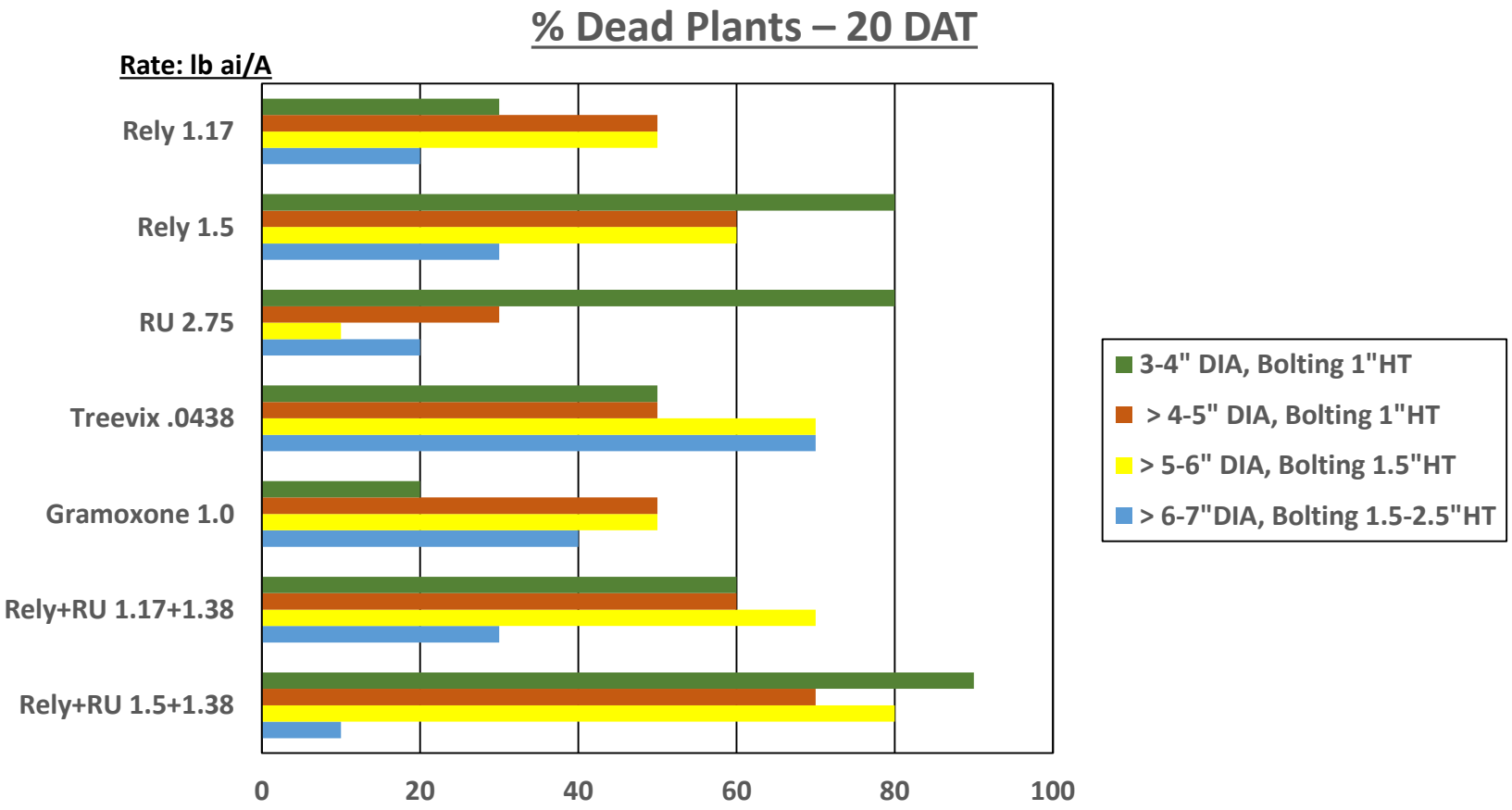
Post-Emergence Herbicide Horseweed Growth Stage
Phase 2
Aberle Vineyard - 2014



Application: Mar 17, 57 gal/A ; Added Hasten @ 1% V/V + ammonium sulfate @ 85 lb/100 gal to each treatment. Rely 280; Roundup Powermax; Gramoxone Inteon; Shark EW; Treevix WDG.

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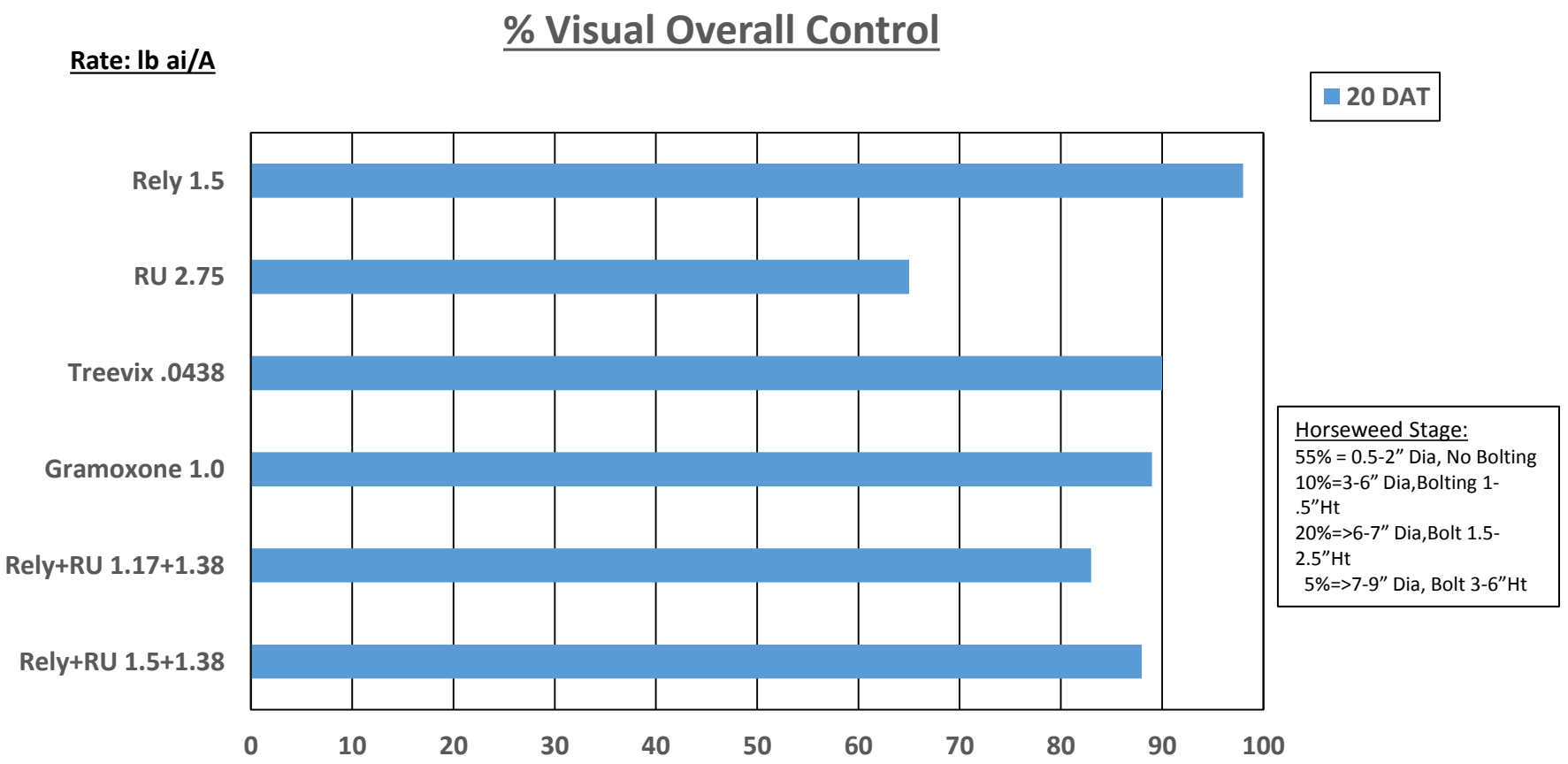
Post-Emergence Herbicide Horseweed Growth Stage
Phase 2 (Cont.)
Aberle Vineyard - 2014



Application: Mar 17, 57 gal/A ; Added Hasten @ 1% V/V + ammonium sulfate @ 85 lb/100 gal to each treatment. Rely 280; Roundup Powermax; Gramoxone Inteon; Shark EW; Treevix WDG.

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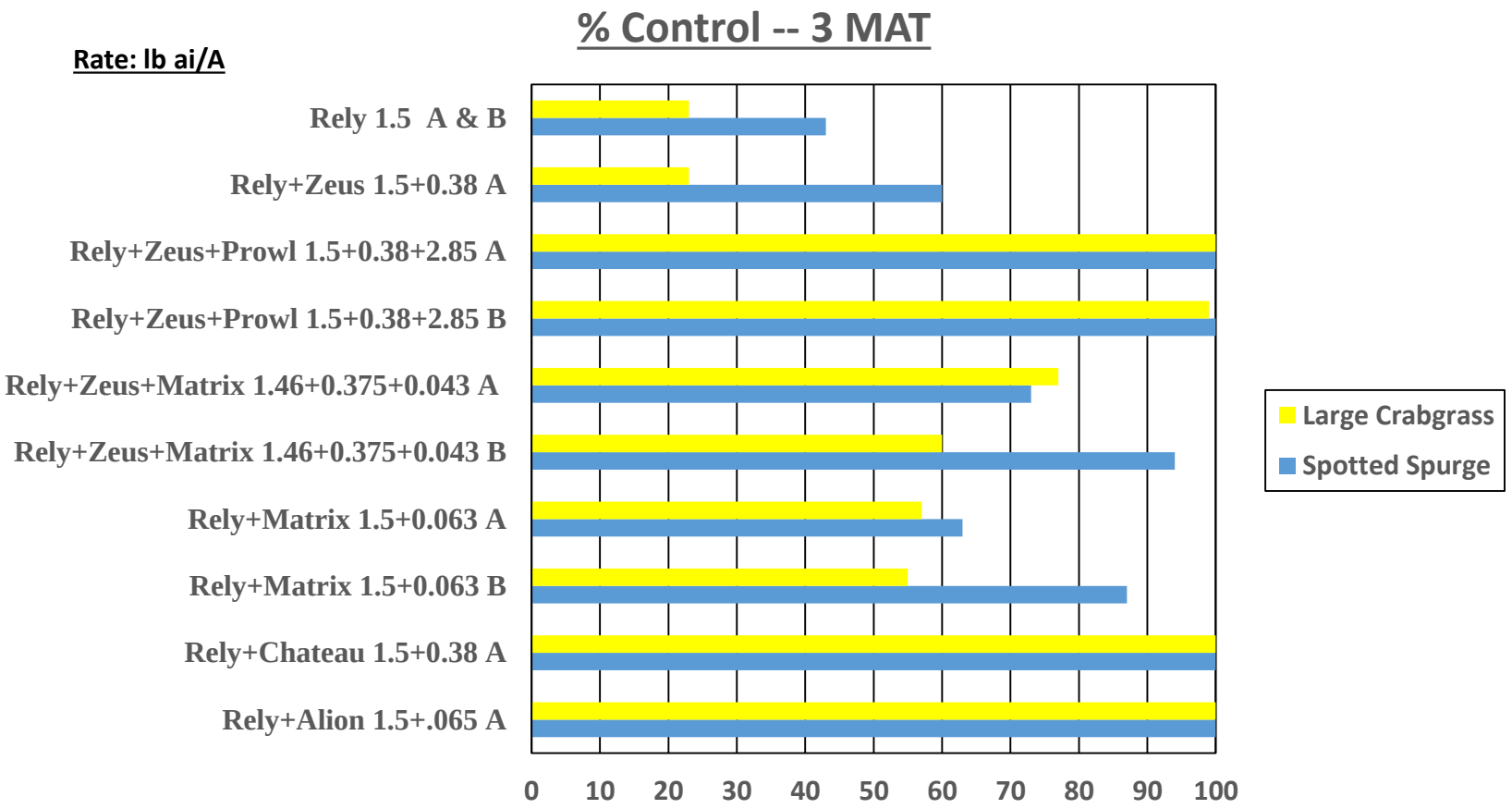
Post-Emergence Winter Herbicide

Season Long Weed Control in Grapes

2014



Application: A = Jan 6, B = Mar 10; 36 G/A; Pre = large crabgrass and spotted spurge.

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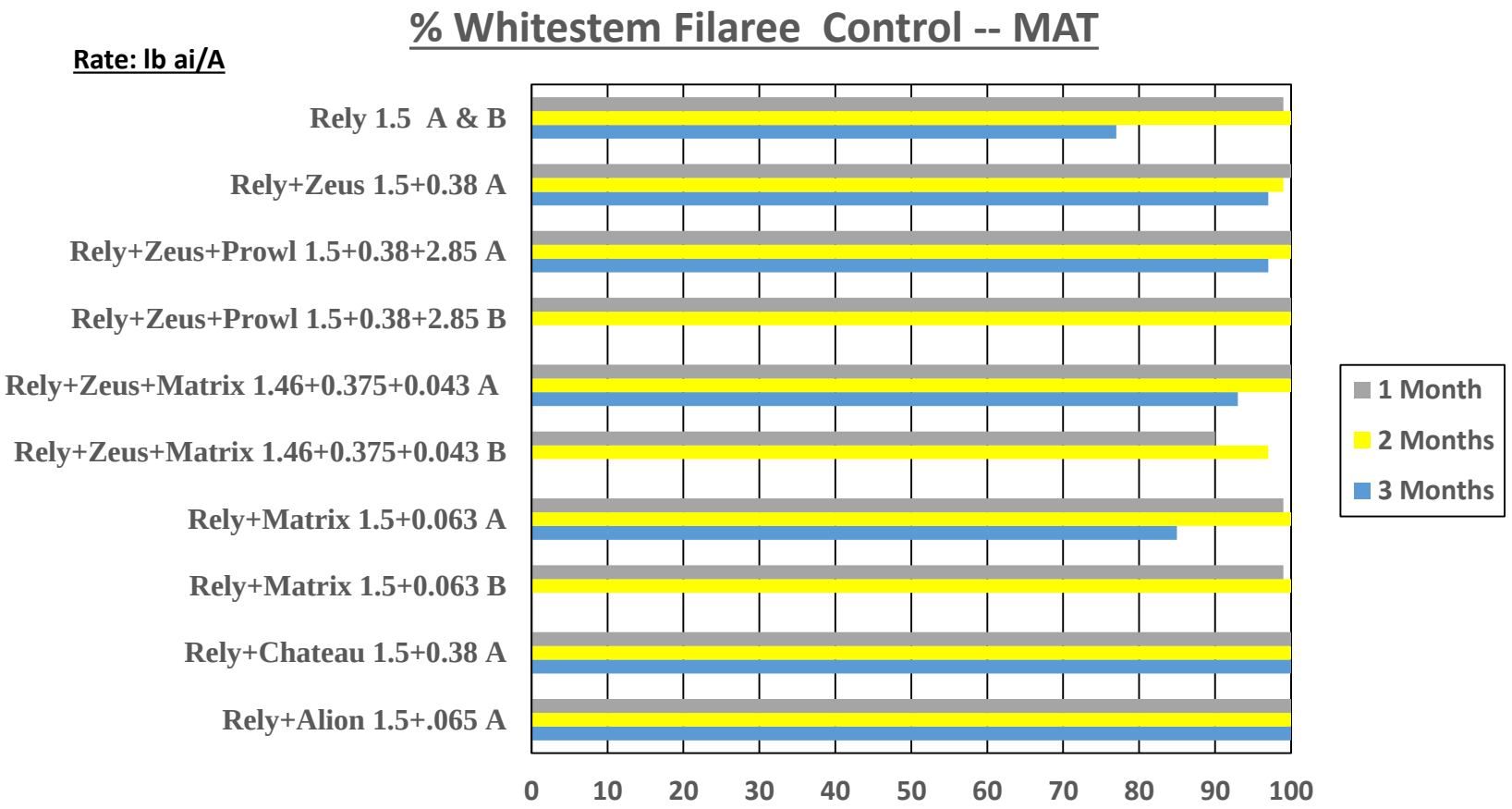
SAN JOAQUIN COUNTY

Post-Emergence Winter Herbicide

Season Long Weed Control in Grapes (Cont.)

2014



Application: A = Jan 6, B = Mar 10; 36 G/A; A Appl = WSF 1-5" Dia; B Appl = WSF 2-7" Dia.

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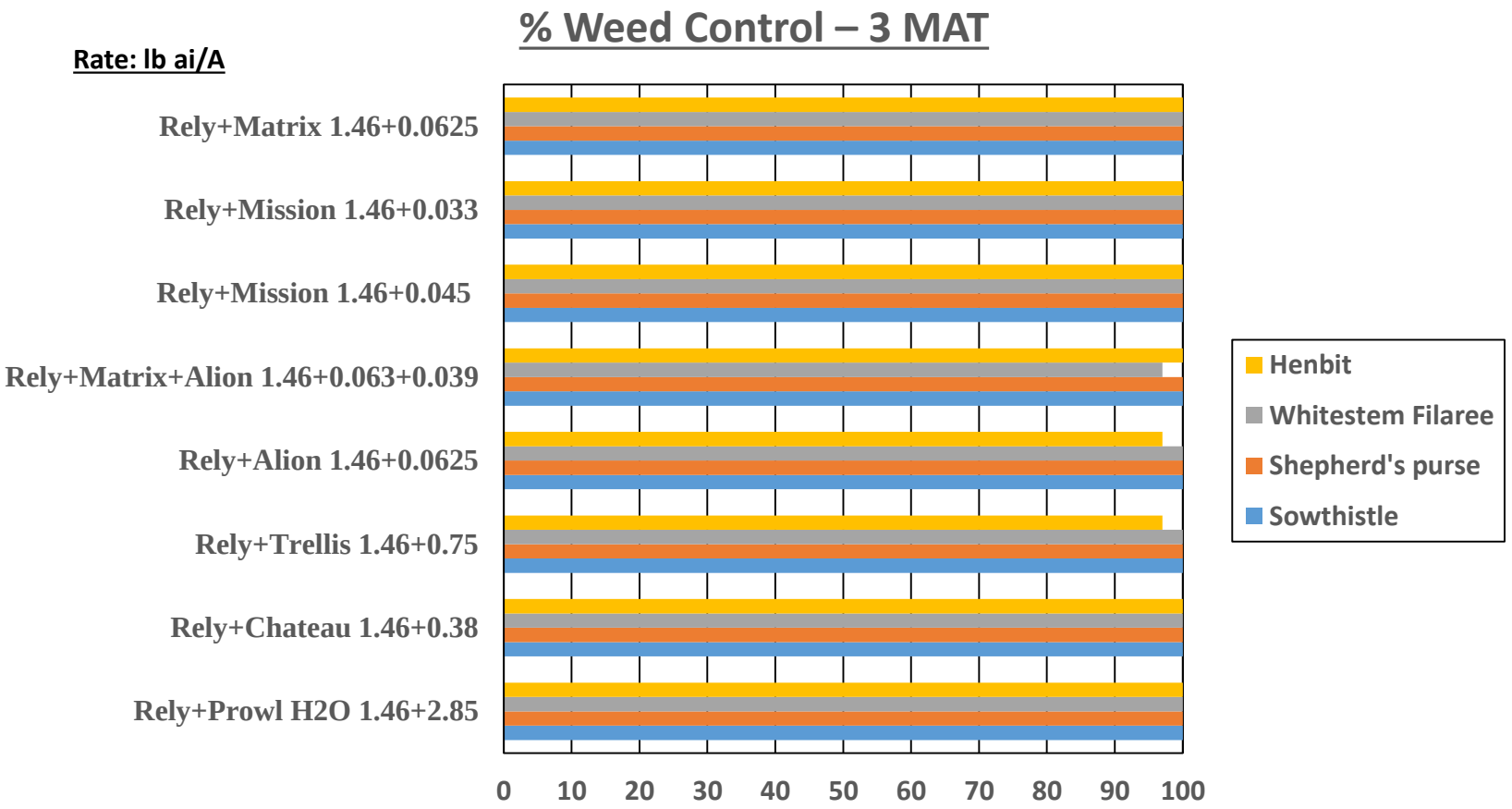
Post-Emergence Winter Herbicide

Season Long Weed Control in Grapes

2013



Application: Jan 21, 2013; 36 G/A; Henbit = 2-6” Ht., Whitestem Filaree = 4-12” Dia., Shepherd’s purse = 4-10” Ht., Annual sothistle = 1-4” Dia.

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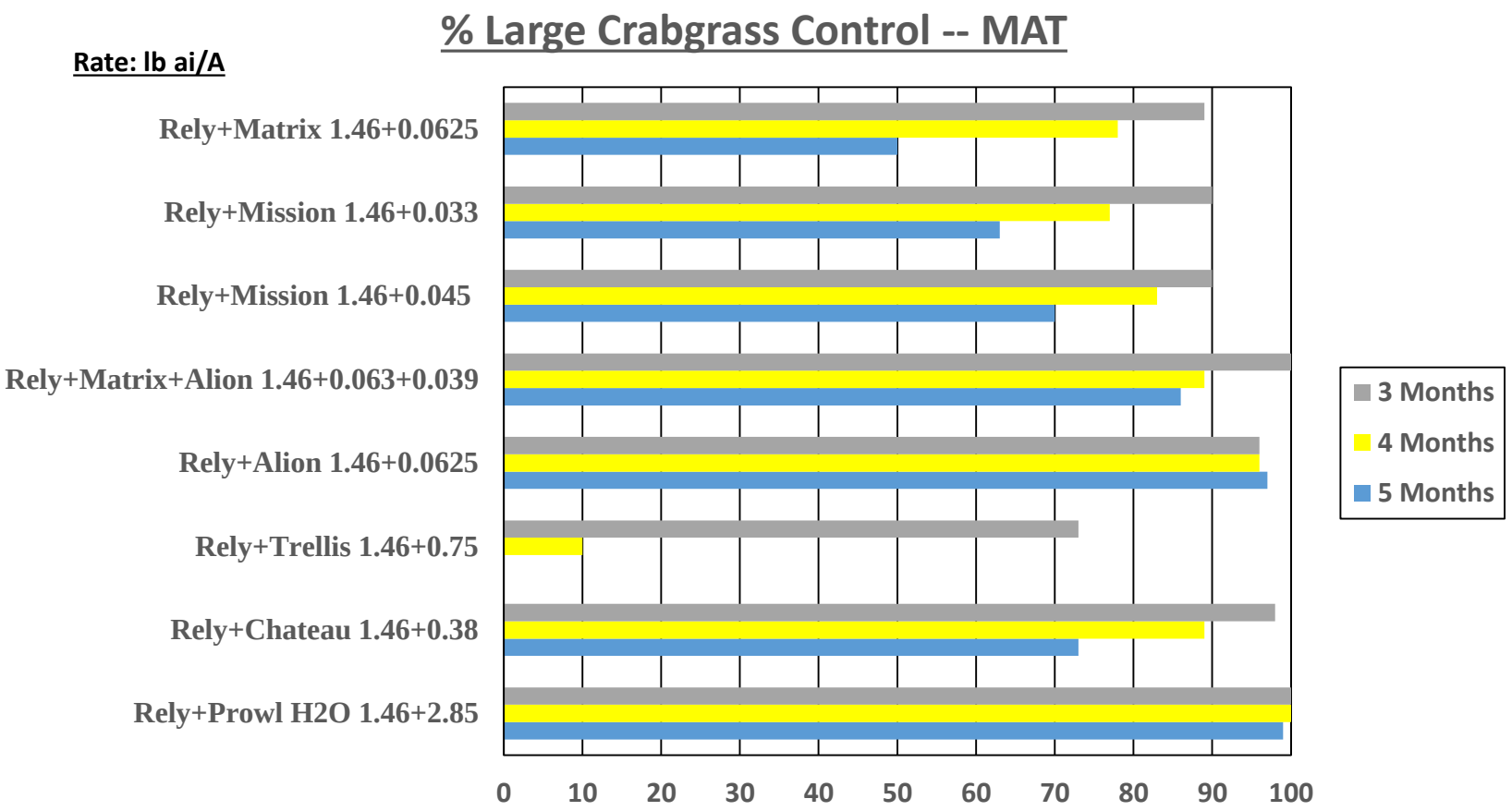
Post-Emergence Winter Herbicide

Season Long Weed Control in Grapes

2013



Application: Jan 21, 2013; 36 G/A; Henbit = 2-6" Ht., Whitestem Filaree = 4-12" Dia., Shepherd's purse = 4-10" Ht., Annual sothistle = 1-4" Dia.

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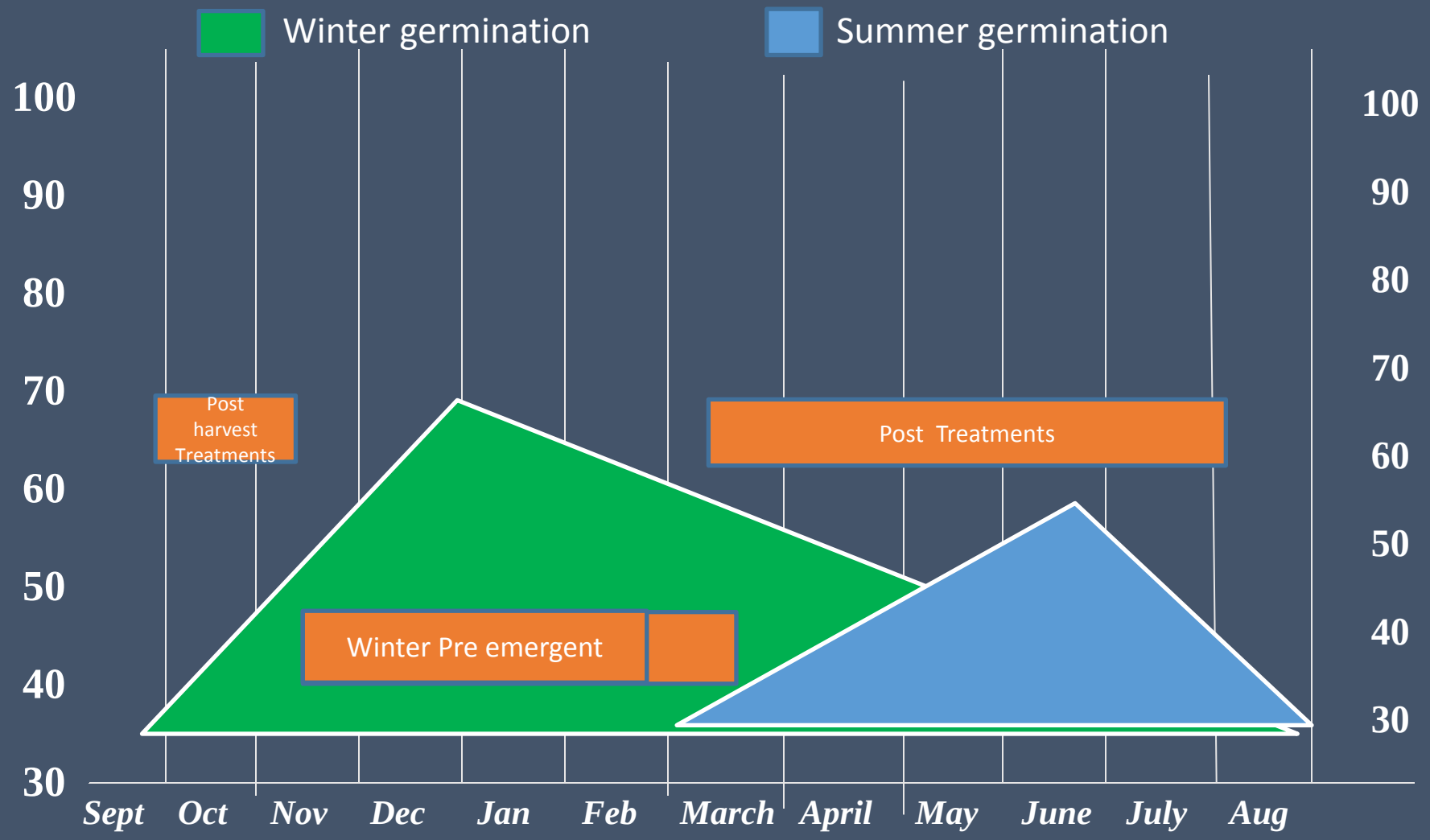
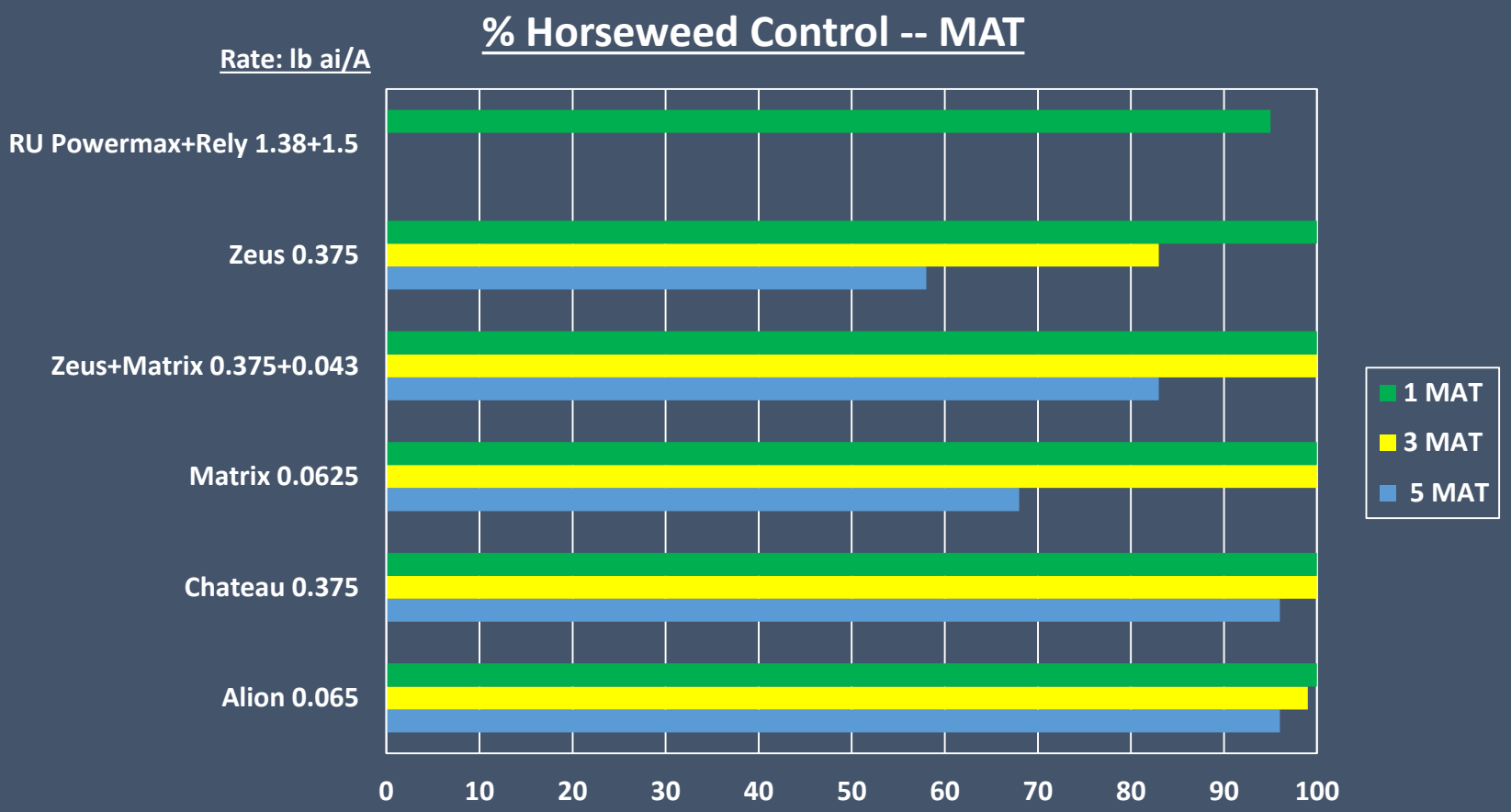
Weed Germination & Herbicide Timings in Vineyards



Horseweed Control in Established Vineyard
Clements Ca
2014



All treatments applied Jan 6, 2014 in 32 gpa water; Horseweed = 0.5-4" dia.; RUPM 1.38 lbai + Rely 280 1.5 lbai + Activator 90 0.25% V/V added to each treatment.

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UCCE EMERITUS
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