Brad Hanson
Cooperative Extension Weed Specialist

Weed Management

Advances in Walnut Production Course
Davis, CA
11-6-18

University of California
Agriculture and Natural Resources

UCDAVIS
DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

Why control weeds?

- Compete for water, nutrients, and light with trees
- Interference is especially problematic during establishment years
- Can affect crop management, irrigation, and harvest operations
- Impacts on other pest problems
- Crop quality concerns?

Complex populations

- Rarely just one weed species present
  - Annual vs perennial vs biennial
  - Grass vs sedges vs broadleaf
- Time of emergence
  - Fall vs spring emergence vs year-round
- Reproductive strategy
  - Seed vs vegetative

Factors affecting orchard weeds

- Orchard age and arrangement
  - Shading and space capture
- Irrigation type, timing, and amount
  - Furrow, sprinklers, micros, drip
- Tillage practices
  - Berms, cross-disking, etc.
- Herbicide options
- Orchard access

Integrated weed management

- Using all available strategies to manage weed populations in a manner that is economically and environmentally sound.
  - cultural
  - mechanical
  - chemical

Goals of IWM

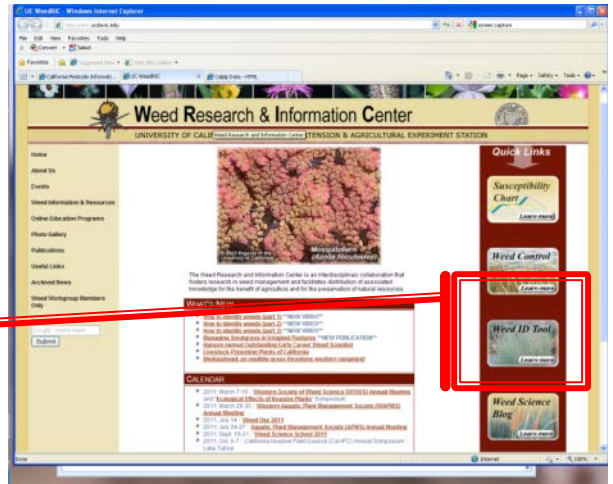
- Both short- and long-term goals
  - Prevent or reduce weed spread
  - Delay and/or suppress weed growth
  - Prevent or suppress weed seed production
  - Reduction of weed seed bank in soil

Weed identification

- Unknown weeds cannot be properly managed
  - No technique controls all weed species
  - Not all weeds cause equal damage (thresholds)
  - Species respond differently to control strategies
    - Even variants within a species (i.e. herbicide resistant biotypes)

Weed Research and Info Center
http://wric.ucdavis.edu

Online weed ID tool



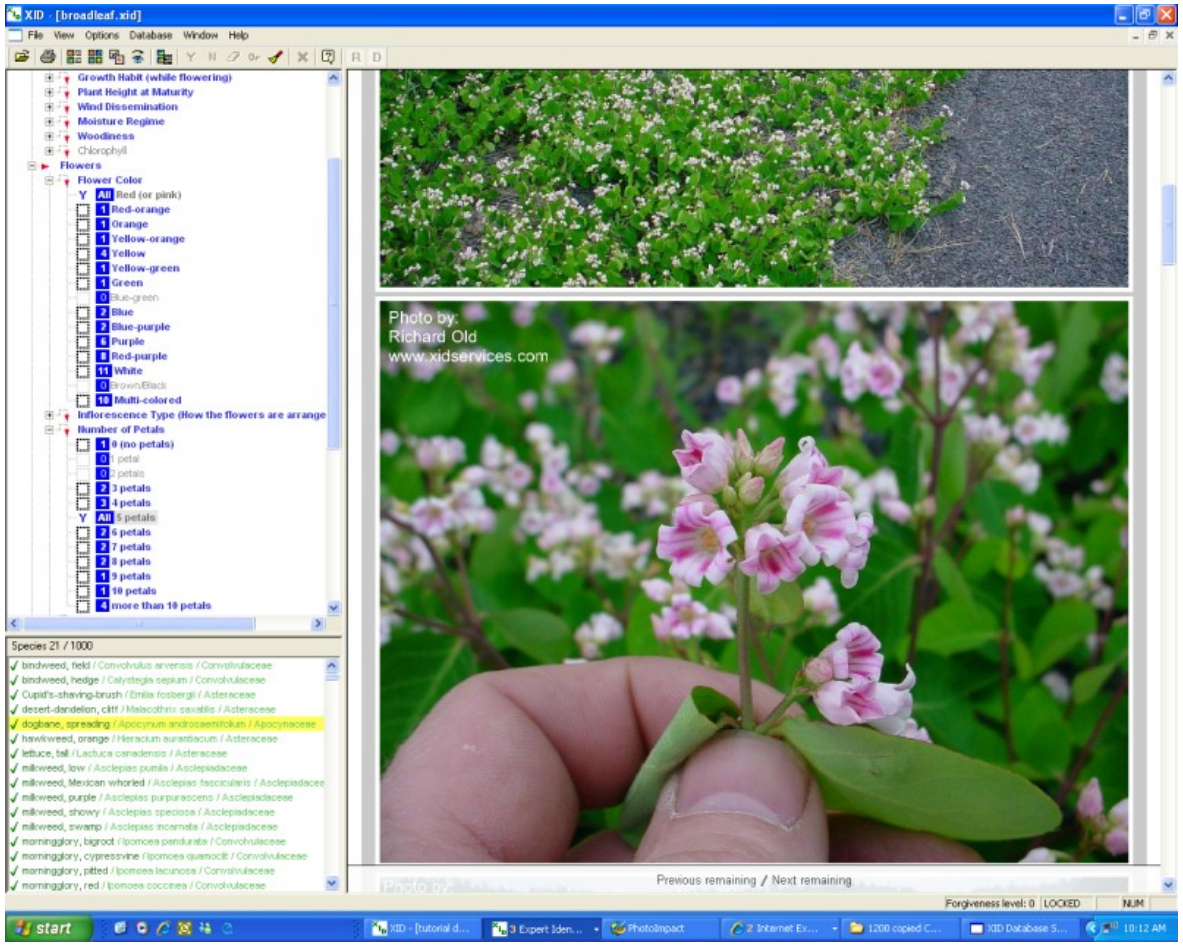
Weed ID Books and Pamphlets

A number of weed books are available

Weed ID - Software

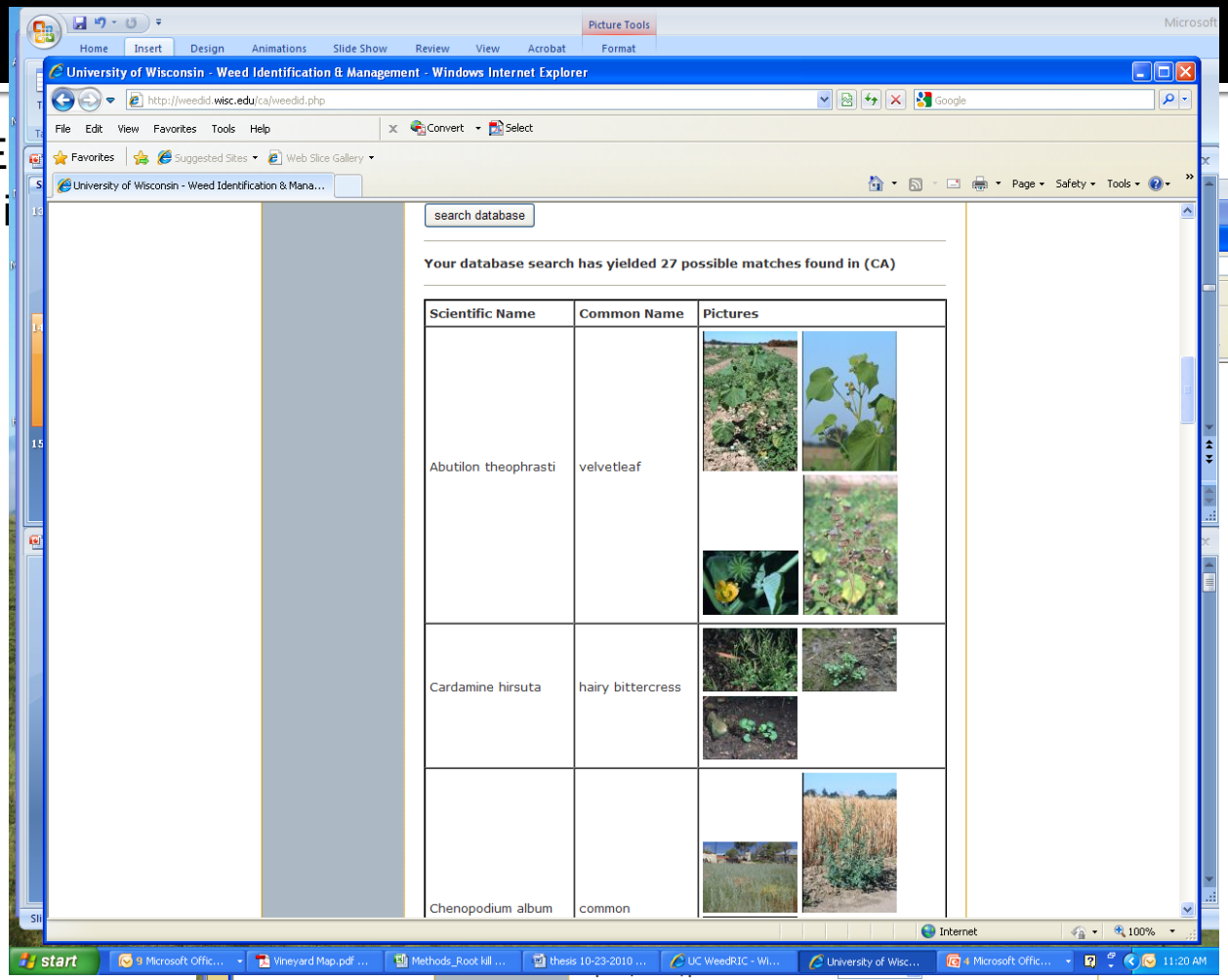
Several available.

I use a set by XID Services
-UC Davis
-WSSA
-WSWS
- others



Online Weed ID Resources

A few online (FRE
resources are avai



UC Davis Weed Research
and Information Center
www.wric.ucdavis.edu

Online Weed ID Resources

UC Integrated Pest Management Program

http://ipm.ucdavis.edu/PMG/menu.weeds.html

University of California • Agriculture and Natural Resources

UC IPM Online

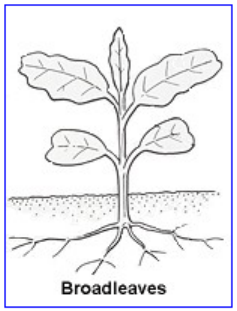
STATEWIDE INTEGRATED PEST MANAGEMENT PROGRAM

The UC Guide to Healthy Lawns

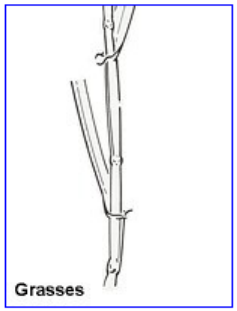
Back to start

Begin key

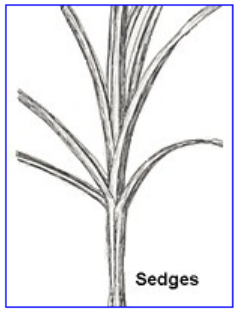
Which illustrated characteristic best matches your weed species?



Leaves are wide, veins branch out in different directions



Leaves are narrow, arranged in sets of 2; stems are rounded or flattened



Leaves are narrow, arranged in sets of 3; stems are triangular in cross section

Grass ID characteristics
Sedge ID characteristics
Broadleaf ID characteristics

Weed management

- Orchard and vineyard floors divided into two management zones: middles and crop row
  - Zones may have very different strategies
  - Also may differ during the life of the orchard

How do we manage weeds?

- A few broad categories
  - Exclusion/sanitation
  - Cultural
  - Mechanical
  - Biological
  - Chemical

Sanitation

- Weed management should be an ongoing concern
  - Scout and manage in the orchard
  - Manage weeds on field margins and access roads
  - Clean equipment between sites
  - Scout and prevent seed set of "new" problems

One years seeding…

Cultural practices

- Irrigation and fertilizer management
- Canopy management
- Cover crops
- Mulches
- Flaming
- Animals

Cover crops

Cover crop issues

ADVANTAGES

- Winter orchard access
- Reduced soil erosion
  - And pesticide and fertilizer runoff
- Addition of OM
- Soil structure and water/root penetration
- Competes with weeds

DISADVANTAGES

- Need to manage 2nd crop
  - More equipment
- Competes for water and nutrients
- Frost concerns
- Vertebrate and insect pests
- Addition of nutrients (N) may be unwanted (vineyard)

Flaming

- Non-chemical
- High fuel cost
- Just need to "heat" not "burn" weeds
- Best on young broadleaf
- No residual control
- Danger of damage to young trees or vines and irrigation systems

Animals

- Animals can be used to manage vegetation in some cases
  - Can work very well … or very poorly
    - Expensive (own or rent?)
    - Management effort
    - Animal health and welfare limits weed control
    - Can damage trees or vines (buds) if left too long
    - Food safety concerns

Mechanical control

- Tillage / cultivation
- Mowing
- Hand labor

- T&V rows vs middles
  - equipment options and costs

Cultivation

ADVANTAGES

- Non-chemical tactic
- Organic matter additions and nitrogen release
- Reduces competition for water
- Reduces frost potential
- Easy control in middles
- No "resistance"

DISADVANTAGES

- Fuel and time costs
- Trunk and root injury
- Dust
- Erosion
- Compaction
- Can spread seed and fragments
- Weeds near tree difficult
- Effects on tree vigor?

Mowing

- **Advantages.**
  - Suppresses weeds, reduces seed set
  - Orchard access and erosion benefits
- **Disadvantages.**
  - Frost potential
  - Weeds still use water and nutrients
  - Favors low growing and perennial weeds
  - Favors grasses *(advantages or disadvantages?)*
  - Cost of repeat operations (slow and frequent)

Chemical control

Herbicides

- CA orchards and vineyard herbicides usually applied to "strips" under the tree/vine row
  - 2-20 ft strip, may treat 20-50% of the floor
  - Middles managed with mowing, tillage, or less intensive herbicide program
  - Often with a "preharvest" broadcast application

Types of herbicides

- Preemergence (PRE)
  - Applied to bare soil and affect germinating seeds and seedlings
  - Provide residual effects (weeks or months)
- Postemergence (POST)
  - "Burn down" treatments applied to the foliage of emerged weeds
  - Can be "contact" or "translocated" materials
  - Some products have residual control, some do not

Factors affecting herbicide choice

- Availability in the crop (registration)
- Weeds to be controlled (weed ID)
- Toxicity and safety (to crop and non-target)
- Soil type and texture
- Cost

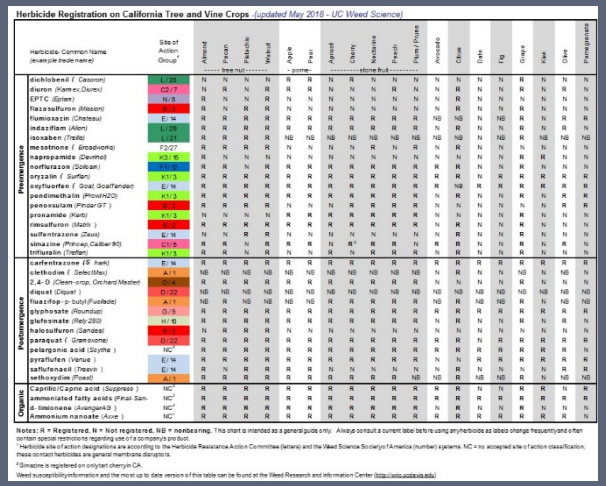
Herbicides registered in walnuts

Karmex
EPTC
Chateau
Alion
Trellis
Broadworks
Solicam

Surflan
Goal
Prowl
Pindar GT
Matrix
Zeus
Princep
Treflan

Shark
*Select***
2,4-D
Diquat**
*Fusilade***
Glyphosate

Rely 280
Sandea
Gramoxone
Venue
Treevix
Poast
O-contacts



Herbicide Registration on California Tree and Vine Crops *(updated May 2018 - UC Weed Science)*

Herbicide- Common Name (example trade name)	Site of Action Group[1]	Almond	Pecan	Pistachio	Walnut	Apple	Pear	Apricot	Cherry	Nectarine	Peach	Plum / Prune	Avocado	Citrus	Date	Fig	Grape	Kiwi	Olive	Pomegranate
		tree nut				pome		stone fruit												
Preemergence																				
dichlobenil (*Casoron*)	L / 20	N	N	N	N	R	R	N	R	N	N	N	N	N	N	N	R	N	N	N
diuron (*Karmex,Direx*)	C2 / 7	N	R	N	R	R	R	N	N	N	R	N	N	R	N	N	R	N	R	N
EPTC (*Eptam*)	N / 8	R	N	N	R	N	N	N	N	N	N	N	N	R	N	N	N	N	N	N
flazasulfuron (*Mission*)	B / 2	R	N	R	R	N	N	N	N	N	N	N	N	R	N	N	R	N	N	N
flumioxazin (*Chateau*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	NB	NB	N	NB	R	N	R	R
indaziflam (*Alion*)	L / 29	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	N
isoxaben (*Trellis*)	L / 21	R	R	R	R	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	NB	R	NB	NB	NB
mesotrione (*Broadworks*)	F2/27	R	R	R	R	N	N	N	N	R	N	R	R	N	N	N	N	N	N	N
napropamide (*Devrinol*)	K3 / 15	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	R	R	N	N
norflurazon (*Solicam*)	F1 / 12	R	R	N	R	R	R	R	R	R	R	R	R	R	N	N	R	N	N	N
oryzalin (*Surflan*)	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	R	R	N	N	R	N	R	R
oxyfluorfen (*Goal, GoalTender*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	NB	R	R	R	R	R	R	R
pendimethalin (*Prowl H2O*)	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	N	R	R	R
penoxsulam (*Pindar GT*)	B / 2	R	R	R	R	N	N	N	R	R	R	R	N	N	N	N	N	R	R	R
pronamide (*Kerb*)	K1 / 3	N	N	N	N	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
rimsulfuron (*Matrix*)	B / 2	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
sulfentrazone (*Zeus*)	E / 14	N	N	R	R	N	N	N	N	N	N	N	R	R	N	N	R	N	N	N
simazine (*Princep, Caliber 90*)	C1 / 5	R	R	N	R	R	R	N	R[3]	R	R	N	R	R	N	N	R	N	R	N
trifluralin (*Treflan*)	K1 / 3	R	R	N	R	N	N	R	N	R	R	R	N	R	N	N	R	N	N	N
Postemergence																				
carfentrazone (*G- hark*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
clethodim (*SelectMax*)	A / 1	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	R	N	N	NB	N	NB	N
2,4- D (*Clean- crop, Orchard Master*)	O / 4	R	R	R	R	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
diquat (*Diquat*)	D / 22	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
fluazifop- p- butyl(*Fusilade*)	A / 1	NB	R	NB	NB	NB	NB	R	R	R	R	R	NB	R	NB	NB	R	NB	NB	NB
glyphosate (*Roundup*)	G / 9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
glufosinate (*Rely 280*)	H / 10	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	N
halosulfuron (*Sandea*)	B / 2	R	R	R	R	N	N	N	N	N	N	N	N	R	N	N	R	N	R	N
paraquat (*Gramoxone*)	D / 22	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
pelargonic acid (*Scythe*)	NC[2]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
pyraflufen (*Venue*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
saflufenacil (*Treevix*)	E / 14	R	N	R	R	R	N	N	N	N	N	N	R	N	N	N	N	R	R	R
sethoxydim (*Poast*)	A / 1	R	R	R	R	R	R	R	R	R	R	R	NB	NB	R	NB	NB	R	N	NB
Organic																				
Caprillic/Capric acid (*Suppress*)	NC[2]	R	R	R	R	R	R	R	R	R	R	R	R	R	N	N	R	R	N	R
ammoniated fatty acids (*Final San-*)	NC[2]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
d- limionene (*AvengerAG*)	NC[2]	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
Ammonium nanoate (*Axxe*)	NC[2]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Notes: R = Registered, N = Not registered, NB = nonbearing. This chart is intended as a general guide only. Always consult a current label before using any herbicide as labels change frequently and often contain special restrictions regarding use of a company's product.

[1] Herbicide site of action designations are according to the Herbicide Resistance Action Committee (letters) and the Weed Science Society of America (number) systems. NC = no accepted site of action classification; these contact herbicides are general membrane disruptors.

[2] Simazine is registered on only tart cherry in CA.

Weed susceptibility information and the most up to date version of this table can be found at the Weed Research and Information Center (http://wric.ucdavis.edu)

Trade names for example only

*** Registered in NB walnuts only*

CA walnut herbicide use

	Top active ingredients (by acres)	2016 treated acreage
1	glyphosate	369,511
2	oxyfluorfen (Goal, Goaltender)	195,651
3	glufosinate (Rely)	92,572
4	paraquat (Gramoxone Inteon)	76,206
5	saflufenacil (Treevix)	69,583
6	indaziflam (Alion)	55,898
7	pendimethalin (Prowl)	44,737
8	rimsulfuron (Matrix)	31,000
9	2,4-D	25,588
10	carfentrazone (Shark)	21,368
11	penoxsulam (Pindar GT)**	20,946
12	flumioxazin (Chateau)	14,485

315,000 A bearing walnut, ~65,000 NB in 2016

Conventional herbicides

ADVANTAGES

- Can be very cost effective (in some cases)
- Consistent results
- Ease of application (speed)
- Crop safety (generally)
- Erosion benefits (vs tillage)
- Season-long control with some products and combos
- Selectivity can be used to maintain desired cover

DISADVANTAGES

- Cost (in some cases)
- Potential for off-site movement with some products
- Regulations and record keeping
- Herbicide resistance can occur
- Crop injury can occur
- Some market sectors have preference against

Herbicide application considerations

- PRE, POST, or PRE/POST mix?
- Tank mixes
- Weed spectrum controlled
- Surfactants and adjuvants
- Coverage (GPA)
- Timing and weed size
- Sprayer calibration (esp. OC nozzles)
- Nozzle selection
- Litter and debris

- Check current herbicide labels
- Scouting and record keeping
- Training and PPE for handlers and applicators
- Potential for off-site movement?
- Double check calculations and recommendations!

Extra challenges in young orchards

- Crop less competitive with weeds
- Greater sensitivity to weed competition
- Greater sensitivity to injury from weed control tactics
- Fewer herbicides registered on new plantings

Orchard weed management

- Weed ID
  - Understand the problem and biology
- Use integrated management tactics
  - Cultural and mechanical approaches
  - Chemical tactics
    - Right herbicide, right target, right time
    - Resistance management considerations
    - Environmental impacts
      - VOC, surface water, ground water

Manage "your" weeds

- Weed management is an annual concern and production cost that must be considered in a local context
- No "one size fits all" solution for all orchards - integrated weed management requires systemic and long-term thinking

T&V herbicide registrations

Herbicide Registration on California Tree and Vine Crops *-(updated May 2018 - UC Weed Science)*

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			----- tree nut -------				- pome-		--------- stone fruit ---------												
Preemergence	**dichlobenil** (*Casoron*)	L / 20	N	N	N	N	R	R	N	R	N	N	N	N	N	N	N	R	N	N	N
	diuron *(Kamex,Diurex)*	C2 / 7	N	R	N	R	R	R	N	N	N	R	N	N	R	N	N	R	N	R	N
	EPTC *(Eptam)*	N / 8	R	N	N	R	N	N	N	N	N	N	N	N	R	N	N	N	N	N	N
	flazasulfuron *(Mission)*	B / 2	R	N	R	R	N	N	N	N	N	N	N	N	R	N	N	R	N	N	N
	flumioxazin *(Chateau)*	E / 14	R	R	R	R	R	R	R	R	R	R	R	NB	NB	N	NB	R	N	R	R
	indaziflam *(Alion)*	L / 29	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	N
	isoxaben *(Trellis)*	L / 21	R	R	R	R	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	NB	R	NB	NB	NB
	mesotrione (*Broadworks*)	F2/27	R	R	R	R	N	N	N	N	R	N	R	N	R	N	N	N	N	N	N
	napropamide *(Devrinol)*	K3 / 15	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	R	R	N	N
	norflurazon *(Solicam)*	F1 / 12	R	R	N	R	R	R	R	R	R	R	R	R	R	N	N	R	N	N	N
	oryzalin (*Surflan*)	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	R	R	N	R	R	R	R	R
	oxyfluorfen (*Goal, GoalTender*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	NB	R	R	R	R	R	R
	pendimethalin *(Prowl H2O)*	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	R
	penoxsulam *(Pindar GT*)	B / 2	R	R	R	R	N	N	N	R	R	R	R	N	N	N	N	N	N	R	R
	pronamide *(Kerb)*	K1 / 3	N	N	N	N	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
	rimsulfuron *(Matrix*)	B / 2	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
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	simazine *(Princep,Caliber 90)*	C1 / 5	R	R	N	R	R	R	N	R[2]	R	R	N	R	R	N	N	R	N	R	N
	trifluralin *(Treflan)*	K1 / 3	R	R	N	R	N	N	R	N	R	R	R	N	R	N	N	R	N	N	N
Postemergence	**carfentrazone** (*S hark*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	clethodim (*SelectMax*)	A / 1	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	R	N	N	NB	N	NB	N
	2,4- D *(Clean- crop, Orchard Master)*	O / 4	R	R	R	R	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
	diquat *(Diquat*)	D / 22	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
	fluazifop- p- butyl *(Fusilade)*	A / 1	NB	R	NB	NB	NB	NB	R	R	R	R	R	NB	R	NB	NB	R	N	NB	NB
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	halosulfuron *(Sandea)*	B / 2	N	R	R	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	paraquat (*Gramoxone*)	D / 22	R	R	R	R	R	R	R	R	R	R	R	R	R	N	R	R	R	R	R
	pelargonic acid *(Scythe*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	N
	pyraflufen *(Venue*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	N	N	R	R	R	R	R	R
	saflufenacil *(Treevix*)	E / 14	R	N	R	R	R	R	N	N	N	N	N	N	R	N	N	N	N	R	R
	sethoxydim *(Poast)*	A / 1	R	R	R	R	R	R	R	R	R	R	NB	NB	R	NB	NB	R	N	NB	NB
Organic	**Caprilic/Capric acid** *(Suppress*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	N	N	R	R	N	R
	ammoniated fatty acids *(Final- San-*	NC[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	d- limionene *(AvengerAG*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
	Ammonium nanoate *(Axxe*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	N

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

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UC Davis Weed Research and Information Center
http://wric.ucdavis.edu/
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