Weed Management in Tree Crops

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Start Early!

- Weed management should start before trees are planted
- Easier to control weeds when trees are not present
  - Especially perennials
- Mechanical control
- More options of chemical control
- Pre and Pos emergent herbicides

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Why?

- Weed control enhances establishment of newly planted trees
- Improve growth and yield of established orchards
- Increase input efficiency (e.g., water, fertilizer, etc.)

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How?

- Weeds compete for crucial resources
  - Water, nutrients and sunlight
  - Aim to have a weed free strip at least 30 inches from trunk
- Interfere with irrigation uniformity
- Can reduce harvest efficiency
  - More difficult to collect nuts from the orchard floor

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Harbor Pests and diseases

- Vertebrates, insects, mites, nematodes and diseases
- Weeds near the trunk: voles and mice
- Gophers are more present in no-tilled orchards
  - Especially when field bindweed and other perennial broadleaves and clovers are present
- Diseases such as crown rot

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Know Your Enemies

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Shepherd's Purse (*Capsella bursa-pastoris*)

- Winter Annual
  - May grow all year in costal areas
- Management
  - Pre: pendimethalin
  - Pos: Glyphosate

Little Mallow *(Malva parviflora)*

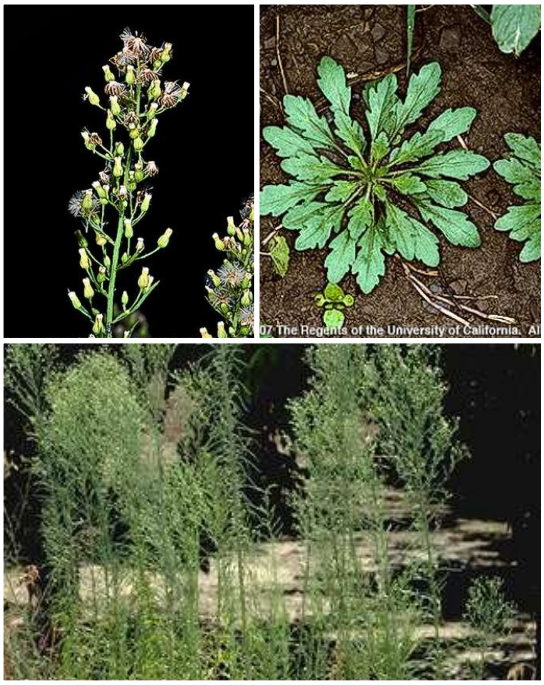
- Winter Annual
- Same family as cotton
- Mostly winter annual
  - Start growing with first rains in the fall
  - Quick develop deep taproot
- Chemical control
  - Not usually controlled with common preemergent herbicides
  - Oxyfluorfen (Goal) can control in higher rates
  - Nature of the seeds make difficult to time herbicide applications
  - Glyphosate is not effective when plants are big

Filaree (*Erodium spp.)*

- Winter annual but sometimes biennial
- Broadleaf filaree, whitestem filaree, and redstem filaree
- Needlelike immature fruit
- Preemergent or post emergent

Horseweed *(Conyza canadensis)*

- Summer annual
- Similar to hairy fleabane
- Summer annual or biennial
- Control at seedling or rosette stages (before woody stems)
- Pre and post control both
  - Pre: clopyralid (transline), Diuron (Karmex)
  - Post: Dicamba, diquat, and glyphosate



Hairy Fleabane (*Conyza bonariense*s)

- Summer annual
- Can withstand many mowings and produce seeds
- Pre: Simazine
- Pos: Paraquat and saflufenacil can control when small (before bolt), glyphosate control susceptible plants up to 19 leaves (2 lb/A)
  - CA: Most populations are not controlled by glyphosate and some are resistant to paraquat

Common purslane (*Portulaca oleracea*)

- Summer annual
- Germinates April/May
- Fleshy stems that can root and grow after cultivation
- Problem for nut drying and pickup during harvest
- Herbicides
  - Pendimethalin + glyphosate in the middles can provide season long control

Junglerice *(Echinochloa colona)*

- Summer annual
- Germinate throughout the summer
- Very variable specie
  - Prostrate up to 3 ft in length
  - Erect up to 3 feet high
- Purplish bands on leaves
  - Distinguish from barnyardgrass (same family) and crabgrass
- Herbicides: Pendimethalin or flumioxazin + glyphosate

Yellow Nutsedge *(Cyperus esculentus)*

- Perennial weed that looks like grass
- Primarily propagates through underground tubers (rhizomes)
  - Mostly in the upper foot of soil
- Control can be achieved by preventing formation of new tubers
  - Repeated well-timed herbicide application
    - Glyphosate and glufosinate

Johnsongrass *(Sorghum halepense)*

- Perennial
- Reproduces by seeds and from rhizomes
- Management
  - Repeated close mowing
  - Tillage every few weeks in summer helps infestation in orchards
  - Just 1X year: encourages rhizome growth
- Herbicide resistance detected

Field Bindweed (*Convolvulus arvensis)*

- Perennial
- Often confused with morningglory
- One of the most problematic weed in temperate regions
- Virus hosts (potato X disease)
- Many herbicides available – Apply when weeds are growing rapidly before bud and drought stress
  - 2,4 D, Dicamba, glyphosate, Imazapyr, etc

Weed Control in newly planted orchards

- Critical period for weed management
- Heavy competition can reduce vigor and productivity
- Weedy orchards take longer to become economically productive
- Critical: avoid injury to trunks and roots
- Weeds around the trunk
  - Selective preemergence herbicide applied in a strip down the tree row
  - Do not spray trunks or leaves (especially if less than 3 years old)
  - Hand hoe until 3-4 yo then swing mower
- Mulch made of plastic or polyester can help

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Weed Control in newly planted orchards

- Herbicides: some weeds are best controlled during nonbearing period
  - Preemergent herbicides should be applied only after soil has been settled after planting to reduce likelihood of tree injury
  - Post-emergent herbicides
    - Protect foliage and bark of trees from direct spray or drift
    - Young trees are very susceptible to herbicide injury
    - Plastic or cardboard wraps help preventing contact

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0 As soon as the soil is settled following planting
Giuliano Carneiro Galdi, 2025-10-18T19:34:11.521

Weed Control in Established Orchards

- Preemergent herbicides
  - "Soil Herbicides" act against germinating weeds
    - Post-harvest herbicide program
  - Applied to bare soil and incorporated
    - Rain or irrigation (0.25 – 0.5")
    - Excess of water can cause runoff or leaching
  - Persistence: several months to a year
  - Effectiveness depends on
    - Debris on soil surface (sweep/blow rows before application)
    - Large seed weeds can germinate below the herbicide barrier
  - Can be combined with postemergent to control weeds that will germinate before preemergent activation

Weed Control in Established Orchards

- Post-emergent herbicides
  - Control emerged weeds
  - Sprayed alone or in mix, broad or spot treatments
  - Applied when weeds are small and happy
- Spot application and weed sensing sprayers reduce chemical use
- Multiple application may be needed for some species (spotted spurge)

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0 FRESNO COUNTY, Calif. (KSEE/KGPE) – Winds as fast as 50 mph slammed the Central Valley over the past few weeks, bringing down trees, damaging powerlines, and leaving a lot of debris. Some of that debris has caused problems for farmers and American Avenue Landfill owned and operated by Fresno County. The issue began after high winds picked up trash from the landfill and swept it onto nearby orchards. The result was a variety of colored plastic trash bags of all sizes wrapping themselves around the branches – and covering areas of the ground.

Giuliano Carneiro Galdi, 2025-10-21T05:30:37.900

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0 GUSS – which stands for Global Unmanned Spray System – was created by the Kingsburg, Calif.-based Crinklaw Farm Services,

Giuliano Carneiro Galdi, 2025-10-21T15:36:39.507

Weed Control in Established Orchards

- Types of post-emergent herbicides
  - **Contact (e.g., Paraquat)**
    - Kills only sprayed tissues
    - Good coverage is essential
    - Multiple sprays for perennial and new germinating weeds
  - **Translocated herbicides (e.g., glyphosate)**
    - Enter and move throughout the plant (roots and shoots)
    - Spray coverage is important but less critical than contact herbicides
  - Tips
    - Add adjuvants (NIS or oil) to increase effectiveness
    - Ammonium sulfate to hard water
    - Pay attention to dust on weed foliage, spray volume and water quality (Ca, Mg, Na, and Fe)

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Management: Cover Crops

- Cover crops: main reasons are to enhance soil quality and potentially increase soil nitrogen if legumes are planted
- Can also help suppress weeds
  - Mainly winter weed species, but can help with summer weeds if cover crop remains or regrowth by spring
    - Compete with weeds
    - Physical barrier
    - Allelopathy
- Can also reduce dust and mitigate spider mite infestations

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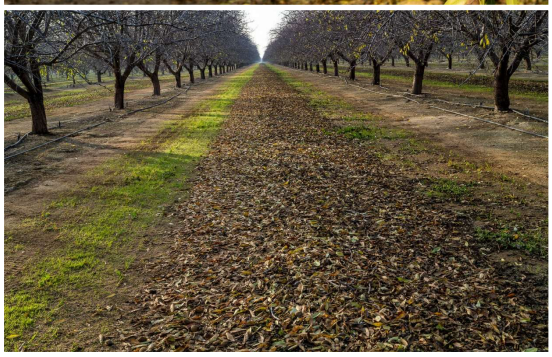
Management: Cover Crops

- Precautions and cons of cover crops
  - Additional water to avoid competition with trees
  - Fall and winter orchard operations will damage cover crops
    - Seed cover crops in alternate middles
    - Plant cover crops in years when operations are not planned
  - Mow cover crops before bloom to reduce frost hazard and eliminate pollination competition (almonds)
    - If not mowed, cover crops are perfect housing for gophers
- An alternative to mowing is to leave cover crop longer and roll it with a ring roller
  - Mulch prevent some weeds and should be gone by harvest



Management: Irrigation

- Irrigation
  - Weed infestation is influenced by method of irrigation and amount of water applied
- **Sprinkler and Emitters**
  - Areas around sprinklers and emitters may require additional weed control efforts
  - Area in between sprinklers have less weed problems than other irrigation methods
- First irrigation after herbicide application is crucial for incorporation of pre-emergent herbicides
  - Pre herbicides can be incorporated with tillage, rainfall or sprinklers but not with furrow and drip
  - Flood irrigation can provide good incorporation as long as it is uniform and the soil is ideal
    - Usually flood irrigating applies more water than require to incorporate pre herbicide
    - Can be a problem in sandy soils

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0 If not, close mowing with a flail mower to chop the cover crop remaining

Giuliano Carneiro Galdi, 2025-10-18T19:33:40.819

Management: Electrical Weed Control (EWC)

- Zasso EWC
  - Tractor mounted device powered by PTO
- Brad Hanson's (UC Davis) trials has showed potential
  - Almonds and Blueberries
- Weed pressure remained lower in EWC treatments
  - Can even suppress nutsedge and field bindweed with multiple treatments
- Con: possible negative effect on soil microbe community
- 2025 Research
  - Hanson's group is investigating how soil moisture at the time of EWC influence its efficacy

Management: Mechanical and Physical

- Hoeing
- Mowing
- Mulching
- Grazing
- Knives and in row cultivation

Management: Chemical

- Common MOA in orchards
  - Glyphosate, glufosinate, oxyfluorfen, indaziflan, rimsulfuron, flumioxazin
- Example of herbicide program in almonds
  - Fall: Prowl + Alion or GoalTender
  - Spring: Rely and Roundup for escapes
  - Spot treatments for sedges with halosulfuron (Sandea) and flazasulfuron (Mission)

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Table 1. **Modes of action, weed control spectrum, and soil residual activity of herbicides labeled for use in vineyards and orchards**

Active ingredient	Trade name	MOA* group	MOA*	Weeds controlled	Soil residual activity	Uses
2,4-D	multiple names	4	synthetic auxin	broadleaves	limited	
acetic acid	WeedPharm	n/a	leaf desiccation	broadleaves and grasses	no	organic systems
carfentrazone	Aim	14	PPO inhibitor	broadleaves	no	
clethodim	Select	1	ACCase inhibitor	grasses only	no	nonbearing crops
clopyralid	Stinger	4	synthetic auxin	broadleaves	limited	
clove leaf oil	Matran	n/a	leaf desiccation	broadleaves and grasses	no	organic systems
dichlobenil	Casoron	20	cell wall synthesis inhibitor	broadleaves and grasses	yes	spot treatment perennials
diuron	Karmex	7	Photosystem II inhibitor	broadleaves and grasses	yes	
fluazifop	Fusilade	1	ACCase inhibitor	grasses only	no	nonbearing crops
flumioxazin	Chateau	14	PPO inhibitor	broadleaves and a few grasses	yes	
glyphosate	Roundup, others	9	EPSP synthase inhibitor	broadleaves and grasses	no	
glufosinate	Rely	10	glutamine synthase inhibitor	broadleaves and grasses	no	
halosulfuron	Sandea	2	ALS inhibitor	broadleaves, grasses, and sedges	yes	nutsedge control POST
indaziflam	Alion	29	cell wall synthesis inhibitor	broadleaves and grasses	yes	
isoxaben	Gallery	21	cell wall synthesis inhibitor	broadleaves	yes	
napropamide	Devrinol	15	very long chain fatty acids inhibitor	grasses and some broadleaves	yes	
norflurazon	Solicam	12	carotenoid biosynthesis inhibitor	broadleaves and grasses	yes	
oryzalin	Surflan	3	microtubule assembly inhibitor	broadleaves and grasses	yes	
oxyfluorfen	Goal	14	PPO inhibitor	broadleaves and a few grasses	yes	
paraquat	Gramoxone	22	Photosystem I inhibitor	broadleaves and grasses	no	
pendimethalin	Prowl	3	microtubule assembly inhibitor	broadleaves and grasses	yes	
pronamide	Kerb	3	microtubule assembly inhibitor	broadleaves and grasses	yes	
rimsulfuron	Matrix	2	ALS inhibitor	broadleaves and grasses	yes	
saflufenacil	Treevix	14	PPO inhibitor	broadleaves	limited	marestail, sharppoint fluvellin
sethoxydim	Poast	1	ACCase inhibitor	grasses only	no	
simazine	Princep	5	Photosystem II inhibitor	broadleaves and grasses	yes	
terbacil	Sinbar	5	Photosystem II inhibitor	broadleaves and grasses	yes	willowweed (*Epilobium* spp.)
trifluralin	Treflan	3	microtubule assembly inhibitor	broadleaves and grasses	yes	

Notes: Check herbicide labels carefully to determine whether the herbicide is labeled for use in your area, for your crop, and for weeds that will be controlled.
*Mode of action: see the Weed Science Society of America (WSSA) website, http://wssa.net/wp-content/uploads/WSSA-Mechanism-of-Action.pdf, for a brief description of above-listed modes of action.

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0 Table from https://anrcatalog.ucanr.edu/pdf/8501.pdf

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Shaded Grey: Labeled
White: Not labeled
NB: Nonbearing only

Table 2. Herbicides labeled for use in citrus, nut, pome fruit, and stone fruit orchards and vineyards

Active ingredient	Common product name	Citrus	Grape	Nuts						Pome fruits		Stone fruits					
				Almond	Chestnut	Hazelnut	Pecan	Pistachio	Walnut	Apple	Pear	Apricot	Cherry	Nectarine	Peach	Plum	Prune
Time of application to weeds: PRE																	
dichlobenil	Casoron																
diuron	Karmex																
indaziflam	Alion																
isoxaben	Gallery	NB		NB			NB	NB									
napropamide	Devrinol																
norflurazon	Solicam																
oryzalin	Surflan																
pendimethalin	Prowl																
pronamide	Kerb																
simazine	Princep																
terbacil	Sinbar										NB	NB	NB			NB	
trifluralin	Treflan				NB	NB					NB		NB				
Time of application to weeds: PRE/POST																	
flumioxazin	Chateau	NB															
halosulfuron	Sandea																
oxyfluorfen	Goal	NB															
Time of application to weeds: POST																	
2,4-D																	
acetic acid	WeedPharm																
carfentrazone	Aim																
clethodim	Select	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
clopyralid	Stinger																
diquat	Reglone	NB		NB			NB	NB									
fluazifop	Fusilade	NB		NB	NB	NB		NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
glyphosate	Roundup																
glufosinate	Rely																
paraquat	Gramoxone																
pyraflufen	Venue																
rimsulfuron	Matrix																
saflufenacil	Treevix																
sethoxydim	Poast															NB	NB

Crop Safety

- Avoid direct contact between tree and herbicide
  - Foliage, roots, green bark, fruit
- Use protective cartoons to avoid trunk damage
- Calibrated well maintained sprayer with correct nozzles
  - Replace nozzles annually → consistent spray distribution
  - Use low-drift nozzles → to minimize off-target spraying
- Smooth middles to reduce boom bounce

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0 Table from: https://anrcatalog.ucanr.edu/pdf/8501.pdf
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Crop Safety - Herbicide Injury (Glyphosate vs Almonds)

Chlorosis growth distortion and stunting

Interveinal chlorosis and margin chlorosis

Growth distortion, leaf stacking and stunting

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Weed Resistance

- **Herbicide Resistance** is the inherited ability of a **plant** to survive and reproduce following exposure to a dose of herbicide normally lethal
- **Herbicide tolerance** is the inherent ability of a **species** to survive and reproduce after herbicide treatment. This implies that there was no selection pressure
  - Weed was never controlled by a given herbicide
- 26 cases of herbicide resistant weed populations in California
- Extensive use of same active ingredient = RESISTANCE

Photo: B. Hanson

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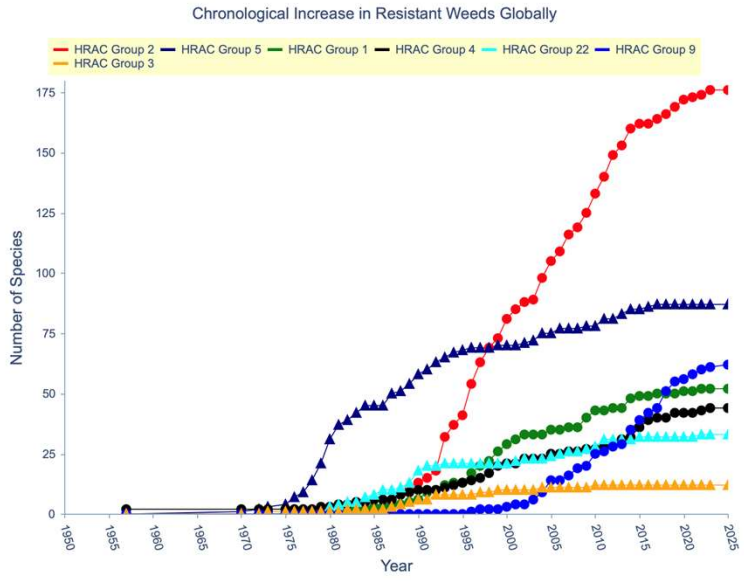

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Thank you

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0 Group 2: ALS inhibitors (acetolacteate synthase)- Raptor, harmony, beyond)
Giuliano Carneiro Galdi, 2025-09-29T16:20:41.944

0 0 First Roundup Ready Crop: 1996 RR soybean was introduced by monsanto)
Giuliano Carneiro Galdi, 2025-09-29T16:21:58.508

0 1 Then cotton and canola (1997), corn 1998), alfalfa and sugarbeet in early 2000s but comertially available in 2011 and 2012
Giuliano Carneiro Galdi, 2025-09-29T16:23:13.099

0 2 Blue triangle: gtoup 5 (atrazine): pigweeds and sommon groundsel resistant populations in US and Canada in mid 70s
Giuliano Carneiro Galdi, 2025-09-29T16:26:20.823