



Weed Control in Florida Citrus

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Program Outline

- ❖ **Cost and Benefits of Weed Control Program**
 - Why control weeds
 - Cost of control programs
- ❖ **Developing a Weed Management Program**
 - Pre and post emergence products
 - Systemic and contact products
 - Product selectivity for broadleaf and grass weeds

Program Outline (cont.)

❖ **Developing a Weed Management Program**

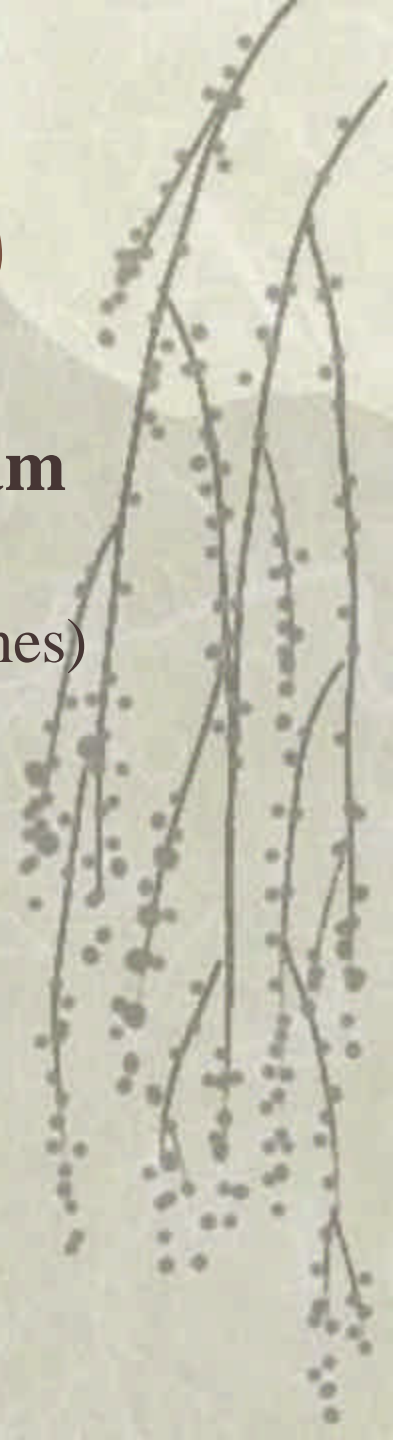
- Seasonality (annual, biannual, perennials)
- Weed types (broadleaves, grasses, sedges & vines)
- Product selection (pre, post, systemic, contact)

❖ **Calibration and Application**

- Benefits of calibration
- Application volumes & pressure

❖ **Herbicide Band Width**

- Selection of application band width
- Cost associated with application band width



*Why Control
Weeds?*



Weeds compete with citrus trees for:

- ❖ nutrients
- ❖ water
- ❖ space
- ❖ light
- ❖ harbor insects and rodents
- ❖ increase fire hazard
- ❖ increase cold damage from radiation freezes (2-4°F colder)
- ❖ interfere with low volume irrigation systems
- ❖ intercept soil-applied chemicals
- ❖ affect harvesting operations

Desirable effects of weeds:

- ❖ minimizes soil erosion from wind and water
- ❖ increases soil organic matter



Citrus production expenses by major categories, 2002-03:*

Indian River Fresh Fruit Grapefruit Cultural Program

❖ Spray (5 sprays, fresh program)	\$338.62	33.1%
❖ Weed Control (middle and in-row)	\$211.05	20.6%
❖ Irrigation (inc. ditch maint.)	\$184.16	18.0%
❖ Tree Replacement	\$128.05	12.5%
❖ Fertilizer/Lime	\$119.72	11.7%
❖ Pruning/Hedging/Topping	<u>\$ 42.94</u>	<u>4.1%</u>
❖ Total Cost Per Acre	\$1,024.54	100.0%

- ❖ * Ronald Muraro. Budgeting Cost and Returns for Indian River Fresh Grapefruit Cultural Program, 2002-03, as published in Citrus Industry Magazine, August 2003.

Weed control/management program cost breakdown

❖ Mow middles	3-4 times/yr	\$29.16
❖ Chemical mow	2 times/yr	\$14.06
❖ General grove work		
– Sprout and vines		\$25.84
❖ Herbicide (material \$105.34, app. \$36.75)		<u>\$141.99</u>
❖ Total weed control cost per acre		\$211.05

Weed control program(s):

❖ **Preventative**

- sanitation
- spot spraying
- hand labor

❖ **Chemical**

- soil-applied preemergence herbicide
- foliar-applied postemergence
 - systemic herbicides
 - selective
 - non-selective
 - contact

Weed control program(s) *(cont'd.):*

- ❖ **Chemical mowing** – sub-lethal rates to suppress the growth and/or regrowth for 45-90 days
- ❖ **Biological** – *Phytophthora palmivora*
- ❖ **Mechanical**
 - mowing
 - tillage – less common due to fibrous root damage and potential erosion in bedded citrus
- ❖ **Hand labor**

Developing a Weed Management Program

- ❖ Preemergence program
- ❖ Postemergence program

Developing a Weed Management Program

- ❖ Preemergence herbicide
 - Herbicide(s) applied to soil surface (not incorporated) before the specified weed has emerged. In citrus, incorporation is by irrigation/rainfall into the zone of seed emergence.
- ❖ Postemergence herbicide
 - Herbicide(s) applied after the specified weed has emerged from the soil and materials generally lack soil activity.

Developing a Weed Management Program (cont.)

- ❖ Systemic/translocated herbicide
 - Moves from one location to another in the plant reaching all plant parts, i.e. roots, stems and leaves.
- ❖ Contact herbicide
 - A herbicide that is phytotoxic on contact with plant tissue rather than as the result of translocation within the plant.

Examples of Major Preemergence Herbicides

Common name	Brand name
Bromacil	Hyvar
Diuron	Karmex, Direx, Diuron
Bromacil + diuron	Krovar I
Thiazopyr	Mandate
Simazine	Princep, Caliber 90, Simazine (4L, 90DF), Sim-Trol
Norflurazon	Solicam
Oryzalin	Surflan
Pendimethalin	Prowl, Pendimax (non-bearing)

Weed Control by Various Products or Methods					
	50% Grove Acreage				50% Grove Acreage
	Under tree – broadleaf		Under tree - grasses		Row middle
Chemical	PRE	POST	PRE	POST	Chemical mow
Bromacil *			X	Limited	
Norflurazon	Limited		X		
Thiazopyr			X		
Oxyfluorfen **	X				
Simazine	X		Limited an. grasses		
Diuron	X		Limited an. grasses		
Oryzalin	Limited		X		
Pendimethalin			X		
Glyphosate		X		X	X
Paraquat		X		X	
Sethoxydim				X	
Fluazifop-p-butyl **				X	
Biological <i>Phytophthora palmivora</i>		Milkweed vine only			
Mechanical Discing/mowing	Limited control of grasses and broadleaf due to inability to get under tree				Control of broadleaf and grasses
X = control (rate and weed species dependent) * location restrictions, ** non-bearing only					

Preemergence Herbicide Treatments and Annual Overall Weed Control (%) for the Ridge and Flatwoods Citrus Production Regions

Herbicide ***	Ridge		Flatwoods	
	Rate (lb product)	Control % *	Rate (lb product)	Control % *
Hyvar 80DF ****	2.0	91 a	2.6	81 b
Direx 80DF	2.0	74 bcd	2.6	59 cde
Hyvar 80DF + Direx 80DF ****	2.0 + 2.0	92 a	2.6 + 2.6	91 a
Direx 80DF + Surflan 80DF	2.0 + 2.0	79 bc	2.6 + 2.6	63 cd
Direx 80DF + Mandate 2E	2.0 + 1 pt	74 b-e	2.6 + 1.33 pt	60 cd
Direx 80DF + Mandate 2E	2.0	76 bcd	2.6 + 2.0 pt	66 c
Solicam 80DF	2.0	70 b-e	3.0	81 b
Solicam 80DF + Direx 80DF	2.0 + 2.0	81 b	3.0 + 2.6	92 a
Solicam 80DF + Simazine 90	2.0 + 2.0	73 b-e	3.0 + 2.9	89 ab
Solicam + Goal 1.6E **	2.0 + 2 qts	81 b	3.0 + 3 qts	88 ab
Surflan 80DF	2.0	64 def	2.5	37 hi
Control		39 g		29 i

Means followed by same letter within a column do not significantly differ (P # 0.05 Waller-Duncan). Percent control data were transformed using arcsin square root percent and are reported in de-transformed units. *Annual weed control based upon the average of 3 treatments per year with ratings at 120 days after treatment. ** non-bearing. ***All treatments including control included glyphosate at 2-3 qts. **** Prohibited from use in specific ridge counties, see label.

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	Rate (lb product)	Control % *	Rate (lb product)	Control % *
Surflan 80DF	2.0	64 def	2.5	37 hi
Goal 1.6E **	2.0 qt	69 cde	3.0 qt	55 c-g
Goal 1.6E ** + Mandate 2E	2.0 qt + 1 pt	76 bcd	3.0 qt + 1.5 pt	64 cd
Goal 1.6E ** + Mandate 2E	2.0 qt + 1.3 pt	78 bc	3.0 qt + 2.0 pt	61 cd
Simazine	2.0	53 f	3.0	47 e-h
Simazine + Surflan 80DF	2.0 + 2.0	75 bcd	3.0 + 2.5	57 c-f
Simazine + Mandate 2E	2.0 + 1 pt	69 cde	3.0 + 1.5 pt	64 cd
Simazine + Mandate 2E	2.0 + 1.3 pt	72 b-e	3.0 + 2.0 pt	53 d-g
Mandate 2E	1.0 pt	62 ef	1.5 pt	46 fgh
Mandate 2E	1.3 pt	68 cde	2.0 pt	42 gh
Control		39 g		29 i

Means followed by same letter within a column do not significantly differ (P # 0.05 Waller-Duncan). Percent control data were transformed using arcsin square root percent and are reported in de-transformed units. *Annual weed control based upon the average of 3 treatments per year with ratings at 120 days after treatment. ** non-bearing. ***All treatments including control included glyphosate at 2-3 qts.

Examples of Major Postemergence Herbicides

Common name	Brand name
Fluazifop-P-butyl	Fusilade (non bearing)
Glyphosate + 2,4-D	Landmaster
Paraquat dichloride	Boa, Gramoxone
Sethoxydim	Poast Plus
Glyphosate	Glyfos, Glyphomax, Roundup, Touchdown, etc.

Examples of Major Systemic Postemergence Herbicides

Common name	Brand name
Glyphosate	Glyfos, Glyphomax, Roundup, Touchdown, etc.

Systemic Postemergence Herbicides (Glyphosate cont'd)

Location	Rate trt/A in A. E.	Comments
Undertree	Annual weeds: 0.75-1.5 lb A.E. Perennial weeds: 1.75-3.75 lb A.E.	Apply in 10-40 gpa. Use ammonium sulfate with some water sources. Avoid contact with fruit, foliage and green bark Suppression of grasses and broadleaf weeds for 45-90 days
Middles Management		
Chemical mowing	Bahiagrass: .094-.188 lb A.E. Bermudagrass: .141-.37 lb A.E.	
Wiping	5-10% solution - carpet wiper 50-100% solution- panel wiper	
Spot trt.	1-2% solution	

Glyphosate (cont'd)

Herb Form	A.E.	A.I.	Rate per treated acre in A.E.- previous slide							Max rate per trt/A (qts)
			0.75 lb	1.5 lb	2.25 lb	.094 lb	.188 lb	.282 lb	.37 lb	
			Equivalent amount products to equal the above pounds of A.E.							
Glyphomax	3.0	4.0	1 qt	2 qt	3 qt	4 oz	8 oz	12 oz	16 Oz	10.6 qts
Roundup Custom	4.0	5.4	24 oz	48 oz	72 oz	3 oz	6 oz	9 oz	12 Oz	8 qts
Roundup Original	3.0	4.0	1 qt	2 qt	3 qt	4 oz	8 oz	12 oz	16 oz	10.6 qts
Roundup UltraMax	3.7	5.0	26 oz	52 oz	78 oz	3.25 oz	6.5 oz	9.75 oz	13 oz	8.5 qts
Touchdown	3.0	3.57	1 qt	2 qt	3 qt	4 oz	8 oz	12 oz	16 oz	8 qts

Glyphosate + 2,4-D *(Landmaster II)*

- ❖ Special registration in 2000
- ❖ Mixture of 2,4-D + glyphosate
- ❖ Special label requirements for record keeping, i.e. wind speed, location of use, etc.
- ❖ Distance requirement from specific crops

Tree age	Rate	Comments
All	2-8 qts + Roundup	See label for use and equipment requirements

Examples of Major Postemergence Contact Herbicides

Common name	Brand name
Paraquat dichloride	Boa, Gramoxone

Selection of herbicide and its rate will vary depending upon:

- ❖ weed species present
- ❖ growth stage of weed species
- ❖ soil type
- ❖ cost of herbicide material(s)
- ❖ scion
- ❖ tree age
- ❖ season



Young groves require greater attention to material selection and rate:

- ❖ tree sensitivity to higher rate
- ❖ sensitivity of young tree trunk to herbicide, especially green trunks
- ❖ greater exposure of soil to sun allows increased weed growth

Weed monitoring:

- ❖ before application, determine stage of growth and type of weeds present
- ❖ possible combination of pre- + postemergence materials may be required
- ❖ combination of preemergence herbicides for control of both broadleaves and grasses
- ❖ encourage rotation of herbicides to broaden control of difficult to control weeds

Four “R’s” of ANY Weed or Pest Control Program

- ❖ right material
- ❖ right amount
- ❖ right time
- ❖ right way
- ❖ Without the proper selection of the four “R’s” any pest control program is subject to failure

Weed Identification

❖ Life cycles

- Annuals – one-year life cycle
- Biennials – two-year life cycle
- Perennials – live more than two years



Weed Classification

❖ Grasses

- Seedling have only one leaf as they emerge from seed.
- Leaves are generally narrow and upright with parallel veins
- Growing point on seedling grasses is sheathed and located below soil surface

Weed Classification

❖ Sedges

- Similar to grasses except that they have triangular stems and leaves arranged in groups of threes



Weed Classification

❖ Broadleaves

- Seedlings have two leaves as they emerge from seeds
- Leaves are generally broad with netlike veins
- Usually have strong central taproot and fairly coarse root system
- Exposed growing points at the end of each stem and in leaf axils

Stages of Plant Development

❖ Four stages

- Seedling – small delicate plantlets
- Vegetative – fast growth; production of stems, roots, and foliage
- Seed production – energy directed toward production of seed
- Maturity – little or no growth or movement of water and nutrients

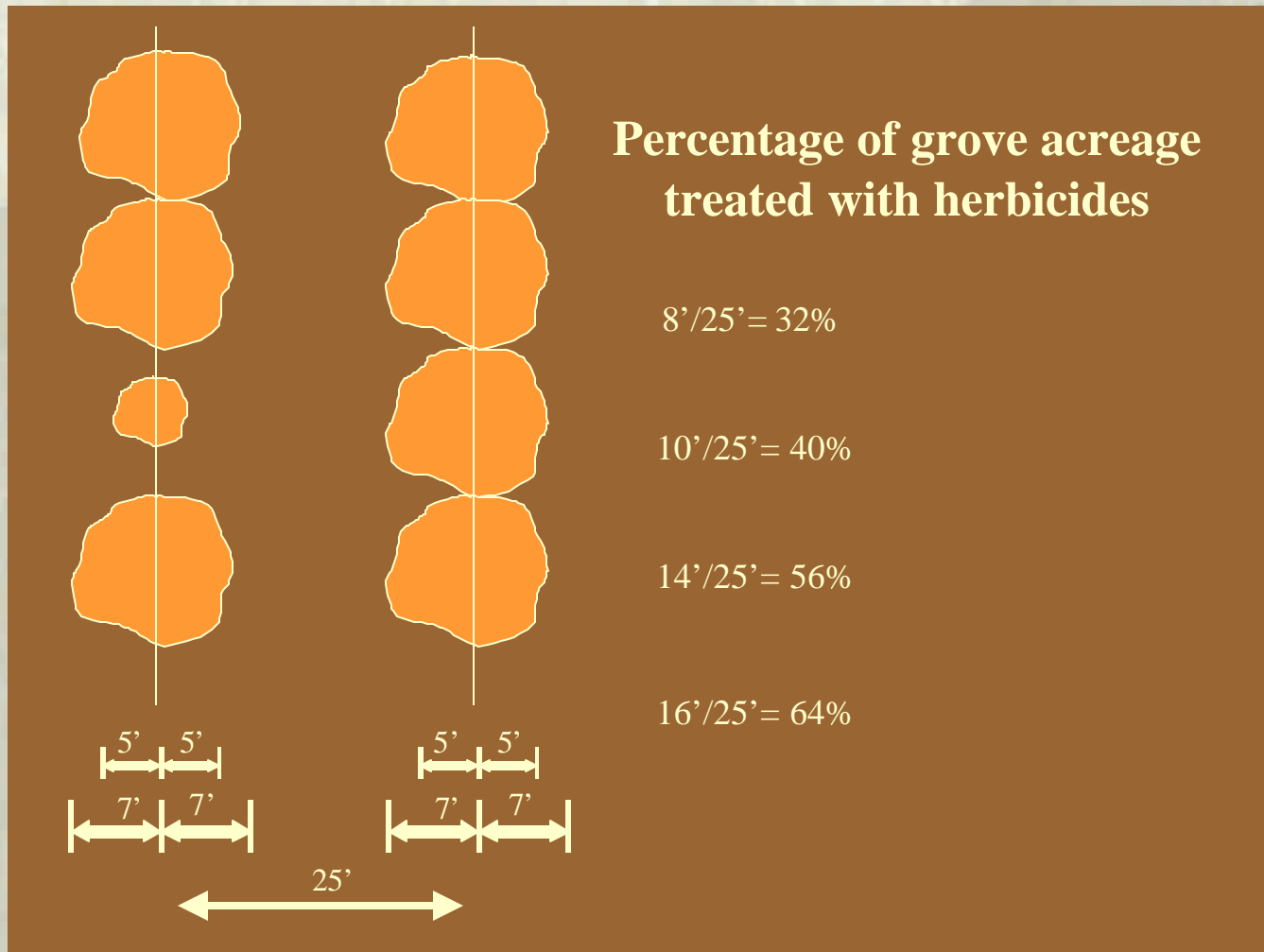
Herbicide application

- ❖ Residual herbicides are generally applied 2-3 times per year
 - Preemergence herbicide applied prior to weed seed germination or in combination with postemergence
 - Mixed with water or suspension fertilizers
 - Some materials may be direct injected into well-designed irrigation systems (chemigation/herbigation)
- ❖ Postemergence herbicides applied 4-6 times per year
 - Possible development of weed tolerance
 - Brazil and Florida pusley
 - dayflower

Herbicide application

- ❖ Improved technology for the selective delivery of multiple herbicide products to specific sites (under tree, variable rate, and row middles)
- ❖ Improved design to reduce tree foliage and fruit contact, spray drift and application in various weed heights
- ❖ Application volume
 - 20-50 GPA for under tree
 - 10-25 GPA for chemical mowing

Adjusting band width to effect cost



Herbicide program

❖ Solicam/diuron/glyphosate

– Solicam	8 lbs x \$14.90 =	\$119.20
– Diuron	8 lbs x \$ 4.03 =	\$ 32.24
– Glyphosate	6 qts x \$35.00 =	\$ 52.50

❖ Total material cost / treated acre = \$203.94

Herbicide program

- ❖ Krovar/diuron/glyphosate

- Krovar 8 lbs x \$11.30 = \$90.40

- Diuron 3 lbs x \$ 4.03 = \$12.09

- Glyphosate 6 qts x \$35.00 = \$52.50

- ❖ Total material cost/treated acre = \$154.99

Band width effect on cost

Band width*	% of soil treated	Solicam program (\$203.94**)	Krovar program (\$154.99**)
8' x 25'	32%	\$65.26	\$49.60
10' x 25'	40%	\$81.58	\$62.00
14' x 25'	56%	\$114.21	\$86.79
16' x 25'	64%	\$130.52	\$99.19

*Total width, thus 8' band = 4' on each side of tree for 25' row spacing, ** total material cost

Conclusion – in-row weed control

- ❖ Combination of herbicides which provide control of both grass and broadleaf weeds increases percent weed control.
- ❖ Weed intensities vary among different locations within the state and with season.
- ❖ Herbicide rates must be adjusted and selected to control weeds present at a given site.
- ❖ Adequate weed control should be obtained at a given site before rates are reduced. Once control is not achieved with a given program, it is difficult to obtain control in the next application of herbicides.

Conclusion – in-row (cont'd)

- ❖ Herbicide products and/or rates that work at one location may not provide effective control at other locations.
- ❖ Apply preemergence herbicides to relatively clean ground to obtain maximum benefit.

Middle Management in Florida Citrus Groves

- ❖ Middle management involves various methods to establish and/or control vegetation in the row middle.



Methods for middle vegetation control

- ❖ Mechanical
 - Mow
 - Tillage
 - Hand hoe
- ❖ Chemical
- ❖ Chemical mow/wiping



Mechanical tillage

- ❖ Discs
- ❖ Choppers
- ❖ Mechanical hoes
- ❖ Hand hoes



Mechanical tillage

❖ Advantages

- Economical
- Only temporary control, must be repeated with each new weed crop
- 5-6 operations per year
- Incorporates seed into soil where they are viable for years
- Warmer on freeze events (2-3°F)

Mechanical tillage (cont.)

❖ Disadvantages

- Damages roots – upward of 75% of roots in top 30 cm of soil (bedded systems)
 - Non tilled blocks twice as many roots in 0-15 cm soil vs. tillage
- Damage to tree trunk and large roots
- Soil erosion
- Ineffective for deep-rooted perennials
 - (bermudagrass, torpedograss, bahiagrass, nutsedge)

Mechanical mowing

❖ Advantage

- Minimizes soil erosion
- Pleasing appearance
- Reduce tall growing species

❖ Disadvantages

- High energy and equipment demand
- High moisture requirement
- Cooler temperatures on minimal freeze nights

Chemical mowing

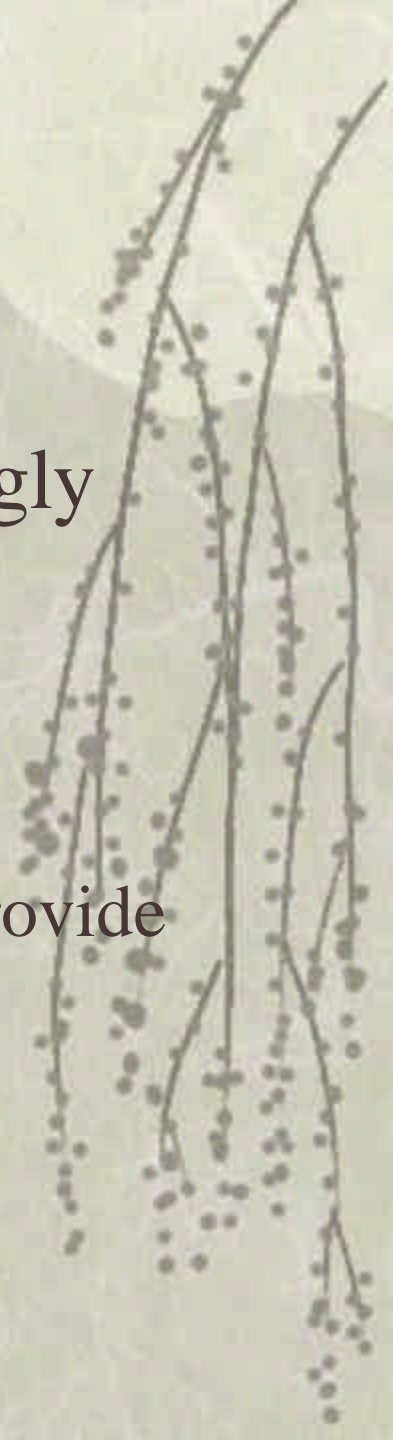
- ❖ Utilizes low rate of glyphosate to suppress vegetative regrowth of grasses and broadleaf weeds
 - Advantages
 - Low energy and equipment demand
 - Suppresses regrowth for up to 90 days
 - Disadvantages
 - Can not apply in drought conditions
 - Needs rain free period of up to several hours
 - Needs good boom design to minimize off target site damage

The background features a stylized, light-colored illustration of a citrus grove. In the distance, a mountain range is visible under a pale sky. In the foreground, several thin, dark branches of a citrus tree are shown, each bearing clusters of small, round fruits. The overall aesthetic is soft and artistic, with a muted color palette.

Vine Control in Florida Citrus

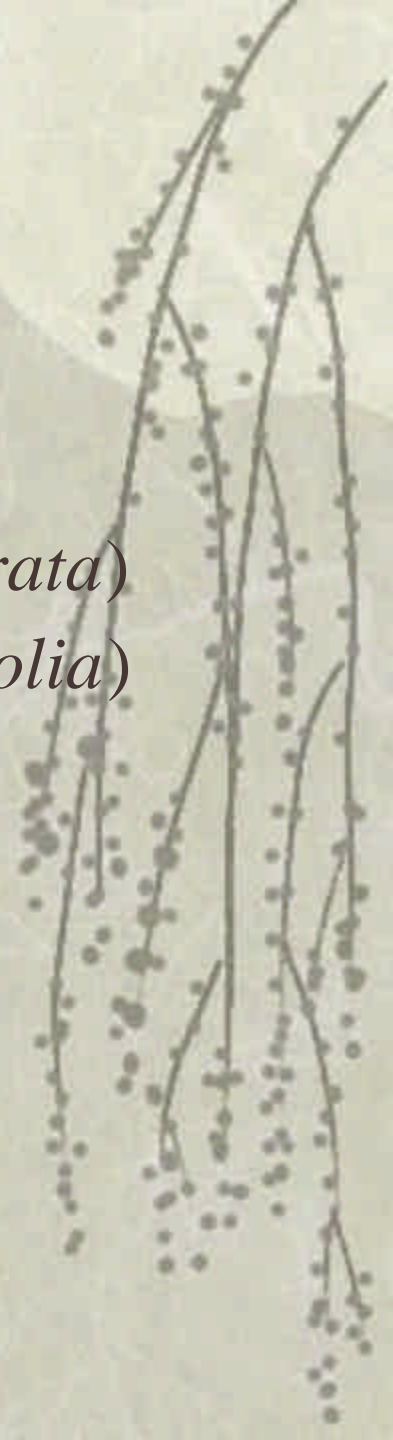
Vines in citrus groves

- ❖ Vine control has become an increasingly difficult task as:
 - Vine spectrum has increased
 - Product application rate has decreased
 - Limited number of products exist that provide broadleaf weed control



Problem vine species

- ❖ Balsam-apple (*Momordica charantia*)
- ❖ Milkweed or strangler vine (*Morrenia odorata*)
- ❖ Virginia creeper (*Parthenocissus quimquefolia*)
- ❖ Peppervine (*Ampelopsis arborea*)
- ❖ Catsclaw (*Bignonia unguis-cati*)
- ❖ Morningglory (*Ipomoea* spp)
- ❖ Possum grape (*Cissus verticulata*)
- ❖ Puncture vine (*Tribulus cistoides*)
- ❖ Phaseybean (*Macroptilium lathyroides*)



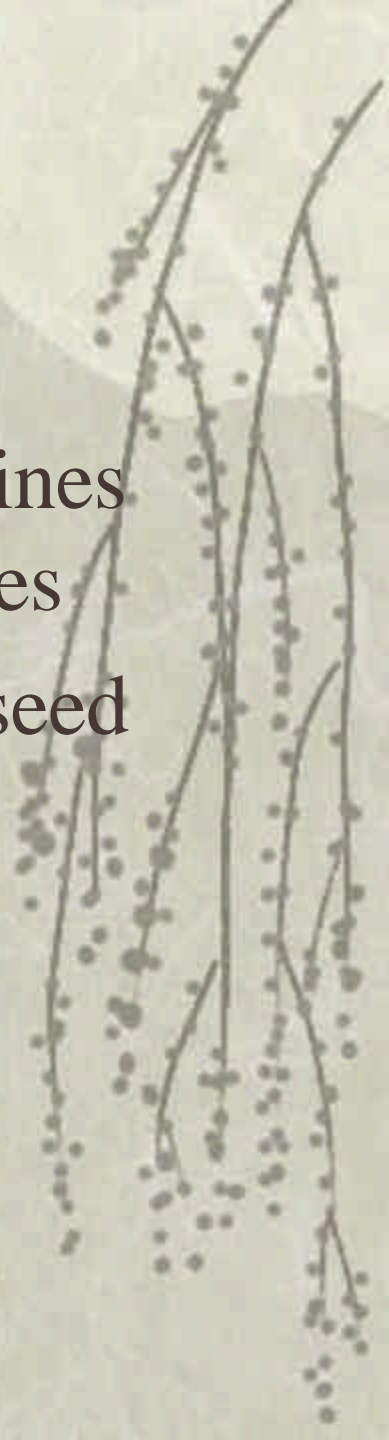
Vine control programs

- ❖ Prevention
- ❖ Preemergence
 - Chemical control
- ❖ Postemergence
 - Chemical control
 - Mechanical
 - Hand labor



Prevention vine control

- ❖ Attempts should be made to control vines while isolated to small area or few trees
- ❖ Preventative programs can minimize seed dispersal
- ❖ Can prove very economical



Preemergence vine control

- ❖ Materials:
 - Simazine
 - Diuron



Preemergence vine control

❖ Simazine

- Must be mixed with postemergence material to control emerged vines/weeds, control enhanced by addition of surfactant
- **Grass or broadleaf control**
 - up to 4 lb ai/A/application
- **Vine control**
 - Princep 4L
 - 2.0 gal/A/product in spring, do not exceed 2.0 gal/A/yr
 - Caliber 90 DF
 - 8.8 lb product, one application yr
 - 7.92 lb ai/A/single application, one application yr
 - Simazine 4L
 - 6.4-9.6 qts/A/yr (6.4-9.6 lb/ai/single application)



Preemergence vine control

❖ Direx

- Must be mixed with postemergence material to control emerged vines/weeds
- Control enhanced by addition of surfactant
- **Grass or broadleaf control**
 - 1.6-3.2 lb ai/A/application
 - Karmex 80DX, Direx 80DF: 2-4 lb
 - Direx 4L: 1.6-3.2 qts
- **Vine control**
 - 3.2 lb ai/A/application

Postemergence vine control

- ❖ Applications should be made while vine is still in seedling stage
- ❖ Once established into tree canopy, insufficient surface contact by the herbicide is provided to obtain sufficient postemergence control
- ❖ Exception:
 - DeVine (*Phytophthora palmivora* MWV) for milkweed vine control



Postemergence vine control

❖ Chemical

- Simazine with POST product
- Diuron with POST product
- Glyphosate
- Paraquat dichloride
- Landmaster II (glyphosate + 2,4-D)

❖ Biological

- *Phytophthora palmivora*

Postemergence vine control

- Glyphosate

- 1.5 to 2.25 lb A.E. per treated acre (equivalent 2 to 3 qts. of Roundup Ultra)
- Roundup, Touchdown, Glyphomax, etc. should be adjusted to provide equal amounts of A.E. per treated acre

- Gramoxone

- Provides only burndown control without killing root system

- Landmaster II

- Annual weeds: 1-8 qts.
- Perennial weeds: 4-8 qts.
- Application with glyphosate will improve effectiveness

Postemergence vine control continued

- ❖ *Phytophthora palmivora* (DeVine, marketed by Encore Technologies)
 - 1 pint (3.2×10^8) live chlamydospores per pint
 - For control of milkweed vine in citrus
 - Fungus initiate root infection with kill beginning in 6-10 weeks
 - Apply with standard herbicide boom using at least 50 gpa or via chemigation
 - Adequate soil moisture is required
 - Do not apply within 45-60 days of Ridomil or Aliette application

Conclusion of weed control

- ❖ Florida citrus growers utilize
 - Preventative,
 - Chemical,
 - Mechanical.



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