Weed Control in Citrus: then and now

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Outline of presentation

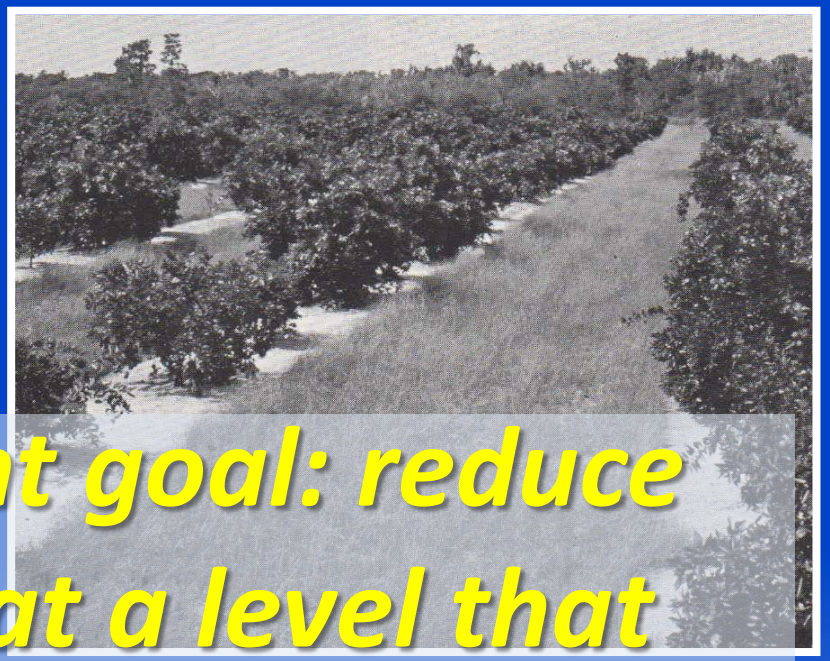
I. Impact of weeds
II. Evolution of weed management in citrus
    a. Weed problems in citrus
    b. Methods
    c. Herbicides
III. Current challenges in weed management in citrus

Impact of weeds on citrus

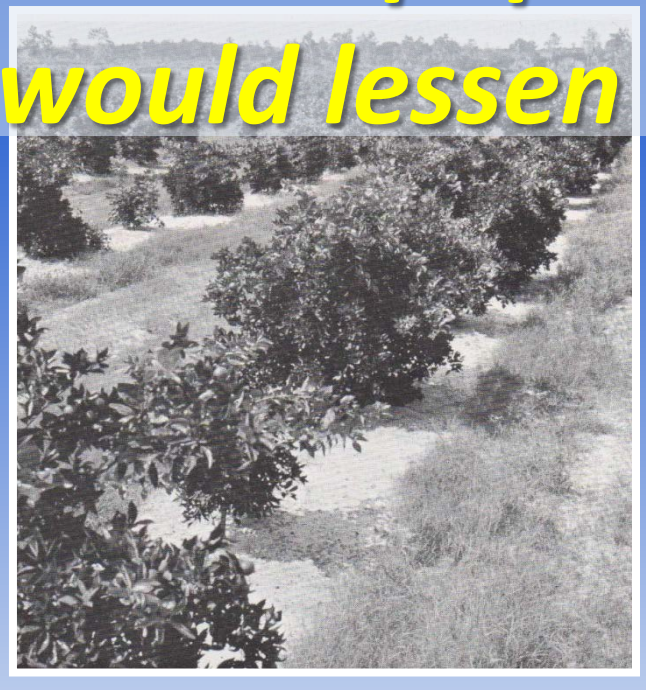
- Yield loss of up to 23- 33%
- Weed control is 10 -15% of production cost in citrus

Impact of weeds on citrus

- Interfere with grove operations such as harvesting
- Serve as alternate host of other pests such as insects and disease
- Reduce soil temperatures during freezing events

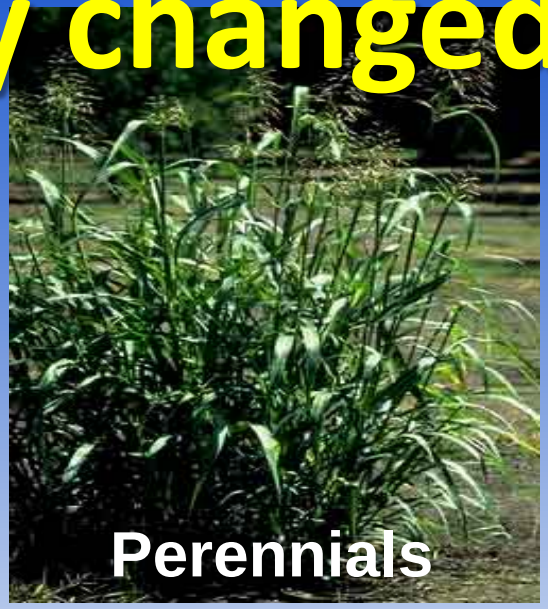


Weed management goal: reduce weed population at a level that would lessen impact of competition



Evolution of Weed Management in Citrus

Weed problems in citrus have they changed?



Weed problems in citrus

- More than 100 species commonly occur in groves
  - 30 species are considered very undesirable
- 60's to early 80s
  - Grasses: paragrass, guineagrass, torpedograss, bermudagrass, vaseygrass, bahiagrass
  - Broadleaf: Spanishneedles, pigweed
  - Vine weeds: milkweed
  - Sedges: nutsedge

Weed problems in citrus

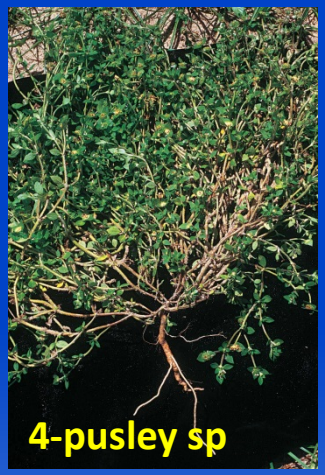
- Mid 80s to 90's
  - 20 species were considered serious problem
  - Grass: guineagrass, torpedograss, vaseygrass
  - Broadleaf: goatweed, teaweed, lantana, saltbrush
  - Vines: milkweed vine, balsam apple, morningglory, Virginia creeper, peppervine, air potato, wild grapes, woevine

Ten most problematic weeds in citrus


1-Spanishneedles

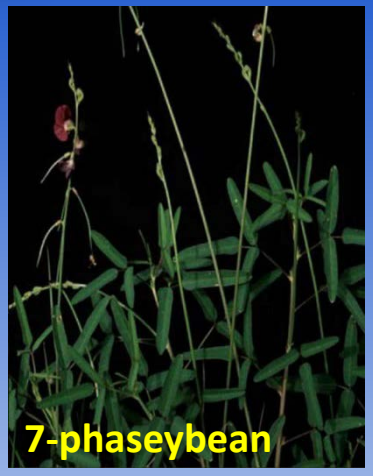

2- Panicum sp.

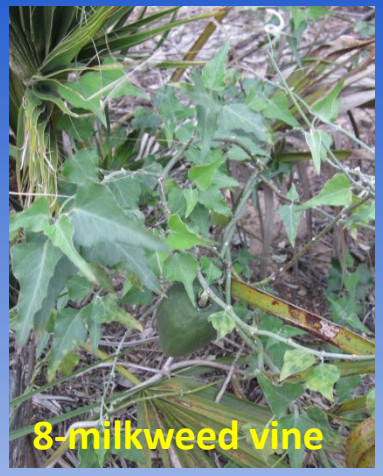

3 –balsam apple


4-pusley sp


5-pigweeds


6-goatweed


7-phaseybean


8-milkweed vine


9-ragweed


10 - dayflower

- Based on a growers' survey conducted in 2012
- Ranking based on growers' response and size of grove

Methods of Weed Control

- Early years (late 60s to early 80s)
  - Mechanical Control
    - Handhoeing
    - Mowing
    - Cultivation
  - Chemical Control

    Herbicides

    Methyl bromide

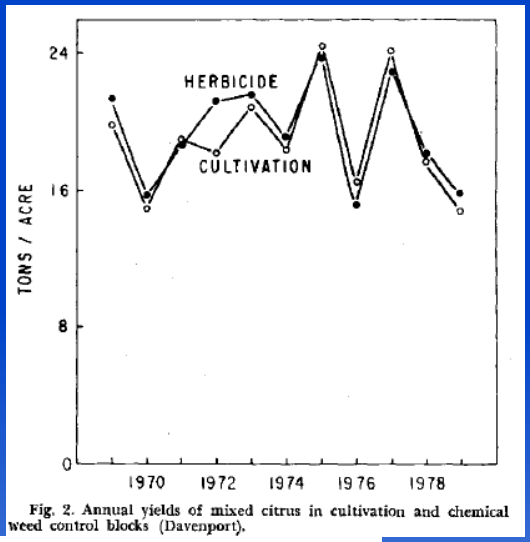


Fig. 2. Annual yields of mixed citrus in cultivation and chemical weed control blocks (Davenport).

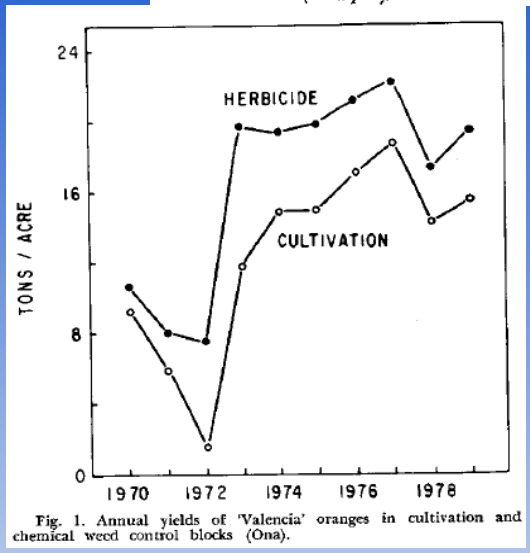


Fig. 1. Annual yields of 'Valencia' oranges in cultivation and chemical weed control blocks (Ona).

Source: Tucker et. Al., 1981

Comparison of weed control and energy costs using cultivation and herbicides

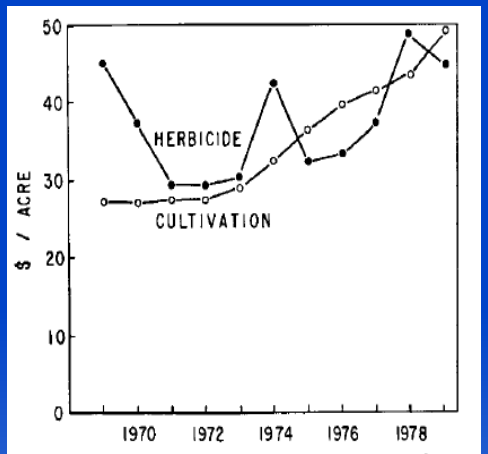


Fig. 3. Total annual cultivation and chemical weed control costs (Ona).

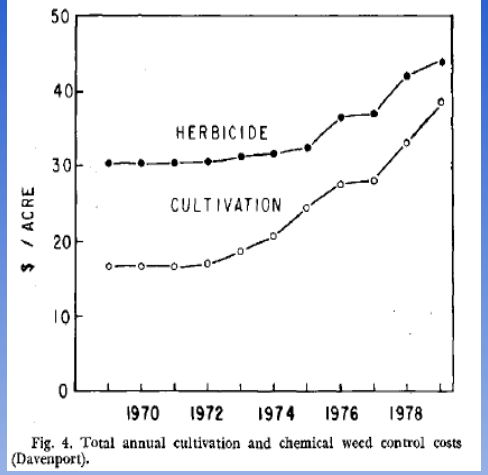


Fig. 4. Total annual cultivation and chemical weed control costs (Davenport).

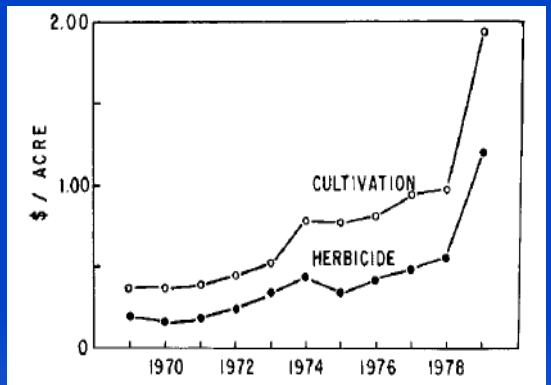


Fig. 5. Energy costs for cultivation and chemical weed control (Ona).

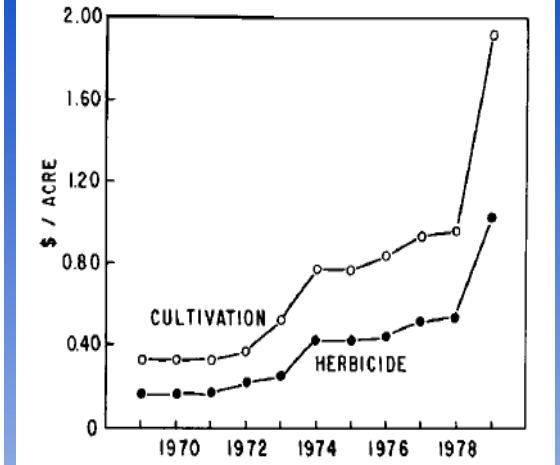


Fig. 6. Energy costs for cultivation and chemical weed control (Davenport).

- Increasing costs associated with use of cultivation prompted the shift to herbicides in citrus in the 70s
- Herbicides are more effective in controlling weeds

Source: Tucker et. Al., 1981

Methods of Weed Control

- Current practices involve:
  - Mowing/chemical mowing in the row middles
  - Herbicides in the tree row
    - Glyphosate used in all groves
    - Tank mix of PRE- and POST-herbicides

Soil-applied Herbicide Registered for Florida citrus (late 60s to 90s)

PRE Herbicide	60s to 70s	80s (1985)	90s
Ametryn	x	Evik 80WP	Evik 80WP
Bromacil	Hyvar x	Hyvar X 80WP, L	Hyvar X 80WP, L
Bromacil + Diuron	x	Krovar I & II	Krovar I & II DF
Dichlobenil	Casoron	x	x
Diuron	Karmex	Karmex 80WP	Karmex 80WP, Direx 4L
Fenuron	Dybar	x	x
Methyl bromide	Methyl bromide	Methyl bromide	Bromo Gas
Norflurazon	x	Solicam 80WP	Solicam 80DF
Oxyflourfen	x	x	Goal
Oryzalin	x	x	Surflan 4 AS
Pendimethalin	x	x	Prowl
Simazine	Simazine	Princep 80WP, 4L; Caliber 90WDG; Sim-Trol 4L	Princep 4L; Caliber 90WDG Simazine 90DF
Terbacil	Sinbar	Sinbar 80 WP	Sinbar
Trifluralin	Treflan	Treflan 4EC	Treflan 4EC
TCA + fenuron TCA + monuron	Urab Urox	x x	x x

Foliar-applied Herbicide registered for Florida citrus (60s to 90s)

POST Herbicide	60s to 70s	80s (1985)	90s
Clethodim	x	x	Prism
Dalapon Dalapon + TCA	Dowpon Dowpon C	Dowpon Dowpon C	x x
2,4-D	Various formulations	Various formulations	Citrus Fix, Hivol-44
2,4,5-T	Various formulations	Various formulations	x
Glyphosate	x	Roundup	Roundup 4L, Ultra 4L
Glyphosate + 2,4-D	x	x	
Fluazifop	x	x	Fusilade 2000 1E
Paraquat	Ortho Paraquat	Ortho paraquat	Gramoxone 1.5L, Extra 2.5 L
Sethoxydim	x	x	Torpedo 1EC
Sulfosate	x	x	Touchdown

Soil-applied Herbicides Registered for Florida citrus (2013)

Common name	Brand name	Rates	Weeds controlled	
		product/ac	Broadleaf	Grasses
Diuron*	Direx, Diuron 4L, 80, 80DF, 80WDG Karmex DF	2-4 lb	C(A)	C(A)
Bromacil*	Hyvar X	2-6 lb	C(A)	C(A&P)
Indaziflam[a]	Alion	5-6.5 fl oz	C	C
Pendimethalin*[nb]	Prowl H_20, Pendimax	6.3-7.0pt 2-4.8 qt		C
Norflurazon*	Solicam	2.5-5 lb	PC	C
Simazine*	Princep 4L, Caliber	1-2.0 gal	C	C (A)
Oryzalin	Oryzalin 4AS, Surflan	0.5-1.5 gal	sC	C
Oxyflourfen[nb]	Goal	6 pt	C	
Bromacil+Diuron*	Krovar	2-4 lb	C(A)	C(A&P)
Trifluralin	Treflan	1-2 pts	C	C
Rimsulfuron[r]	Matrix FNV, SG		C	C

*commonly used; [a]- New; C-control, PC-partial control; A-annual; P-perennial; s-some
r - Restricted ; nb – non bearing trees

Foliar applied (POST) herbicides registered for Florida citrus (2013)

Common name	Brand name	Rate	Weeds controlled		
		product/ac	Broadleaf	Grasses	Sedges
Carfentrazone	Aim EC	2-7.9 fl oz	C	C	C
Clethodim	Prism	6 fl. oz		C	
Glyphosate*	15 formulations	22-43 oz	C	C	C
Glyphosate + 2,4-D	Landmaster	1-8 qt	C	C	C
Fluazifop	Fusilade DX/2E	1-1.5 pt		C	
Paraquat*r	Gramoxone 2/ Inteon	2.5-4 pt	C	C	C
Sethoxydim	Poast Plus	2.25-3.75 pt		C	
Saflufenacil[a]	Treevix	1 oz	C		

*commonly used; a - New; C-control, A-annual; Perennial; s-some; r - Restricted use

Challenges to Weed Management in Citrus

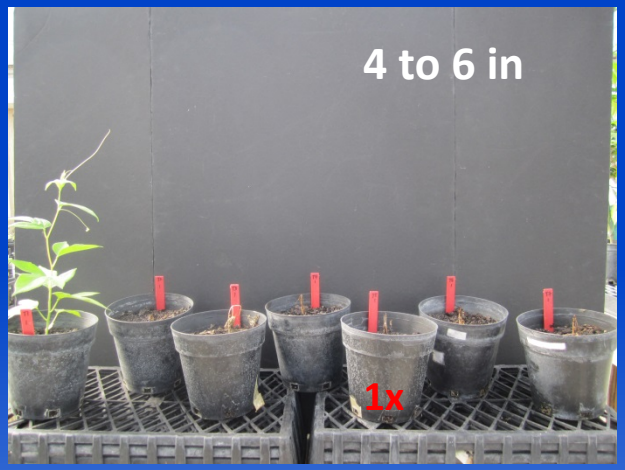
Vine weed control

- Vine weeds continue to be a problem in citrus
  - Milkweed vine problem in 70s and until now
  - Balsam apple identified as #3 most problematic weed
- Harder to control
  - Susceptible parts not reached by herbicide spray
  - Cannot be controlled by glyphosate at older stage
  - Perennial vines can produce new shoot

Response of Milkweed vine to commonly used POST herbicides (28 DAT)

- Milkweed vine was controlled by most commonly used POST herbicides applied at young stage (3 to 4 inches)

Response of maypop to glyphosate (28 DAT)



- Maypop generally was controlled by glyphosate at all rates tested (0.25x to 2x) regardless of age
- But there is more chance of regrowth at 28 DAT when applied to older plants

Development of Herbicide Resistance

- Herbicide Resistance (HR) – acquired ability of a weed to survive herbicide applications that used to control its populations
  - Herbicide application acts as selection pressure

- Herbicide Tolerance (HT) – inherent ability of a weed to survive and reproduce after herbicide treatment
  - No selection pressure
  - Some species are naturally tolerant to herbicides

Development of Herbicide Resistance

- HR develops due to repeated use of one chemistry or herbicide with the same mode of action

- Glyphosate is being used in citrus annually
  - Applications done 3x and as high as 5x
  - Applied alone or tank mixed with PRE or other POST herbicides

Suspected glyphosate resistant/tolerant weeds in citrus

Common name*	Scientific name	Reason for not being controlled*
Spanish needles	*Bidens alba*	Resistance, Tolerance
Ragweed parthenium	*Parthenium hysterophorus*	Resistance, Tolerance
Phaseybean	*Macroptilium lathyroides*	Tolerance
Goatweed	*Scoparia dulcis*	Tolerance
FL/Brazil Pusley	*Richardia scabra/ R. brasiliensis*	Tolerance
Spreading dayflower	*Commelina diffusa*	Tolerance
Dayflower	*C. benghalensis*	Resistance
Nightshade	*Solanum ptychantium*	Resistance

**Based on a grower survey conducted in 2012 by Ramirez et al. These are unconfirmed cases reported by growers*

Development of Herbicide Resistance

- There is a need to confirm resistance status of these weeds by testing in the field and greenhouse studies

- If resistance is confirmed, weed control systems need to be designed to manage resistant weed population

General Principles for HR Management

- Apply integrated weed management practices. Use multiple herbicide modes-of-action with overlapping weed spectrums in rotation, sequences, or mixtures.

- Use the full recommended herbicide rate and proper application timing for the hardest to control weed species present in the field.

General Principles for HR Management

- Scout fields after herbicide application to ensure control has been achieved. Avoid allowing weeds to reproduce by seed or to proliferate vegetatively.

- Monitor site and clean equipment between sites.

Source: HRAC website (www.hracglobal.com)

Conclusion

- Weed problem scenario in citrus has not changed much through the years
- Weed control has evolved from mechanical to heavy reliance on herbicide
- New herbicide chemistries are hard to come by but new ones poses a lot of promise for more effective control

Conclusion

- Vine weeds are becoming a serious problem in citrus (just like in the 70s!)

- Possible herbicide resistance issues need to be resolved/confirmed
  - Pro-active approach in dealing with herbicide resistance
  - Develop weed management strategies for their control

Questions?