

Promising weed control programs for vegetable crops.

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Minor Specialty Crops? Not really!!

- ◆ Vegetables \$12.8 Billion
- ◆ Fruits & Nuts \$13.8 Billion
- ◆ Nursery & Floriculture \$14.7 Billion
- ◆ **Subtotal \$41.3 Billion (43%)**

- ◆ **Total crops \$95.2 Billion**

NASS 2002



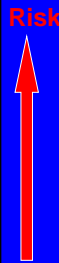
Future trends in agriculture

- ◆ As the costs of land and labor increase in the U.S., growers must accept higher levels of risk to remain profitable.

Blank, 1998

The farming "food chain"

Development stage	Crop type	Value, asset fixity
fourth	High value perennial	Very high, highly fixed
third	High value annual	High, inflexible
second	Low value perennial	Moderate, flexible
first	Low value annual	Low, flexible



Blank, 1998



Relative weed control expenses (\$/A)

Input	Corn	Lettuce	Rasberries
Herbicide/fumigant	24	35	825
Cultivate	6	27	0
Hand weed	0	113	373
Weed costs	30	175	1,198
Crop value (\$/A)	500	6,800	72,000
Weed %	6	2.6	2.0

Kearney et al., Tourte & Smith, Bolda et al.

Crop value and “soft” weed control

- ◆ In low value crops like field corn where the risk of weed control failure is more acceptable and use of “softer” weed control methods are more easily justified.
- ◆ In high value crops like lettuce and raspberry, the risks are high and acceptance of increased risk cannot be tolerated. Weeds will be controlled using all means available.
- ◆ Fresh produce must be available when the customer wants it.
- ◆ Growers use herbicides to manage risk much as they would use insurance (Wiles 2004).

Why are we here today?

“Old” Problems With Specialty Crop Herbicides

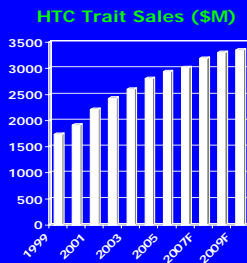
- ◆ Many specialty crop herbicides are old, & some have regulatory problems.
- ◆ Lack of economic incentives for primary registrants to develop new specialty crop herbicides.
- ◆ High liability for registrants.
- ◆ Low tolerance for carryover to rotational crops.
- ◆ Natural herbicide selectivity in vegetable crops is not common.

New Difficulties For Specialty Crop Herbicides

- ◆ The impact of herbicide tolerant crops on the herbicide market & discovery.
- ◆ High costs of new registrations
- ◆ Industry consolidation means fewer companies searching for new herbicides
- ◆ Higher labor costs means greater need for specialty crop herbicides.

Impact of HTC Crops

- ◆ Significant impact on conventional markets & projected to continue growth
- ◆ Corn, soybean, cotton & canola most impacted
- ◆ Discovery into selective herbicides for these markets has likely diminished



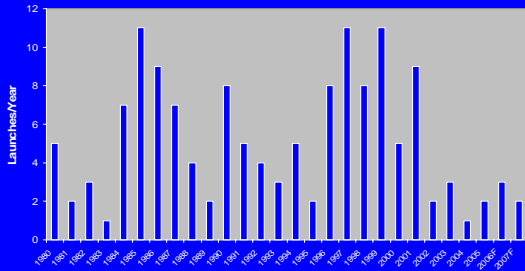
Gast 2006

Increased R&D Costs

- ◆ In 1975-80 the cost of bringing a new product through research, development and registration averaged \$23.1 million
- ◆ Recent studies have shown that this figure has increased to \$152 million in 1995 and \$184 million in 2000.

Gast 2006

Global Herbicide AI Launches



Gast 2006

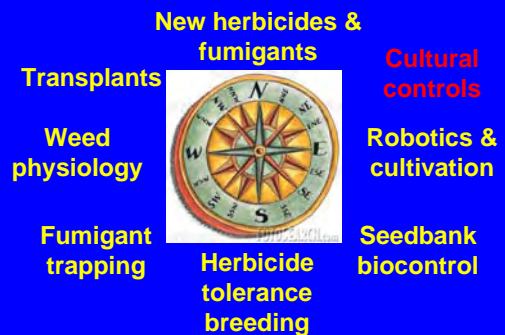
Points So Far....

- ◆ Specialty crops are economically important.
- ◆ As labor and land costs increase, the importance of specialty crops will increase as they tend to be more profitable, but more risky.
- ◆ The scale of risks and benefits of weed control costs in specialty crops are very different than for agronomic crops.
- ◆ Fewer new herbicides will be developed in the future, and those few products will not be adequate to solve many of the existing weed problems in specialty crops.

Challenges For Public Sector Specialty Crop Weed Scientists

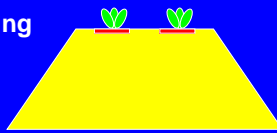
- ◆ There are too few specialty crop weed scientists.
- ◆ Increasing need for research in organic crops.
- ◆ Research funding is scarce and very competitive.
- ◆ Conducting basic/applied research that benefits specialty crops.

Which directions should we go?



Weed control events - lettuce

- ◆ Weed control in rotational/cover crops
- ◆ Preplant tillage
- ◆ Preirrigation and weed removal
- ◆ Herbicide/fumigant application
- ◆ Cultivation
- ◆ Hoeing & hand weeding



Preirrigation – stale seedbed

- ◆ Preirrigation and tillage before planting can be used help reduce weed populations
- ◆ The goal is to stimulate weed emergence before seeding or transplanting

Effect of preirrigation methods on weed emergence



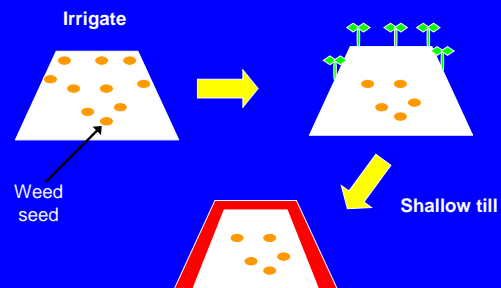
Depth of weed emergence

Species	Optimum depth (in)	Maximum depth (in)
Cm. chickweed	0.4	0.8
Lambsquarters	0.2	2.0
Lg. crabgrass	0.4	1.6
Shepherdspurse	0.2	0.8
Wild mustard	0.4	2.3
Cm. purslane	0.1	0.8

Role of preirrigation in weed management

- ◆ In the dry months of the year, fields are preirrigated to allow proper tillage.
- ◆ The primary objective is to prepare a fine seedbed for planting.
- ◆ Performed properly, preirrigation followed by shallow tillage can remove many weeds and improve weed control.

Preirrigation to control weeds



Preirrigation treatments

- ◆ Furrow, sprinkler or no preirrigation
- ◆ Till and plant 7 or 14 days after preirrigation
- ◆ Conventional lettuce was the crop
- ◆ Hand weeding was timed

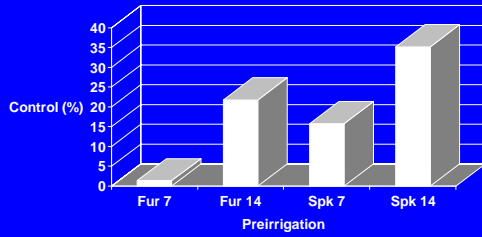
Effects of preirrigation

No preirrigation

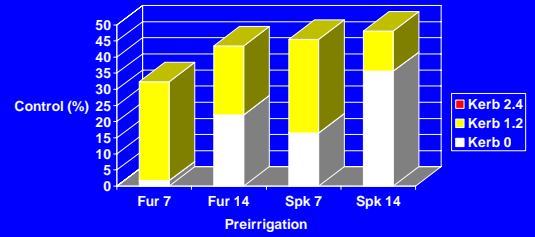
Preirrigation



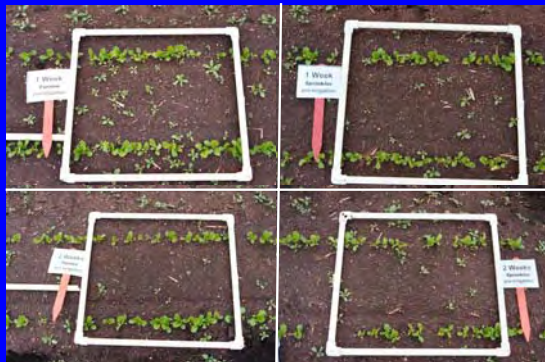
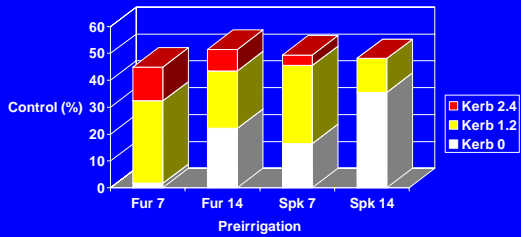
Hand weeding - no herbicide



Hand weeding - Kerb 1.2



Hand weeding - Kerb 2.4



Recommendations - preirrigation

- ◆ Sprinkler preirrigation followed by shallow tillage 14 days later was the best treatment.

Which directions should we go?

New herbicides & fumigants

Cultural controls

Robotics & cultivation


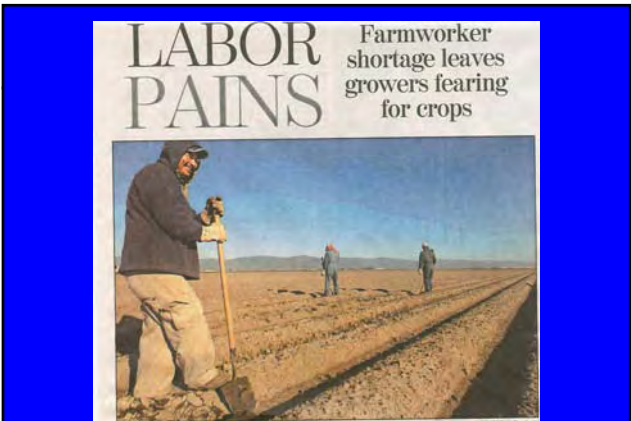
Seedbank biocontrol

Herbicide tolerance breeding

Transplants

Weed physiology


Fumigant trapping

Broccoli production costs related to weed control

Input	Cost/A
Herbicide	\$38.00
Cultivation	\$48.00
Hand hoe	\$94.00

Smith et al. 2004



Eco Dan® cultivator

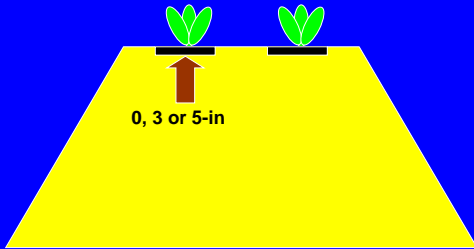
- ◆ Allows faster and closer cultivation.
- ◆ The closer you get to the seedline the fewer weeds left after cultivation.
- ◆ Can cultivate faster with the plant camera than the standard cultivator.



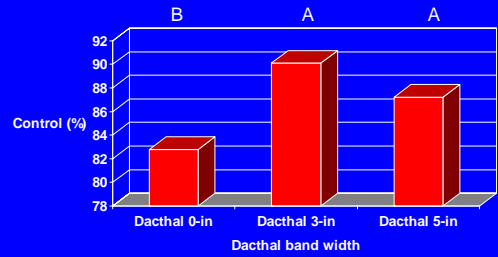
Objectives

- ◆ Determine if herbicide use could be reduced by closer cultivation.
- ◆ Determine if labor inputs could be reduced by closer cultivation

Herbicide band widths of 0, 3 or 5 inches



Effect of Dacthal band-width on weed control in broccoli



2006.08

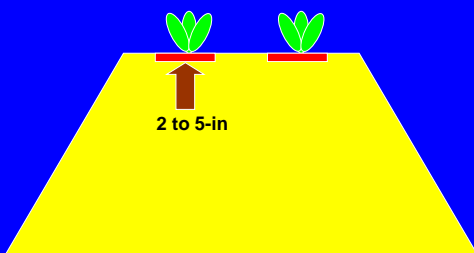
Herbicide conclusions

- ◆ You can cut down to a 3-inch Dacthal or Kerb band if you cultivate a 3-inch band.
- ◆ Material costs for a 5-inch Kerb band on 40-in bed is \$27/A, but a 3-inch band costs \$16/A.
- ◆ Material costs for a 5-inch Dacthal band on 40-in bed is \$60/A, but a 3-inch band costs \$36/A.
- ◆ The effect of reducing the herbicide band width on labor costs appears to be neutral.

Objectives

- ◆ Determine if herbicide use could be reduced by closer cultivation.
- ◆ Determine if labor inputs could be reduced by closer cultivation.

Uncultivated band widths 2, 3, 4 or 5 inches



Uncultivated band widths

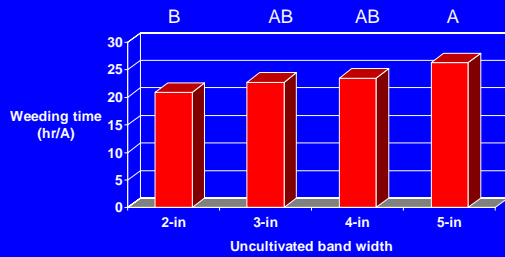


5-inch



2-inch

Weeding times in broccoli



2005.09

Effect of cultivator band width on handweeding

- ◆ The closer you can get to the seed line the faster the handweeding crew can move.

Broccoli production costs related to weed control

Cultivator	Dacthal 0	Dacthal 3	Dacthal 5
2	\$255.00	\$208.05	\$261.08
3	\$256.00	\$227.05	\$296.08
4	\$252.00	\$237.05	\$312.08
5	\$281.00	\$277.05	\$327.08

2005.09

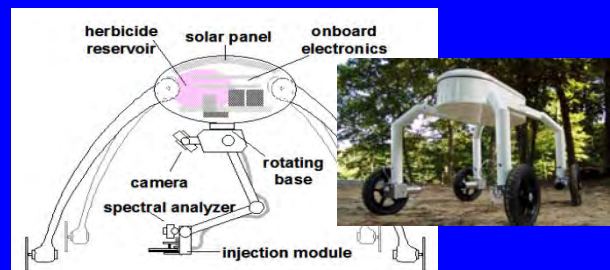
Uncultivated band width effects on weed control

- ◆ If you narrow the uncultivated band width you remove more weeds and therefore weeding times are reduced.
- ◆ So far the data do not indicate that close cultivation reduces yield.

Conclusions

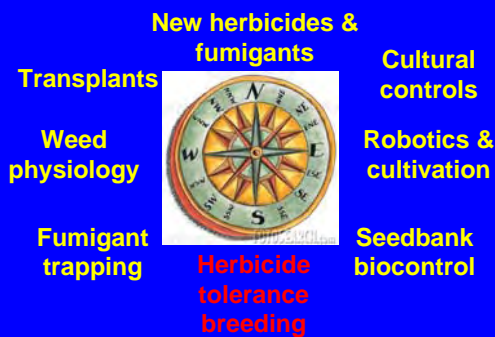
- ◆ Robotic cultivators can help reduce the amount of herbicide needed, improve weed control and make more efficient use of hand weeding.
- ◆ Reduced herbicide use and close cultivation may reduce costs.

Concurrent Solutions, LLC Autonomous Weed Control Robot



info@concurrent.us

Which directions should we go?



Herbicide selectivity

- ◆ Natural selectivity means that the weed is killed by the herbicide and the crop is not.
- ◆ An herbicide that injures a crop is not naturally selective for that crop.
- ◆ However, a crop can sometimes be made tolerant to an herbicide by breeding or chemical safeners, i.e., artificial tolerance.



Background

- ◆ Prickly lettuce (*Lactuca serriola*) tolerant to sulfonylurea (SU) herbicides was crossed to domestic lettuce (*Lactuca sativa*) by researchers at the Univ. of Idaho (Mallory-Smith et al. 1993).
- ◆ The Idaho researchers verified the SU resistance of the *L. sativa* germplasm and named it "ID-BR1"

Idaho Germplasm – ID-BR1

- ◆ ID-BR1 is in a butterhead lettuce variety
- ◆ Beiquan Mou USDA-ARS Salinas has signed an agreement with the Univ. of Idaho and has ID-BR1 germplasm
- ◆ Was developed by conventional breeding.



Sulfosulfuron 40.3 g ha⁻¹

Idaho germplasm summary

- ◆ Maverick (sulfosulfuron) appears to be safe on the ID-BR1 germplasm.
- ◆ Thifensulfuron & tribenuron may have potential as postemergence treatments.
- ◆ We are attempting to develop a new lettuce weed control program based on this technology.

Summary

- ◆ The potential for new minor crop herbicides with natural selectivity is low and breeding for artificial herbicide tolerance may be a way to improve the odds.

Acknowledgments

- ◆ CA Lettuce Research Board
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