Intra-row Cultivation & Lettuce thinning

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Constraints on Specialty Crop Weed Program Improvement

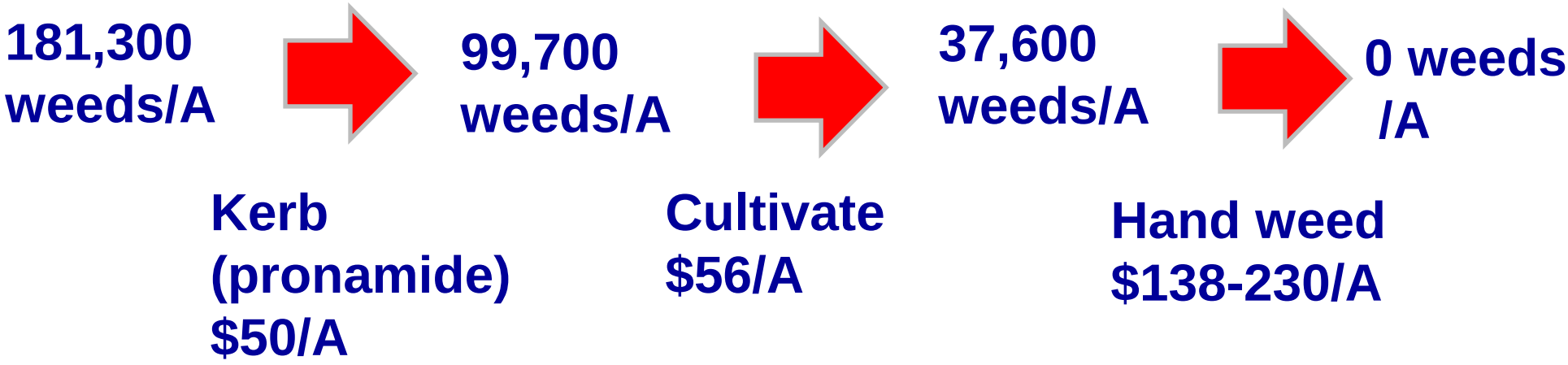
- Economic and regulatory constraints on the pesticide industry.
- Insufficient public and industry resources dedicated to develop non-pesticide technology for pest control in specialty crops.
- The major machinery manufactures are not very interested in specialty crops.

Integrated Weed Management in Vegetables

- Strategies and tactics for IPM
  - Prevention
  - Sanitation
  - Field selection
  - Physical weed management
  - Cultural weed management
  - Chemical weed control

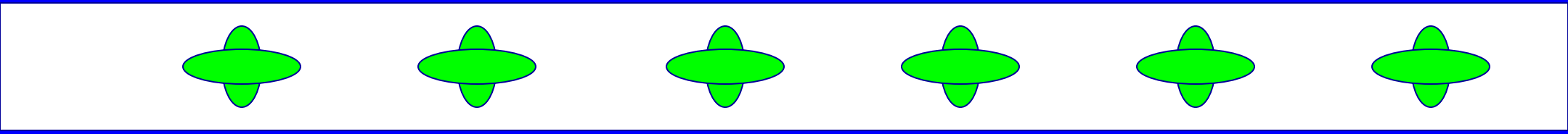
http://www.ipm.ucdavis.edu/

Integrated Weed Management in Lettuce



Tourte & Smith 2010
Fennimore et al. In press

Cultivation



A traditional inter-row cultivator does not reach into the seedline

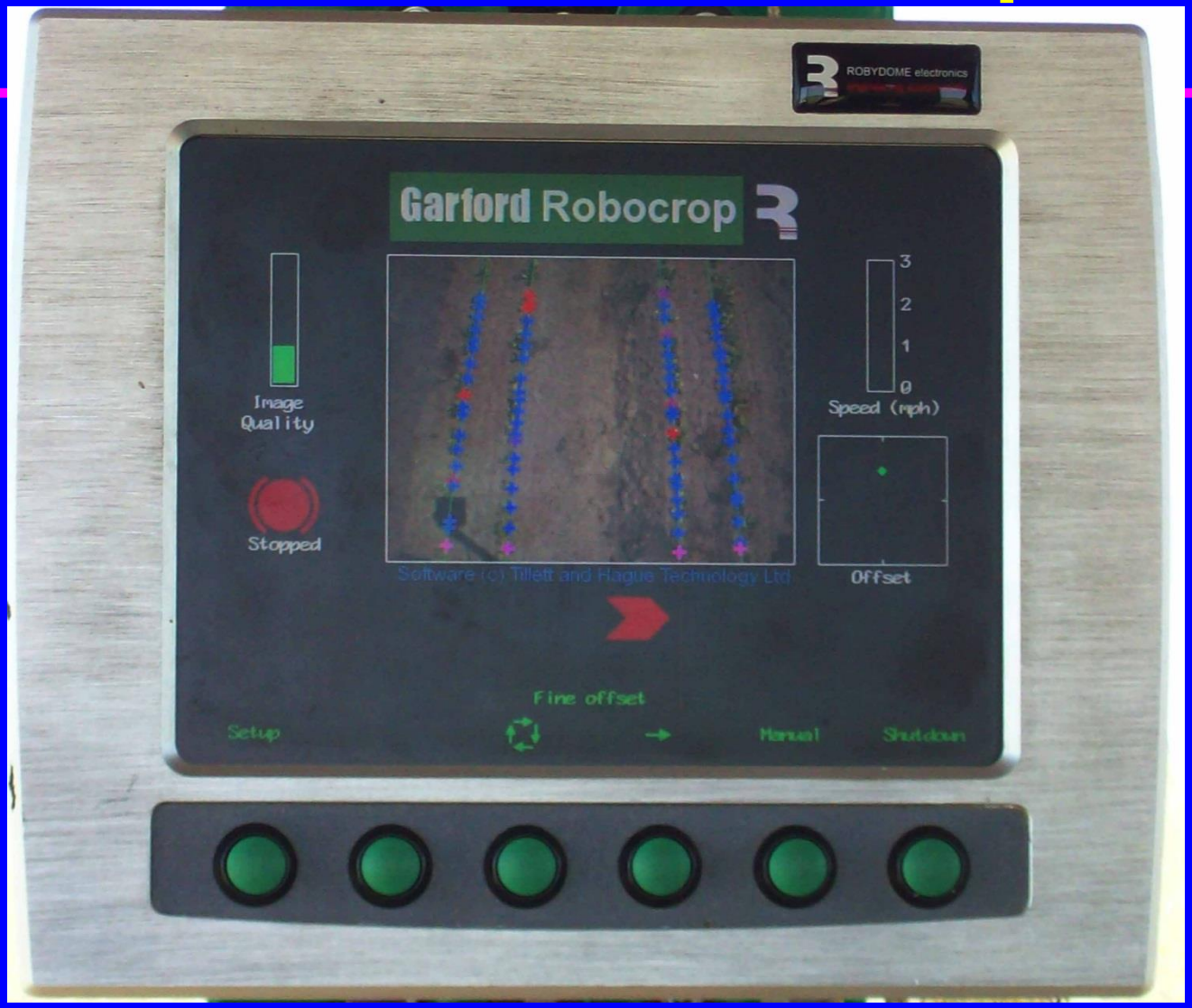
An intra-row cultivator weeds around

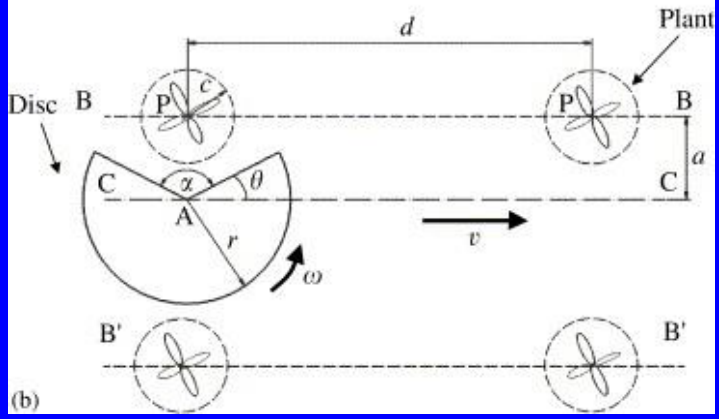
and in the row

Robotic Thinning/Weeding Objectives

- Determine if we can thin and weed lettuce with the rotating cultivator
- Determine if the need for hand weeding and thinning can be reduced with the rotating cultivator
- Measure rotating cultivator effects on lettuce yields

Garford Robocrop Cultivator





http://www.thtechnology.co.uk/index.html

Garford Rotating Cultivator

Lettuce Thinning with the Rotating Cultivator

Before thinning

After thinning

Data & Analysis

- Weed densities measured before & after cultivation
- Hand thinning & weeding times were measured
- Analyzed as split-plot: cultivators, & herbicides

Post Cultivation Weed Densities in Seeded Lettuce

Cultivator	Trial 1	Trial 4	Trial 5
		Densities (1,000/A)	
Rotating	66 b	19 b	45 b
Standard	140 a	37 a	65 a

Thinning Times in Seeded Lettuce

Cultivator	Trial 1	Trial 4	Trial 5
		Time (hr/A)	
Rotating	14.4 b	10.6 b	9.1 b
Standard	20.8 a	12.5 a	14.2 a

Post Cultivation Lettuce Stands in Seeded Lettuce

Cultivator	Trial 1	Trial 4	Trial 5
		Stand (no. 100/ft)	
Rotating	70 b	67 b	84 b
Standard	89 a	94 a	110 a

Yields Seeded Lettuce

Cultivator	Trial 1		
	Yield	Prod. costs	Net returns
	Crtns/A		$ /A
Rotating	943 b	398	10,069
Standard	1,068 a	479	11,376

Bok Choy – Santa Maria

Cultivator	Weeds	Thin time	Stand
	1,000/A	Hr/A	No. /100 ft
Rotating	14 b	18 a	104 a
Standard	28 a	17 a	105 a

Robotic Thinning Studies - Conclusions

- The rotating cultivator reduces stand & yields too much
- The precision needed in seeded lettuce is lacking
- The rotating cultivator reduces hand thinning time
- This cultivator works in transplanted lettuce

In row weeding in transplanted lettuce

- Conducted at the Salinas USDA station in 2009 & 2010.
- Plots were 2 X 40-inch wide beds wide by about 80 ft long. RCBD with 4 reps
- Treatments were the rotating cultivator and the standard cultivator and Kerb at 0 and 1.2 lb ai/A.
- Weed control is based on the difference between pre and post cultivation counts.

Weed densities & weeding times in transplanted lettuce

Cultivator	Trial 2	Trial 6	Trial 2	Trial 6
	Weeds (1,000/A)		Time (hr./A)	
Rotating	2 b	51 b	5.4 b	10.8
Standard	11 a	93 a	6.1 a	11.3

Yield of marketable heads transplanted lettuce

Cultivator	Trial 2		
	Yield	Prod. costs	Net returns
	Crtns/A		$ /A
Rotating	528	360	5,501
Standard	553	307	5,831
P value	0.61		

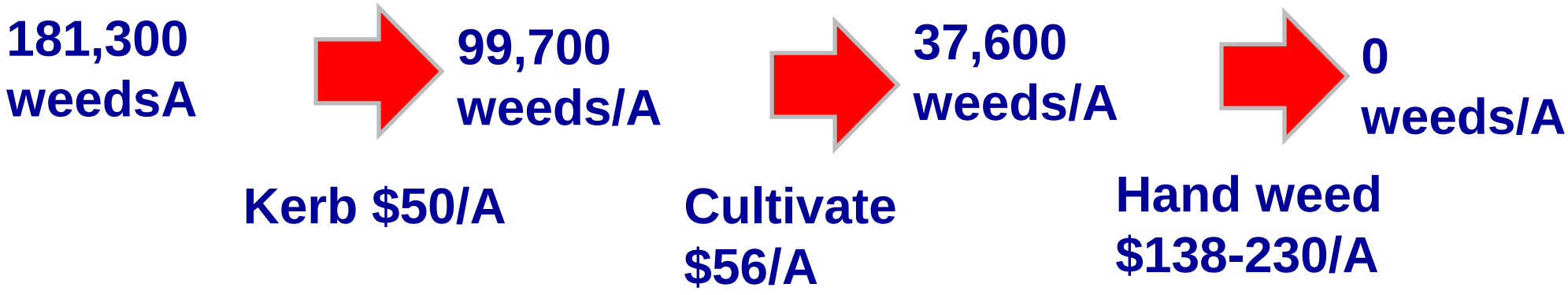
Transplanted lettuce studies - conclusions

- The rotating cultivator removed more weeds than a standard cultivator but hand weeding was not reduced much.
- The rotating & standard cultivator yields were similar.

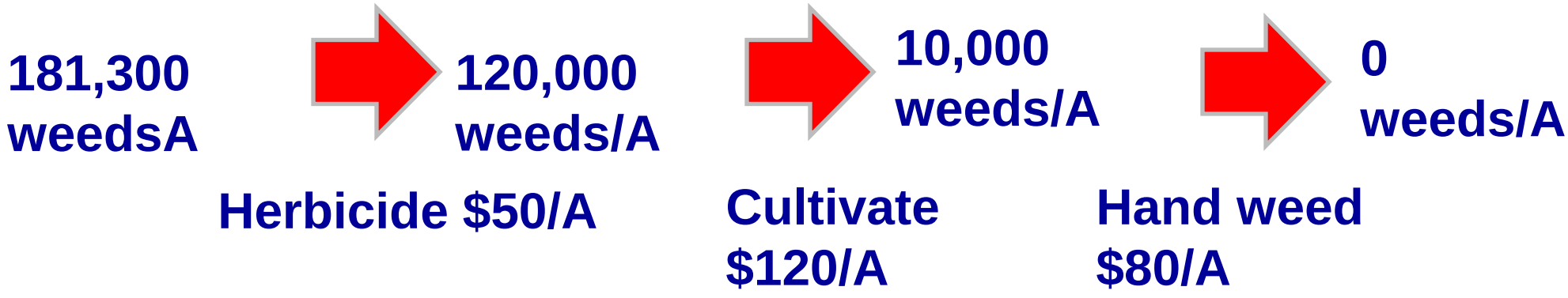
Machine costs

- The rotating cultivator cost is about $15-20K per plant line.
- An 8 plant line unit able to cultivate 4 lettuce beds would be $120-160K.

Standard vs. Alternative Lettuce Weed Management Strategies



Total weed cost = $244 to $336



Total weed cost = $250

LETTUCE THINNING – INTERMITTENT SPRAYERS

Lettuce Thinning- Intermittent Sprayers

Thinning trial Treatments

- Scythe 7% v/v (7 gallons/100 gallons mix)
- AN 20 75% v/v (75 gallons/100 gallons mix)
- Sulfuric acid 10% v/v (10 gallons/100 gallons mix)
- 40-inch twin row beds, 660 ft long

Machine lettuce thinning results

Treatments	Pre thin	Post thin	Thin time	Hand weed	Total time
	No./A	No./A	Hr./A	Hr./A	Hr./A
Grower std	167,129	30,253	4.6	2.8 *	7.4
Machine	169,272	34,343	1.2	5.7	6.9

2012 Fennel Ranch, Salinas

Thinning trial yield

- Standard grower yield 27.1 tons/A
- Machine thinned yield 25.1 tons/A which was significant
- Grower hand thinning costs were $92/A
- Machine thinning costs were $132/A for 1.5 mph.
- Net returns for grower standard $11,877 vs $10,953 for machine thinned

Lettuce thinning

- Need much faster operating speeds for lettuce thinner >1.5 mph.
- Optimize seed spacing at planting to take advantage of the technology
- Need to optimize use of labor – eg. Reduce number of hoe crew passes through the field from two to one.

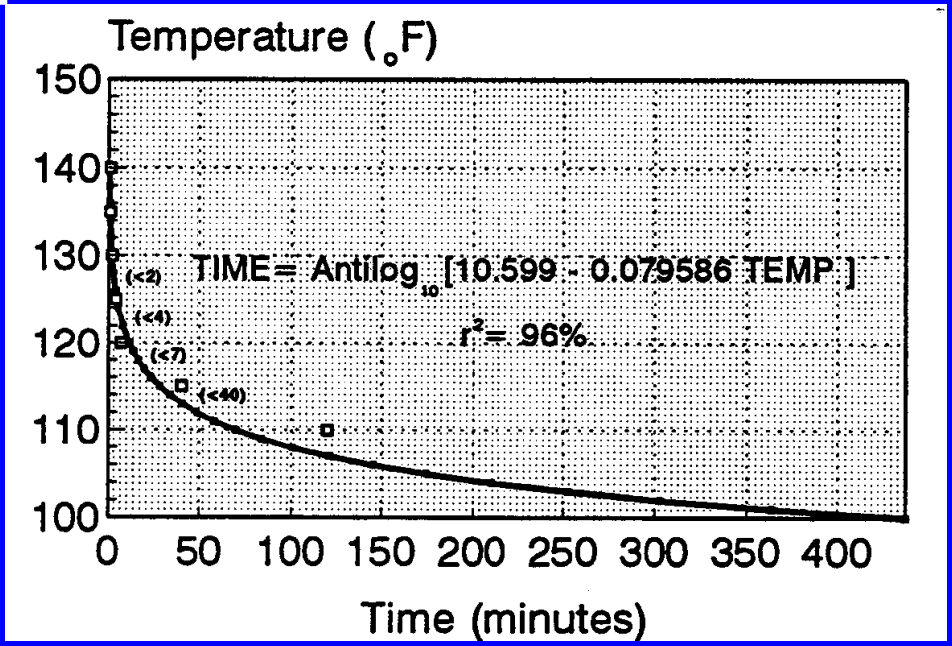
Culticlean

- Is a propane fueled thermal pest control device from the Netherlands
- Heats the soil to about 176˚F for a few seconds.
- Targets weed seeds and soil pathogens

Culticlean at Salinas, May 2013

Time & temperature effect on soil pests

- High temperatures kill soil pests quickly.
- Moderately high temperatures require more time to kill pests.

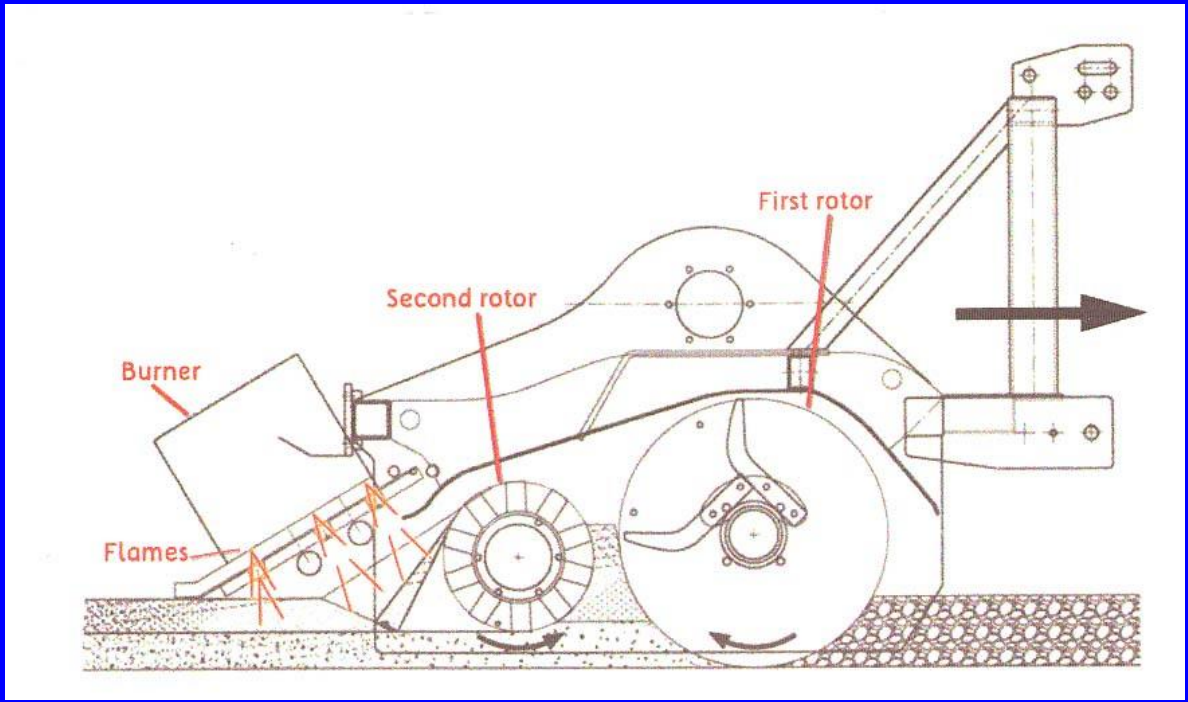


J. Noling 1997

Culticlean trial details

- Conducted at Spence USDA station at Salinas, CA.
- Initiated May 28, 2013
- The site was inoculated with Sclerotinia minor (lettuce drop) and overseeded with weeds.
- Replicated 4 times

Culticlean diagram



Culticlean evaluation in lettuce May-Aug. 2013

Cultivator	Ryegrass	Pigweed	Groundsel
		Number (ft^2)	
Culticlean	61 b	2 a	1 a
Control	87 a	1 a	2 a

Culticlean evaluation in lettuce May-Aug. 2013

Cultivator	Lettuce drop	Head weight	Lettuce yield
	%	Lbs.	Ton/A
Culticlean	10.3 b	2 a	37.4 a
Control	16.1 a	2 a	32.9 a

Culticlean conclusions

- Some reduction in lettuce drop and weeds
- Possible increase in lettuce yield
- The temperature dwell time needs to be increased
  - Insulation

Acknowledgments

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