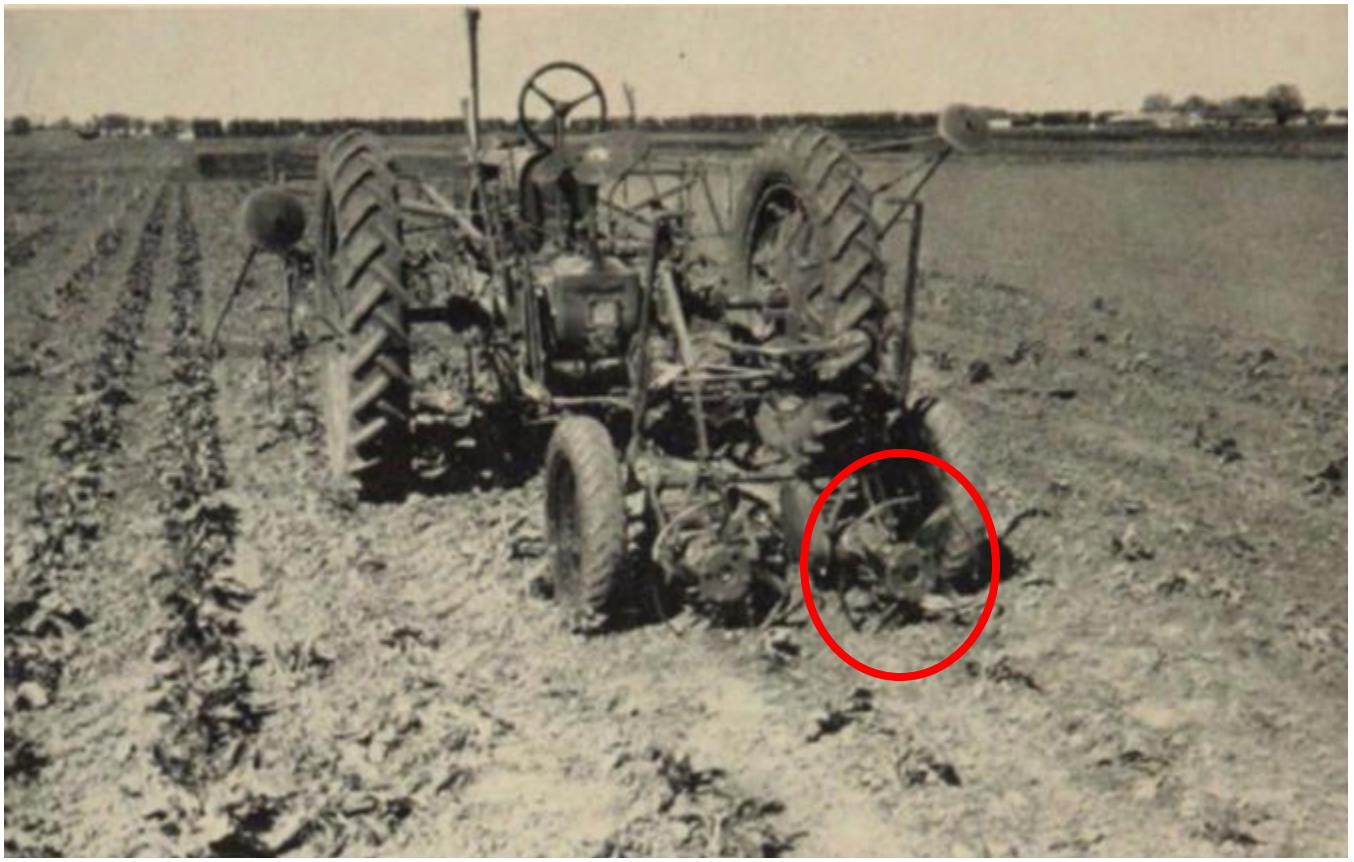
Evaluation of Automated Thinners for Lettuce Production

Richard Smith and Elizabeth Mosqueda,
University of California Cooperative Extension
Monterey County

Mechanical Thinners

- There has been interest in the development of mechanical thinners for sugar beets for many years
- Efforts at UC Davis go back to 1900
- Culminated by a design developed by Roy Garrett, published in 1966
- There were many other designs developed by many researchers in many parts of the country and by grower/fabricators
- Early designs did not use plant detection technology

Colorado State University, 1943



	Man hours per acre	Yield in tons per acre
Complete mechanical thinning	2.45	12.24
Modified mechanical thinning plus long-handled hoe	11.6	11.40
Long-handled hoe thinning	15.6	11.47
Customary hand block and thin	27.2	12.17

A Big Leap Forward with Computer Processing of Camera Images

The Tillet Machine by Garford Corp (England) uses spinning blades that spin around the desired plant

Mechanically thinned lettuce

- **The idea of using a spray to remove unwanted plants was developed in sugar beets and showed advantages over mechanical thinning devices:**
  - **Less inertia**
  - **Fewer moving parts**
  - **More precision**

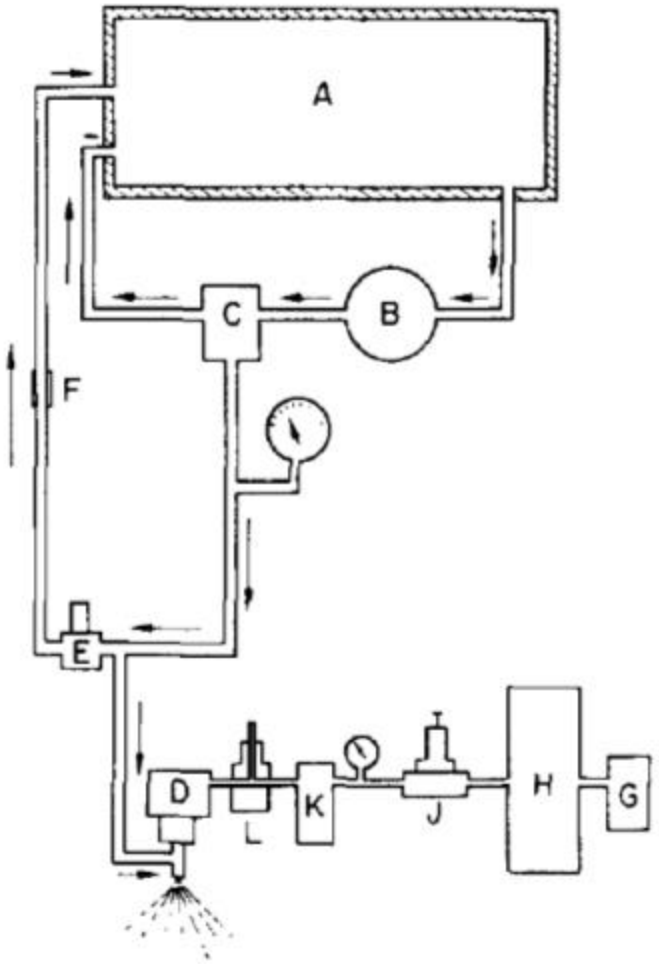


Fig. 2. Hydraulic and pneumatic circuits

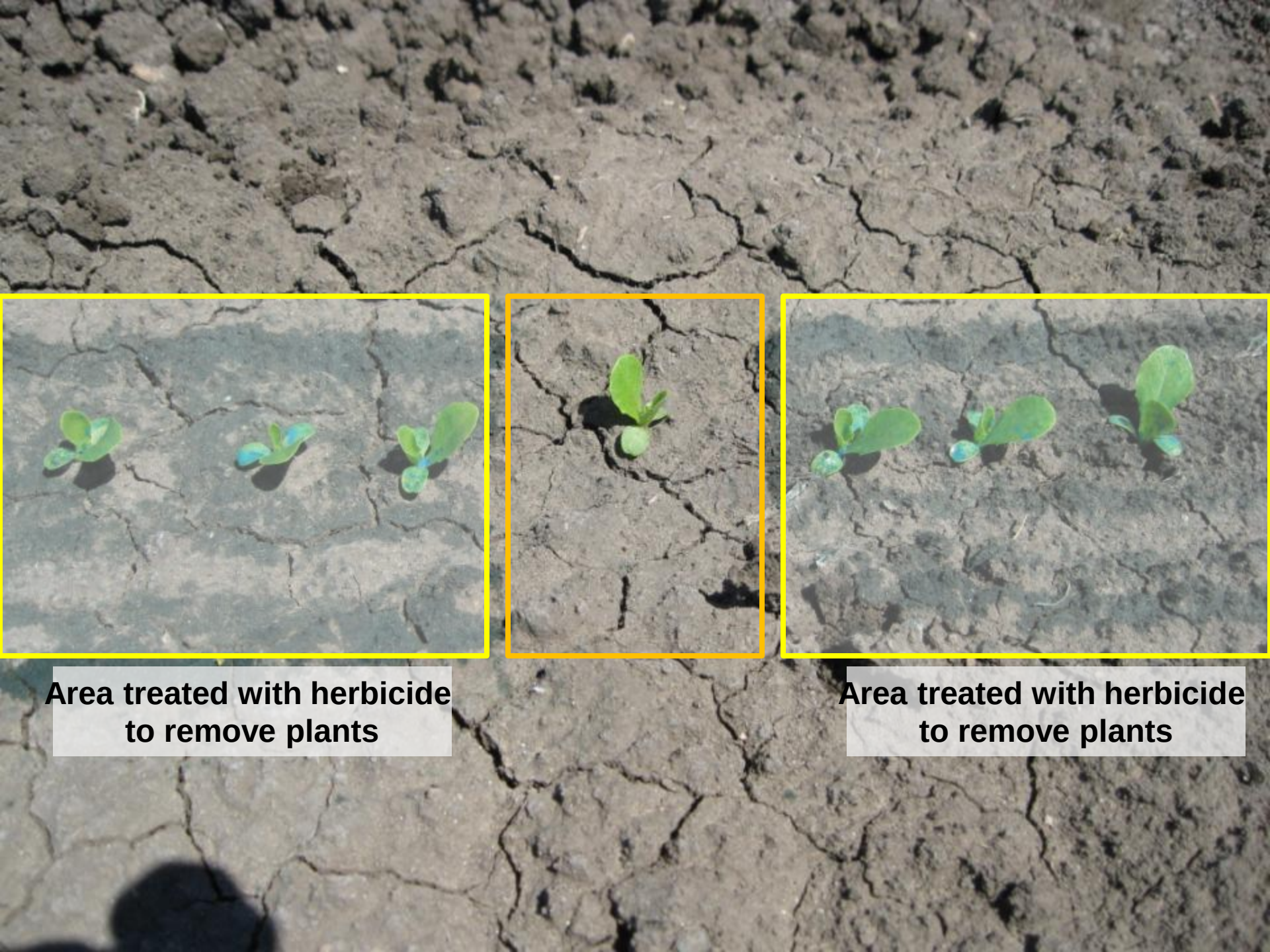
Cox and McLean, 1969

Spray Removal of Plants

- The wedding of spray removal of unwanted plants and computer image processing is a new development
- It is rapidly developing and four companies now have machines
  - Ag Mechtronix
  - Blue River Technology
  - Ramsey Highlander/Oraka
  - Vision Robotics

Mark Siemens, U of Arizona
Field Day at USDA Spence Station 2011


SPLAT 1.0
THINNING ROVER


Area treated with herbicide to remove plants
Area treated with herbicide to remove plants

Spray Material Options on Lettuce

- **Registered on lettuce:**
  - **Glyphosate**
  - **Gramaxone**
  - **Scythe**
  - **Shark**
- **Fertilizers:**
  - **Salt based**
    - **AN20, UN32, Ammonium thiosulfate**
  - **Acid based**
    - **NpHuric**
- **Other materials**
  - **Sulfuric acid**
- **Organic herbicides**

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Thinning/Weeding Trial

- **This trial was conducted under cool, moist conditions:**
  - **Temperatures in the low 60's and significant dew on the plants at time of application**

Thinning/Weeding Trial

Plants Treated when 14 Days Old

Control Material	Rate	Lettuce Control rating	Malva Control rating
BioLink Herbicide	12% v/v	9.8	9.1
Final San-O	20% v/v	3.5	1.8
Weed Pharm	100% v/v	7.0	3.3
Weed Zap	5% v/v	3.5	2.8
Scythe	9% v/v	8.1	6.5
Shark	1.0 oz/A	10.0	10.0
NpHuric	20% v/v	4.0	3.0
14-0-0-5	20 gal/A	8.1	4.0
Untreated	---	0.0	0.0

Conventional Materials

Scythe

Shark

Conventional Materials

NpHuric

14-0-0-5

Organic Materials

Bio Link Herbicide

Final San O

Organic Materials

Weed Pharm

Weed Zap

Registration of Thinning Materials

- **It has taken nearly a year for the specific registration of Shark to wind its way through the registration process at the CDPR**
- **It is in the 30 day waiting period which should be completed by the end of this month**
- **Biolink is completing its registration as an organic herbicide and should be available before the end of this year**

2014 Evaluations of Automated vs Hand Thinning

- Worked with cooperating growers that split fields: half were thinned with automated thinners and the other was hand thinned
- Seven fields were evaluated
- Thinners from three companies conducted the automated thinning (AgMechtronix, Blue River and Foothill Packing)

Time to Thin and Time to Weed & Remove Doubles

Method	Thinning hrs/A	Weed/Double hrs/A*	Total Time hrs/A
Automated	0.9	6.6	7.5
Hand	6.6	5.3	11.9

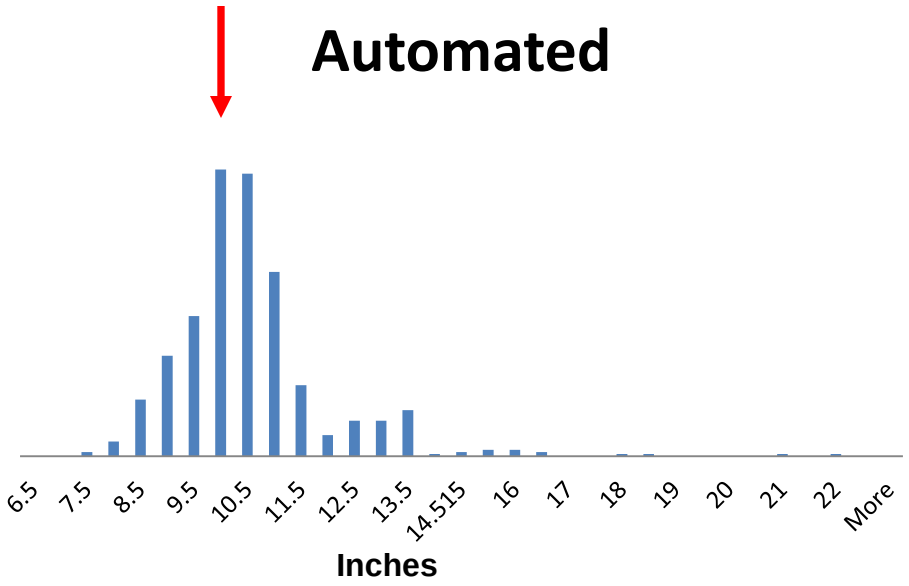
***Automated thinning probably took more time because it left more doubles than hand thinning:**

Automated: 1,024 plants/A
Hand: 148 plants/A

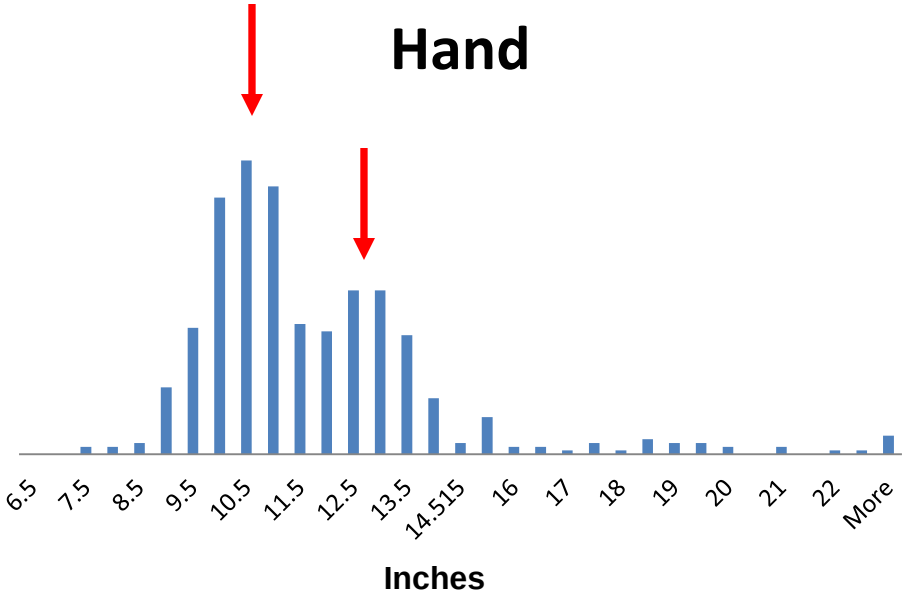
Evaluation of Thinning

Method	Mean plant spacing inches	Percent plants within 9-11 inches
Automated	10.3	71.1
Hand	10.5	57.0

Accuracy of Spacing



Automated thinning tended to cluster around the desired spacing (10 in.) more precisely than hand thinning



Impact on Weeds and Sclerotinia

Method	Weed Control Percent	Sclerotinia Percent
Automated	69.9	4.4
Hand	72.6	4.0

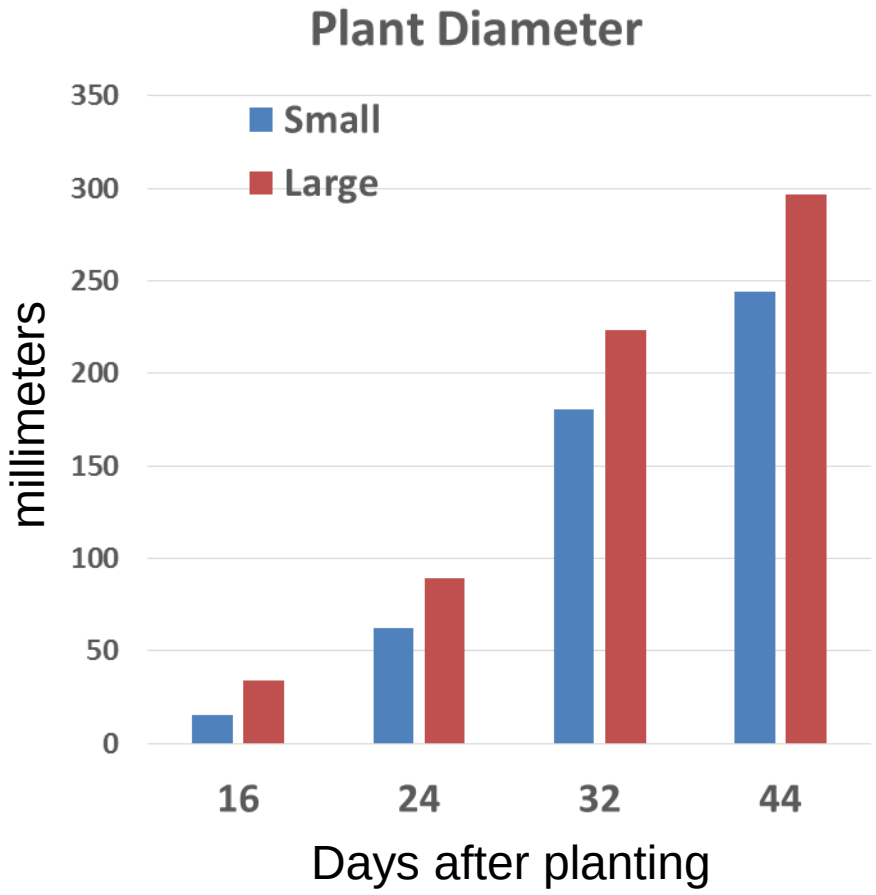
Yield Comparison

Method	Total Yield Boxes/A	Head Weight lbs/head	Unharvested Percent
Automated	1099	1.95	4.4
Hand	1046	1.96	5.4

Further Observations

- **Although we did not measure the difference in the size of the plants left by automated vs hand thinning, we noted at times that auto thinning would take out larger plants and leave smaller plants**
- **In hand thinning, this was mostly not the case**
- **We conducted evaluations to determine if this was of any consequence**

Growth Evaluation of Small vs Larger Plants at Thinning



- **At harvest:**
  - **Small 330.6 grams/plant**
  - **Large 475.5 grams/plant**
- **Smaller plants left at thinning do not catch up with larger plants**

Summary

- Automated thinners using spray technology to remove unwanted plants is a powerful new technology for production of direct seeded lettuce
- The spray materials that are or will soon be available are highly effective
- Automated thinners are more precise than hand thinning
- There is no adverse impact on yield; in fact there is some evidence that yield may be higher
- Challenges that remain include
  - Removal of double
  - Selection of larger plants at thinning may help improve the yield advantage of automated thinning

Acknowledgements

- Cooperating growers
- Automated thinner companies
- Fabian Galvan and Tricia Love, Research Assistants