Potential Use of Transplants In Cool Season Vegetables
and
The Impacts on Weed Control

Richard Smith, Farm Advisor
University of California Cooperative Extension
Monterey County
Current Situation

• Lettuce and broccoli in the Salinas Valley are basically direct seeded
  – Transplanting is used early in the lettuce season and in order to keep plantings on schedule

• However, other crops on the central coast are now transplanted:
  – Celery
  – Cauliflower
  – Leeks
  – Peppers
  – Fresh market tomatoes
Why Transplant Celery

- Painfully slow initial seed germination and plant growth
- Transplanting reduces early season weed issues
- Celery transplants are mowed in the nursery and are uniform in size and easy for the transplant machine to handle
- An automatic transplanter was developed years ago that works well
- Conventional mechanical transplanters also work well given current cost of labor
Why Transplant Celery

- Even with high plant populations the positives favor transplanting
- Celery has excellent registered herbicides (i.e. Caparol, Lorox, Dual Magnum, etc) and other weed control options that make weed control in transplanted celery economical and efficient
Why Transplant Cauliflower

- Low plant population (13,070) makes transplanting more economically viable
- Reduced weed issues
- Transplants produce acceptable quality
Why Transplant Cauliflower

- Cauliflower also has a good set of herbicides (Dacthal, Prefar and Goal)
- The planting configuration allows for effective cultivation:
  1) close early cultivation
  2) can throw dirt on second cultivation
  
Some growers just rely on cultivation
Why is Broccoli not Transplanted?

• High plant population (52,300) makes the economics of transplanting vs direct seeding more difficult

• Market demand is currently easily being met (no need for three crops!)
## Broccoli Transplant Costs

<table>
<thead>
<tr>
<th>Plants Per 1,000</th>
<th>Transplant Per 1,000</th>
<th>Total Cost Per 1,000</th>
<th>Total Cost Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.50</td>
<td>8.00</td>
<td>14.50</td>
<td>758</td>
</tr>
</tbody>
</table>
Why is Lettuce not Transplanted?

- Moderately high plant population (26,150-31,300) makes the economics of transplanting vs direct seeding difficult.
- Market demand is currently being met (no need for three crops?) with current rotation patterns.
- Questions about the quality of transplanted head lettuce.
- Other quality issues.
# Lettuce Transplant Costs

*Not including seed*

<table>
<thead>
<tr>
<th>System</th>
<th>Plants Per 1,000</th>
<th>Transplant Per 1,000</th>
<th>Total Cost Per 1,000</th>
<th>Total Cost Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>10.50</td>
<td>8.00</td>
<td>18.50</td>
<td>485</td>
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<tr>
<td>Organic</td>
<td>13.50</td>
<td>8.00</td>
<td>21.50</td>
<td>563</td>
</tr>
<tr>
<td>Automated (Grower's Transplant)</td>
<td>----</td>
<td>----</td>
<td>16.50</td>
<td>432</td>
</tr>
<tr>
<td>Operation</td>
<td>Seeded</td>
<td>Transplants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeding</td>
<td>169</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transplanting</td>
<td>---</td>
<td>509</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer - Preplant</td>
<td>70</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer - Sidedress</td>
<td>102</td>
<td>102</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide</td>
<td>48</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin/weed</td>
<td>148</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Weed</td>
<td>57</td>
<td>57</td>
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<td></td>
</tr>
<tr>
<td>Cultivation</td>
<td>27</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>167</td>
<td>167</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Production Costs</strong></td>
<td><strong>788</strong></td>
<td><strong>963</strong></td>
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</tbody>
</table>
Current Trends

• Increase in cost of labor
• Decrease in the availability of labor
• Increased costs of inputs (water, fertilizer, pesticides, etc)
• Increased cost of land rent
• Need to intensify the use of land to cover increased costs
• New developments in technology
Availability of labor

Automation

New Technology
Costly
High maintenance
What Will Agriculture in California Look Like in 10 Years

• Will it be more or less as it is now?
• Will the trends we see in 2007 lead to a shift in the economics of production which force crops to be produced in a way that lends itself more to intensification and mechanization?
Based on this situation we feel it is important to explore new weed control options in the event that transplanting of broccoli and lettuce become more common.
Weed Control Options for Transplanted Broccoli

- Goal is already registered specifically for pretransplant use in broccoli
- Broccoli also has excellent post emergence options (i.e. Goal Tender, topical fertilizer applications, grass herbicides)
Weed Control Options for Transplanted Lettuce

• Currently there are no herbicides registered specifically for transplanted lettuce in California
Lettuce: Seedling vs Transplant

- Lettuce is particularly sensitive to damage by herbicides in the seedling stage.
- As a result, there is a very short list of herbicides that are safe for preemergence use: Kerb, Prefar, Balan.
Lettuce: Seedling vs Transplant

Once lettuce is past the seedling stage:

- More tolerant of other herbicides
- More tolerant of physical manipulation
Weed Control Options for Transplanted Lettuce

- Herbicide options for transplanted lettuce:
  - Prowl
  - Dual Magnum
  - Authority
2006 Weed Evaluation

weeds/20 ft²
2006 Crop Safety Evaluation
Phytotoxicity

Bar chart showing phytotoxicity levels for different treatments:
- Untreated
- Kerb 1.2
- Dual 0.95 (High)
- Prowl 1.0
- Authority 0.1

The Dual 0.95 treatment has the highest phytotoxicity level.
2006 Yield Evaluation

Heads per Plot
2007 Weed Evaluation

weeds/20 ft²

- Untreated
- Kerb 1.2
- Dual 0.63
- Dual 0.95
- Prowl 0.5
- Prowl 1.0
2007 Crop Safety Evaluation

Phytotoxicity Rating

- Untreated
- Kerb 1.2
- Dual 0.63
- Dual 0.95
- Prowl 0.5
- Prowl 1.0
2007 Yield Evaluation

Mean Head Weight

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean Head Weight</th>
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</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>1.2</td>
</tr>
<tr>
<td>Kerb 1.2</td>
<td>1.25</td>
</tr>
<tr>
<td>Dual 0.63</td>
<td>1.3</td>
</tr>
<tr>
<td>Dual 0.95</td>
<td>1.35</td>
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<tr>
<td>Prowl 0.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Prowl 1.0</td>
<td>1.45</td>
</tr>
</tbody>
</table>
Herbicides for Transplanted Lettuce

- Steve Fennimore has tested Prowl H2O at rates up to 6 lbs ai/A and has seen good safety.
- He also tested tank mixes with Prowl H2O and Kerb and they look effective.
- Prowl was submitted to the IR4 program to develop a food use tolerance for transplanted lettuce.
Cultivation

- Transplants lend themselves to old and new technologies for weed control
- Transplants give the crop a head start on the weeds
- Transplants are more resistant to physical manipulation
- Transplants are bigger and therefore easier to detect and distinguish from the weeds by existing technology
Close cultivation is not a new idea, but for larger operations, speed is a concern.
Precision Guidance of Cultivators
2” wide band vs standard 4” band

EcoDan

Capable of cultivating close and fast
Intra-row cultivation

Blind

Finger

Torsion
Split Knife
Dave Slaughter, UCD

HYDRAULIC CYLINDER

INFRARED SENSOR

KNIFE
Automated Weed Control in Transplanted Tomatoes

Infrared Tomato Stem Sensor

Weed Knives
Torsion Weeder
Used extensively in Europe
Similar to the Texas Rod Weeder
once popularly used in cotton
Come in different Sizes (7 & 9 mm)
Can be adjusted To different Widths apart
The tines undercut small weeds, but but hit the transplant at an oblique angle.
Percent Weed Control

* Different than 7mm @ P=0.10
Prototype Intra-row weeder

* This machine is being commercialized
* It will be dependant upon good ability to distinguish between crop and weeds which transplanting will facilitate
Final Thoughts

- It is unclear if transplanting of lettuce will take off in the Salinas Valley, but it seems likely.
- It may open the door to the use of hybrids in order to improve uniformity.
- If it does, it will change weed control practices and give growers opportunities to use new and more effective tools.