Development of a Mechanical Undercutting System to Minimize Sweetpotato Skinning during Harvest


Agricultural and Biological Engineering
Pontotoc Ridge – Flatwoods Branch Experiment Station
Disclaimer

- Do not try this at home.
  - This data is very preliminary. We are still developing and testing the system. If you replicate this system at home you do so at your own risk.

- Mention of company or product names is for presentation clarity and does not imply endorsement by the authors or their affiliations, nor exclusion of other suitable products.
Justification

- Sweetpotato Producers:
  - High-value crop with future growth.
  - Industry demand needs continuous supply all year.
  - Harvest and postharvest storage critical to maintaining supply.
  - Skinning and abrasions of roots during harvest and handling contribute 20-25% of storage losses.
Justification

- Sweetpotato producers currently use a de-vining system to manage skin set.
- De-vining is currently not a viable option for bulk harvesting systems.
- A new method is needed to increase skin set for both bulk harvesting and traditional harvesting systems.
Justification
Why Undercutting?

- Used in other cropping systems
  - Plant maturity
  - Skin set
- In tandem with de-vining
- Leave vine intact for bulk harvesting
- Mechanical as opposed to chemical
Objectives

- To develop and test mechanical undercutter systems for use in sweetpotato primarily made from off-the-shelf components.
- To assess the influence of a mechanical undercutting system by quantifying skin set of sweetpotato.
Machine 1

- Developed from components from Roll-a-Cone Manufacturing (Tulia, Tx.). Attached to a toolbar designed and built in house.

- Implement covers two 40in rows and is adjustable for standard row spacing applications.
Machine 1 Components

- Razor Plow Shank and Blade
- Standard Ripper Shank
- Coulter
Machine 1 Components

- Heavy Duty Toolbar
- Coulter
- Bed Shaper
- Cutting Blade
- Ripper
Machine 2

- Even more readily available option to producers
- Created from a modified drop off sweetpotato harvester built by Easley Mfg. (Houston, Ms.)
- Harvesting chains and hydraulics were removed and digging blade modified slightly for undercutting
- Bed shapers added to stabilize rows
Machine 2 Components

- Coulter
- Undercutting blade
- Bed shaper
Procedure

Experimental Design

- Two Varieties (Beauregard "B-14", Evangeline)
- Four Reps
- Split-Plot
- Main Treatment
  1. De-vining
  2. No De-vining
- Sub Treatment
  1. No undercutting
  2. Undercutting with Machine 1
  3. Undercutting with Machine 2
Procedure

- Pontotoc Ridge-Flatwoods Branch Experiment Station, Pontotoc, MS
- Plots managed under typical grower practices
- De-vining and Undercutting occurred on same day
- Plots harvested on 3 and 6 days after treatments with skin measurements on day of harvest
- Significant rainfall event occurred between harvests
- 5 roots randomly selected per plot with 2 skin readings per root
Procedure

- Skin strength measured with modified Halderson tester (Halderson & Henning, 1993; Lulai & Orr, 1993)
Procedure
Machine Operation

- Operating Depth
  - 8-10"

- Operating Speed
  - 4-5 MPH (Yes, really.)

- Toolbar should be near level with gauge wheels to stabilize at operating depth
Machine 2 Testing
Post Undercutting
Post Undercutting

De-vined

Vined
Experiment Results
Results

- **Evangeline Variety**
  - No significant difference among main and sub treatment effects.
  - Higher mean skin set than B-14

<table>
<thead>
<tr>
<th></th>
<th>De-vined</th>
<th></th>
<th>B-14 Mean</th>
</tr>
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<tbody>
<tr>
<td><strong>TRT</strong></td>
<td><strong>Eva Mean</strong></td>
<td><strong>B-14 Mean</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2.20</td>
<td>1.86</td>
<td></td>
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<tr>
<td>Machine 1</td>
<td>2.19</td>
<td>1.74</td>
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<tr>
<td>Machine 2</td>
<td>2.24</td>
<td>1.78</td>
<td></td>
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<tr>
<td><strong>Vined</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2.32</td>
<td>1.82</td>
<td></td>
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<tr>
<td>Machine 1</td>
<td>2.21</td>
<td>2.02</td>
<td></td>
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<tr>
<td>Machine 2</td>
<td>2.22</td>
<td>1.81</td>
<td>Day 6</td>
</tr>
</tbody>
</table>
Results

- Machine 2
  - No significant differences among main and sub treatment effects.
  - No different from control.
- Further adjustment may have been needed for optimal undercutting
Results

Machine 1

Machine 2

Control
## Type 3 Tests of Fixed Effects

### Day 3

<table>
<thead>
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<th>Effect</th>
<th>Pr &gt; F</th>
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<tbody>
<tr>
<td>Main (Vine Condition)</td>
<td>0.0881</td>
</tr>
<tr>
<td>Sub (Undercutting)</td>
<td>0.0523</td>
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<tr>
<td>Main*Sub</td>
<td>0.3141</td>
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### Day 6

<table>
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<tr>
<th>Effect</th>
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<tr>
<td>Main</td>
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<tr>
<td>Sub</td>
<td>0.0893</td>
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<tr>
<td>Main*Sub</td>
<td>&lt; .0001</td>
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</table>
De-Vined

Skinning Force (in-lb)

Day
3
6

n = 40
Standard Error
Vine-On

n = 40
Standard Error

Skinning Force (in-lb)

Day

3
6

Machine 1 (Razor)
Machine 2 (Digger)

A
AB
B

B
A
B

B

A

B

None
Machine 1 (Razor)
Machine 2 (Digger)
## B-14 – Day 3 - LSDs

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>Estimate</th>
<th>Pr &gt; t</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV Easley</td>
<td>DV None</td>
<td>-0.019</td>
<td>0.6664</td>
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<tr>
<td>DV Razor</td>
<td>DV None</td>
<td>-0.062</td>
<td>0.1707</td>
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<tr>
<td>V None</td>
<td>DV None</td>
<td>0.151</td>
<td>0.0342</td>
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<td>V Easley</td>
<td>DV None</td>
<td>0.041</td>
<td>0.5119</td>
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<td>V Razor</td>
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<tr>
<td>Treatment</td>
<td>Control</td>
<td>Estimate</td>
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<tr>
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<td>0.1566</td>
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<tr>
<td>DV Razor</td>
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<td><strong>0.0265</strong></td>
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<tr>
<td>V None</td>
<td>DV None</td>
<td>-0.038</td>
<td>0.5558</td>
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<tr>
<td>V Easley</td>
<td>DV None</td>
<td>-0.055</td>
<td>0.3914</td>
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<tr>
<td>V Razor</td>
<td>DV None</td>
<td>0.160</td>
<td><strong>0.0232</strong></td>
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Conclusions

- Evangeline variety did not respond to treatment
- Machine 2 (digger) no significant effects
- B-14 responds to Machine 1 (Razor) with vine-on
- Razor undercut plots maintained skin strength after rainfall
- 10.9% increase in skin strength
Future Work

- Continued Refinement of Implement
- Repeat Study
  - Examine Time Effects (Day 3, 4, 5, 6, 7, etc.)
- On-Farm Study with Scaled-Up Implement
Acknowledgement

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