Sprout suppression – a technical viewpoint

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Sprout Control Options

• Variety selection
• Low storage temperatures
• Product application
  – In-field
  – In-storage
  – Spray application at packing shed for fresh market
Major Sprout Control Products in the US

- Chlorpropham (CIPC)
- Maleic hydrazide (MH) – field applied
- Diisopropynaphthalene (DIPN; Amplify)
- Dimethylnaphthalene (DMN; 1,4-sight)
- 3-decen-2-one (SmartBlock)
- Clove oil (Biox C; Sprout Torch)- organic
- *Mint oil or other essential oils- organic
Sprout Control Programs

• CIPC based
  – Thermal (forced air storage; recirculation) and/or spray application
  – May have other products in mix or sequence; reduced rates

• No CIPC
  – None, sole or multiple product programs
  – Organic, non-CIPC markets, avoid contamination of storage
  – Seed potato options

• Product for sprout control and to blacken eyes for retail fresh market
  – Thermal or spray
CIPC

• In-storage (1° sprout inhibitor used)
  • apply as thermal fog – *temperature, method of application and equipment are applicator dependent*
  • initial application early, before pile settles, after wound healing
  • depending upon cultivar, temperature and duration in storage, typically apply 15 to 25 ppm; retreat only if necessary (~10-20 ppm)

• Packing sheds
  – Spray (EC; up to 10 ppm) formulation applied to washed potatoes
<table>
<thead>
<tr>
<th></th>
<th>Building 1</th>
<th></th>
<th>Building 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First</td>
<td>Re-application</td>
<td>First</td>
<td>Re-application</td>
</tr>
<tr>
<td></td>
<td>application</td>
<td></td>
<td>application</td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>CIPC 98%</td>
<td>None</td>
<td>CIPC 98%</td>
<td>CIPC 98%</td>
</tr>
<tr>
<td>Rate</td>
<td>1:400; 624lbs</td>
<td>0</td>
<td>1:400; 615lbs</td>
<td>1:500; 178 lbs*</td>
</tr>
<tr>
<td>Application date</td>
<td>11/2/13</td>
<td>Na</td>
<td>11/1/13</td>
<td>4/30/14</td>
</tr>
<tr>
<td>Reversed fan Y or N</td>
<td>No</td>
<td>Na</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Fan speed</td>
<td>“Low”</td>
<td>Na</td>
<td>“Very low”</td>
<td>No circulation</td>
</tr>
<tr>
<td>Application temperature</td>
<td>600°F</td>
<td>Na</td>
<td>900°F</td>
<td>-</td>
</tr>
<tr>
<td>Sampling date</td>
<td>12/5/13</td>
<td>5/29/14</td>
<td>12/5/13</td>
<td>5/29/14</td>
</tr>
<tr>
<td>Mean residue (n=18) ppm</td>
<td>11.8</td>
<td>1.8</td>
<td>5.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Mean Top (n=9) ppm</td>
<td>12.8</td>
<td>0.6</td>
<td>5.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Mean Down 1’ (n=9) ppm</td>
<td>10.8</td>
<td>3.0</td>
<td>5.0</td>
<td>4.8</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>1.1</td>
<td>1.4</td>
<td>NS</td>
<td>2.0</td>
</tr>
<tr>
<td>Mean “Near” (n=6)</td>
<td>10.7</td>
<td>0.9</td>
<td>4.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Mean “Mid” (n=6)</td>
<td>12.0</td>
<td>3.3</td>
<td>3.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Mean “Far” (n=6)</td>
<td>12.7</td>
<td>1.2</td>
<td>7.9</td>
<td>5.3</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>1.4</td>
<td>1.7</td>
<td>0.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Mean Near Top (n=3)</td>
<td>11.0</td>
<td>0.4</td>
<td>4.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Mean Near Dig (n=3)</td>
<td>10.3</td>
<td>1.4</td>
<td>4.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Mean Mid Top (n=3)</td>
<td>13.0</td>
<td>0.9</td>
<td>4.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Mean Mid Dig (n=3)</td>
<td>11.0</td>
<td>5.7</td>
<td>2.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Mean Far Top (n=3)</td>
<td>14.3</td>
<td>0.5</td>
<td>7.9</td>
<td>1.4</td>
</tr>
</tbody>
</table>
CIPC update in United States

- Chlorpropham
  - US MRL (maximum residue level) 30 ppm
  - 2009 USDA Pesticide Data Annual Summary: CIPC found in 80% (596/744) of samples and residue levels of 0.01 to 23 ppm. *Mean detection 2.5 ppm.* All below 30 ppm.
  - Industry commissions sampling for residues.
  - Industry looking for means to reduce rates and residues, utilize alternative chemistries.
  - Applaud
    - Potato Industry CIPC Stewardship Group – “Be CIPC Compliant”
CIPC Stewardship = Global Priority
Maleic Hydrazide applied in field
July

Non-registered compound

Russet Burbank

UTC

Early MH

Late MH

UTC + CIPC

Early MH + CIPC

Late MH + CIPC
Maleic hydrazide

- Effective for severely retarding sprout growth
- Extend dormancy break by approximately 30 days
- Timing important
- Good for aggressive sprouting varieties
- Effective sprout control programs
  - Alone
  - MH-30 followed by CIPC or other sprout inhibitor in storage
Naphthalene based products

- **Diisopropynaphthalene (DIPN)**
  - Typically, thermally applied in combination with CIPC

- **Dimethylnaphthalene (DMN)**
  - No residue issue; exempt from tolerance
  - Thermally applied alone or with CIPC program
  - Aerosol canisters for shipping containers
  - Thermal application to seed (30 days before planting)
3-decen-2-one

- Chemically synthesized food additive. No residue tolerance established because regulated as a food additive
- Apply thermally at pre- or at- visual initiation of sprouting or if advanced sprouting- damage sprouts.
- Long-term sprout control with 1 to 3 applications depending upon storage temperatures and variety
- Higher storage temperatures; aggressive sprouting varieties may need additional applications
- Blackens eyes; damage immediately observed; odor
- Integrate into effective sprout control programs that may include CIPC, MH, others
Essential Oils: **Clove Oil**; Mint Oil

- Mode of action: physically damages sprout
- Reapplication is necessary for long-term control
  - 50 to 100 ppm each treatment
  - Dependent upon variety and storage temperature
  - ~2 to 6 week intervals
- Blackens eyes; Odor
- Effective sprout control programs
  - Alone (organic approved)
  - MH plus clove oil (no CIPC)
  - CIPC plus clove oil = true mix or sequence
  - Spray application at packing shed
Russet Burbank after 9 months in 7.2°C storage (8 applications of mint oil)
Idaho Research on Sprout Suppression

• True mixtures with CIPC: Clove oil, 3-decen-2-one, Canola oil, Peppermint oil
• Liquid versus solid CIPC
• Other alternatives: Pelargonic acid (newly registered in US), sagebrush oil, rosemary oil, muna oil, imazamox, harpin protein, salicylic acid, jasmonic acid, hydrogen peroxide, irradiation, and many others
• Temperature of application, rate, applicator type, sequence, recirculation time, corrosion, taste, processing quality, disease, phytotoxicity, etc.
Some Retailer’s Objective:

to blacken eyes resulting in customer perception that no sprouting will occur
Thermal Aerosol CIPC plus spray

CIPC

Thermal Aerosol CIPC in storage

No CIPC

Thermal Aerosol CIPC plus spray
CIPC

Thermal Aerosol CIPC plus spray
CIPC and clove oil
Time to Reach Customers

At fresh pack: **4 days**

By rail: **18-20 days**

By semi-truck: **3 days**

Distribution: **<7 days**

Rail: up to ~30 days
Semi: up to ~14 days
Collection from truck, after washing and after CIPC spray application on sprout development (g/tuber) after 30 days at 15.5°C.

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Dec Storage A</th>
<th>Jan Storage B</th>
<th>June Storage C</th>
<th>June Storage D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>0</td>
<td>0.03</td>
<td>0.15</td>
<td>0.07</td>
</tr>
<tr>
<td>After wash</td>
<td>0</td>
<td>0.01</td>
<td>0.29</td>
<td>0.53</td>
</tr>
<tr>
<td>After CIPC spray</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

June photos

- Truck sample
- After wash
- After CIPC spray

After 30 days at 15.5°C

Remove 0.8 - 2.5 ppm CIPC
Add 0.9 - 1.9 ppm CIPC
Export: Time to reach customers

Ship and port: ~21 to 45 days
CIPC contamination on seed or CIPC as phytosanitary tool
Seed Exposure to CIPC
### Swabbing for CIPC residues (ppm)

<table>
<thead>
<tr>
<th>Treated Bins</th>
<th>Pre-application</th>
<th>After application</th>
<th>After cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin 1</td>
<td>Both years prior</td>
<td>18</td>
<td>240</td>
</tr>
<tr>
<td>Bin 2</td>
<td>Both years prior</td>
<td>35</td>
<td>1,100</td>
</tr>
<tr>
<td>Bin 3</td>
<td>Both years prior</td>
<td>19</td>
<td>320</td>
</tr>
<tr>
<td>Bin 4</td>
<td>Only 1 year prior</td>
<td>10</td>
<td>210</td>
</tr>
<tr>
<td>Bin 5</td>
<td>Untreated</td>
<td>0.9</td>
<td>-</td>
</tr>
</tbody>
</table>
Window of no-CIPC application

• Cultivar, season and temperature dependent
• First 1-3 months after harvest
  – Need to know market and when potatoes will be moved
  – Risk of plans changing
• Maleic hydrazide for process potatoes – some sprouting is tolerated
• Use of alternatives
Sprout Suppression Options for Organic Potatoes

- Cultivar selection – long dormancy, good storability
- Store as cold as possible for end use
- Thermal applications of clove oil
- Spray application of clove oil EC formulation at packing shed
- Process early and store as frozen or manufactured product or market with stipulation that need to be consumed soon
Current Major Sprout Control Options

- Variety selection and cooler temperatures
- Maleic Hydrazide – field application; 30 day longer dormancy; slow sprout growth
- CIPC – highly effective
- DMN and DIPN – mild sprout suppressants; use in combination with CIPC
- Clove oil- organic; mix with CIPC; blackens sprouts
- 3-decen-2-one – alone or in combination with others. Blackens sprouts

- Development of integrated programs
- New chemistries