Update on Antimicrobial Therapies for HLB Mitigation

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Chemical control of HLB bacterium

Effective molecules

Efficient delivery system

Field application
Using graft-based screening system, more than 100 molecules were evaluated against HLB bacterium

1. Antibiotics: 31
2. Biocides: 25
3. Peptides: 5
4. Fungicide: 6
5. SAR substances: 6
6. Others: 29
Efficiency of the tested compound were divided into 4 groups based on the Ct value in the inoculated plants, scion infected percentage and Las transmission rate. Highly effective: Ct $\geq 36.0$; Effective: $36.0 > Ct \geq 32.0$; Partly effective: $32.0 > Ct \geq 28.0$; Non-effective: Ct $< 28.0$. 

Highly effective, 9
Effective, 25
Partly effective, 22
Non-effective, 46
Effective compounds evaluated by **graft-based screening method**

<table>
<thead>
<tr>
<th>Chemical compounds</th>
<th>Ct value</th>
<th>Phytotoxicity (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicilin or Pennicillin (Antibiotic)</td>
<td>39.7±0.1</td>
<td>N</td>
</tr>
<tr>
<td><strong>Actidione (Fungicide)</strong></td>
<td>39.2±0.8</td>
<td><strong>Y</strong></td>
</tr>
<tr>
<td>Sulfadimethoxine sodium (Antibiotic)</td>
<td>36.8±1.7</td>
<td>N</td>
</tr>
<tr>
<td><strong>Nicotine (Biocide)</strong></td>
<td>36.3±0.4</td>
<td><strong>Y</strong></td>
</tr>
<tr>
<td>80WG (SAR)</td>
<td>35.8±1.1</td>
<td>N</td>
</tr>
<tr>
<td>Sulfathiazole sodium (Antibiotic)</td>
<td>35.7±1.5</td>
<td>N</td>
</tr>
<tr>
<td>DL-buthionine-sulfoximine (Antibiotic)</td>
<td>35.6±0.3</td>
<td>N</td>
</tr>
<tr>
<td>Silver collidal (Others)</td>
<td>35.0±1.8</td>
<td>N</td>
</tr>
<tr>
<td>Poly-l-arginine (Peptide)</td>
<td>34.8±2.1</td>
<td>N</td>
</tr>
<tr>
<td>Surfactin from bacillus subtitlis (Biocide)</td>
<td>34.8±0.7</td>
<td>N</td>
</tr>
<tr>
<td>Poly-D-lysine (Peptide)</td>
<td>34.5±1.3</td>
<td>N</td>
</tr>
<tr>
<td><strong>P-cymene (Others)</strong></td>
<td>34.0±1.1</td>
<td>N</td>
</tr>
<tr>
<td>Carvacrol (Others)</td>
<td>33.9±3.1</td>
<td>N</td>
</tr>
<tr>
<td><strong>Zhongshengmycin (Agri-Antibiotics)</strong></td>
<td>33.7±1.0</td>
<td>N</td>
</tr>
<tr>
<td>Silver nitrate (Others)</td>
<td>32.9±1.6</td>
<td>N</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>25.3±0.8</td>
<td>N</td>
</tr>
</tbody>
</table>
EFFICIENT NANO-DELIVERY SYSTEM
Amp concentration in the HLB-affected citrus leaf after treated with Nano-Amp formulations (Oil in Water) by bark application.
Days after initial treatment

A: Control
B: Nano-Cre-Amp

Ct value

Tap water (CK)

Nano-Cre-Amp
CHEMOTHERAPY COUPLED WITH THERMOTHERAPY
Six experiments combined of 18 chemotherapy treatments from 12 effective compounds and 3 thermotherapy treatments (40, 42, 45°C);

Exp-1: EPL, SDX, STZ

Exp-2: VA, ZS, AMP

Exp-3: Carv, PCY, Carv+PCY

Exp-4: Nic, Zn, Nic+Zn

Exp-5: ACT+SDX, ACT+STZ, QUI+SDX

Exp-6: ACT+ZS, ACT+VA, QUI+STZ
Temp over 42 °C for one week can eliminate the Las bacterium, and promote the citrus growths.

RT  40°C  42 °C  45°C
HLB-affected citrus were treated by chemical compounds over heat-treatment

EPL: Epsilon-Poly-L-Lysine; SDX: Sulfadimethoxine sodium; STZ: Sulfathiazole sodium
HLB-affected citrus were treated by chemical compounds over heat-treatment

VA: Validoxylamine; AMP: Ampicillin; ZS: Zhongshengmycin
HLB-affected citrus were treated by chemical compounds over heat-treatment.

PCY: P-CYMENE; CARV: Carvacrol
HLB-affected citrus were treated by chemical compounds over heat-treatment.
HLB-affected citrus were treated by chemical compounds over heat-treatment

ACT: Actidione; QUI: Gossypol
Soil drench  Bark painting

HLB-affected citrus were treated by chemical compounds over heat-treatment
• **Efficiency** against Las bacterium was dependent on the physics and chemistry of the tested compounds, such as water solubility, molecular size and so on;

• **Amp** and Nic was the most effective compounds to eliminate Las bacterium by soil drench or bark application;

• **ACT and Qui** had phytotoxicity to citrus; but **ACT+VA and ACT+ZS** were also effective to eliminate the Las bacterium.
Trunk-injection

Months after Initial Treatment

Ct value

ZS  VA  CK

0 Mo  2 Mo  4 Mo  6 Mo  8 Mo  10 Mo
Amp-treatment vs Control over months after initial treatment.
Trunk-injection in China

Photo taken at 12 months after initial treatment
Thanks for your attention!