Cultivation Management of Organic Banana Production at TBRI Organic Farm

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Trend of global organic market

- Strong growth has continued in all major European organic markets and in the US, the world’s leading organic market.
- Sales of organic products in China have quadrupled in the last five years.
- Brazil reported an annual growth rate of 40%.
- Market analysts predicted that organic sales in Asia will grow by 20% a year over the next three years.

Soil Association, 2012
World retail sales of organic products

Source: Liu, FAO, 2007
Growth of organic markets for banana over the period 1998-2003

FAO, 2003
Organic banana exports from Peru

Liu, FAO, 2007
Regions and seasons of banana production in Taiwan

Agricultural land: 820,000 ha
For banana production: 13,000 ha

Central regions (July - Dec)

Southern and Eastern regions (Jan - June)
Planting area, production and export volumes of Taiwan banana over the period 1916 - 2011
Adversities of Taiwan banana industry

- Low production efficiency
- Small production scale
- Unavailability of land
- High production cost
- Aging of labor
- Severe loss from Fusarium wilt
A Fusarium wilt-severely infested banana field
Disease Incidence of Fusarium wilt in organic and conventional banana farm
Organic agriculture in Taiwan (COA)

- Technically,
  is the processes of agricultural production without using any synthetic chemicals, plant growth regulators, genetically-modified cultivar, and causing any type of pollution
Why organic in Taiwan?

- To improve soil quality
- To protect Eco- and environmental systems
- To raise resistance against diseases and pests
- To increase production profits
- To enhance taste quality
- To meet consumer’s demand for healthy food
Goals for organic farming of banana in Taiwan

- To reduce loss from Fusarium wilt
- To alleviate soil degradation
- To enhance taste quality
- To increase profits from banana planting
- To sustain Taiwan banana industry
Organic farming at TBRI

- In 1995, launched a pilot study on banana cultivation in organic way
- In 1998, set up experimental plots to compare growth, yield and quality of banana between organic and conventional farming
- In 2008, operated 2.4 hectares of organic farm at TBRI
- In 2010, established another 12.8 hectares for extension and commercial purposes
Organic farm – 2.4 hectares, since 1998
‘Formosana’
(Cavendish, AAA)

Certified by Tse-Xin Organic Certification
Organic farm – 12.8 hectares, since 2010
Tai-Chiao No. 5 (Cavendish, AAA)
Certified by Harmony
Organic Agriculture Foundation
Soil chemical properties of 2.4 hectares of organic farm

<table>
<thead>
<tr>
<th>Cropping year</th>
<th>OM (g/kg)</th>
<th>pH</th>
<th>EC (dS/m)</th>
<th>Available P (mg/kg)</th>
<th>Available K (mg/kg)</th>
<th>Available Ca (mg/kg)</th>
<th>Available Mg (mg/kg)</th>
<th>Exchangeable Fe (mg/kg)</th>
<th>Exchangeable Mn (mg/kg)</th>
<th>Exchangeable Cu (mg/kg)</th>
<th>Exchangeable Zn (mg/kg)</th>
<th>0.1N HCl (mg/kg)</th>
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<td>1999</td>
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<td>3360</td>
<td>110.5</td>
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<td>2005</td>
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<td>149</td>
<td>517</td>
<td>1564</td>
<td>224</td>
<td>310</td>
<td>63</td>
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<td>2006</td>
<td>42.9</td>
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<td>257</td>
<td>219.8</td>
<td>98.3</td>
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<td>2007</td>
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<td>2008</td>
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<td>373.4</td>
<td>2093</td>
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<td>98.9</td>
<td>11.2</td>
<td>29.4</td>
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</table>
Soil chemical properties of 12.8 hectares of organic farm

<table>
<thead>
<tr>
<th>Plot</th>
<th>OM (g/kg)</th>
<th>pH (1:1)</th>
<th>EC (1:5)</th>
<th>Available P (mg/kg)</th>
<th>Available K (mg/kg)</th>
<th>Available Ca (mg/kg)</th>
<th>Available Mg (mg/kg)</th>
<th>Exchangeable Fe (mg/kg)</th>
<th>Exchangeable Mn (mg/kg)</th>
<th>Exchangeable Cu (mg/kg)</th>
<th>Exchangeable Zn (mg/kg)</th>
<th>0.1N HCl Fe (mg/kg)</th>
<th>0.1N HCl Mn (mg/kg)</th>
<th>0.1N HCl Cu (mg/kg)</th>
<th>0.1N HCl Zn (mg/kg)</th>
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<tr>
<td>A1</td>
<td>13.8</td>
<td>4.34</td>
<td>0.12</td>
<td>44.3</td>
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<tr>
<td>A2</td>
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<td>255.2</td>
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<td>290.8</td>
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<td>117.0</td>
<td>265.0</td>
<td>40.5</td>
<td>194.0</td>
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<td>2.8</td>
<td>2.6</td>
<td>27.7</td>
<td>2.8</td>
<td>2.6</td>
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</tr>
<tr>
<td>B3</td>
<td>10.4</td>
<td>4.61</td>
<td>0.08</td>
<td>57.7</td>
<td>119.5</td>
<td>200.5</td>
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<td>3.6</td>
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<td>C</td>
<td>6.4</td>
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<td>1127.8</td>
<td>62.5</td>
<td>203.8</td>
<td>57.7</td>
<td>4.1</td>
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<td>57.7</td>
<td>4.1</td>
<td>3.4</td>
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</tr>
</tbody>
</table>
Soil management

- Application of liming material
- Surface covered with weeds and plant debris
Fertilizer recommendation for conventional bananas

<table>
<thead>
<tr>
<th>Seedling</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>g/plant/crop cycle</td>
<td>g/plant/crop cycle</td>
<td>g/plant/crop cycle</td>
</tr>
<tr>
<td>TC</td>
<td>165~220</td>
<td>83~110</td>
<td>330~440</td>
</tr>
<tr>
<td>Sucker</td>
<td>165~220</td>
<td>83~110</td>
<td>330~440</td>
</tr>
<tr>
<td>Ratoon</td>
<td>110~165</td>
<td>55~83</td>
<td>220~330</td>
</tr>
</tbody>
</table>
Nutrient supplies

- Castor seed meal (5-2-1) 3~5 kg/plant/crop cycle
- Palm bunch ash ($K_2O$ 28~30%) 2.5 kg/plant/crop cycle
- Plant debris
- Liquid fertilizer
Aeration of organic liquid fertilizer
Application of organic liquid fertilizer
Castor seed meal (5-2-1)
Palm bunch ash (K$_2$O 28~30%)
Nutrient recycling from plant residuum
Weed control

- Mechanical weeding
- Hand weeding
- Mulch with leaves, pseudostems and weeds
Tractor weeding
Gas trimmer weeding
Disease and pest controls

- Deleafing
- Garlic-hot pepper-vinegar solution
- Emulsified oils + saponin (0.5%)
Materials for disease and pest controls
Vinegar solution with garlic and hot pepper
Power spraying
Virus-infected plants

BBTV infection

CMV infection
Uprooting of diseased plants immediately
Fusarium wilt-infected plants
Strategies

- Transplant no diseased suckers
- Remove above-ground portion of suckers horizontally
- Prohibit uprooting of diseased plants
- Sanitize desuckering tool frequently
Water management

- Apply 100 mm of water monthly
- Irrigate rhizosphere to a moist condition
- Maintain adequate soil water content (> - 0.3 bar) year round
- Use pipe irrigation to reduce leaf diseases, nutrient losses, spread of Fusarium wilt pathogen
Water supply
- Underground water
- Perforated PE pipe
- Twice a week
Perforated pipe irrigation
Plant and bunch protections

- Propping to support plant and bunch
- Early bagging of bunch
- Bagging bunch with kraft paper bag
- Strengthening mother plant by retaining more suckers during typhoon season
Propping
Plant protection against typhoon
Bunch protection
Advantages of kraft paper cover

- To prevent loss from sunburn
- To reduce uneven degreening
- To avoid infection of freckle disease
- Dust-free
Uneven degreening of banana
Kraft paper bag improves uneven degreening of banana
Sunburn
Harvest and post-harvest handling

Color strip for maturity control
**Maturity control**

| 白露 | 立秋 | 大暑 | 小暑 | 夏至 | 芒种 | 小满 | 立夏 | 青明 | 清明 | 霏雨 | 水立 | 春分 | 阳春 | 立春 | 大寒 | 小寒 | 大雪 | 小雪 | 立冬 | 霜降 | 寒露 | 秋分 | 季節 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 月    | 八月 | 七月 | 六月 | 五月 | 四月 | 三月 | 二月 | 一月 | 二月 | 三月 | 四月 | 五月 | 六月 | 七月 | 八月 | 九月 | 十月 | 十一月 | 十二月 | 一月 | 二月 | 三月 | 四月 |
| 上下 | 中上 | 上下 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 中上 | 上中 | 下中 | 中中 |

**表數日穫收至花開蕉香**
(南部蕉園適用)
Bunch moving
Water shower
Delataxing, weighing and packaging
Mobile packing facility
Pre-cooling
Sale volume of organic banana from TBRI
### Cultivation practices in organic and conventional banana production

<table>
<thead>
<tr>
<th>Cultivation Practices</th>
<th>Organic</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting layout</td>
<td>Single or double row with single follower</td>
<td>Single row with single follower</td>
</tr>
<tr>
<td>Soil management</td>
<td>Liming materials</td>
<td>None</td>
</tr>
<tr>
<td>Nutrient supply</td>
<td>Liquid fertilizer/Castor seed meal/Palm ash</td>
<td>Compound fertilizer (11-5.5-22),</td>
</tr>
<tr>
<td>Weed control</td>
<td>Mechanical weeding/Manual weeding/Dry leaf mulch</td>
<td>Paraquat/Gufosinate/Glyphosate</td>
</tr>
<tr>
<td>Disease control</td>
<td>Emulsified oils/GPV spray</td>
<td>Mancozeb/Propiconazole</td>
</tr>
<tr>
<td>Pest control</td>
<td>Emulsified oils/GPV spray</td>
<td>Chlorpyrifos/Deltamethrin/Phorate</td>
</tr>
<tr>
<td>Water supply</td>
<td>Underground water/Perforated pipe</td>
<td>Underground water/Perforated pipe</td>
</tr>
<tr>
<td>Bunch protection</td>
<td>Kraft paper bag</td>
<td>Kraft paper bag</td>
</tr>
<tr>
<td>Post-harvest handling</td>
<td>Washing/Packaging/Precooling</td>
<td>Packaging/Precooling</td>
</tr>
</tbody>
</table>

GPV-Garlic-hot pepper-vinegar
Conclusion

- Organic banana farming is an alternative to traditional banana farming
- Organic farming reduces loss from Fusarium wilt of banana
- Demand in organic banana is increasing in Taiwan
- Planting banana in organic way is worthy of promotion
Thank you