Potassium management in banana

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Introduction

- Banana is an important tropical and sub-tropical fruit
- Banana is a heavy K-consuming crop
- Guangdong is the most important banana-producing area in China
Fig Banana production in China 2004

- Fujian: 11.1%
- Guangdong: 47.7%
- Guangxi: 19.7%
- Hainan: 13.2%
- Yunnan: 7.0%
- Others: 1.2%
Fig Banana yield composition in China 2004

- Guangdong: 48.9%
- Guangxi: 19.3%
- Hainan: 15.4%
- Fujian: 13.8%
- Yunnan: 2.3%
- Others: 0.4%
Potassium management in banana

- Soil nutrient fertility of banana plantation in Guangdong
- Nutrient demand of banana
- Potassium application in banana
Soil nutrient fertility of banana plantation in Guangdong

Total 110 soil samples
Soil pH of banana plantation in Guangdong

<table>
<thead>
<tr>
<th>Soil pH</th>
<th>Sample percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;4.5</td>
<td>22</td>
</tr>
<tr>
<td>4.5-5.5</td>
<td>44</td>
</tr>
<tr>
<td>5.5-6.5</td>
<td>12.8</td>
</tr>
<tr>
<td>6.5-7.5</td>
<td>17.4</td>
</tr>
<tr>
<td>&gt;7.5</td>
<td>3.7</td>
</tr>
</tbody>
</table>
Soil organic matter and macroelement contents in banana plantation

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>CV(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM (g/kg)</td>
<td>4.6~32.7</td>
<td>17.6</td>
<td>33.1</td>
</tr>
<tr>
<td>Alkalined-N (mg/kg)</td>
<td>13.2~210.1</td>
<td>98.0</td>
<td>34.8</td>
</tr>
<tr>
<td>Avai. P$_2$O$_5$ (mg/kg)</td>
<td>10.5~666.6</td>
<td>189.7</td>
<td>77.0</td>
</tr>
<tr>
<td>Re.Avai. K$_2$O (mg/kg)</td>
<td>33.9~990.5</td>
<td>240.5</td>
<td>72.5</td>
</tr>
<tr>
<td>Sl.Avai. K$_2$O (mg/kg)</td>
<td>75.0~1648.6</td>
<td>596.6</td>
<td>52.1</td>
</tr>
</tbody>
</table>
Frequency of soil readily available K$_2$O in banana plantation
Frequency of soil slowly available K$_2$O in banana plantation

Slowly available K2O

Frequency

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## Soil secondary element contents in banana plantation (mg/kg)

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>CV(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avail. Ca</td>
<td>111.4~4578.0</td>
<td>1225.4</td>
<td>86.1</td>
</tr>
<tr>
<td>Avail. Mg</td>
<td>29.5~729.6</td>
<td>172.9</td>
<td>85.5</td>
</tr>
<tr>
<td>Avail. S</td>
<td>14.4~445.2</td>
<td>109.3</td>
<td>83.3</td>
</tr>
</tbody>
</table>
## Soil micro-element contents in banana plantation (mg/kg)

<table>
<thead>
<tr>
<th>Element</th>
<th>Range</th>
<th>Mean</th>
<th>CV(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avail.Fe</td>
<td>10.0~595.0</td>
<td>168.4</td>
<td>72.3</td>
</tr>
<tr>
<td>Avail.Mn</td>
<td>5.5~368.8</td>
<td>73.0</td>
<td>133.0</td>
</tr>
<tr>
<td>Avail.B</td>
<td>0.0~4.2</td>
<td>0.6</td>
<td>139.4</td>
</tr>
<tr>
<td>Avail.Zn</td>
<td>0.9~24.8</td>
<td>5.2</td>
<td>65.7</td>
</tr>
</tbody>
</table>
Nutrient demand of banana

- Changing trend of foliar nutrient contents
- Changing trend of foliar nutrient ratio
- Nutrient accumulation and distribution
- Nutrient uptake percentage at various growth stages
- Nutrient demand of various varieties
Foliar nutrient contents of banana at various growth stages

Vegetative growth
Flower differentiation
Bud emergence
Early fruit developing
Late fruit developing
Maturing

N

0.0
1.0
2.0
3.0
4.0
Foliar nutrient contents of banana at various growth stages

- Vegetative growth
- Flower differentiation
- Bud emergence
- Early fruit developing
- Late fruit developing
- Maturing

Graph showing the nutrient contents (N and K) at different growth stages.
Foliar nutrient contents of banana at various growth stages

- Vegetative growth
- Flower differentiation
- Bud emergence
- Early fruit developing
- Late fruit developing
- Maturing

- N
- K
- Ca
Foliar nutrient contents of banana at various growth stages

![Graph showing foliar nutrient contents of banana at different growth stages]

- N
- K
- Ca
- Mg
Foliar nutrient contents of banana at various growth stages

![Graph showing nutrient contents of banana at different growth stages. The x-axis represents different growth stages: vegetative growth, flower differentiation, bud emergence, early fruit developing, and late fruit developing. The y-axis represents nutrient content. The nutrients shown are N, P, K, Ca, Mg, and S.](image-url)
Ratio of foliar nutrient content at various growth stages

![Graph showing the ratio of foliar nutrient content at different growth stages. The x-axis represents the growth stages: Vegetative growth, Flower differentiation, Bud emergence, Early fruit developing, Late fruit developing, Maturing. The y-axis represents the ratio of nutrient content. The graph shows peaks and valleys for different nutrient ratios, such as N/K, N/Ca, N/Mg, K/Mg, K/Ca, Ca/Mg.]
Nutrient uptake rate of Baxi banana

To produce 1t fruit, banana demands:

- 15.0kg K
- 4.59kg N
- 2.52kg Ca
- 1.22kg Mg
- 0.40kg S
- 0.41kg P
- 48.51g Mn
- 34.86g Fe
- 7.26g Zn
- 3.81g B
Nutrient demand at various growth stages

Nutrient uptake percentage

- After blossoming
- Bud developing
- Vegetative growth

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>After blossoming</th>
<th>Bud developing</th>
<th>Vegetative growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>19.3</td>
<td>40.5</td>
<td>16.5</td>
</tr>
<tr>
<td>P2O5</td>
<td>17.8</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>K2O</td>
<td>16.5</td>
<td>52.6</td>
<td></td>
</tr>
</tbody>
</table>

Nutrient ratios:
- 1:0.22:3.28
- 1:0.25:4.44
- 1:0.22:3.84
Nutrient distribution in banana plant

- Leaf: 24.4%
- Petiole: 8.2%
- Pseudo stem: 20.6%
- Bunch axle: 1.9%
- Peel: 9.3%
- Pulp: 27.4%
- Corm: 8.2%
Nutrient distribution in banana plant

- Pseudostem: 34.3%
- Pulp: 12.5%
- Leaf: 10.3%
- Petiole: 12.2%
- Peel: 13.6%
- Bunch axle: 7.3%
- Corm
Nutrient distribution in banana plant

Nutrient Distribution:
- Petiole: 29.5%
- Leaf: 26.3%
- Pulp: 30.8%
- Corm: 5.2%
- Peel: 3.8%
- Bunch axle: 1.5%
- Pseudostem: 30.8%

Nutrient Composition:
- Ca
Nutrient distribution in banana plant

- Corm: 15.6%
- Leaf: 19.9%
- Petiole: 15.4%
- Pseudostem: 31.4%
- Bunch axle: 0.9%
- Peel: 3.7%
- Pulp: 13.2%
Nutrient removed by bunch

- 54.8% P
- 38.6% N
- 33.4% K
- 31.5% S
- 17.8% Mg
- 8.0% Ca
N-deficiency decreases the yield by 40~55%
P-deficiency decreases the yield by 34~43%
K-deficiency alters the yield by -17%~+8%
<table>
<thead>
<tr>
<th>Variety</th>
<th>Rate*</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhongba</td>
<td>5.89</td>
<td>0.47</td>
<td>18.77</td>
</tr>
<tr>
<td>Ratio</td>
<td>1</td>
<td>0.08</td>
<td>3.19</td>
</tr>
<tr>
<td>Dwarf</td>
<td>5.93</td>
<td>0.48</td>
<td>18.07</td>
</tr>
<tr>
<td>Ratio</td>
<td>1</td>
<td>0.08</td>
<td>3.05</td>
</tr>
<tr>
<td>Dwarf Dundilei</td>
<td>4.84</td>
<td>0.45</td>
<td>14.9</td>
</tr>
<tr>
<td>Ratio</td>
<td>1</td>
<td>0.09</td>
<td>3.08</td>
</tr>
<tr>
<td>Baxi</td>
<td>4.59</td>
<td>0.41</td>
<td>15.0</td>
</tr>
<tr>
<td>Ratio</td>
<td>1</td>
<td>0.09</td>
<td>3.27</td>
</tr>
</tbody>
</table>
Potassium application in banana

- Suitable application ratio of K and N fertilizer
- Combination of K and Mg
- Split schedule of K fertilizer
Banana yield in treatments with various combinations of N and K fertilizer

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (t/ha)</th>
<th>Yield increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mother plant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₁K₁₁.₁₅</td>
<td>52.3a</td>
<td>—</td>
</tr>
<tr>
<td>N₁K₁.₄</td>
<td>49.9b</td>
<td>—4.5</td>
</tr>
<tr>
<td>N₁K₁.₇</td>
<td>51.1ab</td>
<td>—2.2</td>
</tr>
<tr>
<td><strong>Daughter plant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₁K₀.₈</td>
<td>65.3ab</td>
<td>—6.3</td>
</tr>
<tr>
<td>N₁K₁.₀</td>
<td>69.4a</td>
<td>—</td>
</tr>
<tr>
<td>N₁K₁.₂</td>
<td>61.0bc</td>
<td>—13.7</td>
</tr>
</tbody>
</table>
Balanced fertilization of K guided by soil avail. K\(_2\)O in banana plantation

<table>
<thead>
<tr>
<th>Soil avail. K (K(_2)O, mg/kg)</th>
<th>N rate (N, kg/ha)</th>
<th>K(_2)O/N ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>750~900</td>
<td>Mother plant</td>
</tr>
<tr>
<td>&gt;900</td>
<td>-</td>
<td>0.2~0.3</td>
</tr>
<tr>
<td>600~900</td>
<td>0.3~0.6</td>
<td>0.3~0.4</td>
</tr>
<tr>
<td>300~600</td>
<td>0.6~1.0</td>
<td>0.5~0.8</td>
</tr>
<tr>
<td>150~300</td>
<td>1.0~1.2</td>
<td>0.9~1.1</td>
</tr>
<tr>
<td>75~150</td>
<td>1.2~1.3</td>
<td>1.1~1.2</td>
</tr>
<tr>
<td>&lt;75</td>
<td>1.3~1.5</td>
<td>1.2~1.4</td>
</tr>
</tbody>
</table>
Combination of K and Mg fertilizer

- **Stover and Simonds:** Soil Mg/K ratio keeps 3.3
- **Turner:** Soil Mg/K ratio maintains 3.6
- **López and Solís:** Mg deficiency even in 6.26
- **López:** Soil Mg/K ratio stays 8.5~15.0
Mg addition to banana can’t increase or even decreases the yield while the soil Mg reach 291.6~319.1mg/L with Mg/K ratio of 2.21 or 6.87 in Pearl River delta.

Irrigation water in Pearl River delta contains Mg, Mg addition in this region is not necessary regardless of the soil Mg/K ratio.
Proper combinations of K and Mg increase banana yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (t/ha)</th>
<th>Yield increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>42.9ab</td>
<td>—</td>
</tr>
<tr>
<td>K1Mg1</td>
<td>44.9a</td>
<td>4.8</td>
</tr>
<tr>
<td>K1Mg2</td>
<td>43.3ab</td>
<td>1.0</td>
</tr>
<tr>
<td>K2</td>
<td>41.4b</td>
<td>−3.4</td>
</tr>
<tr>
<td>K2Mg2</td>
<td>45.2a</td>
<td>9.1</td>
</tr>
<tr>
<td>K2Mg3</td>
<td>43.9ab</td>
<td>6.0</td>
</tr>
</tbody>
</table>
Addition of 36~72kg Mg/ha in banana plantation of west Guangdong increases banana yield and help to improve the fruit’s quality.

- Mg addition has great influence to foliar K and Ca, but no obvious rule is observed among them.
- K, Ca and Mg should be considered together in future potassium management in banana.
Split schedule of K fertilizer

Total K$_2$O application rate is divided into:

- Vegetative growth: 20%~25%
- Flower bud differentiation to flower emergence: 45%~50%
- After blossoming: 25%~35%
Split schedule of K fertilizer

Proper K$_2$O/N ratio of K over N fertilizer:

- Vegetative growth: 0.7~0.8
- Flower bud differentiation to flower emergence: 1.2~1.4
- After blossoming: 1.0~1.2
Thanks for your attention!