Effect of Potassium on Quality and Storage life of Fruit Crops

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WHAT IS QUALITY?

-the degree of excellence or superiority, is a combination of attributes, properties, or characteristics that give each commodity value in terms of its intended use
QUALITY COMPONENTS

A) APPEARANCE (VISUAL) QUALITY FACTORS
- Size
- Shape
- Colour
- Gloss
- Defects and Decay

B) TEXTURAL (FEEL) QUALITY FACTORS
- Firmness
- Crispiness
- Juiciness
- Mealiness
- Toughness

C) FLAVOUR (EATING) QUALITY FACTORS
- Sweetness
- Sourness (Acidity)
- Astringency
- Bitterness
- Aroma
- Off-flavours

D) NUTRITIONAL QUALITY FACTORS
- Vitamins (C, A, B, Thiamine, Niacin)
- Minerals
- Dietary Fibre
- Fat
- Oil
- Carotenoids
- Flavonoids
- Sterols
- Antioxidants
Potassium is referred as the quality element for crop production.

Involvement of potassium in physiological processes relevant to crop quality

- activates more than 60 enzyme systems
- aids in photosynthesis
- favours high energy status
- maintains cell turgour
- regulates opening of leaf stomata
- promotes water uptake
- regulates nutrients translocation in plant
- favours carbohydrate transport
- enhances N uptake and protein synthesis
- promotes starch synthesis
Multiple functions of K in many metabolic processes lead to numerous positive effects.

- Increase root growth
- Improve drought resistance
- Reduces water loss and wilting
- Enhances winter hardiness
- Improves resistance to pests and diseases
- Builds cellulose and reduces stalk lodging
- Increases nodulation of legumes.

The specific effect of K on quality are:

- Improves
  - fruit colour and flavour
  - size and shape
- Increases
  - protein content of plants
  - starch content in tubers
  - soluble solids, vitamin C
  - peel thickness
- Reduces
  - acidity
  - physiological disorder
  - incidence of pests & diseases
- Enhances
  - storage and shipping quality.
Fruit crops are heavy feeders of potash and removal of K is higher than N.

Nutrient removal by fruit crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield (t/ha)</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>Uptake (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>40</td>
<td>250</td>
<td>60</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Citrus</td>
<td>30</td>
<td>270</td>
<td>60</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Grapes</td>
<td>20</td>
<td>170</td>
<td>60</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Mango</td>
<td>15</td>
<td>100</td>
<td>25</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Papaya</td>
<td>50</td>
<td>90</td>
<td>25</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Pineapple</td>
<td>50</td>
<td>185</td>
<td>55</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Passion fruit</td>
<td>15</td>
<td>60</td>
<td>15</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

Direct relationship between K supply and

A) Fruit size:
- Citrus (Reese and Koo, 1975)
- Grape (Gopalaswamy and Rao, 1972)
- Banana (Mustaffa, 1988)
- Litchi (Mitra, 2006)
- Mango (Thakur et al., 1983)
- Guava (Mitra et al., 1985)

B) Colour:
- Citrus (Embleton, 1976)
- Grape (Bhargava et al., 1993)
- Apple (Sansavini, 2004)
- Litchi (Menzel, 1983)
- Banana (Turner, 1999)
C) Soluble solids:
- Citrus  (Chundwat et al., 1996)
- Banana  (Chattopadhyay and Bose, 1986, Kumar and Kumar 2007)
- Grape   (Bhargava et al., 1993)
- Guava   (Mitra, 1987, Kundu et al.;2007)
- Mango   (Singh et al., 1984, )
- Papaya  (Jauhari & Singh, 1987)
- Pineapple (Mitra and Roy, 1985)

D) Acidity :
- Citrus   (Ghosh, 1986)
- Grape    (Bhargava et al., 1993)
- Papaya   (Mitra, 2007)
- Guava    (Mitra, 1987)
- Mango    (Banik et al., 1993)
- Pineapple (Mitra and Roy, 1985)
- Banana   (Chattopadhyay and Bose, 1986)

E) Soluble solids:
- Citrus   (Singh & Tripathi, 1978)
- Guava    (Mitra, 1987, Kundu et al.;2007)
- Aonla    (Pathak et al., 2002)
- Banana   (Mustafa, 1988, Kumar and Kumar, 2007)
- Pineapple (Martin-Prevel, 1961, Quaggio et al.;2009)
- Papaya   (Awada and Long, 1987)

F) Storage life :
- Mango   (Shinde et al., 2006)
- Citrus   (Alva et al., 2006)
- Pineapple (Vis, 1989, Quaggio et al.;2009)
- Grape    (Vis, 1989, Bhargava, 2006)
- Banana   (Turner et al., 1999)
### Sulphate of potash foliar spray effects on yield, quality and post-harvest life of Neypoovan banana*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Bunch wt. (kg)</th>
<th>TSS (%)</th>
<th>Acidity (%)</th>
<th>Sugar: acid ratio</th>
<th>Shelf-life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water spray)</td>
<td>10.80</td>
<td>24.4</td>
<td>0.40</td>
<td>50.9</td>
<td>6.5</td>
</tr>
<tr>
<td>0.5% SOP</td>
<td>11.53</td>
<td>27.9</td>
<td>0.30</td>
<td>71.0</td>
<td>7.8</td>
</tr>
<tr>
<td>1.0% SOP</td>
<td>12.63</td>
<td>28.9</td>
<td>0.23</td>
<td>84.3</td>
<td>7.8</td>
</tr>
<tr>
<td>1.5% SOP</td>
<td>14.27</td>
<td>28.9</td>
<td>0.23</td>
<td>976</td>
<td>8.7</td>
</tr>
</tbody>
</table>

* Kumar and Kumar (2007)
  * Sprayed twice, initially after the opening of last hand (7th month after planting) and 30 days later

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### Effect of KCl spray on ‘Sardar’ guava

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fruit weight (g)</th>
<th>TSS (%)</th>
<th>Acidity (%)</th>
<th>Ascorbic acid (mg 100g⁻¹ pulp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water spray)</td>
<td>133.0</td>
<td>11.28</td>
<td>0.296</td>
<td>237.4</td>
</tr>
<tr>
<td>1.0% KCl</td>
<td>136.7</td>
<td>11.52</td>
<td>0.326</td>
<td>239.9</td>
</tr>
<tr>
<td>2.0% KCl</td>
<td>141.8</td>
<td>11.66</td>
<td>0.338</td>
<td>242.4</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>5.61</td>
<td>0.144</td>
<td>0.009</td>
<td>1.543</td>
</tr>
</tbody>
</table>

* Kundu *et al.* (2007)
  * Two spray – May 10th and September 10th.

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### Post-harvest behaviour of pineapple affected by sources of potassium*

<table>
<thead>
<tr>
<th>Source of K</th>
<th>TSS °Brix</th>
<th>Acidity (%)</th>
<th>Firmness (Neuton)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AT HARVEST</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KCl</td>
<td>15.5</td>
<td>0.55</td>
<td>11.7</td>
</tr>
<tr>
<td>K₂SO₄</td>
<td>15.1</td>
<td>0.50</td>
<td>12.7</td>
</tr>
<tr>
<td>K₂SO₄ + KCl</td>
<td>15.4</td>
<td>0.53</td>
<td>13.9</td>
</tr>
<tr>
<td><strong>28 days of STORAGE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KCl</td>
<td>14.7</td>
<td>0.67</td>
<td>8.5</td>
</tr>
<tr>
<td>K₂SO₄</td>
<td>15.4</td>
<td>0.54</td>
<td>9.6</td>
</tr>
<tr>
<td>K₂SO₄ + KCl</td>
<td>15.5</td>
<td>0.59</td>
<td>8.0</td>
</tr>
</tbody>
</table>

* Quaggio et al. (2009)

- Total soluble solids of the smooth Cayenne pineapple fruit pulp varied significantly as a function K rates.
- Total titratable acidity increased in response to K application, especially with KCl.
- The use of K as sulphate resulted better fruit sugar acid ratio, especially at higher K rates.
- Post-harvest characteristics of fruits were more affected by K rates than by K sources.
Increased leaf-K content increased yield and improved fruit quality in litchi*

<table>
<thead>
<tr>
<th>K-rates</th>
<th>Leaf K content (%)</th>
<th>Photosynthesis (µmol CO₂/sq/m/sec)</th>
<th>Water use efficiency (mmol/mol)</th>
<th>Yield (kg/tree)</th>
<th>TSS/acid ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-400 tree⁻¹ year⁻¹</td>
<td>0.95</td>
<td>8.78</td>
<td>20.43</td>
<td>77.3</td>
<td>38.7</td>
</tr>
<tr>
<td>K-600 tree⁻¹ year⁻¹</td>
<td>0.89</td>
<td>5.86</td>
<td>17.47</td>
<td>79.6</td>
<td>48.2</td>
</tr>
<tr>
<td>K-800 tree⁻¹ year⁻¹</td>
<td>1.00</td>
<td>12.19</td>
<td>26.45</td>
<td>78.9</td>
<td>62.1</td>
</tr>
<tr>
<td>SEm±</td>
<td>0.014</td>
<td>0.798</td>
<td>1.41</td>
<td>3.72</td>
<td>2.93</td>
</tr>
</tbody>
</table>

Pathak *et al.* (2007)

Research results from BCKV:

<table>
<thead>
<tr>
<th>K levels (g/plant/year)</th>
<th>Mango (Fazli) 35 years</th>
<th>Banana (Gaint Governor)</th>
<th>Pineapple (Kew) 64,000/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 → 1000g</td>
<td>Fruit weight (g) : 595 → 748 Total sugar (%) : 12.0 → 12.5 (Mallick <em>et al.</em>, 1985)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 → 240g</td>
<td>Fruit weight (g) : 117 → 139 Total sugar (%) : 14.6 → 16.7 (Chattopadhyay and Bose, 1985)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 → 600kg</td>
<td>Fruit weight (kg) : 1.4 → 1.9 Total sugar (%) : 12.8 → 15.2 (Roy <em>et al.</em>, 1987)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Summary

1. Potassium is important in optimizing both crop yield and economic quality.
2. Tree fruit crops, in general require more potassium than nitrogen.
3. The role of potassium in fruit quality has been well documented in many fruits, vegetables, and ornamentals.
4. A balanced nutrition programme allows K to contribute its best towards higher yield, quality, and profitability.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Age</th>
<th>Fruit weight (g)</th>
<th>Fruit weight (kg)</th>
<th>Total sugar (%)</th>
<th>Total sugar (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litchi (Bombai)</td>
<td>22 yrs</td>
<td>200 → 600g</td>
<td></td>
<td>18.1 → 20.6</td>
<td>13.9 → 15.8</td>
</tr>
<tr>
<td>Guava (Sardar)</td>
<td>4 yrs</td>
<td>130 → 260g</td>
<td></td>
<td>152 → 176</td>
<td>7.93 → 8.72</td>
</tr>
<tr>
<td>Papaya (Ranchi)</td>
<td>2500/ha</td>
<td>200 → 600kg</td>
<td></td>
<td>1.42 → 1.64</td>
<td>5.07 → 6.80</td>
</tr>
<tr>
<td>Mandarin orange</td>
<td>22 yrs</td>
<td>200 → 600g</td>
<td></td>
<td>84 → 107</td>
<td>8.3 → 9.8</td>
</tr>
</tbody>
</table>
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