Multi-K®
Potassium Nitrate Products
For Healthy Crops
Contents

- Potassium in the plant
- Multi-K® and its advantages
- Nutrigation™ with Multi-K®
- Foliar nutrition with Haifa Bonus
- Multi-K® properties
- Multi-K® products
- Potassium in the soil
Pioneering Solutions

Haifa’s Specialty Fertilizer Promise Farmers

Enhanced Plant Development

Maximum Nutrient Efficiency

Minimal Environmental Impact
Potassium in the Plant
# Plant Nutrients

**Macro nutrients:**
- **N** (Nitrogen), **P** (Phosphorus), **K** (Potassium)

**Secondary nutrients:**
- **Ca** (Calcium), **Mg** (Magnesium), **S** (Sulfur)

**Micro nutrients:**
- **Fe** (Iron), **Cu** (Copper), **Zn** (Zinc), **B** (Boron), **Mn** (Manganese), **Mo** (Molybdenum), **Cl** (Chloride)
Potassium (K) in the plant

- Necessary for formation of sugars and starch
- Activator of enzymatic reaction
- Maintains turgor
- Regulates opening of leaf stomata
- Build cell walls
Potassium (K) in the plant

Due to its roles in many plant systems, potassium improves plant durability and improves yield quality:

- Improved drought resistance
- Increased winter hardiness
- Better disease resistance
- Improved yield quality
- Longer storage life
Potassium composition of tomato plant

- N 28%
- P\textsubscript{2}O\textsubscript{5} 4%
- MgO 8%
- CaO 28%
- K\textsubscript{2}O 39%
The tomato fruit contains:
up to 82% of total plant K
up to 63% of total plant P
(Source: Atherton and Rudich, 1986)
Relation between K in petiols and sugar content in Sugar-Beet
What is Multi-K®?
What is Multi-K®?

Potassium

Nitrate

K⁺

NO₃⁻

13

46
Nitrate facilitates uptake and improves absorption potassium by the plant.

Advantages: synergistic effect
Advantages: efficient N source

All the nitrogen in Multi-K® is the form of Nitrate (NO$_3^-$)
Advantages: pure plant nutrients

Multi-K® consists of plant nutrients only:

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13%</td>
<td>0%</td>
<td>46%</td>
</tr>
</tbody>
</table>

13% N = 62% NO$_3^-$
46% K$_2$O = 38% K

Total: 100% KNO$_3$
Advantages: free of harmful elements

Multi-K® is free of chloride, sodium and any other harmful elements for the plant
Chloride: the hidden enemy

The effect of chloride concentration in plant tissue on top dry weight:
Multi-K® helps reversing the adverse effects of chloride

Application of nitrate reverses the process of chloride accumulation in the plant tissues.

Source: Kafkafi, Valoras and Letey
Advantages: High solubility

Multi-K is fully soluble in water, safe for Nutrigation through all irrigation systems.
Advantages: High solubility

Multi-K® is more soluble than other chloride-free potassium fertilizers
Advantages: application methods

Multi-K® products suit highly-efficient application methods:

- Nutrigation™
- Foliar application
- Side-dressing

These methods enable matching nutrient supply to plant dynamic needs
Dynamics of Nutrient Uptake

Annual uptake….

… is not consumed at once

The charts show nutritional requirements of tomatoes (grams per plant)
Left: total for the season. Right: weekly consumption.
Nutrigation™ with Multi-K®
# Nutrigration™ with Multi-K® in tomatoes

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop requirements kg/ha</strong></td>
<td>300</td>
<td>60</td>
<td>550</td>
</tr>
<tr>
<td><strong>Correction factor soil application</strong></td>
<td>1.2-1.25</td>
<td>1.9-2.2</td>
<td>1.4-1.6</td>
</tr>
<tr>
<td><strong>Correction factor Nutrigration</strong></td>
<td>1.1-1.2</td>
<td>1.6-1.9</td>
<td>1.2-1.4</td>
</tr>
<tr>
<td><strong>Corrected requirements</strong></td>
<td>330</td>
<td>100</td>
<td>650</td>
</tr>
<tr>
<td><strong>Nutrient level in the soil</strong></td>
<td>20 ppm</td>
<td>150 kg/ha</td>
<td></td>
</tr>
<tr>
<td><strong>Balance to apply</strong></td>
<td>330</td>
<td>100</td>
<td>500</td>
</tr>
</tbody>
</table>
Nutrigation™ with Multi-K® in tomatoes

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required rate kg/ha:</td>
<td>330</td>
<td>100</td>
<td>500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>30%</th>
<th>50%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-dressing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kg/ha</td>
<td>100</td>
<td>50</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>70%</th>
<th>50%</th>
<th>70%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kg/ha</td>
<td>230</td>
<td>50</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>
## Nutrigation™ with Multi-K® in tomatoes

### A. Base-Dressing

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application rate kg/ha:</strong></td>
<td>100</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>AS</td>
<td>TSP</td>
<td>SOP</td>
</tr>
<tr>
<td><strong>Composition kg/ha</strong></td>
<td>21-0-0</td>
<td>0-46-0</td>
<td>0-0-50</td>
</tr>
<tr>
<td></td>
<td>480</td>
<td>110</td>
<td>300</td>
</tr>
</tbody>
</table>
## Nutrigation™ with Multi-K® in tomatoes

### B. Nutrigation

<table>
<thead>
<tr>
<th>Growth phase</th>
<th>N:P₂O₅:K₂O ratio</th>
<th>kg/ha/day</th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N:P₂O₅:K₂O</td>
<td>N: P₂O₅: K₂O</td>
<td>days</td>
<td>N: P₂O₅: K₂O</td>
</tr>
<tr>
<td>Planting to flowering</td>
<td>1:1:1</td>
<td>1.0:1.0:1.0</td>
<td>30</td>
<td>30:30:30</td>
</tr>
<tr>
<td>Flowering to fruit-set</td>
<td>2:0.4:3</td>
<td>4.0:0.8:6.0</td>
<td>25</td>
<td>100:20:150</td>
</tr>
<tr>
<td>Fruit-set to ripening</td>
<td>1:0:2</td>
<td>3.0:0:6.0</td>
<td>20</td>
<td>60:0:120</td>
</tr>
<tr>
<td>Fruit ripening to harvest</td>
<td>2:0:3</td>
<td>1.3:0:1.7</td>
<td>30</td>
<td>40:0:50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>230:50:350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>%</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>70%</td>
<td>70%</td>
<td>50%</td>
<td>70%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>kg/ha</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>230</td>
<td>50</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>
### Nutrigation™ with Multi-K® in tomatoes

#### Detailed Nutrigation program

<table>
<thead>
<tr>
<th>Growth phase</th>
<th>Fertilizers</th>
<th>Ratio</th>
<th>kg/ha/day</th>
<th>kg/ha/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>P₂O₅</td>
<td>K₂O</td>
</tr>
<tr>
<td>Planting to flowering</td>
<td>Multi-K®</td>
<td>30</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Haifa MAP</td>
<td>12</td>
<td>61</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>A.N.</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Flowering to fruit-set</td>
<td>Multi-K®</td>
<td>12</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Haifa MAP</td>
<td>12</td>
<td>61</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>A.N.</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2</td>
<td>0.4</td>
<td>3</td>
</tr>
</tbody>
</table>
## Nutrigation™ with Multi-K® in tomatoes

### Detailed Nutrigation program

<table>
<thead>
<tr>
<th>Growth phase</th>
<th>Fertilizers</th>
<th>Ratio</th>
<th>kg/ha/day</th>
<th>kg/ha/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>P₂O₅</td>
<td>K₂O</td>
</tr>
<tr>
<td>Fruit-set to ripening</td>
<td>Multi-K®</td>
<td>13</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>A.N</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Urea</td>
<td>46</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Fruit ripening to harvest</td>
<td>Multi-K®</td>
<td>13</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>A.N</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Urea</td>
<td>46</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
Foliar Nutrition with Haifa Bonus
Haifa Bonus

- High-K foliar formulas
- Specially designed to allow for concentrated sprays
- Based on Multi-K® potassium nitrate
- Enriched with phosphorus
  - To enhance nutritional value
  - To keep pH at the optimal level for foliar absorption
  - For improved compatibility with pesticides
- Contains special adjuvant
  - For better adhesion to the leaf surface
  - For improved absorption
  - For prolonged action
1. Haifa Bonus is applied by foliar spray and forms droplets on the leaf
2. Portion of the fertilizer is absorbed immediately.
3. When the air gets hot and dry, the fertilizer droplets dry up and nutrient uptake temporarily discontinued.
4. At night, the dew re-dissolves the fertilizer and nutrient uptake is renewed.
Multi-K® Properties
# Water solubility

<table>
<thead>
<tr>
<th>Water temperature (°C)</th>
<th>g Multi-K® / liter water</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>139</td>
</tr>
<tr>
<td>10</td>
<td>212</td>
</tr>
<tr>
<td>20</td>
<td>316</td>
</tr>
<tr>
<td>30</td>
<td>453</td>
</tr>
<tr>
<td>40</td>
<td>613</td>
</tr>
</tbody>
</table>
## pH and EC

<table>
<thead>
<tr>
<th>Concentration (%)</th>
<th>pH</th>
<th>EC (mS/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>6.5</td>
<td>0.68</td>
</tr>
<tr>
<td>0.1</td>
<td>8.7</td>
<td>1.30</td>
</tr>
<tr>
<td>0.15</td>
<td>9.1</td>
<td>1.96</td>
</tr>
<tr>
<td>0.2</td>
<td>9.3</td>
<td>2.60</td>
</tr>
<tr>
<td>0.3</td>
<td>9.6</td>
<td>3.80</td>
</tr>
<tr>
<td>1.0</td>
<td>9.9</td>
<td>11.40</td>
</tr>
</tbody>
</table>
The effect of water temperature on solubility
Dissolution in water: the endothermic effect

![Graph showing temperature change over time with two phases: temperature drop and temperature rise.](image-url)
Multi-K® potassium nitrate

Complete range of potassium nitrate products

- Crystalline Products (Nutrigation, foliar application)
- Prills & Granules (side-dressing)
- Special Grades (greenhouses)
- Enriched formulas (+ P, Mg, B, Zn, S, Micronutrients)
Multi-K® potassium nitrate

- Multi-K® Classic
- Multi-K® GG
- Multi-K® pHast
- Multi-K® TOP
- Multi-npK®
- Multi-K® Mg
- Multi-K® Zn
- Multi-K® ME
- Multi-K® Prills
- Multi-npK® Prills
- Multi-K® Mg Prills
- Haifa Bonus
Multi-K Classic
Crystalline potassium nitrate

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N total</td>
<td>13.4%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>13.4%</td>
</tr>
<tr>
<td>K₂O</td>
<td>46.0%</td>
</tr>
<tr>
<td>K</td>
<td>38.1%</td>
</tr>
<tr>
<td>Insoluble matter</td>
<td>350 ppm</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1.0 g/cm³</td>
</tr>
</tbody>
</table>

Applications
- Nutrigation and foliar feeding of all crops
- Preparation of fertilizer blends
- Production of liquid fertilizers

Packaging
25, 50, 500 and 1000kg bags
**Multi-K GG**
Greenhouse-Grade potassium nitrate

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>N total</td>
<td>13.5%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>13.5%</td>
</tr>
<tr>
<td>K₂O</td>
<td>46.2%</td>
</tr>
<tr>
<td>K</td>
<td>38.4%</td>
</tr>
<tr>
<td>Insoluble matter</td>
<td>350 ppm</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1.1 g/cm³</td>
</tr>
</tbody>
</table>

**Applications**
- Nutrigation and foliar feeding of all crops
- Preparation of fertilizer blends
- Production of liquid fertilizers

**Packaging**
25, 50, 500 and 1000kg bags
## Multi-K pHast

**Low-pH potassium nitrate**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>N total</td>
<td>13.5%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>13.5%</td>
</tr>
<tr>
<td>K₂O</td>
<td>46.2%</td>
</tr>
<tr>
<td>K</td>
<td>38.4%</td>
</tr>
<tr>
<td>pH (10% soln.)</td>
<td>4.0</td>
</tr>
<tr>
<td>Insoluble matter</td>
<td>150 ppm</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1.0 g/cm³</td>
</tr>
</tbody>
</table>

### Applications

- Nutrigation and foliar feeding

### Packaging

- 25, 50, 500 and 1000kg bags
# Multi-K TOP
Top-Grade potassium nitrate

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N total</td>
<td>13.8%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>13.8%</td>
</tr>
<tr>
<td>K₂O</td>
<td>46.5%</td>
</tr>
<tr>
<td>K</td>
<td>38.6%</td>
</tr>
<tr>
<td>pH (10% soln.)</td>
<td>6.0-8.5</td>
</tr>
<tr>
<td>Insoluble matter</td>
<td>180 ppm</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1.0 g/cm³</td>
</tr>
</tbody>
</table>

## Applications
- Hydroponics
- Nutrigation of top-quality crops
- Preparation of fertilizer blends and nutrient solutions

## Packaging
- 25, 500 and 1000kg bags
Multi-npK
Potassium nitrate enriched with phosphorus

Available formulae
- 13-5-42
- 13-3-43
- 13-2-44

Applications
Nutrigation and foliar feeding of all crops

Packaging
25, 500 and 1000kg bags
Multi-K Mg
Potassium nitrate enriched with magnesium

Available formulae
- 12-0-43+2MgO
- 11-0-40+4MgO
- 12-2-43+1MgO
- 12-2-42+2MgO+0.5Mn
- 12-0-42+2MgO+0.2B

Applications
- Nutrigation and foliar feeding of all crops
- Favorable source of potassium for magnesium-consuming crops (e.g. potato, tobacco, bulbs)

Packaging
- 25, 50, 500 and 1000kg bags
Multi-K Zn
Potassium nitrate enriched with zinc

Available formulae
- 11-0-40+4Zn
- 12-0-43+2Zn

Applications
- Nutrigation and foliar feeding of all crops
- Prevention and curing of zinc deficiencies (e.g. in citrus and pecan)

Packaging
- 25, 500 and 1000kg bags
**Multi-K ME**

Potassium nitrate enriched with magnesium and micro-nutrients

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N total</td>
<td>12.0%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>12.0%</td>
</tr>
<tr>
<td>K₂O</td>
<td>43.0%</td>
</tr>
<tr>
<td>K</td>
<td>35.7%</td>
</tr>
<tr>
<td>MgO</td>
<td>1.0%</td>
</tr>
<tr>
<td>pH (10% soln.)</td>
<td>4.5-6.5</td>
</tr>
<tr>
<td>Insoluble matter</td>
<td>500 ppm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micro-Nutrients</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe*</td>
<td>1000 ppm</td>
</tr>
<tr>
<td>B</td>
<td>200 ppm</td>
</tr>
<tr>
<td>Zn*</td>
<td>140 ppm</td>
</tr>
<tr>
<td>Mn*</td>
<td>500 ppm</td>
</tr>
<tr>
<td>Mo</td>
<td>70 ppm</td>
</tr>
<tr>
<td>Cu*</td>
<td>110 ppm</td>
</tr>
</tbody>
</table>

* EDTA chelates

**Applications**

Nutrigation and foliar feeding of all crops

**Packaging**

25 kg bags
Multi-K Prills
Potassium nitrate prills

<table>
<thead>
<tr>
<th>Component</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>N total</td>
<td>13.2%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>13.2%</td>
</tr>
<tr>
<td>K₂O</td>
<td>46.0%</td>
</tr>
<tr>
<td>K</td>
<td>38.1%</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1.2 g/cm³</td>
</tr>
</tbody>
</table>

Applications
- Base-dressing and side-dressing of all crops
- Bulk-blending - production of granular NPK fertilizers

Packaging
- 25, 50, 500 and 1000kg bags
Multi-npK prills
Potassium nitrate enriched with phosphorus

Available formulae
13-3-43
13-2-44

Applications
- Base-dressing and side-dressing of all crops
- Bulk-blending- production of granular NPK fertilizers

Packaging
25, 50, 500 and 1000kg bags
Multi-K Mg prills
Potassium nitrate enriched with magnesium

Available formulae
- 12-0-42+2MgO
- 11-0-39+4MgO

Applications
- Base-dressing and side-dressing of all crops
- Favorable source of potassium for magnesium-consuming crops (e.g. potato, tobacco, bulbs)

Packaging
- 25, 50, 500 and 1000kg bags
Haifa Bonus

- High-K foliar formulas
- Specially designed to allow for concentrated sprays
- Based on Multi-K® potassium nitrate
- Enriched with phosphorus
  - To enhance nutritional value
  - To keep pH at the optimal level for foliar absorption
  - For improved compatibility with pesticides
- Contains special adjuvant
  - For better adhesion to the leaf surface
  - For improved absorption
  - For prolonged action
Potassium in the Soil
The 4 principal components of soil

- Water
- Organic matter
- Soil minerals
- Air
Forms of soil potassium

- Negatively-charged soil particle
- Mineral K – unavailable
- Fixed (non-exchangeable) K – unavailable
- Exchangeable K – absorbed to the surface of soil particles
- K in the soil solution
  Readily available for plant uptake
Typical distribution of K forms in the soil

Mineral K – unavailable

Exchangeable K – absorbed to the surface of soil particles

Fixed (non-exchangeable) K – unavailable

K in the soil solution

Readily available for plant uptake

90-95% of soil potassium is unavailable for plant uptake
Dynamics of soil potassium

- Plant uptake
- Fertilization
- Soil solution
- Exchangeable K
- Fixed K
- Mineral K
- Leaching

- Plant uptake
- Fertilization
- Soil solution
- Exchangeable K
- Fixed K
- Mineral K
- Leaching
Relative size of soil particles

Fine sand

Silt

Clay
Composition of soil mineral matter

Sandy loam
- Sand: 65%
- Silt: 25%
- Clay: 10%

Loam
- Sand: 33%
- Silt: 34%
- Clay: 33%
Potassium availability as a function of content and conc. of exchangeable potassium.
How potassium moves from soil to root

Most potassium reaches root by diffusion

$K^+$ travels only short distance: 7 mm or less

Roots contact only small proportion of the soil

$K^+$ supply near root may be depleted even in high K soil
Pioneering Solutions

Haifa’s Specialty Fertilizer Promise Farmers

Enhanced Plant Development

Maximum Nutrient Efficiency

Minimal Environmental Impact
Summary

Multi-K® is the ideal source of potassium (K) for plants:

- Enriches plant nutrition with nitrate-N
- Contains plant nutrients only
- Free of sodium and chloride
- Suitable for highly-efficient applications
  - Nutrigation™
  - Foliar nutrition (recommended to use Haifa Bonus)
  - Side-dressing
- Wide range of formulae to suit all crops and growth environments.
Thank You

Join-up our knowledge community
www.haifa-group.com/community