Foliar Nutrition with Haifa Products
Foliar Feeding

Foliar application of nutrients offers

- **Complementary fertilization** with high added value
- **Corrective nutrition** when deficiencies are noticed
- **Growth boosting** during critical stages of plant development
Complementary nutrition

Foliar application of nutrients complements soil application or Nutrigation:

- When root uptake is disturbed
  - Sub-optimal soil conditions
  - Diseases or nematodes
- When soil fertilization is inadequate
Corrective nutrition

Foliar uptake of nutrients is much faster than root uptake.

Foliar fertilization is recommended:
- When deficiency symptoms are noted
- When prompt correction of deficiencies is required
Growth boosting

Certain plant development stages are of higher importance in determining final yields.

Foliar application of nutrients during these critical stages will
- Increase yields
- Improve yield quality
The mechanism of foliar nutrition

Stages in foliar uptake of nutrients:

- **Penetration** through cuticle and epidermal cell wall

- **Translocation:**
  - **Cell-to-cell transport** by
    - Passive diffusion or mass flow through the water/fluids between cells (apoplastic movement)
    - Absorption of ions by the cytoplasm’s membrane surface (symplastic movement)
    - Active penetration into protoplast (symplastic movement).
  - Transport through **vascular channels**
    - Phloem (symplastic movement)
    - Xylem (apoplastic movement)
The mechanism of foliar nutrition
Penetration through cuticle and epidermal cell wall

No surfactant

- Hydrophobic surface wax

With surfactant – Lower surface tension, better wetting

- Cutin - external layer - weak negative charge
- Pectin - negative charge
- Cellulose

Epidermal cell
Penetration through cuticle and epidermal cell wall

**Cations:**
Preferred uptake due to electrical attraction to the negatively charged cell membranes and passive diffusion from high to low concentration.

**Anions:**
Only small quantity penetrates, because of rejection by negatively charged cell membrane.
Penetration through cuticle: temperature-dependence

Most solutes do not penetrate through open stomata

Uptake of ions is higher at night, when stomata are closed.
Passive diffusion: uptake is proportional to spray concentration

High concentration
10 g/l

Low concentration
2 g/L
Passive diffusion: uptake is proportional to spray concentration

Efficiency of uptake by passive diffusion improves
• As concentration of solute which can be applied to leaf surface without causing damage is higher
• As the time it remains active state on the leaf surface is longer
Ion absorption by the cytoplasm membrane surface

Scheme of cell-to-cell transport of ions

1. Diffusion / mass flow
2. Absorption by cytoplasm membrane surface
3. Active transport involving ATP
Ion absorption by the cytoplasm membrane surface

Scheme of cell-to-cell transport of ions

1. Diffusion / mass flow
2. Absorption by cytoplasm membrane surface
3. Active transport involving ATP
Transport through vascular channels

• Responsible for convection of nutrients to remote parts of the plant
• Symplastic movement – through phloem
• Apoplastic movement – through xylem
Transport through vascular channels

Phloem

- Companion cell
- Phloem sieve tube
- Sieve plate
Transport through vascular channels

Phloem (symplastic movement):
• Requires energy
• More suitable for cations
• Translocation of anions is very limited, as the cell wall is negatively charged.
• Movement regularly follows the ‘sink-source’ relationship
  Ions are transported from sites where carbohydrates are synthesized (‘source’ - mature leaves), to sites where they are consumed (‘sink’-fruits and growing regions in the roots and shoots).
**Transport through vascular channels**

**Xylem (apoplastic movement):**
- Regulated by the xylem flow.
- The driving force for this flow is water potential differences between soil, leaf and atmosphere.
Successful foliar fertilization

General

• Spray during the cooler and more humid times of the day
• Spray when wind is low
• Never spray plants under stress
• Test for possible side-effects or phytotoxicity by a small trial, spraying a week prior to the intended commercial treatments
• After spraying rinse thoroughly the sprayer and all its parts with fresh water
Successful foliar fertilization

Preparation of tank mix

• Fill $\frac{1}{4}$ - $\frac{1}{3}$ of the spray tank with water. Add the fertilizer(s) and then fill the tank with water.

• When preparing tank mix that includes pesticides, it is advisable:
  • To keep the pH of the spray solution at level of 5.5 - 6.5, to avoid alkaline hydrolysis of the pesticides.
  • To perform compatibility test of the spray-mix prior to large-scale treatment.
Successful foliar fertilization

Setting application rates

• Consider both spray concentration and spray volume.
• If you apply smaller (or larger) volume than recommended, increase (or decrease) the fertilizer concentration of the spray solution accordingly, to keep the total application rate per unit of area.
• Take care that the spray concentration is not too high, as concentrated spray solution may scorch leaves.
Successful foliar fertilization

Setting application rates (cont.)

• In general, effective foliar nutrition requires application rates of at least 20-40 kg Haifa-Bonus™ npK or Poly-Feed® Foliar per hectare per season.

• Plants in areas of humid climate tend to have thinner leaf cuticle, which make them more susceptible to phytotoxcity. For this reason, spray concentrations must be considered more cautiously in these areas.
Haifa’s foliar fertilizers

• Haifa Bonus™ npK
• Poly-Feed® Foliar NPK formulae
• Magnisal® magnesium nitrate
• Haifa MAP mono-ammonium phosphate
• Haifa MKP mono-potassium phosphate
• Haifa ProteK™ systemic PK fertilizer
• Haifa Micro® chelated micro-nutrient formulae
Haifa’s foliar fertilizers

**Haifa Bonus™ npK**

- Special formula, designed to allow for concentrated spray applications
- N-P₂O₅-K₂O composition: 13-2-44
- 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, improved absorption and prolonged action.
1. Haifa-Bonus™ npK is applied by foliar spray and forms droplets on the leaf
2. A portion of the fertilizer is absorbed immediately.
Haifa’s foliar fertilizers

How Haifa Bonus™ npK works

3. When the air gets hot and dry, the fertilizer droplets dry and nutrient uptake temporarily stops.
Haifa’s foliar fertilizers

How Haifa Bonus™ npK works

4. At night, the dew re-dissolves the fertilizer and nutrient uptake is renewed.
Haifa’s foliar fertilizers

Poly Feed® Foliar

• A line of NPK foliar formulae
• Contains high concentrations of micronutrients in the form of EDTA chelates.
• Designed to nourish crops with their exact needs during critical growth phases
  • Boosts yields
  • Improves quality
• Based on low-biuret urea
## Haifa’s foliar fertilizers

### Poly Feed® Foliar formulae

<table>
<thead>
<tr>
<th>Booster Type</th>
<th>Fe</th>
<th>Mn</th>
<th>Zn</th>
<th>Cu</th>
<th>Mo</th>
<th>B</th>
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<tbody>
<tr>
<td>Vegetative Booster 21-21-21</td>
<td>1300</td>
<td>660</td>
<td>200</td>
<td>140</td>
<td>90</td>
<td>200</td>
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<tr>
<td>Flowering Booster 8-52-17</td>
<td>500</td>
<td>250</td>
<td>75</td>
<td>55</td>
<td>35</td>
<td>100</td>
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<tr>
<td>Fruiting Booster 16-8-34</td>
<td>1200</td>
<td>600</td>
<td>180</td>
<td>130</td>
<td>80</td>
<td>200</td>
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## Haifa’s foliar fertilizers

### Poly Feed® Foliar formulae

<table>
<thead>
<tr>
<th></th>
<th>Micronutrients (ppm)</th>
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<tbody>
<tr>
<td></td>
<td>Fe</td>
</tr>
<tr>
<td>Poly-Wheat 23-7-23</td>
<td>1700</td>
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<tr>
<td>Poly-Potato 12-5-40</td>
<td>2000</td>
</tr>
<tr>
<td>Poly-Citrus 16-7-30+2MgO</td>
<td>1000</td>
</tr>
<tr>
<td>Poly-Olive 15-7-30+2MgO</td>
<td>1000</td>
</tr>
<tr>
<td>Poly-Rice 15-15-30</td>
<td>1000</td>
</tr>
<tr>
<td>Poly-Vineyard 4-15-37+3MgO</td>
<td>2300</td>
</tr>
<tr>
<td>Poly-Cotton 12-5-40</td>
<td>2000</td>
</tr>
<tr>
<td>Poly-Sugarbeet 15-7-30+2MgO</td>
<td>1000</td>
</tr>
</tbody>
</table>
Haifa’s foliar fertilizers

Poly Feed® MAR

• NPK formulae enriched with 0.5%-1% seaweed extracts, that contain
  • Nutrients
  • Growth bio-stimulants
  • Conditioners
• Enhances plant development
• Improves soil properties
Haifa’s foliar fertilizers

Magnisal®

• Magnesium nitrate formula, 11-0-0+16MgO
• Provides the magnesium required for healthy development
  • Component of the chlorophyll molecule
  • Essential for photosynthesis and formation of carbohydrates
  • Involved in enzymatic reactions
• Cures and prevents magnesium deficiencies
Haifa’s foliar fertilizers

Haifa MAP

• Fully water-soluble mono-ammonium phosphate 12-61-0
• Highly efficient source of phosphorus and nitrogen
• Recommended for use at the beginning of the growing season
  • P availability is crucial for the establishment of root system
• Double action:
  • Source of N and P nutrition
  • Stabilizing the pH of the spray solution at ~ 5.5, ideal for tank mixes that contain pesticides
Haifa’s foliar fertilizers

Haifa MKP

• Fully water-soluble mono-potassium phosphate 0-52-34
• Nitrogen-free source of phosphorus, ideal when N fertilization should be limited
• Helps increasing sugar contents of sugar-rich fruits
• Triple action
  • Source of N and P nutrition
  • Stabilizing the pH of the spray solution at ~ 5.5, ideal for tank mixes that contain pesticides
• Helps suppressing Powdery Mildew diseases
Haifa’s foliar fertilizers

Haifa ProteK™

- Systemic P-K fertilizer
- Contains phosphorus in the form of phosphite for better uptake
- Enhances vegetative growth and root development
- Increases fruit size and total yields.
- Improves resistance against various diseases
- Uniquely formulated as a crystalline product
- Recommended for: vineyards, citrus, avocado, mango, pomme-fruits, stone-fruits, melon, watermelon, cucumber, onion, pepper, tomatoes, strawberry, rose, chick-pea, maize and various herbs.
## Haifa’s foliar fertilizers

### Haifa ProteK™ Formulae

<table>
<thead>
<tr>
<th></th>
<th>Haifa ProteK™ Standard</th>
<th>Haifa ProteK™ Total</th>
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<tbody>
<tr>
<td>$\text{P}_2\text{O}_5$</td>
<td>26%</td>
<td>-</td>
</tr>
<tr>
<td>$\text{HPO}_3^{2-}$</td>
<td>30%</td>
<td>60%</td>
</tr>
<tr>
<td>$\text{K}_2\text{O}$</td>
<td>37%</td>
<td>39%</td>
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<tr>
<td>$\text{K}$</td>
<td>30.7%</td>
<td>32.4%</td>
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<tr>
<td>pH (1% solution)</td>
<td>4.5-5</td>
<td>4-4.5</td>
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<tr>
<td>Bulk density</td>
<td>0.95 g/cm³</td>
<td>0.8 g/cm³</td>
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Haifa’s foliar fertilizers

Haifa Micro®

• A line of water-soluble chelated micronutrients.
• Micronutrients are highly stable and readily available for plants
• Dissolve rapidly and completely, no risk of clogging of spray nozzles.
## Haifa’s foliar fertilizers

### Haifa Micro® formulae for foliar application

<table>
<thead>
<tr>
<th>Formula</th>
<th>Composition</th>
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<tbody>
<tr>
<td>Multi-Micro® Fe</td>
<td>Iron-EDTA 13%</td>
</tr>
<tr>
<td>Multi-Micro® Mn</td>
<td>Manganese-EDTA 13%</td>
</tr>
<tr>
<td>Multi-Micro® Zn</td>
<td>Zinc-EDTA 14%</td>
</tr>
<tr>
<td>Multi-Micro® Cu</td>
<td>Copper-EDTA 14%</td>
</tr>
<tr>
<td>Multi-Micro® Comb</td>
<td>7.1% Fe, 3.48% Mn, 1.02% Zn, 0.76% Cu, All as EDTA chelates 0.485% Mo as ammonium molybdate</td>
</tr>
</tbody>
</table>