

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

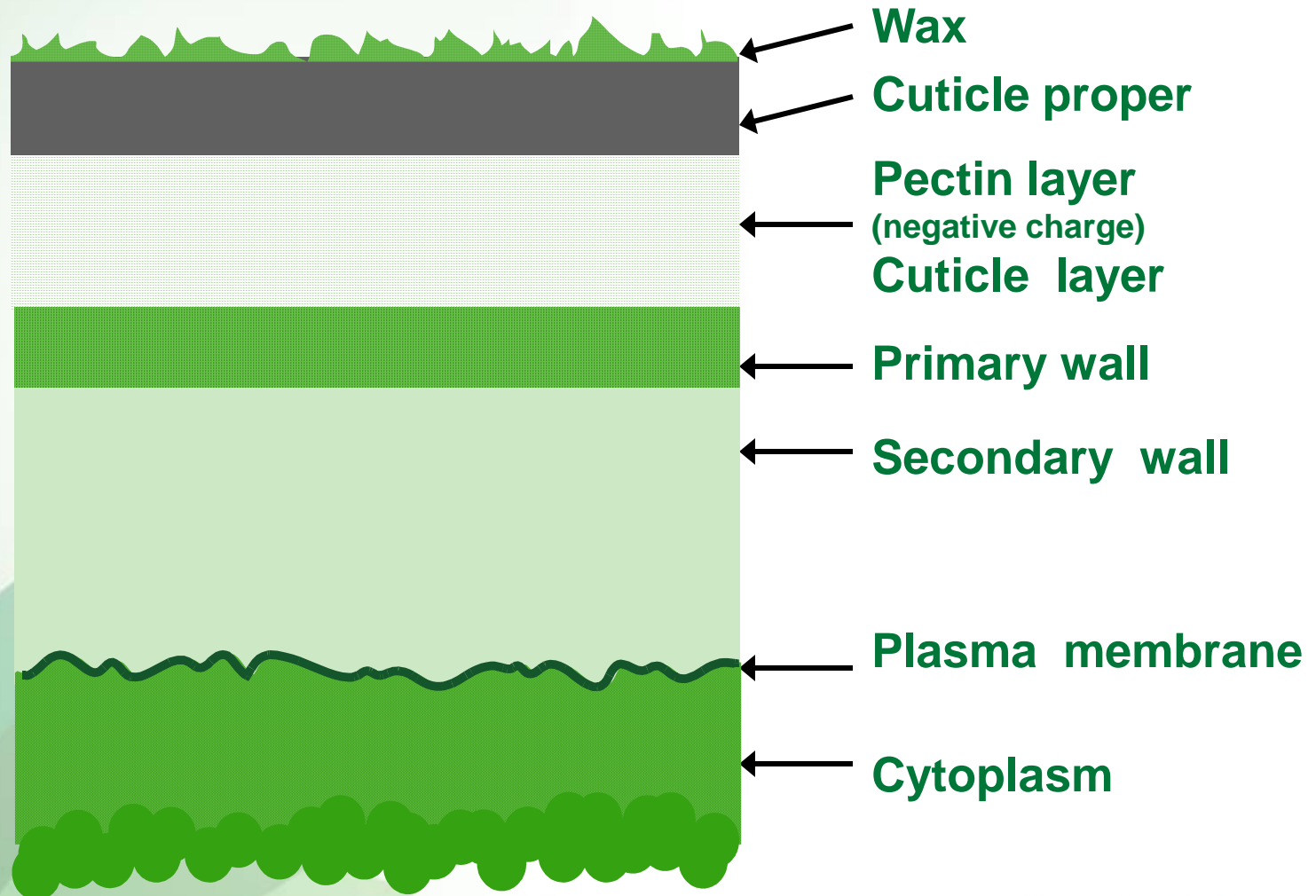
The mechanism of foliar nutrition

Stages in foliar uptake of nutrients:

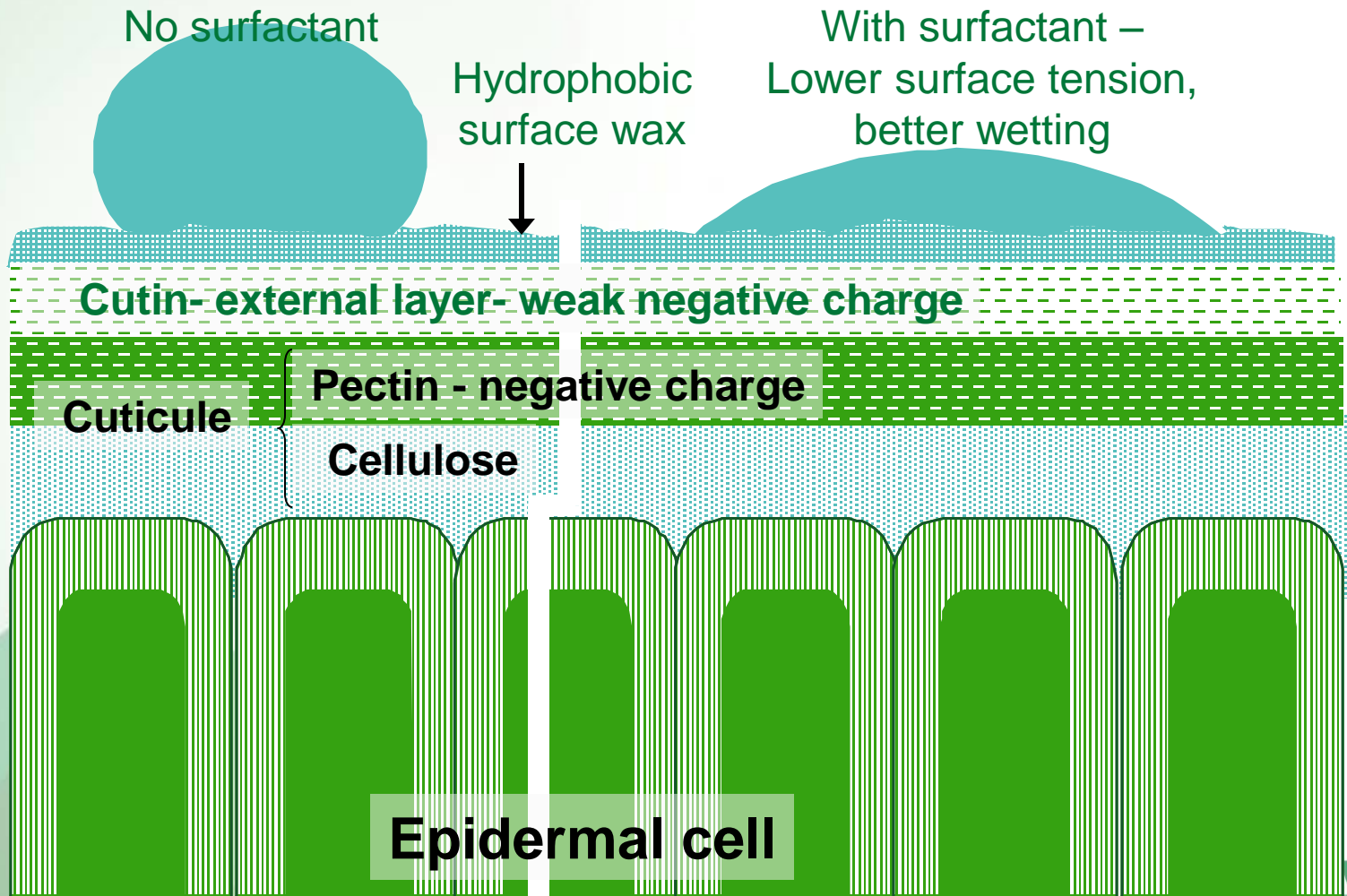
- **Penetration** through cuticle and epidermal cell wall
- **Translocation:**
 - **Cell-to-cell transport by**
 - Passive diffusion or mass flow through the water/fluids between cells (apoplastic movement)
 - Absorption of ions by the cytoplasm's membrane surface (symplastic movement)
 - Active penetration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

The mechanism of foliar nutrition

Scheme of the outer wall of a leaf epidermal cell



Penetration through cuticle and epidermal cell wall



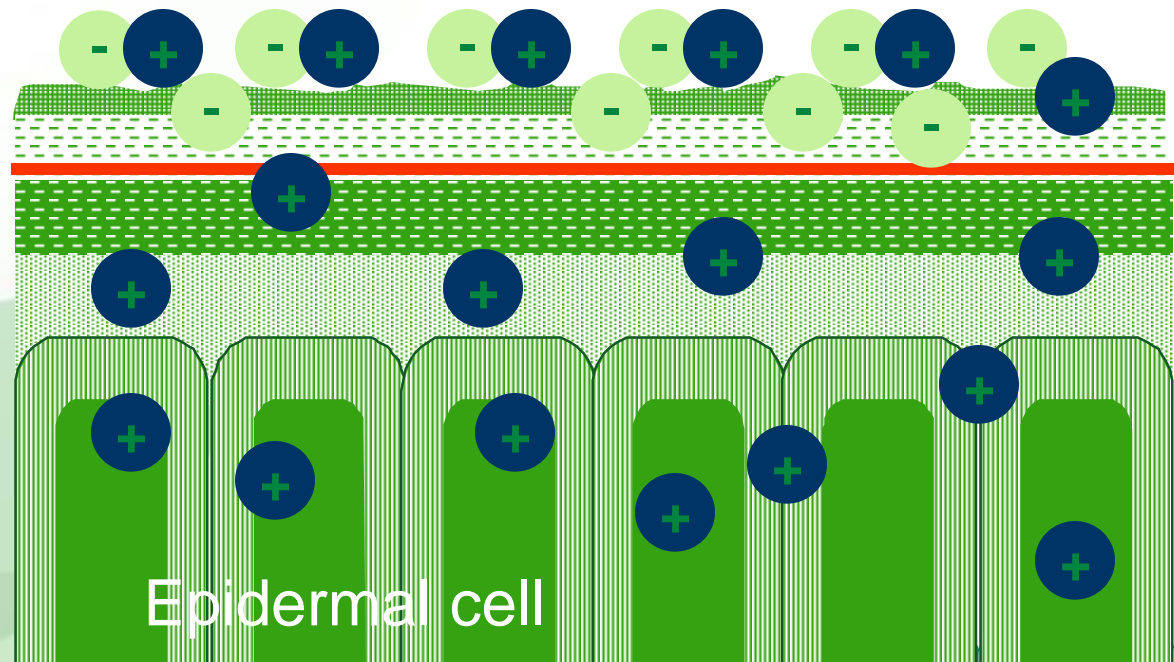
Penetration through cuticle and epidermal cell wall

Cations:

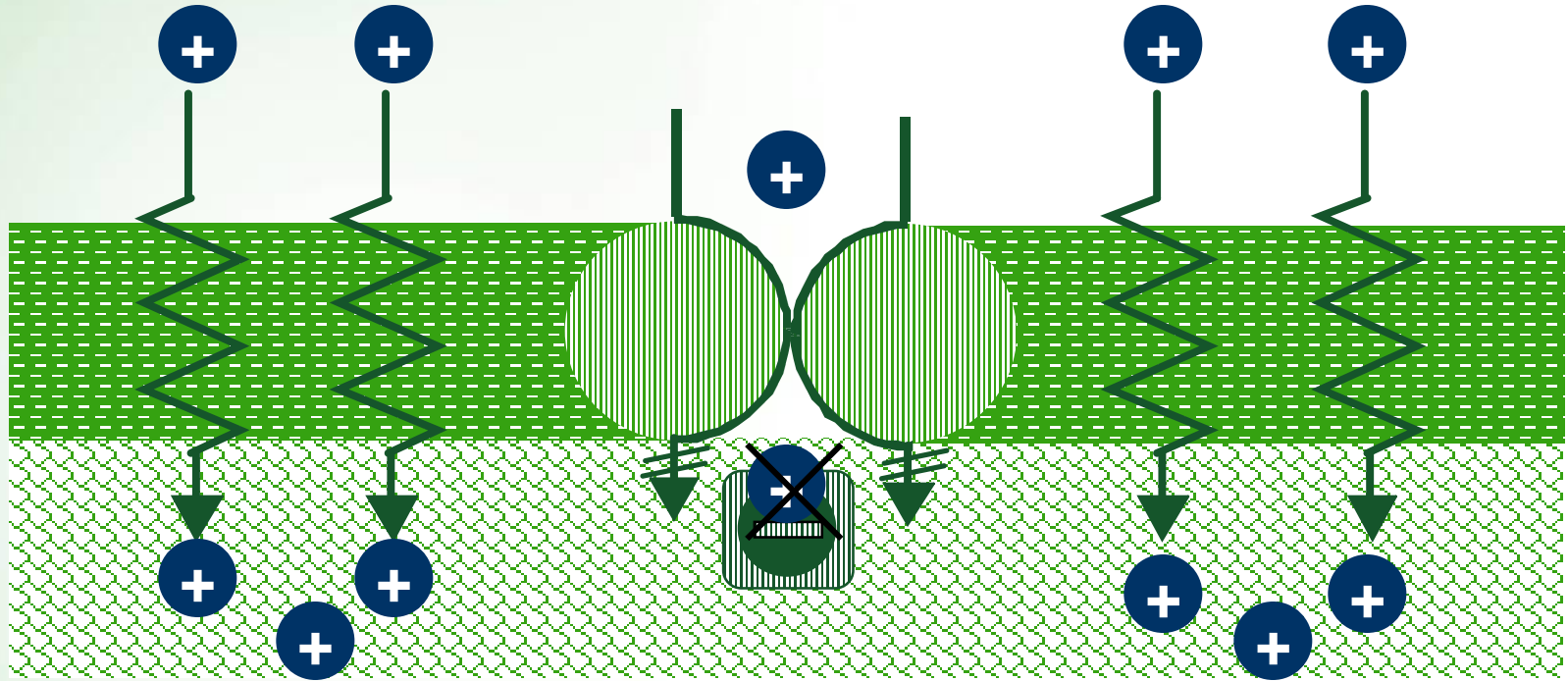
Preferred uptake due to electrical attraction to the negatively charged cell membranes and passive diffusion from high to low concentration.

Anions:

Only small quantity penetrates, because of rejection by negatively charged cell membrane



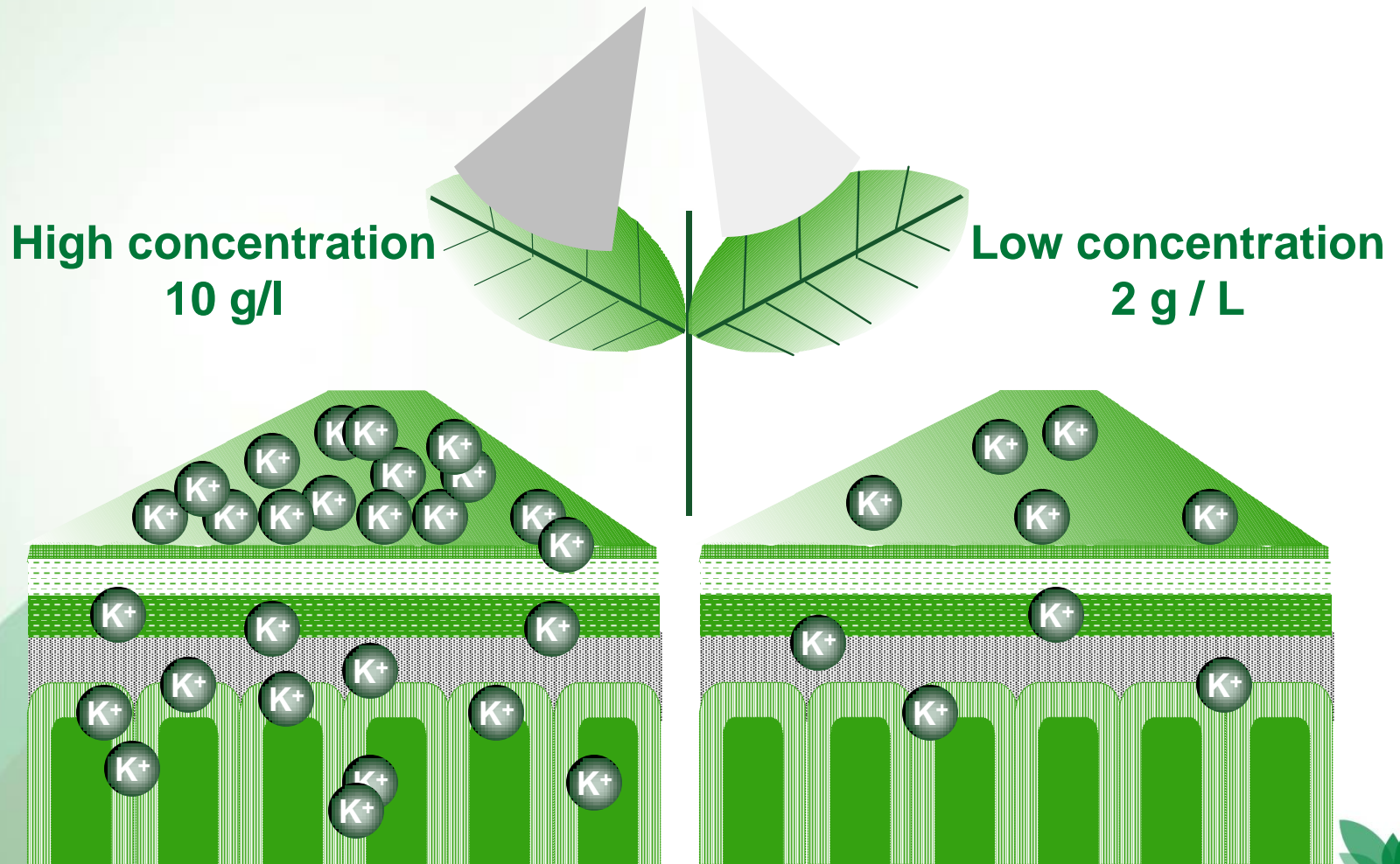
Penetration through cuticle: temperature-dependence



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



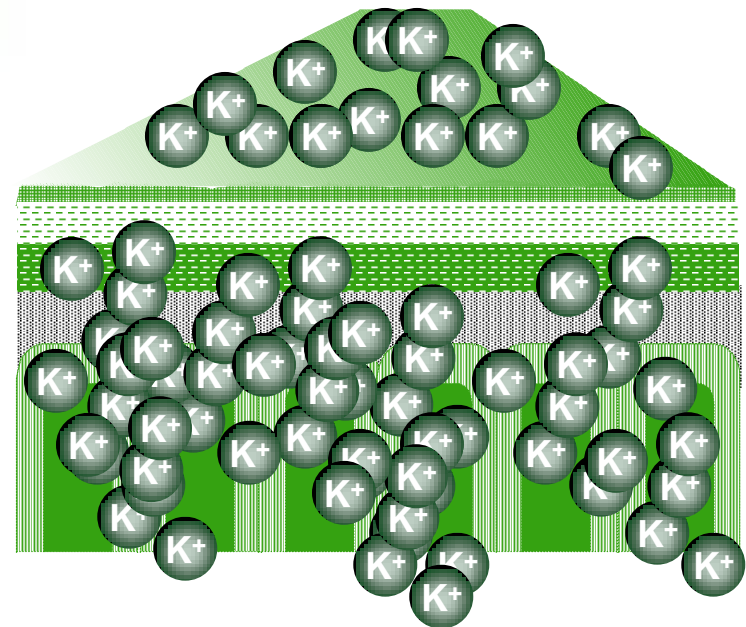
Passive diffusion: uptake is proportional to spray concentration

Passive diffusion is responsible for most of the penetration.

The rate of diffusion across a membrane is proportional to the concentration gradient.

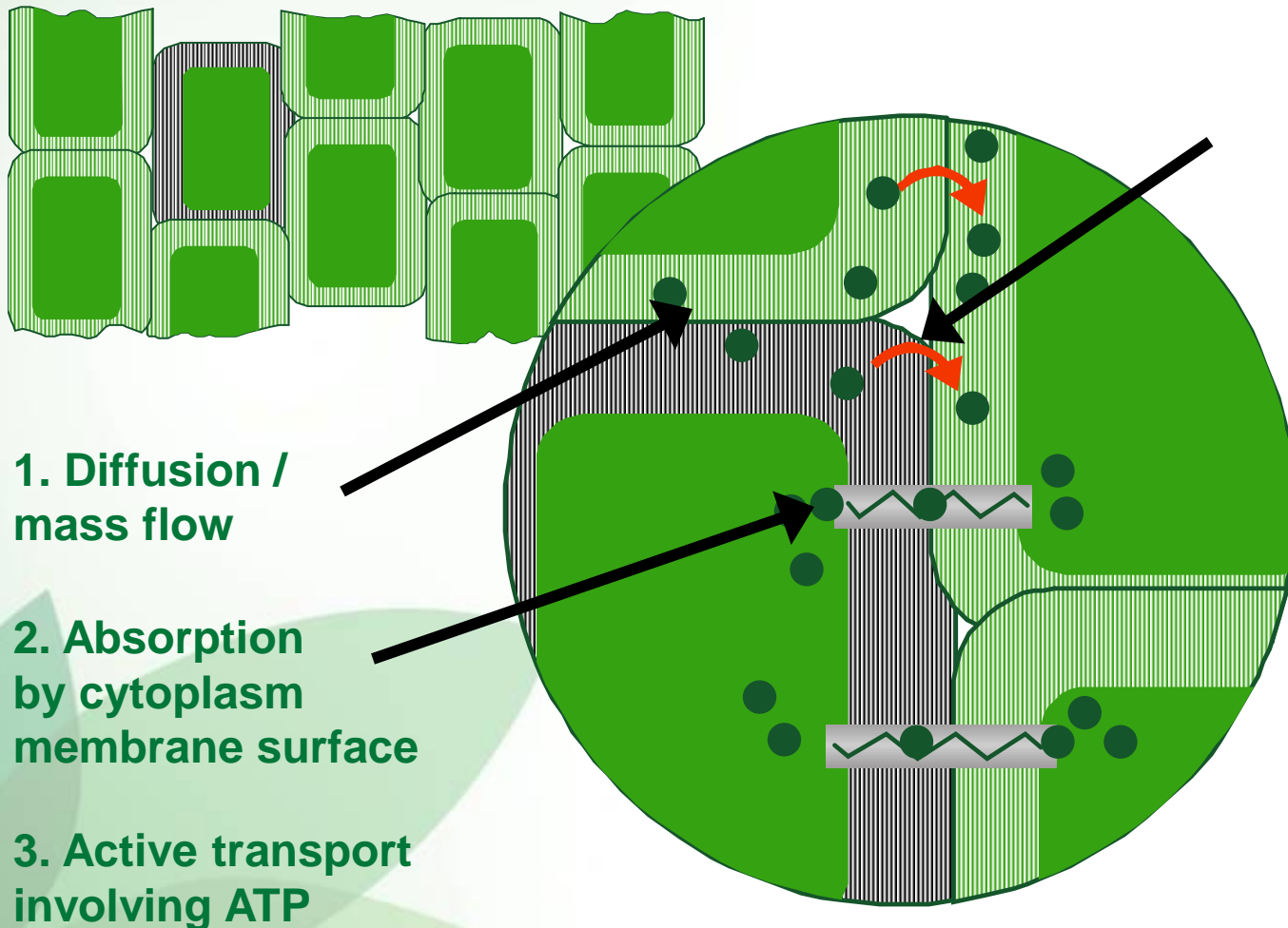
Efficiency of uptake by passive diffusion improves

- 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

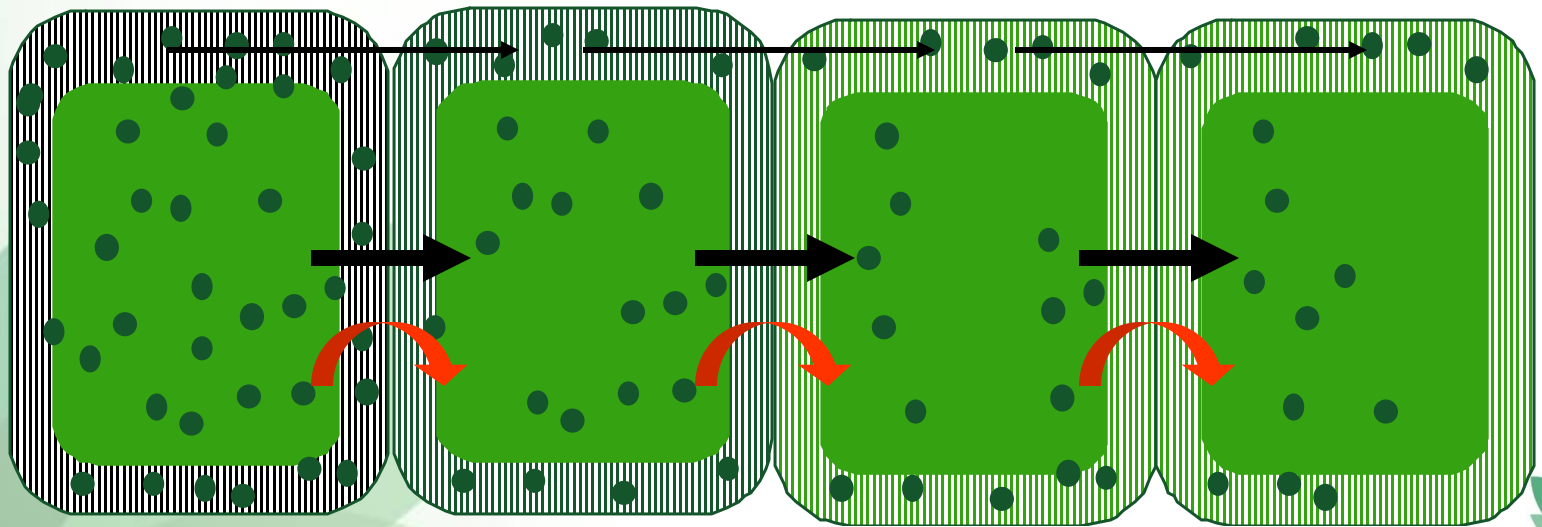
Scheme of cell-to-cell transport of ions



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**



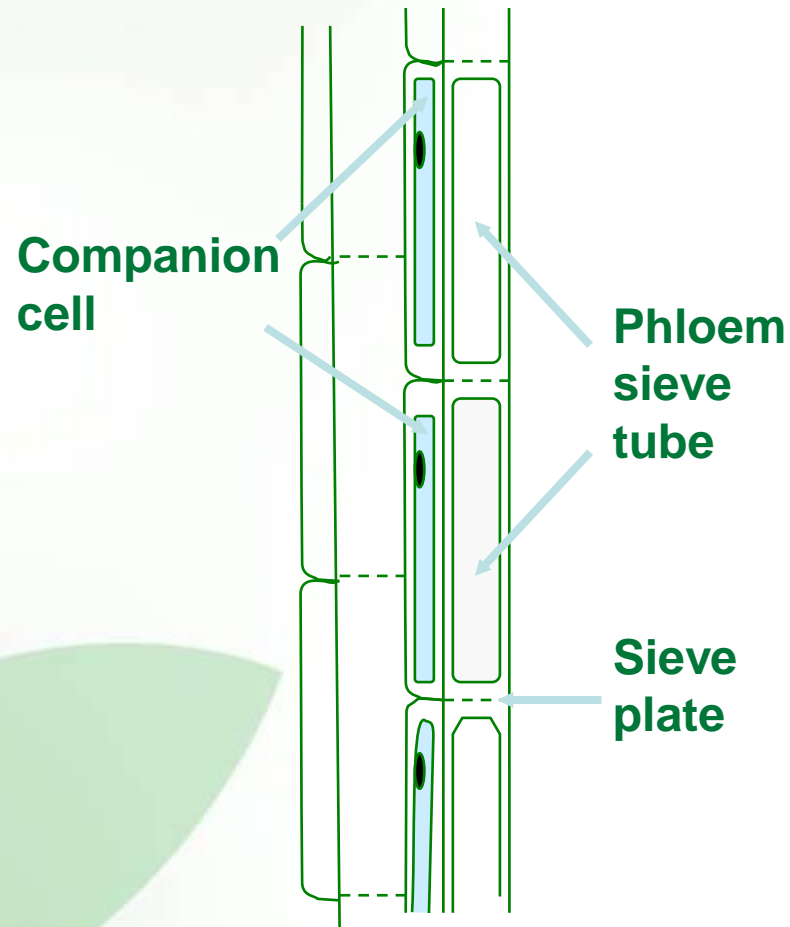
Transport through vascular channels

- Responsible for convection of nutrients to remote parts of the plant
- Symplastic movement – through phloem
- Apoplastic movement – through xylem



Transport through vascular channels

Phloem



Transport through vascular channels

Phloem (symplastic movement):

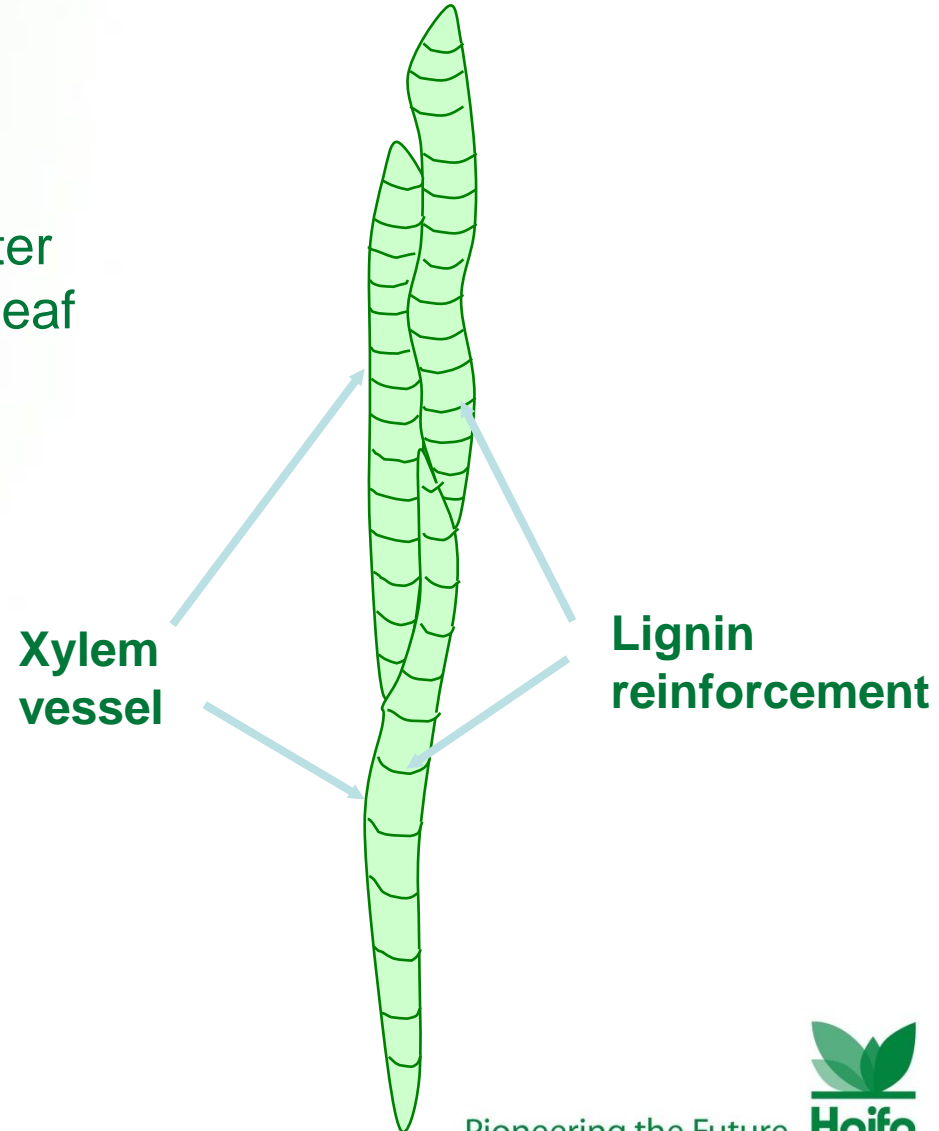
- Requires energy
- More suitable for cations
- Translocation of anions is very limited, as the cell wall is negatively charged.
- Movement regularly follows the 'sink-source' relationship

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 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 phytotoxicity. 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.

Haifa's foliar fertilizers

How Haifa Bonus™ npK works



1. Haifa-Bonus™ npK is applied by foliar spray and forms droplets on the leaf

Haifa's foliar fertilizers

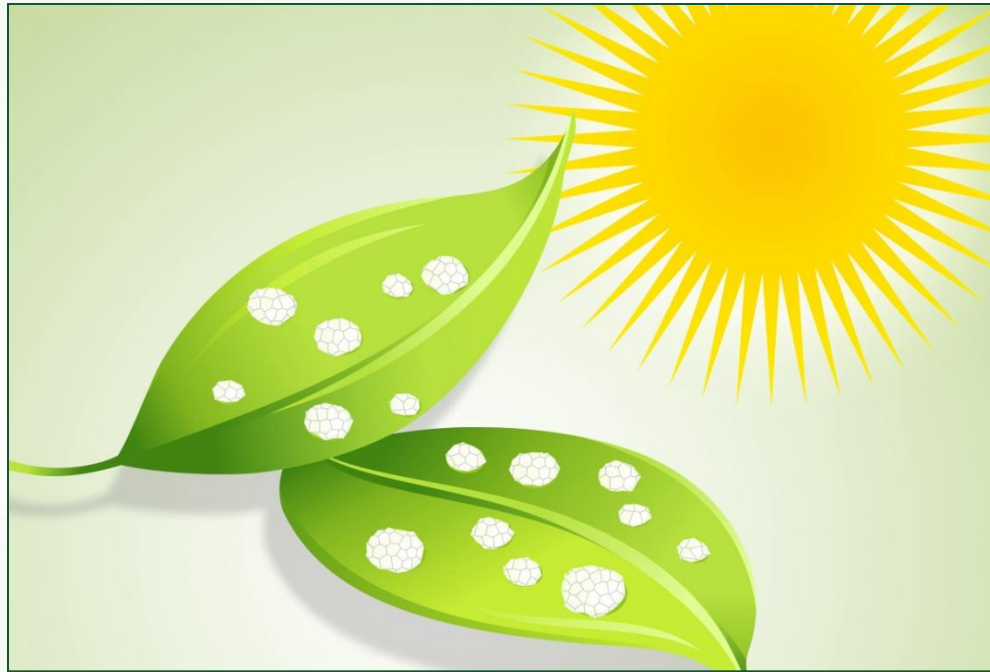
How Haifa Bonus™ npK works



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

		Micronutrients (ppm)					
		Fe	Mn	Zn	Cu	Mo	
Vegetative Booster 21-21-21		1300	660	200	140	90	200
Flowering Booster 8-52-17		500	250	75	55	35	100
Fruiting Booster 16-8-34		1200	600	180	130	80	200

Haifa's foliar fertilizers

Poly Feed[®] Foliar formulae

		Micronutrients (ppm)					
		Fe	Mn	Zn	Cu	Mo	B
Poly-Wheat 23-7-23		1700	850	250	1000	110	200
Poly-Potato 12-5-40		2000	1000	300	220	140	300
Poly-Citrus 16-7-30+2MgO		1000	500	2000	110	70	300
Poly-Olive 15-7-30+2MgO		1000	500	150	110	70	4500
Poly-Rice 15-15-30		1000	1500	150	110	70	200
Poly-Vineyard 4-15-37+3MgO		2300	500	150	110	70	200
Poly-Cotton 12-5-40		2000	1000	300	220	140	300
Poly-Sugarbeet 15-7-30+2MgO		1000	500	150	110	70	4500

Haifa's foliar fertilizers

Poly Feed[®] MAR

- NPK formulae enriched with 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

	Haifa ProteK™ Standard	Haifa ProteK™ Total
P ₂ O ₅	26%	-
HPO ₃ ²⁻	30%	60%
K ₂ O	37%	39%
K	30.7%	32.4%
pH (1% solution)	4.5-5	4-4.5
Bulk density	0.95 g/cm ³	0.8 g/cm ³

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

Multi-Micro [®] Fe	Iron-EDTA 13%
Multi-Micro [®] Mn	Manganese-EDTA 13%
Multi-Micro [®] Zn	Zinc-EDTA 14%
Multi-Micro [®] Cu	Copper-EDTA 14%
Multi-Micro [®] Comb	7.1% Fe, 3.48% Mn, 1.02% Zn, 0.76% Cu, All as EDTA chelates 0.485% Mo as ammonium molybdate

