Teaspoon Feeding™ by Haifa:

Nutritional recommendations for

PEPPERS

Teaspoon Feeding™

Haifa

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Based on Haifa's global marketing operations and profound international agronomical experience, we has a deep understanding of the unique needs of individual growers throughout the world. A dedicated team of professional agronomists and marketing staff supports our customers at all levels of supply and usage chain.

Who we are

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Haifa was established in 1966, aiming to turn Israeli natural resources into potassium nitrate, a premium fertilizer with high added value and an essential ingredient in various industries. Being the world's pioneer and a leading supplier of potassium nitrate, HAIFA has gained production capabilities, application know-how and deep understanding of the marketplace it serves. This has been the strong basis for the development of a whole line of top-quality products.
As an Israeli company, HAIFA is well acquainted with the cutting edge of innovations in agriculture and horticulture, especially those dealing with plant nutrition, enhanced water-use efficiency and with advanced cultivation methods.

Haifa production processes adhere to the most demanding international standards of safety and quality. Our production complies with ISO 9001 (quality), ISO 14001 (environment), and OHSAS 18001 (safety and occupational health) standards.

Nutritional recommendations for

PEPPER

in open-field, tunnels and greenhouse

Botanical name: *Capsicum annuum L.*
Synonyms: Capsicum, bell-pepper, paprika, piment, pimiento, pepperoni, gemusepaprika.

Contents:

1. Growing conditions

1.1 Growing method

Open-field, greenhouse or tunnels

1.2 Soil type

Better results will be obtained by growing in light soil such as sandy loam or loams, well drained, rich in organic matter. The preferable pH of the soil should be between 6.5 and 7.5.

1.3 Specific sensitivities

Sensitivity to soil-borne diseases

Peppers are prone to oil-borne diseases caused by fungi, viruses or bacteria. Therefore it is recommended to avoid growing peppers on plots that used for other sensitive crops (tomatoes, eggplants, Irish potatoes, sweet potatoes, cotton, soybeans and others) on recent years. A regime of 3-year rotation between small grains and pepper is recommended.

Sensitivity to salinity

Under saline conditions, sodium cations compete with the potassium cations for the uptake sites in the roots, and chloride competes for the uptake of nitrate-nitrogen and will reduce yield. This will result in a potassium deficiency in the pepper plants, leading to a low fruit number per plant. Corrective measures under such conditions must include the following steps:

- Abundant application of potassium, as this specific cation can successfully compete with the sodium, and considerably reduce its uptake and negative effects.
- Abundant application of nitrate, as this specific anion can successfully compete with chloride, and markedly reduce its uptake and adverse effects.
- Also, calcium may help to suppress the uptake of sodium. When sufficient calcium is available, the roots prefer uptake of potassium to sodium, and sodium uptake will be suppressed.

Zinc nutrition in plants seems to play a major role in the resistance to salt in pepper and other crops. Adequate zinc (Zn) nutritional status improves salt stress tolerance, possibly, by affecting the structural integrity and controlling the permeability of root cell membranes. Adequate Zn nutrition reduces excessive uptake of sodium (Na^+) by roots in saline conditions.
The methods of implementing these measures are discussed in chapter 2.

Sensitivity to calcium deficiency

Peppers are highly sensitive to calcium deficiency, which is manifested in the Blossom-end rot (BER) symptom on the fruits. Salinity conditions severely enhance BER intensity. But manganese (Mn) was recently found to serve as antioxidant in pepper fruit hence the addition of manganese to peppers grown under salinity may alleviate BER symptoms in the fruits. Special care must be taken to avoid growing conditions, which enhance BER phenomenon. Please read more about it in chapter 2.

1.4 Desirable temperatures

Table 1. Optimal temperatures for pepper plants by growth stage.

Growth stage	Temperature (^{0}C)		
	Minimum	Maximum	Optimal
Germination	13	40	20-25
Vegetative growth	15	32	20-25 (day) 16-18 (night)
Flowering and fruiting	18	35	26-28 (day) 18-20 (night)

1.5 Irrigation

Greenhouse grown peppers enjoy a longer growing season. They consume, therefore, a larger amount of water than open-field grown peppers during their respective growing season.
Water stress affects pepper growth by reducing the number of leaves and the leaf area, resulting in less transpiration and photosynthesis. Root density is reduced by ~20 % under water stress conditions, compared to sufficiently irrigated plants.
Excessive irrigation will cause water-logging, root death due to anaerobic soil conditions, delayed flowering and fruit disorders.
The root system consists of a deep taproot with laterally spread branches about 50 cm long, and adventitious roots. Therefore a drip system equipped with a Nutrigation™ (fertigation) device is advisable.

1.6 Crop uses

Pepper is used as a fresh vegetable, pickled vegetable, fresh chili spice and dried paprika powder.

1.7 Growth stages

Growth stages of plants consist of four general periods, having unique nutritional needs of the plant, consequently requiring different fertilization regimes:

- Vegetative growth from planting or seeding to first flowering.
- From flowering to fruit set
- Fruit ripening to first harvest
- From first to last harvest

The duration of each stage may vary according to growing method, variety characteristics and climatic conditions.

Table 2: An example of various growth stages durations:
Location: Central Israel
Variety: *Maor*
Growing method: Greenhouse
Number of days to flowering: 35-40
Number of days to 1st harvest: 70

Growth stage	Stage duration (days)	Plant age (days)
Planting	1	1
Vegetative	24	25
Flowering	10	35
Fruit set	10	45
1st Harvest	25	70
Harvest to Last Harvest	170	240

2. Nutritional requirements

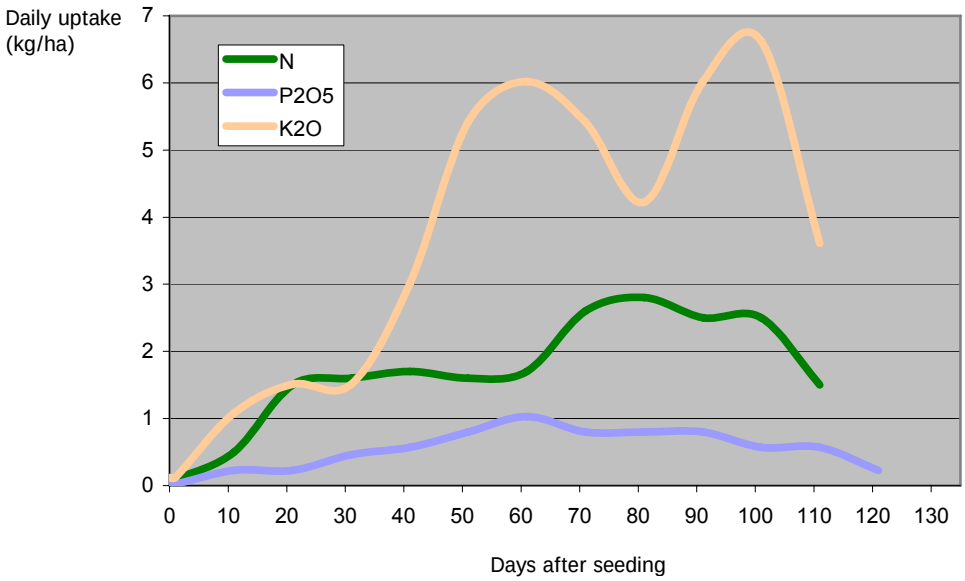
2.1 Main functions of plant nutrients

Table 3: Summary of main functions of plant nutrients:

Nutrient	Functions
Nitrogen (N)	Synthesis of proteins (growth and yield).
Phosphorus (P)	Cellular division and formation of energetic structures.
Potassium (K)	Transport of sugars, stomata control, cofactor of many enzymes, reduces susceptibility to plant diseases and a-biotic stresses, counteracts salinity
Calcium (Ca)	A major building block in cell walls, and reduces susceptibility to diseases.
Sulphur (S)	Synthesis of essential amino acids cystin and methionine.
Magnesium (Mg)	Central part of chlorophyll molecule.
Iron (Fe)	Chlorophyll synthesis.
Manganese (Mn)	Necessary in the photosynthesis process.
Boron (B)	Formation of cell wall. Germination and elongation of pollen tube. Participates in the metabolism and transport of sugars.
Zinc (Zn)	Auxins synthesis.
Copper (Cu)	Influences in the metabolism of nitrogen and carbohydrates.
Molybdenum (Mo)	Component of nitrate-reductase and nitrogenase enzymes.

2.2 Nutrient uptake curves

Figure 1: Nutrient requirements curves (kg/ha/day) in pepper cv *Maor*.
Seeding: July 14th ; Soil type: Sand ; Plant Density: 100,000 plants/ha
Expected yield: 75 T/ha



As can be seen in figure 1, the greatest absorption of nutrients occurs in the first 60 days of growth, and another peak takes place after the first fruit removal. Therefore, the plant requires high nitrogen application early in the growing season with supplemental applications after the fruit initiation stage. Improved nitrogen use efficiency and greater yields are achieved when the nitrogen is applied under polyethylene mulches and with 12 weekly N applications in a drip irrigation system (Nutrigation™). At least 50-90% of the total nitrogen should be applied in nitrate (NO_3^-) form.

2.3 N-P-K functions in pepper

Nitrogen (N) contributes to the vegetative growth of the pepper plant. It is important that the plant, when reaching the flowering stage, will be well developed vegetatively; or it will have a low yielding potential. Pepper plants were found to positively respond (by increasing number of flowers and fruits) to higher nitrogen concentrations than the usual norms for other crops.

Phosphorus (P) is essential for the normal development of the roots and reproductive organs (flowers, fruit, seeds). Highly available phosphorous is needed for the establishment of the transplant. Phosphorus shortage in the soil will result in development of too small and short branches, many undeveloped buds and less fruit in general. Adequate phosphorus enhances early fruit ripening.

Potassium (K) - adequate levels enhance the accumulation of carbohydrates and the resistance to low temperatures and diseases. See figure 2.
Potassium deficiency slows down the growth rate of pepper plants. Potassium deficiency symptoms are: brown spots at the edges of the leaves and fruits, and sometimes there is curling and drying of the leaves. Severe potassium deficiency will retard the transportation of sugars within the plant, leading to starch accumulation in the lower leaves.

Figure 2: Effects of potassium (K) on pepper yield, under constant N rate of 224 kg/ha

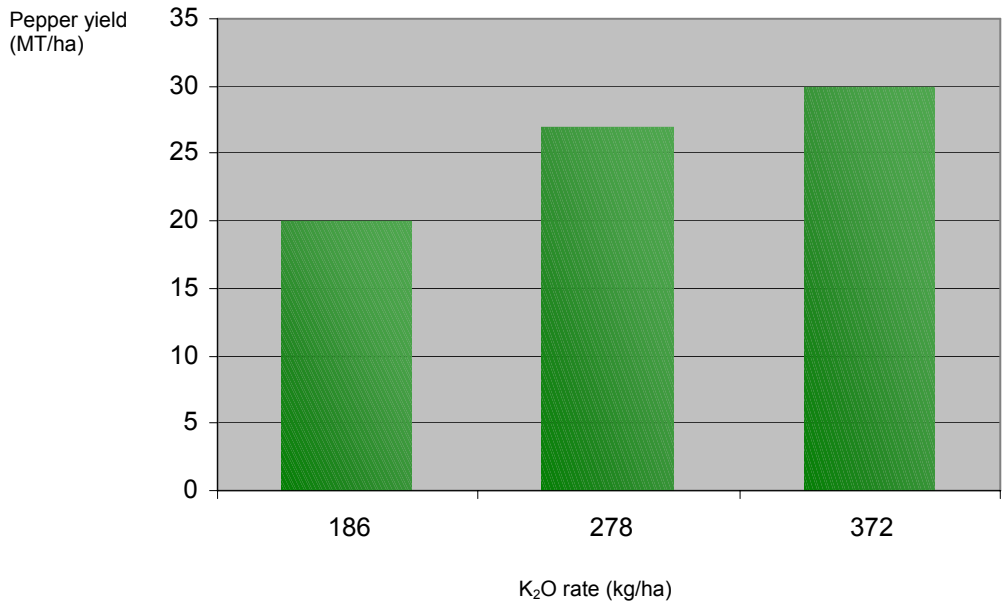


Table 4: Example of optional growing methods and the required rates of macro- and secondary plant nutrients

	Greenhouse	Open Field
Expected yield (T/ha)	75 - 200	11 - 140
Plant density (plants/ha)	50,000 - 100,000	30,000 - 50,000
Nutrients Uptake (kg/ha)		
N	390 - 920	116 - 705
P_2O_5	200 - 330	132 - 276
K_2O	640 - 1530	174 - 1155
CaO	100 - 210	38 - 174
MgO	60 - 150	22 - 115
S	40 - 50	35 - 40

2.4 Nutritional disorders in pepper

Table 5: Visual symptoms exhibited by pepper plants under nutritional disorders

Nutrient	Deficiency symptoms	Excess / Toxicity symptoms
Nitrogen	Plant development gradually slows down. Gradual drying, beginning at leaf margins, of the area between the lower leaf veins. The petioles bend and hang downwards, parallel to the stem. The plant develops few flowers and fruit setting is poor. The fruit receptacle is thin, and the ovary is small. Sometimes there is no fruit development on the plant at all, and on those plants that bear fruits, the fruit is deformed. See figure 3.	Plants are usually dark green in color, have abundant foliage, but usually with a restricted root system. Flowering and seed production can be retarded.
Phosphorus	The plants display limited growth. The leaves are hard and brittle to the touch. Flower formation is defective. Few flowers develop, and in those that do develop, only one in every four or five develops a fruit. The fruit is underdeveloped, with a thin receptacle, and very few seeds. The root system is undeveloped. See figure 4.	No typical primary symptoms. Copper and zinc deficiencies may occur due to excessive phosphorus.
Potassium	Yellow chlorosis spots appear between leaf veins, firstly in the lower leaves. The veins and the areas adjacent to these spots do not change their color. Later, the chlorotic spots become lighter. (This can be seen mainly in the upper parts of the plant). There is little fruit setting, and not much fruit, which is smaller than usual. See figure 5.	Usually not excessively absorbed by plants. Excessive potassium may lead to magnesium, manganese, zinc or iron deficiencies.
Sulfur	Causes leaves to become yellowish.	Reduction in growth and leaf size. Leaf symptoms often absent or poorly defined. Sometimes interveinal yellowing or leaf burning.

Nutrient	Deficiency symptoms	Excess / Toxicity symptoms
Magnesium	Is Common on pepper plants. Yellowing of the leaves is apparent in the interveinal areas and veins remain green. The oldest leaves are affected first. Sometimes magnesium deficiency occurs when excessive applications of potassium have been made. It may also show up under extremely hot dry weather. See figure 6.	Very little information available.
Calcium	The most common reason for Blossom End Rot of the fruit (see figure 7). This may be corrected by foliar spray of calcium chloride or calcium nitrate. Further information following on page 10.	No consistent visible symptoms. Usually associated with excessive soil carbonate.
Iron	Symptoms show at the later stages of growth. The young leaves fade and then become yellow in the areas between the veins. The veins remain green.	Rarely evident in natural conditions. Has been observed after foliar iron sprays manifested as necrotic spots.
Chloride	Wilted leaves, which then become chlorotic bronze, and necrotic. Roots become stunted and thickened near tips.	Burning or firing of leaf tips or margins. Bronzing, yellowing and leaf abscission and sometimes chlorosis. Reduced leaf size and lower growth rate.
Manganese	Chlorotic spots between the upper leaf veins.	Sometimes chlorosis, uneven chlorophyll distribution. Reduction in growth. Lesions and leaf shedding may develop later.
Boron	The deficiency manifests itself very quickly. The lower leaves curl upwards. Growth is stunted. The plant develops a thick, short stem. The apex withers and the leaves become yellow from bottom to top of the plant. See figure 8. There is a reduced production of flowers, and fruit setting is poor.	Yellowing of leaf tip followed by progressive necrosis of the leaf beginning at tip or margins and proceeding toward midrib. See figure 9.
Zinc	The leaves become narrow and small in chili.	Excessive zinc commonly produces iron chlorosis in plants.
Copper	Appear late in the vegetative stage. The leaf margins curl and dry up. The leaves and the fruit become narrow and rectangular.	Reduced growth followed by symptoms of iron chlorosis, stunting, reduced branching, thickening and abnormal darkening of rootlets.
Molybdenum	The foliage turns yellow-green and growth is somewhat restricted. The deficiency occurs most commonly on acidic substrates.	Rarely observed. Sometimes leaves turn golden yellow.

Figure 3: Nitrogen (N) deficiency

Figure 4: Phosphorus (P) deficiency

Figure 5: Potassium (K) deficiency

Figure 6: Magnesium (Mg) deficiency.

Figure 7: Calcium (Ca) deficiency as blossom-end rot (BER) of the fruit

Blossom end rot (BER)

BER occurs mainly during hot weather conditions. Fruits are affected in their early stages of development (10-15 days after fruit set); the cause is related to the rate of calcium supply to the fruit, which is lower than the rate of the fruit growth. This results in the collapse of certain tissues in the fruit, demonstrated as BER. Factors that favor BER are directly related to limited calcium uptake and transport to the fruit, like high salinity, high temperatures and high growing intensity and water shortage.

Pepper spots

Black spot or *stip* is shown in the fruit as grey/black spots, which develop under the skin in the fruit wall about the time the fruit attains a diameter of 8 centimeters or more. As the fruits ripen, the spots slightly enlarge and turn green or yellow. Stip is a calcium disorder, caused by excessive $N\text{-}NH_4$ and K rates. Susceptibility greatly varies by variety.

Figure 8: Boron deficiency; the growing points die and decay, and the leaves are misshapen

Figure 9: Boron excess

2.5 Leaf analysis standards

Table 6: Macro and secondary plant nutrients contents in pepper plant leaves

	Deficient	Normal	High
	% of dry matter		
N	2-2.5	3-4	4-5
P	0.25	0.3-0.4	0.4-0.6
K	2	3.5-4.5	4.5-5.5
Ca	1	1.5-2	5-6
Mg	0.25	0.25-0.4	0.4-0.6
Na		0.1	

Table 7: Micro plant nutrients contents in pepper plant leaves:

	Deficient	Normal	High
	ppm of dry matter		
Fe	50-100	200-300	300-500
Mn	25	80-120	140-200
Zn	25-40	40-50	60-200
Cu		15-20	24-40
B		40-60	60-100
Mo		0.4	0.6

2.6 Plant Nutrient Requirements

Table 8: Nutritional requirements of pepper in greenhouse

Expected yield (Ton/ha)	Removal by yield (kg/ha)					Uptake by whole plant (kg/ha)				
	N	P_2O_5	K_2O	CaO	MgO	N	P_2O_5	K_2O	CaO	MgO
25	50	15	87	12	7	140	35	201	107	32
50	100	30	175	25	15	221	57	330	153	49
75	150	45	262	37	22	303	79	457	198	64
100	200	60	350	50	30	384	101	585	244	81
125	250	75	437	62	37	466	123	712	290	97
150	300	90	525	75	45	547	145	841	336	114
175	350	105	612	87	52	629	167	968	381	129
200	400	120	700	100	60	710	189	1096	427	146

Table 9: Nutritional requirements of pepper in open field

Expected yield (Ton/ha)	Removal by yield (kg/ha)					Uptake by whole plant (kg/ha)				
	N	P_2O_5	K_2O	CaO	MgO	N	P_2O_5	K_2O	CaO	MgO
20	40	12	70	10	6	121	30	173	95	28
40	80	24	140	20	12	191	49	282	137	43
60	120	36	210	30	18	261	67	390	179	57
80	160	48	280	40	24	331	86	499	221	72
100	200	60	350	50	30	402	105	608	263	86
120	240	72	420	60	36	472	124	716	305	100
140	280	84	490	70	42	542	142	825	347	115

3. Fertilization recommendations

The recommendations appearing in this document should be regarded as a general guide only. The exact fertilization program should be determined according to the specific crop needs, soil and water conditions, and the grower's experience. For detailed recommendations, consult a local Haifa representative.

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3.1 Soil-grown pepper

3.1.1 Haifa NutriNet™ web software for Nutigation™ programs

Haifa fertilization recommendations are available online and can be accessed through Haifa's website, www.haifachem.com. Click on Haifa **Know-how** heading, or directly at: http://www.haifa-nutrinet.com and you will enter into **NutriNet™**, a unique expert software program, that will assist you working out the recommended fertilizer rates at different growth stages according to the expected yield under your growing conditions.

The following is an example of recommendations, determined by NutriNet, with the assumption to split the scheduled fertilization into:

a) Base-dressing (pre-plant) fertilizers, followed by:
b) Nutrigation (fertigation) at different growth stages, on sandy-loam soil, when the expected yield is 65 ton/ha:

a) Base-dressing (kg/ha):

Base dressing - pepper

All nutrients in kg/ha

	N	P_2O_5	K_2O	CaO	MgO
Suggested base dressing	92	115	234	76	48
Actual base dressing					

% Surface covered: 100%

Ammonium nitrate (34%)	279
Superphosphate (25%)	460
Potassium sulfate (50%)	468
Dolomite (26%)	292
Magnesium sulfate (16%)	300

Suggestion accepted | Free choice

b) Nutrigation

Total amount of fertigation-applied fertilizers (kg/ha)

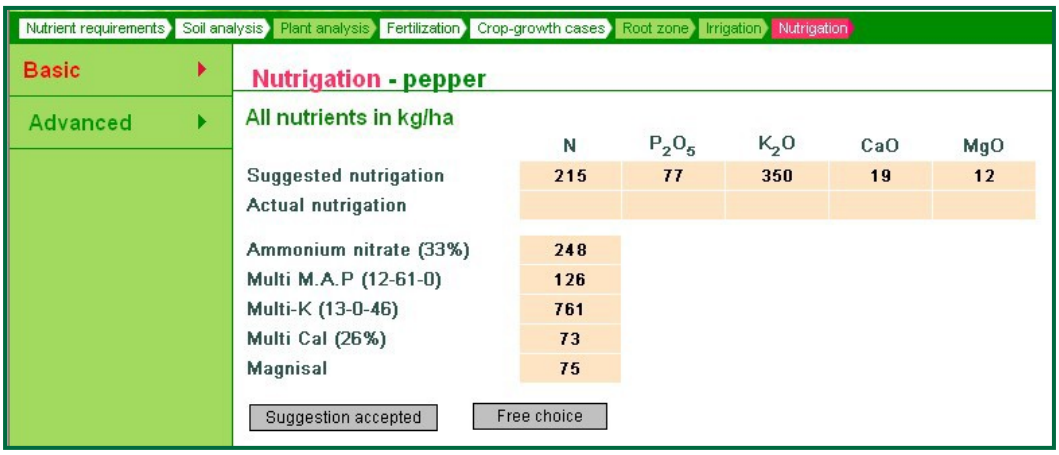

Table 10: The total contribution of plant nutrients from each fertilizer as calculated by NutriNet™:

Fertilizer	kg/ha	N	P_2O_5	K_2O	CaO	MgO
Ammonium nitrate 34-0-0	247.7	81.7				
Multi-MAP 12-61-0	126.2	15.5	77			
Multi-K 13-0-46	760.9	98.9		350		
Calcium nitrate (26% CaO)	73.1	11			19	
Magnesium sulfate (16% MgO)	75					12
Total	1283	215	77	350	19	12

Table 11: Recommended nutrient rates per ha per day and per growth stage as calculated by NutriNet™:

Phase	Days from sowing / planting	kg/ha/day					kg/ha/phase				
		N	P_2O_5	K_2O	CaO	MgO	N	P_2O_5	K_2O	CaO	MgO
Planting	1	1	0	1	0	0	1	0	1	0	0
1st phase	2-30	0.66	0.24	1.07	0.07	0.03	119	7	31	2	1
Main season	31-70	2.65	0.95	43	0.23	0.15	106	38	172	9	6
End season	71-130	1.98	0.72	3.23	0.18	0.12	119	43	194	11	7
						Total	2455	88	398	22	14

Table 12: Recommended fertilizers rates per growth stage

Phase	Days from sowing / planting	kg/ha/phase				
		Ammonium nitrate 34-0-0	Multi-MAP™* 12-61-0	Multi-K® * 13-0-46	Multi-Cal®* (26% CaO)	Magnesium sulfate (16% MgO)
Planting	1	2	0	2	0	0
1st phase	2-30	23	11	67	8	6
Main season	31-70	132	62	374	35	38
End season	71-130	145	70	422	42	44
	Total	**302**	**143**	**965**	**85**	**88**

*

Multi-K® = Potassium nitrate

Multi-MAP™ = Mono-ammonium phosphate

Multi-Cal® = Calcium nitrate

Example: Growing practice of peppers in Israel

Duration of the growth season:

- In the southern part of the country (dry and hot climate) growth season of pepper in net houses starts on August and ends by the end of April. The season is rather long because of the scarcity of precipitates (ca 70 mm per year).
- The summer growth term starts on April and lasts till the end of December.
- In greenhouses and plastic tunnels the growth season is between August and April.
- In open field the season starts on April and ends on June.

Table 13: NK ratio

The N:K ratio is 1-1.5 to 1-2

	Kg / ha /Ton pepper yield
N	20-30
P_2O_5*	27.5
K_2O*	48-60

* Conversion factors: $P = P_2O_5 \times 0.44$; $K = K_2O \times 0.83$

Standard pepper plant density in Israel is 30,000 – 35,000 plants/ ha.
Average yield of open-field grown pepper in Israel is 55 – 70 T/ha.
Average yield of net house grown pepper in Israel is 90 – 110 T/ha.

Table 14: Open field Pepper fertilization program (Planting on the 1-15 of April):

A. Plant nutrients

Growth phase	Stage duration (days)	kg/ha/day			kg/ha/phase		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
First 2 weeks	14	1-1.5	1-1.5	1-1.5	14-21	14-21	14-21
Vegetative Growth	14	2-2.5	1	3.0-4.0	28-35	14	42-56
Flowering - fruit set	40	3.0-4.0	1	4.5-5	120-160	40	180-200
Fruit set - harvest	75	2 - 2.5	1	3.0-4.0	150-185	75	225-300
Total	145				300-400	140-150	460-580

B. Actual fertilizers

Growth phase	Stage duration (days)	kg/ha/day			kg/ha/phase		
		A.N.*	Multi-K®*	Multi-MAP*	A.N.*	Multi-K®*	Multi-MAP*
First 2 weeks	14	0.5-1	2.5-4	3.5-5.5	7-14	35-55	50-75
Vegetative growth	14	0.5-1.5	8-14.5	3.5	7-21	110-200	19
Flowering - fruit set	40	3-5.5	12-13	3.5	120-220	480-520	140
Fruit set - harvest	75	0.5-1.5	8-14.5	3.5	37-110	600-1100	263
Total	145				170-365	1225-1875	470-495

* A.N. = ammonium nitrate

Multi-K® = Potassium nitrate

Multi-MAP = Mono-ammonium phosphate

3.1.2 Poly-Feed® water-soluble NPK fertilizers

Table 15: fertilization recommendations for bell pepper in tunnels. Expected yield: 50 ton/ha

Growth stage	Days	Poly-Feed® formula	kg/ha/day	Total kg/ha
Initial establishment	7	15-30-15	8	56
Vegetative to fruit set	20	19-19-19	13	260
Fruit set to 1st harvest	20	18-9-27	13	260
Harvest	100	18-9-27	13	1300

Table 16: fertilization recommendations for bell pepper in greenhouse. Expected yield: 120 ton/ha

Growth stage	Days	Poly-Feed® formula	kg/ha/day	Total kg/ha
Initial establishment	10	15-30-15	8	80
Vegetative to fruit set	25	19-19-19	13	325
Fruit set to 1st harvest	20	18-9-27	15	600
Harvest	170	18-9-27	13	2210

3.1.3 Multicote® Agri Controlled Release Fertilizer

An $N:P_2O:K_2O$ ratio of 2:1:3 is recommended, as pre-plant application. This application will take care of the nutritional requirement of the plot for the entire growth season.
Multicote® Agri granules should be incorporated into the soil, 10cm deep and 10cm away from the planting row.

Consult a local Haifa representative for detailed explanations and instructions.

Table 17: Multicote® Agri application recommendations bell pepper in greenhouse

kg/ha	Analysis	Longevity
2,500 - 3,500	17-9-27	8 months

3.1.4 Foliar nutrition

To correct plant nutrient deficiency at the critical stage, spray with the suitable Haifa water-soluble fertilizer at a safe concentration. The safe spray concentration may vary, depending on climatic conditions. In order to determine the safe spray concentration, one should spray it on a few plants and check for any phytotoxicity symptoms after 3-5 days.

Table 18: Haifa water-soluble fertilizers for foliar application:

Fertilizer	Curing Treatment	Recommended concentration
Haifa-Bonus™	Potassium deficiency	1 % - 2 %
Multi-MAP™	Phosphorous deficiency	0.5 % - 1 %
Multi-MKP™	Phosphate and potassium deficiency	0.5 % - 1 %
Magnisal®	Magnesium deficiency	0.5 % - 0.75 %
Poly-Feed®	N-P-K and micronutrients deficiency	0.75 % - 1.5 %

Table 19: Example of foliar feeding program (complement to Nutrigation), Mexico

Growth stage	Product	Spray conc. (%)	Application rate (kg/ha)
Transplanting	Poly-Feed® 12-43-12+ME	0.5-1	1-2
Vegetative	Poly-Feed® 19-19-19+ME	1-2	3-4
	Magnisal®	0.5	1-2
	Multi-Micro® Comb	0.1	0.5
Fruit setting	Poly-Feed® 10-10-43+ME	1-2	3-4

Time intervals between sprayings: 15 days

3.2 Soilless-grown pepper

3.2.1 straight fertilizers

There are different growth media with different physical and chemical characteristics. The following are general fertilization recommendations for all soilless growth media.

Fertilizer stock solution: Once dissolved, not all fertilizers are inter-compatible with each other. Therefore, they have to be split into two fertilizer tanks: A and B, according to their compatibility. Fertilizers containing phosphorus (P) or sulfur (S) should be dissolved in Tank A only, while fertilizers containing calcium (Ca) or magnesium (Mg) should be dissolved in Tank B.

The concentration of the fertilizers stock solution depends on:

1. The ambient temperature (higher ambient temperature enables higher concentration)
2. The injection rate - how many liters of the fertilizer solution will be injected into each cubic meter (1000 liters) of the irrigated water

Dividing the injection capacity by one cubic meter should be the concentration of the fertilizer solution. If, for example, the injector will deliver 5 L into each cubic meter of the irrigated water (1000 L / 5 L = 200), the amount of fertilizer dissolved in the tank should be multiplied by 200.

Example I - Holland

The following example was prepared to fit *Dutch* conditions (low transpiration and low water EC). Considerable and proportional reduction in the concentration of the macronutrients should be practiced at lower water quality prevailing in other conditions.

Table 20: Nutrition database for sweet pepper in Holland, grown on rockwool

Parameter	Nutrient solution (ppm)
EC (mS/cm)	2.2
N- NH_4	17.3
N- NO_3	216.9
P	39
H_2PO_4	121.3
K	254.2
Ca	190.5
Mg	36.5
S, total	55.5
SO_4	168.2

Table 21: Recommended water-soluble fertilizers and their rates, to prepare the above recommended solution:

Fertilizers	g/m³	Plant nutrients – g/m³ solution						
		NO_3	NH_4	P*	K*	Ca*	Mg*	S*
Multi-K®	500	65			190			
K_2SO_4	150				63			22.5
Multi-Cal®	1000	155				190		
Magnisal®	120	13.2					10.8	
$MgSO_4$	260						26	33.8
Multi-MAP™	140		16.8	37.8				
Total		233.2	16.8	37.8	253	190	36.8	56.3

Example II – Florida, USA

Table 22: Hydroponic fertilizer solution concentration for growing peppers in a shade house on a composted pine bark medium

Nutrient	Nutrient Concentration (ppm = mg/L)	
	Transplant to first flower	After first flower
N	100	130
P	50	50
K	120	200
Ca	100	150
Mg	40	50
S	50	60

Table 23: Recommended water-soluble fertilizers and their rates to prepare a fertilizer solution from transplant to first flower and a fertilizer solution after first flower.

A. From transplant to first flower

Fertilizers	g/m³	Plant nutrients – g/m³ solution						
		NO_3	NH_4	P*	K*	Ca*	Mg*	S*
Multi-K®	150	19.5			57			
Multi-Cal®	530	82.15				100.7		
$MgSO_4$	400						40	52
Multi-MKP™	220			49.94	61.6			
Total		101.65	0	49.94	118.6	100.7	40	52

* conversion factors: P x 2.29 = P_2O_5 ; K x 1.20 = K_2O ; Ca x 1.40 = CaO ; Mg x 1.66 = MgO ; S x 3.00 = SO_4

B. After first flower

Fertilizers	g/m³	Plant nutrients – g/m³ solution						
		NO_3	NH_4	P*	K*	Ca*	Mg*	S*
Multi-K®	360	46.8			136.8			
Multi-Cal®	680	105.4				129.2		
$MgSO_4$	470						47	61.1
Multi-MKP™	220			49.94	61.6			
Total		152.2	0	49.94	198.4	129.2	47	61.1

Example III – general USDA recommendations:

Table 24: total nutritional requirements

Nutrient	Nutrient Concentration (ppm = mg/L)	
	Transplant to first flower	After first flower
N	70	160
P	50	50
K	119	200
Ca	110	190
Mg	40	48
S	55	65

Table 25: Recommended water-soluble fertilizers and their rates to prepare a fertilizer solution

A. From transplant to first flower

Fertilizers	g/m³	Plant nutrients – g/m³ solution						
		NO_3	NH_4	P*	K*	Ca*	Mg*	S*
Multi-K®	80	10.4			30.4			
K_2SO_4	60				25.2			9
Multi-Cal®	580	89.9				110.2		
$MgSO_4$	400						40	52
Multi-MKP™	220			49.94	61.6			
Total		100.3	0	49.94	117.2	110.2	40	61

B. After first flower

Fertilizers	g/m³	Plant nutrients – g/m³ solution						
		NO_3	NH_4	P*	K*	Ca*	Mg*	S*
Multi-K®	140	18.2			53.2			
K_2SO_4	200				84			30
Multi-Cal®	1000	155				190		
$MgSO_4$	480						48	62.4
Multi-MKP™	220			49.94	61.6			
Total		173.2	0	49.94	198.8	190	48	92.4

* conversion factors: P x 2.29 = P_2O_5 ; K x 1.20 = K_2O ; Ca x 1.40 = CaO ; Mg x 1.66 = MgO ; S x 3.00 = SO_4

Example IV – Israel

Recommendations are for macro nutrients (N, P & K) by growth stages.

Table 26: Recommendations for nutrient concentrations in irrigation (drip) water for soilless grown peppers in Israel.

Growth Stage	Period	(g/m³)		
		N	P*	K*
Establishment –3rd flower	Early Fall	50 - 60	15 - 20	75 - 80
Fruit development and growth	Fall	80 - 100	25 - 30	100 - 120
Harvesting	Winter	150 - 180	30 - 35	200 - 230
Harvesting	Early Spring	140 - 150	30 - 35	160 - 190
Harvesting	Spring-Summer	120 - 130	25 - 30	150 - 160

Important: EC of irrigation water should be lower than 2.0 mS/cm

Table 27: Required amount of fertilizers to supply the above-recommended nutrients, by growth stages

A. Establishment to 3rd flower

Fertilizers	g/m³	Plant nutrients – g/m³ solution			
		NO_3	NH_4	P*	K*
Ammonium nitrate	50 - 70	8.5 - 11.9	8.5 - 11.9		
Multi-K®	200 - 210	26 - 27.3			76 - 79.8
Multi-MAP™	60 - 80		7.2 - 9.6	16.2-21.6	
Sub-total N		50 - 70	8.5 - 11.9		
Total		50.2 - 60.7		16.2 - 21.6	76 - 79.8

* conversion factors: P x 2.29 = P_2O_5 ; K x 1.20 = K_2O ; Ca x 1.40 = CaO ; Mg x 1.66 = MgO ; S x 3.00 = SO_4

B. Fruit development & growth

Fertilizers	g/m³	Plant nutrients – g/m³ solution			
		NO_3	NH_4	P*	K*
Ammonium nitrate	10 - 130	17 – 22.1	17 – 22.1		
Multi-K®	260 - 320	33.8 – 41.6			98.8 – 121.6
Multi-MAP™	90 - 110		10.8 – 13.2	24.3 – 29.7	
Sub-total N		50 - 70	8.5 - 11.9		
Total		78.6 - 99		24.3	98.8 – 121.6

C. Harvesting - winter

Fertilizers	g/m³	Plant nutrients – g/m³ solution			
		NO_3	NH_4	P*	K*
Ammonium nitrate	200 - 250	34 - 42.5	34 - 42.5		
Multi-K®	530 - 610	68.9 - 79.3			201.4 - 231.8
Multi-MAP	110 - 130		13.2 - 15.6	29.7-35.1	
Sub-total N		102.9-121.8	47.2 - 58.1		
Total		150.1 - 179.9		29.7 - 35.1	201.4 - 231.8

D. Harvesting – early spring

Fertilizers	g/m³	Plant nutrients – g/m³ solution			
		NO_3	NH_4	P*	K*
Ammonium nitrate	210 - 200	35.7 - 34	35.7 - 34		
Multi-K®	42 - 500	54.6 - 65			159.6 - 190
Multi-MAP™	110 - 130		13.2 – 15.6	29.7 – 35.1	
Sub-total N		90.3 - 99	48.9 – 49.6		
Total		139.2 – 148.6		29.7	159.6

E. Harvesting - spring - summer

Fertilizers	g/m³	Plant nutrients – g/m³ solution			
		NO_3	NH_4	P*	K*
Ammonium nitrate	160 - 210	27.2 – 35.7	27.2 – 35.7		
Multi-K®	400 - 420	52 – 54.6			152 – 159.6
Multi-MAP™	100 - 110		12 – 13.2	27 – 29.7	
Sub-total N		79.2 – 90.3	39.2 – 48.9		
Total		118.4 – 139.2		27 – 29.7	152 – 159.6

* conversion factors: P x 2.29 = P_2O_5 ; K x 1.20 = K_2O ; Ca x 1.40 = CaO ; Mg x 1.66 = MgO ; S x 3.00 = SO_4

3.2.2 Poly-Feed® water soluble NPK fertilizers

Table 28: Recommended composition of nutritional solution for soilless-grown peppers

A. In moderate or cold climate with low sun radiation and soft water (North and North-East Europe, North France, UK, Japan, Korea)

Concentration in irrigation water (ppm)					Recommended Poly-Feed® formula	Conc. (kg/m³)
N	P	K	Ca	Mg		
190	45	285	130	40	14-10-34+ME	1.0

Some acid and Multi-Cal® calcium nitrate should be added to adjust the pH and to complete calcium requirements.

B. In hot climate with high sun radiation and hard water (Middle East, Mediterranean countries)

Concentration in irrigation water (ppm)					Recommended Poly-Feed® formula	Conc. (kg/m³)
N	P	K	Ca	Mg		
170	40	215	100	35	11-12-33	0.8

Some acid and Multi-Cal® calcium nitrate should be added to adjust the pH and to complete calcium requirements.

Appendix I: Haifa Specialty Fertilizers

Teaspoon-Feeding™

Innovative Technology for Optimal Plant Nutrition and Maximum Yields

Modern agriculture is continuously striving for maximum yields at minimum production costs — while eliminating environmental impact.

Teaspoon-Feeding™ is a revolutionary concept of fertilization that provides plants with balanced nutrition throughout the growth season. Nutrients are provided in measured portions, that exactly or match plant requirements. Teaspoon-Feeding™ is designed to address plants' changing needs during each stage of the growth cycle, ensuring optimal plant development and maximum, high quality yields.

HAIFA fertilizers for Teaspoon-Feeding™ combined with innovative application techniques of Nutrigation, Controlled-Release Nutrition and Foliar Feeding enable precision-controlled composition, quantity, and timing of the nutrient supply that is tailored to the crop and the specific growing conditions.

HAIFA is a pioneering company in the development and marketing of innovative fertilization products and techniques that meet the demands of modern agricultural practice, while taking strictest environmental concerns into consideration.

Nutrigation™ (Fertigation)

Application of top-quality water-soluble fertilizers through the irrigation system is the optimal method for providing balanced plant nutrition throughout the growth season. A balanced Nutrigation™ regime ensures that essential nutrients are placed precisely at the site of intensive root activity and are available in exactly the right quantity - *when plants need them*.

HAIFA offers a wide range of water-soluble fertilizers for Nutrigation™. All products contain only pure plant nutrients and are free of sodium and chloride.

Multi-K®	Comprehensive range of plain and enriched potassium nitrate products
Poly-Feed®	Soluble NPK fertilizers enriched with secondary and micro-nutrients
Multi-MAP™	Mono-ammonium phosphate
Multi-MKP™	Mono-potassium phosphate
Multi-Cal®	Calcium nitrate
Magnisal®	Our original magnesium nitrate fertilizer
Multi-Micro®	Chelated micronutrients
VitaPhos-K™	Precipitation-proof poly-phosphate for soilless Nutrigation™
Multi-ProteK™	Systemic PK fertilizer
Multi-Pepton™	Amino-acid nutritional supplement

Use Haifa NutriNet™ and Haifast™ software to create your optimal Nutrigation™ regime. See details on HAIFA website.

Foliar Feeding

Foliar Teaspoon-Feeding™ is a fast, highly effective method of providing nutrients when used as a supplement to administering fertilizers through the soil. It is an ideal feeding method under certain growth conditions in which absorption of nutrients from the soil is inefficient, or for use on short–term crops. Precision-timed foliar sprays are also a fast-acting and effective method for treating nutrient deficiencies.
Foliar application of the correct nutrients in relatively low concentrations at critical stages in crop development contributes significantly to higher yields and improved quality.

HAIFA offers a selection of fertilizers for foliar application:
Haifa-Bonus™ High-K foliar formulas enriched with special adjuvants for better absorption and prolonged action
Poly-Feed® Foliar NPK formulas enriched with micronutrients specially designed to enhance the crop performance during specific growth stages
Poly-Amin™ Growth promoting foliar amino-acid preparation
Magnisal®, **Multi-MAP™**, **Multi-MKP™**, **Multi-Cal®** and **Multi-Micro®** are also suitable for foliar application.

HAIFA's innovative Teaspoon-Feeding™ fertilizer products and modern application methods provide the ideal solution for the nutritional needs of any crop under all growth conditions.

Controlled Release Nutrition

Multicote® innovative fertilizers for Teaspoon-Feeding™ release plant nutrients gradually and steadily according to plants' needs throughout the growing season.
HAIFA's Multicote polymer-coated fertilizers slowly release plant nutrients into the soil solution at a pre-determined rate. Moisture in the soil is absorbed by the fertilizer granules - dissolving the nutrients inside and releasing them into the root zone.
The release rate is determined by the soil temperature, which is also a major factor affecting plant growth rate. Soil type, humidity, PH, and microbial activity do not affect the release rate.
A single application of Multicote fertilizers is sufficient to provide balanced nutrition for the duration of the growing season – significantly saving labor and costs.
Multicote fertilizers ensure maximal uptake by the root system - leaving no excess fertilizer to contaminate the soil or groundwater.

HAIFA offers a selection of smart controlled-release fertilizers to suit all crops and growing conditions:
Multicote® for nurseries and ornamentals; NPK formulae with release longevities of 4, 6, 8, 12 and 16 months
Multicote® Agri / **Multigro® for** agriculture and horticulture
CoteN™ controlled-release urea for arable crops
Multicote® Turf / **Multigreen®** for turf

Multi-K®

Potassium nitrate products

Multi-K®, Haifa's potassium nitrate, is a unique source of potassium in by its nutritional value, fertilization efficiency and application considerations, and environmental impact.

Multi-K® contains 100% plant macronutrients – potassium (K) and nitrate-nitrogen ($N\text{-}NO_3$). It is free of chloride, sodium and any other plant-detrimental elements.

Plants absorb the potassium and the nitrate from Multi-K® rapidly, in a balanced manner. This improves the movement of both ions in the plant, enhancing its performance.

Crystalline Multi-K products

Crystalline Multi-K® products are fast dissolving and easily integrated in the soil solution. The crystalline form is ideally suited for Nutrigation™ (fertigation) and foliar application.

Nutrigation™ with Multi-K® improves the uptake of potassium and nitrate by the plant roots, and minimizes leaching of nutrients below the root zone. Millions of cultivated acres worldwide have shown the superiority of Multi-K® for Nutrigation™ of high added-value protected crops such as tomatoes, cucumbers, bell-pepper, roses, chrysanthemum, etc. Multi-K® products can be mixed with phosphate, magnesium and calcium fertilizers to prepare nutrient solutions with no risk of clogging of the irrigation system.

Foliar feeding of fruit crops with Multi-K® products results in higher yields and better yield quality. Multi-K® retains atmospheric water when sprayed on leaves, thereby extending the absorption period by the leaves. It is free of harmful elements and highly compatible with other plant nutrients and agrochemicals. Combining Multi-K with other agents results in remarkable savings in labor, time and machinery.

*for high-K foliar nutrition, Bonus-npK® is recommended

Multi-K Classic	13-0-46	Pure potassium nitrate

Special grades

Multi-K GG	13.5-0-46.2	Greenhouse-grade potassium nitrate
Multi-K pHast	13.5-0-46.2	Low-pH potassium nitrate
Multi-K Top	13.8-0-46.5	Hydroponics-grade potassium nitrate

Enriched products

Multi-npK	13-5-42	Potassium nitrate enriched with phosphorus
	13-3-43	
	13-2-44	
Multi-K Mg	12-0-43+2MgO	Potassium nitrate enriched with Magnesium
	11-0-40+4MgO	
	12-2-43+1MgO	
	12-2-42+2MgO+0.5Mn	
	12-0-42+2MgO+0.2B	
Multi-K Zn	11-0-40+4Zn	Potassium nitrate enriched with Zinc
	12-0-43+2Zn	
Multi-K S	12-0-46+4.5 SO_3	Potassium nitrate enriched with Sulfate
Multi-K B	12-0-44+0.5 B	Potassium Nitrate enriched with Boron
Multi-K ME	12-0-43+Mg+ME	Potassium nitrate enriched with magnesium and micronutrients

Multi-K® prills

For direct soil application (side-dressing)

Multi-K Prills	13-0-46	Potassium nitrate prills
Multi-npK Prills	13-3-43	Potassium nitrate enriched with Phosphorus
	13-2-44	
Multi-K Mg Prills	12-0-42+2MgO	Potassium nitrate enriched Magnesium
	11-0-39+4MgO	

Poly-Feed®

Water-soluble NPK fertilizers

Poly-Feed is a range of fully water-soluble NPK fertilizers, designed to provide complete plant nutrition throughout the growth season. The wide choice of formulae and compositions meets the needs of vegetable crops, fruits and flowers at all types of cropping systems.

The benefits of Poly-Feed® products:

- Fully water soluble, safe for use with all irrigation and spraying systems
- Consists of pure plant nutrients exclusively
- Free of chloride, sodium, and other detrimental elements
- Made of high quality ingredients
- Enriched with high levels of micronutrients
- Good handling and storage properties, due to the Granular Matrix Technology

Poly-Feed® GG (Greenhouse Grade)

Soluble NPK fertilizers for Nutrigation™ and foliar feeding of greenhouse-grown crops

Poly-Feed® GG products are suitable for use with water of varied quality. All the formulae are enriched with high concentrations of micronutrients. Special formulae for soilless culture are based on ammonium nitrate and have K_2O/N ratio and nitrate/ammonium ratio adapted to the conditions prevailing in soilless media.

Poly-Feed® GG products are easily identified by the red color of both the bag and the crystals.

Poly-Feed® Drip

Soluble NPK fertilizers for in Nutrigation™ (fertigation) of fruit-trees vegetables, and all types of crops grown in open field

Poly-Feed® Drip formulae are enriched with magnesium and micronutrients. The Granular Matrix Technology (GMT) grants Poly-Feed® Drip products with improved handling and storage properties. Poly-Feed® Drip products are easily identified by the light-blue color of both the bag and the crystals.

Poly-Feed® Foliar

NPK fertilizers for foliar feeding of open-field crops, protected crops and fruit-trees

Poly-Feed® Foliar nourishes crops with their exact needs during critical growth phases, for maximal yields and top quality.

Poly-Feed® Foliar formulae are based on low-biuret urea and contain remarkably high concentrations of micronutrients in the form of EDTA chelates. The Granular Matrix Technology (GMT) grants Poly-Feed® Foliar products with improved handling and storage properties. Poly-Feed® Foliar products are easily identified by the green color of both the bag and the crystals.

Poly-Feed® MAR

NPK fertilizers enhanced with seaweed extracts

Poly-Feed® NPK fertilizers provide crops with all the nutritional elements needed for healthy development. Enrichment with seaweed extracts stimulates plant growth and improves plant nutrition, resulting in better performance of the fertilizer – and the plant.

The seaweed extracts contain a wide range of nutrients, growth bio-stimulants and conditioners that act together to improve both plant development and soil properties.

A variety of Poly-Feed® formulae are now available, enriched with 0.5% seaweed extracts.

Haifa-Bonus™

High K formula for foliar feeding of fruit-trees and field-crops

Haifa-Bonus™ is an innovate foliar preparation, designed to allow for concentrated spray applications. Haifa-Bonus™ is based on Multi-K® potassium nitrate. Phosphorus (P) enrichment enhances the nutritional value of the product, and reduces its pH for optimal absorption.
Haifa-Bonus™ contains special adjuvants for better adhesion to the leaf surface, improved absorption and prolonged action.

The benefits of Haifa-Bonus™

- Enables highly concentrated sprays, thus less applications are required
- Compatible with a large variety of pesticides, enabling tank mixing them with Haifa-Bonus™, thus saving on spray operations
- Consists of pure, fully soluble nutrients only
- Free of sodium and chloride

Multi-MAP™

Mono-ammonium phosphate (12-61-0)

Multi-MAP™ is a fully water-soluble mono-ammonium phosphate (12-61-0) fertilizer, a highly efficient source of phosphorus and nitrogen for plants.
Multi-MAP™ is recommended for use at the beginning of the growth season, when phosphorus availability is crucial for the establishment of root system.
Multi-MAP™ can be tank-mixed with other fertilizers* to meet crop nutritional needs throughout the growth cycle.

Multi-MKP™

Mono-potassium phosphate (0-52-34)

Multi-MKP™ is a fully water-soluble mono-potassium phosphate (0-52-34) fertilizer a highly efficient source of phosphorus and potassium for plants. Due to its high concentration of plant available phosphorous and potassium, it is a widely used fertilizer, consisting of 100% plant nutrients.
Multi-MKP™ is recommended for use at the beginning of the growth season, when phosphorus availability is crucial for the establishment of root system.
Multi-MKP™ can be tank-mixed with other fertilizers* to meet crop nutritional needs throughout the growth cycle.

Multi-Cal®

Calcium Nitrate

Multi-Cal® is a highly efficient source of available calcium and nitrogen for plants. Calcium is a "quality nutrient" that enhances yield quality and prolongs shelf life of the yields. As calcium is not mobile in the plant, it has to be supplied throughout the growth season to keep adequate levels in the plant tissues and to ensure proper development. The nitrate-nitrogen in Multi-Cal® is readily consumed by the plant and improves the efficiency of calcium uptake.

Three grades of Multi-Cal® are available

- **Greenhouse Grade** (15.5-0-0+26.5 CaO) – For Nutrigation™ of greenhouse crops. Suitable for preparation of fertilizer blends and liquid fertilizers.
- **Nutrigation Grade** (15.5-0-0+26.5 CaO) For Nutrigation™ of field-crops and fruit-trees. Suitable for preparation of fertilizer blends and liquid fertilizers.
- **Agri Grade** (15.5-0-0+27CaO) - Granular fertilizer for base- and side-dressing of field crops

Magnisal®

Magnesium nitrate (11-0-0+16 MgO)

Magnisal® is a fully water-soluble magnesium nitrate (11-0-0+16 MgO) fertilizer. Magnesium deficiency retards the development of plants, resulting in decrease of yields.
Magnisal provides plants with the magnesium together with nitrate-nitrogen, which is readily absorbed by the plant. The nitrate in Magnisal® facilitates and accelerates magnesium uptake by the plant. Magnisal® is the most recommended fertilizer to cure and prevent magnesium deficiencies. Magnisal® is supplied in the form of flakes for convenient handling and dissolution.

Multi-Micro®

Chelated micronutrients

Multi-Micro® is a line of water-soluble chelated micronutrients for Nutrigation™ and foliar application of all crops. The chelated form ensures stability and plant-availability of the micronutrients, even in alkaline soils. Multi-Micro products dissolve rapidly and completely in water, with no risk of clogging of spray nozzles or narrow water passages.

Available products:

Multi-Micro® Fe	Iron-EDTA 13%
	Iron-EDDHA 6%
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
Multi-Micro® Soilless combination	6.5% F3-DTPA, 3.48 Mn-EDTA, 1.02% Zn-EDTA, 0.76% Cu-EDTA 0.485% Mo as ammonium molybdate

VitaPhos-K®

Precipitation-proof phosphate for soilless Nutrigation™

VitaPhos-K® provides plant-available phosphate in the form of soluble polyphosphate, which prevents formation of insoluble precipitates.
In the root zone, the polyphosphate undergoes slow hydrolysis, providing plant-available phosphate over time. The composition of VitaPhos-K® ensures that the hydrolysis occurs at the right time and the right location – by the surface of the root.
VitaPhos-K® helps keeping water passages clean of precipitates and free for water flow, as it dismantles precipitates by bonding cations, which are then released again for plant uptake.

Multi-ProteK™

Systemic PK fertilizer

Multi-ProteK™ is an innovative systemic fertilizer, suitable for Nutrigation™ and for foliar application.
Multi-ProteK™ combines phosphate and phosphite to improve phosphorus uptake by the plant, thus eliminating the occurrence of P deficiencies. It enhances vegetative growth and root development, and increases fruit size and total yields. It also improves the resistance of the plant towards various diseases.
Multi-ProteK™ is environmentally safe and practically non-toxic.
When applied by foliar spray, Muli-ProteK™ leaves neither spots nor toxic residues.

Two analyses are available

- **Standard** 0-26-37+30% HPO_3^{2-}
- **Total** 0-0-39+60% HPO_3^{2-}

Multi-Pepton™

Amino-acid nutritional supplement for Nutrigation™

Multi-Pepton™ is a natural bio-stimulant. It contains Amino acids, low molecular weight peptides and humic acids that act together to support the metabolism of the plant and catalyze growth processes, even under adverse environmental conditions.
All the components of Multi-Pepton™ are 100% natural, so they easily integrate with the plant's metabolism.

Poly-Amin™

Growth promoting foliar amino-acid preparation

Poly-Amin™ is a natural bio-stimulant, specially designed for foliar application. It contains amino acids and low molecular weight peptides that act synergistically to catalyze growth processes and to support the metabolism of the plant. Poly-Amin™ helps the plant to overcome adverse environmental conditions.
Poly-Amin™ is absorbed by the leaves quickly and efficiently without scorching. All the components of Poly-Amin™ are 100% natural, so they easily integrate with the plant's metabolism.

Multicote®

Controlled Release Fertilizers

Multicote polymer-coated controlled release fertilizers release plant nutrients slowly and continuously throughout the growth cycle. A single application of Multicote® will take care of optimal plant nutrition over months. Multicote® is available at a wide range of formulae, and with release longevities of 4 to 16 months (at soil temperature of 21°C). Most formulae are enriched with micronutrients.

The advantages of Multicote

- Plant nutritional needs are met by single application per season
- Reliable release profile, which is unaffected by soil type, soil pH, moisture or microbial activity.
- Broad selection of products for an extensive variety of applications
- High concentration of nutrients
- Homogenously distributed in the soil or potting mix

Multicote release longevity

Multicote release rate increases with temperature, and the longevity is decreased accordingly.

	15°C (60°F)	21°C (70°F)	30°C (86°F)
Multicote 4	6 months	4 months	2 months
Multicote 6	7-8 months	6 months	3-4 months
Multicote 8	9-10 months	8 months	5-6 months
Multicote 12	15-16 months	12 months	7-8 months
Multicote 16	20-22 months	16-18 months	9-10 months

Recommended applications

Longevity	Recommended for
4 months	Bedding plants, pot plants and hanging baskets
6 months	Bedding plants, pot plants, garden trees and shrubs
8 months	Container-grown nursery stock, garden trees and shrubs
12 months	Container-grown nursery stock
16 months	Container-grown nursery stock, specially recommended for use in tropical and sub-tropical regions

Multicote® Agri

Controlled Release Fertilizers for Agriculture & Horticulture

Taking advantage of MulticoTech™ polymer coating technology, HAIFA has developed Multicote® AGRI - a family of controlled-release fertilizer products for agriculture and horticulture. Multicote® AGRI products contain polymer-coated sources of nitrogen, phosphorus and potassium, with release longevity of 2-8 months.

Multicote® AGRI products are recommended for cash crops in open field, protected crops and fruit-trees. For arable crops, CoteN™ polymer-coated urea, and CoteN™ Mix polymer-coated urea with readily available nutrient, products are recommended.

Recommended applications

Multicote® AGRI products are highly recommended in the following cases:

- On light soils, where conventional fertilizers are easily leached
- In rainy areas, when rainfall accelerates nutrient leaching
- Wherever nitrogen application is limited e.g., by environmental regulations
- For crops with a shallow root system
- For crops with high nutritional requirements
- In cases where mid-season application is not feasible (e.g. when the crop covers the soil surface, in mulched crops and in muddy fields)

Multicote® Turf

Controlled Release Fertilizers for Turf

Proper nutrition is an essential condition for healthy, vigorous, good-looking turf. Multicote® TURF product line fully addresses all growth factors. It offers optimized fertilization programs for every combination of turf species, climate conditions and maintenance level. Multicote® TURF year-round nutritional programs are composed of formulae with different N:K ratios, addressing the changing nutritional needs of the turf plant and supporting seasonal growth processes.

Product	N:K* ratio	Action
Booster	2:1	Dormancy breaker; Initiates intensive leaf growth
Feeder	1:1	Balanced fertilizer, regulates root and shoot growth. Helps maintaining turf quality and strength during seasons of intensive use.
Keeper	1:2 or 1:3	High-potassium fertilizer supports last leaf growth and builds carbohydrate storage.
Multi-K® Turf	1:3	Quickly available potassium fertilizer; “Quick action for tough periods”.

For close-cut turf, the Multicote® TURF **MINI range** of fine prilled products is recommended.

Appendix II: Conversion tables

From	To	Multiply by	From	To	Multiply by
P	P_2O_5	2.29	P_2O_5	P	0.44
P	PO_4	3.06	PO_4	P	0.32
H_3PO_4	H_2PO_4	0.9898	H_2PO_4	H_3PO_4	1.38
K	K_2O	1.20	K_2O	K	0.83
Ca	CaO	1.40	CaO	Ca	0.71
Mg	MgO	1.66	MgO	Mg	0.60
S	SO_3	2.50	SO_3	S	0.40
S	SO_4	3.00	SO_4	S	0.33
N	NH_4	1.28	NH_4	N	0.82
N	NO_3	4.43	NO_3	N	0.22

From	To	Multiply by	From	To	Multiply by
Acre	Hectare	0.405	Hectare	Acre	2.471
Kilogram	Lbs	2.205	Lbs	Kilogram	0.453
Gram	Ounces	0.035	Ounces	Gram	28.35
Short Ton	MT	0.907	MT	Short Ton	1.1
Gallon (US)	Liters	3.785	Liters	Gallon (US)	0.26
Kg/Ha	Lbs/acre	0.892	Lbs/acre	Kg/Ha	1.12
MT/Ha	Lbs/acre	892	Lbs/acre	MT/Ha	0.001

1 meq	Correspondent element (mg)	1 mmol	Correspondent element (mg)	Weight of ion
NH_4^+	14 mg N	NH_4^+	14 mg N	18 mg NH_4^+
NO_3^-	14 mg N	NO_3^-	14 mg N	62 mg NO_3^-
$H_2PO_4^-$	31 mg P	$H_2PO_4^-$	31 mg P	71 mg P_2O_5
HPO_4^{2-}	31 mg P	HPO_4^{2-}	31 mg P	35,5 mg P_2O_5
HPO_4^{2-}	15.5 mg P	K^+	39 mg K	47 mg K_2O
K^+	39 mg K	Ca^{2+}	40 mg Ca	28 mg CaO
Ca^{2+}	20 mg Ca	Mg^{2+}	24 mg Mg	20 mg MgO
Mg^{2+}	12 mg Mg	SO_4^{2-}	32 mg S	48 mg SO_4
SO_4^{2-}	16 mg S	Na^+	23 mg Na	-
Na^+	23 mg Na	Cl^-	35.5 mg Cl	-

Chile

Trasplante

Regar solamente con agua durante los primeros 10 días y posteriormente iniciar la fertilización de arranque durante las primeras tres semanas después del trasplante.

Cuadro 4. **NUTRIGACIÓN® DE ARRANQUE CON Poly-feed Drip® 13-36-13+2MgO+ME**

DOSIS (kg/ha/semana)	P_2O_5 (kg/ha/semana)	P_2O_5 (kg/ha/día)
6	2.1	0.3
12	4 .3	0.6
18	6 .5	0.9
24	8.6	1.2

Programa foliar para Chile

Cuadro 5. **FERTILIZACIÓN FOLIAR**

Fertilizante	Dosis (%)	Dosis (kg/ha)	Etapa
Poly-feed® 12-43-12+ME	0.5-1.0	1-2	Trasplante
Poly-feed® 19-19-19+ME	1.0-2.0	3-4	Vegetativa
Magnisal®	0.5	1-2	
Multi-Micro® COMB	0.1	0.5	
Poly-feed® 10-10-43+M.E.	1.0-2.0	3-4	Fructificación

Se recomienda acondicionar el agua a pH 6.5
Intervalos de aplicaciones : 15 días

Programas de Nutrigación® para Chile

OPCIÓN 1 NUTRIGACIÓN® EN CAMPO ABIERTO CON MOLÉCULAS




D D T		Demanda de Nutrientes (Kg/ha)					Fertilizantes Recomendados (Kg/ha)					
		N	P_2O_5	K_2O	CaO	MgO	NA*	Multi MAP	Multi npK	Nitrato Calcio	Magnisal	Multi Micro COMB
Trasplante												
	Día											
1 - 10	Etapa	0	0	0	0	0	0	0	0	0	0	0
Estabilización												
	Día	1.0	1.5	0.7	0.5	0.2		2.4	1.7	1.9	1.5	0.10
11 - 30	Etapa	19	30	15	10	5	0	48	34	38	30	2
Botoneo-floración												
	Día	2.0	2.0	3.0	0.5	0.2	0.8	3.0	6.8	1.9	1.5	0.10
31 - 50	Etapa	39	40	60	10	5	16	61	136	38	30	2
Cuaje 1er Fruto												
	Día	3.2	1.0	5.0	1.0	0.5	2.0	1.3	11.4	3.8	3.2	
51 - 75	Etapa	80	25	125	25	13	50	31	285	95	80	0
Fructificación-Cosecha												
	Día	2.5	1.0	4.0	1.0	0.5	0.6	1.4	9.1	3.8	3.2	
76 - 100	Etapa	62	25	100	25	13	15	34	228	95	80	0
TOTAL		**200**	**120**	**300**	**70**	**35**	**81**	**174**	**683**	**266**	**220**	**4**

Nu trigación:
pH: 5.5-6.5
CE: 1.0-2.0 dS/m
No mezclar Nitrato de Calcio con P ni S

NA* Nitrato de Amonio / Fosfonitrato de Amonio

NOTA: Alternativamente recomendamos la aplicación de **Poly-feed Drip® 13-36-13 en el transplante (ver *Cuadro 4*)

OPCIÓN 2 NUTRIGACIÓN® EN CAMPO ABIERTO CON Poly-feed Drip®


D D T		Demanda de Nutrientes (Kg/ha)					Fertilizantes Recomendados (Kg/ha)					
		N	P_2O_5	K_2O	CaO	MgO	13-36-13 +2MgO	18-18-18 +2MgO	14-7-28 +1MgO	12-5-40 +1MgO	Nitrato Calcio	Multi Micro COMB
Trasplante												
	Día											
1 - 10	Etapa	0	0	0	0	0	0	0	0	0	0	0
Estabilización												
	Día	0.8	1.5	0.5	0.5	0.1	4.2				1.9	0.10
11 - 30	Etapa	17	30	11	10	2	84	0	0	0	38	2
Botoneo-floración												
	Día	2.0	2.0	3.0	0.5	0.2	3.7		9.0		1.9	0.10
31 - 50	Etapa	41	39	60	10	3	74	0	180	0	38	2
Cuaje 1er Fruto												
	Día	2.4	1.0	5.0	1.0	0.2		2.5		11.4	3.8	
51 - 75	Etapa	60	26	125	25	4	0	63	0	285	95	0
Fructificación-Cosecha												
	Día	2.2	1.0	4.1	1.0	0.2		3.0		9.0	3.8	
76 - 100	Etapa	55	25	104	25	4	0	75	0	225	95	0
TOTAL		**173**	**120**	**300**	**70**	**13**	**158**	**138**	**180**	**510**	**266**	**4**

Nutrigación:
pH: 5.5-6.5
CE: 1.0-2.0 dS/m
No mezclar Nitrato de Calcio con P ni S

NOTA: Alternativamente recomendamos la aplicación de **Poly-feed Drip® 13-36-13 en el transplante (ver *Cuadro 4*)
En caso de requerir mayor aporte de Magnesio agregar **Magnisal 11-0-0+16MgO**

Programas de Nutrigación® para Chile

Invernaderos, cultivos en suelo

D D T		Demanda de Nutrientes (Kg/ha)						Fertilizantes Recomendados (Kg/ha)					
		N	P_2O_5	K_2O	CaO	MgO	S	NA*	Multi MAP	Multi npK	Nitrato Calcio	Magnisal	Multi Micro COMB
Establecimiento-Floración													
	Día	1.0	1.5	1.1	0.5	0.2			2.4	2.4	1.7	1.4	
11 - 30	Etapa	20	30	21	9	4		0	48	48	34	28	0
Desarrollo de fruto													
	Día	2.0	1.0	3.0	1.0	0.5		0.1	1.4	6.8	3.8	3.1	0.10
31 - 60	Etapa	60	30	90	30	15		3	42	204	114	93	3
Maduración de Fruto-Cosecha													
	Día	3.5	1.0	5.0	1.0	0.5		3.1	1.3	11.4	3.8	3.1	0.10
61 - 120	Etapa	210	60	300	60	30		183	77	681	228	186	6
Cosecha													
	Día	3.5	1.0	5.0	2.0	1.0			1.3	11.4	7.6	6.3	0.10
121 - 180	Etapa	209	60	300	120	60		0	76	681	453	378	6
Cosecha													
	Día	3.5	1.0	5.0	2.0	1.0			1.3	11.4	7.6	6.3	0.00
181 - 240 **	Etapa	209	60	300	120	60		0	76	681	453	378	0
TOTAL		**710**	**240**	**1,010**	**340**	**170**		**186**	**319**	**2,295**	**1,282**	**1,063**	**15**

Nutrigación:
pH: 5.5-6.5
CE: 1.0-2.0 dS/m
No mezclar Nitrato de Calcio con P ni S

NA* Nitrato de Amonio / Fosfonitrato de Amonio
** Ciclo de cultivo variable según variedad y zona geográfica

Invernaderos, cultivos sin suelo: Plantación de Verano

Etapa de desarrollo	Demanda de Nutrientes en ppm (g/m3)					Fertilizantes Recomendados (g/m3)				
	N	P_2O_5	K_2O	CaO	MgO	Multi MKP	Multi npK	Nitrato Calcio	Magnisal	Multi Micro COMB
Establecimiento-Floración	98	50	130	70	40	87	229	263	247	1.0
Crecimiento del fruto	143	80	220	100	50	139	393	376	310	1.5
Maduración del fruto-Cosecha	153	90	220	120	50	158	377	451	310	1.5
Cosecha	141	90	220	100	50	159	377	376	310	1.5
Cosecha	170	100	260	120	60	175	455	451	372	1.5

Notas para Nutrigación® en Invernadero sin suelo:

- Ajustar el pH 5.5 – 6.5
- CE 1.0 – 2.0 dS/m
- No mezclar Nitrato de Calcio con P ni S
- Se recomienda mayor proporción de Nitrógeno nítrico (NO_3) en la solución nutritiva y niveles mínimos o nulos de Nitrógeno amoniacal (NH_4), máximo 10%.

Invernaderos, cultivos sin suelo: Plantación de Otoño

g/m^3 equivale a ppm (partes por millón)

Etapa de desarrollo	Demanda de Nutrientes en ppm (g/m3)					Fertilizantes Recomendados (g/m3)				
	N	P_2O_5	K_2O	CaO	MgO	Multi MKP	Multi npK	Nitrato Calcio	Magnisal	Multi Micro COMB
Establecimiento-Floración	98	50	130	70	40	87	228	263	247	1.0
Crecimiento del fruto	144	80	220	100	50	138	394	376	310	1.5
Maduración del fruto-Cosecha	172	90	270	120	55	155	493	451	341	1.5
Cosecha	163	90	240	120	55	156	424	451	341	1.5
Cosecha	133	80	210	100	40	140	368	376	247	1.5

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Altos rendimientos y mejor calidad de Chile

En México, el chile no sólo es la hortaliza de mayor tradición, es también un cultivo de alto valor económico que se cultiva ampliamente en diversas regiones del País. Existe gran diversidad, entre los que destaca el ancho, serrano, jalapeño y pimiento. Actualmente las variedades de alto rendimiento exigen una nutrición balanceada en cada etapa de desarrollo. La línea de Haifa comprende fertilizantes sólidos solubles de elevada pureza, recomendables para aplicaciones foliares y en los programas de Nutrigación®.

Las dosis de fertilización depende del análisis del suelo, la meta de rendimiento y densidad de plantación.

Cuadro 1. **EXTRACCIÓN DE NUTRIENTES POR TONELADA COSECHADA DE CHILE**

NUTRIENTE		kg/ T.M.
NITRÓGENO	N	3.5
FOSFORO	P_2O_5	0.3
POTASIO	K_2O	5.0
CALCIO	CaO	1.4
MAGNESIO	MgO	1.7
AZUFRE	SO_4	1.8

Cuadro 2. **EXTRACCIÓN DE MICRONUTRIENTES POR TONELADA COSECHADA DE CHILE**

NUTRIENTE		g/ T.M.
FIERRO	Fe	109.2
MANGANESO	Mn	65.5
ZINC	Zn	44.0
COBRE	Cu	43.7
BORO	B	21.8
MOLIBDENO	Mo	0.4

Fertilización de fondo

multi-Ter® Mezcla física mejorada con **multi-npK Prill®**. Se recomienda para suelos medios y arcillosos. El balance de las fórmulas depende del nivel de fósforo en el suelo. Y la dosis de aplicación va de 300 a 400 kg/ha. *(Cuadro 3)*

FÓSFORO EN EL SUELO	BALANCE N-P-K	FÓRMULA multi-Ter®
BAJO	1-3-1	10-30-10
MEDIO	1-2-1	12-24-12
ALTO	1-1-1	15-15-15

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