

‘Haifa Nutri-Net’ - a Comprehensive Crop Nutrition Software, Operated Over the Web

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Abstract

‘Haifa Nutri-Net’ is a powerful tool made to assist growers to formulate their crop nutrition programs and irrigation schemes by integrating virtually all relevant cultivation parameters. This expert software is based on comprehensive databases of crop nutrition, irrigation, soil and climate, covering almost every growth environment. The input stages prompt the user to enter his own data or to capture relevant data from databases available within the program. All these data are then integrated by the software into a detailed optimized crop nutrition program. The more detailed and accurate the input provided, the better it addresses the specific conditions of the grower, and consequently, higher productivity and profitability can be expected.

This software is operated exclusively over the web.

‘Haifa Nutri-Net’ generates a detailed nutrigration (= fertigation) program in accordance with the following parameters:

- Crop-specific nutrition functions of 80 common crops at their typical yield levels.
- Growth methods
- Soil & water parameters
- Climate conditions
- Irrigation method and schedule

While building the nutrition scheme a wide variety of fertilizers is suggested for the different applications. It is formulated in stages, consistent with the irrigation method, and made by the user’s preferences based on pre-planting application and/or side/top dressing and/or nutrigration and supplementary foliar feeding.

When the nutrition scheme is based on nutrigration, the application program is further broken down into fertilizer rates, growth phases and days.

The final scheme can be sent directly from the software as an attachment by e-mail, or printed out and faxed.

The comprehensive databases included in the software can independently serve the user by citing references on nutrient uptake of a variety of crops, supplying a wealth of data characterizing the phenological stages of the crop and Etp (=evapo-transpiration) data, and photos of nutrient deficiency symptoms in many crops.

Haifa Nutri-Net supports the most common units of mass and area.

English and Spanish interfaces are available.

Key-words: base-/ side-/ top- dressing, expert software, fertigation/nutrigration, irrigation, plant nutrition.

1 Introduction

There are many textbooks detailing crop nutritional requirements of numerous crops grown under specific cultivation conditions. There are also computer softwares capable of generating nutrition recommendations for various crops, mainly grown on inert soilless media in greenhouses. Only the capabilities of the computer can help in producing optimal detailed plant nutrition schemes, for field crops, outdoor vegetables, fruit trees and greenhouses, taking into account the extremely complex interrelationships between all growth factors. A partial list of the factors that need to be addressed includes maximization of the yield, the need to adapt nutrient inputs to yield levels and to environment regulations, the extensive variety of soil and climate conditions, previous crop mineral residues, irrigation methods and equipment, a variety of simple fertilisers for base-dressing and specialty fertilisers for top-dressing or continuous feeding by nutrification (fertigation), and so forth. Compiling all this know-how into a working software requires in-depth knowledge of all agronomical factors, their effect on the performance of the crop, and moreover- of quantifying and transforming them into valid algorithms. The intensive proliferation of the Internet now facilitates the dissemination of agricultural know-how throughout the globe. Furthermore, this know-how can thus be easily updated, while the algorithms, crop functions and the interface can be easily changed at the Internet server level, enabling the creation of a community of expert users who mutually contribute to themselves, as well as to the entire interested public. Another benefit of the Internet platform is that it can be used to distribute profound, quantified know-how, which is developed and concentrated by highly developed civilizations, but is not otherwise available to the majority of nutrition- technicians, and growers worldwide. Uploading the most developed know-how to the Internet and making it equally available to all interested surfers can therefore, increase the usage efficiency of agricultural inputs and reduce hunger in the world.

2 Materials and methods

Sources of information and type of data utilized

An extensive list of publications was resourced to obtain all relevant details concerning the mineral (N, P, K, Ca & Mg) nutrition of 80 crops, commonly cultivated by growers all over the world. Many nutrition schemes from over 100 noted growers worldwide were integrated in the databases. Whenever applicable, specific data were utilized for every crop for different cropping managements such as open-field, tunnels and greenhouses. The data were used to produce differential crop nutrition functions for typical yield ranges for different growth conditions. These functions were the building- blocks determining the specific mineral requirements for up to 12 growth-phases per crop.

Additional sources were mined to obtain crop-specific recommended ranges of leaf mineral analyses and photos of nutrient deficiency symptoms.

The soil- related parameters used by the software were taken from professional textbooks. Soil parameters include soil texture, extraction values of pH and E.C., % clay, % active lime, % organic matter, extract contents of NO₃, P, K, Ca, Mg, Na and cation exchange capacity. Whenever appropriate, several extraction and analysis methods were addressed.

Since irrigation- and, hence, nutrification- schemes depend on expected local meteorological conditions that are not always known by the grower, a great number of meteorological stations and their detailed databases were integrated into the software.

In order to help growers, using all kinds of irrigation methods and equipment, take advantage of the software, it provides solutions for a large variety of irrigation methods and water emitting devices such as flooding, sprinklers, micro-jets and drippers.

Software programming

The software has been programmed in "Visual Basic 6". It is operated under MS Explorer or other standard Internet browsers and, therefore, does not require special installation. It employs common "Windows" ('98 and higher) techniques.

Accessing the software

It can be accessed on Haifa Chemicals website: <http://www.haifachem.com/>, which enjoys a wide band communication facility, and can, therefore, serve many users simultaneously. The direct URL for 'Haifa Nutri-Net' is: <http://www.haifa-nutrinet.com/>.

To serve Spanish-speaking users a Spanish interface has been installed too.

Server arrangements and administration system

Considerable space on the server has been allocated for the users, enabling them to create their own private libraries of nutrition scheme files.

The administration system controlling the surfing activity has limited the usage of this software since it was launched in mid 2003 until recently, to Haifa affiliated people only, as their professional tool, and in order to detect and remove all possible bugs, before opening it up to worldwide usage.

The administration system also enables to monitor surfing traffic by country of origin, number of surfing sessions and their durations, and number of completed schemes by dates.

3 Results

A step-by-step process leads the user through the essential stages of building a scheme of fertilisation, irrigation and nutrification for a specific plot. This scheme specifies the nutrients & fertilisation products recommended for every growth stage at a resolution of days. In several stages the user can choose between two or three levels of supplying the information. The more detailed and accurate the data supplied by the user, the higher the quality of the scheme and consequently- the productivity and profitability of the plot for which it was prepared. Finally the program outputs an application schedule of nutrient and irrigation rates per hectare, including concentrations of soluble fertilisers in the irrigation water. Furthermore, it produces a recommendation report that can be forwarded to any remote address by e-mail (directly from the software) or by fax.

Description of the working procedure.

When the user wishes to create a new nutrition program he needs to follow the following steps.

A. Name the new nutrition/irrigation scheme and save it under this name in a private library allocated to him only. Thus every progress step is documented and saved for future reference.

B. Introduce crop data.

1. Select crop in question from the 4 following crop groups, appearing in 4 combo- boxes:
 - 20 vegetable crops, e.g., beans, cucumbers, carrots, lettuce, melons, peppers, squash, tomatoes.
 - 20 field crops, e.g. cotton, maize, pineapple, rice, soybean, sugar beets, tobacco.
 - 20 fruit trees, e.g. apples, vineyard, oranges, grapefruits, nectarines, olives, peaches, pears, prunes.
 - 20 subtropical & tropical crops, e.g. banana, coffee, durian, guava, kiwi, litchi, mango, papaya.
2. Select growth method between open field, tunnel or greenhouse
3. Enter expected yield level.
4. Insert previous crop details, to take into consideration its nutritional residues in the soil.

After pressing 'enter' the software instantaneously computes the total expected rates of N, P, K, Ca & Mg required to optimally support the expected yield. The nutrient rates removed by the yield and those taken up by the whole plant are presented in different fields. A corresponding set of figures indicates the default nutrient rates needed to be supplied in kg/ha (see figure 1). At this stage a specifically designed tool expresses the results also in a variety of other area units (rai, dunam, acre /feddan, mu) and mass units (pound and bushel). Additionally, the user can now retrieve crop- specific literature citing the data utilized to produce this recommendation.

C. Introduce soil data

1. Select between basic and two advanced levels of information about soil properties.
2. Introduce all soil data available, such as soil texture, extraction pH and E.C., % clay, % active lime, % organic matter, extract contents of: NO₃, P, K, Ca, Mg, Na and cation exchange capacity. Wherever appropriate, relevant extraction and analysis methods should be selected. When completing this process, the software will take into account the actual soil fertility and update the recommendations obtained at step B.

3. Alternatively, when dealing with fruit trees the user is prompted to introduce leaf analysis data because this information is generally more indicative regarding the nutritional status of the trees.

D. Select irrigation method

1. Select the current irrigation method between flooding, pivot, sprinklers, micro-jet or dripping.
2. Select between nutrification and side- or top- dressing of the fertilizers during crop growth.
3. The software will consequently distribute the recommended nutrients (determined at step C) between base-dressing and side- or top- dressings or nutrification, after considering the typical efficiency factors of these application methods under the soil characteristics specified at step C.

When completing this stage the user can also overrule the recommendations and dictate other figures according to parameters that were not previously quantified, such as his personal experience with the plot in question. The use of foliar feeding can be inserted at this stage and the nutrients applied by this method can be either added or deducted from the previously planned applications.

E. Select fertiliser application methods and rates

1. *Base- dressing.* Based on the allocation of nutrients for base-dressing indicated at the end of step D, the software suggests a variety of common high longevity fertilisers (e.g. superphosphate, potassium sulfate, dolomite & magnesium sulfate) and their application rates, to supply the nutrient rates required. See figure 2.
2. *Side-/ top- dressing and nutrification.* Based on the allocation of nutrients for side- or top dressing indicated at the end of step D. The software offers a variety of fully soluble fertilizers and their application rates, to supply the nutrient rates required. Free choice of fertilisers and their rates is offered at this stage too.

F. Prepare nutrification program

1. *Introduce irrigation parameters.* The user selects and quantifies several agro-meteorological, irrigation efficiency and soil-parameters (e.g. evapo-transpiration rate, wetted area percentage, field capacity & wilting point) concerning the irrigation schedule. Again, if the user needs help in completing these data, he can easily access built-in large databases that cover most of the agricultural regions in the world. Crop-specific water requirements and root- system profile are taken care of as well. Then the user is prompted to define main growth stages at a resolution of days. After considering all these data, a complete irrigation scheme is formulated by growth stages and growth days. The user can amend this scheme based on personal experience.
2. *Nutrition scheme.* Based on the allocation of nutrients for the previously defined growth stages and on the irrigation scheme, a nutrification scheme is formulated by growth stages and growth days. The nutrification scheme suggests the nutrients and the specialty fertilizers to supply them, as well as their rates, at a resolution of growth stages and growth days (e.g. kg nitrogen per ha for the flowering stage, and kg of ammonium-nitrate per ha per day). Table 1 depicts the actual figures obtained for the greenhouse pepper nutrification scheme presented in figures 1 & 2. These rates can be expressed also in other units as mentioned in step B4. A special function enables assessment of the concentrations of the fertilizers in the irrigation water to check for dangerously high values.

G. Prepare status reports.

Such reports can be produced at any stage of formulating the scheme. The reports can be e-mailed from the software itself or printed out and sent to a remote address for discussion or as a final recommendation. Table 2 shows how all climate- dependent water balance factors for greenhouse peppers are worked out by growth stages. Table 3 shows how the above water deficits are supplied by irrigations, defined by their timing, intervals and rates.

Usage dynamics

Usage statistics produced by the administration system show that the total usage among Haifa- affiliated agronomists has more than trebled, from 94 new programs created in the first third of 2004, to 310 created in the first third of 2005 (figure 3). As of mid May 2005, we had over 6000 users sessions. The usage was more or less evenly distributed between Asia, Africa, Europe and the Americas (figure 4).

Technical accessories. This module contains a very rich toolbox that can be helpful to any user. Some of the most useful tools we can mention are: many specific nutrient deficiency symptoms, crop nutrition literature, crop nutritional requirements, meteorological databases, and technical irrigation tables.

4 Discussion

Since the 'Haifa Nutri-Net' software had been launched in mid-2003 it passed many changes. These changes made it, on the one hand more sophisticated, more professional, and more capable of addressing different cultivation conditions. On the other hand the changes introduced made it more accessible and intuitively operated by the common user. It is now very comprehensive and capable of creating crop nutrition schemes for a large variety of agricultural and horticultural cultivation conditions, worldwide.

It is our intention to make 'Haifa Nutri-Net' more available and useful by offering it to all interested parties, such as growers, crop nutrition technicians and supervisors, consultants, advisors and extension officers, students, researchers and policy makers in the agricultural sector. In order to enhance its usage we will add the following functions to it: translate it to several more languages; add other crops of interest; start a users' forum; create an open library of nutrition recommendations for the crops addressed by this software, to help the users make sure their results are within the norm; enable users to create their own meteorological databases, and more.

The ever-increasing usage figures (Fig. 3) and the feedbacks from the users show that the childhood bugs have been overcome, and that this is now a mature product. The massive interest that was translated to considerable usage was equally distributed around the world (Fig. 4). We feel that by this we realized one of the goals of this software, to distribute advanced crop nutrition methods to both the developed and the developing parts of the world. We therefore, as of May 2005, opened it up to every interested surfer, worldwide in order to try and make it a standard tool for the benefit of mankind.

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6 Tables and figures

Table 1 A nutrification scheme produced by 'Haifa-Nutri-Net', for greenhouse peppers, by growth stages

Growth phase	Days from sowing/ planting	Days per phase	Recommendation for fertilizer application (kg/ha)		
			Ammonium nitrate (33% N)	Mono-ammonium phosphate (12-61-0)	Multi-K (potassium nitrate) 13-0-46
Planting	1	1	0	0	0
Vegetative	25	24	18	2	22
Flowering	35	10	8	2	9
Fruit-set	45	10	8	2	9
First harvest	70	25	33	5	48
Harvest	120	50	70	8	93
Harvest	170	50	140	16	187
Last harvest	240	70	144	18	198

Table 2 Water requirement factors for greenhouse peppers by growth stages, as compiled by 'Haifa-Nutri-Net'.

Growth phase	Pan evaporation (mm/day)	Water requirement (m ³ /ha)	Rainfall (mm)	Water deficit (m ³ /ha)	Day	Month
Planting	2.8	3	7	0	15	3
Vegetative	3.08	222	21	12	9	4
Flowering	3.57	143	9	53	19	4
Fruit-set	3.78	189	8	109	29	4
First harvest	4.21	736	16	576	24	5
Harvest	5.21	2086	6	2026	13	7
Harvest	5.16	2063	8	1983	1	9
Last harvest	3.17	1777	47	1307	10	11

Table 3 An irrigation scheme for greenhouse peppers by growth stages, as produced by 'Haifa-Nutri-Net'.

Growth phase	Number of irrigations per growth phase	Irrigation rate (m ³ /irrigation)	Interval (days)	Total water application (m ³ /ha/phase)	Total water application (m ³ /ha)
Planting	1	0	1	0	0
Vegetative	1	12	24	12	12
Flowering	1	53	10	53	65
Fruit-set	2	55	5	110	175
First harvest	6	96	4	576	751
Harvest	16	127	3	2032	2783
Harvest	16	124	3	1904	4767
Last harvest	9	145	8	1305	6072

Haifa Nutri-Net דיטריט

Nutrient requirements
Soil analysis
Plant analysis
Fertilization
Crop-growth cases
Root zone
Irrigation
Nutrigation

Vegetables ▶

- peas
- pepper
- potatoes
- radish
- squash
- strawberry
- tomatoes
- watermelon


Field crops ▶

Orchards ▶

Sub-tropical ▶

Crop-nutrition literature

Nutrient requirements - pepper



Growth method : greenhouse ▼

Yield range : 15 - 200 tons/ha

Expected Yield : 70 tons/ha Enter

Nutrients requirements (kg/ha)				
N	P ₂ O ₅	K ₂ O	CaO	MgO
Removal by yield				
140	42	245	35	21
Uptake by whole plants				
286	75	432	189	62
Available nutrients from recycled previous crop				
 	 	 	 	
Recommended application rates (default)				
343	219	562	95	62

Fig. 1 Screen of crop selection and nutrient requirements

Haifa Nutri-Net דיטריט

Nutrient requirements
Soil analysis
Plant analysis
Fertilization
Crop-growth cases
Root zone
Irrigation
Nutrigation

Fertilization ▶

Base dressing ▶

Top/side dressing ▶

Foliar feeding ▶

Base dressing - pepper

All nutrients in kg/ha

	N	P ₂ O ₅	K ₂ O	CaO	MgO
Suggested base dressing	76	29	121	0	38
Actual base dressing					

% Surface covered 100% ▼

Ammonium nitrate (34%)	230
Superphosphate (25%)	117
Potassium sulfate (50%)	243
Dolomite (26%)	0
Magnesium sulfate (16%)	234

Suggestion accepted
Free choice




Fig. 2 Screen of fertilizers selection for base-dressing

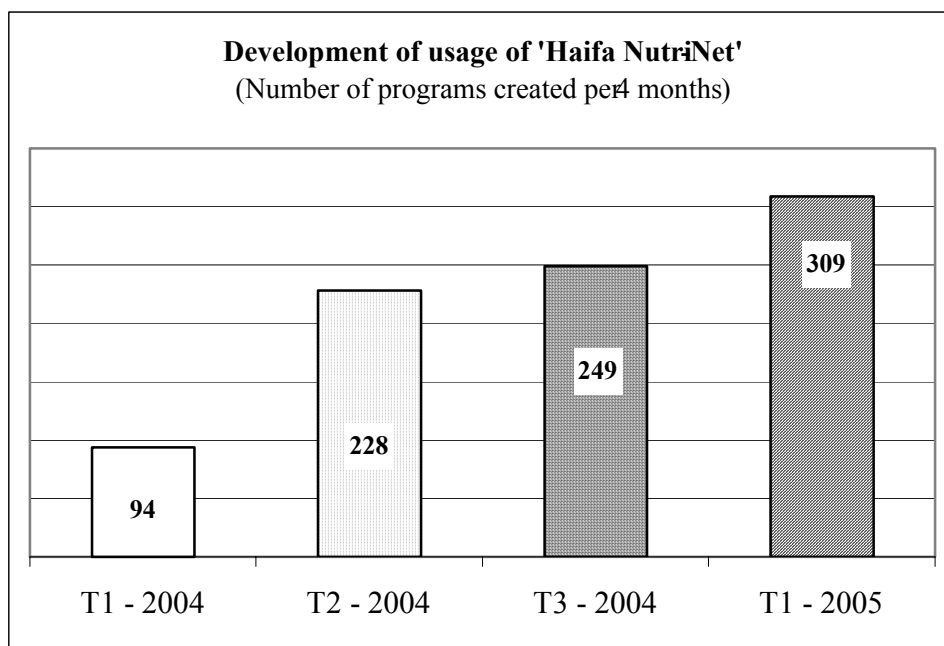


Figure 3 Usage dynamics of Haifa Nutri-Net among Haifa- affiliated agronomists

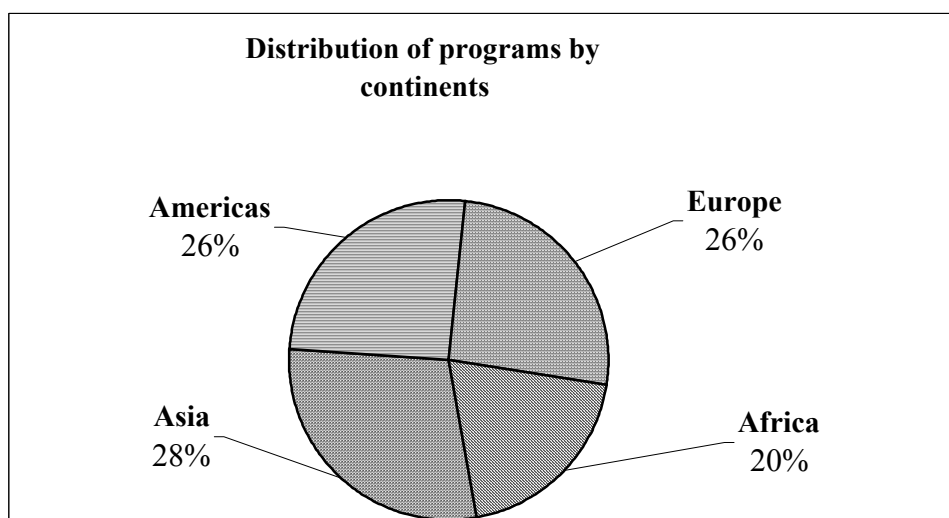


Figure 4 Distribution of programs created by 'Haifa Nutri-Net' users by continents