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FERTPUNICA® computer program for calculating pomegranate drip fertigation

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SUMMARY – The computer program described in this article calculates the irrigation and fertilisation needs for pomegranate cultivation, from the data introduced by the user, enabling programming and automation in the nutrition process.

Key words: Pomegranate, irrigation, fertilisation, sector, conductivity, texture, drip irrigation.

RESUME – *"Le logiciel Fertpunica® pour calculer l'irrigation fertilisante goutte-à-goutte pour le grenadier". Le logiciel décrit dans cet article calcule les besoins en irrigation et fertilisation pour la culture du grenadier, à partir des données introduites par l'usager, en permettant ainsi la programmation et l'automatisation du processus de nutrition.*

Mots-clés : *Grenade, irrigation, fertilisation, secteur, conductivité, texture, irrigation goutte-à-goutte.*

Introduction

The calculation of water and mineral needs in crops is the basis for establishing a needs programme for a given species.

Using computers, the calculation process can be automated, and different alternatives can be analysed to provide the necessary nutritive elements for the plants. The computer program is easier to use if it is complemented by one or more data bases; this saves much time in planning for technicians responsible for setting up nutritive programmes on the estates they manage.

The aim of this work is to present a computer program specifically for pomegranate fertigation, which is as rational as possible, using as a calculation basis the fundamental information which determines the crop's nutritive needs.

Materials and methods

The vegetable matter to be used in this computer application is the pomegranate. The application is known as FERTPUNICA® Ver 2.1, and it calculates both water and nutritive mineral elements for drip irrigated plants. This program has been designed bearing in mind both computing aspects and the most important agronomic factors.

Computing aspects

The software is designed for use within WINDOWS, which makes it easier and more intuitive to use. The program can be used on a 32 bit platform, which means that it is faster than programs designed for 16 bit platforms; it therefore has quite an acceptable speed. It should also be pointed out that printing can be done through the Windows printing system, which makes this process easier and high quality (which would not be the case in MS-DOS).

The program works with any IBM-PC type computer, and requires a Pentium processor with a minimum 8 Mb RAM memory. The program works correctly with this hardware, although it is preferable to have a more powerful computer, as WINDOWS uses up a lot of memory space, and it will function better with a quicker and larger memory. A Jet motor is used for the databases, as it has advantages which are well known to computer experts.

The FERTPUNICA® user only needs user-level computer knowledge, but does need basic knowledge of agronomy, such as: electrical conductivity of irrigation water, PET (potential evapotranspiration), fertilisers, etc.

Agronomic aspects

We will deal with many more agronomic than computer aspects.

The program has various data bases, in which information can be kept on estates, with their respective heads and sectors. There are also data bases where new (simple or complex) fertilisers, agrometeorological stations and special treatments can be introduced. The following is a description of the information which can be registered in the program.

The information on the *estates* is: name, owner, situation and agrometeorological stations assigned to each estate. Once the proposal has been made and printed out, the name and situation show which estate they correspond to. The information on the agrometeorological station will be used by FERTPUNICA® to obtain the necessary ETo (evaporation in millimetres in the area during the corresponding month) to calculate water needs, when we are ready to make the proposal.

The *heads* have information on the EC (electrical conductivity) of water from that source, percentage of water availability, and nutrient content of the water. The EC is used to calculate the appropriate leaching fraction, and to contribute an extra amount of fertilisers (if necessary) due to losses from nutrient percolation. The percentage of water availability is useful in cases of drought or when we want to add extra water for special reasons (e.g. when irrigation has not been possible during the last week because of burst pipes, broken pumps, etc.). Finally, nutrient content of the irrigation water is useful, so that any nutrients found here can be deducted from the fertiliser (under the direction of the technician).

The *sectors* have information on number of trees in the sector, average diameter of the tree tops, plantation layout (length by width), number of drips per stem, drip flow rate, crop, stem, variety, associated crop (where appropriate), and soil texture. The number of trees and the plantation layout show the extension to receive fertigation. The diameter of the tree top and the plantation layout show if they are seedlings or fully productive trees, as these are treated differently; a seedling has a (2-1-1) balance as it is unproductive, and therefore does not need much potassium (because there is no crop extraction), whereas a fully productive tree has a (2-1-2) balance, as it undergoes greater potassium extraction through harvesting. The number of drips per stem, their flow rate and the soil texture, determine the size of the irrigated area and irrigation time, which is reduced automatically (depending on the program configuration) if the irrigated area is small and the crop can not use all the water. The crops, stems and varieties are of interest for future versions, to differentiate the interpretation of foliar analyses, but it must be said that, for fertilisation, we differentiate between: pomegranate seedlings, crop varieties which are harvested in September-October or in October-November, etc. Everything will be considered in order to carry out the correct fertigation. Of course, at all times, complete control of the program will be in the hands of the technician who advises on fertigation: FERTPUNICA® establishes the percentages, balances, etc. which correspond to each variety, but the technician can modify any calculation at any time for a given sector.

In the section on *new varieties*, the programme allows us to introduce varieties in the data bases which were not previously included. The introduced varieties can be selected when we introduce a new sector or modify an existing one. This section gives the program great versatility, as each variety is treated in a specific way when fertigation proposals are made.

The *agrometeorological stations* (AS) register name, monthly evaporation in mm/month and the method used to calculate the ETo. Once an agrometeorological station has been introduced, it will be available for assignation to any estate, so that when the fertigation proposal is made, a specific ETo

will be used depending on the month and the station. The AS permit us to save the PET obtained by the following methods: Penman, Class A tank and Thornthwaite.

The *fertiliser* data base has the following information: name, richness in N, P_2O_5, K_2O, MgO and Ca, and the type of fertiliser (nitrogen, phosphorus, potassium, magnesium or calcium). Once a fertiliser has been introduced into the program, it can be used to obtain the fertigation proposal. If we want to use a complex which does not have the balance we have set, FERTPUNICA® calculates the needs according to the nitrogen content, as this nutrient should be treated more carefully in fertilisation than the rest; if there were an excess of any of the elements, the program would inform us of this.

There is also a database where *special treatments* can be introduced, with the following points: name of the treatment, month(s) in which we want the program to remind us to apply it/them, and species to receive the treatment. This section is especially for the application of herbicides, chelates and other products which could be of interest. There is also an option which permits the program to discount the days when special treatments are applied from those when fertilisation was planned; it automatically subtracts the days when special treatment is applied, and the unused fertiliser from those days is distributed on the days which are free for fertilisation.

There is another database for *history*, where all the fertigation proposals are stored, so that at any moment we can easily find out what was done on an estate in a given period. This also allows us to see the different percentages of N, P_2O_5, K_2O, MgO, Ca and water contributions. This section facilitates planning, etc.

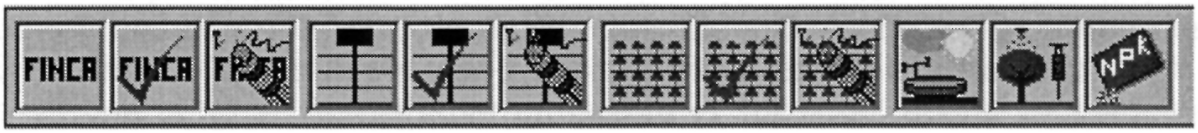
Once all the databases have been described, we make them all interactive, which means that they can be seen, modified, printed, etc.

We will now look at the basic functioning of the programme. When we turn FERTPUNICA® on from the WINDOWS program administrator, the first thing to appear is the title page window (Fig. 1), which disappears after a few seconds and the general program window, from which we control all the program functions, appears on the screen.

Fig. 1 (See Annex I for English translation of terms)

As can be seen in Fig. 2, all the information on the estate, head and sector can be seen on the screen. At the top of the screen, the Data Access, Uses, and About... menus appear, which can not be described fully because of the scope of this article, but it should be said that the main functions of the programme can be carried out from the toolbar (Fig. 3).

Fig. 2 (See Annex I for English translation of terms)



1.- Introducir finca
2.- Modificar finca
3.- Borrar finca
4.- Introducir cabezal
5.- Modificar cabezal
6.- Borrar cabezal
7.- Introducir sector
8.- Modificar sector
9.- Borrar sector
10.- Estaciones Agrometeorológicas
11.- Tratamientos especiales
12.- Fertilizantes

Fig. 3 (See Annex I for English translation of terms)

To clarify the explanation, we will give an example of a fertigation proposal for the month of May 1998, using the information seen in Fig. 2. Firstly we select the month and the year, and then press the CALCULATE ESTATE button; the window shown in Fig. 4 appears on the screen, and here we define the fertigation variables for each of the sectors.

Fig. 4 (See Annex I for English translation of terms)

Fig. 4 shows the estate, head and sector for which the fertigation variables are being established. Firstly we will define the *temperature forecast*: High, Normal or Low; we can then establish the water forecast. The tensiometer determines the soil humidity; the reading will modify from 0 cb to 35 cb, depending on whether the humidity is at a saturated, optimum or dry level (saturated = 0 cb, optimum = 15 cb and dry = 35 cb). A 12" tensiometer is used, 30 cm from the drip; if these humidity meters are not available on the estate, we will leave the default reading of 15 cb. With these parameters, the program adapts the irrigation time to the crop's water needs. These values will only vary when conditions are not normal.

Another section is the *water base contribution*; currently, some irrigators add a pre-fertilisation to the irrigation water at the head, which means that the water reaches the estates with fertilisers included. The program discounts the fertiliser amounts contained in the irrigation water, under the supervision of the technician using the program; if we do not want to take into account all the nutrient contribution, we can vary the percentage as desired, for example if the irrigation uniformity is 85%. This section is also useful for registering the nutrient contribution of the irrigation water (introducing the water analysis).

For the monthly fertilisation percentage, fertilisation percentages and a balance are automatically assigned when the data relating to a sector is introduced, depending on the variety and diameter of the tree (adapting to each different situation). In this specific case, it was established that 15% N, P_2O_5, K_2O, and MgO, and 0% Ca, should be added. All of the parameters established by FERTPUNICA® can be varied. In this example, we leave them unchanged. The fertilisers we choose for the fertigation are those shown in Fig. 4.

Once all the fertigation variables are established, we accept them so that FERTPUNICA® will calculate the water and fertilisers to be added. After accepting, a new window will appear (Fig. 5) with all the information supplied, where we can observe for the irrigation: (i) the m^3 of water to be added

per month; (ii) m^3 per day; (iii) number of irrigation times per month; (iv) number of irrigation times per week; (v) reduction applied for the wet area (reduction in water, which can not be used any more because of the lack of wet area); and (vi) length of irrigation time per day in hours and minutes; for the fertilisation, we see: (i) the fertilising units (FU) for the different nutrients (N, P_2O_5, K_2O, MgO and Ca) contributed throughout the month of May; (ii) the balance used in the calculations; and (iii) kilograms applied per month and per day of each of the different fertilisers chosen.

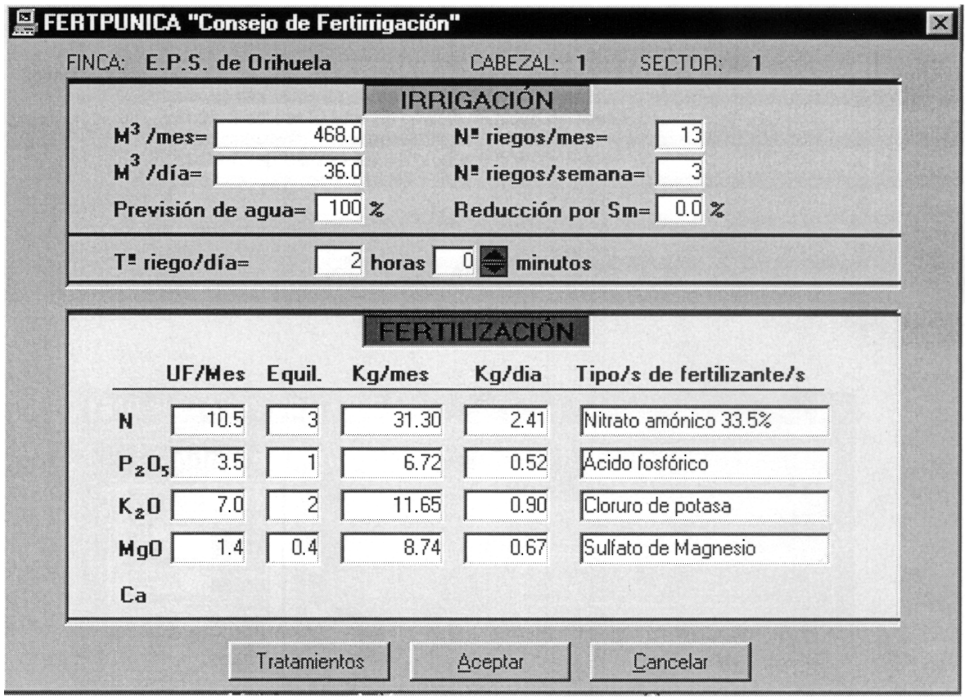


Fig. 5 (See Annex I for English translation of terms)

If we decide to apply a special treatment in this sector, we press the button for the TREATMENTS window shown in Fig. 5, and another window (Fig. 6) appears, showing a list with the treatments available in May which are applicable to the variety found in this sector, and another list with the treatments in May which are applicable to all varieties; therefore if we want to apply a special treatment during this month, we press the day of the month (the calendar is on the right of the screen in Fig. 6) and immediately the chosen treatment will appear in the lines at the bottom of the window, as illustrated in the example.

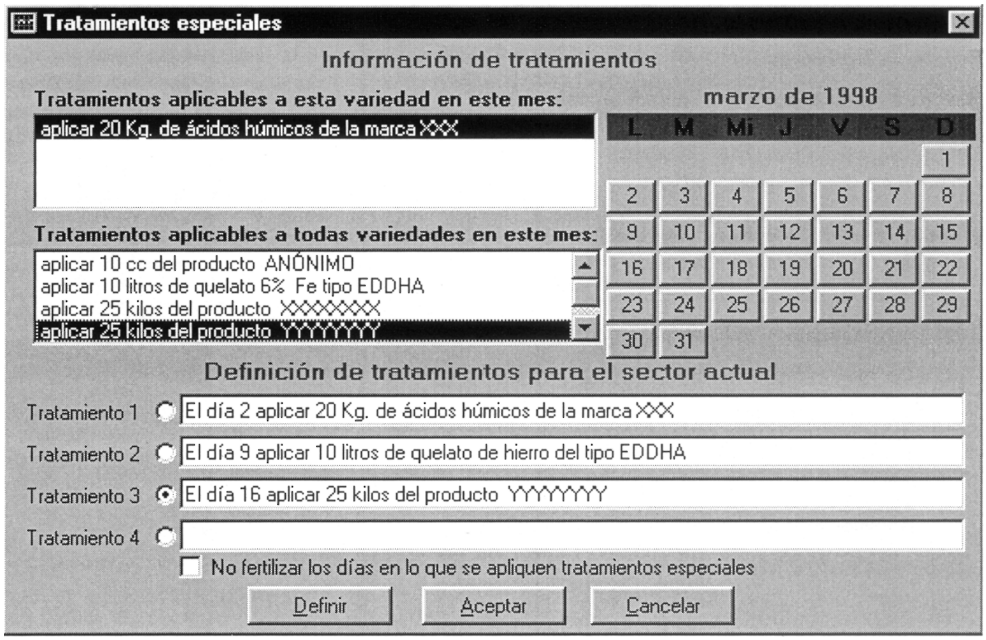


Fig. 6 (See Annex I for English translation of terms)

If we choose the option of not fertilising on the days when special treatments are carried out, FERTPUNICA® discounts the days when treatments are applied from the days when fertilisation was planned, and it then increases the dosage of fertilisers per day; similarly, a note will appear on the printout stating that on special treatment days, fertiliser is not applied. If we press "Accept", we repeat the whole process for sector No. 2 (depending on the configuration) and once all the heads and sectors of the estate have been reviewed, the window will appear for the results printout (Fig. 7).

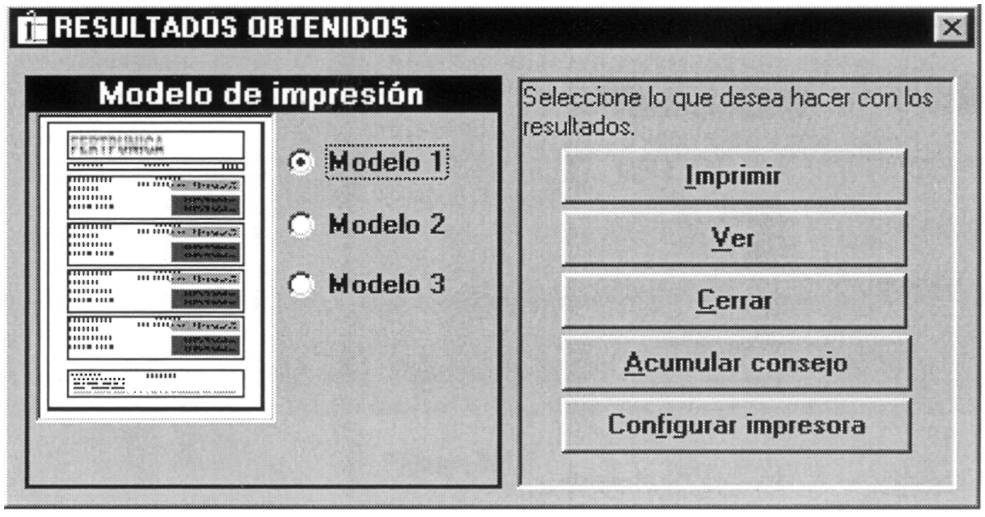
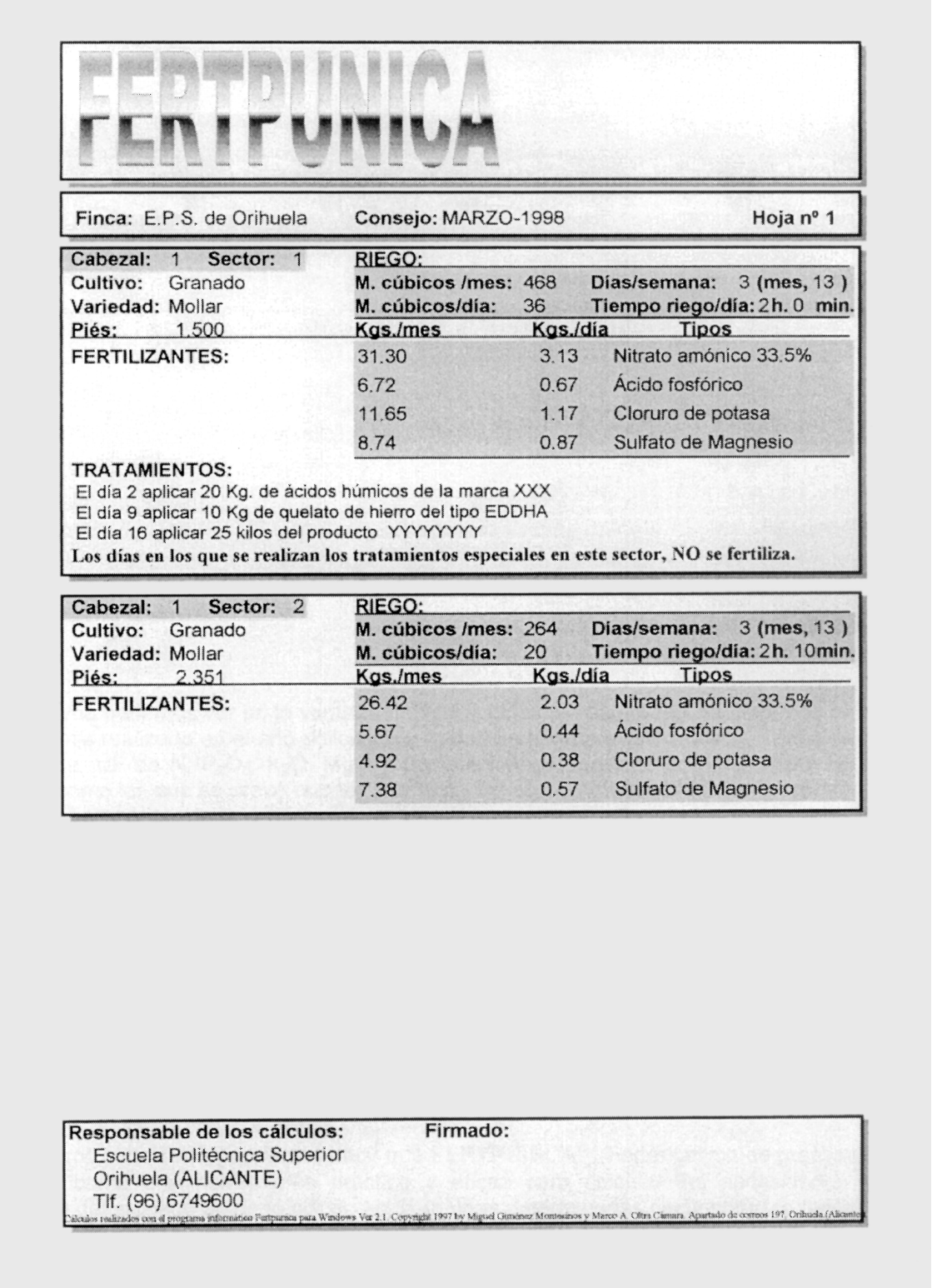


Fig. 7 (See Annex I for English translation of terms)

As we can see in Fig. 7, we can print the results, see them on the screen (copy of the printed sheet), add the proposal to history (store the results for estate sector control), and configure the printer (print with higher or lower quality, paper size, etc.).

The program has many printing models, adapting to each estate (whether it has more or less sectors) and an example is shown in Fig. 8.



FERTPUNICA

Finca: E.P.S. de Orihuela Consejo: MARZO-1998 Hoja nº 1

Cabezal: 1 Sector: 1
Cultivo: Granado
Variedad: Mollar
Piés: 1.500

RIEGO:
M. cúbicos /mes: 468 Días/semana: 3 (mes, 13)
M. cúbicos/día: 36 Tiempo riego/día: 2h. 0 min.

FERTILIZANTES:	Kgs./mes	Kgs./día	Tipos
	31.30	3.13	Nitrato amónico 33.5%
	6.72	0.67	Ácido fosfórico
	11.65	1.17	Cloruro de potasa
	8.74	0.87	Sulfato de Magnesio

TRATAMIENTOS:
El día 2 aplicar 20 Kg. de ácidos húmicos de la marca XXX
El día 9 aplicar 10 Kg de quelato de hierro del tipo EDDHA
El día 16 aplicar 25 kilos del producto YYYYYYY
Los días en los que se realizan los tratamientos especiales en este sector, NO se fertiliza.

Cabezal: 1 Sector: 2
Cultivo: Granado
Variedad: Mollar
Piés: 2.351

RIEGO:
M. cúbicos /mes: 264 Días/semana: 3 (mes, 13)
M. cúbicos/día: 20 Tiempo riego/día: 2h. 10min.

FERTILIZANTES:	Kgs./mes	Kgs./día	Tipos
	26.42	2.03	Nitrato amónico 33.5%
	5.67	0.44	Ácido fosfórico
	4.92	0.38	Cloruro de potasa
	7.38	0.57	Sulfato de Magnesio

Responsable de los cálculos: Firmado:
Escuela Politécnica Superior
Orihuela (ALICANTE)
Tlf. (96) 6749600

Cálculos realizados con el programa informático Fertpunica para Windows Ver 2.1. Copyright 1997 by Miguel Giménez Montesinos y Marco A. Oltra Cámara. Apartado de correos 197. Orihuela (Alicante)

Fig. 8 (See Annex I for English translation of terms)

The program also has a section which shows the history of proposals for an estate, which is a very useful option as it allows us to stipulate what will be done on the estate, and the percentages of the different nutrients applied until now. If we press the button "HISTORY", shown in the window in Fig. 2, a window will appear showing the years when accumulated results are available, and if, as in our example, we press the year 1998, a window will appear as in Fig. 9.

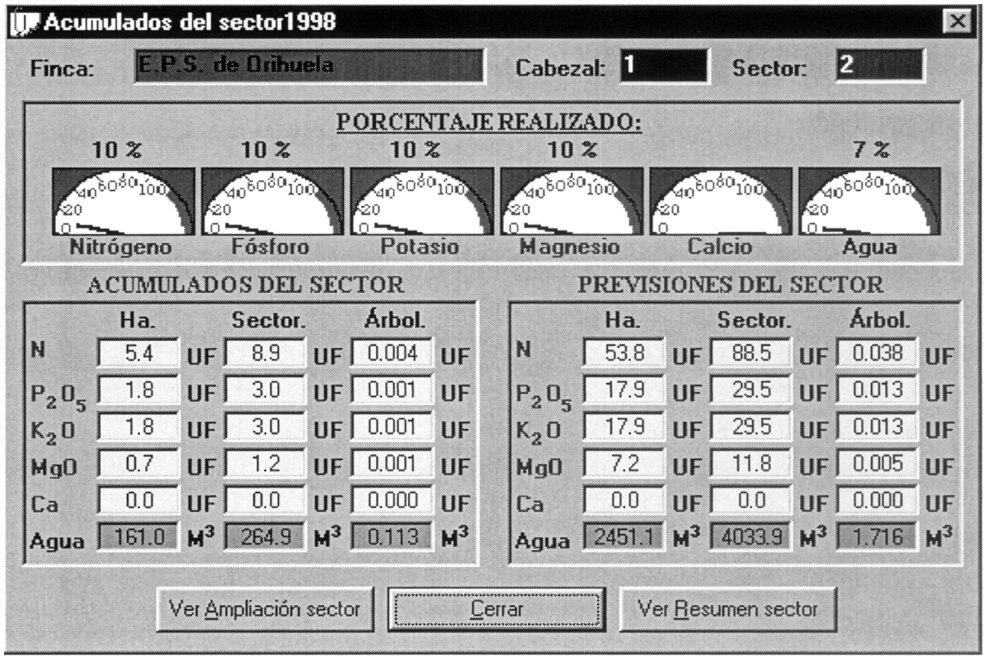


Fig. 9 (See Annex I for English translation of terms)

As we can see in the window showing the sector history (Fig. 9), we have information on what we have done, and what is planned, during the requested year. We have information on FU of N, P_2O_5, K_2O, MgO and Ca applied per sector, per hectare and per tree, and the prevision for the rest of the year. We also know the cubic metres of water used, and the prevision per year, per sector and per tree. This versatility, information, etc. shown by the program make FERTPUNICA® one of the most complete programs existing for pomegranate fertigation. The program can also be configured by the user: to give standard or directed proposals; to give daily, weekly, fortnightly or monthly proposals; to include magnesium; to maintain the special treatments for all the sectors, etc.

Many other functions of the program could also be explained if the scope of this article were wider.

Conclusions

In conclusion, we would like to say that FERTPUNICA® (Pomegranate Fertigation) Ver 2.1 has been conceived as a practical and efficient tool to calculate the irrigation and fertilisation needs for pomegranates using drip irrigation, under set conditions described by the user.

Further reading

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Annex I. English translation of terms used in figures

FERTPUNICA - POMEGRANATE FERTIGATION

The use of this product is authorised to:

Plant Production Department

Fig. 1

Data access – Uses – About...

Estate Information

Estate:
Owner:
Situation:
Station:

Sector Information

Sector:
No. trees:
Tree diameter:
Plantation layout:
Drips/stem:
Drip flow rate:
Crop:
Variety:
Stem:
Associated crop:
Soil Texture
Crop code:
Irrigated area:

Head Information

Head
Electrical conductivity:

CALCULATE PROPOSAL

Estates
Heads
Sectors
Month
Year
No. days/week
No. days/month
History
CALENDAR
Print model
CALCULATION
Whole Estate
One head
One sector (without printing)
CALCULATE ESTATE

Fig. 2

1. Introduce estate
2. Modify estate
3. Erase estate
4. Introduce head
5. Modify head
6. Erase head
7. Introduce sector
8. Modify sector
9. Erase sector
10. Agrometeorological stations
11. Special treatments
12. Fertilisers

Fig. 3

Fertigation variables

ESTATE HEAD SECTOR

IRRIGATION

Temperature forecast
High
Normal
Low

Water forecast
Program to ...%

Tensiometer reading
Indicate the average tensiometer readings during the last month.

Water base contribution
Take into account
Ignore
Take into account ...%

FERTILISATION

Fertilisation %
This month
Balance
Types
Simple
Complex
Fertilisers
Irrigation days – Accept – Cancel

Fig. 4

FERTPUNICA "Fertigation proposal"

Estate Head Sector
IRRIGATION
M3/Month
M3/Day
Water forecast
No. irrigation/month
No. irrigation/week
Reduction for wet area
Irrigation time/day – hours – minutes

FERTILISATION
FU/month
Balance
Kg/month
Kg/day
Type/s of fertiliser/s

Treatments – Accept – Cancel

Fig. 5

Special Treatments

Treatment information

March 1998
Treatments applicable to this variety this month
Treatments applicable to all varieties this month

Description of treatments for this sector
Do not fertilise on days when special treatments are applied
Define – Accept – Cancel

Fig. 6

RESULTS
Print model
Model 1, 2, 3
Select what you want to do with the results
Print
See
Close
Add to history
Configure printer

Fig. 7

FERTPUNICA
Estate: Proposal: March 1988 Page 1

Head: Sector:
Crop:
Variety:
Stems:
FERTILISERS:

IRRIGATION:
M3/month Days/week:
M3/day Irrigation time/day:
Kg/month Kg/day Types

TREATMENTS:

Person responsible for calculations: Signed:

Fig. 8

Sector History 1998

Estate Head Sector
Percentage carried out:
Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Water

Sector History Sector Prevision

See Sector amplification Close See Sector summary

Fig. 9