Drip-Irriwater
USER MANUAL

Code registered in 2010 with the number 02/2010/3036 on the Spanish "General Registry of Intellectual Property".

The Drip-Irriwater software can be obtained directly from the authors.

AUTHORS

Arbat Pujolràs, Gerard *

Artigas Tremoleda, Ramon **

Barragán Fernández, Javier ***

Puig Bargués, Jaume *

Ramírez de Cartagena Bisbe, Francisco *

* Higher Polytechnic School, University of Girona, Spain

** Inforolot S.A., Olot, Spain

*** School of Agricultural and Forestry Engineering, University of Lleida, Spain

CONTENTS

1.- Introduction

The Drip-Irriwater code allows to simulate soil water distribution under surface drip irrigation in order to design and manage this type of systems. The information provided by the code, in the case of an isolated emitter, shows the shape, dimensions and water content of the volume of wet soil, in particular the wetted radius and depth. These variables are the basic planning factors in the agronomic design phase and therefore have a direct relationship with crop production and the efficient use of water and energy.

The numerical method used by the Drip-IrriWater code it is based on the Richards equation, which describes the movement of water in unsaturated soils. This equation is solved using the method of finite differences, taking into consideration an axisymmetric flow, evaporation of water from the soil and the formation of a pond area under the emitter.

The code takes into account the type of soil and the presence of different horizons with different physical and hydraulic properties, allowing to choose between different methods to define the soil hydraulic functions. The remaining input parameters are the initial water content of the soil, the drip rate, the irrigation time and the water redistribution time after irrigation.

Finally, the code has a very user friendly interface which makes it easy to use, allowing simple data entry and providing a clear numerical and graphical display of the results.

2. - Code structure

The Drip-Irriwater code consists of two separate computer programs: the graphical user interface (GUI) and the program performing the numerical procedure.

The graphical user interface is written in C#, using Microsoft .NET framework. Its function is to enable the entry of the input variables and display the results (soil water content and hydraulic potential distribution).

The main code performing the numerical operations was written in the FORTRAN language, using Compaq Digital Visual Fortran 6.0.

Figure 1 shows how the two computer programs that make up the software Drip-Irriwater are related.

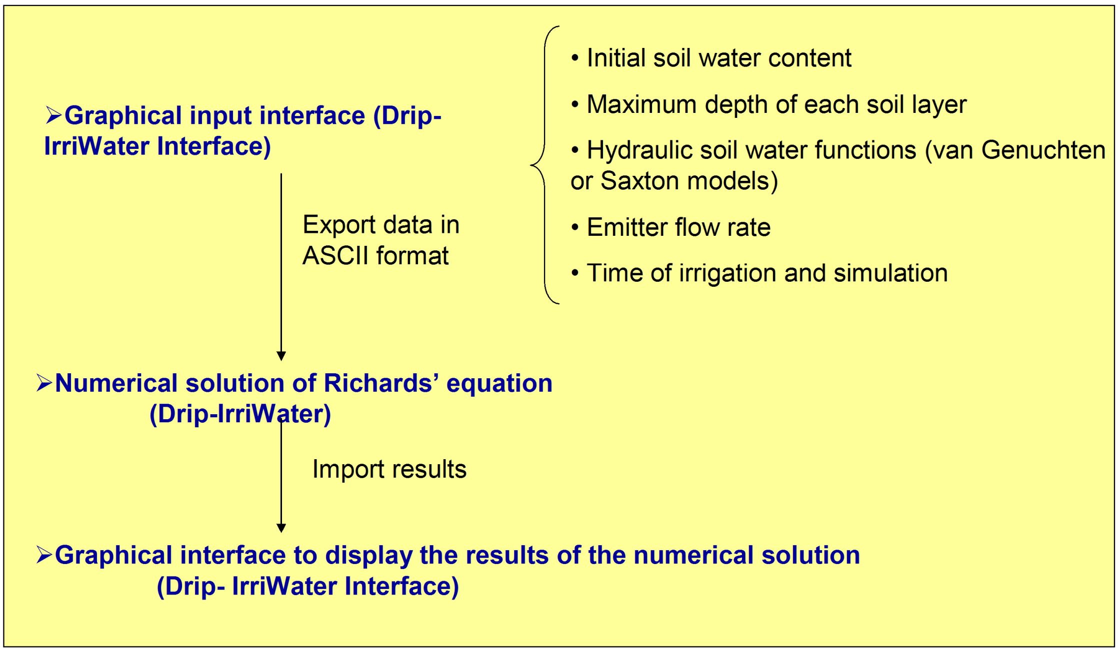


Figure 1. Structure of the Drip-Irriwater software.

3.- Installing and running the software

The program can be run directly from the executable file *Drip-Irriwater Interface.exe*, without having to install the program on the computer.

If the program is to be installed on the computer in order to be started from the Windows® Start menu, run the file *setup.exe*.

4.- User manual for the Drip-IrriWater Interface

4.1 Data entry

All the necessary model parameters are set on the INPUT screen (Figure 2).

Please note that the decimal mark should be a comma (,) and must be modified in accordance with the regional settings on your computer's operating system.

The order of the data input is shown below.

1.- Enter the number of soil horizons [**Layers Number**]. The program allows a maximum of 8 horizons.

Once the number of horizons has been set (see Figure 2), the program opens a window that displays the data to be entered for each horizon.

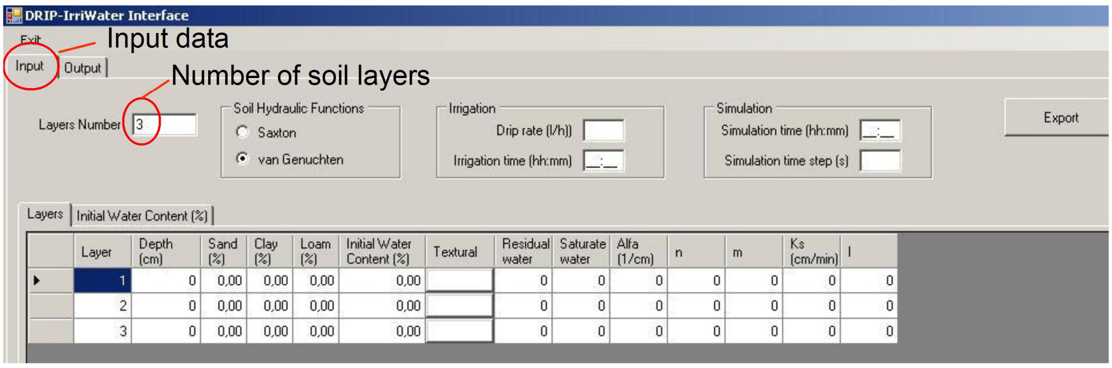


Figure 2. Selecting the number of horizons

2.- Choose the calculation method for the soil hydraulic functions [**Soil Hydraulic Functions**]. Two options are available:

2.a.- Saxton. Water retention and hydraulic conductivity functions are considered according to the model proposed by Saxton et al. (1986). In this case, the following data must be entered: the depth of each horizon [Depth (cm)], the percentage of sand [Sand (%)], clay [Clay (%)] and loam [Loam(%)], as well as the initial water content [Initial Water Content (%)] for each horizon(Figure 3).

2.b.- van Genuchten. Water retention and hydraulic conductivity functions are considered according to the model proposed by van

Genuchten-Mualem (van Genuchten, 1980). Two options are available:

2.b.1. Select the textural class for each horizon using the dropdown menu that opens when positioning the mouse under the respective Textural class tab [Textural Class]; the program then automatically assigns the parameters of the soil hydraulic functions according to the values proposed by Carsel and Parrish (1988), (Figure 4).

2.b.2. Manually enter the parameters that define the hydraulic functions, modifying the parameters proposed for the particular textural class.

You must also enter the depth of each horizon [Depth (cm)], and the initial water content [Initial Water Content (%)].

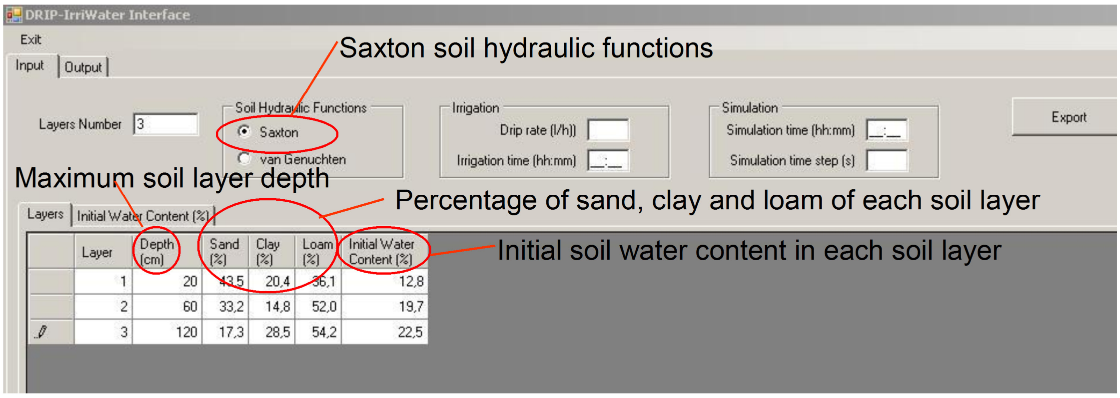


Figure 3. Selection of the textural class and definition of parameters in accordance with Saxton's model.

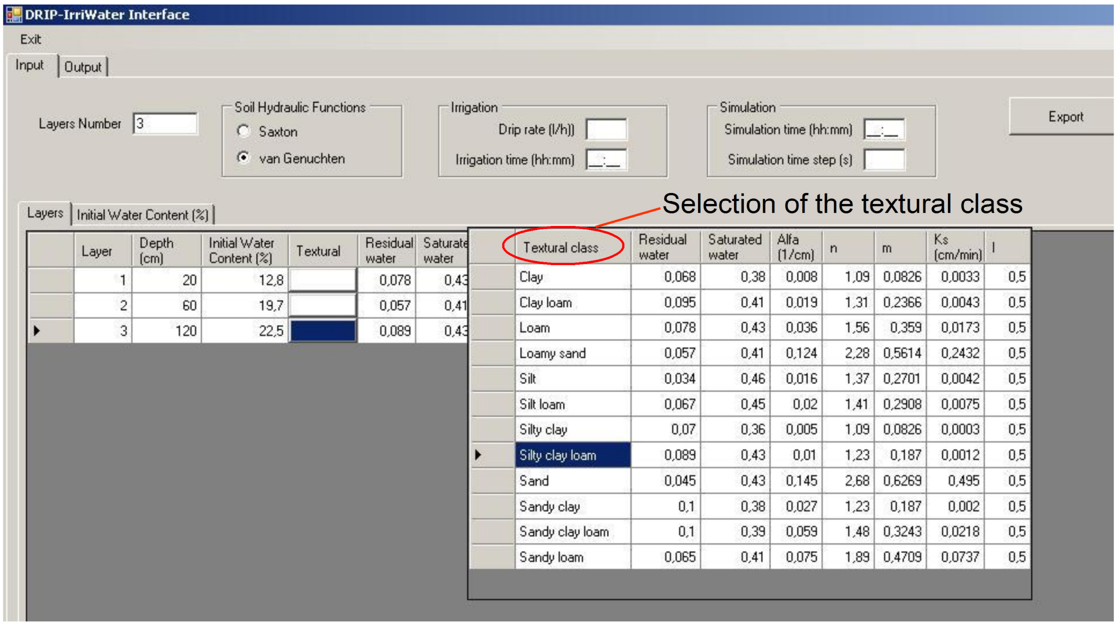


Figure 4. Selection of the textural class and definition of parameters in accordance with the model of van Genuchten-Mualem.

3.- Enter the irrigation parameters: drip rate [Drip rate (l/h)] and irrigation time [Irrigation time(hh: mm)].

4.- Enter the parameters related to the numerical solution. You need to indicate the simulation time [Simulation time (hh: mm)], i.e. the time from the start of the irrigation to the specific time when you want to know the soil water content. This value must be equal to or greater than the irrigation time. You also need to indicate the time step used in the simulation [Simulation time step (s)], i.e. the time interval applied between two consecutive iterations in order to solve the Richards equation. This must be an integer and a value of 1 second is generally recommended.

4.2 Program execution

After selecting all the required parameters, press the data export button [Export] to create the ASCII files required by the Drip-Irriwater program. Once the export files have been created, accept the export process (see Figure 5) and then proceed to run the calculation program by clicking the [Execute] button (see 6 Figure).

While the program is running, a window displaying the iteration time corresponding to the numerical resolution of the Richards equation (Figure 7). It is important to note that in some cases the numerical solution may not converge and that in those cases the iterative process will be interrupted before reaching the final solution. In such cases, an alternative approach may consist in changing the soil hydraulic functions, from Saxton to van Genuchten, or vice versa.

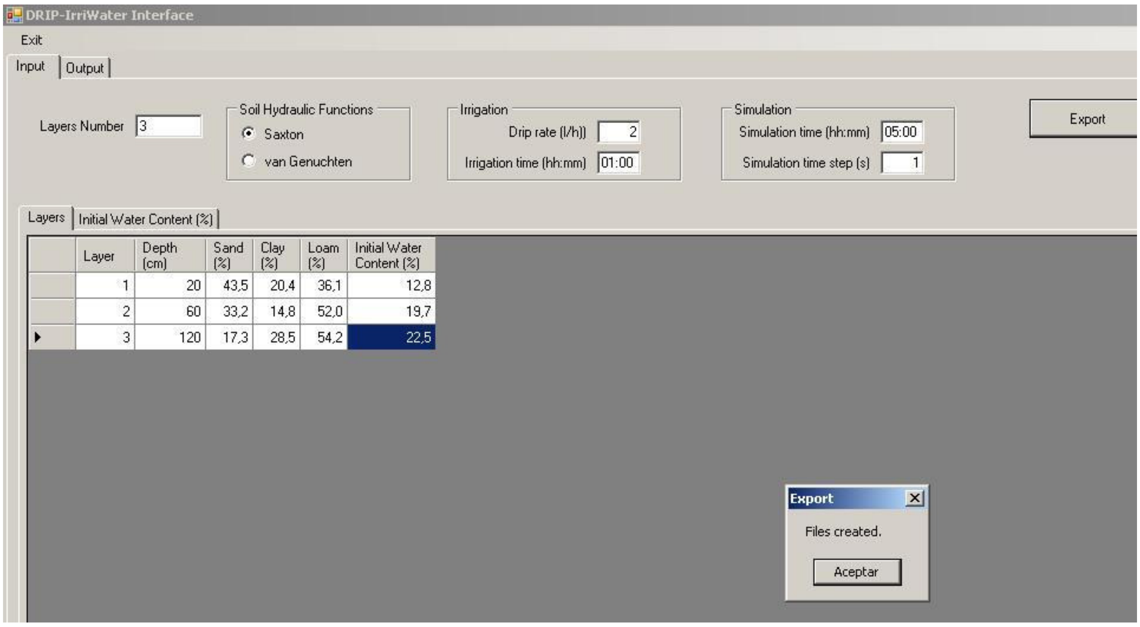


Figure 5. Input data export.

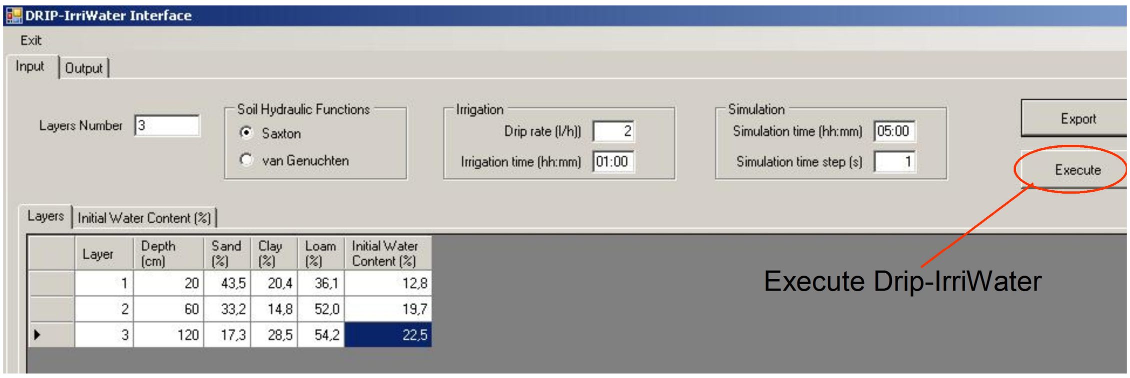


Figure 6. Execution of the Drip-IrriWater calculation program.

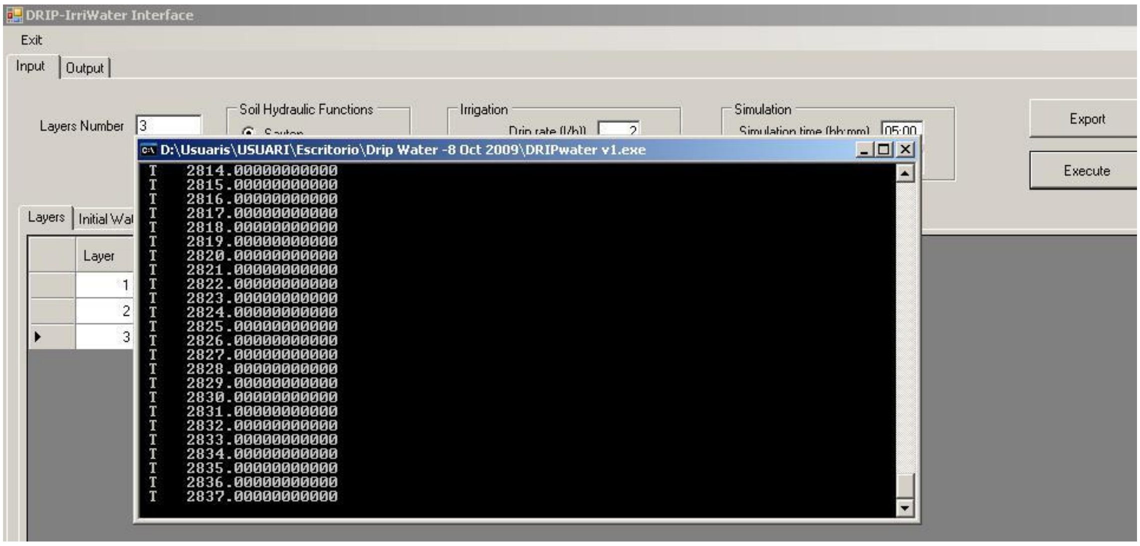
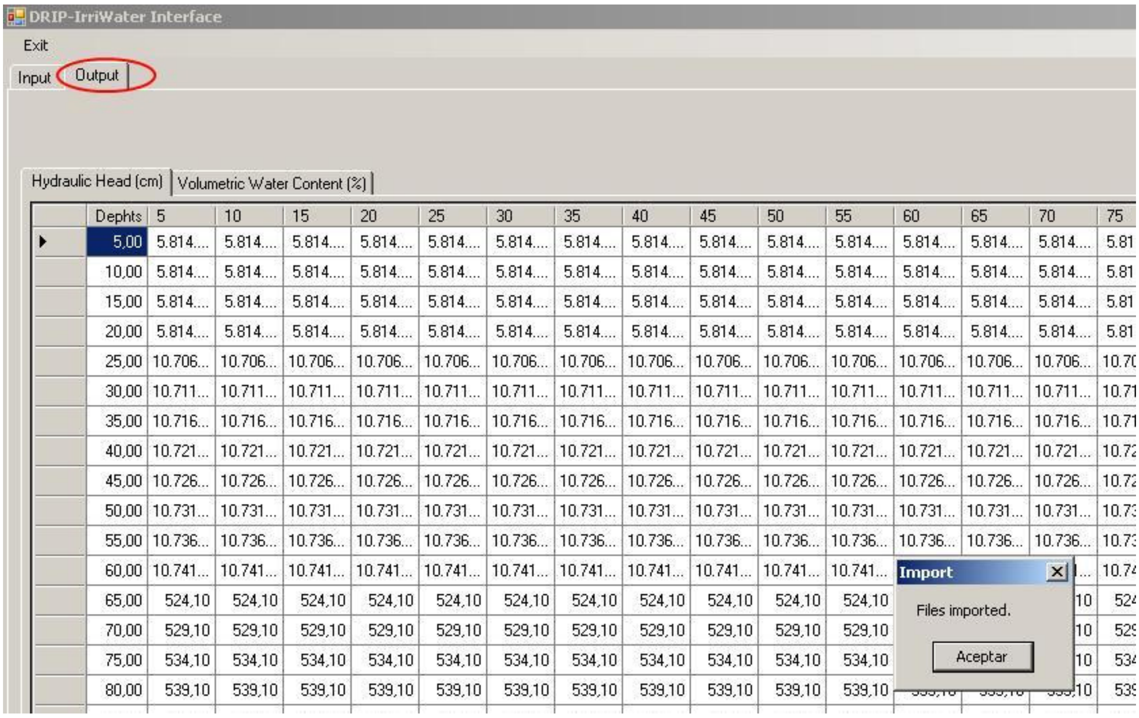


Figure 7. Iteration time shown during program execution.

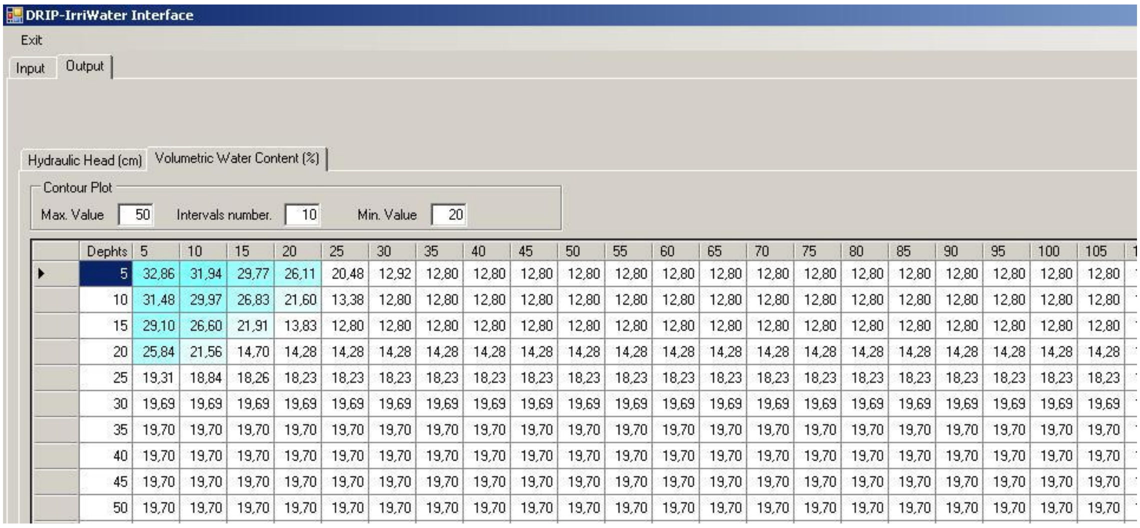
4.3 Displaying the results

The window shown in Figure 7 automatically closes when the calculation is reached. To view the results, go to the Output tab and import the results (Figure 8). The numerical values of the hydraulic potential [Hydraulic Head (cm)] and the volumetric water content of the soil [Volumetric Water Content (%)] are displayed on this screen. In addition, using a blue colour scale, it is possible to visualise the extension of the soil volume wetted by the emitter, i.e. the area where the water content has increased in relation to its initial value (Figure 9). The appearance of the chart can be modified by changing the colour scale parameters: maximum [max. value], range [Intervals number] y minimum [min. value].



Dephts	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
5,00	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.81
10,00	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.81
15,00	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.81
20,00	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.814....	5.81
25,00	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.706...	10.70
30,00	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.711...	10.71
35,00	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.716...	10.71
40,00	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.721...	10.72
45,00	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.726...	10.72
50,00	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.731...	10.73
55,00	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.736...	10.73
60,00	10.741...	10.741...	10.741...	10.741...	10.741...	10.741...	10.741...	10.741...	10.741...	10.741...	10.741...	[illegible]	[illegible]	...	10.74
65,00	524,10	524,10	524,10	524,10	524,10	524,10	524,10	524,10	524,10	524,10	524,10	[illegible]	[illegible]	10	524
70,00	529,10	529,10	529,10	529,10	529,10	529,10	529,10	529,10	529,10	529,10	529,10	[illegible]	[illegible]	10	529
75,00	534,10	534,10	534,10	534,10	534,10	534,10	534,10	534,10	534,10	534,10	534,10	[illegible]	[illegible]	10	534
80,00	539,10	539,10	539,10	539,10	539,10	539,10	539,10	539,10	539,10	539,10	539,10	[illegible]	[illegible]	10	539

Figure 8. Output screen [Output] showing the values for the hydraulic potential [Hydraulic head (cm)].



Dephts	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
5	32,86	31,94	29,77	26,11	20,48	12,92	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80
10	31,48	29,97	26,83	21,60	13,38	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80
15	29,10	26,60	21,91	13,83	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80	12,80
20	25,84	21,56	14,70	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28	14,28
25	19,31	18,84	18,26	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23	18,23
30	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69	19,69
35	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70
40	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70
45	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70
50	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70	19,70

Figure 9. Output screen [Output] showing the values for the volumetric water content [Volumetric water content %)].

5.- Bibliography

Carsel, R. and Parrish, R. (1988). Developing joint probability of soil water retention characteristics. Water Resources Research, 24(5), 755-769.

Saxton K.E; Rawls W.J; Romberger J.S. and Papendick R.I. (1986). Estimating generalized soil-water characteristics from texture. Soil Science Society of America Journal, 50(4), 1031–1036.

van Genuchten, M.T. (1980). A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Science Society of America Journal, 44(5), 892-898.