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The new functions that can be added at the soft for horizontal drainage design DrenVSubIR

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Abstract: The objective of this paper is to study the possibilities for the performances betting of DrenVSubIR soft starting from the observations made up when this was tested for the conditions from experimental drainage fields from Bihor County.
The DrenVSubIR soft, used for agricultural drainage design is made out three modules, the first one for determining distance between horizontal drains, with help the Ernst – David relation, the second one for verifying the possibility of using the drainage in sub irrigation and the third one for the technical and economical calculation of a hectare of equipped land.
In the experimental drainage fields from Bihor County (Avram Iancu, Cefa, Sanmartin and Diosig) were verified over the years, different variations of drainage, with or without prism ballast filter associated with deep-loosening work through scarifying.
Simulating the conditions from these experimental drainage fields led to the same distance between drains with the distance obtained in the experiments. This simulations allows the identification of the main defiences of DrenVSubIR soft.

Keywords: DrenVSubIR soft, drain pipe, filtering prism, deep loosening, not permanent regime;

1. INTRODUCTION

The main problem at the projection of the underground drainage with horizontal pipes is to establish the distance between the drain wires in permanently working regime and checking the results obtained for the working of the drainage in a not permanent regime. (Wehry A, et al., 1982; Man et al., 2010)

Underground drainage with horizontal pipes designing, in the operating permanent system can be made with DrenVSubIR software, which is based on the relationship between loss of vertical, horizontal, radial hydraulic load and the entry into drain and respectively the distance between drains, established by Ernst and completed by David. (Man T.E., 1982)

The DrenVSubIR software is a calculating program implemented by Faculty of Environmental Protection from Oradea and consists of three modules, the first one is of calculating the distance between drain wires, the second for checking the possibility of using the drainage at subirrigation and the third for the technical economical (the cost) calculus of ha, of drained field.

For calibration software DrenVSubIR was used the data obtained in the experimental drainage fields from Bihor county, establishing its particular module used for sizing the distance between absorbing drains, in the permanent regime, inclusively on heavy and compress soils, for checking reversibility of the drainage in subirrigation and respectively for the calculus of the costs of a hectare equipped land. (Sabău et al., 2010)

2. MATERIALS AND METHOD

The previous researches looking DrenVsubIR soft calibration, with help of the data obtained in drainage experimental fields from Diosig, Avram Iancu, Cefa and Sânmartin (Ciobanu et Domuţa, 2003) has praised the its usage advantages in the drainage design but and the some deficiencies.

The objective of this paper is to study the possibilities for the completion with new functions of DrenVSubIR soft starting from the observations made up when this was tested for the conditions from experimental drainage fields from Bihor County.

3. RESULTS AND DISCUSSIONS

The mains deficiencies of DrenVsubIR software are:

- it considered that the soil profile is double layered and the placement of drain tubes is above the separation plan of the two layers;
- the mains required input data for the module of distance between absorbing drains is saturated hydraulic conductivities of the two layers K_1 and K_2, in m/day but the soil profile have more much layers with different conductivities;
- don't can be used for the design of drainage associated with drain mole or deep loosening works, specific of hard and compact soils;

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- after the establish of the distance between the drains in permanent regime, these can't be verified in not permanent regime hypothesis;

- the module for "technical and economical calculus" establish the cost of a hectare equipped land using only in function of a kilometer of drain cost;

The first problem, when the drains are placed above the plan of layers separation can be resolved considering the layer above the drains, with saturated hydraulic conductivity K_1 and respectively the layer under the drains, K_2 and the setting of the distance until the separating line of the layers at Do = 0,001 m.

The saturated hydraulic conductivity, used by the DrenVsubIR software is the real saturated hydraulic conductivity K_R, determined "in situ" through the borehole method (Hooghoudt) that characterizing overall the horizons. In exchange the soil profile is created from more horizons, having different saturated hydraulic conductivities determinate in laboratory through pedological methods (cylinder method) K_P and these is a punctual characteristic.

Canarache, 1990 mentions that between the hydraulic conductivity determinate through laboratory pedological method K_P and the real hydraulic conductivity, determined through the borehole method (Hooghoudt) K_R, there are differences, the real conductivity being bigger than the pedological conductivity.

The saturated hydraulic conductivities of the horizons that create the soil profile are determined through the cylinder method and these are pedological conductivities K_P. For transforming the pedological saturated hydraulic conductivities K_P in real saturated hydraulic conductivities K_R, the polynomial correlation of second degree $K_R = 0{,}2489\ K_P^2 + 0{,}8289\ K_P + 0{,}0519$ can be used, very significant from a statistical point of view ($R^2 = 0{,}9996$) established after the data presented in Canarache A. 1990.

For this we propose the introduction of a new module named Input Data in that firstly it asks the digging depth of drains and then it asks if the real saturated hydraulic conductivity of layers from above and from bottom of drains plane are knows. If this are knows it asks the values K_1 and K_2 in m/day.

If the values K_1 and K_2 of real hydraulic conductivity are not knowing it asks: the number of soil layers, the thickness of these and their pedological saturated hydraulic conductivity, K_P in mm/ hour or in m/day.

A new module, introduced after the input Data module, can realize the obtaining of the real hydraulic conductivity values K_R of the two layers from above and from bottom of drains plane. (Figure 1.)

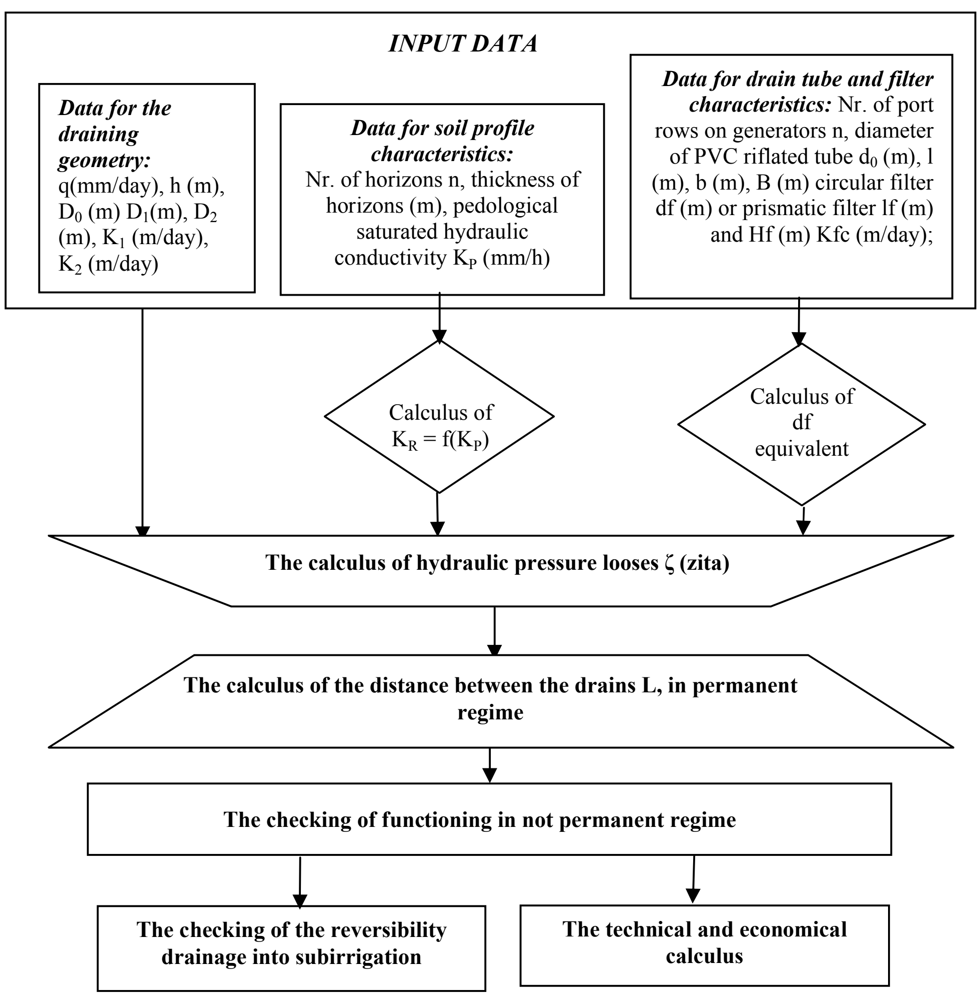

Figure 1. The new functions of DrenVsubIR software

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The drainage design on hard and compact soils can be released when the DrenVsubIR software can calculate the hydraulic resistance coefficient ζ (zita) for drainage with sorted ballast filter prism and take in consideration the real hydraulic conductivity of layer with deep loosening.

The necessary input data for to calculate the hydraulic resistance coefficient zita are the characteristic data of the drain tube of riflated PVC: diameter (m), the number of port rows on generators n, the width of rectangular slots l (m), the length of the slots orientated after generators b (m) and the characteristic data of the filter, filter diameter df (m) and respectively hydraulic conductivity of the clogged filter Kfc (m/day). Therefore, the DrenVsubIR soft works with wrapped up filters that have circular form.

In order to DrenVsubIR program to utilize the filter prism is required to ask at the input module of characteristic filter data if the filter is circular or prismatic. If the filter is prismatic the program demands the breadth and the width in meter of these. Having these values, before of the module for the calculus of the hydraulic resistance coefficient zita, can be introduced a calculus stage of equivalent diameter df, for the case of prismatic filter, using the relationship:

$$df = 2r = U/\pi; \qquad (1.)$$

where U is the perimeter of the filter prism.

For hydraulic conductivity of clogged ballast filter prism was considered that the value closest to reality is that experimentally determined by Man, 1982 respectively Kfc = 12.4 m/day.

Module to calculate the distance between the drains of the DrenVSubIR program present the advantage that once established drain tube type, its characteristics and filtering material, the total hydraulic load losses remain unchanged, which allows testing by testing several types of drainage.

Using the known characteristics of the soils of drainage fields, for the same drain tubes and filtering prisms have tried several values of equivalent hydraulic conductivity K_{Re1} above the drain lines aiming to obtain the distance between drains L = 30 m.

Equivalent actual hydraulic conductivity K_{Re} of upper layer of horizontal siting plane of drain tubes are very close, being between 6.447 m/day at Cefa and 6529 m/day at Diosig. Given that these values cumulative the effect of hydraulic conductivity of high prism of graded ballast, Kfc = 12.4 m/day and knowing the scarifying depth and filter height can estimate the effect of deep loosening through scarifying.

Actual hydraulic conductivity values of deep loose layer by scarifying are also very close, between 4.746 m/day at Cefa and 4.852 m/day at Diosig, with an average standard deviation of ± 0.044 m/day. Knowing these value, K_{Re} = 4,8 m/day, it can use the software DrenVSubIR to design the drainage associated with works of deep loosening through scarifying.

The checking of the drainage designed for working in not permanent regime in experimental field Diosig has been made with the relation Glover Dumm:

$$\frac{pL^2}{10KD} = \frac{t}{\ln\left(1{,}16\frac{h_0}{h_t}\right)}; \qquad (2.)$$

where:

p is drainable porosity in %, and cab be calculated with the relation $p = K^{1/2}$, where hydraulic conductivity is expressed in cm/day;

L is the distance between drains in meter;

KD is the hydraulic transmissivity, in m^2/day, calculated as product of K, hydraulic conductivity, in m/day and average thickness of the moistened horizon:

$$D = D_0 + \frac{h_0 + h_t}{4}; \qquad (3.)$$

h_0 is the initial level of water tale, after the stop of rain;

h_t is the final level of water table, corresponding for proposed drainage norm;

t is the time in day, necessary for lowering the water table level from the initial level h_0 to the final level h_t;

The checking of drainage working in not permanent regime of a same variants studied (L = 50, 35 and 20 m) in experimental field Diosig shows that the time necessary for lowerig the water table level from the surface of land, h_0 =0,8 m, the depth of drains to the water table level corresponding at drainage norm h_t = 0,4 m is of 29 – 4 days (Table 1.)

The module for checking the drainage functioning in not permanent regime can be introduced at finish, forwards the module for technical and economical calculus.

Table 1. The characteristic of the functioning in not permanent regime of the variants from the Diosig experimental field

L (m)	t/j	K (m/day)	PD (%)	D (m)	KD (m^2/day)	j	t days
50	0,84	1,742	13,2	0,549	0,956	34	29
35	0,84	1,927	13,9	0,544	1,048	16	14
20	0,84	2,682	16,4	0,517	1,387	5	4

The technical and economical calculus establishes the cost of a hectare equipped land using the distance between drains in permanent regime and the price of a kilometer of drain pipe.

The required element is the cost of 1 km length drain tube posed, but we still have the associated works, with the price reported on surface unit. We propose the grouping in two categories of required elements, the first price reported on 1 km of length drain tube and the second the price reported on the surface of 1 hectare, for the associated works. In the first category it require the price of 1 km of ditch, 1 km of drain tube, 1 km length of filter and în the second category it require the cost of 1 hectare of mole drainage or 1 hectare deep loosening by scarifying. (Table 2.)

Table 2. The costs of studied drainage variants calculated with the DrainVSubIR program for the experimental field Avram Iancu, Bihor County

Nr. crt.	Variants	Price of 1 km drain					Price of 1 ha with associated works			Total costs Ron/ha
		Ditch Ron/Km	Drain tube Ron/km	Filter Ron/km	Unit Price Ron/km	Total drainage Ron/ha	Mole drainage Ron/ha	Scari-fying Ron/ha	Total assoc. works Ron/ha	
1.	Ff	1500	7000	-	8500	23311	-	-	-	23311
2.	Fa	1500	7000	100	8600	4938	-	-	-	4938
3.	Fm	1500	7000	150	8650	3892	-	-	-	3892
4.	Fî	1500	7000	300	8800	2946	-	-	-	2946
5.	Ff + Cr	1500	7000	-	8500	16144	110	-	110	16254
6.	Fa + Cr	1500	7000	100	8600	5198	110	-	110	5308
7.	Fm + Cr	1500	7000	150	8650	3823	110	-	110	3933
8.	Fî + Cr	1500	7000	300	8800	2882	110	-	110	2992
9.	Ff + Sc	1500	7000	-	8500	11596	-	130	130	11726
10.	Fa + Sc	1500	7000	100	8600	5509	-	130	130	5639
11.	Fm + Sc	1500	7000	150	8650	3759	-	130	130	3889
12.	Fî + Sc	1500	7000	300	8800	2862	-	130	130	2992

Ff – No filter prism; Fa – filter prism out of soil for acidity correction with a 0,1 m height; Fm – filter prism of sorted ballast with a height of 0,1 m; Fî – sorted ballast filter prism of 0,2 m; Cr – mole drain perpendicular on the drain direction; Sc – deep loosening through scarification, on the perpendicular direction of the drains;

The total costs of one hectare equipped represent the sum of drainage price, in Ron/ha and the price of associated works, in Ron/ha. The unit price of drainage in Ron/km represents the sum of ditch price, drain tube price and filter price. The total drainage cost is calculated in function of distance between the rains, determined by "The checking of the drainage designed for working in not permanent regime" module.

4. CONCLUSIONS

Taking in consideration the observations from the drainage experimental fields the structure of DrenVsubIR software shell be modified, having two new modules, the first "INPUT DATA" and last but one module "The checking of functioning in not permanent regime".

The module "INPUT DATA" have the required characteristics grouped in three categories: the first, "Data for the draining geometry", in which if not know the real hydraulic conductivity of the layers it opens the window "Data for soil profile characteristics", where it may introduced the pedological hydraulic conductivity of soil layers. The third group requires "Data for drain tube and filter characteristics" and he differentiates the circular filter and prismatic filter.

Before the module "The calculus of hydraulic pressure looses ζ (zita)", the program makes preparatory calculus being determined the real hydraulic conductivity K_R of the two layers from above and from bottom of drains plane and respectively the equivalent diameter of the prismatic filter df.

The module "The calculus of the distance between the drains L, in permanent regime" was bettering for the design the drainage upon the hard and compact soils using the drainage in association with deep loosening works.

After the module "The calculus of the distance between the drains L, in permanent regime" is introduced a new module "The checking of functioning in not permanent regime" that determine the time necessary for lowering the water level table from the surface of land, the depth of drains to the water level table corresponding at drainage norm.

The module "The checking of the reversibility drainage into subirrigation" is not modified bat it use the distance between drains resulted after the checking of functioning in not permanent regime.

The last module "The technical and economical calculus" take in consideration the same distance between drains, established in not permanent regime and make the difference between the unit price of drain in Ron/Km length of drainage tube the price of associated works expressed in Ron/ha equipped surface.

With the new functions introduced DrenVsubIR software shell have expanding possibilities for using and betting performances in the design of the agricultural drainage.

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