THE EFFECTS ESTIMATIONS OF DRAINAGE AND SUBIRRIGATION WITH DrenVSubIR PROGRAM IN DRAINAGE EXPERIMENTAL FIELD FROM AVRAM IANDU, BIHOR COUNTY

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Abstract.
The main method for drought control is the irrigation and in the sub humid zones, with drainage development project in systems, the problem is to investigate the use possibility of these systems for irriation water administration at plant. This is the study of the reversibility's drainage-irrigation.
The objectives of this work are the verification of the reversibility's drainage-irrigation and the estimation of economic effects of the variants studied in drainage experimental Field Avram Iancu, Bihor county, using DrenVSubIR specialized program. This is consisted of three modules, the first from distance between the drains calculation using Ernst-David equation, the second for the verification of the reversibility's drainage-irrigation and the third for the economic calculus.
For the pedo-climatical conditions of drainage experimental field from Avram Iancu are confirmed the research results effectuated here in 1984-1990 period, some variants are reversible in subirrigation and their economic effects are superior given the situation of conventional drainage variants.

Key words: drought, drainage pipe, conventional drainage, subirrigation, mole drain, deep loosening.

INTRODUCTION

In the context of the climate changes about 2 % of the total agricultural surface, about 15 million hectares is affected by severe drought (Nicolescu C. *et al.* 2007) This tendency of desertification is present in the Western Plain Romania, the number of days with severe drought being higher. It represents after pollution the second biggest problem humanity faces in the second half of the last century and the beginning of this one (Man T.E. and Cristina Modra, 2008).

The main method for fighting drought is by using irrigation, but that implies using a large volume of water. These restraints affect the volumes of water used in agriculture, thus some answers to questions related to the vulnerability and the capacity of agriculture to adapt to the new conditions and measures. (Sveden M. and Nana Kündel, 2009). In order to ensure a proper water management some methods that are efficient economically for watering are needed.

The surfaces set up with drainage systems, conceived for eliminating excess water (conventional drain) can be used for adjusting the level of the soil water (controlled drainage) or for administrating water through subirrigation (reversible irrigation drain) (Belcher H.W. and F.M. D'ltri, 1995). This method has the advantage that in wet periods the system works in conventional drain, thus eliminating the excess water in the soil profile, the controlled drain allows the humidity control in the root area by controlling the level of the ground water and the quantity of water coming from conventional drain and in the drought periods the system is used for subirrigation, the water needed is brought through a network of drainage channels.

Controlled drainage and sub irrigation by using drainage tubes have been used as methods for distributing water to the roots, have been used in the USA for 30 years, first in greenhouses and solariums, than in vegetable irrigation, than in irrigation for fruit trees and field crops. (Skaggs R.W., 1999) The reversible drain in subirrigation allows the control of the soil water, water economy, no extra investments, high yield gains, the reduction of nutrient losses.

The first studies in Romania date back to the period mentioned above. The concept used in Romania implies projecting the conventional drain and than checking to see if it can be used as a controlled drain and whether it is reversible in subirrigation. (Wehry A., et al, 1985) In order for a conventional drain to work in controlled drainage or in subirrigation it has to allow the level of the ground water to be maintained the minimum easily available content and the field capacity.

The objectives of this work are the verification of the reversibility's drainage-irrigation and the estimation of economic effects of the variants studied in drainage experimental Field Avram Iancu, Bihor county, using DrenVSubIR specialized program.

MATERIAL AND METHODS

The experimental drainage field from Avram Iancu was set up in the low plain field of the Crişul Negru river, when the drainage system from south western Bihor county was set up, in 1983, on a gleical, cambical phaeosiom with a high content of colloidal clay, higher with 50 % on the entire profile and with hydraulic conductivity determined using the cylinder methods (pedological method) between 7,9 mm/h and 1,2 mm/h. (Ciobanu Gh., et al. 2003)

In order to carry out underground drainage, 14 variants of drainage were studied, with distances between tubes varying from (L) of 15, 30 and 45 m, no filter or prism filter from soil (Fa), or rubble with the height of 5 - 10 cm (Fm) and from rubble with the height 15 - 20 cm (Fî) associated or not with mole drain or deep loosening through scarification.

The yield gains registered in maize (31 %) in the experimental period and the time needed for recovering the investment (12 years) imposed using the high filter rubble prism and deep loosening by scarification on the studied area of V12 with a 30 m distance between drains, compared to the variant proposed by the engineer.

The calculation program DrenVSubIR is made out of 3 modules, the first one for calculating the distance between the drain in a permanent regime, the second for verifying the reversibility of the conventional drain in subirrigation, and a third one for calculating the technical and economical module (costs) for a drained hectare. (Bodog Marinela et al. 2007, Teuşdea A.C. et al. 2008)

The module for dimensioning the distance between drains in a permanent regime uses the Ernst relation, completed by David, that proposes adding to the hydraulic losses the resistance of the water in the drain filter complex, with the aid of some experimental coefficients.

The "Check Subirrigation" mode uses the values determined at projecting the distance between drains, after which detrmine the height of the depression curve for usage in subirrigation H_o and the height of the water needed in the drain H_C, for the humidity needed for the field capacity in the upper layer of the soil profile.

This height is obtained by pressing "Calcul subirigaţie" button in which the program sums up the heights for the minimum easily available level Hm with the hydraulic charge needed to ensure subirrigation h at which we add the losses of hydraulic charge at water exiting the drain filter complex h_i and the loss of hydraulic charge along the drain tube. h_{Ld}.

After determining the height of the water in the channel the program calculates $H_C + z$ and compares this values to the depth of the waterproof layer H. If $H_C + z < H$, the message that ”subirrigation is possible” appears in a window on the right side. For when $H_C + z > H$, the message displayed is ”subirrigation is not possible” on the drain network entered previously.

The third module, “Technical economical calculus” estimates the costs for a drained hectare.

Knowing the results of researches from Avram Iancu drainage field and the pedoclimatical conditions the paper verify the results obtained in dimensioning the horizontal drains, the reversibility of the conventional drain in subirrigation and estimating their economical effects, using the DrenVSubIR soft.

RESULTS AND DISCUSSION

For the conditions in the drainage field from Avram Iancu the entry data is: specific water drain q = 0,007 m/day, drain pose depth 0,9 m, drain norm z = 0,4 m, the loss of total hydraulic charge h = 0,5 m.

In the hypothesis of multi layer soil in which the separation plain between the two layers is identical to the plain of the 0.9 m drain pose, the hydraulic saturated conductivity of the upper layer K_{H1e} was determined using the relation:

$$K_{H1e} = \frac{d_1 K_{H1} + d_2 K_{H2} + ... + d_n K_{Hn}}{d_1 + d_2 + ... + d_n}; \qquad [1.]$$

The saturated hydraulic conductivity underneath the plain of the drains is given by the BCG horizon, of the soil profile K_{H2} = 0,076 m/day. (Table 1.)

Table 1.

Some hidro-phisical proprieties of the Faeozion gleic, cambic soil, from Avram Iancu, Bihor County

Horizon	Deepness (cm)	Clay (%) <0,002 mm	Textural class	CC (%)	CO (%)	K (mm/h)	K_H (m/day)	D_e (m)	K_{He} (m/day)
Ap	0-29	67,0	AL	38,5	16,8	7,9	0,2180	0-0,9	0,1375
AmGo	29-43	64,0	LA	36,3	13,9	5,0	0,1550		
BvGo	43-81	59,1	LA	34,5	13,0	1,6	0,0841	0,9-1,2	0,076
BCG	81-120	56,8	LA	32,8	11,6	1,2	0,0760		

Because the separation plain of the two layers is identical to the drain pose plain, the distance between this is D_O = 0,001 m. The distance vertically in the drain plain to the waterproof layer is D_2 = 2,0 m. In the drain field from Avram Iancu a P.V.C. pipe, with a diameter Φ = 0,065 m, with rectangular holes set on distributors n = 6 rows, with width l = 0,001 m, length b = 0,005 m the distance between them of B = 0,025 m.

Checking the distance between drain wires using the DrenVSubIR soft. By using this module of DrenVSubIR program the distance between drain wires L (m) in 12 similar variants to the ones in Avram Iancu was calculated. (Table 2.)

For the variants with no filter prism is the same as diameter of the tube do = df = 0,065 m, and the hydraulic conductivity of the clogged filter Kfc is the same as the horizon on a depth of 0,9 m.

In the area with filter prism, when calculating the hydraulic conductivity of the upper layer, the height of the filter prism and the conductivity of the filter were taken into consideration. The conductivity of the filter were considered to be, for the prism made out of soil, similar to the one in the bio accumulation layer: A_p, Kfc = 0,2180 m/day; for the rubble filter prism the Kfc = 12,4 m/day was used, determined experimentally by Wehry A et al. 1982.

Considering that the ameliorative works associated with a life period of 4 to 6 years, after which they have be redone, it is considered that the hydraulic conductivity is doubled when using the mole drain, and is tripled when using the scarification.

Table 2.

The distance between drains (L) calculated with the DrenVSubIR

Nr. crt.	**Variant**	**K_{1e} (m/day)**	**K_2**	**Filter Prism**		**ζ (zita)**	**L (m)**
				df (m)	**Kfc (m/day)**		
1.	Ff	0,1375	0,076	0,065	0,076	1,62	3,6
2.	Fa	0,1969	0,076	0,159	0,2180	-1,66	17,4
3.	Fm	1,507	0,076	0,159	12,4	-3,38	22,2
4.	Fî	2,8844	0,076	0,223	12,4	-5,61	29,9
5.	Ff + Cr	0,228	0,076	0,065	0,076	1,62	5,4
6.	Fa + Cr	0,2437	0,076	0,159	0,2180	-1,66	16,5
7.	Fm + Cr	1,5973	0,076	0,159	12,4	-3,39	22,5
8.	Fî + Cr	2,9657	0,076	0,223	12,4	-5,61	30,1
9.	Ff + Sc	0,3954	0,076	0,065	0,076	1,62	7,5
10.	Fa + Sc	0,4109	0,076	0,159	0,218	-1,66	15,8
11.	Fm + Sc	1,7644	0,076	0,159	12,4	-3,39	23,0
12.	Fî + Sc	3,0939	0,076	0,223	12,4	-5,61	30,4

Note: Ff – No filter prism; Fa – filter prism out of soil for acidity correction with a 0,1 m height; Fm – filter prism out of rubble with a height of 0,1 m; Fî – rubble 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 values obtained for the distances between drains are between 3,6 for the variant with no filter prism and no ameliorative works and 30,4 m for the variant with filter prism of high rubble associated with deep loosening by scarification.

By operating the dimension between wires program, with the same filter material and the same ameliorative works we get the same results as the ones obtained in the experimental drainage field from Avram Iancu between 1984 - 1990, L = 30,4 m high rubble filter prism (Fî) associated with deep loosening by scarification (Sc).

Checking reversibility in subirrigation of the drain variants studied with the DenVSubIR soft. In order to function in the conditions of controlled drain and sub irrigation we need to adjust the level of ground water by maintain the level of the water in the drain channel at a level in which the humidity in the upper layer of soil is between the level of the active humidity, between the minimum easily available water content (Pmin) and field capacity (CC).

The results of using the "Subirrigation Verification – David equation" of the program for drains that have been conventionally designed shows the possibility of reversibility between drain and sub irrigation when distances between drains are bigger than 20 m, with filter prism out of rubble of 10 cm (Fm) or 20 cm (Fî), no matter if they are associated or not with soil reclamation works. (Table 3.)

Table 3.

Verifying through sub irrigation the drain varinats designed with the DrenVSubIR program

Nr. crt.	Variants	K_{le} (m/day)	Kfc (m/day)	L (m)	Hc (m)	Hc+z (m)	H (m)	Reversibility drain/ sub irrigation
1.	Ff	0,1375	0,076	3,6	2,36	3,05	2,90	NO
2.	Fa	0,1969	0,218	17,4	2,97	3,66	2,90	NO
3.	Fm	1,507	12,4	22,2	2,03	2,72	2,90	YES
4.	Fî	2,8844	12,4	29,9	1,95	2,64	2,90	YES
5.	Ff + Cr	0,228	0,076	5,4	2,33	3,02	2,90	NO
6.	Fa + Cr	0,2437	0,218	16,6	2,68	3,37	2,90	NO
7.	Fm + Cr	1,5973	12,4	22,5	2,02	2,71	2,90	YES
8.	Fî + Cr	2,9657	12,4	30,1	1,95	2,64	2,90	YES
9.	Ff + Sc	0,3954	0,076	7,5	2,27	2,96	2,90	NO
10.	Fa + Sc	0,4109	0,218	15,8	2,32	3,01	2,90	NO
11.	Fm + Sc	1,7644	12,4	23,0	2,02	2,71	2,90	YES
12.	Fî + Sc	3,0939	12,4	30,4	1,95	2,64	2,90	YES

In order to retain the water coming from conventional drain or the volume of water brought by the channel network, in the case of subirrigation we need to place some dams, that will regulate the level of the water at the depths from above.

Checking the costs and estimated economical effects of the drain variants studied with the DenVSubIR soft. The calculus of the costs for a drained hectare, specific investment, is using for the choice of the cheapest variant of conventional drainage and subirrigation. Knowing the maize yields of variant studied in Avram Iancu drainage field (1984-1990) we can estimate the economic effect of these and the time for investment retrieve (TIR). (Table 4.)

Table 4.

The estimated economic effects of drainage and subirrigation variants

Nr. crt.	Variants	Conventional drain			Subirrigation		
		Specific investment (RON/ha)	Economic effect RON/ha and year	TIR (Years)	Specific investment (RON/ha)	Economic effect RON/ha and year	TIR (Years)
1.	3,6 m Ff	23923	25,6	934	NO REVERSIBILY		
2.	17,4 m Fa	4938	60,8	81	NO REVERSIBILY		
3.	22,2 m Fm	3892	115,2	34	5450	121,6	49
4.	29,9 m Fî	2946	144,0	20	4120	294,4	14
5.	5,4 m Ff+Cr	16348	80,0	204	NO REVERSIBILY		
6.	16,6 m Fa+Cr	5338	121,6	44	NO REVERSIBILY		
7.	22,5 m Fm+Cr	3955	192,0	21	5340	393,6	14
8.	30,1 m Fî+Cr	3009	268,8	11	4060	550,4	7
9.	7,5 m Ff+Sc	11725	256,0	46	NO REVERSIBILY		
10.	15,8 m Fa+Sc	5639	272,0	21	NO REVERSIBILY		
11.	23,0 m Fm+Sc	3889	294,4	13	5055	601,6	8
12.	30,4 m Fî+Sc	2993	390,4	8	3890	800,0	5

Considering that the cost of this extra investment in subirrigation is not linked to the distance between drains and that the conditions for moisture on the soil profile, larger in the case of conventional drain, will make yield grow, the time for investment retrieve decreases.

The most indicated variant for subirrigation is the one with the biggest distance between drains V_{12}, L = 30,4 m Fî +Sc, with the biggest economic effect and the shortest time for investment retrieve of 5 years.

CONCLUSIONS

In the Western Plain of Romania, in Avram Iancu, Bihor county, on a cambical, gleical phaeosiom, between 1984-1990 more conventional drainage variants were studied with distances between drains of (L) 15, 30 and 45 m, with no filter (Ff) or with a filter prism out of soil (Fa) out of rubble, 10 cm high (Fm) and 20 cm high ($F_î$) with no soil reclamation works or associated with mole drain (Cr) and deep loosening by scarification on perpendicular direction as the drains (Sc).

Using the module for dimensioning the drain from the DrenVSubIR projecting program in similar conditions to the ones from the field of Avram Iancu led to the same results indicating V_{12} L = 30,4 m, Fî + Sc.

Testing reversibility between drainage – sub irrigation for the conventional drains designed, by using the check up module "Subirrigation Verification – David equation" of the same program can be used for sub irrigation for all variants with distances larger than 20 m and rubble filter prism.

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