THE INFLUENCE OF HORIZONTAL DRAINAGE ON CROPS PRODUCTION IN THE TRIAL PLOT LACU SARAT, BRAILA

INFLUENȚA LUCRĂRII DE DRENAJ ORIZONTAL ASUPRA PRODUCȚIEI ÎN CÂMPUL EXPERIMENTAL LACU SĂRAT, BRĂILA

Valentina COTEȚ, M. L. EFTENE, Victoria MOCANU

National R & D Institute for Soil Science, Agrochemistry and Environment Protection – ICPA Bucharest

Bvd. Marasti 61, sect. 1, 011464, Bucharest, e-mail: vali_c76@yahoo.com

Abstract: *The soils of the Braila Plain present a sound importance for the agriculture of this region. In this area one can find some of the most fertile soils from Romania and the most various and important crops. However, often, the soils with a good fertility are interspersed with areas of saline soils or soils with salinisation risk and low productivity. The soil ameliorative works carried out in the trial plot influenced the evolution of the soils and of the ground waters quality. The effect of this evolution has been reflected in higher yields, and in a better technical-economic ways for improving saline and alkaline soils. The aim of this paper is to emphasize the effect of the horizontal drainage, which is included into the ameliorative scheme of the Lacu Sarat trial plot, next to the deep loosening, ameliorative irrigation, ameliorative organic or/and mineral fertilization, plowing with or without soil material inverting, mulching, and amendment. The main characteristics of those works consist in that they are applied according to the specific conditions of the soil. Each ameliorative work belongs to a complex, aims to obtain amelioration of certain soil characteristics, so that, in the end the whole works set will lead to a consistent soil improvement in order to achieve favourable conditions for crops growth. The results presented here were obtained within 1998-2004 period at the Lacu Sarat trial plot in natural conditions in the frame of the ameliorative field scheme and also the crops structure. The results presented here are faced with the benchmark variant = 100, identified as the variant with the minimum ameliorative practices (only chemical fertilization, paraplaw tillage and amendation), due to the lack of a real benchmark variant (without ameliorative interventions). In order to obtain amelioration of the soil an important condition is to assure an efficient*

Rezumat: *Solurile Câmpiei Brăilei prezintă o importanță considerabilă pentru agricultura acestei regiuni. În această zonă se găsesc cele mai fertile soluri din România şi cele mai variate şi mai importante culturi. Totuşi, adesea zonele cu soluri cu o fertilitate bună se întrepătrund cu zone cu soluri saline sau soluri cu risc de salinizare şi productivitate scăzută. Lucrările ameliorative efectuate în câmpul experimental au influențat evoluția calității solurilor şi a apelor freatice. Efectul acestei evoluții trebuie să se reflecte în producții mai mari şi într-o modalitate mai bună de a ameliora solurile saline şi alcaline. Obiectivul acestei lucrări este să sublinieze efectul drenajului orizontal, care este inclus în schema ameliorativă a câmpului experimental de la Lacu Sărat, alături de afânarea adâncă, irigația ameliorativă, fertilizarea organică şi/sau chimică, aratura cu sau fară răsturnarea brazdei, mulcirea şi amendarea. Caracteristicile principale ale acestor lucrări constau în faptul că sunt aplicate conform condițiile ameliorative ale solului. Fiecare lucrare ameliorativă aparține unui complex, urmând să obțină ameliorarea anumitor caracteristici de sol aşa încât, în final întregul complex de lucrări să ducă la o ameliorare substanțială a solului pentru a obține condiții favorabile pentru dezvoltarea culturilor. Rezultatele prezentate aici au fost obținute în perioada 1998-2004 la câmpul experimental Lacu Sărat în condiții naturale în cadrul schemei ameliorative din teren şi de asemenea a structurii culturilor. Rezultatele prezentate aici sunt comparate cu varianta martor = 100, considerată varianta cu lucrari ameliorative minime (doar fertilizare chimică, aratură fară întoarcerea brazdei şi amendare), datorită lipsei unei variante martor propriu-zise (fără lucrări ameliorative). O condiție importantă pentru a obține ameliorarea drainage. Drainage is being used to eliminate stagnant water occuring on the surface of the soil, the water from ameliorative*

irrigation and also to maintain ground water table to a certain depth. In that case we can get a continuous descendant water flow for removing, eliminate salts prevent resalinization and to lead to a negative soluble salts balance. To help achieving the radical amelioration of the soil and to conduct to a more efficient and rational use of the land, alongside with the complex works for the amelioration of the saline and alkali soils, during amelioration and exploitation itself, agrofitotehnical and agro ameliorative measures should be applied.

solului este asigurarea unui drenaj eficient. Drenajul, este folosit pentru a elimina apa stagnantă de la suprafaţa solului, apa de la irigaţia ameliorativă şi de asemenea pentru a menţine panza freatică la o anumita adâncime. În acest caz putem obţine un curent descendent continuu pentru a îndeparta şi elimina sărurile şi pentru a preveni resalinizarea şi pentru a obţine un bilanţ negativ de săruri solubile. Pentru a se ajunge la ameliorarea radicală a solului şi la o folosire mai eficientă şi raţională a terenului, trebuie ca în timpul ameliorării şi exploatării să se aplice măsuri agrofitotehnice şi agroameliorative alături de lucrările complexe de ameliorare a solurilor saline şi alcaline.

Key words**:** *horizontal drainage, treatment of variant, crop yield*
Cuvinte cheies**:** *drenaj orizontal, variantă de tratament, producţie*

INTRODUCTION

Ensuring a good drainage is an essential condition for the success of soil improvement.

Drainage setup needs to be designed so as to have functionality, correlated to the field ameliorative conditions and to the use it's going to do.

On salty soils, drainage aims to eliminate stagnant water occurring at soil surface and the water originating from off, as well as to keep ground water at a certain depth in order to make a continuous descending flow of water which ensures the leaching off of salts and prevents soil resalinization, the sum of soluble salts becoming negative.

In soils with salinization potential, drainage is applied to prevent the accumulation of soils within the soil profile, thus improving the hydro saline regime of soils.

Drainage setup provides a certain ameliorative basis, but that alone cannot solve the problem of salinization. Literature mentions many cases when soils became more saline if, the drainage setup is not being associated with ameliorative technologies.

The pipes are made of ceramics, polyethylene, plastic, polyviniline, asbocement, stone, fascine etc. Filtering materials are gravel, sand, glass wool, glass fibbers etc. Filtering materials have two aims: to protect drains against clogging and to increase the capacity to filter water in soil (SANDU, 1984).

MATERIAL AND METHODS

Lacu Sarat trial plot is located in a depressionary area which accumulates ground waters from neighbouring higher, this phenomenon being also the cause of soil degradation processes by salinization and recurrent water excess. Surface deposits are made of loess and the fields texture varies from loamy-sandy to loamy-clayey. On the bottom of the valley, where the trial plot is placed, ground waters reach levels of less than 2 m and in some parts less than 1 m depth. The soil is a slightly-moderately salinized chernozem. As far as climate is concerned, the trial plot is sited in the dry steppe, characterized by hot and dry summers, with a mean multiannual temperature of 10.90C, precipitations of 452 mm annually, potential evapotranspiration of 705 mm and a climatic water deficit of 345 mm (Braila Weather Facility).

The natural conditions of the trial plot were the basis for the layout for several treatments:

- horizontal drainage,
- deep loosening,
- ameliorative irrigation,
- organic fertilization,
- chemical fertilization,
- soil tillage with soil material inverting,
- without soil material inverting (paraplow) and
- mulching

The trial plot, with a surface of 8 ha, was divided in 8 technological treatments (parcels) each treatment being composed of several treatments (table 1).

Table 1

Improvements applied to Lacu Sarat trial plot, Braila

Treatments of variant	Treatments										
	Drainage			Deep loosening	Ameliorative irrigation	Fertilization		Soil tillage		Mulching	Amendment
	high intense (20 m)	moderately intense (40 m)	no drainage			organic	chemical	with soil material inverting	without soil material inverting (paraplow)		
V_1	✓			✓	✓	✓	✓		✓		✓
V_2	✓			✓	✓		✓		✓		✓
V_3	✓			✓	✓		✓	✓			✓
V_4	✓				✓		✓		✓		✓
V_5	✓			✓			✓		✓		✓
V_6	✓			✓			✓		✓	✓	✓
V_7		✓		✓	✓		✓		✓		✓
V_8			✓	✓	✓		✓		✓		✓
V_{8a}			✓				✓	✓			

V1 - Drainage with 20 m between the drains + Deep loosening + Ameliorative irrigation + Organic fertilization + Chemical fertilization + Paraplow + Amendment;

V2 - Drainage with 20 m between the drains + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment;

V3 - Drainage with 20 m between the drains + Deep loosening + Ameliorative irrigation + Chemical fertilization + Soil tillage with soil material inverting + Amendment;

V4 - Drainage with 20 m between the drains + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment;

V5 - Drainage with 20 m between the drains + Deep loosening + Chemical fertilization + Paraplow + Amendment;

V6 - Drainage with 20 m between the drains + Deep loosening + Chemical fertilization + Paraplow + Mulching + Amendment;

V7 - Drainage with 40 m between the drains + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment;

V8 - No drainage + deep loosening + Ameliorative irrigation + Chemical fertilization

+ Paraplow + Amendment;

V8a - No drainage + Chemical fertilization + Soil tillage with soil material inverting + Amendment.

This paper will present the influence of horizontal drainage on the yields of the crops sown in the trial plot in the studied period, which was made through a buried drainage setup with ceramic pipes of 70 mm in diameter, positioned at the depth of 1 m, with a rubble filter in three situations of intensity:

- high intensity – drain lines positioned at a 20 m distance;
- moderate intensity – drain lines positioned at a 40 m distance;
- low intensity – no drainage.

RESULTS AND DISCUSSIONS

The yield findings for the studied crops in the trial lot for the agricultural years 1998 – 1999, 1999 – 2000, 2002 – 2003, 2003 – 2004 are presented in table 2, both as absolute and relative values compared to the benchmark treatment = 100, which in the trial context can be considered $\mathbf{V_{8a}}$ (***No drainage*** + chemical fertilization + soil tillage with soil material inverting + amendment) which undergone the least improvements, an actual benchmark (with no improvement) treatment missing.

The interpretation of yield data was carried out so as to highlight the influence of a sole improvement (technological link), by comparing the pairs of treatments with similar technologies, but lacking an improvement (the reference point) considered comparison treatment (COTEŢ, 2008), (table 2) as follows:

- for ***intense drainage*** (D = 20 m) $\mathbf{V_2}$ (Drainage with 20 m between the drains + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment) with $\mathbf{V_8}$ (No drainage + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment);
- for ***moderate drainage*** (D = 40 m) $\mathbf{V_7}$ (Drainage with 40 m between the drains + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment) with $\mathbf{V_8}$ (No drainage + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment).
- for the treatment with ***no drainage and other improvements*** $\mathbf{V_8}$ (No drainage + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment) with $\mathbf{V_2}$ (Drainage with 20 m between the drains + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment);
- for the treatment with ***no drainage and no other improvements*** $\mathbf{V_{8a}}$ (No drainage + Chemical fertilization + Soil tillage with soil material inverting + Amendment) with $\mathbf{V_8}$ (No drainage + Deep loosening + Ameliorative irrigation + Chemical fertilization + Paraplow + Amendment).

Intense drainage (D = 20 m), determined significant yield enhancements reaching 25 – 114%, the highest being in maize green matter and sunflower (figure 1).

Moderate drainage (D = 40 m), lead to important yield enhancements, between 6 and 36% in all crops, the highest being recorded in sunflower, 15 – 36% (figure 1).

With no drainage (D = 0 m), but with the application of different ameliorative measures, low yields were obtained, even 50% lower than the reference treatment, with decreases of 20 – 53% in all crops (figure 1).

When no ameliorative measures are applied, except for chemical fertilization and amendment, the decreasing yield is obvious, but 4 – 24% lower than the previous case (figure 1).

Table 2

Influence of drainage

Influence of applied improvement	Agricultural year	Yield (kg/ha)								%			
		Compared treatment				Reference treatment							
Intense drainage (20 m) (V2 - V8)	1998/1999	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
		4884	3246	2535	500	3776	3110	1892	307	129	104	134	163
	1999/2000	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**
		3748	4266	3285	28571	1810	2933	2104	22857	207	145	156	125
	2002/2003			**3**	**6**			**3**	**6**			**3**	**6**
				1120	20100			570	9400			196	214
	2003/2004			**3**	**6**			**3**	**6**			**3**	**6**
				1125	20200			550	9500			205	213
Moderate drainage (40 m) (V7 - V8)	1998/1999	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
		3995	3150	2225	350	3776	3110	1892	307	106	101	118	114
	1999/2000	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**
		2385	3200	2428	24540	1810	2933	2104	22857	132	109	115	107
	2002/2003			**3**	**6**			**3**	**6**			**3**	**6**
				700	10500			570	9400			123	112
	2003/2004			**3**	**6**			**3**	**6**			**3**	**6**
				750	12700			550	9500			136	134
No drainage (with other treatments) (V8 - V2)	1998/1999	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
		3776	3110	1892	307	4884	3246	2535	500	77	96	75	61
	1999/2000	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**
		1810	2933	2104	22857	3748	4266	3285	28571	48	69	64	80
	2002/2003			**3**	**6**			**3**	**6**			**3**	**6**
				570	9400			1120	20100			51	47
	2003/2004			**3**	**6**			**3**	**6**			**3**	**6**
				550	9500			1125	20200			49	47
No drainage (without other treatments) (V8a - V8)	1998/1999	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**1**
		2866	2736	1236	290	3776	3110	1892	307	76	88	65	94
	1999/2000	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**	**1**	**5**	**3**	**4**
		1460	2766	1361	20000	1810	2933	2104	22857	81	94	65	88
	2002/2003			**3**	**6**			**3**	**6**			**3**	**6**
				520	9000			570	9400			91	96
	2003/2004			**3**	**6**			**3**	**6**			**3**	**6**
				525	9300			550	9500			95	98

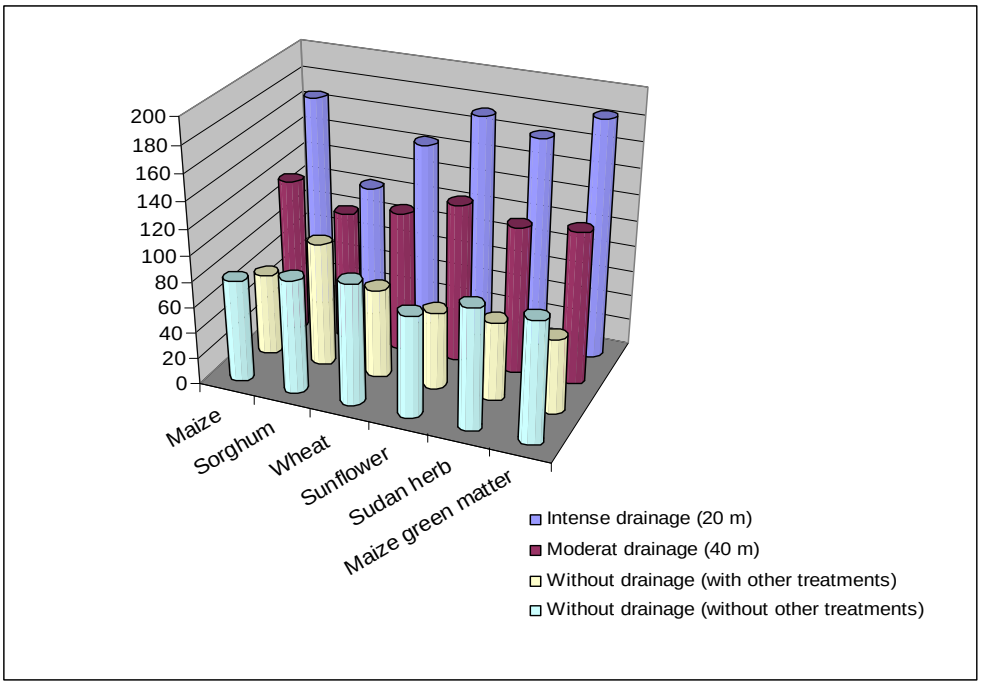

Figure 1. Variation of mean relative yield (%) in crops due to drainage

CONCLUSIONS

Drainage triggered significant yield increases, the value being double in the case of intense drainage (D = 20 m).

The lack of drainage strongly affects the development of crop plants, due to the unfavourable air-water regime related to the presence of groundwater close to the surface.

The effect of the measures applied in association confirm the efficiency of drainage on yield amounts which increase from the treatments with no drainage to the ones with moderate drainage (D = 40 m) and finally to the intense drainage (D = 20 m).

The most important conclusion is that even soils of slightly-moderately salinized chernozem type can have yields close to the ones obtained on unsalinized soils provided drainage and other ameliorative technologies are applied.

BIBLIOGRAFY

1. COTEŢ VALENTINA, 2008 - Cercetări privind influenţa unor măsuri agrofitotehnice asupra solului şi producţiei la principalele culturi de câmp în condiţiile cernoziomului freatic umed slab salinizat şi slab alcalizat din zona Brăila. Teză de doctorat.
2. SANDU GH., 1984 - Solurile saline şi alcalice din R. S. România - Ameliorarea lor, Editura Ceres, Bucureşti.