MODIFICATIONS OF THE PHYSICAL PROPERTIES OF THE PRELUVOSOIL FROM ORADEA IN THE LONG TERM TRIAL WITH IRRIGATION

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Abstract

The paper is based on the researches carried out in the Agricultural Research and Development Station Oradea. The researches started in 1976 and in the irrigated variant the soil moisture was determined 10 to 10 days for maintaining the soil water reserve on irrigation depth between easily available water content and field capacity. Thus, an average irrigation rate of 2560 m³/ha was used in the 9 experimental crops. The average of the annual rainfall for the 1976 – 2011 period was pf 615.0 mm. The technologies used were correlated with the needes of the crops, such as melioration crop rotation, chemical fertilizers in accordance with the chemical export on the yield and manure (40 t/ha) used in potato and sugarbeet. After 35 years of irrigation use the soil structure degree (38.62%) did not decrease in comparison to the unirrigated maize – wheat crop rotation (37.01%). Bulk density, total porosity, penetration resistance and hydraulic conductivity have worse values than the ones in the unirrigated variant.

Keywords: irrigation, crop rotation, manure, physical and chemical properties improve

INTRODUCTION

The climate change determined a major global problems: drought and desertification (Budoi G., Penescu A. 1996, Domuta C., 2005, 2007, 2009, Doorembos J., W.O. Pruitt, 1992). There are drought and desertification in Romania, too; Dobrogea and the South-Eastern part are considered the area with desertification. Other areas are an important part of Moldavia and the Romanian Plain and a small part of the Western Plain.(Canarache A., 1990). The irrigation is the main possibility to control the drought and desertification. The Crisurilor Plain is a part of the Western Plain and it was known for its large areas with water logging. Also the rainfall is not in accordance with the optimum water requirement of the crops. In 1968 the researches regarding the irrigation crop started in Girisu de Cris and in 1976 the researches regarding the crops' water consumption were carried out in Oradea. (Domuta C., 2005, 2009)

The researches regarding the irrigation use in the Crisurilor Plain emphasized the irrigation opportunity in the sustainable agriculture system, the yield gains produced by irrigation were statistically significant every year, the maize, soybean and sugarbeet yields showed improvements in their

stability and quality, and the water use efficiency improved, as well. The correlations quantified in the soil-water-plant-atmosphere system (soil moisture-yield, soil moisture – yield gains, water consumption – yield, climate indexes – yield) and economical efficiency sustain the irrigation opportunity in this area. The paper presents the irrigation impact on the main physical and chemical properties of the soil based on a 35 years' study.

MATERIAL AND METHOD

The researches were carried out in the long term trial placed in 1976 on the preluvosoil from Agricultural Research and Development Station Oradea, in order to study the soil water balance and the crop water consumption. The research data was compared with the data determined in an experiment with wheat-maize crop rotations near the research field for water balance study. The crop rotatation used in the research field for the soil water balance study was a melioration one: alfalfa 1st year – alfalfa 2nd year – maize – bean – wheat – soybean – sugarbeet – sunflower – potato.

In the ploughed land, the colloid clay content is of 31.5%.

The field capacity (FC) is a medium one on the soil profile and the wilting point (WP) has a medium value to 80 cm depth and a high value below this depth. The easily available water content (Wea) was established considering the soil's texture (Brejea R., 2010, Domuta C., 2009). As a consequence, the following formula was used: Wea=WP+2/3(FC-WP).

During the research period (1976-2011), on the irrigation depth (0-50 cm for wheat and bean; 0-75 cm for maize, soybean, sunflower, sugarbeet, potato, alfalfa 1st year; 0-75 cm for alfalfa 2nd year) ten to ten days determinations of the soil moisture permitted to maintain the soil water reserve between the easily available water content and the field capacity. The accomplishment of this objective determined the use of 2.560 m^3/ha of irrigation water in the studied period and in the studied crops.

The water source for irrigation is ground water at a 15 m depth. The main chemical properties of the irrigation water used are presented in table 1. The natrium content (12.9%) is low and the salinization potential is low, too (CSR=-17; SAR=0.52) (table 1).

Table 1

Chemical parametes of the irrigation water used in the research field, Oradea

Ca^{2+}	Mg^{2+}	Na^{+}	K^{-}	CO^{2}_{3}	HCO_3	CL^{-}	SO_4^{2-}	pH	Na %	Rezid. min. fix g/l	SAR	CSR	N. Florea Class
mg/l													
49.1	44.0	20.8	2.7	-	266.8	35.4	80.3	7.3	12.9	0.5	0.53	-1.8	II

The crop technologies included the use of the chemical fertilizers according to the yield export for every crop and a medium rate on the melioration crop rotation: N 140 kg/ha s.a, P_2O_5 110 kg/ha s.a and K_2O 90 kg/ha s.a. In the sugarbeet and the potato crop a dose of 40 t/ha of manure was used.

The macrostructure's hydrostability (aggregates >0.25 mm) was determined using the Cseratzki method[11]. The bulk density, hydraulic conductivity and the penetration resistance were determined using the same cylinders with a volume of 100 cm^3 [6]. The humus content, pH, the mobile phosphorus and mobile potassium content were determined using the common methods of the agrochemistry laboratories, in a laboratory of the Agricultural Research and Development Station Oradea[8].

The research data was analysed using the variance analysis method[12].

RESULTS AND DISCUSSIONS

The irrigation influence on the soil structure

The soil aggregates with a diameter bigger than 0.25 mm from the variant with irrigated melioration crop rotation had a value of 38.62%, higher than the value (37.01%) determined in the variant with unirrigated wheat-maize crop rotation but the difference (1.61%; 4%) is not statistically assured. In the variant with unirrigated melioration crop rotation, the macro aggregates' hydro stability increased statistically very significant in comparison with the unirrigated wheat-maize and an important difference (12.58%; 32.6%) was registered in comparison with the irrigated melioration crop rotation (table 2)

Table 2

Irrigation influence on the macrostructue's hydrostability, in the conditions of the preluvosoil from Oradea 1976-2011

Crop rotation	Macrostructure hydrostability		Difference		Statistical significance
	%	%	%	%	
1.Unirrigated wheat–maize	37.01	100	-	-	Control
2. Irrigated melioration crop rotation	38.62	104	1.61	4	-
3. Unirrigated melioration crop rotation	51.20	138	14.19	38	xxx

LSD 5%= 2.01; LSD 1%= 3.95; LSD 0.1%= 6.03

Analyzing the situation of the macro aggregates for every determined diameter, a very different situation was registered regarding the macro aggregates with a diameter > 5.0 mm; in the variant with unirrigated melioration crop rotation a value (2.80%) with 618% higher than the value

(0.39%) from the unirrigated wheat-maize crop rotation was determined; the value (0.62%) from the irrigated melioration crop rotation is with 39% higher than the value registered in the unirrigated wheat-maize crop rotation. There were differences regarding the macro aggregates' hydro stability in the 2.0 mm, 1.0 mm and 0.25 mm case, too (table 3).

Table 3

Irrigation and crop rotation influence on macroaggregates diameter (mm), Oradea 1976-2011

Crop rotation	Macro aggregates diameter							
	>5 mm		2.1-5 mm		1.1-2.0 mm		0.25 – 1.0 mm	
	%	%	%	%	%	%	%	%
1.Unirrigated wheat–maize	0.39	100	3.88	100	3.10	100	29.64	100
2. Irrigated melioration crop rotation	0.62	139	2.88	74	3.45	111	31.64	107
3. Unirrigated melioration crop rotation	2.80	718	3.90	101	3.76	121	40.74	137

The irrigation influence on the bulk density and on the total porosity

In the variant with unirrigated wheat-maize crop rotation, the value of the bulk density (1.34 g/cm^3) is high. In the variant with irrigated melioration crop rotation, the value of the bulk density (1.40 g/cm^3) increased statistically significant but is situated in the same characterization class. The value from unirrigated melioration crop rotation (1.20 g/cm^3) is statistically very significant lower than the value registered in the wheat-maize crop rotation emphasizing the importance of the melioration crop rotation in the evolution of the soil's physical properties (table 4).

Table 4

Modifications of the bulk density under the irrigation and crop rotation influence, Oradea 1976-2011

Crop rotation	Bulk density		Difference		Statistical significance
	g/cm^3	%	g/cm^3	%	
1.Unirrigated wheat–maize	1.34	100	-	-	Control
2. Irrigated melioration crop rotation	1.40	104.5	0.06	4.5	x
3. Unirrigated melioration crop rotation	1.20	89.6	-0.14	-10.4	000

LSD 5%= 0.05; LSD 1%= 0.09; LSD 0.1%= 0.13

As a consequence, in comparison with the total porosity (49.4 %) determine din the unirrigated wheat-maize crop rotation, in the irrigated melioration crop rotation a smaller value was determined (47.1%) but the values are situated in the same characterization class. The value of the total porosity (54.7%) in the unirrigated melioration crop rotation is statistically

very significant, higher than the one registered in the unirrigated wheat-maize crop rotation (table 5).

Table 5

Modifications of the total porosity under the irrigation and crop rotation influence, Oradea 1976-2011

Crop rotation	Total porosity		Difference		Statistical significance
	%	%	%	%	
1.Unirrigated wheat–maize	49.4	100	-	-	Control
2. Irrigated melioration crop rotation	47.1	95.4	-2.3	-4.6	0
3. Unirrigated melioration crop rotation	54.7	110.8	5.3	10.8	xxx

LSD 5%= 0.9; LSD 1%= 2.6; LSD 0.1%= 4.9

The irrigation influence on the penetration resistance

In the irrigated melioration crop rotation the value of the penetration resistance (31.38 kg/cm^2) is statistically significant higher than the value (29.3 kg/cm^2) determined in the unirrigated wheat-maize crop rotation but the values are situated in the same characterization class, a median one. In unirrigated conditions, the melioration crop rotation determined a decrease of the penetration resistance with 32.7% statistically very significant. The characterization class changes to "small", in this case (table 6).

Table 6

Modifications of the penetration rezistance under the irrigation and crop rotation influence, Oradea 1976-2011

Crop rotation	Penetration resistance		Difference		Statistical significance
	kg/cm^2	%	kg/cm^2	%	
1.Unirrigated wheat–maize	29.3	100	-	-	Control
2. Irrigated melioration crop rotation	31.38	107.1	0.8	7.1	x
3. Unirrigated melioration crop rotation	19.71	67.3	-3.7	-32.7	000

LSD 5%=0.6; LSD 1%= 1.4; LSD 0.1%= 3.5

The irrigation influence on the hydraulic conductivity

Irrigation did not have a statistically significant influence, the value of the hydraulic conductivity registered in the melioration crop rotation, 13.5 mm/h, is very close to the value registered in the wheat-maize crop rotation (14.0 mm/h). In the unirrigated melioration crop rotation, the hydraulic conductivity (20.6 mm/h) is statistically very significant higher than the value determined in the unirrigated wheat-maize crop rotation (table 7).

Table 7

Modifications of the hydraulic conductivity under the irrigation and crop rotation influence, Oradea 1976-2011

Crop rotation	Hydraulic conductivity		Difference		Statistical significance
	mm/h	%	mm/h	%	
1.Unirrigated wheat–maize	14.0	100	-	-	Control
2. Irrigated melioration crop rotation	13.5	96.5	-0.5	-3.5	-
3. Unirrigated melioration crop rotation	20.6	147.2	6.6	47.2	xxx

LSD 5%= 1.7; LSD 1%= 3.1; LSD 0.1%= 5.6

CONCLUSIONS

The researches that were carried out in the long term trial with crop rotation placed on the preluvosoil from Oradea, in 1976, in the Northern-Western part of Romania, led to the following conclusions:

In the melioration crop rotation with alfalfa, after 35 years of a correct irrigation use, the macro aggregates' hydro stability degree (38.62%) did not decrease in comparison with the unirrigated wheat-maize crop rotation. In unirrigated conditions, the value (51.2%) determined in the melioration crop is very significant, higher than the value determined in the wheat-maize crop rotation; the highest differences were registered in the aggregates with a diameter bigger than 5 mm.

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