INFLUENCE OF THE SOIL MANAGEMENT ON THE MAIN PHYSICAL PROPERTIES OF THE EROSIONED SOILS FROM NORTH-WESTERN ROMANIA

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Abstract

The paper based on the researches carried out in the plots for flow check placed on the hill with 10% slope placed in 1999 at Agricultural Research and Development Station Oradea. The area is characterized by average of the multianual rainfall of 620 mm. The following variant were studied: clean fallow, pasture, maize seeded from hill to valley, maize seeded on the level curves direction, wheat. The physical analysis were made in the profiles situated in the top and at the base of the hill. The biggest difference between structure degree determined at the base of the hill and top of the hill was registered in the variant with clean fallow (40,2%); in the other variants the differences were of 33,3% in the variant with maize seeded from hill to valey, of 12% in the variant with maize seeded on the level curves, of 8,2% in the wheat and of 7,6% in the pasture. In the horizons of the profile from the base of the hill the values of the bulk density were smaller than the values registered in the top of the hill, the total porosity values were bigger, the hydraulic conductivity values were bigger too and the penetration rezistance values were smaller. As consequence, the yields determined at the base of the hill were bigger than the yields determined in the top of the hill; in the maize seeded from hill to valley the differenes were bigger than the differenes registered in the variant with the maize seeded on the level curves. The results researches sustain the need of the soil management against erosion based on the protective plants and the crop on the level curves direction.

Keywords: macrostructure hydrostability, bulk density, total porosity, penetration rezistance, hydraulic conductivity, erosion

INTRODUCTION

Erosion affects important surfaces in Romania, including the soil in the western part of the country. In the Bihor County (North Western part), a surface of 200.000 hectares (38%) has a slope bigger than 5% and there is the risk of potential erosion. (Domuţa C., 2005; Domuţa C, Brejea R., 2010) A specific soil management is needed on the erosioned soil (Benton J., 2002, Brejea R., 2009, 2010, Domuţa C., et al, 2010, Guş P. et al., 2007, Niţu I et al., 2000, Neamţu T., 1996,) and the researches regarding this point of view were started in 1973 at Cordău by Colibaş I et all. Colibaş I, Colibaş Maria and Mihuţ I. conducted researches regarding the soil management of the soil erosion in Hidişelul de Sus (1980-1983) and Pocola (starting with 1983). After 1986, the coordinator of the researches regarding soil erosion from Pocola was Domuţa C.; researches regarding the crop rotation, chemical and organic (manure and green manure) fertilizers were made.

After 1990, the researches were continued at Beiuş, where researches in the plots for soil losses were added. In 1999, the researches regarding the soil management and the soil losses determination in the special plots were carried out in Oradea; this paper presents the results obtained in these plots.

MATERIAL AND METHOD

The researches were carried out in Agricultural Research and Development Station Oradea on a hill with 8% slope. The plots for the soil erosion measurement were placed in the following variants: V1=clean fallow, V2=maize from top to valley, V3=maize on the level curve direction, V4=wheat, V5=pasture. The plots dimensions were 45x3.5 m and metal panels were placed at the base of the plots as well as soil dams between the plots on the hill.

The physical properties of the soil after 15 years of research were determined in a laboratory from the Agricultural Research and Development Station Oradea. The macroaggregates' hydrostability was determined by wet sifting using the Cseratzki method. The bulk density (BD) was determined in 5 repetitions using cylinders with a diameter of 100 cm^3; the same cylinders were used in order to determine the penetration resistance and the hydraulic conductivity of the soil. The total porosity was calculated using the following formula: TP=(1-DA/D)x100, in which D=density=2.65 g/cm^3. The rainfall data was registered in the Meteorological Station Oradea at 45°03' latitude and 21°56' longitude; the annual rainfall registered was of 585.7 mm in 2008, of 501,4 mm in 2009, of 869.0 mm in 2010 and of 569.7 mm in 2011. The data regarding the soil physical properties and yield were processed using the analysis variant method. (Domuţa C., 2006)

The correlations between bulk density and hydraulic conductivity, bulk density and penetration rezistance, penetration rezistance-hydraulic conductivity were determined using spreadsheets software. The generated equation that had the best R-squared value was taken into consideration; the regression types available were linear, logarithmic, exponential, power and polynomial ones.

RESULTS AND DISCUSSION

Macroagregates hydrostability

At the top of the hill the smallest value of the macroagregates was registered in the variant with clean fallow (37.6%) and the biggest value was registered in the variant with pasture (56.0%). The biggest difference between macrostructure hydrostability at the top of the hill in comparison with the base of the hill was registered in the variant with clean fallow

(43.3%) and the smallest (5.9%) was registered in the variant with pasture; the differences are very significant in the variants with clean fallow, maize from top to valley, maize on the level curves and wheat and distingue significant in the pasture (table 1)

Table 1

The influence of the crop system on the macroagregates hydrostability in the top and base of the hill, Oradea 2012

Position on the hill	Macroagregates		Difference	Statistically significant
	%	%	%	
Clean fallow				
Top of the hill	37.6	100	-	Control
Base of the hill	53.9	143.3	43.3	***
LSD $_{5\%}$ 2.1		LSD $_{1\%}$ 4.6	LSD $_{0.1\%}$ 8.2	
Maize from top to valley				
Top of the hill	42.0	100	-	Control
Base of the hill	54.0	128.6	28.6	***
LSD $_{5\%}$ 1.8		LSD $_{1\%}$ 3.9	LSD $_{0.1\%}$ 6.4	
Maize on the level curves				
Top of the hill	46.7	100	-	Control
Base of the hill	55.7	119.3	19.3	***
LSD $_{5\%}$ 1.5		LSD $_{1\%}$ 2.9	LSD $_{0.1\%}$ 4.7	
Wheat				
Top of the hill	50.2	100	-	Control
Base of the hill	56.3	112.2	12.2	***
LSD $_{5\%}$ 1.4		LSD $_{1\%}$ 2.7	LSD $_{0.1\%}$ 4.3	
Pasture				
Top of the hill	56.0	100	-	Control
Base of the hill	59.3	105.9	5.9	**
LSD $_{5\%}$ 1.3		LSD $_{1\%}$ 2.5	LSD $_{0.1\%}$ 4.0	

Bulk density

Both at the top of the hill (1.61 g/cm^3) and at the base of the hill (1.50 g/cm^3), the biggest values of the bulk density were registered in the variant with clean fallow. The smallest values of the bulk density, 1.33 g/cm^3 at the top of the hill land and 1.26 g/cm^3 at the base of the hill, were registered in the pasture. The biggest difference between bulk density value at the top of the hill in comparison with the base of the hill was registered in the variant with clean fallow (-6.8%) and the smallest value (-5.3%) was registered in the pasture. The bulk density values at the base of the hill are smaller than the values registered at the top of the hill, and the differences between the determination position are very significant statistically. (table 2)

Total porosity

Total porosity values at the top of the hill are smaller than the values determined at the base of the hill, the differences are very significant statistically in all the variants. Both at the top of the hill and at the base of

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the hill, the smallest values were registered in the variant with clean fallow and the biggest values were determined in the variant with pasture. The difference between the total porosity value registered at the top of the hill and base of the hill is very significant statistically in clean fallow, significant statistically in maize from top to valley and maize on the level curves direction and significant statistically in the variants with wheat and pasture. The relative differences value between the total porosity value at the base of the hill and at the top of the hill decreased from the variant without plants (12%) to pasture (5.2%): 8.3% in the variant with maize from top to valley, 7.6% in the variant with maize on the level curves direction, 4.0% in the variant with wheat. (table 3)

Table 2

The influence of the crop system on the bulk density (BD) of the soil in the top and base of the hill, Oradea 2012

Position on the hill	BD		Difference	Statistically significant
	g/cm^3	%	%	
Clean fallow				
Top of the hill	1.61	100	-	Control
Base of the hill	1.50	93.2	-6.8	ooo
LSD $_{5\%}$ 0.03		LSD $_{1\%}$ 0.06		LSD $_{0.1\%}$ 0.09
Maize from top to valley				
Top of the hill	1.56	100	-	Control
Base of the hill	1.47	94.2	-5.8	ooo
LSD $_{5\%}$ 0.02		LSD $_{1\%}$ 0.05		LSD $_{0.1\%}$ 0.08
Maize on the level curves				
Top of the hill	1.45	100	-	Control
Base of the hill	1.37	94.4	-5.6	ooo
LSD $_{5\%}$ 0.02		LSD $_{1\%}$ 0.04		LSD $_{0.1\%}$ 0.06
Wheat				
Top of the hill	1.39	100	-	Control
Base of the hill	1.31	94.2	-5.8	ooo
LSD $_{5\%}$ 0.03		LSD $_{1\%}$ 0.05		LSD $_{0.1\%}$ 0.07
Pasture				
Top of the hill	1.33	100	-	Control
Base of the hill	1.26	94.7	-5.3	ooo
LSD $_{5\%}$ 0.02		LSD $_{1\%}$ 0.04		LSD $_{0.1\%}$ 0.06

Table 3

The influence of the crop system on the total porosity (TP) of the soil in the top and base of the hill, Oradea 2012

Position on the hill	BD		Difference	Statistically
	g/cm^3	%	%	significant
Clean fallow				
Top of the hill	39.2	100	-	Control
Base of the hill	43.4	112.0	12.0	***
LSD $_{5\%}$ 1.2		LSD $_{1\%}$ 2.3	LSD $_{0.1\%}$ 4.0	
Maize from top to valley				
Top of the hill	41.1	100	-	Control
Base of the hill	44.5	108.3	8.3	**
LSD $_{5\%}$ 1.1		LSD $_{1\%}$ 2.3	LSD $_{0.1\%}$ 3.9	
Maize on the level curves				
Top of the hill	45.3	100	-	Control
Base of the hill	48.3	107.6	7.6	**
LSD $_{5\%}$ 1.0		LSD $_{1\%}$ 2.2	LSD $_{0.1\%}$ 3.85	
Wheat				
Top of the hill	47.5	100	-	Control
Base of the hill	49.4	104.0	4.0	*
LSD $_{5\%}$ 1.1		LSD $_{1\%}$ 2.3	LSD $_{0.1\%}$ 3.7	
Pasture				
Top of the hill	49.8	100	-	Control
Base of the hill	52.4	105.2	5.2	*
LSD $_{5\%}$ 1.2		LSD $_{1\%}$ 2.6	LSD $_{0.1\%}$ 4.1	

Penetration resistance

The biggest values of the penetration resistance were registered in the variant without vegetation, both at the top of the hill (56.0 kgf/cm^2) and at the base of the hill (44.0 kgf/cm^2). Here, the biggest relative difference between the base and top of the hill was registered, 21.4%; in the other variant, the differnces were of -21.0% in the variant with maize seeded from top to valley, of -20.8% in the variant with maize seeded on the level curves direction, -20.7% in the variant with wheat and of -17.7% in the variant with pasture; the differences are very significant statistically. In comparison with penetration resistance determined from clean fallow at the top of the hill, 56.0%, in the other variant the values registered are smaller, with 9% in the variant with maize seeded from hill to valley, with 30% in the variant with maize seeded on the level curves direction, with 40% in the variant with wheat and with 53% in the variant whith pasture; at the base of the hill the differences were of 85% in the variant with maize seeded from hill to valley, of 29.9% in the variant with maize seeded on the level curves direction, of 39.1% in the variant with wheat and of 51.6% in the variant with pasture. (table 4)

Table 4

The influence of the crop system on the penetration resistance (PR) of the soil at the top and base of the hill, Oradea 2012

Position on the hill	PR		Difference	Statistically significant
	kgf/cm^2	%	%	
Clean fallow				
Top of the hill	56.0	100	-	Control
Base of the hill	44.0	78.6	-21.4	ooo
LSD $_{5\%}$ 1.9		LSD $_{1\%}$ 3.7	LSD $_{0.1\%}$ 5.6	
Maize from top to valley				
Top of the hill	51.0	100	-	Control
Base of the hill	40.3	79.0	-21.0	ooo
LSD $_{5\%}$ 2.1		LSD $_{1\%}$ 3.4	LSD $_{0.1\%}$ 6.1	
Maize on the level curves				
Top of the hill	39.4	100	-	Control
Base of the hill	31.2	79.2	-20.8	ooo
LSD $_{5\%}$ 1.8		LSD $_{1\%}$ 3.1	LSD $_{0.1\%}$ 5.7	
Wheat				
Top of the hill	33.8	100	-	Control
Base of the hill	26.8	79.3	-20.7	ooo
LSD $_{5\%}$ 2.2		LSD $_{1\%}$ 4.4	LSD $_{0.1\%}$ 6.6	
Pasture				
Top of the hill	26.6	100	-	Control
Base of the hill	21.9	82.3	-17.7	ooo
LSD $_{5\%}$ 1.7		LSD $_{1\%}$ 2.9	LSD $_{0.1\%}$ 4.3	

Hydraulic conductivity

There was the smallest value of the hydraulic conductivity at the top of the hill in the variant with clean fallow, 1.25 mm/h; in the other variants, the values of the hydraulic conductivity increased with 50.4% in the variant with maize seeded from hill to valley, with 153.2% in the variant with maize seeded on the level curves direction, with 218.4% in the variant with wheat and with 376.8% in the variant with pasture. At the base of the hill, the values of the hydraulic conductivity are very close (3.05 mm/h and 3.06 mm/h) in the variants with clean fallow and maize from top to valley, respectively; in the other variants, the values are bigger, the differences in comparison with the clean fallow were of 40.9% in the variant with maize seeded on the level curves direction, with 64.3% in the variant with wheat and with 132.1% in the variant with pasture. The differences between the values of the hydraulic conductivity at the base of the hill and top of the hill are very significant in the variants with clean fallow and distinguishing significant in the other variants. (table 5)

Table 5

The influence of the crop system on the hydraulic conductivity (HC) of the soil at the top and base of the hill, Oradea 2012

Position on the hill	HC		Difference	Statistically significant
	mm/h	%	%	
Clean fallow				
Top of the hill	1.25	100	-	Control
Base of the hill	3.05	244.0	144.0	***
LSD $_{5\%}$ 0.37	LSD $_{1\%}$ 0.72		LSD $_{0.1\%}$ 1.07	
Maize from top to valley				
Top of the hill	1.88	100	-	Control
Base of the hill	3.06	162.8	62.8	***
LSD $_{5\%}$ 0.45	LSD $_{1\%}$ 0.91		LSD $_{0.1\%}$ 1.13	
Maize on the level curves				
Top of the hill	3.29	100	-	Control
Base of the hill	4.30	130.6	30.6	**
LSD $_{5\%}$ 0.37	LSD $_{1\%}$ 0.76		LSD $_{0.1\%}$ 1.12	
Wheat				
Top of the hill	3.98	100	-	Control
Base of the hill	5.01	125.9	25.9	**
LSD $_{5\%}$ 0.41	LSD $_{1\%}$ 0.79		LSD $_{0.1\%}$ 1.14	
Pasture				
Top of the hill	5.96	100	-	Control
Base of the hill	7.08	118.8	18.8	**
LSD $_{5\%}$ 0.40	LSD $_{1\%}$ 0.82		LSD $_{0.1\%}$ 1.21	

Influence of the position of the hill on the maize yield

The maize yield obtained at the base of the hill is bigger than the yield obtained in the top of the hill. The differences are very significant every year both in maize seeded from hill to valley and in maize seeded on the level curves direction. All the differences are very significant statistically. (table 6,7)

Table 6

The influence of the position of the hill on yield in maize seeded from top to valley, Oradea 2008-2011

Year	Position on the hill	Yield		Difference		Statistically significant
		Kg/ha	%	Kg/ha	%	
2008	Top of the hill	3300	100	-	-	Control
	Base of the hill	4970	150.6	1670	50.6	***
	LSD $_{5\%}$ 120	LSD $_{1\%}$ 390		LSD $_{0.1\%}$ 640		
2009	Top of the hill	2940	100	-	-	Control
	Base of the hill	4320	146.9	1380	46.9	***
	LSD $_{5\%}$ 170	LSD $_{1\%}$ 490		LSD $_{0.1\%}$ 810		
2010	Top of the hill	5200	100	-	-	Control
	Base of the hill	8120	157.7	2920	57.7	***
	LSD $_{5\%}$ 210	LSD $_{1\%}$ 540		LSD $_{0.1\%}$ 910		
2011	Top of the hill	2750	100	-	-	Control
	Base of the hill	4070	148	1320	48	***
	LSD $_{5\%}$ 225	LSD $_{1\%}$ 490		LSD $_{0.1\%}$ 860		

Table 7

The influence of the position of the hill on yield in maize seeded on the level curves direction, Oradea 2008-2011

Year	Position on the hill	Yield		Difference		Statistically significant
		Kg/ha	%	Kg/ha	%	
2008	Top of the hill	3910	100	-	-	Control
	Base of the hill	4810	123.0	900	23.0	***
	LSD $_{5\%}$ 130		LSD $_{1\%}$ 290		LSD $_{0.1\%}$ 530	
2009	Top of the hill	3405	100	-	-	Control
	Base of the hill	4150	121.9	745	21.9	***
	LSD $_{5\%}$ 155		LSD $_{1\%}$ 320		LSD $_{0.1\%}$ 590	
2010	Top of the hill	5930	100	-	-	Control
	Base of the hill	7720	130.2	1790	30.2	***
	LSD $_{5\%}$ 210		LSD $_{1\%}$ 395		LSD $_{0.1\%}$ 720	
2011	Top of the hill	3520	100	-	-	Control
	Base of the hill	4310	122.4	790	22.4	***
	LSD $_{5\%}$ 140		LSD $_{1\%}$ 240		LSD $_{0.1\%}$ 510	

Corrrelations between the soil physical properties

There were inverse links between bulk density and hydraulic conductivity (y = -20,228 Ln (x) + 10,912, R^2 = 0,9607) and between penetration resistance and hydraulic conductivity (y = -5,7943Ln(x) + 24,588, R^2 = 0,9686). A direct link was registered between bulk density and penetration resistance (y = 103,93x2 - 204,27x + 116,21, R^2 = 0,9946). All the correlations are very significant statistically assured.

CONCLUSIONS

The researches were carried out in an experiment placed at the Agricultural Research and Development Station Oradea in 1999 on the hill with a slope of 10% in the plots for flow check in the following variants: clean fallow, pasture, maize seeded from hill to valley, maize seeded on the level curves direction, wheat.

The results of the researches led to the following conclusions:

- The biggest difference between structure degree determined at the base of the hill and top of the hill was registered in the variant with clean fallow (40.2%); in the other variants the differences were of 33.3% in the variant with maize seeded from hill to valley, of 12% in the variant with

maize seeded on the level curves, of 8.2% in the wheat and of 7.6% in the pasture.

- In the horizons of the profile from the base of the hill, the values of the bulk density were smaller than the values registered at the top of the hill, the total porosity values were bigger, the hydraulic conductivity values were bigger, too while the penetration resistance values were smaller. As consequence, the yields determined at the base of the hill were bigger than the yields determined in the top of the hill; in the maize seeded from hill to valley the differences were bigger than the differences registered in the variant with maize seeded on the level curves.

- The results of the researches permitted to quantify the direct correlations between bulk density and penetration resistance and the inverse correlations between bulk density and hydraulic conductivity and between penetration resistance and hydraulic conductivity.

Both in the maize seeded on the level curves and especially in the maize seeded from top to valley, there were differences between the maize yields obtained at the base of the hill and the top. The differences are very significant statistically.

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