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The Soil Erosion and Water

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Abstract

Soil erosion and water are deeply interconnected, with each influencing the other's behavior and effects. Soil erosion involves the removal of the topsoil layer, primarily driven by water and wind, and poses significant environmental concerns, impacting soil health, agricultural productivity, and water quality. To study soil erosion levels, a bifactorial experiment was conducted, considering factors such as crop type and crop location. Another bifactorial experiment was organized to identify solutions for improving eroded soil on slopes, focusing on types of green manure and culture location based on experimental schemes. Water reserve in the soil and water recovery efficiency were determined using established methodologies. For the soil water reserve measured at a depth of 50 cm throughout the vegetation period of meadows and corn crops between July and September of 2021 and 2022, the findings showed reductions ranging from 89 m^3/ha for experimental variant 1a (control meadow at the top of the slope) to 172 m^3/ha for experimental variant 3b (corn cultivated in the hill-valley direction at the base of the slope). These results indicate that decreases in the water reserve are much less pronounced in meadows located at the top of the slope but nearly double for corn crops in the hill-valley direction at the base of the slope.

Keywords: bifactorial experiment, depth, management practices, reserve.

1. Introduction

Soil erosion and water are intricately linked, with each influencing the other's dynamics and impacts. Soil erosion refers to the displacement of the upper layer of soil, primarily due to water and wind, and is a significant environmental concern affecting soil health, agricultural productivity, and water quality [1, 5].

Water plays a crucial role in soil erosion through processes such as rainfall impact, surface runoff, and riverine transport. When raindrops hit the soil surface, they can break apart soil aggregates, a process known as splash erosion. The force of raindrops dislodges soil particles, making them more susceptible to being carried away by surface runoff. This runoff, which occurs when the soil's infiltration capacity is exceeded, further transports the dislodged particles downhill, leading to sheet, rill, and gully erosion. Sheet erosion is the uniform removal of soil in thin layers across a large area, often going unnoticed until significant topsoil is lost. Rill erosion forms small channels as runoff concentrates in small streams, cutting into the soil. Gully erosion is more severe, creating large channels or gullies that can remove substantial amounts of soil and alter the landscape [2, 7, 9].

The impact of soil erosion extends beyond soil loss. It depletes the nutrient-rich topsoil, reducing the land's fertility and its ability to support plant growth. This loss leads to decreased agricultural yields and increased reliance on fertilizers, which can be economically and environmentally unsustainable [2, 10].

Furthermore, eroded soil particles often carry nutrients and pollutants into water bodies, contributing to water quality degradation. Sediment-laden runoff can clog waterways, reduce reservoir capacity, and harm aquatic ecosystems by smothering fish habitats and reducing light penetration [3, 6, 11].

Effective soil and water management practices are essential to mitigate soil erosion. Techniques such as contour farming, terracing, and the use of cover crops help reduce runoff velocity and increase water infiltration. Maintaining vegetation cover, whether through natural means or artificial mulching, protects the soil from direct rainfall impact and helps stabilize the soil structure [4, 6, 8, 10, 12].

The water in fluence on soil erosion was the purpose of this study conducted on eroded soil located in an area with 12° slope on meadows located on both hill peaks, and base meadows, and also on maize crops mainained on curve levels also in hilly areas.

2. Material and Method

The experiments were carried out in the village of Valea Mare de Criș, Borod commune, Bihor county, in order to study the level of soil erosion and to identify solutions to improve the eroded soil on the slope, according to the method of randomized blocks, in three repetitions, each plot having, as already mentioned, an area of 60 m^2. In order to carry out the study of the level of soil erosion, a bifactorial experiment was organized, with the factors represented by the type of crop (meadow and corn) and the location of the crop (on level curves and in the hill-valley direction), and to identify improvement solutions of the soil eroded on the slope, a bifactorial experiment was organized, with the factors represented by the type of green manure (in pure culture and in mixtures of three species each) and the location of the culture (on level curves and in the hill-valley direction), according to experimental schemes. Determination of the water reserve in the soil and the efficiency of water recovery according to established methodologies [6].

3. Results and Discussions

The study of the soil water reserve at two depths, highlights the fact that at the base of the slope there were higher water reserves than at the top of the slope, in the case of all the results obtained according to the sampling data. Between the water reserve reported for the base and the top of the slope, the largest differences are reported in August. For the depth interval 0 – 25 cm the difference is equal to 53 m^3/ha – control variant 1, 51 m^3/ha – experimental variant 2, 77 m^3/ha – experimental variant 3, and for the depth interval 0 – 50 cm the difference is equal to 149 m^3/ha – the control variant 1,160 m^3/ha – experimental variant 2, 146 m^3/ha – experimental variant 3 (Table 1).

Table 1. The means of the soil water deposits recorded at two depths of the eroded arable field according to experimental variants, July – September 2021 – 2022, m^3/ha

Issue	A, cm	Measurements data, 2021 – 2022			
		1.07	22.07	15.08	7.09
1a	0 – 25	492	412	533	371
	0 – 50	1027	981	1098	938
1b	0 – 25	532	436	586	391
	0 – 50	1080	1091	1247	987
2a	0 – 25	485	398	533	359
	0 – 50	1025	965	1122	912
2b	0 – 25	523	417	584	382
	0 – 50	1072	1083	1282	971
3a	0 – 25	446	372	521	326
	0 – 50	1012	865	1156	875
3b	0 – 25	477	415	598	348
	0 – 50	1068	980	1302	896

A – adâncimea/depth; 1a - Control experimental variant 1, meadow, peak; 1b - Control experimental variant 1, meadow, base; 2a – Experimental variant 2 cultivated with maize by level curves, peak; 2b – Experimental variant 2 cultivated with maize by level curves, base; 3a – Experimental variant 3 cultivated with maize by direction hill-valley, peak; 3ab – Experimental variant 3 cultivated with maize by direction hill-valley, base.

The smallest differences are reported for the month of September, respectively in the case of the 0-25 cm depth range, the differences are equal to: 20 m^3/ha - control variant, 23 m^3/ha - experimental variant 2 and 22 m^3/ha - experimental variant 3 For the 0-50 cm depth range, the difference is equal to 49 m³/ha in the case of the control variant 1, 59 m³/ha in the case of the experimental variant 2 and 41 m³/ha in the case of the experimental variant 3 (Table 1).

The present study highlighted the fact that, also as a result of erosion, the average soil water reserve, for the depth interval 0-50 cm, shows lower values at the top of the slope, compared to its base. The highest average of soil water, equal to 1302 m³/ha, is reported for the base of the slope, experimental variant 3b, cultivated with corn in the hill-valley direction, related to the month of August, but the differences compared to the other crop systems with similar location (experimental variants 1 control and 2b), are not statistically assured at the 5% significance level (Table 2). In July, the highest soil water averages, equal to 1080 m³/ha and 1091 m³/ha respectively, are reported for the base of the slope, the experimental variant 1 control, cultivated with alfalfa, and in this case, for the value reported at the beginning of July the difference from the culture systems with similar location (experimental variants 2b and 3b), are not statistically assured at the 5% significance threshold, while for the value reported in mid-July the difference from the culture system with similar location related to experimental variant 3b is statistically ensured at the 5% significance threshold.

In September, the highest average of soil water, equal to 987 m³/ha, is reported for the base of the slope, variant 1 control, cultivated with alfalfa, but, similar to August, the differences compared to the other crop systems with similar location (experimental variants 1 control and 2b), are not statistically assured at the 5% significance level (Table 2).

Table 2. The soil water deposits recorded at 50 cm depth of the eroded arable field according to experimental variants, 2021 – 2022

Issue	Measurements data, 2021– 2022			
	1.07	22.07	15.08	7.09
1a	1027ab	981cab	1098ca	938ab
1b	1080ab	1091cb	1247ca	987ab
2a	1025a	965acb	1122a	912a
2b	1072ab	1083b	1282ca	971ab
3a	1012b	865bac	1156a	875ba
3b	1068ab	980ac	1302ca	896ab
Mean	1047,33	1010,83	1201,17	929,83
CV (%)	2,79	11,09	7,23	4,69
$LSD_{5\%}$	6,983	5,302	4,693	5,963
F	116,832*	119,645*	125,684*	121,943*

1a - Control experimental variant 1, meadow, peak; 1b - Control experimental variant 1, meadow, base; 2a – Experimental variant 2 cultivated with maize by level curves, peak; 2b – Experimental variant 2 cultivated with maize by level curves, base; 3a – Experimental variant 3 cultivated with maize by direction hill-valley, peak; 3ab – Experimental variant 3 cultivated with maize by direction hill-valley, base; CV% – variation coefficient; LSD – Least Significant Differences; F – Fisher coefficient; the means with same letter are statistically insignificant; a - p > 0,05%; b – p > 0.05%; c – p > 0.01%.

Distinctly statistically significant differences between soil water reserves are reported, depending on the experimental variants, according to the test ($LSD_{5\%}$). The differences between the averages of the analyzed indicator are predominantly statistically significant, at different degrees of significance, both between the experimental variants corresponding to the top and base of the slope, and between them (Table 2).

4. Conclusions

For the soil water reserve recorded at a depth of 50 cm over the entire vegetation period of the meadows and the corn crop located in the period July - September 2021 and 2022, decreases are reported in the range of 89 m³/ha corresponding to the experimental variant 1a control meadow located at the top of the slope and 172 m³/ha related to the experimental variant 3b corresponding to the cultivation of corn in the hill-valley direction, located at the base of the slope. These results highlight much less pronounced decreases in the water reserve in the conditions of the cultivated meadows, at the top of the slope, but they almost double in the case of the corn culture in the hill-valley direction, at the base of the slope.

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