ORIGINAL ARTICLE

RESEARCHES REGARDING FIGHTING AGAINST EROSION ON NEW FOUNDED CULTIVATED GRASS LANDS IN THE NORTH WEST OF ROMANIA

CERCETARI PRIVIND LUPTA ANTIEROZIONALA PE PAŞUNILE NOU ÎNFIINȚATE ÎN NORD – VESTUL ROMÂNIEI

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REZUMAT SCURT

Una dintre problemele de prim plan, care prin prisma importanței ei prezintă interes pentru întreaga suprafață în pantă a țării, este prevenirea şi lupta împotriva eroziunii solului. Cu toate că au fost executate lucrări antierozionale pe suprafețe semnificative, ritmul lor este inferior ritmului de evoluție a eroziunii solului şi nici măcar aceste lucrări nu şi-au atins întotdeauna scopul. Experiențele făcute au arătat rolul decisive al covorului vegetal în lupta împotriva eroziunii, având şi avantajul unor producții mari de nutrețuri în cazul utilizării materialului biologic pe diverse terenuri în pantă. Măsurile antierozionale cu caracter biologic trebuie să aibă la bază cercetări amănunțite ale vegetației, pentru stabilirea speciilor şi a amestecurilor de ierburi care corespund condițiilor din regiunea respectivă.

ABSTRACT

One of the first order problems which interest through its importance the whole billowy surface of the country is the preventing and fighting against soil erosion. Although there were made antierozional works on significant surfaces, their rhythm is inferior the development rhythm of the soil erosion and even these works didn't always reach their aim. The experiments made revealed the decidedly part of the vegetal cover in fighting against soil erosion , part amplified also by the high productions of fodder gained in the case of using the biological material on different slope lands. The antierozional measures with biological character must have at their origin a study and detailed researches of the vegetation, for establishing the species and the herb mixtures corresponding to the conditions from the respective region.

KEY WORDS: erosion, infiltrometre with wool plies, control lot, total runoff

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RESEARCH REGARDING SOIL EROSION IN NW ROMANIA

DETAILED ABSTRACT

The soil represents the most precious resource at man's disposal for satisfying his needs, and, although it has a continuously forming process, is also under the influence of degradation, natural or artificial.

Although the soil erosion is a physical process, it has numerous economical consequences, affecting the productivity of the economical increase, the distribution of the incomes , the assurance of the food needs from own resources, generally, it affects people's life.

During the fight against this calamity, it was demonstrated that the vegetation has an decidedly effect in controlling the soil erosion, through retaining a part of the water quantity resulted from precipitations, thus reducing very much the runoff and so, the erosion.

The experiments made in the hydrographical basin "Prodaia" from Jucu village, Cluj district, confirmed the all-out part of the vegetal cover in controlling the soil erosion.

In the experiments were used different variants consisting in mixtures of perennial herbs (grains and leguminous) and also annual plants. The research methods used were the method of runoff controlling lots and the infiltrometre method.

The experimental results gained after the first method; respectively the runoffs provoked by the torrential rainfalls are presented in the Table 1 from the paperwork. As aims, there were looked out: total runoff quantities, the eroded soil quantities and the losses of nutritional elements which take place during the soil washing.

The results gained using the second method, respective the method of the infiltrometre, have established, moreover the aims studied with the first method and leaked water quantities, also the speed of water infiltration in the soil. These results are presented in the paperwork in tables 2 and 3, results gained in dependency with the two intensities of the artificial rainfall, respectively an intensity of 0.8 mm/min and 1.5 mm/min.

On the base of the gained results there were established the correlations between the aspersion time and the quantity of eroded soil, correlations presented in Figure 1.

It was demonstrated, as a conclusion of these experiments that the water infiltration in soil depends significant by the vegetal cover, the structure and organic material contents of the soil, and also the intensity and the duration of the rainfall.

The best results regarding the antierozional protection were gained at the variants represented by the mixtures of perennial herbs, especially the 2nd and the 3rd year of vegetation.

INTRODUCTION

The soil erosion process represents today one of the most aggressive and disastrous phenomena in almost all the temperate and warm areas of the world and it came to a stadium when we cannot wait any longer, because every year amplifies and increase the consequences of erosion and the fight against this calamity became harder and more expensive.

While the soil erosion is a physical process, it has numerous economical consequences, affecting the productivity of economical increase, the distribution of incomes, the assurance of need of food from the own resources, so it affects the people's life.

Although it have been made anti-erozional works on significant surfaces, their rhythm is inferior the one of the soil erosion development, and these works themselves didn't attain their purpose always.

The works made and the plant cultivated on slope lands modifies essentially the infiltration and the runoff, terms with special weight in hydrological balance of the slopes.

The quantitative estimation of these modifications of great interest for the agriculture practised on the slopes has worried many specialists all over the world. In Romania: Moțoc and Tudor – 1958[9], Stănescu and partners – 1962[10], Dumitrescu – 1975[2] , Ionescu – 1976[4], Dirja – 1998 [1]. In Spain M. Martinez-Mena, J. Alvarez Rogel, J. Albaladejo, V.M. Castilla(1999)[8] studied the influence of vegetable cover on soil erosion using the artificial rainfall obtained through aspersion. Researchers from Australia, like R. J. Loch, C. Pocknee, K. G. Evans (1995-1996)[3][5][6] have been studied the erosion problem, insisting on the universal equation of erosion U.S.L.E. and on the factors which interfere in this equation. In Norway, H Lundekvam and S. Skoien(1998)[7] emphasise the importance of soil works in stopping the erosion. S. A. Swaity, University of Hawaii, USA (1997)[11], lay stress on the actual factors which leads to the start and evolution of the soil erosion.

MATERIALS AND METHODS

The experiments were placed in the hydrographical basin "Prodaia", Jucu village, Cluj District, fruition categories being 80% pastoral land and grass land.

These experiments had as aim the quantification of the soil erosion phenomena on new founded grass lands and the possibility of fighting against this phenomenon typically for the hill areas from Transylvania.

Through these experiments it was watched over the following aims:

- looking out the pluvial attack and the critical season of erosion in dependency with the torrential rainfalls.
- the determination of the parameters of the runoffs, respectively the infiltration capacity, the study of the infiltration speed, the establishing of the time after it start the runoff on the lot and the calculation of the runoff coefficients.
- looking out the soil erosion through establishing the water quantity leaked behind the natural and simulated torrential rainfalls, the determination of eroded soil quantity in dependency with the total runoff (water + soil) and turbidity.
- the calculation of nutritional elements(N, P, K) loss, the training downstream of the herbicides as a result of the surface runoffs, looked through the prism of the water and soil pollution.

These aims watched over during the experiments came supporting the elaboration of some schemes and solutions of optimizing the eroded soil protection programs in dependency with the gravity and the danger of erosion (quantitative indicators) with the prognosis of the eroded soils fertilization level from the lots situated on slope lands and the gained productions.

The experimental field was placed in the perimeter of researches station from Jucu village, the land being situated in the north – North West extremity of Transylvanian Plain, at the interference area with the Somesan Table-land. Geomorphologic, the perimeter is represented by slope lands on both parts of Prodaia Valley and the west basin closing area. The experiments were placed on the south slope of the hydrographical basin, slope with an average inclination of 22%.

The research methods used were: the method of runoff lots and the infiltrometre method.

The runoff lots have a total surface of 600 square meters, being in fact six variants, each of them with the dimensions of 25×4 m. The variants were placed in such a manner that every lot was isolated of outside contribution with metallic walls made from bands of sheet, with a length of 10 m, width of 0.45m, with 15 cm from width buried in the soil. Every experimental lot had, at the downstream extremity a sewer for the runoffs connected with a collector basin. The capacity of the collector runoffs is 250 litres, every basin having a discharge connection. The collector basins are marked inside, so, after every torrential rainfall can be exactly read the volume of soil and water leaked from every lot.

The measuring of soil and water runoffs for every experimental variant was made after volumetric method. The chemical properties (phosphorus and potassium – the mobile forms) of the water and soil tests harvested behind the runoffs were established in the chemistry laboratory of the research station from Jucu.

The pluviometry parameters were gained using the pluviometre which collects the whole water quantity fallen in the point where it has been installed, while the pluviographic parameters needed a pluviograph, which recorded the duration of the rainfall and the water quantity fallen, the rainfall intensity resulting then from calculations.

For finding the eroded solid material quantity it was established the turbidity of the total runoff quantities (water + soil). The runoff coefficient was gained reporting the total leaked water volume and the volume of the precipitations which determined the runoff.

The studies and researches regarding the erosion using the runoff lots were combined with researches using the infiltrometre. The experiments using the infiltrometre were made on the lots for controlling the runoffs, in the same conditions of relief, slope, clime and soil. The results of these experiments were used for extrapolate the results gained using the runoff lots.

For experiments it was used the infiltrometre with wool plies for producing the spots of artificial rainfall. The using of such an installation is more favourable than the method of determining the infiltration using the water layer, because it permits the gaining of infiltration curves closer than the real ones which appear during the rainfalls.

The infiltrometre with wool plies is composed from two big parts: a system which produces the simulated rainfall and a metallic frame having a sewer which collects the runoff in a marked vase. The rainfall drops falls from the height of 1.75 m., which determines these drops to execute a mechanical work equivalent with the one of the rainfalls which usually produces the erosion.

The infiltrometre is based on the principle of determining the infiltration through the difference between the water given under aspersion form and the provoked runoff.

The pluviometry of the rainfall was checked in the laboratory and in the field, assuring intensities of the simulated rainfalls of 0.8mm/min and 1.5 mm/min using beans of 0.7mm and 1.2 mm. The measuring of the runoffs resulted behind the simulated rainfalls were made with a marked vase at every five minutes.

The infiltration was established indirectly through calculation, in correspondence with the balance equation, subtracting the gained runoff from the fallen water quantity.

The measurements and the determination were made in 3 repetitions for every experimental variant, respectively in the lower part, the middle one and the upper one, maintaining the same position on the whole period of the experiments.

The experiments, started already from 1991, when the experimental field was founded used different experimental variants, consisting in sowing the experimental lots with perennial herbs in different mixtures between grains and leguminous, and cultivating the lots with annual plants like millet, maize, rye. Every year, an experimental lot was maintained with dead fallow without weeds, this lot being considered as a witness variant.

The mixtures of leguminous and grains used during these years were:

1. Simple mixture 1 made from: Bromus inermis 50% + Onobrychis viciifolia 50%
2. Simple mixture 2 made from: Bromus inermis 50% + Medicago sativa 50%
3. Complex mixture 1 made from: Dactylis glomerata 23.3% + Onobrychis viciifolia 30% + Bromus inermis 23.3% + Lolium perene 23.3%

4. Complex mixture 2 made from: Medicago sativa 30% + Dactylis glomerata 23.3% + + Bromus inermis 23.3% + Lolium perene 23.3%

With the view to found experimental lots were made works for preparing the geminating layer, on the level lines direction, and, after the sowing, was made the rolling of the lots.

RESULTS AND DISCUSSIONS

From the multitude of results obtained from the founding of the experimental lot will be presented in what will follow the most significant results recorded in the last years.

Between 1998-2000, moreover the 4 variants sowed wits mixtures of perennial herbs it was used a variant sowed with successive of pellets and rye. As witness variant it was used an un-sowed lot, dead fallow maintained without weeds.

Table 1: The results obtained on these 6 variants using the method of lots with controlled runoff

Variant	Total runoff (l/m^2)	Eroded soil t/ha/year	Annual runoff coefficient	Loss P_2O_5 Kg/ha	Loss K_2O Kg/ha	Covering degree %
V_1 – dead fallow	24.87	29.507	0.38	4.012	15.100	0
V_2 – simple mixture 1	4.72	0.546	0.07	0.083	0.318	70
V_3 – simple mixture 2	4.88	0.564	0.07	0.092	0.340	68
V_4 – complex mixture 1	4.03	0.358	0.06	0.051	0.198	76
V_5 – complex mixture 2	4.28	0.385	0.07	0.060	0.255	74
V_6 – pellets + rye	9.85	7.069	0.14	1.166	4.270	73

Table 2: The results obtained on the 7 experimental variants at an intensity i=0.8 mm/min, between 1998-2000

Year	Variant	Leaked water	Runoff coefficient	Eroded soil (t/ha)	Humus Kg/ha	Losses Phosphorus Kg/ha	Potassium Kg/ha	Infiltrated water Mc/ha	Average infiltration speed Mm/min
1998	V_1	250.00	0.69	43.07	1141.36	3.53	8.07	110.00	0.24
	V_2	186.00	0.52	11.07	301.10	0.86	2.90	174.00	0.39
	V_3	130.80	0.36	4.10	111.11	0.30	1.05	229.20	0.51
	V_4	180.00	0.50	10.04	277.10	0.75	2.62	180.00	0.40
	V_5	170.00	0.74	9.46	260.15	0.71	2.46	190.00	0.42
	V_6	164.40	0.46	7.80	214.50	0.58	2.02	195.60	0.43
	V_7	150.40	0.42	7.51	206.50	0.56	1.95	209.60	0.48
1999	V_1	244.40	0.68	41.40	1109.52	3.39	7.71	115.60	0.26
	V_2	194.00	0.54	11.90	326.06	0.93	3.08	166.00	0.37
	V_3	121.20	0.34	3.23	88.18	0.24	0.81	238.80	0.53
	V_4	72.80	0.20	0.37	10.28	0.03	0.10	287.20	0.56
	V_5	70.80	0.20	0.35	9.73	0.02	0.09	289.20	0.64
	V_6	62.80	0.17	0.30	8.13	0.02	0.08	297.20	0.66
	V_7	53.30	0.17	0.22	5.94	0.02	0.05	306.70	0.68
2000	V_1	236.20	0.66	36.95	971.79	3.07	6.84	123.80	0.28
	V_2	198.80	0.55	12.78	348.89	1.00	3.31	161.20	0.36
	V_3	112.50	0.31	3.13	85.45	0.23	0.79	247.50	0.55
	V_4	75.60	0.21	0.41	11.40	0.03	0.11	286.80	0.63
	V_5	73.20	0.20	0.37	10.29	0.03	0.09	284.40	0.63
	V_6	67.60	0.19	0.35	9.73	0.03	0.09	292.40	0.65
	V_7	62.80	0.17	0.29	8.06	0.02	0.07	294.20	0.66

The considered variants were: V_1 – dead fallow maintained without weeds;V_2 – spring pellets;V_3 – fodder rye;V_4 – Simple mixture 2;V_5 – Simple mixture 1;V_6 – Complex mixture 2;V_7 – Complex mixture 1

Analyzing these results it can be noticed that the biggest losses of soil and nutritional elements, after the witness variant, were recorded on the variant with pellets and rye, the variants with mix0tures of perennial herbs offering a very good protection of the soil against the erosion.

These variants were also used for the experiments using the infiltrometre with wool plies, using the 2 artificial rainfall intensities, of 0.8 mm/min and respectively 1.5 mm/min. Moreover the aims looked out with the help of the lots of control, in the case of the infiltrometre was also looked out the water infiltration in the soil and also the infiltration speed.

The results gained on the 7 variants considered, using the infiltrometre, on an artificial rainfall with the intensity of 0.8 mm/min are presented in Table 2.

Table 3: Results were obtained in the case of an artificial rainfall intensity of 1.5 mm/min

Year	Variant	Leaked water	Runoff coefficient	Eroded soil (t/ha)	Humus Kg/ha	Losses Phosphorus Kg/ha	Potassium Kg/ha	Infiltrated water Mc/ha
	V_1	510.60	0.76	119.85	3211.98	9.83	23.37	164.40
1	V_2	389.50	0.58	23.80	662.53	1.89	6.26	285.50
9	V_3	265.70	0.39	12.97	351.49	0.95	3.32	450.50
9	V_4	378.80	0.56	23.93	660.47	1.82	6.25	296.20
8	V_5	362.50	0.54	23.06	643.15	1.71	6.00	312.50
	V_6	339.70	0.50	20.54	564.80	1.58	6.34	335.30
	V_7	326.60	0.48	19.53	537.00	1.48	5.06	348.40
	V_1	499.00	0.74	114.69	3039.29	9.52	20.53	176.00
	V_2	409.10	0.61	24.18	681.36	1.99	6.56	265.90
1	V_3	250.80	0.37	11.25	307.12	0.83	2.82	424.20
9	V_4	137.40	0.20	0.82	22.80	0.06	0.21	537.60
9	V_5	132.30	0.20	0.76	21.13	0.05	0.19	542.70
9	V_6	121.80	0.18	0.60	16.26	0.04	0.15	553..20
	V_7	112.90	0.17	0.54	14.58	0.04	0.13	562.10
	V_1	484.60	0.72	110.16	2897.21	9.14	20.38	190.40
	V_2	414.41	0.61	29.90	816.27	2.36	7.74	260.90
	V_3	246.60	0.37	10.12	276.28	0.75	2.54	428.40
	V_4	144.20	0.21	0.88	24.46	0.07	0.23	530.80
	V_5	139.80	0.21	0.86	23.90	0.06	0.22	535.20
	V_6	127.60	0.19	0.71	19.74	0.05	0.18	547.40
	V_7	118.70	0.18	0.60	16.68	0.04	0.15	556.30

From the results gained, it can be observed the fact that the values of the soil loss are directly proportional with the leaked water quantities, and also the loss of nutritional elements and in dependency with the soil content in these elements.

Also, the values of infiltration speed are directly proportional with the values of the infiltrated water quantities, these ones being reverse proportional with the values of leaked water quantities.

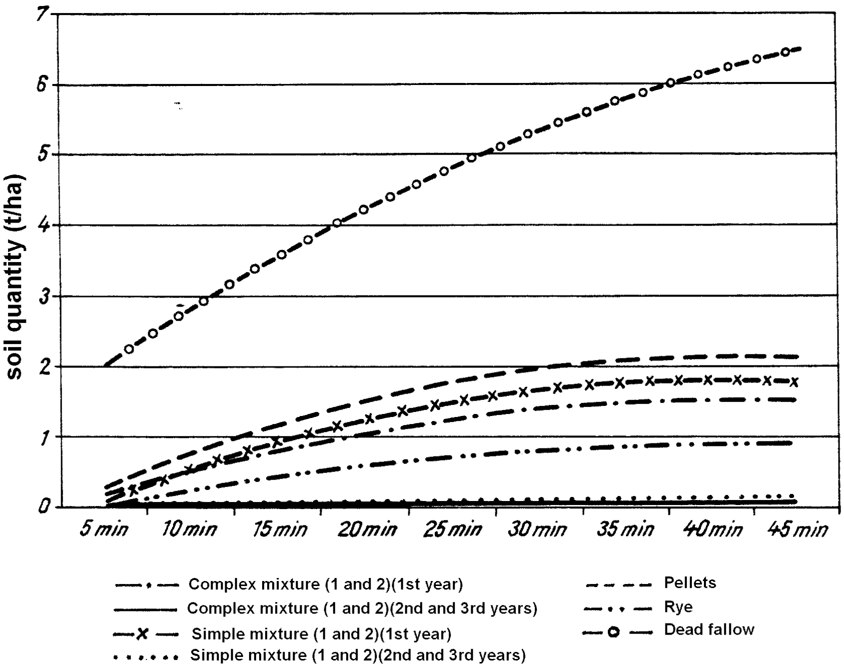
There are presented further the correlations which exist between the time of aspersion and the eroded soil quantity, considered for every 5 minutes period, of the simulated rainfall. (Figure 1)

The regression equations gained for this type of correlations are second degree equations, partially directly, with distinct significant correlations coefficients.

Their distribution in decreasing sequence on the correlations graphic corresponds with the soil protection against erosion. Thus, after the dead fallow (witness variant), it follows the pellets corresponding curve, then the simple mixtures of perennial herbs (1 and 2, first year of vegetation), the complex mixture(1 and 2, first year of vegetation), the rye and the complex mixtures (1 and 2, the 2nd and the 3rd year of vegetation).

In the case of the complex mixtures 1 and 2, the 2nd and the 3rd year of vegetation, it can be noticed from the graphic that the soil erosion is inconsiderable (under 1 to/ha) even at great intensities of the rainfall.

Figure 1: The correlation between the aspersion time and the eroded soil quantity, on simulated rainfalls with i=1.5 mm/min.



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The experiences realized on new founded grasslands have revealed , through the gained results, the total runoff quantities (liquids and solids) due to the torrential rainfalls, on different variants, sowed with mixtures of perennial herbs or with annual plants, comparing with a witness variant (dead fallow maintained without weeds). Thus it was emphasized the essential part of the vegetal cover in the soil protection against the erosion.

Due to a better antierozional protection, the soil losses under the culture of perennial herbs (simple and complex mixtures) were reduced for 70-75 times, comparing with the lot leaved as a dead fallow, and 8-9 times reduced for the lot sowed with pellets and fodder rye(successive cultures).

The grasslands situated on the slope lands can be enhanced through a complex of hydro improvement works and transformed in grasslands sowed with complex mixtures (grains and leguminous) which have a very good covering, so that to be gained good fodder productions, and, on the other side, the erosion process to be stopped.

The applying of the system of antierozional measures and agro-phyto-technical works to assure the correct choice of the plant types specific to the soil and climatic conditions of the respective slopes has also a very important part in the preventing and fighting against soil erosion.

REFERENCES

[1] Dîrja M., 1998 – “Stabilirea complexului de lucrări pentru prevenirea şi combaterea eroziunii solului pe pajişti nou înfiinţate în zonele colinare” – Teză de doctorat, Cluj Napoca

[2] Dumitrescu N., A Grânaru, 1975 – Prevenirea şi combaterea eroziunii solului pe pajiştile din silvostepa Moldovei” Lucrare ştiinţifică SCPP Măgurele, vol VI, p.177-183.

[3] Evans K.G., R. J. Loch, 1996 – “Using the rusle to identify factors controlling erosion rates of

mine soils", Land degradation development, vol 7, pg. 267-277.

[4] Ionescu V., 1976 – "Contribuții la stabilirrea unor corelații între scurgerile de pe versanți şi factorii naturali care le influentează, într-un bazin hidrografic din platforma Covurlui, în vederea dimensionării lucrărilor de combatere a eroziunii solului ", Teză de doctorat, Bucureşti.

[5] Loch R.J., C. Pocknee, 1995 – "Effects of aggregation on soil erodability: Australian experience", Journal of soil and water conservation, vol 50, no..5. pg. 504-506.

[6] Loch R.J., 1996 – "Using rill/interrill comparison to infer likely responses of erosion to slope length: implications for land management", Australian Journal Soil Res., no. 34, pg. 489-502

[7] Lundekvam H., S. Skoien, 1998 – "Soil erosion in Norway. An overview of measurements from soil loss plots", Soil Use and Management, no. 14, pg 84-89

[8] Martinez-Mena M., J. Alvarez Rogel, J. Albaladejo, V.M. Castilla, 1999 – "Influence of vegetal cover on sediment particle size distribution in natural rainfall conditions in a semiarid enviroment", catena 38, pg. 175-190

[9] Moțoc M., T. Tudor, 1958 – "Cercetări preliminare asupra capacității de infiltrație a solurilor în podgoria Drăgăşani, cu ajutorul aspersiunii". Probleme de Pedologie, Academia Republicii Populare Române

[10] Stănescu P., S. Tudor, L. Mihalache, T. Ciolacu, 1962 – "Infiltrația şi rezistența la eroziune a solurilor din podgoriile Valea Călugărească, Drăgăşani şi Târgu Jiu"

[11] Swaity S.A.El., 1997 – "Factors affecting soil erosion hazards and conservation needs for tropical steeplands", Soil technology 11 (1997), pag. 3-16

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