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LONG -TERM RESULTS FROM CULTIVATED RUNOFF PLOTS FROM UPPER ȚĂRNII VALLEY, TUTOVA ROLLING HILLS, ROMANIA

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ABSTRACT - The paper presents experimental results reported for a period of 24 years, during 1985-2008, on runoff and erosion processes, measured on some runoff plots. They are located on the left hillside of the Upper Tărnii Valley, Eastern Romania, on mollisols (Cambic Chernozem), developed on top of loams, moderately eroded, with a 12% slope. The average of multiannual precipitation is 492.2 mm. From the total of eight plots, six of them are 100m^2 (25×4m with 1 m border areas between them) and the other two are 150 m^2 (37.5×4m). Six plots were cultivated with different crops as follows: corn, beans, soybeans, winter wheat and bromegrass. Two check plots of 100 and 150m^2 were maintained like black fallow, always free of weeds. Also, annually one of the crops is cultivated both in the 100m^2 and 150 m^2 variants. Averages of soil losses in the study period of time were 0,16 to/ha/y for bromegrass, 0,86 to/ha/y for winter wheat, 5,60 to/ha/y for Beans, 9,30 to/ha/y for corn and 43,12 to/ha/y for black fallow. The intensity of erosion processes has been marked by some historical rainstorm events that have exceeded the value of 80 mm for which the soil losses ranged between 20 and 35 to/ha/y for the black fallow check plot. During the period of vegetation maximum peak erosion rates for winter wheat and beans were registered in May while for the rest of crops and for the black fallow maximum values were noticed in June.

Key words : Runoff; Soil loss; Runoff plots.

REZUMAT - Rezultate pe termen lung de la parcelele pentru controlul scurgerilor din bazinul superior Valea Țărnii, Colinele Tutovei, România. Lucrarea prezintă rezultatele experimentale obținute pe o perioada de 24 de ani, între 1985 si 2008, privind procesele de scurgere şi eroziune, măsurate pe parcele de controlul scurgerilor. Acestea sunt situate pe versantul stâng Valea Țărnii, Colinele Tutovei, estul României, pe soluri molice (cernoziom cambic), dezvoltate pe un substrat lutos, moderat erodate, cu o pantă de 12%. Media anuală a precipitațiilor este de 492,2 mm. Dintr-un total de opt parcele, şase au suprafața de 100 m^2 (25 x 4m, cu o bandă între ele de 1 m lățime), iar celelalte două au

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150 m^2 (37,5 x 4m). Şase parcele au fost cultivate cu diverse culturi, precum: porumb, fasole, soia, grâu şi bromus. Două parcele martor, de 100 si 150 m^2, sunt menţinute ca ogor negru permanent. De asemenea, anual, una dintre culturi există atât în varianta de 100 m^2, cât şi în varianta de 150 m^2. Media pierderilor de sol în perioada studiată a fost de 0,16 t/ha/an la bromus, 0,86 t/ha/an la grâu, 5,60 t/ha/an pentru fasole şi soia, 9,30 t/ha/an pentru porumb şi 43,12 t/ha/an la ogorul negru. Intensitatea proceselor erozionale a fost marcată de câteva evenimente pluviale istorice, care au depăşit valoarea de 80 mm, pentru care pierderile de sol au variat între 20 şi 35 t/ha/an la ogorul negru. În perioada de vegetaţie, vârful maxim al ratelor de eroziune pentru grâu si porumb s-a înregistrat în luna mai, în timp ce pentru restul culturilor, precum si pentru ogorul negru, valorile maxime au fost în luna iunie.

Cuvinte cheie: scurgere; eroziune; parcele de scurgere.

INTRODUCTION

Torrential rains that fall in hilly areas may affect the land of at least two ways: lost a large amount of water through runoff, water that could be used by plants, which emphasizes the phenomenon of drought; lost significant and valuable amounts of soil by sheet and deep erosion processes. Therefore, the drought is caused not only by the scarcity of rainfalls but also by the relief that diminish water use efficiency by plants in the upper horizon of soil, as the effect of runoff.

Quantitative estimate of the losses of water and soil on sloping land is the base of the strategy for applying conservation practices on an agricultural territory. At the same time is the start point in the realization of projects of watershed planning to combat soil erosion.

Determining the value of erosion for a certain area of land can be done by simple methods, like field surveys, or using mathematical models, of which the best known is the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith, 1978. In Romania, a similar equation, adapted to local condition has been developed by Moţoc and Sevastel, 2002.

Lately, have been developed more powerful programs to simulate the processes involved in triggering soil erosion, which are, in fact, complex technologies that include knowledge of various fields (Toy *et al*., 2002).

On the basis of all these methods are, however, field observations and the measurements on the experimental plots for determining runoff and erosion. These arise from the need to find a common denominator in terms of diversity of relief, climate and soil from the whole world (Hudson, 1993). Therefore, all mathematical models for simulation of soil erosion, can be validated or not if it has a set of data well enough statistical sustained so that calculation errors to fall in some acceptable limits (Schmidt, 2000).

MATERIALS AND METHODS

The study area is located on the left hillside of the Upper Ţărnii Valley ($46^0$15’57”N, $27^0$37’11”E, elevation 210-220m, 12% slope) from Tutova Rolling

Hills, Eastern Romania where the soil is represented by a cambic chernozem, moderately eroded.

The following soil conservation measures were used: intercropping, contour planting, strip cropping, a grassed waterway and a drainage network.

Two stations provided meteorological data : one of them is located 5 km S-E, in Barlad town and it registered data since 1941; the other one is an automatic weather station and is positioned in the neighborhood of the site, on the territory of Perieni Research Center.

Historical registrations indicated that yearly average of precipitation and temperature at Bârlad station are 493 mm and 9.8 ^{o}C respectively. A maximum monthly average of precipitation is placed in June with 75.6 mm while the minimum is 24.4 mm in March.

The critical season of erosion is between May and August but in the last decade data showed that these limits are about to change and they trend to enlarge until the middle of September.

Evolution of air temperature, represented by multiannual curve, is marked by a minimum in January (-3.2 ^{0}C) and a maximum in July (21.3 ^{0}C).

The last extreme rainfall events that were associated with the highest values of runoff and erosion were registered in August 29, 2004 (76.3 mm), May 07, 2005 (53.5 mm) and September 05, 2007 (88.5 mm) (Nistor *et al*., 2007).

The monitoring of runoff and erosion was made continuously between 1985 and 2008 on some runoff plots situated on the left hillside of the Upper Ţărnii Valley, Tutova Rolling Hills, Eastern Romania (*Figure 1*).

From the total of eight plots, six of them are 100m^2 (25×4m with 1 m border areas between them) and the other two are 150m^2 (37.5×4m). Runoff collection was made in three calibrated tanks disposed in cascade. If the first recipient is filled with water and sediment, the surplus will be exhausted through a device such as a part of runoff will pass in the second tank and the other four parties will be discharged outside. And if the second tank will fill, the third receiver will become operational by the same system of division of runoff.

Figure 1 - Runoff plots from Upper Ţărnii Valley

Six plots were cultivated with different crops as follows: corn, beans, soybeans, winter wheat and bromegrass. Two check plots of 100 and 150m^2 were maintained like black fallow, always free of weeds. Also, annually one of the crops is cultivated both in the 100m^2 and 150 m^2 variants (Popa *et al*., 2007).

RESULTS AND DISCUSSION

The studied period included a number of 24 years, a period long enough so that the number of pluvial events that triggered the process of soil erosion to have an acceptable statistical significance.

Analysis of the frequency of runoff and soil losses, seen compared for the main crops (*Figure 2*) shows, maximum values for the plot with

black fallow. Note that the most important losses of water (over 60% of total), by flowing to the surface of soil, due to rainfalls in the first three categories, in other words, rainfalls with values below 30 mm. Also, major runoff was recorded for torrential rains that have exceeded 50 mm. As for the soil losses, they correspond in good measure to runoff but their weight increases greatly with rainfalls for more than 50 mm. For corn, the general appearance is changed in that, although significant runoff occurs, soil losses are reduced almost by half.

In the case of beans, one can say that the large number of rain in the category below 30 mm makes the loss of water and soil to represent approx. third of the total while rain exceeding 80 mm causing the loss of water and soil over 50% of the total.

Finally, the situation for winter wheat is completely different from the previous ones. The maximum values of runoff and erosion are registered for the category of rains between 20 and 30 mm that are the most numerous.

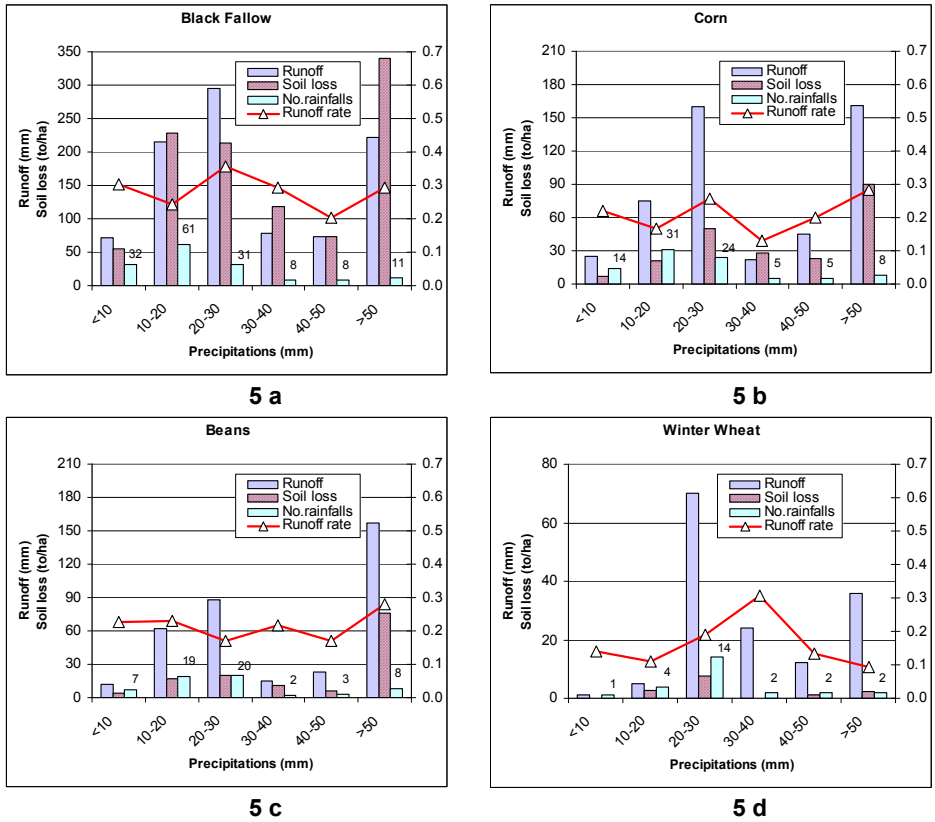

Figure 2 - Frequency of runoff, soil loss and rainfalls which triggered runoff during 1985-2008 for: 5a – black fallow, **5b** - corn, **5c** - beans, **5d** – winter wheat

Comparing the four cases analyzed is observed that the losses of water and soil according to the frequency of rainfall size are highest for black fallow, less for corn and beans and very uneven for winter wheat. This is due to influence of plant cover that is ineffective for black fallow and maximum for winter wheat. The latter is most vulnerable during sowing, in late October and early November and offers the best protection against soil erosion in June, before the harvest, when the vegetative mass reaches the maximum value. After harvest, although the degree of protection of winter wheat stubble is lower, only very high number of rainfall in July and August makes runoff to have higher values, while soil losses are insignificant.

Monthly variation of runoff and erosion is shown in *Figures 3 and 4*. As a general note, it is observed that the peak value of studied parameters is, usually in June when the monthly average rainfall has also the maximum value.

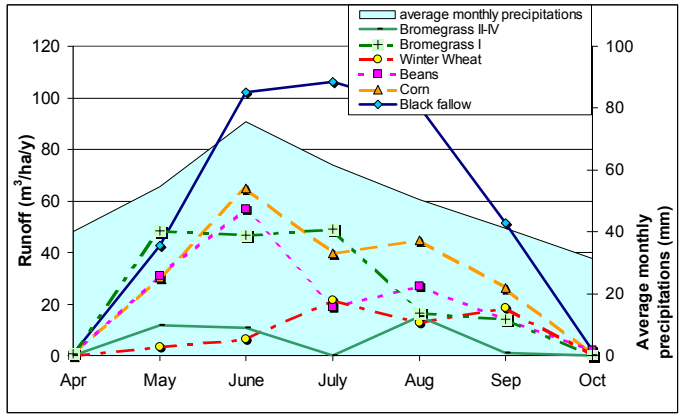

Figure 3 - Average monthly runoff during 1985-2008 for the main crops

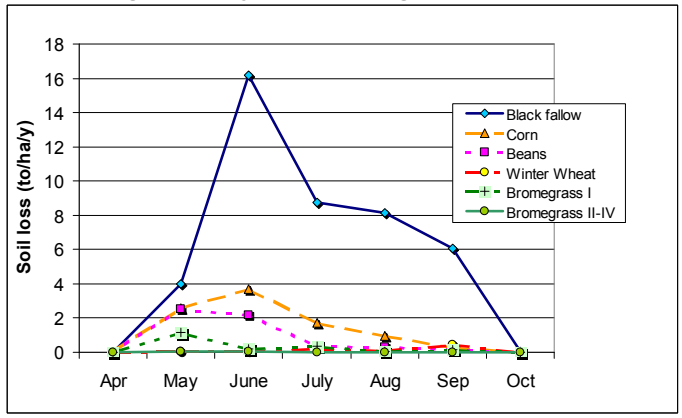

Figure 4 - Average monthly soil loss during 1985-2008 for the main crops

In the case of runoff, the highest values are recorded for permanent black fallow during the months of June, July and August. Although the amount of rainfall begins to decline in July and August, runoff is maintained at approximately the level of June, most likely due to decreased ability of water infiltration into the soil as a result of high temperatures during this period of the year leading to crust formation on the soil surface.

For the crops of winter wheat, beans and bromegrass, the runoff in August is about the same level because they are all at the stubble phase. Graph of soil loss indicates that the erosion in the case of most crops is highest in June with the exception of winter wheat and bromegrass year I for which the greatest soil losses are recorded in May.

Figure 5 shows the multiannual values of runoff and erosion of the entire period of 24 years for all examined crops. Highest value of erosion, of 43.1 t/ha/year, has been registered on the black fallow, average values of 5.6 and 9.3 t/ha/year for beans, and maize and minimum values of 0,9 and 0.16 for winter wheat and bromegrass. Runoff reflects generally the same shape of graphics, except the crop of bromegrass year I where large value of runoff is because the technology of sowing involves a greater compaction of the soil which decreases the capacity of water infiltration.

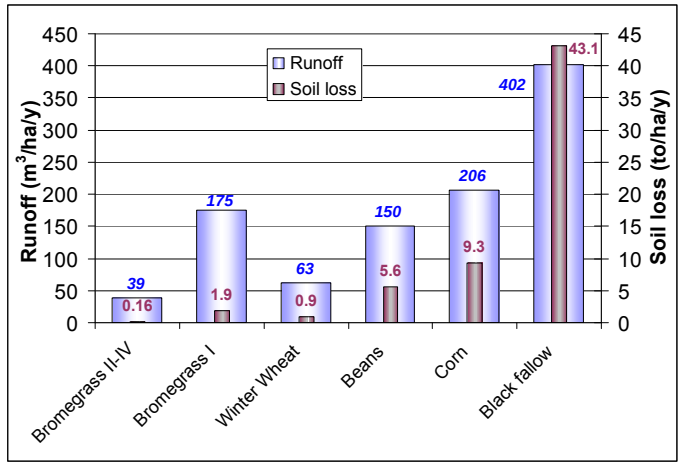

Figure 5 - Multiannual average of runoff and soil loss values during 1985-2008

CONCLUSIONS

In the natural conditions of the Upper Ţărnii Valley, Eastern Romania, study results for a period of time of 24 years, on some runoff plots cultivated by corn, beans, soybeans, winter wheat and bromegrass, have shown how different crops provide protection against soil erosion.

The averages of soil losses were 0,16 to/ha/y for bromegrass, 0,9

to/ha/y for winter wheat, 5,6 to/ha/y for beans, 9,3 to/ha/y for corn and 43,1 to/ha/y for black fallow;

During the period of vegetation highest values of runoff have been recorded for permanent black fallow during the months of June, July and August.

Maximum peak erosion rates for winter wheat and beans were registered in May while for the rest of crops and for black fallow plot maximum values were noticed in June.

REFERENCES

Hudson N.W., 1993 - *Field measurement of soil erosion and runoff.* Edited by Silsoe Asociates Ampthill, Bedfort, United Kingdom

Moţoc M., Sevastel M., 2002 - Evaluarea factorilor care determină riscul eroziunii hidrice în suprafaţă ***(****Assessment of the Factors that Cause Water Erosion at Surface).* Editura Bren, Bucureşti

Nistor D., Popa N., Nistor DOINA, Hurjui C., 2007 - *The Results of long-term application of conservation practices in Tutova Rolling Hills, Eastern Romania, in terms of soil erosion control, nutrients balance and soil compaction. Book of Abstracts,* p 118, Edited by C.Dazzi, The 5th ESSC Congress, Palermo, Italy

Popa N., Mărgineanu R., Filiche E., Petrovici G., 2006 - *Estimating soil erosion rates by using conversional models. A comparative study between simulated and measured on runoff plots.* Vol. 49, Agronomy Series of University of Agricultural Sciences and Veterinary Medicine Iaţi, Romania

Schmitdt J., 2000 - *Soil erosion: application of physically based models*. Edited by Springer-Verlag, Berlin, Heidelberg, Germany

Toy T.J., Foster G.R., Renard K.G., 2002 - *Soil erosion: prediction, measurement, and control.* Edited by J.Wiley&Sons, Inc., New York, USA

Wischmeier W.H., Smith D.D., 1978 - *Predicting Rainfall Erosion Losses - A Guide to Conservation Planning.* USDA,Washington, DC