ENRICHMENT RATE OF ORGANIC CARBON CONTENT IN SEDIMENT PRODUCED BY INTERRIL EROSION WITH TWO SURFACE COVER DEGREES

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Abstract

The surface cover play an important role in controlling soil erosion processes; however, sometimes can redirect selectivity mechanisms, producing an important delivery of particles with a high potential of pollution. The objectives of this work were analyze the changes produced by cover surface on splash and wash selectivity and its implication on enrichment rate in organic carbon content.

Samples from pasture and conventional tillage from a silty loam typic Argiudoll, were used in order to analyze the detachment rate with different cover degrees; in laboratory a rain of 55 mm. h^{-1} (1340 J.m $^{-2}$) were applied with a rain simulator and special trays. The particles from splash and wash were sieved at 1mm; 0.5 mm; 0.25 mm; 0.05 mm and 0.025 mm size, dried and weighted. The enrichment rate was estimated by means of ER= (Wet sieved aggregate fraction (%) of sediment)x(wet sieved aggregate fraction (%) of in situ soil) $^{-1}$. The organic carbon content of in situ samples and from each particles size of splash and wash were measured, and the enrichment rate in carbon content (EROC) by means of EROC = (Organic C content (%) in aggregate fraction of sediment)x(Organic C content (%) of in situ soil)$^{-1}$ were determined too.

It was found that the increase of surface cover has produced a decrease in total detachment rate of splash and wash in CT, but has not modified the total detachment rate of splash and wash in Pasture plot. Splash selectivity in CT plot has increased particles smaller than 0.025 mm, but in Wash selectivity, not any differences were observed. In pasture plot, splash and wash selectivity increased the proportion of the same particles

The ER of splash have decreased 50 percent approximately in Pasture plot, but in particles of 0,25 mm, it was found a reduction of 3 to 1; nevertheless wash enrichment rate did not show any differences with changes in cover degrees in this plot.

Not any modification was found in ER from Conventional tillage plot. The enrichment rate in organic carbon content (EROC) in Pasture was modified by change cover of 30 % to 60 %; only in splash of particles to 0.25 at 0.5 mm, the EROC were reduced; in Conventional Tillage plot, a despite of expected, the increase in surface cover degree have produced a highest increase in carbon concentration.

Those changes could be due to many aggregates have residues of organic matter included within it, which can be released by breakdown, and modify EROC as an unexpected source of organic carbon.

Key words: Argentina, Enrichment rate; Enrichment Organic Carbon rate; Selectivity; Splash and wash; Surface cover, Rainfall simulator.

Sélectivité du carbone organique dans les sédiments produits par la battance et par ruissellement sur des parcelles avec deux niveaux de couverture : simulation de pluies en Argentine.

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RÉSUMÉ

La couverture superficielle joue un rôle important pour contrôler l'érosion du sol; cependant, parfois elle peut orienter les mécanismes de sélectivité vers la production d'un important transport de particules fines susceptibles de polluer. L'objectif du travail est d'analyser la modification que la couverture végétale a produit sur la sélectivité du splash et du lavage par le ruissellement et les conséquences sur l'enrichissement du carbone organique dans les sédiments.

Le comportement des échantillons d´agrégats du sol cultivé et du sol sous prairie, avec 2 degrés de couverture artificielle est étudié avec un simulateur de pluies au laboratoire (55 mm x h^{-1} 1340 j x m^{-1}) avec des récipients spéciaux pour attraper les partícules érodées. Ces particules sont tamisées entre 1; 0,5; 0,25 et 0,025 mm et après ils sont séchés a 60 °C, et ils sont pesés. Pour évaluer la relation d'enrichissement (RE) nous avons choisi : RE = (fraction d'agrégat du sédiment (%) tamisé en humide) / (fraction d'agrégat du sol (%) tamisé en humide) . Et pour évaluer la relation d'enrichissement du carbone organique (RECO) du sédiment, choisi: RECO= (teneur en carbone organique (%) dans la fraction d'agrégat du sédiment) / (teneur en carbone organique (%) du sols) .

Le couvert a diminué l´érosion dans les sols cultivés, mais il n'a pas diminué l´érosion dans les sols avec prairie.
La RE diminue 50% dans la prairie, cependant elle n´a pas changé dans le sol cultivé. L´ RECO a augmenté dans le sols cultivé avec l´augmentation de la couverture, mais ce traitement n´a pas produit d'effet sur l´RECO de la prairie.

Mots-clés : Argentine, Coefficient de sélectivité, Matières organiques, Splash & wash, Couverture végétale

INTRODUCTION

Splash and wash detachment could be modified by mean of surface cover, because its play a important role in controling soil erosion processes. However, the detachment rate in interrill erosion when the direct impact of rainfall are prevent, can be redirect selectivity mechanisms, producing an important delivery of particles with a higher pollution potential, because its colloidal nature.

Low aggregate stability can contribute to increase the organic carbon loses, because aggregates can to include residues of organic matter within them. Due to this low physical protection, the breakdown of aggregates could to determine higher loss of organic matter by water erosion.

The objective of this work was to analyze the behavior of different land use situations with two contrasts surface cover degrees under rain simulator, in order to establish the changes in selectivity produced in splash and wash and its implication on enrichment rate in carbon content in the sediment.

MATERIALS AND METHODS:

Samples of aggregates of two different situations, pasture and conventional tillage from a silty loam typic Argiudoll, were used in order to analyze the detachment rate with different cover degrees; artificial material were used to represent 30 % and 60 % surface cover degrees in all situations. In laboratory a rain of 55 mm. h^{-1} (1340 J.m^{-2}) produced by a rain simulator were used with special trays to measure splash and wash detachment. The particles were sieved at 1mm; 0.5 mm; 0.25 mm; 0.05 mm and 0.025 mm size, dried and weighted. The enrichment rate was estimated by mean of ER= (Wet sieved aggregate fraction (%) of sediment) / (wet sieved aggregate fraction (%) of in situ soil) (Wan, El Swaify, 1998).

The Organic carbon content (Walkley, Black, in Black, 1965) of in situ samples and from each splash and wash detachment particles sizes were measured, and the enrichment rate in organic carbon content (EROC) by mean of EROC = (Organic content (%) in aggregate fraction of sediment) / (Organic carbon content (%) of in situ soil) were analyzed too. Aggregate associated organic matter (Beare et. al., 1994) was determined by dispersion of soil aggregates of 8 mm; 4,8 to 2 mm and < 2 mm with Sodium hexametaphosphate; particulate organic matter (POM) were collected in two sieves at 0,5 mm and 0,05 mm, washed and weighted; their total organic carbon (CPOM) by dry combustion (550 °C) were recorded too.

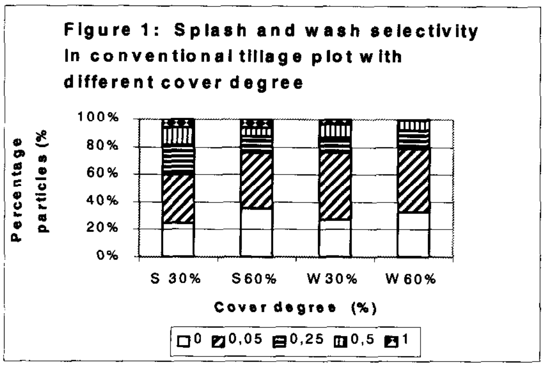
RESULTS AND DISCUSION:

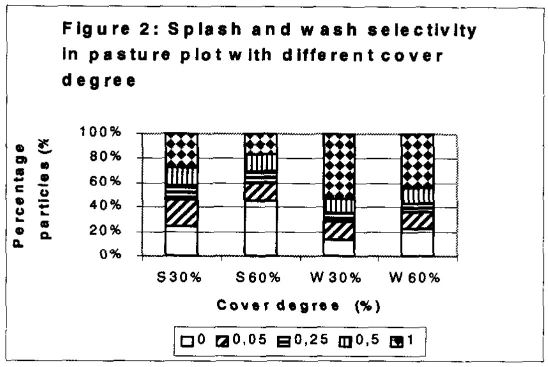
Table 1 show that to increase cover degree of 30 % to 60% have produced decreasing lower than proportionality in the detachment rate of CT splash and wash but have not importance in Pasture plot, probably due to the higher aggregate stability in this situation. The lowers efficiency in the control of soil erosion processes, could explain the differences found by different authors in the relationship between the cover degree and the reduction in water erosion process (Roth, Eggert,1994; Palis, et al., 1997; Rienzi, Sanzano, 2000; Rienzi, Kvolek, 2001) .

Table 1: Splash and wash detachment under two different cover degrees

COVER DEGREE	CT splash ($g.m^{-2}$)	CT wash ($g.m^{-2}$)	Pasture Splash ($g.m^{-2}$)	Pasture Wash ($g.m^{-2}$)
30 %	363.78 a	541.73 a	53.2 a	154.8 a
60 %	215.06 b	234.79 b	40.29 a	131.3 a
Different letter in the same column, mean significative differences at $p < 0,05$				

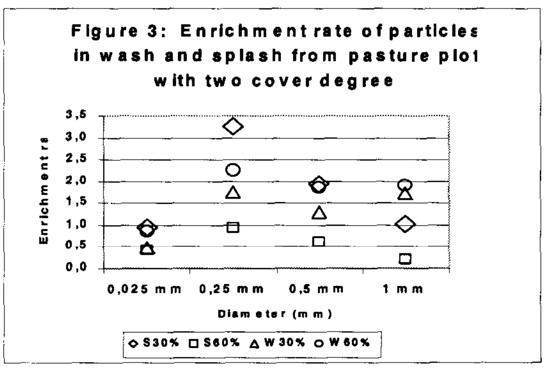
Other consequences of the interactions between cover and the characteristics of the soil erosion could be observed in their effects on selectivity. Figure 1 show that splash selectivity in CT plot have reduced the participation of 0,5 and 0.25 mm particles size and have increased particles smaller than 0.025 mm; in wash, the modification in cover degree have not any difference in selectivity of particles size.





In Pasture plot (Figure 2) splash selectivity have reduced particles of 1 and 0.05 mm size and increased the proportion of particles smaller than 0,025 mm. The wash selectivity have modified particles of 1 mm size and increased smaller than 0,025 mm.

Those changes have influenced particles enrichment rate (ER); the figure 3 shows that in the pasture plot, the ER of splash have decreased 50 percent aproximately in all particles sizes, except in particles of 0,25 mm, which show a high significant reduction of 3 to 1. Wash enrichment rate did not shown any differences with changes in cover degrees; the ER was more than 1 in all sizes, at exception to smaller than 0,025 mm particles size (ER0.3)



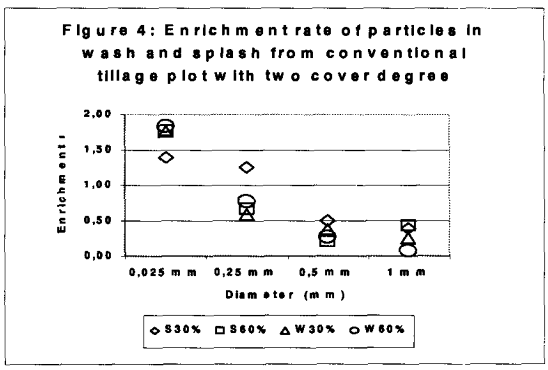


Figure 4 show that in conventional tillage plot, the effect of increasing cover degrees have not produced any modification in enrichment rate, except in particles of 0,25 mm that were detachment by splash. In order to analize the delivery of organic carbon in the sediment produced by interrill erosion, the enrichment rate of organic carbon content (EROC) was measured in particles detachment by splash and wash.

Changing cover of 30 % to 60 % did not produce a high decrease in the EROC; only in 0.25 and 0.5 mm particles size from splash, the EROC were reduced (Figure 5); in conventional tillage plot (Figure 6) a despite of expected, the increase in cover degree have produced a highest increase in carbon concentration.

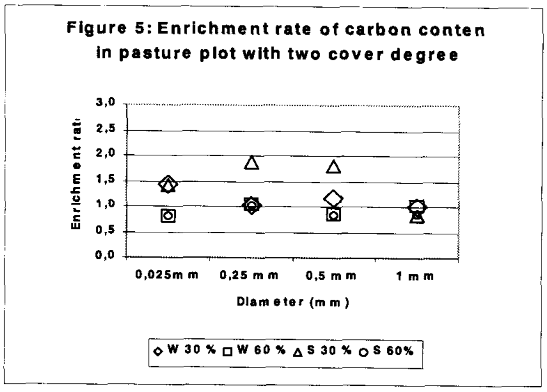


Figure 5: Enrichment rate of carbon conten in pasture plot with two cover degree

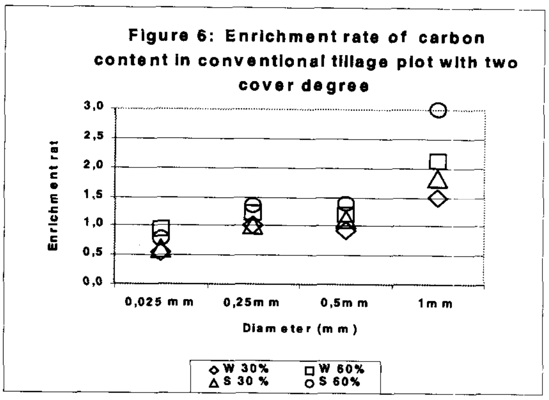


Figure 6: Enrichment rate of carbon content in conventional tillage plot with two cover degree

Due to cover material were artificial, non removible by water and the same type in all cases, not any influence in carbon content are expected of them; the significant changes between situations suggest that other mechanism could explain the observed behavior.

Those changes could be due to aggregation aspects, which generally are not analized; many aggregates included residues of organic matter within them, which can be delivered when they have breakdown by rainfall, such as an unexpected source of organic carbon.

Figures 7 and 8 show what happened when the residues of organic matter within aggregates were considered; a great variability was observed in aggregate associated (particulate) organic matter (POM) of 0,5 mm and 0,05 mm in every diameter of soil particles, but was observed that the land use, modified POM 0,05 mm, but not POM 0,5 mm (Figure 7).

The quality of POM, measured as the total organic carbon content, were changed in inverse way with the aggregate diameter size; the higher aggregate have a lowest CPOM 0,5 and 0,05 mm.

The Figure 8 show that in the pasture, the POM of 0,5 and 0,05 mm only have been reduced in the highest aggregate size, but the amount of CPOM in 0,5 mm are low and the CPOM 0,05 mm have not significant changes, when the aggregate diameter change.

The specific aggregate stability will determine if the detachment by splash or wash does produce delivery of high or low concentrated carbon particles, which can modify both the ER and EROC. The effect of cover is negligible to modify that mechanism, but could represent other important source of carbon, too.

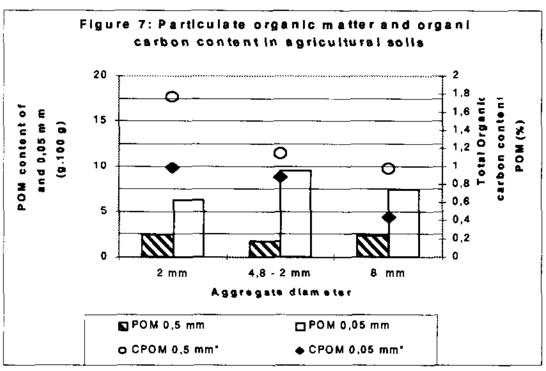


Figure 7: Particulate organic matter and organi carbon content in agricultural soils

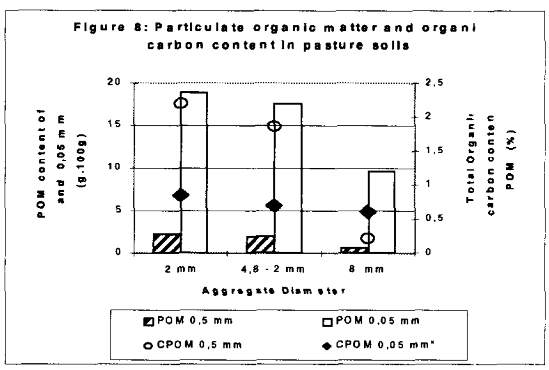


Figure 8: Particulate organic matter and organi carbon content in pasture soils

The quality of residues, such as aggregate associated or as surface cover, can be very different due to include roots, steam, leaf and seed; its influence as aggregation factors and their carbon content should be considered in order to evaluate how can modify the sediment enrichment rate and the EROC. The influence of pasture in to build aggregates should be considered also, by analyzing the management practices that can be recommended in order to prevent non point source of pollution, because the roots and continuous contribution of organic residues by long time should to produce differences in soil aggregation.

Simple crop rotation, which will produce high amount of residues predominately in harvest periods, should to produce poor soil aggregation and enhanced sediment delivery rate with higher EROC.

CONCLUSIONS

Its was found that the enrichment rate (ER) in interrill erosion could be modified by change the surface cover, but the enrichment rate of organic carbon content (EROC) only could be reduced by increasing aggregates stability. We suggest that this situation is probably due to specific interactions between different amount of organic residues and its quality, considered as organic carbon content; those differences should be responsible for aggregate stability, which can modify the cover efficiency and produce more selectivity in the erosion processes. By other hand, the quality of residue can modify by itself the EROC, by acting as source of organic carbon. The aggregate stability, particulate organic matter and the organic content of surface residue should be measured in order to evaluate the enrichment rate of organic carbon in soil erosion processes.

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