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Soil Erosion Assessment of Soil Organic Carbon loss from Sloped Lands

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Summary

Soil loss from sloped lands induces soil degradation by removing soil nutrients from soil surface and aggravating soil physical properties. The soil loss affects directly water quality in reservoirs. Soil organic carbon (SOC) improves soil physical and chemical properties by increase in aggregation and nutrient availability within soils. SOC is vulnerable to soil erosion because of relatively smaller bulk density and its location at the soil surface. It is important to evaluate the amounts of SOC loss from different soil properties and planting crops. The objective of this study was to assess the amounts of SOC loss from the sloped land during rainfall season. The experimental site was located on steep land with the slope of 15% in Suwon, Korea. The investigation was conducted during 2010. There was no planting crop on one plot, while soybean and Chinese cabbage were planted on the second and third plots, respectively. The organic carbon was measured from soil samples using Turin's method and from runoff using TOC analyser after filtering <0.45µm (Sievers 900, USA). Total amount of organic carbon was 1,013.9 kg ha^{-1} in plot with loam, 689.9 kg ha^{-1} in plot with clay loam and 472.9 kg ha^{-1} in plot with sandy loam on the bare soil. The concentrations were 2.7 ppm in plot with clay loam, 2.2 ppm in plot with sandy loam and 2.0 ppm in plot with loam.

Keywords: soil erosion, soil organic carbon, lysimeter

Introduction

Soil erosion is a natural geological phenomenon, but makes severe soil degradation especially in arable land. The accelerated soil erosion by agriculture activity aggravates soil quality related to reducing nutrient and degrading soil structure. Soil organic carbon (SOC) is important in terms of soil physical characteristic like porosity and aggregate stability (LE BISSONNAIS and ARROUAYS 1997, RHOTON et al. 2002) and also affects nutrient availability (SCHIETTECATTE et al. 2008). Soil organic carbon is one of the first soil constituents removed by erosion since it is of relatively low density and is concentrated near the soil surface (LUCAS et al. 1997). Although the loss of nutrient is compensated for by input of fertilizer, the loss of organic C (OC) is not easily restored (SCHIETTECATTE et al., 2008). Whereas the studies on estimate of soil erosion have been carried a lot, erosion-induced soil organic carbon loss is poorly quantified. The purpose of this study was to quantify OC loss from the erosion on a sloped land under rainfall. The experiment was conducted on the lysimeter plots located on the slope with three textures to find an influence of soil texture on the erosion and OC. The objectives were to determine concentration and total amount of OC.

Material and Methods

The study was conducted on the lysimeter plot located at the National Academy of Agricultural Science (NAAS) in Suwon, Korea (37° 16' 42.67" N, 126° 59' 0.11" E) between May to September in 2010. The plot had a 15% slope and was partitioned respectively, which of each plot is 5m in length and 2m wide. Each plot was excavated and filled with 10 high gravels at the bottom of the plot. Sands were filled on top of the gravel layer and then three different soil textures were filled up to the surface of all plots. Each plot has one of three textural types: clay loam, loam and sandy loam. The collector of runoff was positioned at the end of the plot, linked with bowl to empty through pipe. Soybean and Chinese cabbage were planted on the second and third plots, respectively. These crops were selected because they are widely planted in Korea. After each rainfall event ceased, the amount of runoff and soil loss were measured from each plot. The eroded soil was dried and then weighted. And then it was sieved by 2mm for analysis of OC.

Rainfall data were obtained from the Korea meteorological information portal service system. The EI_{30} was calculated using RUSLE (RENARD et al. 1997). The procedure was defined as:

$EI_{30}\ \sum(KExR) \times I_{30}$ (MJ•mm/ha/h) (1)

Table 1. **Monthly rainfall and EI_{30}**

Month	May	June	July	August	September	Total
Precipitation (mm month^{-1})	79.5	90.2	199	319	355.9	1043.6
EI_{30} (MJ mm ha^{-1} hr^{-1})	71.5	115.4	740.9	1212.4	2300.8	4441.0

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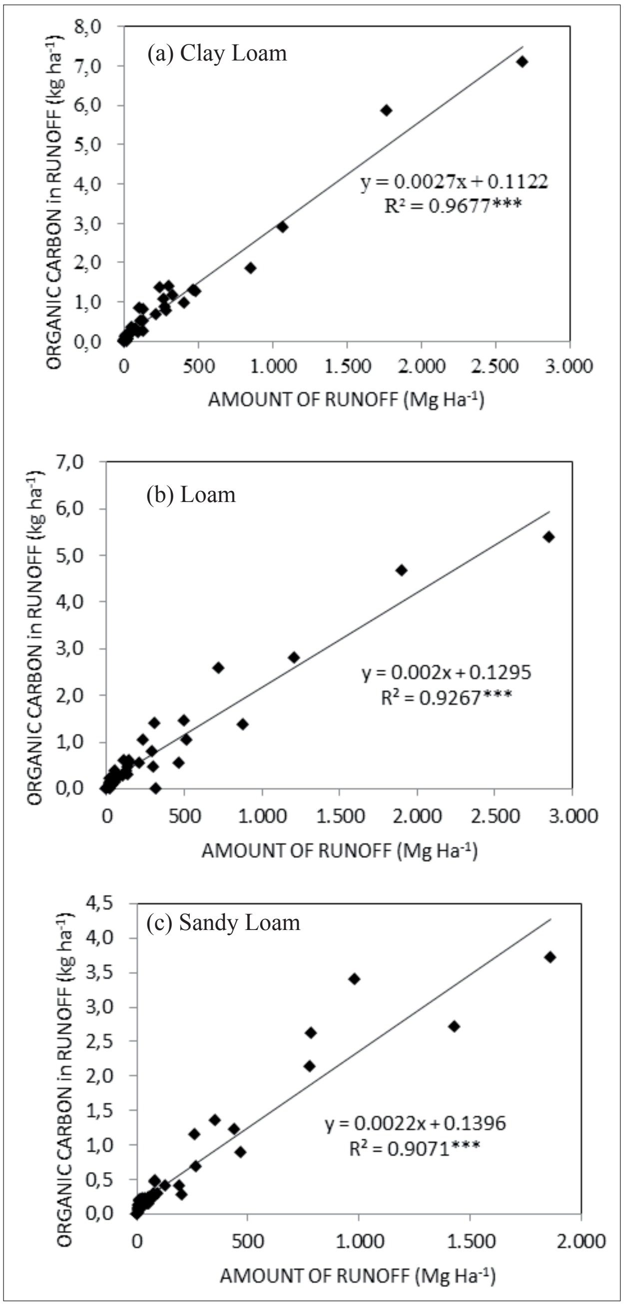

Figure 1. **Relationship of amount of runoff and organic carbon per event for the soil texture. ($p<0.001$)**

KE=0.119+0.0873 log I (2)

where KE is the kinetic energy (MJ/ha/mm), R is rainfall amount (mm) and I is rainfall intensity (mm/h). The organic carbon was measured from soil samples using Turin's method and from runoff using TOC analyser after filtering <0.45μm (Sievers 900, USA). Relationships between the amount of runoff and organic carbon in runoff were analyzed by using SAS statistics.

Results and Discussion

During the study there was 1,043 mm, rainfall amount and 4,441 MJ mm ha^{-1} hr^{-1}, EI_{30} (*Table 1*). Total amount of sediment was most in plot with loam (70.7 Mg ha^{-1}) and least in plot with sandy loam (37.5 Mg ha^{-1}) for the bare soil. Total runoff amount was same trend with sediment in plot with loam (617.8 mm) and in plot with sandy loam (477.5 mm) for the bare soil plot (*Table 2*). In the crop plot, total amount of sediment and runoff was higher on the Chinese cabbage plot than soybean plot. This difference is resulted from manly cropping period, which is Chinese cabbage is cultivated on May to June and September to the start of November in Korea. Amount of organic carbon was most in plot with loam and most in plot with Chinese cabbage from both of sediment and runoff. Total amount of organic carbon was 1,013.9 kg ha^{-1} in plot with loam, 689.9 kg ha^{-1} in plot with clay loam and 472.9 kg ha^{-1} in plot with sandy loam on the basis of bare soil. The amount of runoff and organic carbon in runoff per event was correlated for plots with three textures (*Figure 1*). This outcome reflects that the amount of organic carbon is related to the amount runoff directly. The concentrations were 2.7 ppm in plot with clay loam, 2.2 ppm in plot with sandy loam and 2.0 ppm in plot with loam. The difference of concentrations is slightly, but the value was highest in clay loam. This study showed the quantity of loss of organic carbon and the relationship amount of organic carbon in runoff and of runoff on the sloped land with different soil texture and crops under rainfall. Concentrations difference among plot with soil texture is related to soil physiochemical properties of soil aggravate, infiltration, residue, CEC. In this sense, future researches need to focus on the relations of loss of organic carbon and soil properties.

Literature

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Table 2. **The total amount of sediment and runoff organic carbon loss from the plot for soil texture and crops for the experiment period**

Plot	Treatment	Sediment ($Mg\ ha^{-1}$)	Runoff (mm)	Amount of organic carbon ($kg\ ha^{-1}$)		
				Sediment	Runoff	Total
Clay Loam	Bare soil	60.5	572.0	673.7	16.2	689.9
	Chinese cabbage	12.8	364.8	196.4	12.8	209.2
	Soybean	0.9	149.2	18.6	4.6	23.2
Loam	Bare soil	70.7	617.8	1,001.6	12.3	1,013.9
	Chinese cabbage	31.5	435.4	556.9	12.8	569.6
	Soybean	1.6	181.9	24.1	5.0	29.1
Sandy Loam	Bare soil	37.5	477.5	460.0	12.9	472.9
	Chinese cabbage	8.0	294.2	98.9	7.7	106.6
	Soybean	0.0	127.9	0.5	4.7	5.2