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Erosion rate and conservation techniques of soils under rain-fed agriculture

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Abstract: An experiment was conducted to determine the effect of rainfall on erosion and conservation of soils under different agricultural practices. The experiment was carried out during monsoon season (June-September) of 2006. The experiment was conducted with 12 treatments in twelve plots. The result recorded the rainfall of June, July, August and September in 2006, respectively, as 335.5 mm, 306.5 mm, 365.8 mm and 411.4 mm. The maximum eroded soil loss was obtained from bare plot with high tillage T_3 (7.8 t/ha) and that of minimum was observed in grass and water hyacinth mulched (1.5 t/ha) treatment T_{12} through out months of experimentation. The rate of erosion of the soil was found to markedly control by the physical and chemical properties of the soil. The erosion of the soil also correspondingly altered the physico-chemical properties of the soil. The sand, silt and clay content eroded about 34%, 3% and 16%, respectively. The organic matter content of the initial, eroded and field soil was, respectively, ranging from 1.1% to 1.8%, 1.2% to 1.9% and 1.0% to 1.7%, which indicates the striking loss of organic matter. The pH value and NPKS are high recorded in the eroded soil collection. It was reveled that erosion of soil depleted the nutrient of the field soil. Topsoil conservation is proved to be important for maintaining soil nutrient status by proper agricultural practices and mulching proved to be the potent technique in conserving soil nutrient loss by erosion mostly triggered by rain splash.
Key words: Soil nutrient, erosion, conservation, rain-fed agriculture.

Introduction

Soil erosion is a worldwide environmental problem that degrades soil productivity and water quality, causes sedimentation and increases the probability of floods. Erosion control requires a quantitative and qualitative evaluation of potential soil erosion on a specific site, and the knowledge of terrain information, soils, cropping system and management practices. (Da Ouyang, 2001). Different agronomic practices like ploughing, laddering, roughing, weeding, gap filling, fallow, natural precipitation (rain) and supplemented watering by irrigation are direct or indirect determinant factor of the soil erosion. Rain, though a natural phenomenon it has been considered as integral part agricultural enterprises and also have marked effect on soil properties including its erosion. Soil erosion has appeared as a severe problem and its adverse effects on soil fertility, vegetation, economy and human welfare have received wide attention. It causes land degradation, loss of soil fertility; decreases crop yields and creates so many hazards in farming system. Erosion also encourages natural calamities like floods, cyclones, drought, ground water problems, environmental imbalance, deforestation, formation of desert land (Hudson, 1975). The mitigation of soil erosion is of great importance in the maintenance of crop yields. It is estimated from available measurements that a huge amount of soil washed out of the fields and pastures every year. Not only structural soil losses in the erosion process but also a proportionally higher percentage of plant nutrients, organic matter and fine soil particle are the removal material lost than from the original soil (Wang, 2000). Mulching is used sporadically for conservation of soil in our country by using grass, straw, leaves, polythene sheet, water hyacinth and also by added soil. Farmers of Bangladesh till today do not know the effect of mulching on conservation of soil and amount of soil loss under different cultural practices during monsoon due to lack of sufficient research findings in this regard.

So, considering above view and facts the present piece of research work was carried out to quantify the amount of soil loss as affected by the selected agricultural practices, efficacy of different conservation techniques and the relation between soil erosion and physical and chemical properties of the soils.

Materials and Methods

The experiment was conducted at the Bangladesh Agricultural University Farm, under the Department of Environmental Science, during June to October 2006. The land was first opened on 7th May, 2006 by repeated spading, laddering and leveling. Weeds, stubbles, and crop residues were removed from the land. Each plot was separated by ails to avoid the amalgamation of eroded soil. The experiment was conducted with 12 treatments, namely T_1=Bare plot. T_2=Bare plot applying cow dung. T_3=Bare plot with high number of tillage operation. T_4=Planting dhaincha with high number of tillage operation.T_5=Rice grown in line sowing T_6=Rice grown in broadcasting T_7=Grass coverage T_8=Cultivation of mungbeen with tillage operation T_9=Cultivation of Jute with tillage operation. T_{10}=Mulching with dry grasses T_{11}=Mulching with rice straw T_{12}=Mulching with mixture of grass and water hyacinth. Every plot was under the open sky, thus subjected to with homogenous effect of rain. The unit plot size was 2.25m x 1m. The blocks were separated by the drains of 100cm. The selected crops were dhaincha, rice, mungbeen, and jute , planted in each of the plots separately. Mulching was done by the straw, grass and grass with water hyacinth. Some plots were covered by long grass as well. Intercultural operations were done properly according to the needs of the crop. Weeding was done in each plot. Thinning was done in case of jute. A bamboo hedge was made to protect the plot from damage. Two scales (sticks) were setup at both sides in each plot. Primarily it was setup in zero level. A big tin container was set up in the end of the plot with a 2 inches cylindrical plastic pipe to catch the runoff soil in the container. Data of soil loss were collected from the plot in every week and then made average. The data on rainfall and temperature were collected from the weather yard, Bangladesh Agricultural University, Mymensingh. Sand, silt and clay percentage determination was carried out by popular hydrometer method. And soil chemical and nutrient analysis was carried out by different techniques and methods such as glass-electrode pH meter as described by

Jackson (1958). Soil salinity was determined by the help of conductivity meter, the percent of organic carbon was determined by wet-oxidation method as outlined by Page (1982). Recorded data were statistically analyzed using correlation techniques and mean differences and standard deviation.

Results and Discussion

Soil losses in different months were shown in the Table 1. In the month of June, 2006 the average rainfall data were recorded to 335.5 mm in the experimental field area and the highest and lowest value of soil loss were recorded in T_3 and T_{12} treatment, respectively.

Table 1. Soil loss through different cultural practices

Treatment	June (335.5 mm)	July (306.5 mm)	August (365.8 mm)	September (411.4 mm)	Loss of soil in cm	Weight of loss soil (kg)	Total loss in (mt/h)
T_1	0.5	0.25	0.50	1.20	2.45	1.57	6.82
T_2	0.5	0.30	1.00	1.05	2.85	1.72	7.50
T_3	0.55	0.35	1.05	1.05	3.00	1.81	7.80
T_4	0.45	0.20	0.70	0.45	1.95	1.30	5.85
T_5	0.50	0.30	0.45	0.45	1.75	1.10	4.50
T_6	0.35	0.30	0.70	0.60	1.95	1.25	5.50
T_7	0.25	0.30	0.75	0.65	1.80	0.82	3.00
T_8	0.45	0.30	0.90	0.40	2.05	1.35	5.55
T_9	0.40	0.30	0.70	0.45	1.85	1.20	5.17
T_{10}	0.25	0.20	0.25	0.15	0.85	0.45	2.25
T_{11}	0.15	0.10	0.30	0.15	0.70	0.35	1.85
T_{12}	0.10	0.10	0.20	0.15	0.55	0.30	1.50

In the month of July, 2006 the average rainfall data were recorded 306.5 mm and the highest and lowest value of soil loss were recorded in the T_3, T_{11} and T_{12} treatments, respectively. Moderate type of erosion recorded in all other treatments. In the month of August, 2006 the average rainfall data was recorded 365.8 mm and the highest and lowest value of soil loss were recorded in the T_1, T_{10}, T_{11} and T_{12} treatment, respectively. In the month of September, 2006 the average rainfall data were recorded 411.4 mm and the highest and lowest value of soil loss were recorded in the T_3 and T_{12} treatment, respectively. The highest amount of topsoil loss was observed in the month of September when amount of rainfall as well as runoff were greater than other months. Among the three bare plots, T_3 show the highest level (3 cm) of soil loss. The plots T_4, T_8, T_9 practiced high tillage show the moderate types of soil loss (1.8, 2.05 and 1.85). Tillage intensity had a significant effect on soil erosion. The highest amount of soil loss (7.8 t/ha) was obtained from T_3. The other plots T_4, T_8, T_9 practiced with tillage showed moderate types of soil loss due to present of other factors. No tillage with mulch (T_{10}, T_{11}, T_{12}) performed high soil conservation results. Different mulching practices significantly decreased soil loss than other plots. Mulching practiced in the plot (T_{10}, T_{11}, T_{12}) showed lower level (0.85, 0.75, 0.55 cm) of soil loss. It also indicates that combination of grass with water hyacinth showed the better performance.

Organic matter, electrical conductivity and pH values were shown in the Table 2. The pH values of soil sample of initial, eroded and field soil were 6.86 to 5.36, 6.93 to 5.26 and 6.50 to 5.10. Out of 36 samples the high pH value at initial soil recorded from T_7 treatment (6.93). The lowest pH value was observed T_{11} treatment (5.25) at eroded soil. The values of electrical conductivity of initial, eroded and field soil were ranged from 120 to 34, 125 to 49 and 115 to 31 respectively. The organic matter content of soil samples were ranging from 1.12% to 1.80%, 1.21% to 1.92% and 1.00% to 1.69%. The highest organic matter content of initial, eroded and field soil were recorded at T_2 (1.8) T_2 (1.92) T_{12} (1.69) treatments. The lowest organic matter content of initial soil was observed in T_1 treatment. The range of organic matter of soil sample (initial soil, eroded soil and field soil) was respectively (1.8 to 1.11). (1.69-1), (1.92 to 1.21).

Nitrogen, available phosphorus, potash and sulphur content values were shown in the Table 3. The Nitrogen content of the initial, eroded and field soil were ranging from 0.11% to 0.06%, 0.19% to 0.10% and 0.18% to 0.05% respectively. The maximum value of initial, eroded and field soil were recorded T_2(0.11%), T_2 (0.19%) and T_8 (0.18%) treatment respectively. The lowest values of initial, eroded and field soil were recorded in T_3 (0.06%),T_3 (0.10%)and T_1 (0.05%),T_3 (0.05%)and T_5 (0.05%) treatments. The value of available phosphorus the initial, eroded and field soil were ranging from 16 to 9 ppm, 16 to 11 ppm and 12 to 8 ppm respectively. The highest values of initial, eroded and field soil were recorded in T_2. T_8 and T_8 treatments respectively. The lowest values of initial soil in T_3, T_6. And in case of field soil it was recorded in T_1, T_3 T_5 and T_8 treatments.

The value potassium content of the initial, eroded and field soil were soil ranging from 1.65 to 1.42 meq/100g, 1.76 to 1.54 meq/100g and1.61 to 1.37 meq/100g soil respectively. The highest values of initial, eroded and field soil were recorded in T_{10}, treatments for all cases. The lowest values of initial, eroded and field soil were recorded in T_6, T_2 and T_6 treatment respectively.

The values of sulphur content of initial, eroded and field soil were ranging from 12.51 to 9.2 ppm, 14.45 to 11.50 ppm and 10.80 to 7.80 ppm respectively. The highest values of initial, eroded and field soil were recorded in T_2, T_2 and T_3 treatment respectively. The lowest values of initial, eroded and field soil were recorded in T_9, T_1 and T_9 treatment respectively.

Table 2. Nutrient (pH, EC, OM) fluxes of different soil

Treatment	Initial Soil			Eroded Soil			Field Soil		
	PH	EC	OM	PH	EC	OM	PH	EC	OM
T_1	5.95	82	1.12	5.89	87	1.24	6.12	80	1.01
T_2	6.05	92	1.80	5.97	97	1.92	6.22	91	1.42
T_3	6.27	72	1.111	6.17	79	1.21	6.48	69	1.00
T_4	5.75	91	1.75	5.50	96	1.88	6.16	86	1.42
T_5	6.8	109	1.28	6.45	114	1.43	6.92	104	1.17
T_6	6.85	120	1.31	6.50	122	1.42	6.84	115	1.20
T_7	6.55	120	1.35	6.48	125	1.47	6.93	112	1.24
T_8	5.95	87	1.53	5.80	91	1.62	6.2	82	1.35
T_9	6.2	85	1.24	5.98	94	1.37	6.15	81	1.12
T_{10}	5.45	34	1.59	5.19	49	1.73	5.45	31	1.48
T_{11}	5.35	39	1.46	5.10	54	1.60	5.25	34	1.69
T_{12}	5.75	47	1.56	5.55	60	1.68	5.58	41	1.69
Mean	6.08	81.50	1.43	5.88	89.00	1.55	6.19	77.17	1.32
SD	0.483	29.088	0.228	0.478	25.085	0.231	0.556	28.683	0.235
Co- efficient	0.079	0.357	0.160	0.081	0.282	0.149	0.090	0.372	0.178

Table 3. Nutrient (N, P, K, S) fluxes of different soil

Treatment	Initial Soil				Eroded Soil				Field Soil			
	N	P	K	S	N	P	K	S	N	P	K	S
T_1	0.07	9	1.45	9.56	0.11	12	1.56	11.50	0.05	8	1.40	8.75
T_2	0.11	16	1.43	12.51	0.19	13	1.54	14.45	0.09	12	1.38	10.37
T_3	0.06	10	1.54	11.90	0.10	11	1.65	12.90	0.05	8	1.49	10.80
T_4	0.08	11	1.55	11.85	0.14	14	1.66	13.85	0.15	9	1.50	10.50
T_5	0.07	9	1.56	10.95	0.11	12	1.67	13.95	0.05	8	1.51	10.20
T_6	0.08	9	1.42	10.55	0.11	11	1.55	12.55	0.06	8	1.37	10.10
T_7	0.08	10	1.48	9.61	0.12	12	1.59	12.25	0.06	9	1.41	8.30
T_8	0.10	14	1.59	11.23	0.16	16	1.70	13.54	0.18	12	1.50	9.25
T_9	0.07	10	1.64	9.2	0.11	13	1.75	12.58	0.06	9	1.60	7.80
T_{10}	0.10	11	1.65	11.21	0.14	13	1.76	15.12	0.08	9	1.61	9.58
T_{11}	0.09	11	1.57	10.15	0.13	14	1.68	12.54	0.07	10	1.50	8.75
T_{12}	0.09	12	1.61	10.25	0.14	13	1.72	13.01	0.07	11	1.55	8.85
Mean	0.08	11.00	1.54	10.75	0.13	12.83	1.65	13.19	0.08	9.42	1.49	9.44
SD	0.015	2.132	0.079	1.039	0.026	1.403	0.077	1.023	0.042	1.505	0.081	0.963
Co- efficient	0.180	0.194	0.051	0.097	0.200	0.109	0.046	0.078	0.515	0.160	0.054	0.102

Bangladesh being a tropical country enjoys the monsoon climate of heavy rainfall. Rainfall is unique governing factor of the crop production of Bangladesh. A lot of crops are gown on rainfed condition during monsoon (June to September) season. But this valuable rainfall has a great impact on massive amount of soil loss other than wind and different cultural practices unless it is not conserved. Topsoil is a major factor for incremental and successful crop cultivation. The major portion of soil nutrient is available for the plant contented in the top soil. To save the soil and maintaining the productivity of the soil, topsoil conservation is very important for sustainable agriculture. Mulching is the best technique to save soil loss form erosion and safe guard soil organic matter content. Finally it is concluded that rainfall has a vital role

on soil erosion and mulching has a major role to soil conservation.

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