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Article

Soil erosion control from trash residues at varying land slopes under simulated rainfall conditions

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Abstract: Trash mulches are very effective in preventing soil erosion; reduce sediment transport rate, runoff rate and increasing infiltration. The study was carried out with the objectives to observe the sediment outflow from sugar cane leaf (trash) mulch treatments at selected land slopes under simulated rainfall conditions by using rainfall simulator of size 10 m × 1.2 m × 0.5 m with the locally available soil material collected from Pantnagar. In the present study, trash mulches with different quantities were selected to observe the effect of mulching in soil loss reduction. The quantity of mulch was taken as, 6 t/ha, 8 t/ha and 10 t/ha, three rainfall intensities viz. 11cm/h, 13cm/h and 14.65cm/h at 0%, 2% and 4% land slopes were selected. The duration of rainfall was fixed (10 minutes) for every mulch treatment. The total runoff volume was found to be varying with different mulch rates for particular rainfall input and land slope. The runoff distribution pattern was observed to be increasing with the increase in land slope. The average sediment concentration (SC) and outflow was found to be increasing with the increasing land slope, but SC and outflow decreased with increasing mulch rate for particular land slope and rainfall intensity. The SOR (SOR) for no mulch treated land was higher as compared to trash mulch treated lands. Mathematical relationships were developed for relating SOR, SC, land slope and rainfall intensity for a particular mulch treatment. It was observed that values of SOR and average SC had a good correlation with rainfall intensity and land slope for each mulch treatment. The correlation coefficients of developed models were found to be more than 90%.

Keywords: Organic mulching; rainfall simulator; Hydraulic Tilting flume system; Sediment concentration; Sediment outflow rate.

1. Introduction

The degradation of land is usually described in terms of loss of natural resources (soil, water, fauna and flora) or by referencing the biophysical processes through which the land functions. Soil erosion and sediment outflow from agricultural lands called land degradation are very serious global problem [1–4]. The degradation of land is one of the main causes of low crop productivity [5–7]. The productivity of some lands has decreased

 doi:10.20944/preprints202204.0302.v1

by 50% due to soil erosion and desertification [8].The soil resources of the world are finite, functionally non-renewable and prone to different forms of degradation due to over-exploitation and faulty management practices [9]. Soil degradation has reached alarming proportions in many parts of the world, especially in the tropics and sub-tropics.

Erosion occurs when surface soil is lost or removed by the effects of moving water, wind, or ice. This negatively impacts agricultural land by affecting fertility, landscape beauty, water ecosystems, environmental management, and crop production [10,11]. Soil erosion caused by water is a major factor contributing to land degradation in India and many other countries, as it far exceeds the natural soil formation rates [12]. In the 2016 FAO reports, 75 billion tons of soil are transported every year by erosion from arable lands throughout the world, which equals 400 billion dollars every year [13]. In India, the problem of soil erosion is quite serious as about 18.5% of the world total soil erosion occurs here [14]. India loses about 16.4 t of soil/ha/yr. of which 29% is lost permanently into the sea, 10% gets deposited in the reservoirs reducing their capacity by 1–2% every year and the remaining 61% gets displaced from one place to another [15]. There are several stages or type of water erosion including splash, sheet, interrill, rill, gully and stream bank erosion [16–19]. These processes are governed by a large number of variable pertaining to rainfall, soil system, land topography, land slope, crop cover condition and management practices [18,20–23]. The sediment generation is governed by the erosivity of erosive agents and the erodibility of the soil system, while the transportation process is mainly influenced by the transport capacity of runoff [24–26]. Erosion by water, rainfall and runoff are the erosive agents, rainfall energy is expanded in detaching soil particles and transportability of the sediment depends upon its velocity of runoff [24,26–29].

In general, well-established, dense vegetation can effectively protect soils against soil erosion over the long term, however, erosive power of rain and runoff interferes with the establishment of vegetation/straw cover [30]. The top layer of soil provides nutrients and a physically and biologically environment important to plant growth [31]. The other important factor that affects the soil loss and helps in reducing the rate of soil erosion is the presence of crop and cover condition. The vegetation on surface help in controlling the kinetic energy of falling raindrops and binding of soil materials by the root system resists the detachment of soil aggregates [20,28]. The C-Factor is defined as the ratio of soil loss from the cover length to corresponding loss from clean tilled continuous fallow land under specified condition and measures.

There are various methods of soil conservation which exhibit different performance and mechanism. The various natural and organic mulches, viz. crop residues leaf litter, wood chips, bark chips, biological geo-textiles gravels and crushed stone are used for conservation of soil [30,32–39]. Therefore, mulches have extraordinary potential in soil erosion, sediment control and runoff reduction [33,37–41]. When vegetation is not established, we can be use organic mulches to quickly protect the soil surface against the erosive forces of rainfall [42]. Organic mulches can be very effective in preventing soil erosion to absorbs the impact of raindrops and reduce the detachment of soil aggregates. It also reduces soil erosion, sediment transport rate and increases soil organic matter & hence improves surface aggregation in environmentally friendly manner [37,43–49]. Mulches covers are effective in increasing infiltration and reducing evaporation, runoff rate and sediments transport rate [50–53]. It is difficult to conduct such studies on mulches under actual field conditions, simply because of the reason that in actual conditions, it may not be feasible to obtain requisite number of rain storms of desired intensity and duration. In such situations, the conduct and replication of experiments under a particular set of combinations of variables is not practically possible as it will require huge financial, labour and time resources.

There have been a number of studies evaluating how different surface coverings reduce surface runoff and soil loss, including rock fragments [54–58], biological geotextiles [30], and crop residues [59–66], grass [67–69], geo-textiles [30,70], post-fire ash and cover

[71–73], tillage [64,66,74,75], and combined cover such as rock and litter [76–79]. However, little leaf litter has been tested [42,80], with varying results [81].

As an accepted alternate approach, this study can be conduct conveniently under controlled conditions of laboratory using simulated rainfall, whose parameters could be regulated as per requirements of the experiments. The aim of this paper is to investigate the effect of sugarcane crop mulch/residues on the runoff and sediment yield under different rainfall intensity and land slopes. Keeping the above facts in consideration, a study was undertaken with the help of rainfall simulation system and a tilting hydraulic flume of 10 m × 1.2 m size with following objectives; to compare the effect of sugarcane mulch treatments, various rainfall intensity and land slope on runoff and sediment yield under simulated rainfall condition.

2. Materials and Methods

2.1. Experimental design

The experiment design was developed in the department of Soil and Water Conservation Engineering, College of Technology, G.B. Pant University of Agriculture and Technology Pantnagar, Uttarakhand (Figure 1). The variable rainfall parameter was generated by using rainfall simulation system while the varying conditions of land slope were obtained with the help of the hydraulic tilting flume(Figure 2). This rainfall simulation system produces rainfall almost similar to the natural rainfall. In this study, the uniformity coefficient of the generated rainfall ranges from 87.54% to 92.10% and the terminal velocity of falling raindrops has been reported to vary from 7.674 m/s to 9.496 m/s in the selected operating pressure range 0.1 kg/cm^2 to 0.6 kg/cm^2. The hydraulic tilting flume of 10 m length and 1.2 m width, filled with soil material, was used as a test plot.

a

b

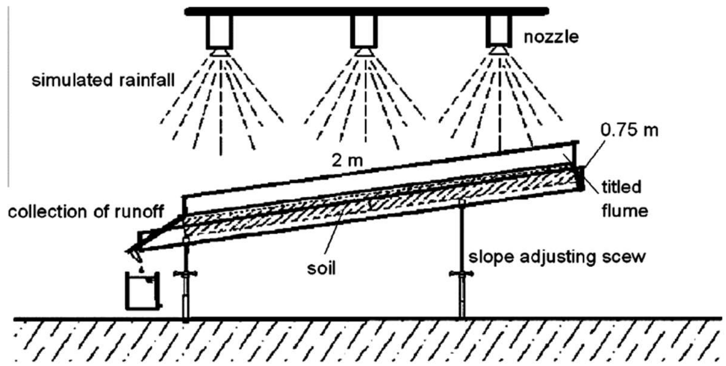

Figure 1. (a) laboratory and (b) Rainfall simulation unit.

Figure 2. Experimental plot with trash (sugarcane leaf) mulch treatment.

2.2. *Recording and control devices*

A runoff diversion tray of the size of 163 cm × 35 cm × 13.4 cm was placed at the downstream end of the test-plot (hydraulic flume) just blow the multi slot divisor to convey the runoff coming from the multi slot divisor to measuring notch. It was fitted in such a way so that the runoff water did not leak or spill. A 90^0 V-notch was installed at the end of the total runoff to obtain the accurate determinations of the total runoff volume. A part from this, various other devices have been used such as multi-slot divisor, runoff collection tank and measuring cylinder. A time period of 10 minutes was used for each recording and replication. The simulator was operated at a specified operating pressure for different duration and the volume of runoff collected in the runoff collection tank was recorded. The runoff passed through multi slot divisor was conveyed to a runoff collection tank from which 100 cm^3 sample were collected after thoroughly stirring, so that collected small samples represent the entire body of runoff. The collected sample was kept in the electric oven for 24 hr, at 105 ^oC. By subtracting the empty sampler's weight from the oven dried weight, the amount of sediment present in 100 cm^3 sample was obtained. This sediment amount in 100 cm^3 was then converted in SC, ppm and total sediment present in the total runoff volume and then SOR ($g/m^2/min$) was calculated.

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2.3. Experimental treatments

The soil filled in a flume, although, cannot resemble exactly with the natural conditions, efforts were made to create the conditions in the test plot, as similar as possible, to natural site conditions. Once the soil was filled in the test flume and an appropriate mulch treatment was applied, the rainfall simulator was operated at very low intensity to get the soil fully saturated. After the soil becomes saturated the intensity of rainfall was adjusted to a desired level and the flume was subjected to a desired slope with the help of slope adjusting mechanism. The rainfall simulator was operated for a specified duration and the total runoff generated was recorded. A number of small samples were obtained from this collected runoff for determining the SC and sediment yield. In this study three rainfall intensities i.e., 11 cm/h., 13cm/h., 14.63 cm/h. obtained at the respective operating pressure of 0.2kg/cm^2, 0.3 kg/cm^2 and 0.4 kg/cm^2 were used.

To observe sediment outflow, the test flume was subjected to three number of slope i.e. 0%, 2%, 4% for each mulching treatment and rainfall intensity. In this way, the total combinations for a single mulching treatment became 27. Trash (sugarcane leaf) mulch and without mulch have been used for treatments (Figure 2). Mulches were used in three quantities of mulches rate viz. 600 g/m^2, 800 g/m^2 and 1000 g/m^2.

The particle size distribution of soil and filter material (sand) were determined separately in the laboratory by following the standard techniques of sieve analysis. About 1 kg of dried soil material was taken and oven dried before performing. The properties were analyzed and given as: Sand-51.6%, Silt-31.8% and Clay-16.6%. Textural class-sandy loam, Bulk density-1.72 g/cm^3, Permeability-3.4 × 10^{-5} cm/sec, Infiltration rate-1.0 cm/h, % Water holding capacity-29.10, % Porosity-40, % Organic matter content-2.5 and pH-7.8.

3. Results and Discussions

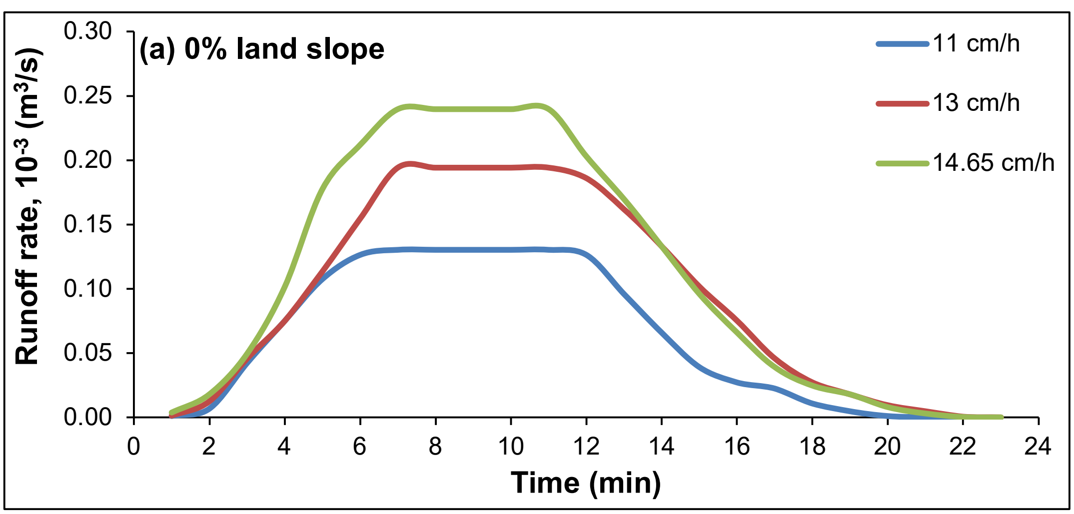
Figure 3-10 illustrates major result measured in our laboratory experiments: rainfall, runoff, sediment concentration, slope, and mulch treatment. A summary of some of the information contained in the flow graphs in these figures is provided in Table 1-3. The significant result of observed runoff volume, sediment concentration and outflow rate at different rainfall intensities and land slopes for trash (sugarcane) mulch summarized and show in Table 1. It was observed that for 6 t/ha mulch rate, the volume of runoff increased from 74480 cm^3 to 137270 cm^3 and the total SOR increased from 0.43 g/m^2/min to 1.26 g/m^2/min when rainfall intensity increased from 11 cm/h to 14.65 cm/h at 0-4% land slope. At other selected land slopes, the total runoff volume for 11 cm/h rainfall intensity was found 74480, 81550 and 90300 cm^3; for 13 cm/hr 107450, 111650 and 112350 cm^3; for 14.65 cm/hr 132300, 132650 and 137270 cm^3 at land slope 0%, 2% and 4% respectively.

Table 1. Observed runoff volume, SC and outflow rate at different rainfall intensities and land slopes for trash (sugarcane) mulch.

Mulch rate	S (%)	I (cm/h)	Volume of runoff (cm^3)	Weight of sediment in a 100 cm^3 representative sample (g)				Average SC	Total sediment outflow (g)	SOR (g/m^2/min)
				I	II	III	Average			
6 t/ha	0	11	74480	0.06	0.07	0.08	0.070	700.00	52.14	0.43
		13	107450	0.08	0.08	0.07	0.077	766.67	82.38	0.69
		14.65	132300	0.09	0.08	0.08	0.083	833.33	110.25	0.92
	2	11	81550	0.09	0.08	0.07	0.080	800.00	65.24	0.54
		13	111650	0.09	0.08	0.09	0.087	866.67	96.76	0.81
		14.65	132650	0.09	0.10	0.10	0.097	966.67	128.23	1.07
	4	11	90300	0.09	0.10	0.07	0.087	866.67	78.26	0.65
		13	112350	0.10	0.09	0.10	0.097	966.67	108.61	0.91
		14.65	137270	0.09	0.12	0.12	0.110	1100.00	151.00	1.26
8 t/ha	0	11	71400	0.06	0.06	0.05	0.057	566.67	40.46	0.34

		13	106050	0.06	0.06	0.07	0.063	633.33	67.17	0.56
		14.65	128870	0.07	0.07	0.07	0.070	700.00	90.21	0.75
	2	11	80850	0.07	0.07	0.06	0.067	666.67	53.90	0.45
		13	105700	0.07	0.08	0.07	0.073	733.33	77.51	0.65
		14.65	134050	0.08	0.08	0.07	0.077	766.67	102.77	0.86
	4	11	91840	0.07	0.06	0.08	0.070	700.00	64.29	0.54
		13	107415	0.07	0.08	0.08	0.077	766.67	82.35	0.69
		14.65	138240	0.08	0.08	0.08	0.080	800.00	110.59	0.92
10 t/ha	0	11	68670	0.04	0.04	0.05	0.043	433.33	29.76	0.25
		13	99540	0.05	0.05	0.06	0.053	533.33	53.09	0.44
		14.65	126070	0.06	0.05	0.06	0.057	566.67	71.44	0.60
	2	11	76650	0.05	0.05	0.05	0.050	500.00	38.33	0.32
		13	98700	0.06	0.06	0.05	0.057	566.67	55.93	0.47
		14.65	129150	0.06	0.06	0.07	0.063	633.33	81.80	0.68
	4	11	82600	0.05	0.06	0.05	0.053	533.33	44.05	0.37
		13	101570	0.06	0.05	0.07	0.060	600.00	60.94	0.51
		14.65	130340	0.07	0.07	0.07	0.070	700.00	91.24	0.76

Similarly, for 8 t/ha mulch rate, the volume of runoff increased from 71400 cm^3 to 138240 cm^3 and the total SOR increased from 0.34 $g/m^2/min$ to 0.92 $g/m^2/min$ when rainfall intensity increased from 11 cm/h to 14.65 cm/h at 0-4% land slope. At other selected land slopes, the total runoff volume for 11 cm/h rainfall intensity was found 71400, 80850 and 91840 cm^3; for 13 cm/hr 106050, 105700 and 107415 cm^3; for 14.65 cm/hr 128870, 134050 and 138240 cm^3 at land slope 0%, 2% and 4% respectively. The result for the mulching treatment at the rate of 10 t/ha, the volume of runoff increased from 68670 cm^3 to 130340 cm^3 and the total SOR increased from 0.25 $g/m^2/min$ to 0.76 $g/m^2/min$ when rainfall intensity increased from 11 cm/h to 14.65 cm/h at 0-4% land slope. At other selected land slopes, the total runoff volume for 11 cm/h rainfall intensity was found 68670, 76650 and 82600 cm^3; for 13 cm/hr 99540, 98700 and 101570 cm^3; for 14.65 cm/hr 126070, 129150 and 130340 cm^3 at land slope 0%, 2% and 4% respectively. Figure 3-5 shows the measured runoff hydrograph at 0%, 2%, and 4% land slopes using simulated rainfall intensities (11, 13, 14.65 cm/hr) for 6, 8 and 10 ton/ha trash (sugarcane leaf) mulch. The mulching treatments were presented as percentages of deviation from the bare soil control. The hydrograph of runoff decreased with mowing rates of 6, 8, and 10 tons per hectare.



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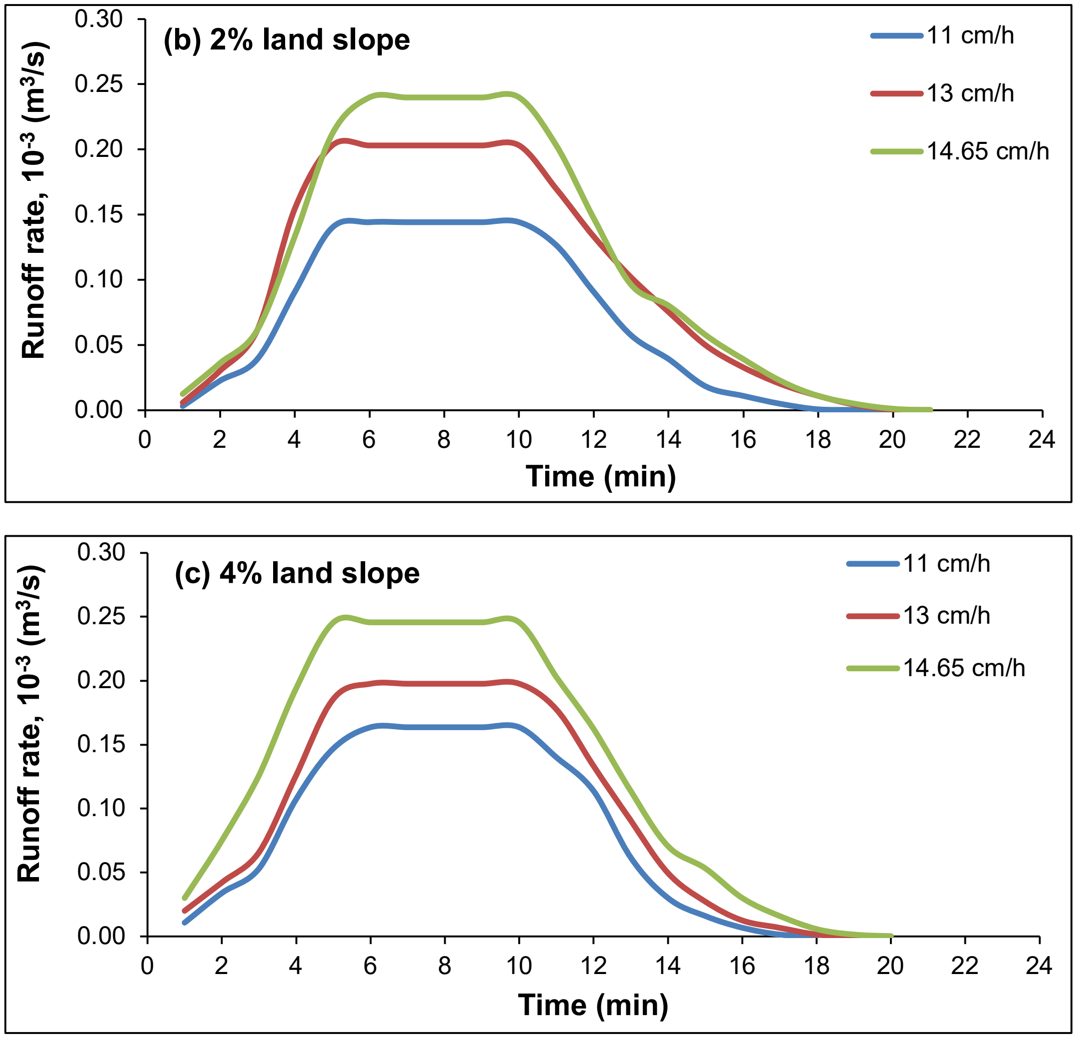
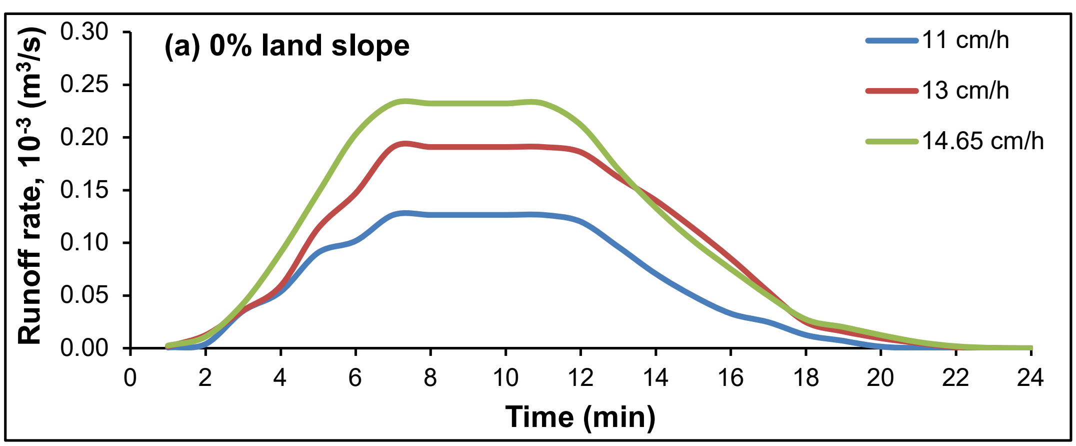


Figure 3. Observed runoff hydrograph at 0%, 2%, and 4% land slopes using simulated rainfall intensities for 6 ton/ha trash (sugarcane leaf) mulch.



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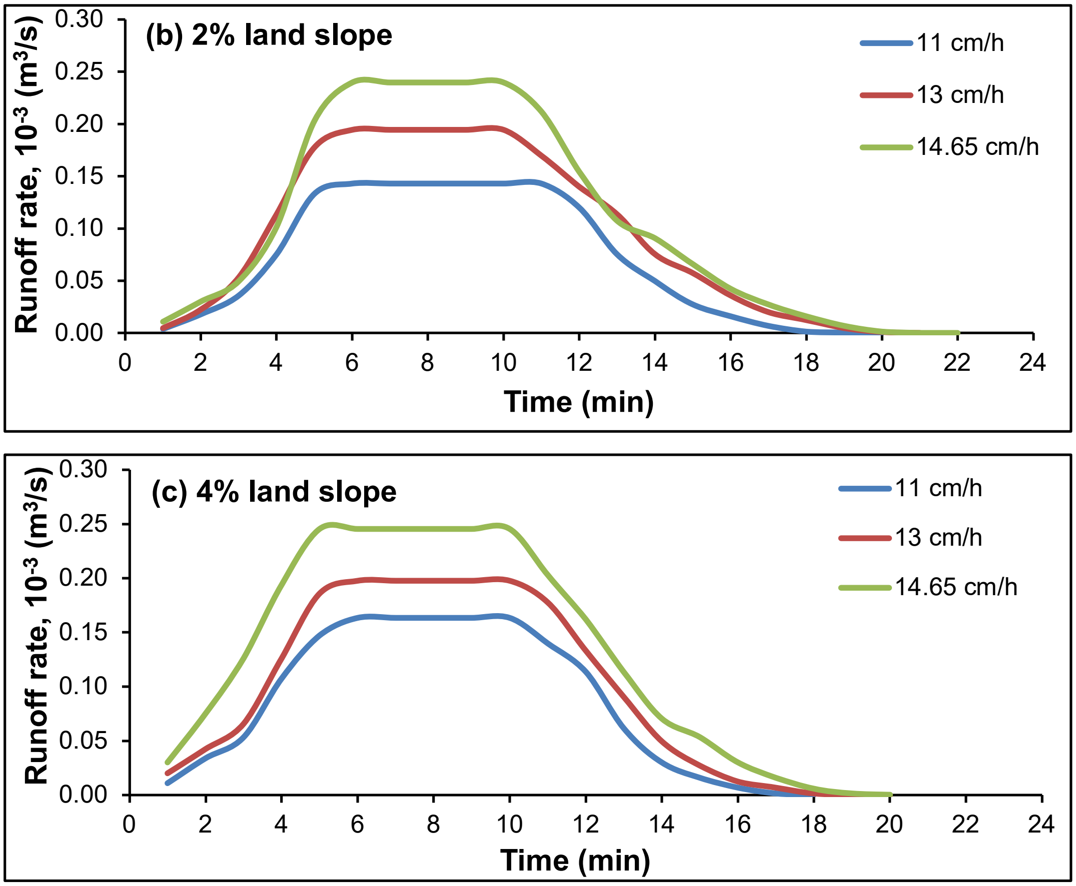
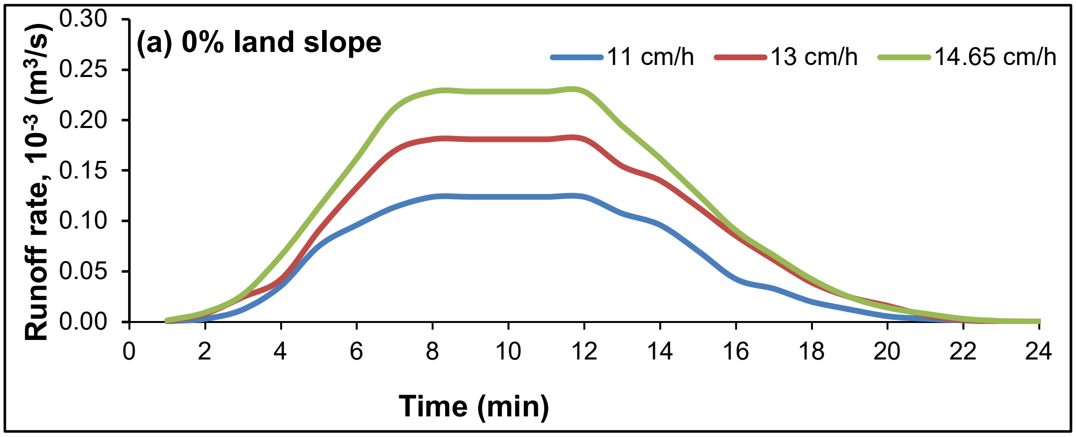


Figure 4. Observed runoff hydrograph at 0, 2, and 4% land slopes using simulated rainfall intensities for 8 ton/ha trash (sugarcane leaf) mulch.



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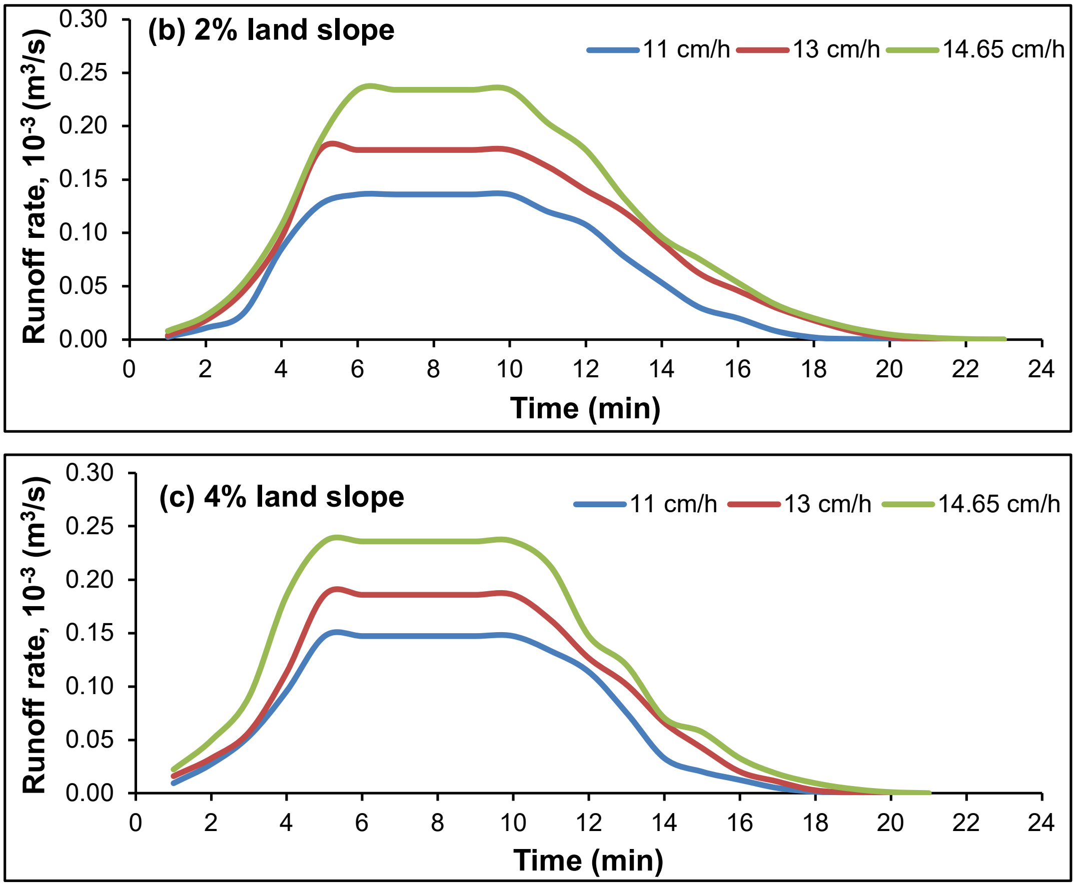
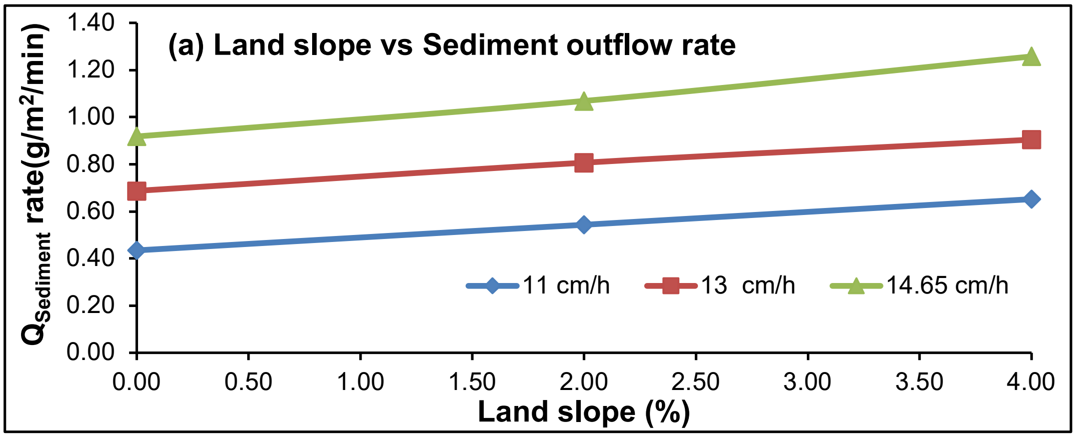


Figure 5. Observed runoff hydrograph at 0%, 2%, and 4% land slopes using simulated rainfall intensities for 10 ton/ha trash (sugarcane leaf) mulch.

In Figures 6-8 and Table 1, shows the reduction in total sediment outflow and sediment yield rate in the grassplots over time varying rainfall intensities and land slopes for rate of trash (sugarcane leaf) mulch as compared to the bare soil plot. Result show that as trash rate increases total sediment outflow and sediment yield rate decreases, and as land slope and rainfall intensity are increases, the total sediment outflow and sediment yield rate increases, but the quantity with more mulch rate was found to be less on average.



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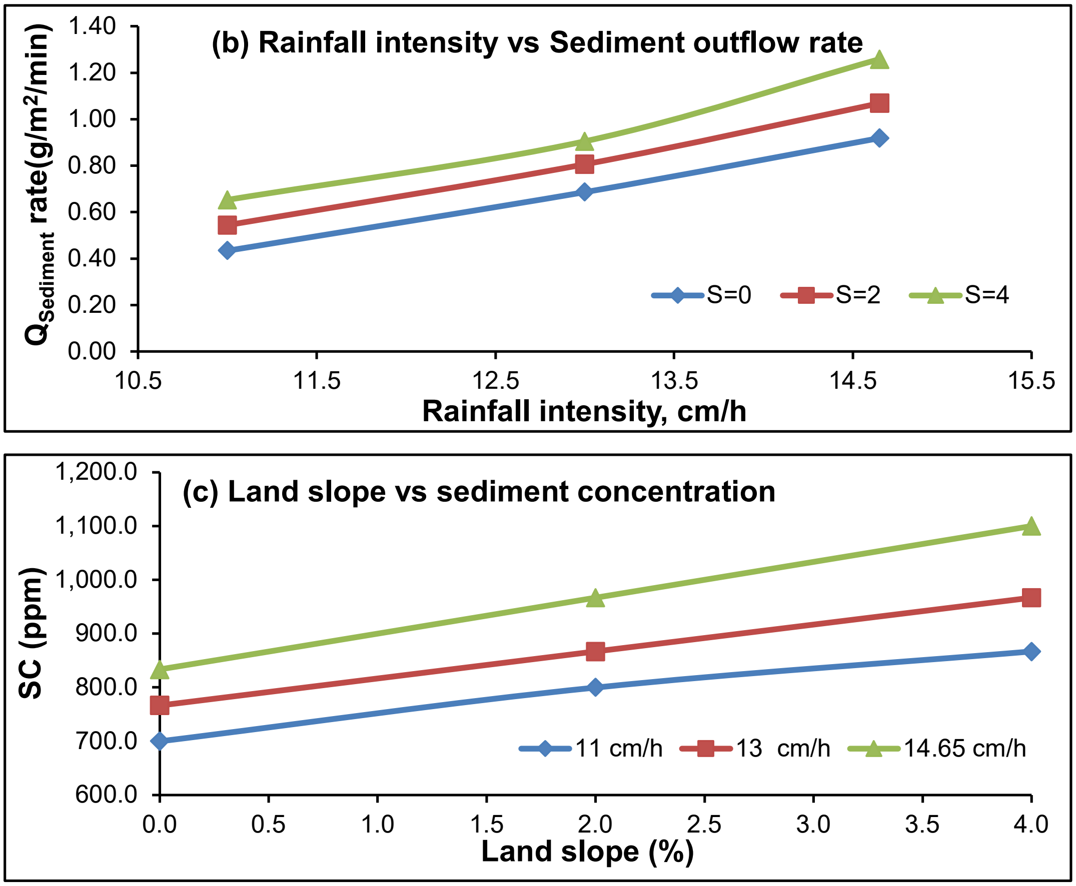
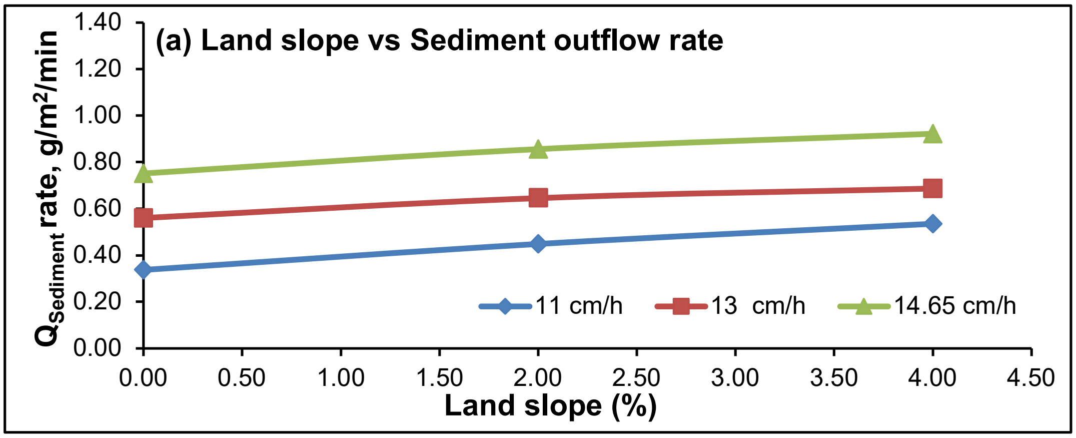


Figure 6. Observed sediment outflow rate and concentration (SC) with varying rainfall intensities and land slopes for 6 ton/ha trash (sugarcane leaf) mulch.



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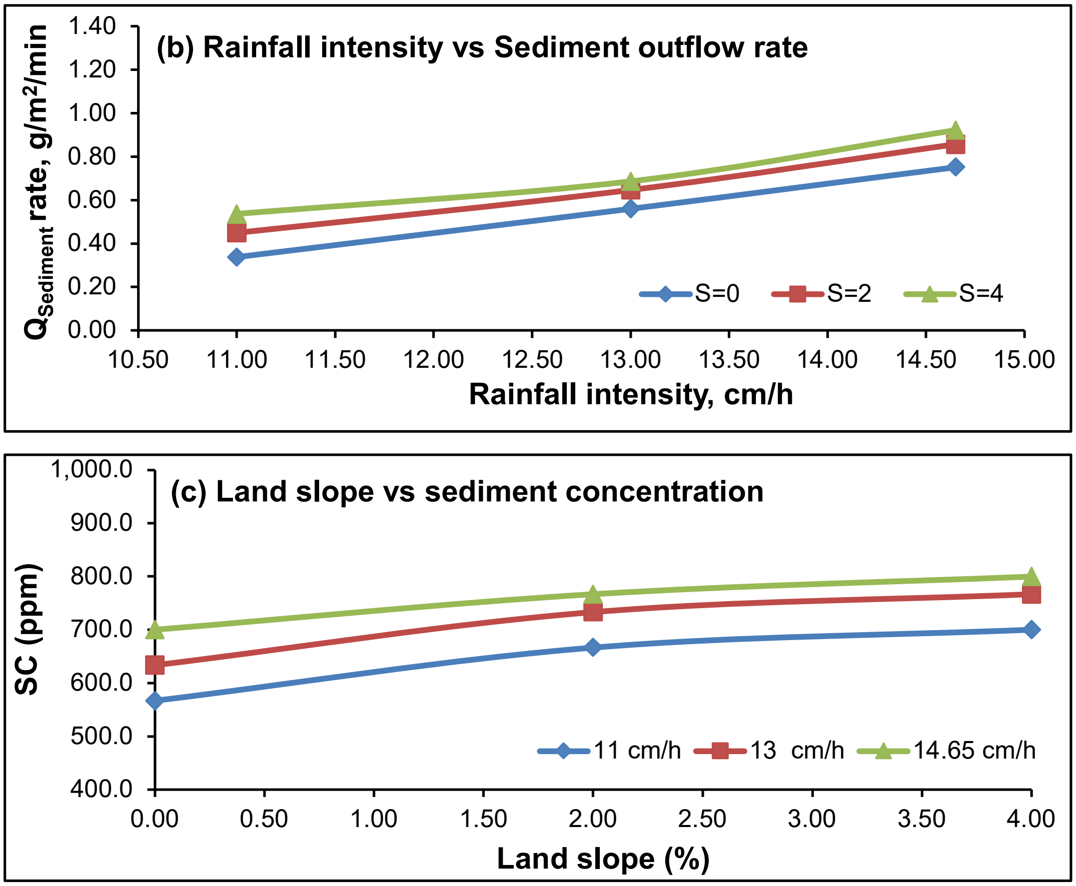
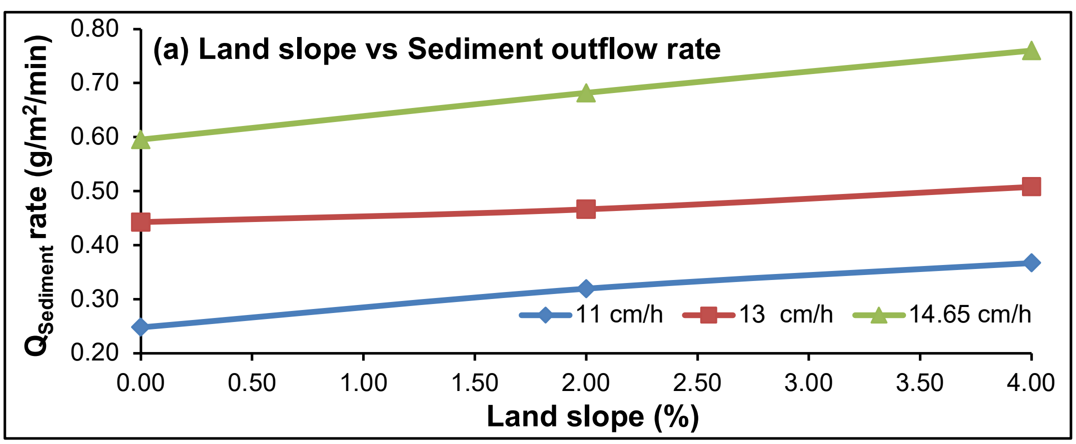


Figure 7. Observed sediment outflow rate and concentration with varying rainfall intensities and land slopes for 8 ton/ha trash (sugarcane leaf) mulch.



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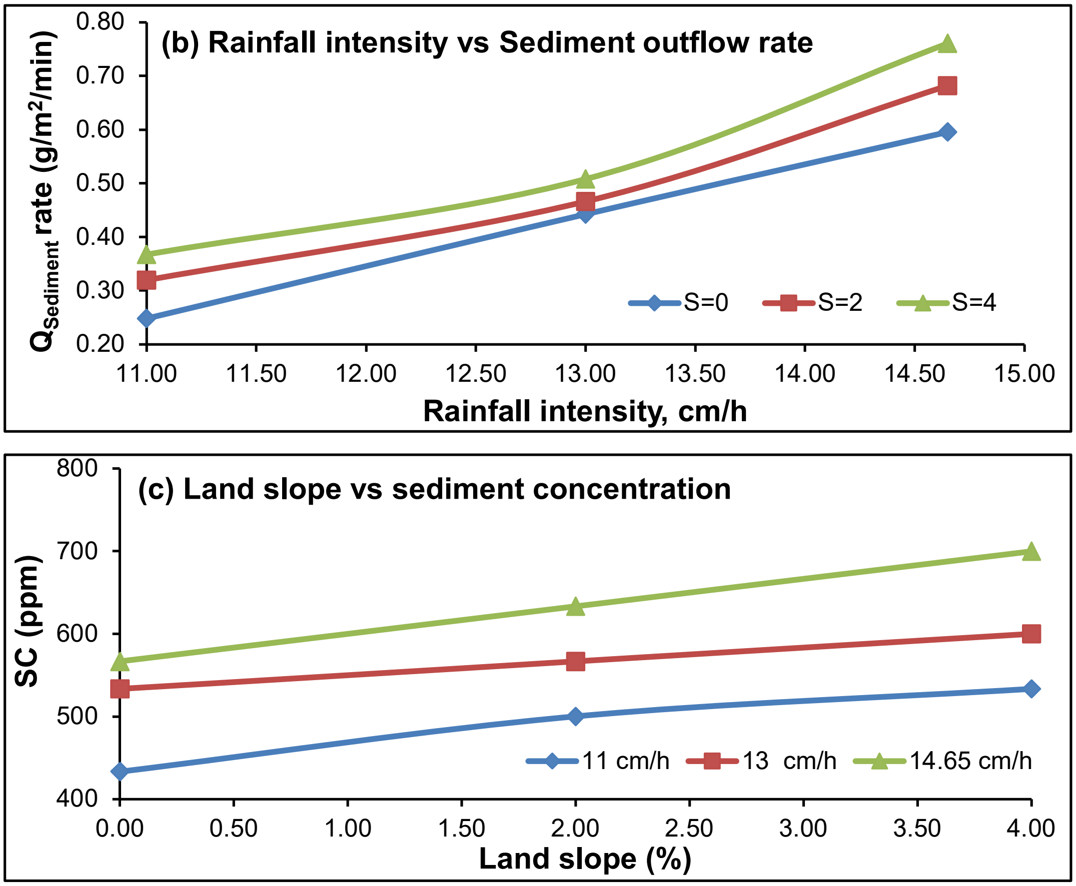

Figure 8 Observed sediment outflow rate and concentration with varying rainfall intensities and land slopes for 10 ton/ha trash (sugarcane leaf) mulch.

The decreases are attributed to the following factors: 1) protection of the soil against raindrops; 2) higher hydraulic roughness due to the straw cover, therefore retarding surface flow and enhancing infiltration; and 3) water retention due to the mulch cover. Runoff rate reduced significantly at the downstream end of the flume, causing the mulch adopted. During all rainfall events, mulching treatments resulted in significantly higher infiltration and abstraction (e.g., surface accumulation and water retention in the straw); therefore, runoff was significantly reduced.

Figures 6-8 shows sediment discharge rate and sediment concentration are presented for all rainfall intensities and land slopes for mulch trash treatments (sugarcane leaf). Table 2 summarizes the information regarding sediment dynamics.

Table 2. This is a table. Tables should be placed in the main text near to the first time they are cited.

SOR (g/m²/min)												
S (%)	I=11cm/h				I=13cm/h				I=14.65cm/h			
	Mulch rate (t/ha)				Mulch rate (t/ha)				Mulch rate (t/ha)			
	No mulch	6	8	10	No mulch	6	8	10	No mulch	6	8	10
0	2.67	0.43	0.34	0.25	4.04	0.69	0.56	0.44	5.24	0.92	0.75	0.60
2	3.65	0.54	0.45	0.32	5.31	0.81	0.65	0.47	6.53	1.07	0.86	0.68
4	4.67	0.65	0.54	0.37	6.62	0.91	0.69	0.51	8.35	1.26	0.92	0.76

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In Figure 6 (a) and Figure 6 (b), observed SOR at 0% land slope was found to be between 0.434 g/m²/min to 0.918 g/m²/min at rainfall intensities 11cm/h to 14.65 cm/h, respectively, at 0% land slope and a similar trend was also followed by 2% and 4% land slopes in 6 t/ha mulch treatment. In Figure 6 (c), SC was found to be 700 ppm, 766 ppm and 833 ppm at 0% land slope for 11cm/h, 13cm/h and 14.65 cm/h rainfall intensities, respectively. Graphical behavior of treatments viz. 8 and 10 t/ha have also been shown in Figure 7 and Figure 8.

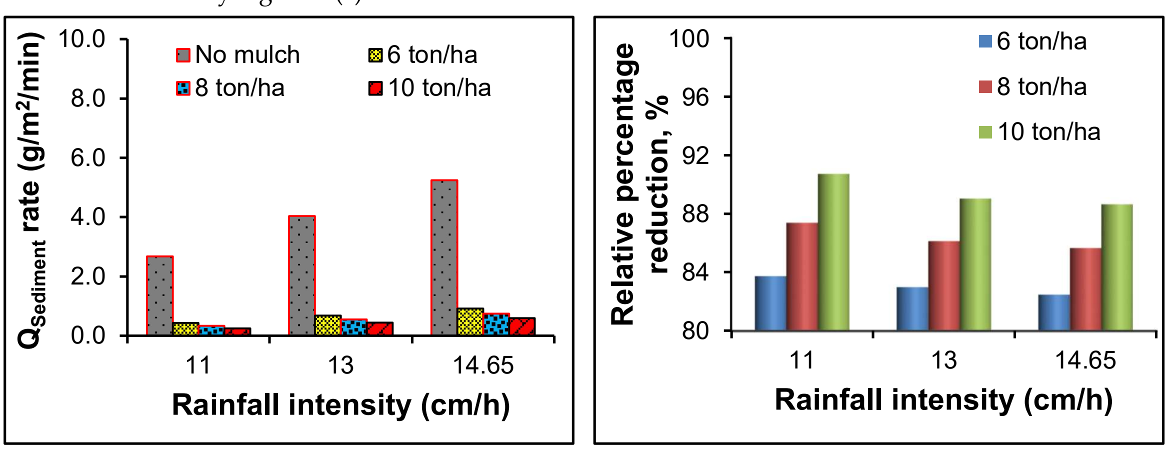
In the past, sediment yield rate and runoff rate have been regarded as linear events under net detachment conditions, or as quadratic regressions under depositional conditions. Sediment discharge rate (SOR) and sediment concentration (SC) was a function of rainfall intensity/runoff rate (I) and land slope (S) for each treatment and their relationship could be well described by the linear equation (1) and (2). Mathematical models for SOR and SC for this treatment have been given as:

$$SOR = -0.080M + 0.045 + 0.119I - 0.335;\ R^2 = 96.11 \quad (1)$$

$$SC = -77.778M + 36.111S + 39.485I + 754.878;\ R^2 = 96.11 \quad (2)$$

It appeared that sediment concentrations correlated negatively with mulch rate, indicating that the detachment and weathering of raindrops may be an important factor in controlling inter-rill transfer. Mulching significantly reduced erosion rates in all land slopes and rainfall events. There was a greater difference between the sediment loss rates from low mulch and high mulch covers when rainfall profiles were uniform, whereas both outcomes were similar when rainfall patterns and land slope varied over time.

In Table 3 and in Figure 9, observed values of SORs for no mulch were observed to be 2.671 g/m²/min, 4.0347 g/ m²/min, and 5.242 g/m²/min, at 0% land slope. For 6 t/ha trash mulch, the SORs were found to be 0.4344 g/m²/min, 0.686 g/m²/min and 0.918 g/m²/min. the values for 8 t/ha trash mulch were 0.337 g/m²/min, 0.559 g/m²/min and 0.752 g/m²/min and for 10 t/ha trash mulch the values were 0.247 g/m² /min, 0.444 g/m²/min and 0.595 g/m²/min for rainfall intensities of 11 cm/h, 13 cm/h and 14.65cm/h respectively. As observed from Figure 9 (a), no mulch treatment yielded highest SOR as compared to other mulching treatments at any selected slope. The similar trend was observed at 2% land slope for all rainfall intensities (Figure 9 b). The SOR at 4% land slope for selected mulch treatment was found to have similar trend as in case of 0% and 2% land slopes as indicated by Figure 9 (c).



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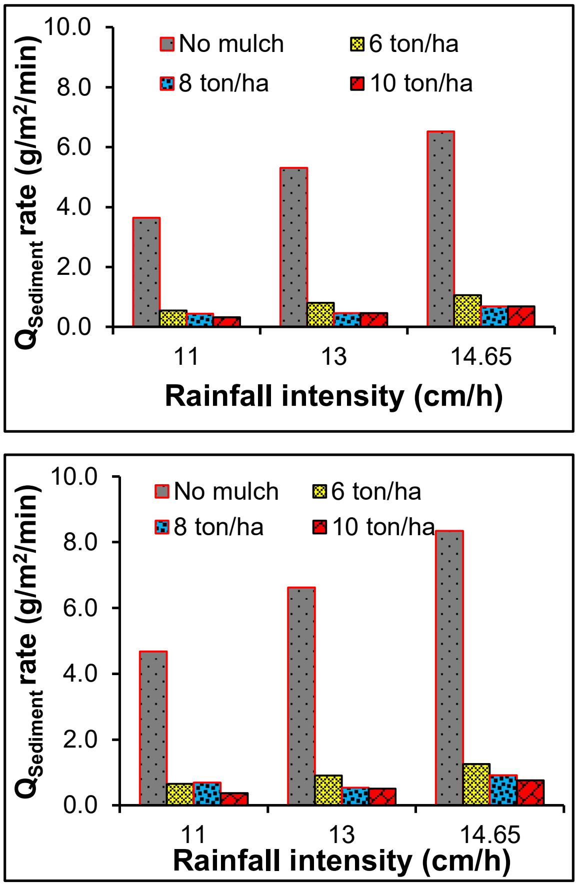

Figure 9. Comparison of sediment outflow rate for different trash mulch rate treatment using selected rainfall intensities at 0, 2, and 4% land slopes.

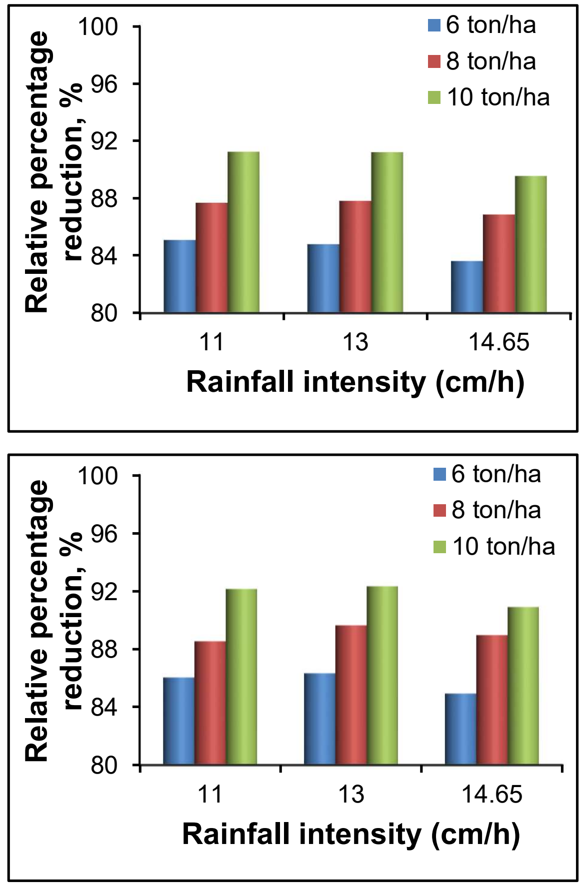

Figure 10. Comparison of relative present reduction in sediment outflow rate for different trash mulch rate treatments and rainfall intensities with respect to no mulch at 0, 2, and 4% land slopes.

The calculated values of relative percentage reduction in observed SOR for 6 t/ha trash mulch was found as 83.734%, 82.985% and 82.475% at 0% land slope (Table 3).

Table 3. Relative percentage reduction in observed SOR for 6 ton/ha, 8 ton/ha and 10 ton/ha Trash (Sugarcane leaf) mulch as compared to no mulch at selected land slopes and rainfall intensities.

S %	I, (cm/hr)	No mulch	Trash mulch, 6 t/ha	Trash mulch, 8 t/ha	Trash mulch, 10 t/ha	7=(col.3-col.4) *100/(col.3)	8=(col.3-col.5) * 100/(col.3)	9=(col.3-col.6) * 100/(col.3)
0	11	2.67	0.43	0.34	0.25	83.73	87.38	90.72
	13	4.03	0.69	0.56	0.44	82.99	86.13	89.04
	14.65	5.24	0.92	0.75	0.60	82.48	85.66	88.64
2	11	3.65	0.54	0.45	0.32	85.10	87.69	91.25
	13	5.31	0.81	0.65	0.47	84.80	87.82	91.21
	14.65	6.52	1.07	0.86	0.68	83.62	86.87	89.55
4	11	4.67	0.65	0.54	0.37	86.04	88.53	92.14
	13	6.62	0.91	0.69	0.51	86.33	89.63	92.33
	14.65	8.35	1.26	0.92	0.76	84.93	88.96	90.90

The values for 8 t/ha trash mulch were found as 87.377%, 86.127%, 85.660% and 90.716%, 89.035%, 88.644% for 10 t/ha trash mulch and 11 cm/h, 13cm/h and 14.65 cm/h

 doi:10.20944/preprints202204.0302.v1

rainfall intensities, respectively, at selected land slope. It was observed from Figure 10, the 10 t/ha trash mulch was more effective in controlling SOR as compared to lower mulch rates when rainfall intensity increased from 11 cm/h to 14.65 cm/h at a particular land slope. Mulching reduces sediment transport and increases infiltration, making it an effective soil and water conservation technique. We recommend further field research involving different soil mulch covers, in different climate zones, since mulching effectiveness is strongly influenced by the distribution and characteristics of rainfall throughout the year.

5. Conclusions

The study was carried out with the objectives to determine the sediment outflow and concentration for varying land slopes and simulated rainfall intensities for selected mulch treatments along with no mulch treatment under saturated antecedent moisture conditions. This was done to save the time, as to observe sediment outflow rate under dry conditions required to fill the soil material each time for every combination and was not feasible within the limited time. Attempts were also made to compare and quantify the effects of various combinations of input variables on sediment outflow and sediment concentration. The study was conducted under laboratory conditions by using a rainfall simulator produced rainfall intensities viz. 11 cm/h, 13cm/h and 14.65 cm/h. The hydraulic tilting flume was used to create a test plot with varying land slopes viz. 0%, 2% and 4%. The care was taken to compact each layer of soil filled in the test flume attained a bulk density similar to natural field conditions. It was observed that the values of sediment outflow rate had a good multiple correlations with land slope and value of rainfall intensity for the respective cases of simulated rainfall condition and correlation coefficient was found to be more than 90%. The sediment outflow rate was found to be increasing with the increase in land slope and rainfall intensity for every mulching treatment. The sediment outflow rate from 10 ton/ha trash mulching is most effective in controlling the sediment outflow rate and sediment concentration for every combination of rainfall intensity and land slope.

Author Contributions: "Conceptualization, Sachin Kumar Singh and P. S. Kashyap; methodology, Sachin Kumar Singh; software, Dinesh Kumar Vishwakarma; validation, Sachin Kumar Singh and P. S. Kashyap; formal analysis, Sachin Kumar Singh; investigation, P. S. Kashyap; resources, P. S. Kashyap; data curation, Sachin Kumar Singh and Dinesh Kumar Vishwakarma; writing—original draft preparation, Sachin Kumar Singh and Dinesh Kumar Vishwakarma; writing—review and editing, Pankaj Kumar, Rohitashw Kumar, Akhilesh Kumar and Ahmed Elbeltagi; visualization, Dinesh Kumar Vishwakarma; supervision, P. S. Kashyap; project administration, P. S. Kashyap; funding acquisition, Nadhir Al-Ansari. All authors have read and agreed to the published version of the manuscript."

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The experimental work was carried out at the Laboratory of Hydraulics, of the Department of Soil and Water Engineering, College of Technology of the G.B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ullah, S.; Ali, A.; Iqbal, M.; Javid, M.; Imran, M. Geospatial assessment of soil erosion intensity and sediment yield: a case study of Potohar Region, Pakistan. *Environ. Earth Sci.* **2018**, *77*, 705, doi:10.1007/s12665-018-7867-7.
2. Pimentel, D. Soil Erosion: A Food and Environmental Threat. *Environ. Dev. Sustain.* **2006**, *8*, 119–137, doi:10.1007/s10668-005-

1262-8.
3. Ashraf, M.; Fayyaz-ul-Hussan; Khan, M.A. Sustainable environment management: impact of Agriculture. *Sci. Technol. Dev.* **2000**, *19*, 51–57.
4. Hobbs, P.R. Conservation agriculture: what is it and why is it important for future sustainable food production? *J. Agric. Sci.* **2007**, *145*, 127.
5. Shah, Z.; Arshad, M. *Land degradation in Pakistan: a serious threat to environments and economic sustainability*; 2006;
6. Khresat, S.A.; Rawajfih, Z.; Mohammad, M. Land degradation in north-western Jordan: causes and processes. *J. Arid Environ.* **1998**, *39*, 623–629, doi:https://doi.org/10.1006/jare.1998.0385.
7. Abdi, O.A.; Glover, E.K.; Luukkanen, O. Causes and Impacts of Land Degradation and Desertification: Case Study of the Sudan. *Int. J. A griculture For.* **2013**, *3*, 40–51, doi:10.5923/j.ijaf.20130302.03.
8. Eswaran, H.; Lal, R.; Reich, P.F. Land degradation: an overview. *Responses to L. Degrad.* **2001**, 20–35.
9. Lal, R. Restoring Soil Quality to Mitigate Soil Degradation. *Sustainability* 2015, *7*, 5875–5895.
10. Lal, R. Soil erosion and the global carbon budget. *Environ. Int.* **2003**, *29*, 437–450, doi:https://doi.org/10.1016/S0160-4120(02)00192-7.
11. Ashraf, M.; Hassan, F.U.; Saleem, A.; Iqbal, M.M. Soil conservation and management: A prerequisite for sustainable agriculture in pothwar. *Sci. Technol. Dev.* **2002**, *21*, 25–31.
12. Pimentel, D.; Burgess, M. Soil Erosion Threatens Food Production. *Agriculture* 2013, *3*, 443–463.
13. Aytop, H.; Şenol, S. The effect of different land use planning scenarios on the amount of total soil losses in the Mikail Stream Micro-Basin. *Environ. Monit. Assess.* **2022**, *194*, 321, doi:10.1007/s10661-022-09937-2.
14. Tsegaye, L.; Bharti, R. Assessment of the effects of agricultural management practices on soil erosion and sediment yield in Rib watershed, Ethiopia. *Int. J. Environ. Sci. Technol.* **2022**, doi:10.1007/s13762-022-04018-w.
15. Mandal, D.; Sharda, V.N. Assessment of permissible soil loss in India employing a quantitative bio-physical model. *Curr. Sci.* **2011**, *100*, 383–390.
16. Kumar, S.; Kalambukattu, J.G. Modeling and Monitoring Soil Erosion by Water Using Remote Sensing Satellite Data and GIS BT - Anthropogeomorphology: A Geospatial Technology Based Approach. In; Bhunia, G.S., Chatterjee, U., Lalmalsawmzauva, K.C., Shit, P.K., Eds.; Springer International Publishing: Cham, 2022; pp. 273–304 ISBN 978-3-030-77572-8.
17. Svoray, T. The Case of Agricultural Catchments BT - A Geoinformatics Approach to Water Erosion: Soil Loss and Beyond. In; Svoray, T., Ed.; Springer International Publishing: Cham, 2022; pp. 39–74 ISBN 978-3-030-91536-0.
18. Su, Y.; Zhang, Y.; Wang, H.; Lei, N.; Li, P.; Wang, J. Interactive Effects of Rainfall Intensity and Initial Thaw Depth on Slope Erosion. *Sustainability* 2022, *14*, 3172.
19. Li, Y.; Lu, X.; Washington-Allen, R.A.; Li, Y. Microtopographic Controls on Erosion and Deposition of a Rilled Hillslope in Eastern Tennessee, USA. *Remote Sens.* 2022, *14*.
20. Wischmeier, W.H.; Smith, D.D. *Predicting rainfall-erosion losses from cropland east of the Rocky Mountains: Guide for selection of practices for soil and water conservation*; Agricultural Research Service, US Department of Agriculture, 1965;
21. Cruse, R.; Flanagan, D.; Frankenberger, J.; Gelder, B.; Herzmann, D.; James, D.; Krajewski, W.; Kraszewski, M.; Laflen, J.; Opsomer, J.; et al. Daily estimates of rainfall, water runoff, and soil erosion in Iowa. *J. Soil Water Conserv.* **2006**, *61*, 191 LP – 199.
22. Prasannakumar, V.; Vijith, H.; Abinod, S.; Geetha, N. Estimation of soil erosion risk within a small mountainous sub-watershed in Kerala, India, using Revised Universal Soil Loss Equation (RUSLE) and geo-information technology. *Geosci. Front.* **2012**, *3*, 209–215, doi:https://doi.org/10.1016/j.gsf.2011.11.003.
23. Kayet, N.; Pathak, K.; Chakrabarty, A.; Sahoo, S. Evaluation of soil loss estimation using the RUSLE model and SCS-CN

method in hillslope mining areas. *Int. Soil Water Conserv. Res.* **2018**, *6*, 31–42, doi:https://doi.org/10.1016/j.iswcr.2017.11.002.

24. Bryan, R.B. Soil erodibility and processes of water erosion on hillslope. *Geomorphology* **2000**, *32*, 385–415, doi:https://doi.org/10.1016/S0169-555X(99)00105-1.
25. Aksoy, H.; Kavvas, M.L. A review of hillslope and watershed scale erosion and sediment transport models. *CATENA* **2005**, *64*, 247–271, doi:https://doi.org/10.1016/j.catena.2005.08.008.
26. Mahmoodabadi, M.; Sajjadi, S.A. Effects of rain intensity, slope gradient and particle size distribution on the relative contributions of splash and wash loads to rain-induced erosion. *Geomorphology* **2016**, *253*, 159–167, doi:https://doi.org/10.1016/j.geomorph.2015.10.010.
27. Lu, J.; Zheng, F.; Li, G.; Bian, F.; An, J. The effects of raindrop impact and runoff detachment on hillslope soil erosion and soil aggregate loss in the Mollisol region of Northeast China. *Soil Tillage Res.* **2016**, *161*, 79–85, doi:https://doi.org/10.1016/j.still.2016.04.002.
28. Meyer, L.D.; Wischmeier, W.H. Mathematical simulation of the process of soil erosion by water. *Trans. ASAE* **1969**, *12*, 754–758.
29. Foster, G.R.; Young, R.A.; Römkens, M.J.M.; Onstad, C.A. Processes of Soil Erosion by Water. *Soil Eros. Crop Product.* 1985, 137–162.
30. Smets, T.; Poesen, J.; Bhattacharyya, R.; Fullen, M.A.; Subedi, M.; Booth, C.A.; Kertész, A.; Szalai, Z.; Toth, A.; Jankauskas, B.; et al. Evaluation of biological geotextiles for reducing runoff and soil loss under various environmental conditions using laboratory and field plot data. *L. Degrad. Dev.* **2011**, *22*, 480–494, doi:https://doi.org/10.1002/ldr.1095.
31. Ferreras, L.; Gomez, E.; Toresani, S.; Firpo, I.; Rotondo, R. Effect of organic amendments on some physical, chemical and biological properties in a horticultural soil. *Bioresour. Technol.* **2006**, *97*, 635–640, doi:https://doi.org/10.1016/j.biortech.2005.03.018.
32. Ruiz Sinoga, J.D.; Romero Diaz, A.; Ferre Bueno, E.; Martínez Murillo, J.F. The role of soil surface conditions in regulating runoff and erosion processes on a metamorphic hillslope (Southern Spain): Soil surface conditions, runoff and erosion in Southern Spain. *CATENA* **2010**, *80*, 131–139, doi:https://doi.org/10.1016/j.catena.2009.09.007.
33. Ruy, S.; Findeling, A.; Chadoeuf, J. Effect of mulching techniques on plot scale runoff: FDTF modeling and sensitivity analysis. *J. Hydrol.* **2006**, *326*, 277–294, doi:https://doi.org/10.1016/j.jhydrol.2005.11.003.
34. Gilley, J.E.; Finkner, S.C.; Varvel, G.E. Runoff and erosion as affected by sorghum and soybean residue. *Trans. ASAE* **1986**, *29*, 1605–1610, doi:doi: 10.13031/2013.30361.
35. Faucette, L.B.; Risse, L.M.; Nearing, M.A.; Gaskin, J.W.; West, L.T. Runoff, erosion, and nutrient losses from compost and mulch blankets under simulated rainfall. *J. Soil Water Conserv.* **2004**, *59*, 154 LP – 160.
36. Truman, C.C.; Reeves, D.W.; Shaw, J.N.; Motta, A.C.; Burmester, C.H.; Raper, R.L.; Schwab, E.B. Tillage impacts on soil property, runoff, and soil loss variations from a rhodic paleudult under simulated rainfall. *J. Soil Water Conserv.* **2003**, *58*, 258 LP – 267.
37. Poesen, J.W.A.; Lavee, H. Effects of size and incorporation of synthetic mulch on runoff and sediment yield from interrils in a laboratory study with simulated rainfall. *Soil Tillage Res.* **1991**, *21*, 209–223, doi:https://doi.org/10.1016/0167-1987(91)90021-O.
38. Sadeghi, S.H.R.; Gholami, L.; Sharifi, E.; Khaledi Darvishan, A.; Homaee, M. Scale effect on runoff and soil loss control using rice straw mulch under laboratory conditions. *Solid Earth* **2015**, *6*, 1–8, doi:10.5194/se-6-1-2015.
39. Gholami, L.; Sadeghi, S.H.; Homaee, M. Straw Mulching Effect on Splash Erosion, Runoff, and Sediment Yield from Eroded Plots. *Soil Sci. Soc. Am. J.* **2013**, *77*, 268–278, doi:https://doi.org/10.2136/sssaj2012.0271.
40. Gholami, L.; Banasik, K.; Sadeghi, S.H.; Darvishan, A.K.; Hejduk, L. Effectiveness of Straw Mulch on Infiltration, Splash Erosion, Runoff and Sediment in Laboratory Conditions. *J. Water L. Dev.* 2014, 51–60.

41. Jin, K.; Cornelis, W.M.; Gabriels, D.; Schiettecatte, W.; De Neve, S.; Lu, J.; Buysse, T.; Wu, H.; Cai, D.; Jin, J.; et al. Soil management effects on runoff and soil loss from field rainfall simulation. *CATENA* **2008**, *75*, 191–199, doi:https://doi.org/10.1016/j.catena.2008.06.002.
42. Smets, T.; Poesen, J.; Knapen, A. Spatial scale effects on the effectiveness of organic mulches in reducing soil erosion by water. *Earth-Science Rev.* **2008**, *89*, 1–12, doi:https://doi.org/10.1016/j.earscirev.2008.04.001.
43. Bot, A.; Benites, J. *The importance of soil organic matter: Key to drought-resistant soil and sustained food production*; Food & Agriculture Org., 2005; ISBN 9251053669.
44. Obalum, S.E.; Chibuike, G.U.; Peth, S.; Ouyang, Y. Soil organic matter as sole indicator of soil degradation. *Environ. Monit. Assess.* **2017**, *189*, 176, doi:10.1007/s10661-017-5881-y.
45. Sur, H.S.; Ghuman, B.S. Soil management and rainwater conservation and use in alluvial soils under medium rainfall. *Bull. Indian Soc. Soil Sci.* **1994**, *16*, 56–65.
46. Oades, J.M. Soil organic matter and structural stability: mechanisms and implications for management. *Plant Soil* **1984**, *76*, 319–337, doi:10.1007/BF02205590.
47. Fageria, N.K. Role of Soil Organic Matter in Maintaining Sustainability of Cropping Systems. *Commun. Soil Sci. Plant Anal.* **2012**, *43*, 2063–2113, doi:10.1080/00103624.2012.697234.
48. Greene, R.S.B.; Kinnell, P.I.A.; Wood, J.T. Role of plant cover and stock trampling on runoff and soil-erosion from semi-arid wooded rangelands. *Soil Res.* **1994**, *32*, 953–973.
49. Polyakov, V.; Lal, R. Modeling soil organic matter dynamics as affected by soil water erosion. *Environ. Int.* **2004**, *30*, 547–556, doi:https://doi.org/10.1016/j.envint.2003.10.011.
50. Shi, Z.H.; Yue, B.J.; Wang, L.; Fang, N.F.; Wang, D.; Wu, F.Z. Effects of Mulch Cover Rate on Interrill Erosion Processes and the Size Selectivity of Eroded Sediment on Steep Slopes. *Soil Sci. Soc. Am. J.* **2013**, *77*, 257–267, doi:https://doi.org/10.2136/sssaj2012.0273.
51. Guo, T.; Wang, Q.; Li, D.; Zhuang, J. Effect of surface stone cover on sediment and solute transport on the slope of fallow land in the semi-arid loess region of northwestern China. *J. Soils Sediments* **2010**, *10*, 1200–1208, doi:10.1007/s11368-010-0257-8.
52. Prosdocimi, M.; Jordán, A.; Tarolli, P.; Keesstra, S.; Novara, A.; Cerdà, A. The immediate effectiveness of barley straw mulch in reducing soil erodibility and surface runoff generation in Mediterranean vineyards. *Sci. Total Environ.* **2016**, *547*, 323–330, doi:https://doi.org/10.1016/j.scitotenv.2015.12.076.
53. Montenegro, A.A.A.; Abrantes, J.R.C.B.; de Lima, J.L.M.P.; Singh, V.P.; Santos, T.E.M. Impact of mulching on soil and water dynamics under intermittent simulated rainfall. *CATENA* **2013**, *109*, 139–149, doi:https://doi.org/10.1016/j.catena.2013.03.018.
54. Abrahams, A.D.; Parsons, A.J. Relation between infiltration and stone cover on a semiarid hillslope, southern Arizona. *J. Hydrol.* **1991**, *122*, 49–59, doi:https://doi.org/10.1016/0022-1694(91)90171-D.
55. Valentin, C.; Casenave, A. Infiltration into Sealed Soils as Influenced by Gravel Cover. *Soil Sci. Soc. Am. J.* **1992**, *56*, 1667–1673, doi:https://doi.org/10.2136/sssaj1992.03615995005600060002x.
56. Poesen, J.W.; Torri, D.; Bunte, K. Effects of rock fragments on soil erosion by water at different spatial scales: a review. *CATENA* **1994**, *23*, 141–166, doi:https://doi.org/10.1016/0341-8162(94)90058-2.
57. Cerdà, A. Effects of rock fragment cover on soil infiltration, interrill runoff and erosion. *Eur. J. Soil Sci.* **2001**, *52*, 59–68, doi:https://doi.org/10.1046/j.1365-2389.2001.00354.x.
58. Zavala, L.M.; Jordán, A.; Bellinfante, N.; Gil, J. Relationships between rock fragment cover and soil hydrological response in a Mediterranean environment. *Soil Sci. Plant Nutr.* **2010**, *56*, 95–104, doi:10.1111/j.1747-0765.2009.00429.x.
59. Thierfelder, C.; Wall, P.C. Effects of conservation agriculture techniques on infiltration and soil water content in Zambia and Zimbabwe. *Soil Tillage Res.* **2009**, *105*, 217–227, doi:https://doi.org/10.1016/j.still.2009.07.007.

60. Ranaivoson, L.; Naudin, K.; Ripoche, A.; Affholder, F.; Rabeharisoa, L.; Corbeels, M. Agro-ecological functions of crop residues under conservation agriculture. A review. *Agron. Sustain. Dev.* **2017**, *37*, 26, doi:10.1007/s13593-017-0432-z.
61. Unger, P.W.; Stewart, B.A.; Parr, J.F.; Singh, R.P. Crop residue management and tillage methods for conserving soil and water in semi-arid regions. *Soil Tillage Res.* **1991**, *20*, 219–240, doi:https://doi.org/10.1016/0167-1987(91)90041-U.
62. Yang, J.H.; Liu, H.Q.; Zhang, J.P.; Rahma, A.E.; Lei, T.W. Lab simulation of soil erosion on cultivated soil slopes with wheat straw incorporation. *CATENA* **2022**, *210*, 105865, doi:https://doi.org/10.1016/j.catena.2021.105865.
63. Molla, A.; Desta, G.; Molla, G.A.; Desta, G.; Dananto, M. Soil Management and Crop Practice Effect on Soil Water Infiltration and Soil Water Storage in the Humid Lowlands of Beles Sub-Basin , Ethiopia Getnet Soil Management and Crop Practice Effect on Soil Water Infiltration and Soil Water Storage in the Humid L. *Hydrology* **2022**, *10*, 1–11, doi:10.11648/j.hyd.20221001.11.
64. Dao, T.H. Tillage and Winter Wheat Residue Management Effects on Water Infiltration and Storage. *Soil Sci. Soc. Am. J.* **1993**, *57*, 1586–1595, doi:https://doi.org/10.2136/sssaj1993.03615995005700060032x.
65. Findeling, A.; Ruy, S.; Scopel, E. Modeling the effects of a partial residue mulch on runoff using a physically based approach. *J. Hydrol.* **2003**, *275*, 49–66, doi:https://doi.org/10.1016/S0022-1694(03)00021-0.
66. Akis, R.; Lal, R. Evaluation of Seasonal Effects of Tillage and Drainage Management Practices on Soil Physical Properties and Infiltration Characteristics in a Silt-Loam Soil. *Eur. J. Sci. Technol.* **2022**, 1011–1023, doi:10.31590/ejosat.1050860.
67. Adekalu, K.O.; Olorunfemi, I.A.; Osunbitan, J.A. Grass mulching effect on infiltration, surface runoff and soil loss of three agricultural soils in Nigeria. *Bioresour. Technol.* **2007**, *98*, 912–917, doi:https://doi.org/10.1016/j.biortech.2006.02.044.
68. Pan, C.; Shangguan, Z. Runoff hydraulic characteristics and sediment generation in sloped grassplots under simulated rainfall conditions. *J. Hydrol.* **2006**, *331*, 178–185, doi:https://doi.org/10.1016/j.jhydrol.2006.05.011.
69. Pan, C.; Ma, L.; Shangguan, Z. Effectiveness of grass strips in trapping suspended sediments from runoff. *Earth Surf. Process. Landforms* **2010**, *35*, 1006–1013, doi:https://doi.org/10.1002/esp.1997.
70. Bhattacharyya, R.; Smets, T.; Fullen, M.A.; Poesen, J.; Booth, C.A. Effectiveness of geotextiles in reducing runoff and soil loss: A synthesis. *CATENA* **2010**, *81*, 184–195, doi:https://doi.org/10.1016/j.catena.2010.03.003.
71. Cerdà, A.; Doerr, S.H. The effect of ash and needle cover on surface runoff and erosion in the immediate post-fire period. *CATENA* **2008**, *74*, 256–263, doi:https://doi.org/10.1016/j.catena.2008.03.010.
72. Robichaud, P.R.; Lewis, S.A.; Wagenbrenner, J.W.; Ashmun, L.E.; Brown, R.E. Post-fire mulching for runoff and erosion mitigation: Part I: Effectiveness at reducing hillslope erosion rates. *CATENA* **2013**, *105*, 75–92, doi:https://doi.org/10.1016/j.catena.2012.11.015.
73. Robichaud, P.R.; Wagenbrenner, J.W.; Lewis, S.A.; Ashmun, L.E.; Brown, R.E.; Wohlgemuth, P.M. Post-fire mulching for runoff and erosion mitigation Part II: Effectiveness in reducing runoff and sediment yields from small catchments. *CATENA* **2013**, *105*, 93–111, doi:https://doi.org/10.1016/j.catena.2012.11.016.
74. Govindasamy, P.; Mowrer, J.; Rajan, N.; Provin, T.; Hons, F.; Bagavathiannan, M. Influence of long-term (36 years) tillage practices on soil physical properties in a grain sorghum experiment in Southeast Texas. *Arch. Agron. Soil Sci.* **2021**, *67*, 234–244, doi:10.1080/03650340.2020.1720914.
75. Wang, Y.; Qiao, J.; Ji, W.; Sun, J.; Huo, D.; Liu, Y.; Chen, H. Effects of crop residue managements and tillage practices on variations of soil penetration resistance in sloping farmland of Mollisols. *Int. J. Agric. Biol. Eng.* **2021**, *14*, 164–171, doi:10.25165/j.ijabe.20221501.6526.
76. Benkobi, L.; Trlica, M.J.; Smith, J.L. Soil Loss as Affected by Different Combinations of Surface Litter and Rock. *J. Environ. Qual.* **1993**, *22*, 657–661, doi:https://doi.org/10.2134/jeq1993.00472425002200040003x.
77. Schmalz, H.J.; Taylor, R. V; Johnson, T.N.; Kennedy, P.L.; DeBano, S.J.; Newingham, B.A.; McDaniel, P.A. Soil Morphologic Properties and Cattle Stocking Rate Affect Dynamic Soil Properties. *Rangel. Ecol. Manag.* **2013**, *66*, 445–453,

doi:https://doi.org/10.2111/REM-D-12-00040.1.

78. Li, X.; Niu, J.; Xie, B. The Effect of Leaf Litter Cover on Surface Runoff and Soil Erosion in Northern China. *PLoS One* **2014**, *9*, e107789.

79. Weltz, M.A.; Kidwell, M.R.; Fox, H.D. Influence of abiotic and biotic factors in measuring and modeling soil erosion on rangelands: State of knowledge. *J. Range Manag.* **1998**, *51*, 482–495, doi:10.2307/4003363.

80. Smets, T.; Poesen, J.; Bochet, E. Impact of plot length on the effectiveness of different soil-surface covers in reducing runoff and soil loss by water. *Prog. Phys. Geogr. Earth Environ.* **2008**, *32*, 654–677, doi:10.1177/0309133308101473.

81. Miyata, S.; Kosugi, K.I.; Gomi, T.; Mizuyama, T. T. Mizuyama (2009), Effects of forest floor coverage on overland flow and soil erosion on hillslopes in Japanese cypress plantation forests. *Water Resour. Res* **2009**, *45*, 1–7, doi:doi: 10.1029/2008WR007270.