DOI: 10.17707/AgricultForest.64.1.06

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EFFECT OF SAWDUST ON SPLASH EROSION IN LABORATORY CONDITION

SUMMARY

Splash erosion is caused by the impact of raindrops on the soil surface and leads to the detachment of the soil particles. The most effective measures for reducing soil splash are the use of conditioners to improve soil aggregates stability and/or to deploy physical barriers to minimize raindrop impacts. The present study has been conducted to examine the efficiency of sawdust to reduce splash erosion rate in an 15% gradient slope with sandy-clay-loam soil in the laboratory condition, To achieve the study purposes, the soil were covered by sawdust with the surfaces percentages of 30, 50, 70 and 90% in splash cups were placed on the soil in three replicates for each control and treated conditions. A portable rainfall simulator was used to simulate rainfall with the intensity and duration of 40 mm h^{-1} and 15 min, respectively. The results of splash showed that the sawdust reduced both total and net splash.

Keywords: soil amendments, soil conservation, soil erosion, rainfall simulator.

INTRODUCTION

The splash erosion, as in other forms of soil erosion, is a function of raindrop impact energy and of aggregate stability. The most effective soil splash reduction measures are the use of amendments for improvement and reinforcement of soil aggregates and the deployment of physical barriers to minimize raindrop impacts (Kukal & Sarkar 2010 & 2011, Gholami *et al*., 2012). The sawdust is an organic amendment, that it can splash erosion control and increasing infiltration. Existing wood waste and sawdust in the North of Iran comes from wood residues from primary timber processing mills and wood residues in forest floor (Buchanan *et al*., 2002; Copeland *et al*., 2009). Despite the remarkable effort that has been made in recycling wood residues, a great amount of these materials are still being unused. Sawdust is a carbonaceous organic substance which has a very high carbon to nitrogen ratio (typically C:N in sawdust is 300:1) (Tran, 2005). In a study by Johnson (1944), tomato yield

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Paper presented at the 8th International Scientific Agricultural Symposium "AGROSYM 2017".
Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

was greater in plots where sawdust was applied as a surface mulch than in sawdust incorporated plots in the first year. Lunt (1955) obtained the bulk density decreased, moisture increased and total nitrogen and organic carbon increased in all treatments amended with wood chips as compared to check plots. Allison (1965) indicated the most wood products do not contain a concentration of toxic compounds high enough to appreciably affect their use in agriculture. Bulmer (2000) indicated the sawdust application such as trees with more rate and soil with higher organic matter level and more moisture retention relative to untreated soil.

Sawdust mulch could increase the soil oxygen diffusion rate, maintain a more uniform soil temperature, reduce the surface crusting and soil bulk density, and increase the aeration porosity and soil moisture (Johnson, 1944; Lareau, 1989; Khan *et al*., 2000; Tran, 2005). Robichoud *et al*. (2000) applied the wood chips on changing soil erosion in forest areas. They showed that the soil loss reduced with wood chips application. Elliot and Robichaud (2001) showed that the wood chips with size of large wood chips, small wood chips and mixture of wood chip sizes with rates of 80 % could control soil erosion. Buchanan *et al*. (2002), in plot scale and slope of 55 %, stated that the erosion was not significantly different in the small wood chip treatment toward control plots. Whiles, the soil erosion rates in the large wood chip and mixture of chip sizes had significantly different toward the control treatment. Lory *et al*. (2002) survived the effect of sawdust to pen surfaces on nitrogen losses and stated that the sawdust treatment retained more nitrogen in manure when removed from the pen surface and after composting. Also increasing carbon by sawdust additions reduced nitrogen losses by 21 %.

Applying wood chips and agricultural straw by Foltz and Dooley (2003) showed that the soil erosion significantly reduced in plot scale with 4 m^2 area and slope of 5 %. They stated that the straw and two types of wood chips (width of 4 and 16 mm) and two types had lengths of 60, 120, and 240 mm were equally effective in reducing erosion by over 98 %. Yanosek *et al.* (2006) evaluated performance of wood chips in erosion control with two slopes, two soil textures, and three cover amounts. The soil loss to 70 % was reduced in comparison to bare soil, for all cover amounts tested and among each soil type, slope and flow event. Foltz and Wagenbrenner (2010) evaluated of three wood chips blends at 50 and 70 % ground cover for post-fire erosion control on small plots. There was no difference between application rates of 50 and 70% for either of the rainfall plus concentrated flows tested. León *et al.* (2015) in the Zuera Mountains, near the city of Zaragoza (Spain) evaluated the effect wood chips on splash erosion after wildfire and they stated that the wood chips could decrease splash erosion.

The existing literature studied the effectiveness of sawdust only in soil quality. But studies on the efficacy of sawdust on changing splash erosion in rangeland condition did not record. Therefore, this study aimed to determine the efficiency of sawdust with cover 30, 50, 70 and 90 % on splash erosion in laboratory condition.

MATERIAL AND METHODS

The experiments were conducted using splash cups in Laboratory condition using rainfall simulator. A sandy-clay soil was collected of rangeland, Alborz Mountains, Northern Iran. The collected soil was then prepared to be applied to laboratory condition (Thompson, Beckmann 1959; Loch, Donnollan, 1988; Kukal, Sarkar, 2011). The pH, EC and organic matter of experimented soil were 7.32, 74.1 µmohs cm^{-1} and 1.92 %, respectively.

To achieve the study purpose, the sawdust was selected and tested in the laboratory experiments with the cover of 30, 50, 70 and 90 % and then spreading at the surface of soil (Kukal, Sarkar, 2011, Sadeghi *et al.*, 2015a, 2015b).

In this study, three splash cups (Morgan, 1978) were used to measure splash erosion. The splashed sediment samples have been collected from upward and downward segments (Gholami *et al.*, 2013, 2014, Sadeghi *et al.*, 2015a) of cups in each treated and control plot, with the intensity of 50 mm h^{-1}. The splash sediments were then measured using decantation procedure and oven drying at 105 ^{o}C for 24 h and weighed by means of high-precision scales (0.001 g) (Sadeghi *et al.*, 2015b; Gholami *et al.*, 2016).

RESULTS AND DISCUSSION

The results of splash erosion before and after sawdust application with rates of 30, 50, 70 and 90 % are shown in Table 1.

Table 1. Net and Total splash erosion (g m^{-2}) resulted from treated control conditions

Plots	Cup No.	Net Splash	Net Splash
Control	1	102.30	158.68
	2	118.90	195.92
	3	95.79	172.43
Average		105.66	175.68
Standard Deviation		11.92	18.83
30	1	93.08	145.49
	2	85.41	152.93
	3	72.92	109.28
Average		83.80	135.90
Standard Deviation		10.18	23.35
Conservation		20.69	22.64
50	1	91.26	136.04
	2	58.84	89.37
	3	69.22	124.96
Average		73.11	116.79
Standard Deviation		16.56	24.38
Conservation		30.81	33.52

70	1	64.04	111.64
	2	59.21	88.32
	3	83.36	131.92
Average		68.87	110.63
Standard Deviation		12.78	21.82
Conservation		34.82	37.03
90	1	78.38	79.69
	2	61.42	98.86
	3	49.59	112.32
Average		63.13	96.96
Standard Deviation		14.47	16.40
Conservation		40.25	44.81

The results of Table 1 show that the sawdust could decrease splash erosion (Gholami *et al*., 2013; Sadeghi *et al*., 2015a, 2015b) the decreased rates were from 21.57 to 46.65 % in net splash erosion from 22.64 to 44.81 % in total splash erosion. The sawdust had the significant effect on reduction of net and total splash erosion at level of 95 and 99 percent, respectively. The reduction of splash erosion using sawdust could finally decrease soil erosion, Robichaud *et al*., (2000), Elliot, Robichaud (2001), Foltz, Wagenbrenner (2010) and León *et al*. (2015) stated the wood chips could control soil erosion. The results of statistical comparison by applying paired t-Test also verified the significant difference between treated and control plots (p=0.001). The results also showed that the sawdust had significant effect in short period after applying on splash erosion. Yanosek *et al*. (2006) and Gholami *et al*. (2013) also reported that the rice straw and wood chips were impressive in a short period.

CONCLUSIONS

The present study was conducted for the study of sawdust effect on splash erosion in laboratory condition. The results showed that the sawdust could protect the soil aggregates from direct impact energy of raindrops. When splash erosion is reduced, the amount of erosion declined and consequently sediment yield decreased. It can finally be mentioned that the sawdust can provide good effects in reduction of splash erosion.

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