Solid Earth Discuss., 6, C610–C622, 2014
www.solid-earth-discuss.net/6/C610/2014/

Solid Earth
Discussions
Open Access

Interactive comment on "Coffee husk mulch on soil erosion and runoff: experiences under rainfall simulation experiment" *by* H. Moreno-Ramón et al.

H. Moreno-Ramón et al.

hecmora@prv.upv.es

Received and published: 16 June 2014

Dear referee, first of all, thank you for your comments and suggestions. Below, we have replied all the questions that you had.

The paper describes a study evaluating coffee-husk mulch as an erosion and runoff mitigation technique. The experiment compared runoff and erosion rates across three levels of mulching (none, surface application, and integrated in the soil), four soils, and two crusting classes (without and with rain crust).

Coffee husks appear to be an effective mulch for reducing runoff and erosion at the plot scales, and using the residue as a mulch could be a useful application. I am not aware of coffee husk residue being tested as a mulch in other work, and the study also

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

addresses the impacts of the presence of soil crust on runoff and erosion. Despite the novelty of the material being tested, the contributions to our understanding of the effect of mulches or soil crusting on hydrologic and erosion responses are not clear. This should be better explained in the discussion of the results. The scientific significance of this work is fair as presented and may be elevated to good if the authors can improve the discussion of the results.

The presentation of the work is poor and requires substantial revision. There are many grammatical errors, and these often make the results difficult to interpret. The authors should have the manuscript edited to improve the presentation in English, especially with regard to sentence structure and reducing redundancy.

The methods, results, and discussion are unnecessarily brief, and this makes the study hard to interpret and the scientific quality of the paper poor. The results could not be replicated given the current description.

As a general comment, we have read all your comments and we have improved the article with the aim to clarify your doubts. The English have been revised throughout all the paper.

Some of the major issues in the study are:

There is no mention of the antecedent soil moisture condition, except that half the plots had rain applied to form a crust. Were the non-crusted plots wet without crusting? Or were the crusted plots dried to the same soil moisture after the crusts were formed? If neither case, the crusting may be confounded with the soil moisture condition, which would also affect runoff and erosion the results.

At the moment of the rainfall simulation all the soils were dry. The crust was created during 6 months and after that, the trays were left at ambient temperature. The natural drying process acted over the soils.

We added that information in the text.

SED

6, C610–C622, 2014

"When the damping cycles were finished, soil trays were left at ambient temperature until they were completely dry"

It is not clear whether the crust-forming rainfall was applied after the mulch was incorporated or if the mulch was incorporated after the crust was formed. If the B treatment was applied after the crusting, then the crust would be disturbed by the mulching and this combination would not be comparable to the others. A more concise presentation of the sequence of presentation of the plots is necessary to understand the experiment.

Thanks for your advice. In that regard, we have modified and changed the paragraphs to a better understanding in methods section.

"According to previous studies (Prats et al., 2012; Montenegro et al., 2013), the soil coverage percentage was 80-85 % in the S and B trays. To obtain the same cover, an amount of 0.73 kg m-2 of coffee residue on the S trays and a 1.6 kg m-2 on B trays (0.05 m of depth) were deposed and mixed respectively before the crust formation. The same cover surface percentage was chosen with the aim to avoid an interference in the erosion results due to the different amount of residue on the soil surface. Fideling et al., (2013) concluded that a small amount of residue applied on the soil surface, can dramatically cut down the runoff. In concordance with Leys et al., (2010) it is necessary about 2 or 3 times more material in buried treatments to achieve the same percentage of soil cover. This larger dose of coffee husk in the buried treatment increased the amount of soil organic matter. Therefore, it affected the aggregate stability and other physical properties that control water movement behavior in the soil. Anyway, the organic matter content in the coffee husk was low (2.5%) because it had a higher content of inorganic compounds. In this case our priority was to obtain the same soil surface protection by the residue against the erosion forces. Once the trays were prepared, one of each treatment pair was periodically dampened for a period of 6 months to generate surface crusts (Figure 1). At least, 5 cycles of wetting-drying were applied monthly. Distilled water was sprayed on the soil surface to avoid the runoff generation. When the damping cycles were finished, soil trays were left at ambient temperature

SED
6, C610–C622, 2014

until they were completely dry. They were placed at 12% of slope under the rainfall simulator. Erosion trays were prepared without stones or vegetation that protect soil from the direct impact of rainfall drops. Slope and vegetation conditions (12% and 0% respectively) reproduced the unfavorable soil condition, which is common in agricultural areas. The laboratory layout was provided with a collector system at the end of the tray, which collected the runoff (Figure 1)."

The methods indicate the Shapiro-Wilks test was used to test for normality. But Tabl 4 shows that the means for the sediment loss and concentration were very different from their medians, which is a very coarse indicator for non-normality. Were these data normal? If not this should ANOVA analysis should be revised, using either non-parametric methods, data transformation, or a statistical model that can accommodate non-normal distributions. Since some of the interactions were significant, the groups should not be pooled in the statistical analysis.

Thanks for your comment. As you says, the data are not normal, so in that situation is necessary to use non parametric methods. It was a mistake in our paper, but now we have used non parametric methods: Mann-Whitney and Kruskal-Wallis for determining the statistically significant influence among the factors and the measured variables. The values of statistically significance have been similar, and you can see in the table below.

(The table is added in the attached document)

Factors Levels Time to runoff Runoff Infiltration rate Soil loss Sediment Concentration (min) (mm) (mm h-1) (g m-2) (g l-1) Treatment Superficial 2.20 b* 20.87 a 47.98a 235.04 a 11.47 a Buried 2.69 b 12.48 b 77.09 b 121.92 b 10.63 a Control 0.62 a 23.24 a 46.10 a 1084.07 c 46.19 b Soil condition Without crust 2.25 a 15.57 a 65.94 a 389.50 a 22.43 a With crust 1.42 b 22.16 b 48.19 b 571.18 a 23.09 a Soil class I 1.99 a 18.19 a 55.89 a 644.07 a 30.66 a II 1.92 a 20.62 a 52.89 a 431.61 a 19.66 a III 1.5 a 16.52 a 65.52 a 334.26 a 16.26 a IV 1.97 a 20.14 a 53.94 a 511.44 a 24.48 a

SED
6, C610–C622, 2014

The text in the discussion section is:

“The data were statistically analyzed by non parametric methods because the set of data did not show a normal behavior with the Shapiro–Wilk test. The Mann-Whitney and Kruskal-Wallis tests were applied to the data with the aim to find the relationships among the factors (categorical independent variables) and determined parameters (quantitative dependent variables). The statistical significant differences were tested at 0.05 and 0.01 level. The analyses were completed using the computer software package SPSS and Statgraphics Centurion XVI.I.”

The presentation of both infiltration and runoff and sediment concentration and soil losses is a bit redundant and could be simplified.

We have changed the section order:

1. - We have added one new section (according to one referee): 3.1 Soil characteristics. 2. - We have joined time to runoff and runoff in one section called: 3.2 runoff 3. - We have described the infiltration rate in another section, because although it is a calculated parameter by Horton equation: 3.3 Infiltration rate 4. - We have joined soil loss and sediment concentration in one section: 3.4 soil losses.

With this new distribution we have been able to summarize ideas and improve the discussion.

The discussion points do not show the importance of the study nor do they put the work in proper context of other work relating to mulching of agricultural soils.

We have improved the discussion.

The conclusions are mostly based on the results, but they are overly brief and do not address all of the key findings of the study.

We have changed the conclusions according to the objectives: The outcomes of this study show clearly that coffee husk could be used as a mulch to reduce soil erosion

SED
6, C610–C622, 2014

problems. 1. The coffee husk can be used as an erosion protector because it increases the infiltration rate, decreases the runoff amount, and the time to runoff is delayed. In the same way, soil loss and sediment concentration decrease after coffee husk application. 2. The residue shows a higher efficiency when it is buried because it stimulates an improvement in soil quality parameters and it obtains the best outcomes in all the studied variables. When the residue is spread on the surface, the soil quality is improved at lower degree and the results do not show a good improvement on runoff depth and infiltration rate. In these cases the soil response is similar to the control treatments. 3. Coffee husk cannot cushion the effect of crust. In crusted soils the action of burying or spreading the coffee husk does not get to maintain the same response of soil against the rainfall. 4. The differences among the studied soils (salinity, organic matter content, etc.) do not show statistically significant differences. However coffee husk improves the soil quality and therefore it has been a good improver for that type of soils. As a general conclusion, on the one hand, coffee husk reduces soil losses, sediment concentration and runoff depth; and on the other hand, it increases the time to runoff and infiltration rates, so it can be used as mulch for soil protection against erosion. With low mulch application rates (1.6 kg m-2) and under loamy textured soils, the outcomes have been satisfactory. By these reasons, future detailed studies will be necessaries for determining the effectiveness of this byproduct in field conditions

Specific comments:

p. 1128 line 16-17 needs a reference.

The reference is: (Montgomery 2012 and Hockbridge, 2012). We had rewritten the reference in one bracket, but now we have changed:

“It is estimated that 20 million km2 of agricultural lands are affected by soil erosion in the world, and 1.3 million km2 are affected by water soil erosion in Europe (Montgomery, 2012; Hockbridge, 2012).”

p. 1128 line 1 there are many references relating use of mulches in burned areas, any

SED
6, C610–C622, 2014

of which would be more relevant than Leon et al. 2013 that relates to effects of ash cover.

We have revised and refined the text. We removed those citations that we have considered redundant.

p. 1129 line 26-27 could be a discussion point.

We have added that point to our discussion and we have related with physical soil properties.

p.1130 line 10-11 the point is not clear

It is a reference of Bielders et al. (1996), but we have changed the sentence because it was not the idea that we wanted to reflect: The new sentence is:

“Bielders et al. (1996) concluded that mulch can be the main cause that affects the thickness and crust type in soils”

p. 1131 line 6. I suspect that infiltration rate and sediment concentration were calculated. If so the method should be stated. (see 1133 line 13)

In that regard, the method to calculate the infiltration rate is defined in the P.1133 line 19 . We used the Horton equation:

“The Horton (1940) equation was used to estimate the infiltration rate (mm h-1), and the steady state infiltration rate after one hour (K1h) was calculated. This parameter is the infiltration rate when the soil is completely saturated under a constant rainfall intensity. In the experimental conditions, at 1 hour, all the erosion trays raise this situation. Previous studies have demonstrated the efficiency of Horton’s regression for the determination of the infiltration rate at saturation conditions (Ibáñez, 2001; Telis, 2001; Hsu et al., 2002).”

The other variables are now defined in a new paragraph:

"The runoff was picked up in plastic containers at intervals of 3 minutes. Seven volumes were taken during the 21 minutes of each rainfall simulation. Subsequently, the runoff was filtered in a calibrated paper that had been previously gauged and the solid losses were determined by the gravimetric method. The total runoff (mm) was calculated by adding the seven volumes generated. Both data, water volumes and sediment weight were used to calculate soil losses (g m-2) and sediment concentration (g l-1)."

p. 1131 line 9 state the general location of the river

We have added the location:

"The rainfall simulations were carried out on air-dried soils samples collected in the river Turia alluvial plain (Valencia-Spain)."

p. 1131 line 12 how were the different soils selected?

We showed the soil characteristics in table 1. In addition, the text showed the principal and different characteristics among them in concordance with the advices of some referees:

"Table 1 illustrates the main characteristics of used soils. Soil III was the most saline (ECe= 7.89 dS m-1) whereas soil I had the highest content of organic matter (OM= 6.27 %). Soil II had the largest water storage capacity, in contrast with soil IV that showed the lowest (9.42 – 6.88 % respectively)."

p. 1132 line 5 the mulch dimensions are quite small. It would be useful to know how much mulch was removed in the simulations, even if this was not rigorously measured. Discussion about the movement of the mulch in the presence of other forces (wind, rilling) or the degradation of the mulch over time would also aid in the application of this mulch as an erosion control practice.

Thanks for your suggestion. The error in measurements due the coffee husk losses have been calculated and it was less than 1% in weight, so it is not important. In the same way, during the experience we observed a movement of coffee husk in the trays

due to the diffuse erosion, but the coffee husk was retained in the trays. In that sense the objective of this paper was to assess the mulch against hydric erosion, and could be an interesting way to research about the effect of wind or rilling in the future.

p. 1132 line 6 how was the soil packed in the trays? Was the soil bulk density measured and consistent across all trays?

We have changed the soil trays preparation section, and we have explained it. In reference to the bulk density, it was measured at the beginning of the experience and at the end. The same actions were done with porosity and aggregates stability.

p. 1132 line 13-15 it is incorrect to say that previous research agrees with the current study. Rephrase to indicate you followed the guidance of the previous work.

Thaks for your advice. We have changed this sentence.

“In concordance with Leys et al., (2010) it is necessary about 2 or 3 times more material in buried treatments to achieve the same percentage of soil cover”

p. 1132 line 15-17 were these attributes measured after the incorporation of the mulch? If so report the values, and if not delete or provide a citation.

We measured these parameters, and now we have added in the review article in a new table.

Soil Class Treatment Porosity (%) Aggregate stability (%) I Superficial 51.75 5.73 Buried 60.00 25.20 II Superficial 48.50 5.73 Buried 51.70 12.91 III Superficial 46.00 6.43 Buried 50.00 19.18 IV Superficial 45.00 9.44 Buried 47.65 14.88

p. 1132 line 20-23 should be in the introduction and not methods.

According to your advice, We have changed these sentences to the introduction section.

p. 1132 line 24-27 should be combined and moved to the preceding paragraph.

SED
6, C610–C622, 2014

Thanks for you advice. We have changed the order for a better understanding.

p. 1132 line 28 fig. 1, while quite informative, does not show the collector system.

We have changed the figure, and in one of them you can see the collector system

Table 2 would be more informative if it showed the actual values and the significance for each interaction. Since some interactions are significant the groups should not be pooled. Table 3 is unnecessary.

Thanks for your advice. We have removed the table 3 and we have prepared a new table with the physical improvements. The table n°2 reflects now the statistically relationships and influence between the variables and the factors

p. 1135 lines 3-4 are unclear.

It was a mistake when we prepare the text. It was removed.

p. 1135 line 8 it is not clear which treatment(s) had significantly different infiltration rates.

We have changed this paragraph for a better understanding.

“The infiltration rate showed a great increase in B treatments compared to S and C, and by this reason the treatment factor was statistically significant ($p<0.01$). S and C registered similar outcomes (Figure 2a and 2b) and B improved the infiltration rate by 60.7% and 67.2% (S and C respectively).”

p. 1135 lines 18-19 are speculative,f as the study did present the effect of the mulch on the soil properties.

We have added the data of the new table 3. This is a part of the discussion:

“Authors like Thierfelder and Wall, 2009 and Thierfelder et al., (2013), indicated that the non-tillage/mulch combination (surface application) resulted in the development of biological activity and the presence of roots, which increased the preferential flow and

SED
6, C610–C622, 2014

therefore the infiltration rate. In our study, the infiltration rates increased, but there were not vegetation and biological activity development in the simulation trays, so it did not generate preferential channels for water movement. The residue application improved soil quality as you see in the previous section, and by this reason the unique way for water infiltration was the increase of the matrix flow."

p. 1135 lines 21-25 are unclear.

We have rewritten the discussion text and soil class was not significant

"In reference to soil class factor, although soil III showed the highest infiltration rate, the factor was not statistically significant."

p. 1136 lines 8- 9 say that crusted soils and uncrusted soils both reduced the infiltration rate. This is counter intuitive and contrary to 1135 lines 13-14.

In that paragraph we wanted to explain the coffee addition over the crust effect. In that sense we wanted to reflect an average data (B and S treatments) in crusted soils against C data (crusted) and the same way to non-crusted data. It was a bad sentence, and now we have rewritten for a better understanding.

"In any case after residue addition, crusted soils (average value of B-WC and S-WC) reduced on average the infiltration rate 15.15 mm h-1 respect to bare crusted soil (C-WC), whereas non-crusted treatments (average value of B-WOC and S-WOC) decreased 17.84 mm h-1 respect to C-WOC (Figure 2a and 2b). Coffee husk addition did not avoid the crust effect over infiltration rate."

p. 1136 lines 11- 13 Figure 1 has a nice photo of the soil crust for a soil, but since the soil type and treatment for the soil in the photo are not identified or compared to other soils/treatments the photo does not support the statement that the high silt content in soil I produced thicker crusts.

We understand your suggestion, but it is impossible to add a set of photos with all the analyzed situations. By these reason the reference to figure 1 has been removed.

SED
6, C610–C622, 2014

Table 2 the values for runoff and average infiltration rate do not add up to the applied amount of rainfall. Perhaps this is due to the modeling of the infiltration rate using the Horton equation. The modeled and actual infiltration rates should be compared or the error (in modeled values, measured values, or applied rainfall rates) should be addressed.

You have reason. These data do not match because the runoff as the experience is after 21 min of rain while the infiltration rate is estimated after 1 hour (K1h). In that sense, the infiltration in 60 minutes is less than 21 min. In our experience we decided to estimate K1h because at that moment, the soil saturation conditions were stable.

Sections 3.2 and 3.3 are largely redundant as the runoff and infiltration rates are complements. I don't see the value in presenting both analyses.

We have rewritte the sections and separated the discussion in two different ways.

p. 1138 line 1-3 if the interaction between treatment and crusting did not produce significantly different sediment concentrations then why indicate the specific crust-treatment combinations that produced the highest and lowest sediment concentrations? The earlier statements are sufficient.

According to your suggestion, we have modified the text and avoided the redundant information.

p. 1138 lines 4-20 are hard to follow as there are several points introduced in this single paragraph. Also this discussion would benefit from more explicit and clear presentation of the differences in the soil properties as they relate to the sediment concentration results. Also, the magnitude of the possible error of the inclusion of the husks in the sediment losses should be quantified. Additional discussion of the results for the crusted plots where rilling occurred would be useful.

We have improved the discussion and related with soil losses.

p. 1138 lines 21-28 and p. 1139 lines 12-18 the studies by Groen and Woods and Prats

SED
6, C610–C622, 2014

et al. were in burned soils and are not directly comparable to the current study. The site details, especially the soil conditions, in the other cited works vary dramatically, and more explanation of the conditions would be useful to put the current study's results in context.

We have added more information about the study conditions. There was no data about coffee husk, and we have to compare with other mulch situations. However we have added several experiences like Gholami et al. 2012 to the new discussion.

p. 1139 line 25 the presentation of the results is not sufficient to conclude that the residue is most effective at reducing soil loss in soils of low quality.

We have added information about soil quality that reflects our idea.

p. 1140 line 15 the soil loss was always greater than zero so the word 'avoided' should be deleted. The conclusions are overly brief and condensed. Specific statements about the effects of each factor (mulching, crusting, soil type) should be presented for the runoff and sediment

We have improved the conclusion section as you can see in the previous point of this document.

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/6/C610/2014/sed-6-C610-2014-supplement.pdf

---

Interactive comment on Solid Earth Discuss., 6, 1127, 2014.