A STUDY ON THE INFLUENCE OF SOIL CONDITIONER ON THE RATE SOIL LOST USING A RAINFALL SIMULATOR

Mohammad Davajd
Faculty of Agriculture, Gachon Mada University

The effect of Unifarm\textregistered\textsubscript{ACL} (UF) soil conditioner on prevented erosion on Red Yellow Podzolic Soil was studied in this experiment. Soil samples were taken from the surface (S) and subsurface (B) layers. The length of the slope was 50 cm and the intensity of rainfall applied was 50 mm/hr. This experiment was carried out at 3% slope degree. This experiment was conducted in the laboratory using a rainfall simulator equipment.

The result of this experiment pointed that the UF soil conditioner could reduce the erosion processes by splash and runoff erosion on both surface and subsurface soil samples. The influence of soil conditioner on surface soil was greater than on subsurface soil. It meant that surface soil is less susceptible to erosion than subsurface soil.

INTRODUCTION

Rainfall simulators are research tools designed to apply water in a form similar to natural rainstorms (Meyer, 1988). Field plot experiments on soil loss measurement depend upon natural rainfall, which is always unpredictable and frequency preserve (Hudson, 1971). Nowadays, rainfall simulation equipment is one of the important instruments in soil erosion and hydrologic experiments. However, rainfall characteristics must be simulated properly, data analyzed carefully, and results interpreted judiciously to obtain reliable information on the conditions to which the simulated rainfall are applied.

This instrument is used not only in the laboratory but also in the fields. This instrument has four main advantages, which are all very important.

1. The speed of the research is greatly accelerated since the results are no longer dependent upon waiting for the right kind of rain to come at the right time.
2. The efficiency of the research is increased by control of one of the most important variables, it is longer necessary to interpolate or extrapolate the results from the strip which most matched the requirements, meaning that the same storm can be created over and over until the results have been tested and confirmed. The last one is more adaptable than natural rainfall research. These advantages, naturally only accumulate from the use of an efficient simulator, and this might be defined as one which can reproduce, accurately and repeatedly, artificial rain which will have precisely the same effect on the soil as natural rain. The design objectives of simulators have therefore changed with better knowledge of the features of rainfall which cause erosion.

Formally, the rainfall simulators were designed only to apply a given quantity of water. Then the next stage was concern to apply it at intensities comparable with real rain. From about 1940 on the size of falling raindrops was known, so the design objective becomes to reproduce the drop-size distribution of natural rain. Around 1950 it was shown that erosion is linked with
The influence of soil conditions on the kinetic energy, and so the simulator was expected also to reproduce this characteristic. This steady increase in knowledge of what the rainfall simulator should be trying to do, has made them increasingly effective. Today there are a number of really efficient models available to the conservation research worker, and they form one of his most valuable tools. The rainfall simulator of the laboratory of the "Groenestijn voor Bodemfysika, Faculty van de Landbouwwetenschappen, RUG" was intended for laboratory use. It can be used in studies of factors that influence the water erosion processes except in plant management factors. Gabriels (1974) in his doctoral thesis described this rainfall simulator and its applications in determining factors of water erosion processes.

**MATERIALS AND METHODS**

The soil used in this study was Red Yellow Podzolic soil that came from West Kalimantan, Indonesia. The soil samples were taken from the surface (S) and the subsurface (B) layers. The preparation of soil sample was done by dry sieving method. Three classes of aggregates 8.3-4.2 mm, 4.2-2.8 mm and 2.8-2.0 mm in diameter were separated. These were mixed each other in proportion 35%, 35% and 30% respectively. The rainfall simulator usually needs distilled or free ion water, the latter is used in this study.

Rainfall intensity was measured by a rain gauge before and/or during the experiment. Four different lengths of soil run off container: 30 cm, 45 cm, 55 cm and 90 cm were available in the equipment as well as the splash board for measuring the splash erosion. The runoff materials was measured every 10 minutes and its aggregate distribution was determined directly by wet sieving method. Seven classes of aggregated were distinguished as follows: (1) > 2 mm, (2) 2.0-1.0 mm, (3) 1.0-0.5 mm, (4) 0.5-0.3 mm, (5) 0.3-0.15 mm, (6) 0.15-0.075 mm, (7) < 0.075 mm.

The splash material measured as total amount of splash material during the experimental period. Duration of the experiment was 2 hours rain period for each treatment. Kinetic energy of the rainfall is derived from its drop velocity and mass of water that fall on the soil. The formula is as follows:

\[
KE = \frac{1}{2} MV
\]

Where:
- \(KE\) = kinetic energy
- \(M\) = mass of water
- \(V\) = velocity of raindrop

\[
M = I \times A
\]

Where:
- \(I\) = rainfall intensity
- \(A\) = area of soil container

The drop velocity is derived from its diameter and falling height. A drop diameter is derived from the volume of a single drop that can be measured directly. Falling height of drop can also be measured directly. To predict a drop velocity usually the monograph of LAW is used as it is shown in figure 1 (Gabriels, 1974).

Table 1. A schematic lay-out of the combinations of the experiment and code of plots of the soil treatment

<table>
<thead>
<tr>
<th>Layer</th>
<th>Untreated (G)</th>
<th>Treated (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface (S)</td>
<td>ST</td>
<td>ST</td>
</tr>
<tr>
<td>Subsurface (B)</td>
<td>SU</td>
<td>SU</td>
</tr>
</tbody>
</table>
Washed and splashed materials are dried by hot plate before they are weighted. The experimental design of this study can be simplified as shown in table 1.

The 50 mm/hour rainfall intensities was applied in this study and the only 50 cm length of the soil container was applied.

![Figure 1. Relationship between drop diameter and drop velocity at different falling height.](image)

Total number of the experiment combination are 4. All of them were treated in 33% slope degrees. The soil samples were taken from the surface (S) and the subsurface (B) layers. Ureaformaldehyde (UF) was applied as a soil conditioner in a dose of 100 g/m². Thus the experiment comprised four combination as follow: (1) SU-surface layer soil, untreated, (2) ST-surface layer soil, treated, (3) BL-subsurface layer soil, untreated, (4) BT-subsurface layer soil, treated.

The length of the runoff container was 50 cm and the intensity of rainfall applied was 50 mm/hr. The period of one experiment run was 50 minutes and the measurements were carried out every 15 minutes, both for the runoff and the splash material. The aggregate distribution was performed only for the runoff material.

RESULT AND DISCUSSION

The results of the first experiment are shown in table 2 of this report. Time to runoff or runoff threshold is duration of rainfall, in minutes, to start runoff. It is one of the most important hillslope hydrological parameters governing the initiation of interrill wash and the eventual development of rills (Deppey and Bryan, 1985). Time to runoff (Tr) is longer than the time to ponding (Tp), and (Tr - Tp) can be significant especially on tilled fields with a pronounced microtopography. Time to runoff is related to infiltration rate (fr), hydraulic conductivity (k), and the rainfall intensity (IR). It is also influenced indirectly by the soil properties and slope.

Generally, the influence of rainfall is clear enough, while the influence of slope length is not so clear. The time to runoff is more than 25 minutes in the lowest intensity for length slopes. It was longer than in the medium and highest intensities which were less than 10 minutes for all of the slope length. It was very possible that the soil saturation and water percolation longer slopes was faster to reach due to greater quantity of water. The time to reach nearly constant runoff was longer in the lowest intensity than in the medium and highest ones. It appeared about 65-70 minutes after rainfall started. Whereas in the medium intensity it was about 20
The Influence of Soil Conditioner

minutes and for high intensity it was constant directly the runoff started. The results of the experiment is summarized shown in table 2. In general UF soil conditioner reduce the erosion processes: i.e. splash and runoff erosion - both surface and subsurface soil samples. The influence of soil conditioner on surface soil was greater than on subsurface soil. It means that surface soil is become less susceptible to erosion than subsurface soil. It also could be seen that the erosion on untreated subsurface was greater than on untreated surface soil. In treated surface soil, soil loss due to runoff erosion was higher than splash erosion. Other treatments were not so much differentiated between soil loss due to runoff erosion and splash erosion. In the early rainfall the soil loss on treated soil very small and become greater after more than 75 minutes execution.

<table>
<thead>
<tr>
<th>Interval (minute)</th>
<th>SU</th>
<th>ST</th>
<th>BU</th>
<th>BT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>0.08</td>
<td>0.38</td>
<td>0.24</td>
<td>1.17</td>
</tr>
<tr>
<td>15-30</td>
<td>20.84</td>
<td>18.57</td>
<td>1.00</td>
<td>4.74</td>
</tr>
<tr>
<td>30-45</td>
<td>29.94</td>
<td>21.56</td>
<td>3.49</td>
<td>9.21</td>
</tr>
<tr>
<td>45-60</td>
<td>29.16</td>
<td>30.43</td>
<td>5.40</td>
<td>10.41</td>
</tr>
<tr>
<td>60-75</td>
<td>27.27</td>
<td>25.06</td>
<td>7.67</td>
<td>10.31</td>
</tr>
<tr>
<td>75-90</td>
<td>26.96</td>
<td>24.54</td>
<td>10.27</td>
<td>12.65</td>
</tr>
<tr>
<td>Total</td>
<td>136.35</td>
<td>123.94</td>
<td>20.67</td>
<td>48.44</td>
</tr>
</tbody>
</table>

Note: SU: surface soil layer, untreated
ST: surface soil layer, treated by 100 g/m UF soil conditioner
BU: subsurface layer, untreated
BT: subsurface layer, treated by 100 g/m UF soil conditioner
R: runoff erosion (soil loss) in gram
S: splash erosion (soil loss) in gram

CONCLUSION
On the basis of the studies worked out the following conclusions can be drawn that,

1. The rate on 100 g/m UF soil conditioner showed a good effect on surface samples of the Red Yellow Podzolic soil, while on subsurface samples it was not clear. It can be supposed that applying higher rate of soil conditioner might show significant effect on subsurface layer.

2. The influence of soil conditioner on soil loss became less effective after the rainfall take place in a long time.

REFERENCES
De Vreeschauwe D., R. Lal & M. De Boodt (1978). Comparison of De- 
schability Indices in relation to Soil Erodibility for Some 
Important Nigerian Soils. Pedologie xxviii, 1, p. 5-26, 2 fig, 6 
tab. Ghent.

Gabriel, Donald (1974). Studie van Het 
Water erosie proces Door 
Middel van Regenvalsimulatie op 
at dan Niel Kunstmattig 
Gestruktuurde Grond.

Tuinhouw bodemkunde, 
Fakulteit Von de Land 
Bouwswetenschappen, 
Rijksuniversiteit Gent.

Gabriel, D.M. De Boodt, & W. Minjaaw 
(1973). Discription Of A 
Rainfall Simulator For Soil 
Erosion Studies. Meded. Fakulteit 
von de Landhouw Wetenschappen 
Reksumversitit, Gent. XXXVIII, 
(2), 294-303.

Gabriel, D, W.C. Moldenhauer & Don 
Kirkham (1973). Infiltration,

Hydraulic Conductivity, and 
Resistance to Water Drop Impact 
of Clod Beds as Affected by 
Chemical Treatment. Soil. Sci., 

Gabriels, D. & W.C. Moldenhauer 
(1978). Size Distribution of 
Eroded Material from simalated 
Rainfall. Effect a Range of 

Hudson, N.W. (1957). The Design of 
Field Experiments on Soil 
Erosion. J. Agric. Eng. Res. 2 (4), 
1957.

Hudson, N. (1971). Soil Conservation, 
Cornel Univ. Press, Ithaca, New 
Yok, 328 pp.

Scientific Publishing Co. 
Amsterdam, Oxford, N.Y., 547 
pp.