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Influence of Different Mulches and Combination of Biochar and Sawdust Ash on Soil Permeability

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Abstract - *Permeability is defined as the ability of a porous media to transmit fluids. The stability of a structure is also depends on the amount of moisture under the soil. This paper is focused on the impact of addition of different mulches and combination of biochar and sawdust ash on soil permeability. Soil sample was collected from Vadavathor dumping yard site, Kottayam, Kerala. Site soil was examined initially and different combinations of both the adsorbents and mulches were added into the soil. The coefficient of permeability of the soil samples were determined using falling head method. The results showed that* ***k*** *value of the sample reduced for different combinations due to the action of cations, which hindered the flow of water. Mulches like straw, rubber, cardboard, woodchips were placed into the soil at different thickness(2cm, 3cm, 4cm -height) and adsorbents were added for a maximum of 4cm height(1cm-1cm,1cm-2cm,1cm-3cm,2cm-1cm,2cm-2cm,3cm-1cm). Both the mulches and combination of adsorbents showed a reduction in permeability.*

Key Words: Permeability, Mulches, Adsorbents, Combination, Biochar, Sawdust ash.

1. INTRODUCTION

There exist various measures for altering the permeability of the soil. Soil permeability is basically a measure of the ease with which water can flow through a soil. Permeability depends on porosity – the higher the porosity the higher the permeability. It is one of the most important geotechnical parameters that determine the behaviour of the soil. The three main parameters that determine the soil characteristics are shear strength, settlement and permeability. If the coefficient of permeability (k value) of the soil is higher, it shows that the passage of water through the sample is easier, there offers less resistance to the flow of fluids. There are many materials available in the market for altering the permeability. Reducing the ease with which the water can flow into the soil, that is reduction of permeability using locally available low cost mulches is an effective way.

Mulching is the process or practice of covering the soil/ground to make more favorable condition for improving soil characteristics. Mulch technical term means covering of soil, while natural mulches such as leaf, stray, dead leaves and compost have been used for centuries. Mulching effects are physical (infiltration, improved water-holding capacity, soil structure and if decomposing organic material is correctly incorporated into the soil it also has a positive effect on aeration), chemical (soil pH, release of small amounts of nutrients, decomposing) and biological (temperature regulation for increasing microorganism activity)[1].

Rubber powder was usually taken from recycled rubber from automotive and truck scrap tires. Crumb rubbers were obtained from tyre manufactures. Cardboard mulches saves water loss through evaporation. It prevents soil compaction and maintains balanced soil temperatures. Straw mulch is organic. It is convenient to use and it also maintains soil moisture. Straw is collected from nearby field. Wood chips prevent weed growth and reduce light passage.

Mulches chosen for this study include straw, rubber, cardboard, woodchips. The materials were collected from the local market nearby.

Adsorbents selected for this work were biochar and sawdust ash. Sawdust is the term given to the product formed after cutting the wood log. It occurs in various sizes and shapes. It occurs in abundant quantity. Such a large amount of sawdust waste is mostly fed to landfill disposals [2].

Therefore effective utilization of sawdust ash is of great importance. It can be used for reducing the permeability of the soil. Waste sawdust ash is sourced from a sawmill.

Biochar is a kind of charcoal made from the pyrolysis of a wide range of biomass feedstock, including crop, wood and yard wastes, and manures etc. It is also interesting because it has been demonstrated to improve soil quality and crop growth [3].It can be also used for lowering the permeability of the soil. Biochar required for the study is obtained from wood ash. Logs of wood are sourced from a local timber mill.

2. MATERIALS

For the experimental work the site soil was collected from Vadavathor dumping yard site, Kottayam, kerala. Initial soil tests were conducted on the collected sample. Soil was dig out and packed in plastic bags, foreign matters like pieces of wood, cut glasses, plastic covers etc were removed from the soil carefully. Field density was also determined.

Fig -1: Vadavathor dumping yard site

Table -1: Initial test results on site soil collected.

Field density	1.603g/cc
Specific gravity	2.22
Liquid limit	46%
Plastic limit	25%
Shrinkage limit	20.8%
Permeability	$9.347x10^{-3}$cm/sec
pH	4.2
Optimum moisture content by standard proctor test	18.5%
Maximum dry density	1.55g/cc

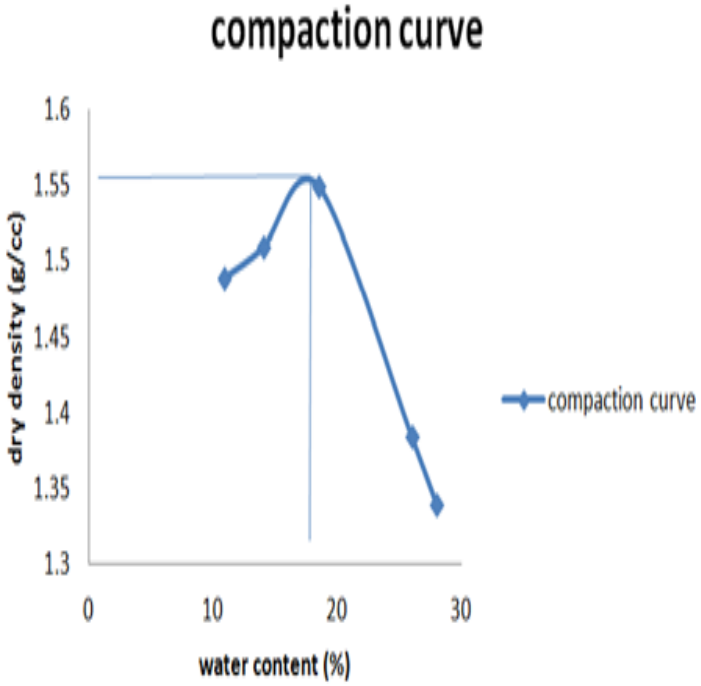

Fig -2: Compaction curve: standard proctor test

Mulches required for the research (straw, rubber, cardboard, woodchips) were collected and cleaned. They were kept in air tight plastic bags, so that the effect of moisture was reduced. Straw were cut into small pieces of 1cm length. Rubber was obtained in the crumbed form. Small Cardboard pieces were used. Woodchips of equal thicknesses were chosen. Adsorbents were placed in plastic containers, carefully handled with the dust. Biochar and sawdust ash were obtained in the form of activated carbons.Tests were conducted on both the adsorbents. This shows specific gravity 1.269 and 1.67 for biochar and sawdust ash respectively.

Fig -3: Mulches like Straw, Cardboard, Rubber, and Woodchips.

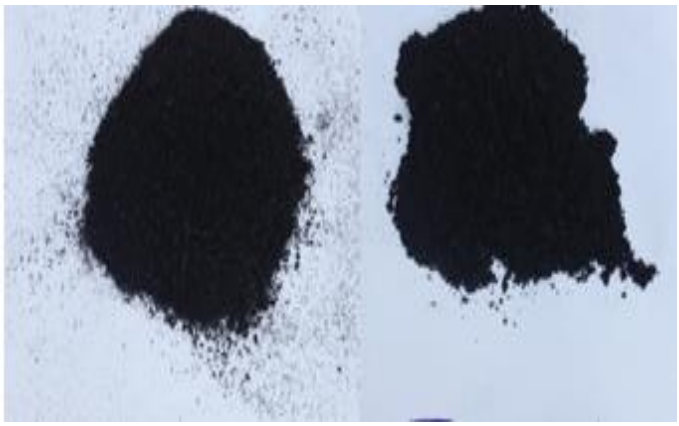

Fig -4: Biochar and Sawdust ash

3. METHODOLOGY

For observing the alteration in the value of coefficient of permeability of the soil by adding different mulches and combinations of biochar and sawdust ash into the soil, falling head method is adopted. Both mulches and adsorbents were spread at the center. They were sandwiched between the soil in the mould. The initial permeability of the sample was determined by filling up the mould with the field density. Mulches like straw, rubber, cardboard, woodchips and adsorbents like biochar and sawdust ash were added for different thicknesses. Permeability tests were conducted after the addition of the materials and the value of coefficient of permeability is compared with the initial value of coefficient of permeability of the site soil.

Permeability determination (IS:2720(Part17)-1986)

$k = c \log (h_1/h_2) / t$

$c = 2.303aL/A$

Where, k = Coefficient of permeability

a = Area of the stand pipe (3.14cm^2)

A = Area of the mould (78.54 cm^2)

L = Length of the mould (12.7 cm)

h_1 = Initial height of water

h_2 = Final height of water

head drop=Δh

t= Time required to get head drop of Δh.

Fig -5: Apparatus for permeability test

Fig -6: Mould ready for permeability test -Mulches

Fig -7: Mould ready for permeability test -Adsorbents

4. RESULTS and DISCUSSION

The results of the permeability tests conducted for different mulches like straw, rubber, cardboard, and woodchips for different thickness shows that:

Table -2: Coefficient of permeability for different mulches

Mulches	Coefficient of permeability (k value) cm/sec
Rubber 2cm	5.610×10^{-3}
Rubber 3cm	4.808×10^{-3}
Rubber 4cm	3.883×10^{-3}
Straw 2cm	5.224×10^{-3}
Straw 3cm	4.764×10^{-3}
Straw 4cm	4.207×10^{-3}
Woodchips 2cm	7.767×10^{-3}
Woodchips 3cm	6.721×10^{-3}
Woodchips 4cm	5.314×10^{-3}
Cardboard 2cm	8.415×10^{-3}
Cardboard 3cm	6.731×10^{-3}
Cardboard 4cm	5.048×10^{-3}

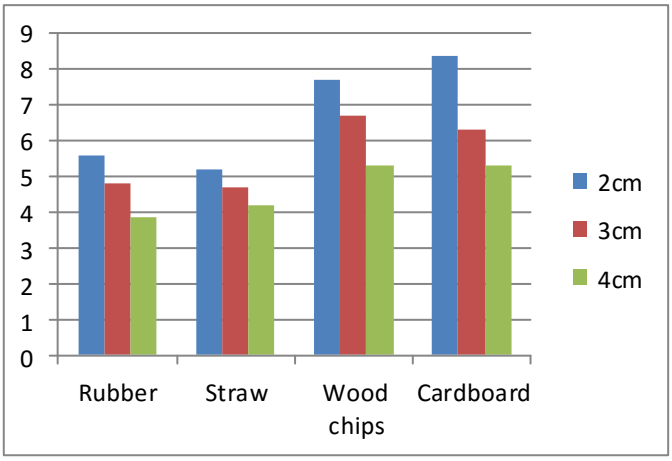

Chart-1: Coefficient of permeability for different mulches at various thicknesses

The permeability test results for the combination of adsorbents like biochar and sawdust ash were shown below:

Table -3: Coefficient of permeability for combination of adsorbents

Permeability test results (k value)	
Biochar and sawdust ash	Coefficient of permeability (k,cm/sec)
1cm-1cm	2.049×10^{-3}
1cm-2cm	2.224×10^{-3}
1cm-3cm	1.603×10^{-3}
2cm-1cm	1.187×10^{-3}
2cm-2cm	4.589×10^{-4}
3cm-1cm	7.212×10^{-4}

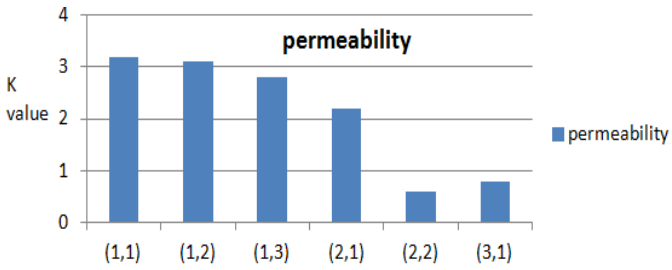

Chart-2: Coefficient of permeability for different combinations of biochar and sawdust ash respectively.

The chart 2 was drawn between combinations of biochar and sawdust ash on X-axis (cm) and coefficient of permeability (cm/sec) on Y-axis

5. CONCLUSIONS

From the experiments carried out as part of the study on effect of placement of mulches and combination of adsorbents on the soil permeability, it was observed that the value of coefficient of permeability was reduced. Mulches like straw, rubber, cardboard, and woodchips were placed into the soil at different thickness (2cm, 3cm, 4cm -height) It is seen that the coefficient of permeability was reduced maximum for rubber mulch added for 4cm thickness. Adsorbents were added for different thickness (1cm-1cm, 1cm-2cm, 1cm-3cm, 2cm-1cm, 2cm-2cm, 3cm-1cm). Among these combinations 2cm-2cm each of biochar and sawdust ash showed better result.

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REFERENCES

[1] Dalorima L.T, Bunu A., Kyari Z., Mohammed T" Effects of Different Mulching Materials on the Growth Performance of Okra in Maiduguri" International Research Journal of Agricultural Science and Soil Science (ISSN: 2251-0044) Vol. 4(8) pp. 145-149, September, 2014

[2] Venkatesh and Dr. G. Sreenivasa Reddy "Effect Of Waste Saw Dust Ash On Compaction And Permeability Properties Of Black Cotton Soil" International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 7, Number 1 (2016), pp. 27-32

[3] Lehmann, J.; Joseph "Biochar for environmental management An introduction" Environmental Management, Science and Technology 2009

[4] Nilakshi Talukdar, Kmenlang Dame Dkhar, Kaushik Talukdar "The Effect of Rice Husk Ash and Sawdust on the Engineering Properties of Soil" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 3, March 2016

[5] Istuti singh "Geotechnical properties of natural soil using rice husk ash and lime " SSRG International Journal of Civil Engineering (SSRG-IJCE) – EFES April 2015

[6] Awokola .S, Dare E., Akinwamide J.T and Eshiett I. "Engineering Properties of Sawdust Modified Clay Soil" Int. J. Pure App. Biosci. 3 (5): 35-41 (2015)

[7] Oluyege, J.O et al "Effect of charcoal-sand filtration, chemical disinfection and solar, Heating on bacteriological and physiochemical quality of surface water", ISSN-2319-2119 RESEARCH ARTICLE The Experiment, 2014, Vol. 21(2), 1462-1470 2014

[8] Gbenga M. Ayininuola" IMPACT OF HARDWOOD AND SOFTWOOD ASHES ON SOIL GEOTECHNICAL PROPERTIES" Transnational Journal of Science and Technology, TJST December 2013 edition vol.3, No.10 ISSN 1857-8047

[9] P. T. Ravichandran*, A. Shiva Prasad, K. Divya Krishnan and P. R. Kannan Rajkumar" Effect of Addition of Waste Tyre Crumb Rubber on Weak Soil Stabilisation" Indian Journal of Science and Technology, *Vol 9(5), DOI: 10.17485/ijst/2016/v9i5/87259, February 2016*

[10] Joan Lordan, Miquel Pascual, Josep M.Villar "USE OF ORGANIC MULCH TOENHANCE WATER-USE EFFICIENCY" Journal of Agricultural Research(2015) ISSN