

## Application of Geotextiles in Erosion Control -A Field Experiment-

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**Abstract:** The paper presents the results of a field experiment conducted in the campus of Advanced Material and Processes Research Institute (CSIR), Bhopal, Madhya Pradesh, India, to test the effectiveness of geotextiles as a soil erosion control measure. To date, there is no specific geotextile like sisal geotextile commercially available. But sisal is a locally available plant and the textile can be produced by small-scale industry. So, this is a better alternative materials for soil erosion control. There is a need for specific information about significant parameters of such products in terms of erosion control. The results reveal that treatment with sisal geotextiles in comparison with coir and jute geotextiles, is an effective eco-hydrological measure to protect the steep slope lands from erosion. This paper analyses the performance of the sisal geotextile as compare to other geotextiles with respect to soil erosion control.

**Keywords:** Fiber, Geotextiles, Runoff, Soil erosion control

### 1. Introduction

In the present experiment Sisal, Jute and Coir are used as natural fibers geotextiles. Presently in India, coir and jute geotextiles are used since long time. But the use of sisal based geotextile is very limited in India. The research team is being carrying out an field research to compare the effectiveness of sisal geotextile with jute and coir geotextiles. Following is the short introduction of different fibers which are being used in the present research work.

Jute is natural multi filament fiber, durable and simple to both produce and dispose. Biodegradable woven jute is accessible in a number of weave densities, initially anticipated as a geotextile to avoid land sliding and consequent to deforestation.

Coir is a natural insulation material produced from flax fibers, intertwined together into non-woven matting, which can then be set in lofts or put into wall cavities. Coir geotextiles are applied in areas of erosion control, soil conservation, and other civil and bioengineering applications. It also has the appropriate strength and toughness to protect the slopes from erosion while permitting vegetation to flourish. They can dissolve the energy of flowing water and absorb the extra solar radiation.

Sisal has evolved in nature as a xerophyte plant and it is scanty and shrunken stomata, heavy waxy cuticle and thick-set root system. In India best land very naturally goes for food crops and waste land that is used for sisal plantation is usually poor in nutrient, dry and unfit for food crop. Sisal can be grown on all uncultivated wastelands under rainfed conditions thus avoiding the loss of crop due to frequent droughts. The crop requires less inputs and management in comparison to other crops of such value; except care at nursery stage. It is the most promising crop for the tribal and underdeveloped part of the country, where lands and labor are available in plenty. Sisal checks soil erosion, provide opportunities for employment generation in fields and factories and raw materials to the cottage industries. Thus it may help in raising the socio-economic status of the rural communities.

### 2. Materials and Methods

In India, application of geotextiles for erosion control is still in infant stage and experiments are being carried out in different parts of the country. There are several forms of geotextiles out of which, the three natural fibres based geotextiles are used in the present research work.

The geotextiles, which are being used in the experimental work, are Jute, Coir and sisal geotextiles. The experiment is being carried out in four plots of 7 sq. m. each (2 m × 3.5 m). The slope of the each plot is 17° in same type of black cotton soil. An analysis and comparison is made of soil erosion parameters for sisal and two other geotextiles (made from coir and jute) under the natural rainfall condition.

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Coir, Sisal and Jute geotextiles have been used in this experiment as a temporary erosion control measure to stabilize soil. Geotextiles are used with mesh opening of 36 mm<sup>2</sup> and a density of 0.80 Kg/m<sup>2</sup> for sisal, 0.68 Kg/m<sup>2</sup> for jute and 0.70 Kg/m<sup>2</sup> for coir. Three types of geotextiles (Jute, Sisal and Coir) are installed in three plots and fourth plot is in the virgin condition (Figs. 1 - 6). The fabrics are fixed on the earth surface with the help of iron pegs.

The water samples are collected from the collected runoff – water in the separate tanks for each plot for 24 hours. The soil loss and runoff volume are measured which are significant parameters to erosion control. Rainfall was measured using a self-recording rain gauge installed at field site.

The field experiment results of one-year data of sisal, jute and coir geotextiles are shown in following Figs. 7 and 8.



Fig. 1. Experimental plots without Geotextile.



Fig. 2. View of plots After Installation of Geotextile.



Fig. 3. Sisal Geotextile.



Fig. 4. Coir Geotextile.



Fig. 5. Jute Geotextile.



Fig. 6. Plot without Geotextile.

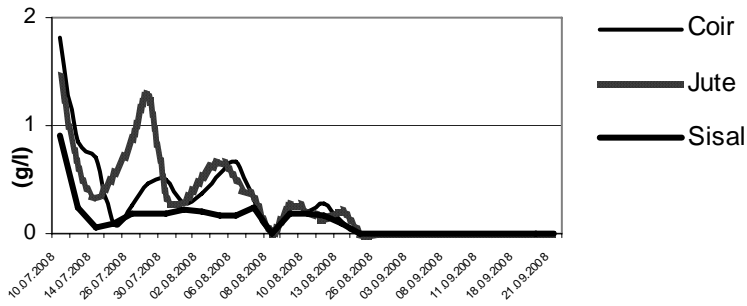


Fig. 7. Comparative Soil Erosion.

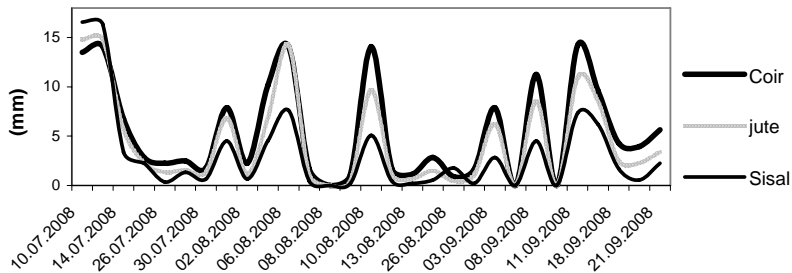


Fig. 8. Rainfall- Runoff Relationship.

Presently, the reported chemical, physical and mechanical properties of Jute, Coir and Sisal fibers are used for the comparative study of degradability which are shown in the following **Tables 1, 2 and 3** respectively.

**Table 1. Chemical Properties of Fibers.**

Materials	Cellulose wt %	Hemicellulose wt %	Lignin wt %	Pectin	Water Soluble	Wax wt %	Humidity
Jute	61 – 71.50	13.60 – 20.4	12 - 15	0.20	1.10	0.50	12.60
Coir	36 - 43	0.15 - 0.25	41 - 45	3 - 4	-	-	-
Sisal	66 - 72	10 - 13	8 – 11	10	16.20	2	11.00

Data Source: R.V. SILVA & E.M.F. AQUINO – Nov. 2007

**Table 2. Physical Properties of Fibers.**

Materials	Length (m)	Diameter (mm)	Density (gm/cm <sup>3</sup> )
Jute	0.15 – 0.36	0.10 – 0.20	1.47
Coir	0.15 – 0.20	0.01 – 0.02	1.40
Sisal	0.60 – 1.2	0.05 – 0.20	1.35

Data Source: Mohini Saxena & U.S. SHARMA – 2008

**Table 3. Mechanical Properties of Fibers.**

Materials	Tensile Strength (MPa)	Tensile modulus (GPa)	Elongation at break %
Jute	393 - 773	26.50	1.20
Coir	131- 175	4 - 13	41 - 45
Sisal	511 - 635	9.40 - 22	2 - 3

Data Source: R.V. SILVA & E.M.F. AQUINO – Nov. 2007

### 3. Results and Discussion

The studies carried out on the geotextiles have shown very positive result for the soil erosion control. An analysis and comparison is made of soil erosion parameters for sisal and two other geotextiles (made from coir and jute), which are being tested on the land slope of 17% under the natural rainfall condition. Runoff volume and soil loss for daily 24 hours are measured as important parameters which are very significant to erosion control.

The comparative amount of soil loss (gram/litre) is shown in figure 7. The Sisal geotextile plot has fewer amounts as compare to coir and jute geotextile plots. It is also observed that virgin plot shows a higher amount of soil erosion because of the high runoff value.

It is observed that the sisal geotextile has less amount of runoff – water as compare to other experimental plots. The runoff (mm) comparison of different geotextile is shown in figure 8 which shows that runoff in sisal geotextile is less as compare to other geotextiles.

Thus on the basis of the field experiment result of one year data of sisal, jute and coir geotextiles results shown in Figures 7 and 8, it is observed that the;

1. Sisal geotextile is able to reduce runoff volume and total soil loss compared with the results of these parameters from jute, coir and bare soil.
2. The physical properties of sisal geotextile may be used to explain observed variations in soil erosion rates and runoff volumes, compared with other geotextiles products.

The research work is still continued on above said geotextiles. At the end of the project, research team is expecting more valuable findings regarding the sisal geotextile, which, aims to evaluate the use of sisal as an erosion control geotextile.

### 4. Conclusions

All the physical, chemical, mechanical and field experiment data show that the sisal geotextile has better scope for soil erosion control. Therefore, sisal geotextile may be used for slope stabilization and soil erosion control.

Sisal suppliers will need to provide reliable data giving technical details of the geotextiles offered and their expected behavior.

Thus, comparative study shows that, the sisal geotextile has very convincing result for soil and water conservation. The sediment loss and runoff data show that the sisal geotextile absorbs more water and therefore, the runoff and sediment erosion are less as compare to Jute and coir geotextiles.

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