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Erosion studies under vetiver hedge management in Ibadan, South-Westhern Nigeria

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ABSTRACT

The effects of vetiver grass strips on sediment trapping and soil loss were studied during 2010 raining season. Field studies, conducted on 6% alfisol of loamy sand texture which is susceptible to sealing, allowed the comparison of three situations corresponding to buffer strip widths of 3 and 40 m located at the down slope end of a bare experimental field. This study aimed at comparing the rate of soil loss under vetiver grass strip and non-vetiver hedges. The mean total sediment yield of the control plot was greater (28.76 kg/ha) than those in the vetiver plots. The yield was in the trend of non-vetiver plot > plot 2 > plot 1 > plot 3 (28.76kg/ha > 8.94 kg/ha > 4.09 kg/ha > 3.99 kg/ha respectively). %). Statistical comparison of soil loss among the plots revealed that non-vetiver plot was highly significantly different from the vetiver plots, while vetiver plot 2 was significantly different from vetiver plots 1 and 3 ($p < 0.05$)

Key words: soil loss, vetiver grass strip, sediment trapping, alfisols

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INTRODUCTION

Nigeria as a country is endowed with a vast range of soils and ecological environments. Many of these soils are suitable for a variety of food crops, perennial crops, pastures or forest reserves, depending upon the prevailing climate [9] An important factor responsible for the declining food production in south- west and other parts of Nigeria is the mismanagement of natural resources, and the resulting soil loss through overland flow. The growing competition for water and declining fresh water resources, the utilization of marginal quality water for agriculture has posed a new challenge for environmental management [12].

According to [5], rainfall erosion is the interaction of two items; the rain and the soil. The amount of erosion which occurs in any given circumstances will be influenced by both. From observation, one storm can cause more erosion than another on the same land and the storm will cause more erosion on one field than the other [3] The amount of soil erosion which occurs under given conditions is influenced not only by the properties of the soil, but also by the treatment or management it receives. Water contaminated with metallic effluent can cause several health problems [13]

There are many conservation measures that have been used to control soil loss. They include: stubble mulching, crop rotation, alley cropping, terracing, strip cropping and so forth. The measures according to [2] are virtually known to the farmers, but due to farmers' level of illiteracy and conservatism, they found it difficult to adopt these measures.

Most farmers admitted that despite improvement in their farming method/techniques there have been consistent decline in quantity of crop harvest [12]. They are yet to be convinced that it is profitable to conserve the soil.

In recent times however, towards a sustainable agriculture, research has been intensified on the efficacy of vetiver grass technology to combat soil erosion and other agricultural problems [4]. Therefore the objective of this study was to compare the rate of soil loss under vetiver grass strip and non-vetiver hedges

MATERIALS AND METHODS

2.1. *Location and Environments of Site*

2.1.1 Experimental Site

The study was conducted on runoff plots of the Agronomy Department, University of Ibadan, located at Parry Road. Ibadan is located between latitude 7˚ 25' and 7˚ 31' North of the equator, and longitude 3˚ 51' and 3˚ 56'East of the Greenwich Meridian. Ibadan and its environs shared the climatic condition that prevails in most of Oyo State. There are two seasons, the dry and the wet seasons. The wet season is characterized by a mean annual rainfall of 1289.2mm, [1].

2.2. Construction of Runoff plots:

Runoff plots in the experimental site were demarcated from one another by well constructed bunds of 25cm high with the traditional hoe. Amendments of these bunds were carried out whenever it was broken. The soils from the bunds were not allowed to spread to the main plot. This was to minimize experimental error. The size of each runoff plot was 40m × 3m. At the bottom end of each plot, soil and water runoff collecting devices made up of concrete weirs (30cm high) were constructed throughout the demarcated plots, each with a collecting soil loss ditch of 40 cm long, 30cm wide, and 10cm deep. The lower end of the plot was cemented and three PVC pipes of 1m long and 10cm diameter were installed to convey the runoff to the drums[8]

2.3 Measurement and Sampling of Soil loss

A determination of soil loss was carried out after every rain storm that causes erosion[7]. Prior to collection of soil loss from the tanks, the contents of the tanks The determination of soil sediment carried by runoff water into the collecting tanks was done by sampling a known volume of the mixture from each tank after every storm. Before taking the aliquot from the tanks into 50cl bottle, the runoff water was thoroughly stirred. The sample taken from each of the tanks was taken to the laboratory and allowed to settle for two to three days while the water in the tanks was drained for further use. The settled aliquot was further filtered with Whatman's filter paper and the sediment (residue) was put into a Petri-dish and oven dried [6]. The dried sample was weighed and thereafter multiplied with the total runoff water in the collecting device to obtain the total weight of soil washed by runoff into the respective collecting devices. This amount was then added to the dry weight of the eroded soil collected from the ditch. The sediment was expressed in kilogramme per hectare ($kgha^{-1}$) using this equation:

$$\text{Total sediment } (kgha^{-1}) = \frac{\text{Sediment (kg)}}{\text{Area (ha)}}$$

$$\text{Sed.} = \frac{\sum_{i=1.....n}^{n} \text{Dws} \times \text{Vol. of runoff}}{\text{Mq}}$$

Where,
Sed. = sediment yield within the plot
Dws = Dry weight of sediment from the aliquot (g)
Vol. = volume of runoff water in each tank (cm^3)
Mq = measure of the aliquot (litre)
$\sum$ = the sum of dry weight of sediment from the tanks
n = number of tanks

The eroded soils in the ditches were collected and weighed. A known weight from each of the fresh samples was oven dried at 105˚C. The oven dried weight was then added to the one already obtained from the ditch as the total soil eroded from the plot. This was then converted to $kgha^{-1}$ of soil.

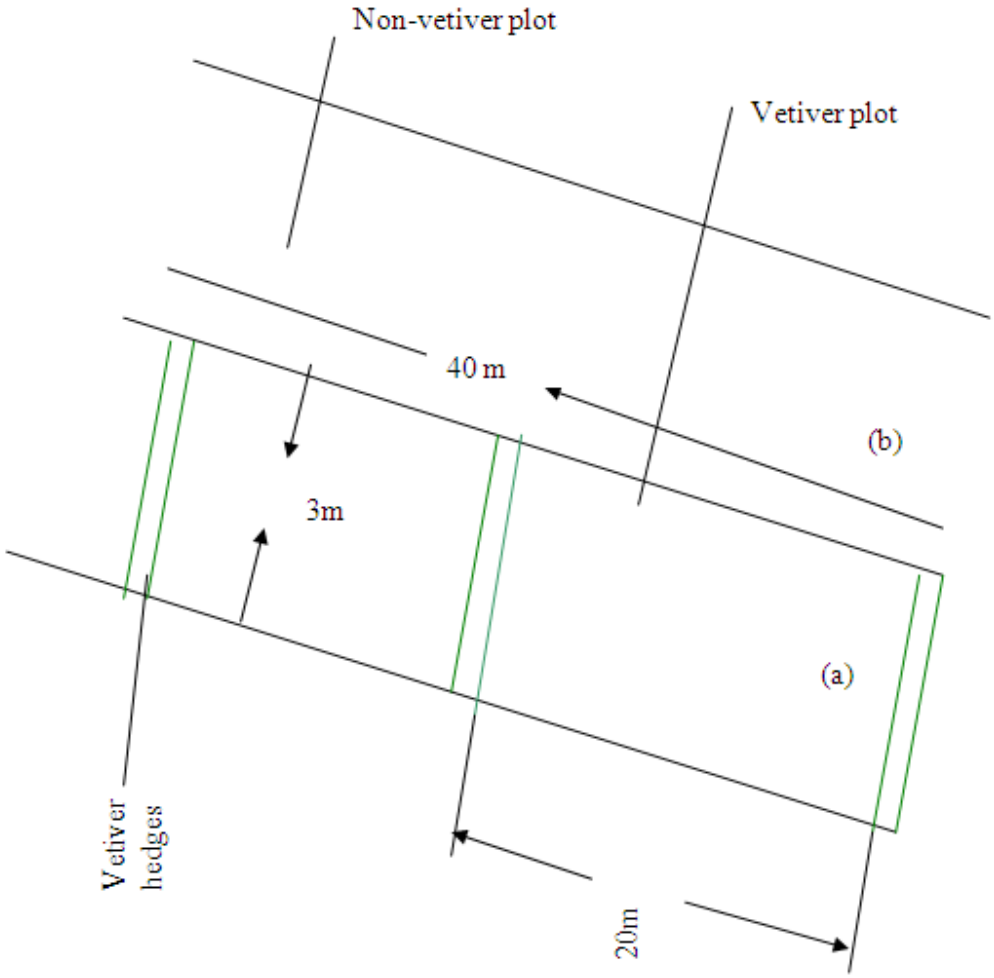

Plate 2.1 A diagram showing the Vetiver plot a) and (b) No - vetiver plot

2.4. Statistical Concepts and Analysis of Experimental Data

The experiment consisted of two treatments; vetiver and non-vetiver plots replicated three times on a 6% slope. The treatments were arranged in a Randomized Complete Block Design (RCBD). The variability of the soil loss was determined using the equation:

$$\text{Soil loss (kg/ha)} = \frac{\text{weight of eroded sediment (kg)}}{\text{Area of plot (ha)}}$$

Least significant difference (LSD) was used to compare the means. Coefficient of variation and Correlation analyses were carried out to measure degree of variation between vetiver and non-vetiver plots.

RESULTS AND DISCUSSION

3.1 Soil loss among the Plots

As shown in table 3.1, the control plot soil loss yield ranged from 5.42 - 86.25kg/ha with a mean value of 28.76kg/ha, in plot 1, it ranged from 0.8-13.86kg/ha with a mean of 4.09 kg/ha and plot 2 recorded a range of 3.85 - 23.16kg/ha with a mean of 8.94kg/ha, while plot 3 had a range of 0.71 – 10.42kg/ha with mean value of 3.99kg/ha. The mean total sediment yield of the control plot was greater (28.76 kg/ha) than those in the vetiver plots. The yield was in the trend of non-vetiver plot > plot 2 > plot 1 > plot 3 (28.76kg/ha > 8.94 kg/ha > 4.09 kg/ha > 3.99 kg/ha respectively). %).

Statistical comparison of soil loss among the plots revealed that non-vetiver plot was highly significantly different from the vetiver plots, while vetiver plot 2 was significantly different from vetiver plots 1 and 3 ($p < 0.05$). [2] has demonstrated the usefulness and efficacy of vetiver grass strips as a soil and water conservation measures. In their research findings, vetiver grass strips apart from reducing soil loss and runoff water through effective soil particles trapping action, it improves crop yields.

Table 3.1. Sediment yield (kg/ha) among Vetiver and Non-vetiver plots for eight storms

No. of Storms	Non-vetiver plot (Control)	Vetiver Plot 1	Vetiver Plot 2	Vetiver Plot 3	Mean	Std dev
First	86.25	13.86	23.16	10.42	15.81	5.38
Second	6.25	0.8	5.66	0.71	2.39	2.31
Third	30.25	5.28	7.91	2.77	5.32	2.10
Forth	70.08	7.95	12.93	5.63	8.84	3.05
Fifth	13.33	0.87	5.86	4.36	3.70	2.09
Sixth	5.42	0.92	5.02	1.48	2.47	1.82
Seventh	12.72	2.09	3.58	1.94	2.54	0.74
Eighth	5.75	0.91	7.42	4.61	4.31	2.67
Mean	**28.76**	**4.09**	**8.94**	**3.99**	**5.67**	**2.52**

Std dev. = Standard deviation

3.2. The variability in the amounts of soil loss among plots of the same land during rainstorm.

In comparing the effect of one storm and that of the other storm has provided a relative measure of the power of each storm to cause erosion. Also on a farm, a few centimeters away, the soil is different in soil loss during a given rain storm, this work is in line with earlier work of Browning, [2]. The amount of soil loss is different among plots of the same field (Fig. 1). The difference is because one soil is more easily eroded than the other, and this vulnerability to erosion is what is meant by erodibility. It is the reciprocal of the soil's resistance to erosion.

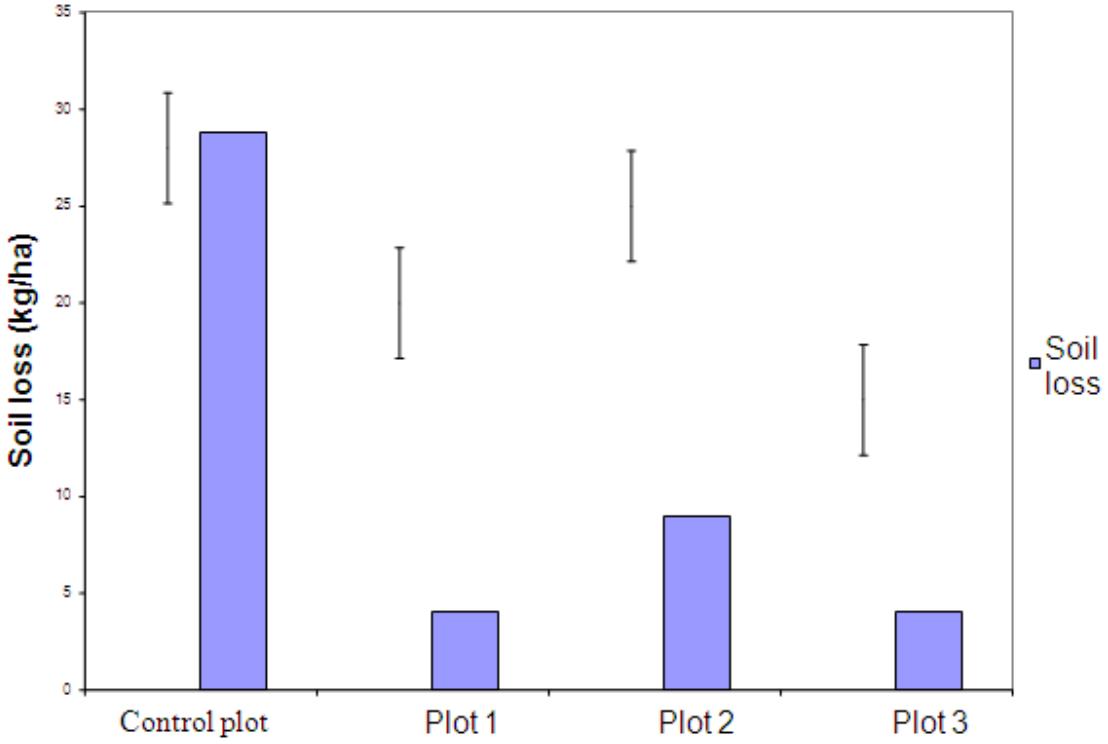

Fig 3.1. Mean soil loss (kg/ha) among plots in vetiver and non-vetiver plots

CONCLUSION

A comparative evaluation of the efficacy of vetiver grass strips as soil and water conservation measures is modest attempt to determine the best way to explore the use of vetiver grass technology in Nigeria. Soil loss was more

pronounced in the control plot than vetiver plots of the same land. Vetiver grass hedge is meant to reduce the velocity of runoff water and in turn have an effect on deposition of eroded soils from up slope to different places along the topography.

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