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Nitrogen-use efficiency of maize under erosion control management techniques

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ABSTRACT

A field trial was conducted in Ibadan to determine the nitrogen use efficiency (NUE) of maize crop under vetiver grass strip erosion control management. Nitrogen fertilizer (Urea) was applied at the rate of 100kg nitrogen per hectare. Vetiver was planted at 20m interval and compared with no vetiver plot. Runoff and sediment collecting devices were installed on the field with maize as the test crop. Grain yield, NUE, soil loss and runoff showed no significant difference between treatments when subjected to T - test at 5 %.however best performance in terms of the above parameters were obtained under vetiver grass plot. NUE was 9.6% in vetiver and12.4% in no vetiver plot. Vetiver reduced runoff as percentage of rainfall from 35% (No vetiver plot) to 2.51% and soil loss of 77.9 % to 22.9%.

Key words : *Nitrogen usage, Maize, Vetiver sp., Yield, Reduced erosion and Soil loss*

Introduction

The loss of soil fertility particularly from top soil due to erosion is one of the major environmental burdens in developing nations. This calls for urgent attention to avert the trend since nutrient loss is difficult to replace within foreseeable future. FAO (1993) observed that most of the soil nitrogen, and sulphur and part of the available phosphorus that normally occurs in the organic matter of the surface layer are usually eroded. However, nitrogen and water are both limiting factors for agronomic production in the tropics. Nitrogen losses from agricultural system have created a concern especially in the potential impact of farming practices on environmental quality. Nitrogen in the form of nitrate is highly mobile in the soil and generally follows the flow of water (Benson *et al.*, 1992). In western Nigeria, Lal (1998) reported average annual loss of approximate 2540kg/ha of organic carbon, 210kg of nitrogen, 11.12kg/ha of phosphorous, 18.6kg/ha of potassium, 140kg/ha of calcium and 11.0kg/ha of magnesium from runoff and eroded sediments. World consumption of nitrogen fertilizer was 85,529,551 metric tonnes in 1999 (FAO 2001). Of the total nitrogen fertilizer consumed, cereal production accounted for 60% (FAO, 1995). Only 33% of the total nitrogen applied for cereal production in the world is actually removed in the grain (Raun *et al.*, 1999). With the increasing cost of nitrogen fertilizer due to natural gas shortage, the unaccounted 67% is now estimated to be worth more than 20 billion annually (Raun *et al.*, 2001). Considering these poor use efficiencies, and the associated cost of improper management, technological advances are needed to reduce excess nutrient application and losses. Increasing the nitrogen use efficiency (NUE) of maize through modifications in farming practices would be beneficial in improving the efficiency of fertilizer system (Akintoye *et al.*, 1999). This is the premise upon which this study is based.

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Materials and Methods

The experiment was conducted at the University of Ibadan Teaching and Research Farm, Ibadan. Vetiver grass strips were established on a 6% slope at surface intervals of 20m on erosion plots of 40m long and 3m wide. Plots with and without Vetiver grass strips constituted the treatment and control respectively. Treatments were replicated three times in a randomized complete block design. Maize was used as test crop. Urea fertilizer was applied at the rate of 100kgN/ha using side placement. Each runoff plot was confined by asbestos sheets extending 15cm above and 15cm below the ground surface in order to prevent leakages in and out of the plot across each boundary. A trench, 1.2m deep, 1.2m wide and 18m long was dug at the end of the plots. Two oil drums each of 200 litres capacity were positioned at the end of each plot to receive runoff water. Runoff and soil loss were collected in a trough from which one third of the runoff was channeled into the first drum and the overflow was channeled into the second drum. Soil losses were estimated from the soil collected in the trough after each storm and also from sediments in the runoff water. Aliquots of 100ml of soil suspension were also collected for No_3^-N analysis. The soil loss was also analysed for total nitrogen, phosphorous, potassium, organic carbon, the nitrogen use efficiency (NUE) was calculated using Moll (1982) equation:

NUE % = grain produced/ unit nitrogen supplied

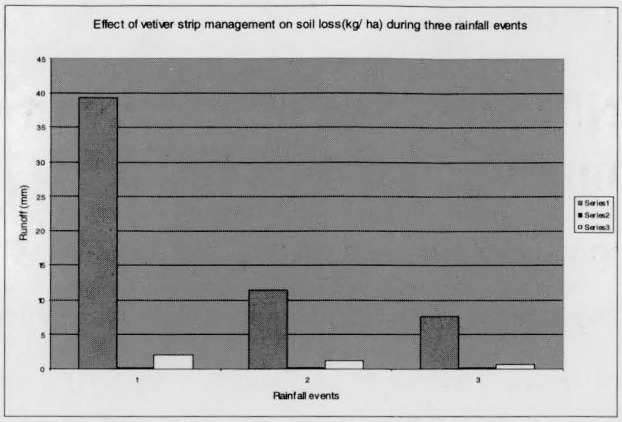

Fig. 1. Effect of vetiver strip management on soil loss (kg/ha) during three rainfall events

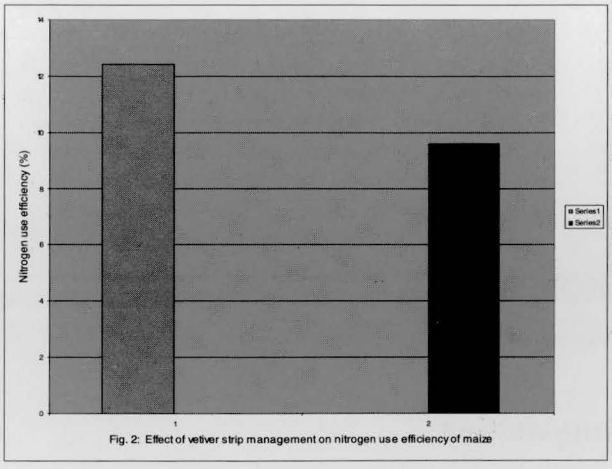

Fig. 2. Effect of vetiver strip management on nitrogen use efficiency of maize

Results and Discussion

The results showed that grain yield increase in a vetiver plot with a mean grain yield of 149.88kg per hectare while that of no vetiver plot was 100.80kg per hectare. Though there was no significant difference between the grain of both treatment, yet mean grain yield of no vetiver (NV) plot was 67.8% of the yield on vetiver (V) plot as shown in Figure 1. The fact that there was no significant difference in the treatment is attributed to water stress cessation of rain at tasseling and silk stage of the crop the nutrient loss as obtain in the analyzed runoff and eroded sediment (Figure 1). The highest value for soil loss and runoff was obtained in no- vetiver plot as shown in Table 1. The difference in runoff rate is associated with a reduction in runoff velocity with better filtration of water into the soil. Vetiver accounted for 22.2% of the total soil loss while no vetiver accounted for 77.8% of the entire soil loss.

The vetiver plot held back more nitrate in runoff water than no vetiver plot (Table 2). The amount of nitrate N found in runoff under vetiver grass was higher than that of no- vetiver, this may be due to dilution factor. Therefore a little amount of runoff contains more nitrates N. Even though the differ-

Table 1. The mean runoff (mm) as percentage of rainfall

Rainfall events	Mean runoff		Mean runoff as % Rainfall	
	V	NV	V	NV
11.40	0.14	2.06	1.20	18.04
7.70	0.09	1.19	1.13	15.36
39.30	0.07	0.63	0.18	1.60

Table 2. The chemical properties of runoff

Rainfall events	Water pH		Nitrate- N(pp)	
	Vetiver (V)	No- Vetiver (NV)	V	NV
1	6.9	6.0	0.97	0.77
2	6.9	6.5	0.52	0.31
3	7.2	6.2	0.28	0.20
X	7.0	6.2	0.59	0.43
CV (%)	2.47	4.04	59.40	70.9

Table 3. The nutrient status and particle size distribution of soil loss

Treatments	% Clay	% Silt	% Sand	Soil pH	% Organic Carbon	% Total Nitrogen	P (ppm)	K (meq/ 100g)
Vetiver	3.8	4.0	92.2	7.5	2.13	0.065	5.8	0.24
No Vetiver	4.6	4.2	91.2	7.5	2.18	0.074	6.2	0.25

ences were not significant during the season, a similar trend was also observed in soil sediment analyzed from both plots (Table 3).

Nitrogen use efficiency according to Moll *et al.* (1982) and Bock (1984), methods gave highest value in vetiver plot which was 12.4% and 9.6% in no vetiver plot (Fig 2). Nitrogen use efficiency was enhanced by vetiver grass strips when nitrogen fertilizer was applied to the soil, the increase was attributed to water and nutrients that were prevented from being lost in runoff and soil loss that was trapped under the vetiver hedge system.

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