EVALUATION OF BIOENGINEERING SOIL EROSION CONTROL TECHNIQUES IN STANDARD USLE PLOTS

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Introduction

Bioengineering control measures have been applied to highway construction to improve slope stability and minimise slope erosion, (Franti, 1996; Ahmad, 1990). However, most estimates of soil erosion emphasised on agricultural land. Soil loss equations have been developed using data from studies conducted on cropland. Little information on bioengineering characteristics and performances has been obtained. Additional information is needed to properly select appropriate vegetation measures from currently available alternatives. The selection varies in cost and erosion control efficiency. The objective of this study was to quantify the effect of commonly used bioengineering measures for soil erosion control especially on slopes. The effect of biodegradable mat on vegetation growth and development was examined. The initial costs of the erosion control techniques were also considered to provide a comparison of cost-benefit.

Materials and Methods

The site selected for the study was located at the Biological and Agricultural Engineering Department Field Station, UPM. The site consists of ten standard Universal Soil Loss Equation (USLE) plots, which measure 1.8 m wide by 22 m long, on 9 % slope. Rainfall was measured with tipping bucket pluviometer, which was located at the head of the plots. A laptop computer was used with data loggers to record and download the precipitation depth and intensity data. The data obtained from this record for kinetic energy and rainfall erosivity computations as EI_{30}, $KE>25$ and AI_m. The plots were given the following ten treatments: Vetiver (*Vetiveria zizanioides*), the leaf was trimmed monthly to about 40 cm height; a legume (*Arachis pintoi*); Bare (control); hydroseeding after laying coco-rice straw mat ("coco-fibromat" + hydroseeding); hydroseeding before laying rice straw mat (hydroseeding + "fibromat"); hydroseeding after laying rice straw mat ("fibromat" + hydroseeding); hydroseeding alone; hydroseeding after laying geojute ("geojute" + hydroseeding); spot turfing with cowgrass (*Axonopus compressus*); Close turfing with cowgrass.

Results and Discussion

Runoff and soil losses from different treatments using standard USLE plots were measured during a one-year study period. Bioengineering soil erosion control techniques were found to have significant effect on reducing soil loss. Close turfing gave better soil protection than the other grass species, reducing soil loss by 99% compared to the bare plot. The addition of "fibromat" to the hydroseeding plot resulted in significantly lower soil loss. All hydroseeding plots overlaid with biomats gave better protection, resulting in C factor lower than 0.004. Close turfing produced C factor of 0.004, compared to 0.017 for spot turfing, 0.021 for hydroseeding only, 0.122 for vetiver and 0.213 for the legume. Runoff was also greatly reduced by infiltration into the root systems. Vetiver gave 81.2% and 61.8% less soil loss and runoff. Vetiver planted as hedges across the plot slowed down the runoff and sediments deposited behind the hedges. As a result, it reduces water velocity, soil and water losses. *Arachis pintoi* legume was least effective with 67.0% and 41.4% reduction in soil loss and runoff, respectively to the bare plot. This may be due to poor propagation of the legume with less fertiliser input. The bare plot produced 170.3 t/ha/y of soil loss during the study period, which was far greater than the acceptable limit, 13 t/ha/y (Morgan, 1979). Plots treated with legume and vetiver also gave soil loss above the permissible value with 56.1 t/ha/y and 32.0 t/ha/y, respectively. Soil loss from the spot and close turfing, which were the better protection among the treatments, produced 4.5 t/ha/y and 1.0 t/ha/y, respectively, were lower than the acceptable limit.

No significant differences were observed during the 8-months study among the hydroseeding plots with biomats. Hydroseeding alone had significantly greater soil loss than all other treatments. These results indicate the necessity of combining hydroseeding with biomats in order to prevent soil erosion on slopes with highly erodable soils for quick establishment of cover crop or grass. Erosivity indices have been developed by many authors (Hudson, 1971; Lal, 1977; Morgan, 1979). From statistical correlation results of erosion in our climate, soil loss from the bare plot was better correlated with $KE>25$ than raindepth, EI_{30} and AI_m. Cost of hydroseeding with biomats can be as low as RM 5 per m^2 compared to RM 10 for vetiver, and RM 4 for close turfing. However each has its own advantages which merit consideration depending on the site conditions.

Conclusions

In a one-year study period, close turfing with cowgrass was found to be the best treatment, reducing soil loss by 99% compared to the bare plot. Hydroseeding + "fibromat" gives better protection among the plots treated with hydroseeding reducing soil loss by a factor of fifty-seven compared to hydroseeding alone. Hydroseeding overlaid with "fibromat" gave the best protection with a C factor of 0.0004. Without biomats, hydroseeding alone required 6 months to form about 90% cover in order to have effective protection. The $KE>25$ can be considered as a better erosivity index than any other commonly used indices.

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