

Use of Vegetation Enhanced by Green Soil Stabilization to Protect Kansas Roadsides from Erosion

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Introduction

The primary objective of this study was to investigate the feasibility of using lignin, an environmentally friendly biopolymer, for sustainable protection of Kansas roadsides against wind and rainfall erosion during the critical stage of construction that occurs prior to the emergence of a vegetative cover. Results from laboratory-scale experiments showed that spraying lignin over the surface of dry, silty soil provided very good to excellent protection against erosion. A crust formed on the surface of the soil upon spraying, thus inducing increased bonding among the particles and increased compressive strength, resulting in a decreased amount of wind erosion with increased spraying rate. Although the lignin used in this study is water-soluble, its presence in the soil increased viscosity of the pore fluid, thus decreasing hydraulic conductivity and decreasing the amount of rain erosion. Lignin concentration of 1% at 0.0325 gal/ft² was sufficient to suppress wind erosion, while 15% at 0.123 gal/ft² was required to decrease the amount of rainfall erosion tenfold and sixfold for sloped and horizontal soil configurations, respectively. Additionally, lignin concentrations up to 4% and spraying rate of 0.0866 gal/ft² did not affect monocot and dicot counts or vegetative cover size in field trials. Lower zinc and iron levels were found in soil treated with 1% and 2% lignin, but no difference was observed at 4% lignin compared to the untreated soil.

Project Description

Construction sites are traditionally cleared from vegetation prior to construction, thus exposing unprotected soil to erosion prior to the establishment of new vegetation. Therefore, this study addresses the need for protection against wind and rainfall erosion during the critical construction phase that occurs prior to the germination of new vegetation using a sustainable, environmentally friendly approach that utilizes lignin, a biopolymer that is a by-product of paper mill and bio-fuel industries. Lignin, which is natural phenolic polymer with high molecular weight and complex composition and structure, is the main component of the plant cell wall, enhancing its rigidity, while its hydrophobic properties promote transport through the vascular bundles in a plant (Schuetz et al., 2014). With cellulose and hemicellulose, lignin forms plant skeleton. Lignin isolated from lignocellulosic biomass is the second most abundant natural polymer after cellulose (Ganewatta et al., 2019). Furthermore, lignin can regenerate in natural conditions via photosynthesis, resulting in approximately 50 billion tons per year (Shen et al., 2015). Lignosulfonates, which are produced from lignin from sulfite pulping of wood, are renewable, inherently biodegradable, and non-toxic. These plant-friendly materials offer a sustainable alternative to synthetic polymers, making them ideally suited to protect against wind and rain erosion prior to grass germination.

The primary objective of this investigation study was to demonstrate the effectiveness of the lignin product for protecting Kansas roadsides against wind and rain erosion during the critical construction phase that occurs prior to vegetation germination. Another research objective included the evaluation of lignin effects on soil nutrients and the percentage of vegetative cover. Consequently, the investigation was comprised of laboratory-scale erosion tests and

field trial, as well as hand penetrometer tests in laboratory and field settings to reveal underlying erosion and strength mechanisms.

Project Results

The primary goal of this research was to assess the feasibility of using lignin (calcium/sodium lignosulfonate) to decrease and prevent rainfall and wind erosion on Kansas roadsides prior to the emergence of a vegetative cover. Experimental research was devised and divided into two experimental groups. The objective of the first group was to assess the effectiveness of lignin solution to prevent rainfall and wind erosion using laboratory-scale hand penetrometer tests, wind erosion tests, and rainfall erosion tests on horizontal and sloped soil configurations. The objective of the second group of tests was to investigate the effects of lignin on the emergence of vegetative cover and the level of soil nutrients via a field trial involving 5 ft by 5 ft plots laid out in a randomized complete block design.

In summary, spraying lignin solution onto the surface of silty soil is an effective, environmentally friendly, and sustainable solution to significantly decrease the amount of wind and rainfall erosion. Lower spraying rate and significantly lower lignin concentration were required to suppress wind erosion than to decrease rainfall erosion from 16.8% to 2.7% for the horizontal configuration and from 51.7% to 5.3% for the sloped configuration.

Project Information

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