Carbon Sequestration on Surface Mine Lands

Quarterly Report

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ABSTRACT

During this quarter a general forest monitoring program was conducted to measure treatment effects on above ground and below ground carbon © and Nitrogen (N) pools for the tree planting areas. Detailed studies to address specific questions pertaining to Carbon cycling was initiated with the development of plots to examine the influence of mycorrhizae, spoil chemical and mineralogical properties, and use of amendment on forest establishment and carbon sequestration.

Efforts continued during this period to examine decomposition and heterotrophic respiration on C cycling in the reforestation plots. Projected climate change resulting from elevated atmospheric carbon dioxide has given rise to various strategies to sequester carbon in various terrestrial ecosystems. Reclaimed surface mine soils present one such potential carbon sink where traditional reclamation objectives can complement carbon sequestration.

New plantings required the modification and design and installation on monitoring equipment. Maintenance and data monitoring on past and present installations are a continuing operation. The Department of Mining Engineering continued the collection of penetration resistance, penetration depth, and bulk density on both old and new treatment areas. Data processing and analysis is in process for these variables.

Project scientists and graduate students continue to present results at scientific meetings, tours and field days presentations of the research areas are being conducted on a request basis.

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INTRODUCTION

EXECUTIVE SUMMARY

This project, unless it is extended, is in its final phase. The 500+ acreages of sample plots have been established, final data collection will be completed within the next two months and data analyses will be completed in another two months. The final report will be completed in a timely manner after that. This project has the potential to yield some very valuable results in the future. As the trees mature and the monitoring systems continue to record very detailed data on the carbon (C) and nitrogen (N) variables as well as water quality data and tree growth, researchers will be able to gain a more detailed understanding of the dynamic potential of the nations surface mined areas.

EXPERIMENTAL

General Forest Monitoring Program

A monitoring program to measure treatment effects on above ground and below ground carbon (C) and nitrogen (N) pools for tree planting areas continues. New sample plots were established during this period in areas planted in 2005. The plots were designed to both sample planted species and to account for differences related to site preparation activities and micro-topographic variability amongst planting units. These plots will be monitored in a similar fashion as those plots established in 2003 and 2004 (Graves et al., 2004). Soil and tissue analyses from samples collected in the field from 2004 have been or are currently being processed in the laboratory. Results from these activities will be presented in the Final Report.

Mineland Reforestation Mycorrhizae Study

Detailed studies to address specific questions pertaining to carbon cycling were initiated with the development of plots to examine the influence of mycorrhizae, spoil chemical, and mineralogical properties, and use of amendments on forest establishment and carbon sequestration. A factorial experiment using inoculated vs. non-inoculated species in non-fertilized, fertilized only, amended (organic mulch) only, and fertilized + amended plots were initiated in 2004 and described in the 6th Quarter Report (Graves et al., 2004). During this period, plots that had been inoculated were sprayed with MycorTree® ectomycorrhizal spores per the manufacturers' instructions (approx. 10 g spores per 5 L of water and each plant received approx. 100 mL of solution). The spray contained both Pt (*pisolithus tinctorius*) and Sc (*Scleroderma cepa*) spores, which were included in the inoculum used at the Morgan Co. nursery. The application was performed to potentially enhance the inoculation index of the planted seedlings. The non-mycorrhizal plots received an application of fungicide (Bayleton; 1 kg per plot) to suppress natural inoculation. Results from these activities will be presented in the Final Report.

Decomposition and Soil CO₂ Efflux

Efforts to examine decomposition and heterotrophic respiration on C cycling in the reforestation plots continued during this period. Samples were collected at the six reforested mine sites along a chronosequence (age after reclamation between 1 and 8 years) and six adjacent forested sites along a chronosequence (between ages 3 and 20 years). Three previously installed litter bags were collected from each location, weighed and analyzed for C and N content. In addition, permeable columns that were inserted into the soil at each site (15 cm depth) in close proximity to the litter bags were also extracted and analyzed. The columns consisted of a homogenized spoil material with known C and N concentrations contained within a nylon bag. PVC collars that were installed at each site were evaluated for soil CO₂ efflux using a LI-COR LI-8100 Automated Soil CO₂ Flux System. Litter from collectors placed at each site were sampled, dried, weighed, and separated to determine % species present and analyzed for C and N. Results from these activities will be presented in the Final Report.

Development of a Rapid Assessment Method for Quantifying Carbon Sequestration on Reclaimed Coal Mine Sites

Projected climate change resulting from elevated atmospheric carbon dioxide has given rise to various strategies designed to sequester carbon in various terrestrial ecosystems. Reclaimed coal mine soils present one such potential carbon sink where traditional reclamation objectives can complement carbon sequestration. However, quantifying “new” carbon (carbon that has been added to soil through recent biological processes) on reclaimed mine soils have proven to be difficult due to carbonates and coal particles present in the reclaimed coal mine spoils. Visible coal particles can be removed, but the microscopic coal dust particles remain. Additionally, with the advent of carbon trading on the stock market, rapid quantification of newly sequestered carbon has proven to be elusive.

The focus of this project is to assess the potential of thermogravimetric analysis as a rapid simple and direct method for differentiating and quantifying “new” carbon from “old” carbon (carbon of geologic origin) on reclaimed coal mine sites and provide a standard procedure for determining carbon sequestered in soil “sinks.” Thermogravimetry is a physico-chemical technique where the weight change is measured and recorded during the incremental heating of the soil sample over a temperature range of 25 to 1000°C. Grass litter and limestone were used as representative organic and inorganic carbon fractions, while coal was used to differentiate the “old” and “new” carbon within the organic fraction. Recoveries of mixtures at the 95% confidence interval were found to be $94.49 \pm 2.11\%$ (litter), and $108.88 \pm 2.88\%$ (limestone) respectively. Each of the above components appeared as distinct separate peaks on the thermograph, with litter appearing between 260-390°C,

and limestone 640-740° C. Overlapping peaks for the organic carbon represented by the grass litter may be indicative of cellulose and lignin fractions. Ongoing work in this area is being carried out to separate such peaks which may further enhance TG as an effective method to determine “new” carbon and to simultaneously monitor organic matter degradation. Results and further details from these activities will be presented in the Final Report.

Hydrology and Water Quality

Research personnel continued the modification of subsurface data acquisition station for the new Bent Mountain loose spoil test plots and the seven year old Starfire installations. Rainfall data was processed for each individual storm event including quarterly, intensity and duration for the period of April through June, 2005. Water level was evaluated to develop storm hydrographs to compute run off volume and determine water turbidity, settleable solids and suspended sediment concentration.

The Department of Mining Engineering collected penetration resistance penetration depth and bulk density from the reclamation test cells. This data collection consisted of samples from Laurel Fork, 17 West mine, Bent Mountain and the Gibraltar mine. These samples were taken at 2, 6, and 12 inches in depth. These samples are presently being evaluated and quantified.

Additionally two tours were conducted on the research areas that were attended by 36 researchers, scientists and professional personnel. The following two papers were also presented during this quarter.

Angel, P.N., C.D. Barton, C. Graves, R. Sweigard and R. Warner. 2005. Improved Methods for the Establishment of Forests on Surface Mined Lands. American Society of Mine Reclamation Annual Conference; Breckenridge CO. June 13-16

Barton, C.D., P. Rothman, and P.M. Angel. 2005. American Chestnut and Mineland Reforestation. Board of Directors Meeting for the American Chestnut Foundation; Bristol, TN. April 16

CONCLUSIONS

No conclusions are yet determined as there is an additional quarter of data gathering to be completed and analyzed. This data analysis will be completed and presented in the project final report.