Strategies for Carbon Sequestration and Reducing Greenhouse Gas Emissions from Nursery Production Systems

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ABSTRACT

Over the past three decades, no issue has received more attention from the scientific community than global warming and the possible impacts it may have on the global environment. Increased atmospheric carbon dioxide (CO_2) concentration, along with those of other trace gases [i.e., methane (CH_4), and nitrous oxide (N_2O)], are widely thought to be the main driving factors behind global warming. Much of the work on reducing greenhouse gas emissions and on carbon (C) sequestration has been conducted in row crop and forest systems; however, virtually no work has focused on contribution from sectors of the specialty crop industry such as horticulture. Horticulture is a multi-billion dollar industry; the economic impact of the nursery, greenhouse, and sod industry was $2.8 billion in Alabama in 2008. The nursery industry needs to determine what contributions can be made to reduce the rise in atmospheric CO_2 concentration via enhanced C sequestration (capture and storage), and to reduce GHG from horticultural systems through changes in production management. The work described here represents initial efforts to address these issues. Studies focus on the effects of growth media on soil CO_2 efflux from outplanted horticultural species and on the effects of container size on trace gas emissions. Soil CO_2 efflux data, using a novel, continuous Automated Carbon Efflux Systems (ACES) have been collected and are being processed and analyzed. Trace gas emission samples have been collected and are being analyzed using gas chromatography.

INTRODUCTION

The well documented increase in greenhouse gases (GHG) has raised concerns regarding the potential for global warming and associated environmental impacts. Emissions of the three most important long-lived greenhouse gases have increased drastically since the industrial revolution. Carbon dioxide, CH_4, and N_2O concentrations in the atmosphere have increased by approximately 35%, 155%, and 18%, respectively, since 1750. Currently, experts in most economic sectors are searching for ways to reduce GHG emissions to reduce the C footprint from the world's largest industries. In addition to environmental concerns from C emissions, possibilities of strict new federal regulations and emission standards may cause many industries to drastically alter their production practices to comply with new laws.

Agriculture is one of the United States largest industries and contributed ~ 7% of the total US GHG emissions in 2005. Historically, agriculture has affected GHG levels in the atmosphere through cultivation and fertilization of soils, production of ruminant livestock, management of livestock manure, land use conversions, and fuel consumption. While agriculture has produced large amounts of GHG, new production practices have been shown to capture and store C, possibly making this large industry a future C sink. Much of the work on C sequestration has been done in forestry and row cropping systems; however, there is a need to determine what can be done by various sectors of the specialty crop industry to mitigate the influences of agriculture on climate change.

Horticulture is a multi-billion dollar industry. In Alabama, the economic impact of the nursery, greenhouse, and sod industry was $2.8 billion in 2008. However, no previous research has specifically addressed the environmental impacts of common horticultural practices. The nursery industry needs to determine what contributions can be made to reduce the rise in atmospheric CO_2 concentrations via enhanced C sequestration (capture and storage), and to reduce GHG from horticultural systems through changes in production management.

PROJECT OBJECTIVES

- ✓ Determine the carbon sequestration potential within nursery systems
- ✓ Develop strategies for increasing carbon sequestration above current levels
- ✓ Measure greenhouse gas emissions from nursery production systems
- ✓ Develop practices to reduce greenhouse gas emissions from nursery production systems

Effects of Growth Media on Soil CO_2 Efflux from Outplanted Horticultural Species

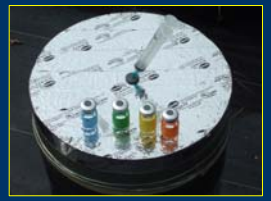
Automated Carbon Efflux System

Crape Myrtle (*Lagerstroemia* x 'Acoma')

Magnolia (*Magnolia grandiflora*)

Shumard Oak (*Quercus shumardii*)

Effects of Container Size on Trace Gas Emissions from Dwarf Yaupon Holly (*Ilex vomitoria* 'Nana')



PILOT PROJECT 1

In the first year, we are focusing on determining potential C storage techniques that can be implemented in the nursery and landscape industries (Objectives 1 and 2). The Horticulture Department at Auburn University has ongoing research to develop alternative substrates for horticultural production. This study utilizes three growth substrates: (1) Pine Bark (industry standard); (2) Clean Chip Residual; and (3) Whole Tree. Plants were grown in these differing substrates and then outplanted to the field. Initial soil samples were collected in Summer, 2009 for determination of soil C and N. At this time, Automated Carbon Efflux Systems (ACES; USDA Forest Service, Southern Research Station Laboratory, Research Triangle Park, NC; U.S. patent # 6,692,970) were installed adjacent to three plant species within this study [crape myrtle (*Lagerstroemia* x 'Acoma'), Magnolia (*Magnolia grandiflora*), and Shumard Oak (*Quercus shumardii*)] to continuously (24 hr d^{-1}) monitor C lost through soil respiration; these systems concurrently measure soil moisture and temperature. There are three replicate sampling chambers for each of the potting media x plant species combinations; there are also three chambers in non-plant areas. Biomass was and will continue to be assessed to determine the amount of C in plant material. Also, soil samples will continue to be taken to monitor changes in soil C. Having information on both inputs (biomass) and outputs (respiration) will allow determination of C sequestration potential in these potting media/plant species systems.

PILOT PROJECT 2

This pilot project will also focus on the effect of nursery container size on greenhouse gas (GHG) emissions to begin identifying components of the industry that may impact GHG emissions. If a direct relationship between the volume of potting media and gas emissions can be established, then future measurements in different management schemes could be potentially scaled to determine industry level impacts in different potting systems. In this study, dwarf yaupon holly (*Ilex vomitoria* 'Nana') is being grown in three container sizes commonly used in the nursery industry: (1) trade gallon; (2) gallon; and (3) three gallon. Potting media and growing practices follow Auburn University standard production practices. Greenhouse gas emissions are being assessed weekly from ten containers of each size with plants and five containers of each size without plants. Greenhouse gas emissions are being sampled *in situ* using the static closed chamber method according to USDA's Greenhouse Gas Reduction Through Agricultural Carbon Enhancement network (GRACEnet) protocols. Each container (with or without a plant) is placed inside a base PVC cylinder. A vented flux chamber is placed on top of the base cylinder. Gas samples for CO_2, CH_4, and N_2O are taken at 0, 15, 30, and 45 min intervals following chamber closure, allowing gas flux rate to be calculated from the change in concentration over the 45 min interval. Gas samples are collected with polypropylene syringes, injected into evacuated glass vials, and analyzed using gas chromatography (Shimadzu GC-2014).

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