From Forest Nursery Notes Winter 2013

75. © Effects of fertilizer placement on trace gas emissions from nursery container production. Marble, S. C., Prior, S. A., Runion, G. B., and Torbert, H. A. HortScience 47(8):1056-1062. 2012.

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Effects of Fertilizer Placement on Trace Gas Emissions from Nursery Container Production

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Additional index words. carbon dioxide, climate change, greenhouse gases, horticulture, methane, nitrous oxide

***Abstract*. Increased trace gas emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are widely believed to be a primary cause of global warming. Agriculture is a large contributor to these emissions; however, its role in climate change is unique in that it can act as a source of trace gas emissions or it can act as a major sink. Furthermore, agriculture can significantly reduce emissions through changes in production management practices. Much of the research on agriculture's role in mitigation of greenhouse gas (GHG) emissions has been conducted in row crops and pastures as well as forestry and animal production systems with little focus on contributions from specialty crop industries such as horticulture. Our objective was to determine efflux patterns of CO_2, CH_4, and N_2O associated with three different fertilization methods (dibble, incorporated, and topdressed) commonly used in nursery container production. Weekly measurements indicated that CO_2 fluxes were slightly lower when fertilizer was dibbled compared with the other two methods. Nitrous oxide fluxes were consistently highest when fertilizer was incorporated. Methane flux was generally low with few differences among treatments. Results from this study begin to provide data that can be used to implement mitigation strategies in container plant production, which will help growers adapt to possible emission regulations and benefit from future GHG mitigation or offset programs.**

Over the past several decades global warming has received increased attention from the scientific community including possible impacts of increased temperature on the global environment. Anthropogenically enhanced climate change is still highly debatable; however, emissions of the three most important long-lived GHGs (CO_2, CH_4, and N_2O) are known to have substantially increased in the past 25 years (Dlugokencky et al., 2005; Keeling and Whorf, 2005; Prinn et al., 2000). Experts in almost every industry are searching for ways to reduce GHG emissions and lessen their respective carbon (C) footprint.

One area of particular interest in GHG mitigation research is agricultural production. Agriculture occupies 37% of the earth's land surface producing ≈20% of total GHG emissions (Cole et al., 1997; Smith et al., 2008). High levels of CO_2 are emitted from agricultural production primarily through land use changes (deforestation), fossil fuel use, biomass burning, and soil disturbance accounting for 33% of total C emissions between 1850 and 1998, exceeding all other anthropogenic activities besides energy production (Houghton, 2003; IPCC, 2007; Johnson et al., 2007; Watson et al., 2000). Agricultural production is the largest contributor of anthropogenic CH_4 and N_2O emissions accounting for 52% and 84%, respectively, of annual anthropogenic global emissions (Smith et al., 2008). The major sources of CH_4 production from agriculture include enteric fermentation in ruminant animals, flooded rice fields, biomass burning, and manure management and storage (Cole et al., 1997; Johnson et al., 1993; USDA, 2008). Nitrous oxide emissions are a direct result of increased use of synthetic fertilizers and production of legumes, resulting in 80% of the total N_2O emissions in the United States (Mosier et al., 2003).

Agriculture production is unique compared with other industries in that it can act as a GHG source but can also act as a sink for GHG through changes in production management. Increased C storage through conservation or "no-till" has been shown to maintain or increase soil C levels and reduce fossil fuel use (Paustian et al., 1997; Reicosky et al., 1999; Smith et al., 1998). Methane emissions have been shown to be greatly reduced by adding feed supplementation to the diets of ruminant animals and by proper manure handling (Cole et al., 1997; Leng, 1991; Lin et al., 1994; Safley et al., 1992). Nitrous oxide emissions can be reduced by improving nitrogen (N) use efficiency (Kroeze et al., 1999; Kroeze and Mosier, 2000). Proper N fertilization timing (Weier et al., 1993) and placement (Oenema et al., 2001; Youngdahl et al., 1986) have also been shown to successfully reduce total N loss.

Several best management practices have been developed for reducing emissions of CO_2 (Paustian et al., 2000), CH_4 (Mosier et al., 1998), and N_2O (Snyder et al., 2007) from agricultural production. Other programs such as Greenhouse Gas Reduction through Agricultural Carbon Enhancement network (GRACEnet) have also been initiated by the USDA-ARS to focus on reducing GHG emissions by altering current agricultural production practices. Past research has focused predominantly on agronomic, forestry, and animal production systems with little attention given to specialty industries such as horticulture. The green industry (nursery, greenhouse, and sod production) is one of the fastest growing sectors in agriculture (Hall et al., 2005); however, almost no research has focused on the impacts of this industry on GHG emissions.

Providing best management options for reducing GHG would not only reduce the environmental impact of the industry, but could benefit growers financially. There are now government and industry programs that provide tax incentives and payments to encourage farmers to reduce emissions and provide C offsets by altering current production practices (Chicago Climate Exchange, 2009; Environmental Protection Agency, 2009; National Farmers Union, 2009; Schmidt, 2009). There is also speculation that agricultural GHG emissions could be "capped" or taxed in the future (Adams, 2009; Blanford and Josling, 2009; Moore and Bruggen, 2011).

Received for publication 2 Apr. 2012. Accepted for publication 1 June 2012.
This work was supported by the USDA-ARS Floriculture and Nursery Research Initiative and the Horticulture Research Institute.
We thank Barry G. Dorman and Gary M. Foster for technical assistance.
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