Short-term C-fluxes in Biosolid-Amended Soils During Turfgrass Establishment

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In a world increasingly aware of climate change, researchers are evaluating what plant systems are sequestering C released from the burning fossil fuels and C released from soil disturbance. Coupling use of biosolids amendments with sod production may be one way to both enhance sustainability of the industry and sequester C.

Research has evaluated C-sequestration in prairies; agriculture; golf courses; turf systems with biosolids additions; and more. Many of these studies focus on established vegetation or estimates of the change in Soil Organic Carbon (SOC) and not gas exchange measurements.

Sod production is unique, consisting of initial plowing or cultivation followed by seeding and an 18- to 24-month production cycle where at the end, 12-18 mm of soil is removed with the plant material. What happens to gas exchange of CO_2 from the time of plowing, incorporation of biosolids, through full vegetative cover? Our study's objective was to determine gaseous C-flux from biosolids amended and non-biosolids amended soil over the course of preplant cultivation, through germination, and achievement of full turfgrass cover.

FIGURE 1

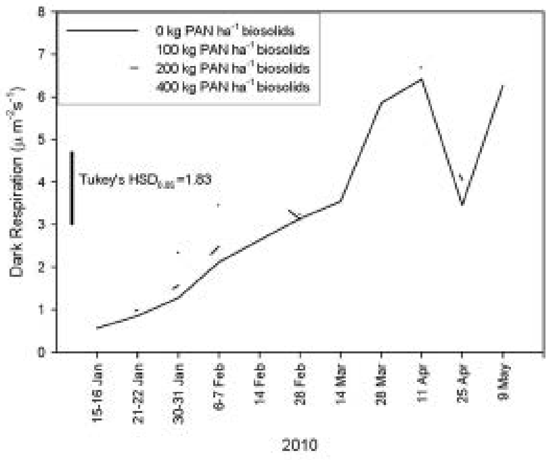

Figure 1: Post-plant dark respiration (μ m^{-2}s^{-1}) as affected by biosolids rate and date over the course of the 16-week establishment study. Respiration readings taken at two-week intervals after first month. Biosolids rates: 0, 100, 200, and 400 kg Plant Available Nitrogen (PAN) ha^{-1}.

The experimental design for a 16-week greenhouse study (January, 10 2010 to May 11, 2010) was a randomized complete block with five replications. Main plots were vegetated and non-vegetated containers, while subplots consisted of 0, 100, 200 and 400 kg Plant Available Nitrogen (PAN) per hectare from biosolids (control, low, medium and high). All containers were thoroughly watered and sown with 35 kilograms per hectare Kentucky bluegrass (*Poa pratensis* L.).

All treatments received 50 kilograms PAN per hectare from urea monthly to ensure N was not a limiting factor. CO_2 flux measurements were collected using an infrared gas analyzer (model LI-6400 XT, LI-COR, Lincoln, Nebraska). CO_2 flux measurements were initially made at frequent intervals to capture any C-flux from container packing, initial watering and seeding.

In the absence of vegetation during the first three weeks, CO_2 flux measurements were confined to dark respiration (Rd) measurements using LI-COR's soil respiration chamber. Once vegetation was present, measurements were collected at two-week intervals using a custom built, clear acrylic chamber with dimensions to match the soil chamber to estimate Gross Primary Productivity (GPP) followed by Rd with the soil chamber. Quality ratings (1-9 scale) and clippings were collected weekly.

Biosolids rate significantly affected preplant Rd between the control and high rate of biosolids. Rd for the high rate was nearly double that of the control (data not shown). Post-plant Rd nearly quadrupled with vegetation by the end of the study as the plants grew and matured while the non-vegetated treatment remained relatively steady throughout the study (data not shown). Post-plant Rd was affected by biosolids rate and date due to some significant differences between the control and

FIGURE 2

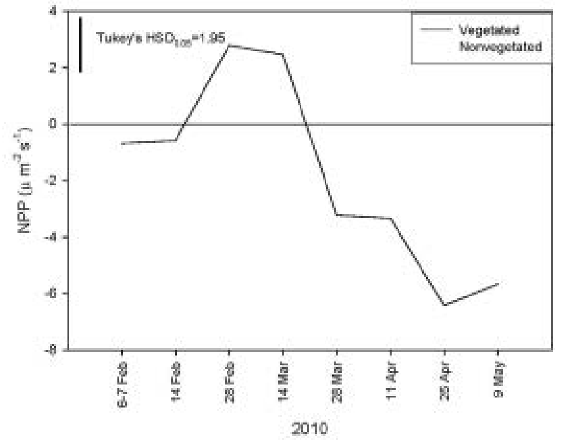

Figure 2: Net Primary Productivity (NPP) (μ $m^{-2}s^{-1}$) as affected by vegetation and date over the course of the 16-week establishment study. Readings taken at two-week intervals after first month.

FIGURE 3

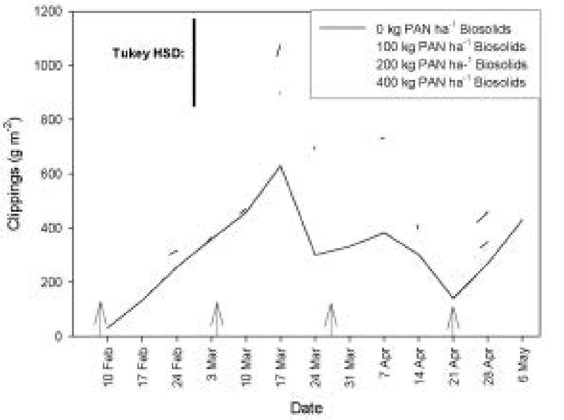

Figure 3: Weekly clipping yield during course of 16-week establishment study with preplant biosolids application rates of 0, 100, 200, and 400 kg Plant Available Nitrogen (PAN) ha^{-1}. Arrows indicate leaching events (dotted arrow) or fertilization with urea at 50 kg PAN ha^{-1} (solid arrow). Statistically significant day*treatment interaction ($P<0.0000$). Tukey's HSD=330.

high biosolids rate on a few days (Figure 1).

GPP was affected by both vegetation and date. GPP rate increased during the time of rapid growth relatively early in the study and decreased about midway through the study possibly due to supraoptimal temperatures for Kentucky bluegrass (data not shown).

Net Primary Productivity (NPP) was affected by vegetation and date. NPP increased as vegetative cover developed for several weeks following germination (Figure 2).

NPP declined as the plants matured and temperatures increased above optimum for Kentucky bluegrass. Clipping yield was highly dynamic, peaking after N-fertilization events and tending to decline after thorough watering events. The period of high growth during the weeks of February 14 through March 14 when NPP was positive is evident in the clipping yield during those same dates by continued increases in clipping weights each week. The high rate consistently produced more clippings than the other treatments, and was statistically different on a few separate dates, but that was primarily between the control and high rate (Figure 3).

Turf quality increased for all treatments through mid-April; however, at this time, powdery mildew development greatly decreased the quality of the high biosolids rate while the other treatments saw continued increases in quality (data not shown).

Biosolids amendments to sod fields increased pre-plant Rd; increased post-plant Rd in some instances; increased clipping yield; and increased quality until disease pressure was too high. NPP was not affected by biosolids but declined once turf began to mature and as temperatures increased above optimal, indicating there may be conditions under which turfgrass systems may serve as a source of CO_2 emissions. The conclusion of whether or not turfgrass or a turfgrass system amended with biosolids is really sequestering an ecologically important quantity of C cannot be answered by gas-exchange data alone and would need supporting data on C content of the soil, plant tissue and dissolved organic C in leachate. Sample analysis of all these factors is in progress with this 2010 study as well as a 2011 run of the study to examine year to year differences.

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Ad Index

Advertiser	Page
The Andersons	5
Audubon	27
B A S F Corp	9, CV3
Bell Laboratories	35
Buffalo Turbine	6
DuPont	11
Duro Tire	21
Golfdom Summit	34
GroPower	2
Jacobsen	CV2
John Deere	28
Knox Fertilizer	BB, 3
Kochek	17
Lebanon Turf	CV4
PBI/Gordon	7
Seago	2
Sonic Solutions	23
Sto-Cote	17
Syngenta	13
White Metal Golf	17
Wireless Solutions	35