Understanding the carbon balance in turfgrass ecosystems

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Public concerns about climate change, and a growing number of government and business commitments to emissions reductions have increased focus on carbon sequestration in vegetated landscapes as a nature-based climate solution. Turfgrasses are broadly used for sports (golf, football, soccer, baseball, tennis, etc.), residential and commercial areas (home lawns and commercial real estate), and public municipalities (parks, schools, and roadsides) in the urban system, and have the potential to mitigate urban CO_2 emissions. Considering this, the overarching objective of this project is to determine the impact of high versus low levels of mowing, nitrogen fertilization, and irrigation on carbon sequestration of cool-season turfgrass. Our goal is to evaluate trade-offs between the resources required to maintain healthy turf, its carbon sequestration potential, and to ultimately develop recommendations to minimize the greenhouse emissions associated with turfgrass maintenance. To research this objective, we conducted an extensive review of the current literature and performed a meta-analysis. We also initiated several field trials in Corvallis, OR.

Findings produced from the literature review/meta-analysis showed that newly established turfgrass is usually a substantial carbon sink, rapidly accumulating carbon in the soil for more than a decade. As turfgrass matures, carbon sequestration rates diminish and reach a carbon neutral state around 50 years after establishment. This is due to the fact that as soils accumulate more organic matter, soil microbes also acclimate and decompose organic matter more quickly, so that accumulation eventually ceases and the total quantity of organic matter stored in soil levels off. An estimate of net greenhouse gas emissions determined that recently-established turfgrass (less than 10 years old) is a CO_2 sink on average even when including emissions from mowing and fertilization practices. This analysis also suggested that the use of synthetic fertilizers is a major source of greenhouse gas productions within turfgrass management. Using locally-sourced compost, rather than synthetic nitrogen fertilizer, could potentially help to reduce fertilizer-related emissions

We wanted to know if turfgrass continued to be a net carbon sink if irrigation, mowing frequency, and N-fertilizer amounts were reduced. To quantify this, several field trials were initiated at the OSU Lewis-Brown Farm in Corvallis, OR. For these projects, we are utilizing two methods to quantify CO_2 uptake and emissions between turfgrass and the atmosphere. The first method captures high-frequency dynamics on one field, and uses an automatic clear chamber system (EoSense Inc., Dartmouth, Nova Scotia, Canada) which measures CO_2 exchange every hour under optimum management practices (weekly mowing, fertilization four times per year, and daily irrigation during periods of heat stress). This method of data collection provides a continuous measure of CO_2 exchange rate throughout the year, and allows us to calculate an annual carbon budget (Figure 1). The second method allows us to measure more plots and treatments, using a portable, manual, clear chamber system (PP Systems, Amesbury, MA). We use this device to measure CO_2 exchange at mid-day, when turfgrass is growing most actively, once every two weeks from plots receiving different management practices of mowing (2 inches and 4 inches), fertilization (0 and 4 lbs. N per 1,000 sq ft per year), and irrigation (non-irrigated control to 0.6 cm of precipitation applied four times per week (June through September) (Figure 2).

Preliminary data from the field trials suggests that in our local climate (Willamette valley, OR), cool-season turfgrass was able to assimilate atmospheric CO_2 at high rates during cool months which suggested a winter carbon sink. During summer, environmental stresses including heat and drought can largely reduce the ability of cool-season turfgrass to assimilate atmospheric CO_2. Fertilization and mowing height can affect CO_2 flux rates during cool months. When differences were observed, turfgrass maintained at the 2" mowing height sequestered more carbon on average than the turfgrass mowed at a 4" height. This is likely because the lower mowing height is stimulating more lateral growth or turfgrass density. During the cool months, fertilization typically increased turfgrass carbon sequestration. Fertilizer applications did not improve summer carbon sequestration. These results would suggest that fertilizer applied during periods of peak growth and development will stimulate growth and improve carbon sequestration, and fertilizer applications should be avoided during periods of environmental stress (i.e., the summer months). Summer irrigation provided very little to no improvements in carbon sequestration. This is likely because irrigation not only increased turfgrass growth, but it also increased soil microbial activity, prompting decay of soil organic matter and releasing CO_2 into the atmosphere. So far, our findings suggest that management practices (mowing, fertilization, and irrigation) have limited effects on CO_2 flux rate. Therefore, low input turfgrass is likely a good choice for reducing management inputs while maintaining carbon sequestration and other environmental benefits.

We will continue to collect data to calculate an annual carbon balance, which will provide a better understanding of the cool-season turfgrass system in our local environment. This effort will provide information on the net emissions of turfgrass, which will help allow turfgrass professionals to explain their environmental impacts to a concerned public and identify risks and opportunities associated with emerging carbon programs. We also hope to identify best management practices for enhancing carbon sequestration and to deliver these results to turfgrass seed producers, turfgrass managers (golf course superintendents, commercial turfgrass managers, school and park employees), and other users (home owners and master gardener programs).

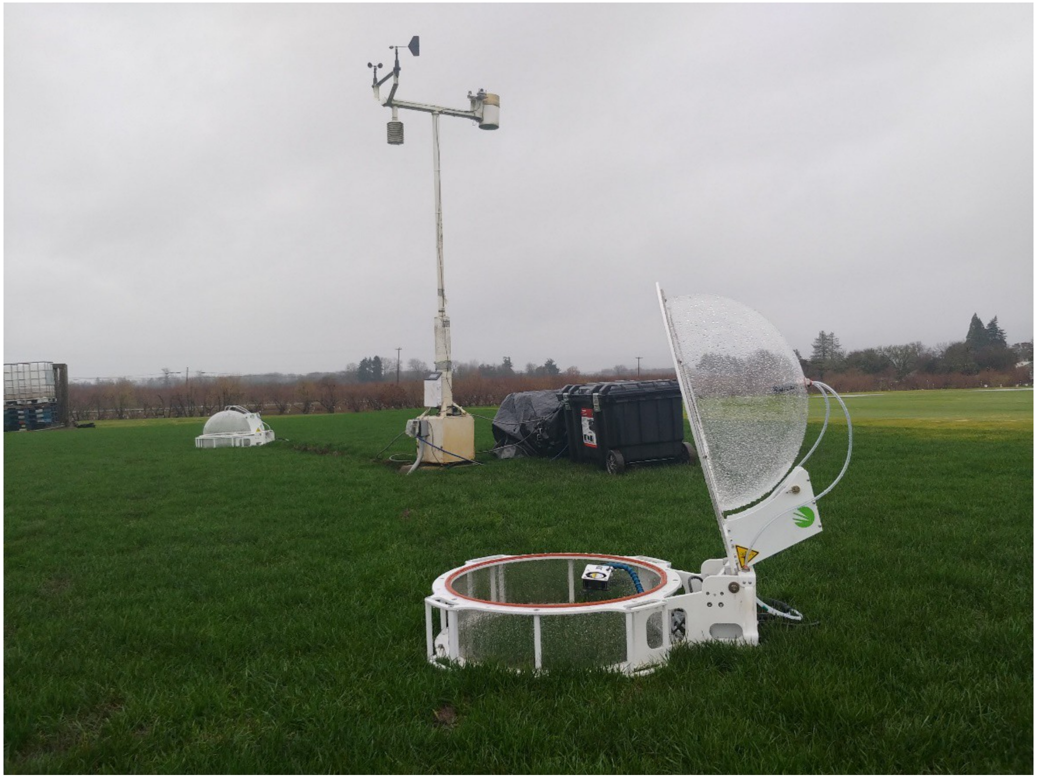

Figure 1: CO_2 flux is recorded every hour with two automatic chambers on a new stand of perennial ryegrass at the Lewis-Brown Horticulture Farm in Corvallis, Oregon.

Figure 2: Carbon sequestration is collected every two weeks on a subset of treatments focusing

on mowing, irrigation, and fertility trials on a mixed stand of cool-season turfgrasses.