SOIL CARBON AND NITROGEN DYNAMICS IN A SILVOPASTURE AGROFORESTRY ECOSYSTEM IN NORTH ALABAMA

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ABSTRACT

Agroforestry systems are used to manage, maintain and develop the ecosystem with the aim of achieving agricultural and economic growth which also helps in sustaining the environment. The study was conducted at the Winfred Thomas Agricultural Research Station, Hazel Green, Alabama in the Tennessee Valley Region of North Alabama in 2011 and 2012. A total of 13 treatments were used in a split-plot experimental design. Soil samples from the study area were analyzed for soil pH, total soil C and N. Data for soil moisture, soil temperature and soil CO₂ fluxes were collected in the field. Inorganic fertilizer application increased total soil C in the fertilized plots, by an average of 91% in the 0-90cm soil depth. Forest plantations plot had higher total soil N and C, compared to the agroforestry plantation suggesting a higher potential for soil C and N sequestration in the densely planted system compared to the wider agroforestry planting. Soil CO₂ fluxes in the grass pasture system were consistently higher compared to those in the loblolly pine plots prior to grazing. The soil CO₂ fluxes were significant and highly correlated to the soil temperature in the silvopasture plots. Changes in total soil C due to management practices usually take time to be realized. Therefore, with time, forage production and litter accumulation, due to fertilization application, can increase soil C storage due to more biomass input.

RESULTS AND DISCUSSION

There were no differences in TSN content between the no-fertilized (NF) control plots and the fertilized (FF) plots at each soil depth in 2013 Figure 1. In 2012, TSN in the fertilized plots were 22.5% , 80%, 75%, 50%, and 25% higher compared to the unfertilized control plots in the 0-5 cm, 5-15 cm, 15-30 cm, 30-60 cm, and 60-90 cm soil depths, respectively. Figure 2.

Total Soil N in the standard forest plots was significantly higher than that in NF and FF plots in the 0.15 cm soil depth in 2011, whereas in 2012, TSN in the standard forest plots was higher than that in the unfertilized plots.

The higher TSN in the forest plantation plots indicate a higher potential for soil C sequestration in the densely planted system compared to the wider agroforestry planting.

There was significant difference in the TSN in 2011 and 2012 (Anova Table 3).

Soil Carbon dioxide (CO₂) Fluxes, Temperature and Moisture

Soil CO₂ fluxes were significantly and highly positively correlated to soil temperature in the silvopasture plots (r = 0.2289; p=0.0001) and negatively correlated to soil moisture content (r = -0.3609; p=0.0001). A positive correlation between soil temperature and soil moisture, basically means that CO₂ fluxes increase when temperature is high and it decreases when the temperature is low. The results from this study are in agreement with reports other scientists who also found weak correlations between CO₂ fluxes and soil water content.

Results from many models have suggested that climate warming will accelerate the release of carbon dioxide from soils, leading to additional warming. Temperature and water content are the factors most commonly related to temporal variation in CO₂ efflux from soil (Davidson et al., 2000).

Amongst several other factors, agricultural management strategies have an effect on both the emission of CO₂ from soil and its sequestration capacity in soil. According to Goshul et al. (1995), such practices are of importance not only in terms of agricultural sustainability but also in issues related to climate change.

MATERIALS AND METHODS

Research Site

The study is conducted at the Winfred Thomas Agricultural Research Station, Hazel Green, Alabama (latitude 35° 45' N and longitude 86° 59' W) in the Tennessee Valley region of north Alabama. The soil at the study site is a Decatur silt loam (fine, kaolinitic, thermic, Rhodic Paleudult). An existing loblolly pine agroforestry planting and loblolly pine plantation.

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Data Collected

Soil Sampling: Soil was sampled using a tractor mounted soil probe (0-5, 5-15, 15-30, 30-60 and 60-90 cm) depths respectively.

Soil pH: This was measured using an Accumet pH meter.

Temperature: Temperature was measured using the Munnix digital soil thermometers inserted in the 0-15 cm soil profile.

Moisture: Soil moisture was measured using a Delta-T PR2 soil moisture probe (Delta-T Devices Ltd. Cambridge, England) attached to a Delta-HZII readout unit (10, 20, 30, 40, 60 and 100 cm depths).

Soil CO₂ Fluxes: This was measured using the portable IRGA based LI-6400-09 (LI-COR, 1997) soil CO₂ flux measuring system (LI-COR Inc. Lincoln, NE).

Soil Total C and N: Total C and N was analyzed using the dry combustion (Dumas method), with LECO TruSpec CN analyzer.

REFERENCES


