Agricultural Greenhouse Gases Program (AGGP)

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Perennial Vegetation Increases Root Respiration but not Microbial Respiration in Agroforestry Systems

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The Motivation

In order to fully understand the impact of management practices on greenhouse gas (GHG) balance in agricultural systems, the components of soil respiration: autotrophic (Ra, root) and heterotrophic (Rh, microbial) respirations need to be studied. It is the microbial respiration that causes soil organic carbon (C) to be lost from the system and contributes to global warming. While Ra and Rh can each account for about 50% of total soil respiration, this ratio varies widely among ecosystems. This study aims to determine the impact of agroforestry systems and land use type on Ra to Rh ratio and ecosystem GHG balance.

Methods

We selected 36 sites for three agroforestry systems: 12 each of hedgerow, shelterbelt (white spruce dominated) and silvopasture (aspen dominated) sites. The sites were distributed across a 250 x 300 km area centered around Edmonton, spanning from the Dark Brown Chernozemic to the Dark Gray Chernozemic soil zones. In each site, plots were set up in the forested area and in the agriculture production area (herbland, including grazed pasture and annual crop production areas). Environmental parameters and Ra and Rh (using a modified root exclusion method) were determined over two growing seasons in 2013 and 2014. The temperature sensitivity of soil respiration (both Ra and Rh) was analyzed.

The Result

Over the two growing seasons, mean Rh across all treatments was 54% of the total respiration. Within agroforestry systems, Rh accounted for more of the total respiration in herbland (59%) than in forest land cover type (41%), indicating that more of the soil C was being mineralized and released to the atmosphere in the herbland. Sensitivity of Rh to temperature was greater in herbland than in forest land cover type, while that of Ra was greater in forest than in herbland.

The temperature sensitivity of Ra was consistently greater in silvopasture than in hedgerow and shelterbelt, but the opposite was found for Rh, indicating that in terms of soil organic C, there was a better mechanism for conservation in the silvopastoral system.

Implications

Measuring total respiration alone can suggest a totally different conclusion. The Rh data is consistent with other measurements (such as soil C content) among agroforestry systems and between land uses that the forested land use has a lower rate of soil C loss than the herbland.

Maintaining perennial vegetation cover reduces GHG emissions (particularly microbial respiration) from the agricultural landscape in central Alberta.

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