Conventional and Organic Management Effects on Annual and Perennial Root Biomass

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Introduction

Roots are the primary carbon input to soils and play an important role in regulating the terrestrial carbon cycle. However, accurately assessing root carbon inputs remains a challenging task, especially deciphering the effects of management practices on root carbon quantity. Recent breeding efforts have developed perennial crops that produce edible grains without the need to replant or till every year. It is projected that these crops will provide more ecosystem services than annual crops. Research regarding ecosystem services in these intensively managed perennial crops is scarce and belowground C dynamics are unknown. This experiment compared annual winter wheat and perennial intermediate wheatgrass root biomass under conventional and organic management practices.

Figure 1. Annual Winter Wheat (Left) and Perennial Intermediate Wheatgrass (Right)

Objectives

- Determine the quantity of root biomass for annual winter wheat and perennial intermediate wheatgrass
- Investigate the effects of management on root biomass for both species
- Assess root turnover for both species

Methods

Table 1. PWES Management History

	Age of Stand	Planting Date	Sampling Date	Harvest Date
Annual Winter Wheat	1 Year	Oct. 8, 2010	June 17, 2011	July 21, 2011
Perennial Intermediate Wheatgrass	2nd Year	Nov. 12, 2009	June 17, 2011	Aug. 17, 2011

Figure 2. KBS, Hickory Corners, MI

- **Study:** Perennial Wheat Ecosystem Services (PWES)
- **Location:** Kellogg Biological Station (KBS), located in Southwest Michigan
- **Experimental Design:** Split-plot randomized complete block design. Replicated four times.
- **Sampling:** Roots were extracted from deep soil cores (1m)
- **Root Separation:** Dry and wet sieving (coarse and fine roots)
- **Root Turnover:** A Bartz Technology® minirhizotron camera was used to determine root turnover
- **Statistical Analysis**: Data was analyzed using Proc Mixed in SAS ($p \leq 0.05$)

Results

Total Coarse Root Biomass

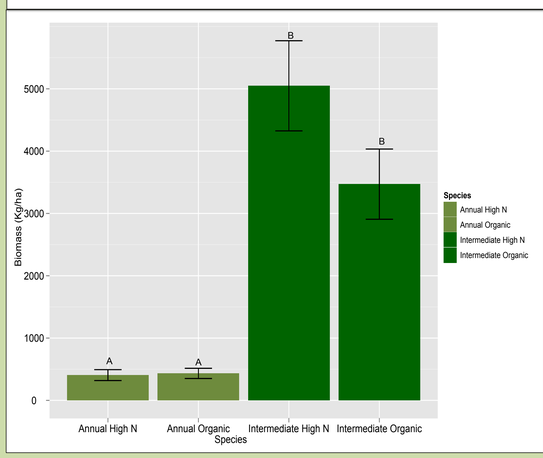

Figure 3. Total coarse root biomass across a management and species gradient. Biomass was significantly higher in perennial intermediate wheatgrass compared to annual winter wheat. Values indicate a trend towards management effects (conventional high N and organic) on root biomass as well.

Coarse Root Biomass by Depth

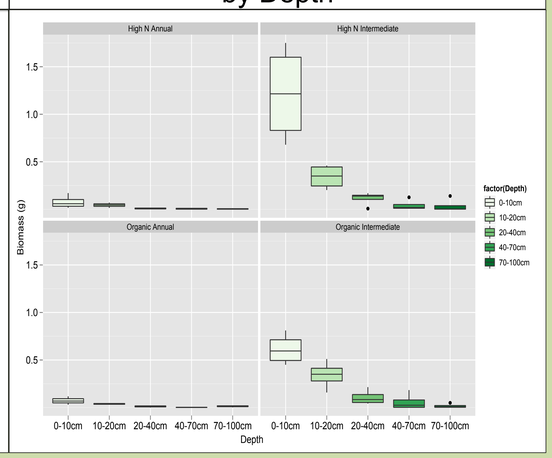

Figure 4. Total coarse root biomass by depth. In general, root biomass decreased by depth. A significant difference in root biomass between conventional high N and organic intermediate wheatgrass was evident at 0-10cm.

Total Aboveground Biomass

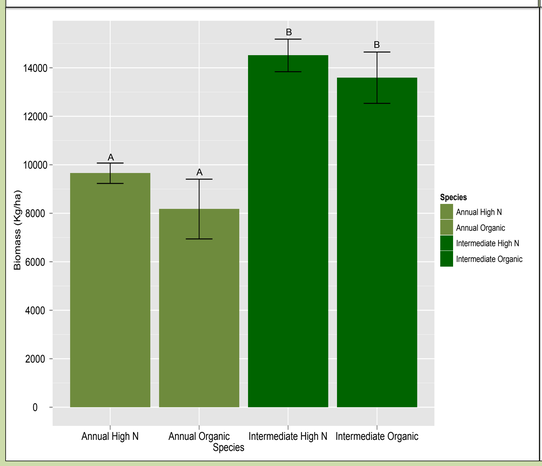

Figure 5. Total aboveground biomass across a species and management gradient. Intermediate wheatgrass had significantly higher aboveground biomass than annual winter wheat.

Coarse Root to Shoot Ratio

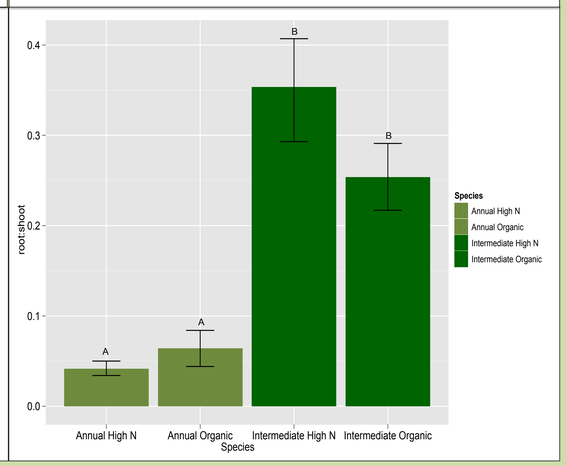

Figure 6. Coarse root to shoot ratio across a species and management gradient. Intermediate wheatgrass had significantly higher root:shoot ratios compared to annual winter wheat.

Root Turnover

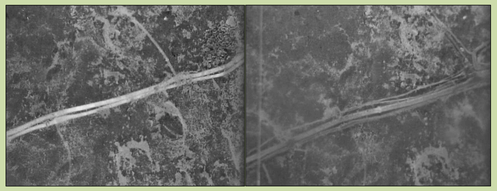

Figure 7. Annual winter wheat root turnover. Images captured in June 2011 (left) and September 2011 (right). Roots started visibly decomposing 8 weeks after harvest.

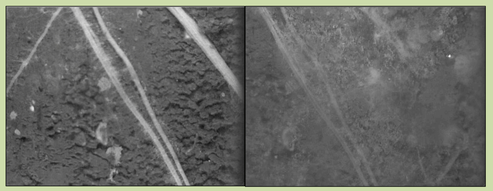

Figure 8. Intermediate wheatgrass root turnover. Images captured in June 2011 (left) and September 2011 (right). Roots started visibly decomposing 5 weeks after harvest.

Conclusions

- Intermediate wheatgrass total coarse root biomass was five times greater than annual winter wheat total coarse root biomass. This has large implications for soil carbon storage.
- Annual winter wheat and intermediate wheatgrass allocate biomass differently.
- Root biomass steadily decreases by depth.
- Strong trend towards a species and management interaction.

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