Effects of Silvopasture Techniques on Root and Soil Health

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Introduction

Silvopasture is an agroforestry management plan that incorporates trees, forage, and grazing animals into a single system in order to achieve optimal environmental biodiversity, sustainability, and productivity (Jose, 2019). The main reasons for the absence of widely implemented silvopastural practices is that there are few examples, and the cost of establishment is relatively high (Orefice et al., 2017). It can be daunting to completely change a farming system without assurance of it being successful. This system manages relationships and boundaries between agricultural and environmental aspects (Beckert et al., 2016). While all parts of the design are crucial for the highest level of productivity, this study explores the connection between basal area (tree density), forage, root nutrient acquisition, and soil productivity.

Objectives and Hypothesis

- The objective of this study was to examine how basal area and vegetation type affect root structure and soil health.
- The hypothesis was that basal area and vegetation type significantly affect belowground productivity.

Materials and Methods

Site Description

- The experimental site is 21.55 acres, located within the Arkansas River Valley ecoregion at USDA-ARS Research center in Booneville, AR (N35°05.56 W93°57.880).

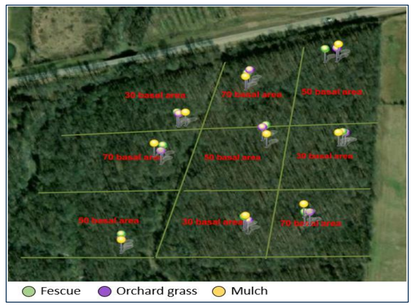

Figure 1. Map of Booneville site with different basal areas and treatments. Sample locations are indicated by the pushpin icons.

- The site was divided into 9 plots (Fig. 1) of 3 replicated basal areas (30, 50, and 70 ft^2 per acre).
- Within each basal plot, 3 forage subplots (22.3 m^2) established and seeded in 2020 (Fig. 2): fescue, orchard grass, mulch.

Sampling and Analysis

- 27 samples were collected using a soil auger for root fragments and soil analysis.
- Aboveground biomass collected using randomly placed 0.25-m^2 quadrant and hand-shearing vegetation.
- Soil analyses: pH, EC, organic matter (OM), particulate OM, and gravimetric water content (WC) by oven drying.
- Root fragments were separated from soil for biomass and structure analysis utilizing a root scanner (Fig. 2).
- Data analyzed by two-way ANOVA and means separation (P = 0.05, n = 3).

Figure 2. Orchard grass plot within the silvopasture site (left), and roots collected to be scanned for length and structure (right).

Results and Discussion

Root Biomass

- Orchard grass root biomass increased compared to the mulch control (Fig. 3).
- There was no significant difference between basal areas (P > 0.05).

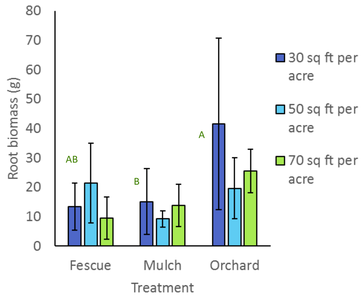

Figure 3. Mean (± standard deviation) root biomass (n =3). Forages with different letters above bars are significantly different (P < 0.05).

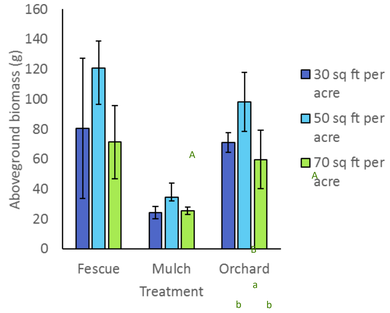

Figure 4. Mean (± standard deviation) aboveground biomass (n = 3). Forages with different capital letters and basal areas with different lower case letters (shown in mulch) above bars are significantly different (P < 0.05).

Aboveground Biomass

- Aboveground biomass increased in 50 compared to 30 and 70 ft^2 per acre (Fig. 4).
- There was no significant difference between the basal areas of 30 and 70 ft^2 per acre.
- Vegetation increased aboveground production.

- Productivity difference might be caused by the plants preference for a middle intensity light canopy.

Specific Root Length

- There is no relationship between specific root length and basal area (P > 0.05, Fig. 5).
- Specific root length (SLR, similar to aboveground biomass, Fig. 4) was greater in fescue and orchard grass than the mulch control.
- Vegetation increased belowground production as well as aboveground.

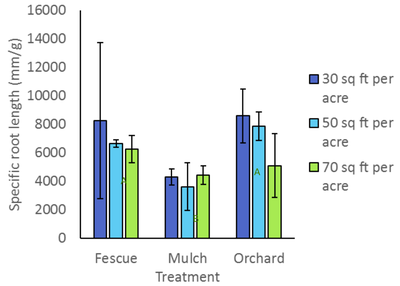

Figure 5. Mean (± standard deviation) specific root length (n = 3). Forages with different letters above bars are significantly different (P < 0.05).

- Basal area did not affect root structure, electrical conductivity, water content, or particulate or soil organic matter (Fig. 6, P > 0.05), but pH in 30 was lower than 70 ft^2 per acre (data not shown, P < 0.05).

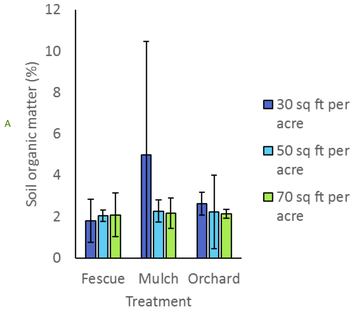

Figure 6. Mean (± standard deviation) % soil organic matter (n = 3). Forages with a similar letter above bars are not significantly different (P > 0.05).

Discussion

- Basal area did not have a short-term effect on belowground productivity or soil health, while forage affected root structure.
- Many properties within a forest system such as soil and nutrient cycling change on a relatively slow timeline, which often prevents results from developing until a passed.

Conclusions & Implications

- Silvopasture management practices increased production within one growing season, but did not have sufficient verification for soil health to be effective methods within one growing season without further evidence.
  - More research should be done to explore the effect silvopasture has on soil health.
  - Different forage treatments could be used, or longer time could be spent allowing the soil to adjust.
- There was no clear simple significant association between forest tree density, forage, and soil productivity in one growing season.
  - Silvopasture techniques should be studied for long-term impacts in regards to soil responses.
  - Relationships between the species in the system are complex and present challenges in identifying relationships between variables.
  - Fluctuation in results may depend on other variables besides basal area and vegetation type.

References

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