From Seasons to Regions: Unraveling the Productivity and Fuel Moisture Variations of C3 and C4 Grassland Species

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Introduction

- Wildfire frequency is closely tracked. Data shows a steady increase since 2004 with burned acreage growing to a noticeable extent almost every month. Simultaneously, wildfire seasons occurs earlier each year (1).
- Recent research highlights the critical ecological role of grasslands due to their unique biodiversity (2).
- Species composition and moisture content of grassland plants influence wildfire behavior.
- Varied growth forms of C3 and C4 species could impact fire frequency and intensity.

Research Question: How does the productivity and fuel moisture of C3 and C4 dominated communities differ? Does it vary through time and space?

C3 Photosynthesis

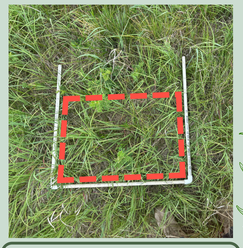
- Sensitivity to both drought and intense direct sunlight, making an earlier and cooler growth period more suitable (3).
- Typically smaller in size than C4 species (4).

C4 Photosynthesis

- Productive use of limited water availability curbs seasonal restrictions experienced by C3 species (3).
- Compared to C3, growth is more efficient; therefore, they tend to be larger under climatic stress (4).

Methods

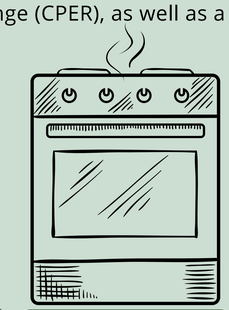
- **Determine C3 vs C4 Grassland Species**
- **Data Collection and Processing**
  - 2023 Flammability Project: Samples from 120 Boulder, CO plots
    - Plots differentiated by top three prominent species: species coverage of **>50% C4 = C4 dominant** vs. **>50% C3 = C3 dominant**
  - 2024 Field Moisture Project: Randomized locations at the Central Plains Experimental Range (CPER), as well as a restored grassland west of Ault, CO. Biomass was similarly collected, but bagged individually by species



Green standing biomass cut and placed in paper bag.

Dry litter collected and placed in separate paper bag to standing biomass.

Plot is cleared. Collected biomass' weighed, recorded, and placed in oven.



Biomass is heated at low temperature to remove all moisture.

Percent moisture determined by ***(wet - dry mass) / dry mass***

- **Data Analysis in R**

Results

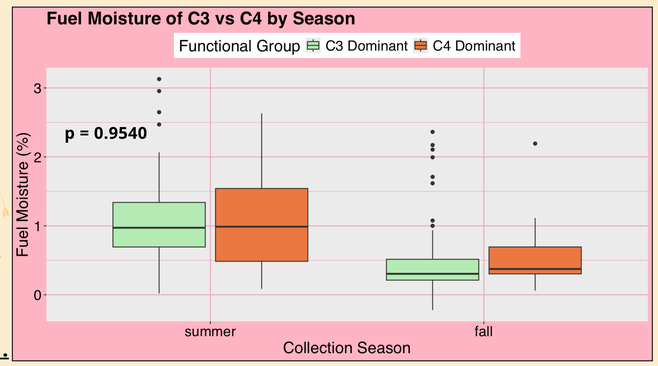


Fig. 1. There were no significant differences observed between the fuel moisture of C3 and C4 functional groups, within a season, collected in 2023.

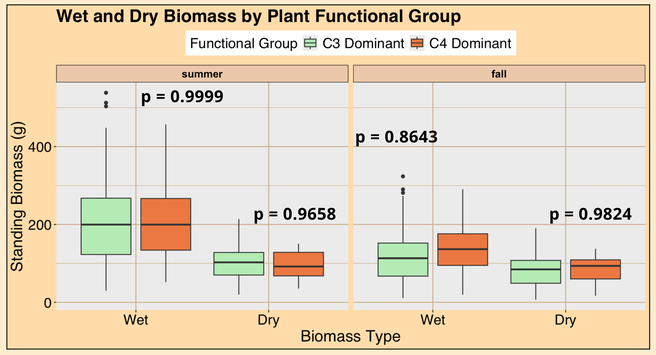


Fig. 2. Similarly to the fuel moisture analyzed in Fig.1., the wet and dry biomass of C3 and C4 species, also collected in 2023, did not show any significance.

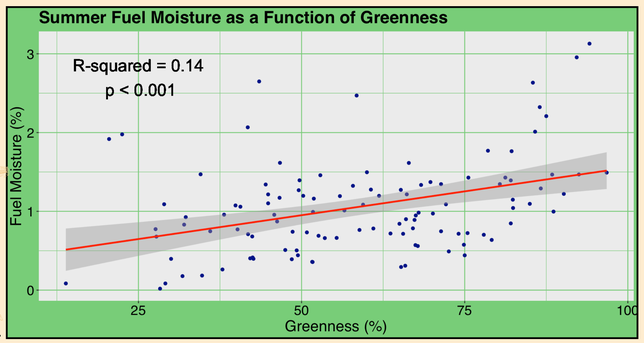


Fig. 3. There is a significant correlation between plot level fuel moisture and percent greenness during the 2023 summer months of July and August. This explains the fundamental relationship between a plant's access to water, water content and the percent photosynthetic green tissue that is living.

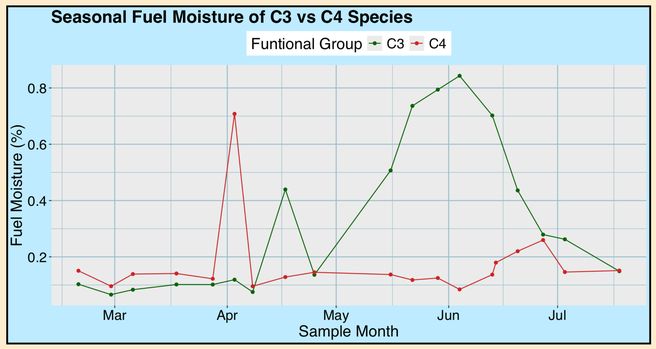


Fig. 4. There is a significant difference in the fuel moisture between C3 and C4 species over the course of the growing season (p = 0.0187) as seen in the 2024 Field Moisture data. C3 and C4 species tended to follow a general trend of increasing in fuel moisture either early or late in the season. In some instances there are exceptions amongst species regardless of C3 or C4 trends.

Discussion & Conclusion

- Results from July and August showed minimal differences in biomass weight (**Fig.2.**) and fuel moisture levels between C3 and C4 species (**Fig.1.**).
- **Fig.3.** Illustrates a foundational understanding that a greener landscape will have a higher percent moisture. Playing a relevant role both in species growth and flammability when moisture is not present.
- Seasonal variation in C3 and C4 species was generally estimated correctly. A majority of C3 growth, indicated by increasing moisture, occurred earlier in the season between April and May; whereas, C4 species began to show a similar upwards slope between June and July (**Fig.4.**). Furthermore, near the end of July, the lines display a final intersection, showing us an equilibrium represented by much of the data. This is where C3 species are beginning to dry as C4 continue growth.

Minimal differences found in C3 vs. C4 fuel moisture and biomass, suggesting their varied growth styles likely do not have a consequential effect on wildfires' behavior. However, categorizing a plot as C3 or C4 dominant at 50% coverage may not fully respect the actual species composition present to an acute level. This leaves potential for the data and its final outcome to be skewed. Furthermore, the two-year timeframe of the data has limitations when capturing long-term ecological dynamics. Without including climatic data especially, it is challenging to assess the scope of growth variability from one year to the next. This study provides a foundation for further exploration of C3 and C4 species in response to seasonal changes and their potential impact on wildfire risk in grassland ecosystems.

REFERENCES
ACKNOWLEDGMENTS
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