Setaria: The effect of root limitation on biomass in *Setaria*

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Intro

Setaria is a commonly used grass in research because it is a good representative of many grasses used in agriculture and biofuel industries (2). *Setaria* is a C_4 grass. C_4 plants do not undergo photorespiration(3). This equates to it being a more efficient energy producer (5). We decided to conduct a study on the relationship between root and shoot biomass using *Setaria*. Our purpose when we began this study was to gather information on how much aboveground and belowground space *Setaria* really needed and to measure the ratio between root and shoot biomass. Due to lab limitations we were only able to conduct our study on root limitations. Our hypothesis was that if *Setaria* was limited in root space, it would not grow as effectively as *Setaria* with unrestricted root space. Additionally, we hypothesized that this would be true even if nutrient treatments were applied. We believe our hypothesis is supported by previous studies conducted that showed that root growth is directly related to shoot growth (1,4).

Image 1: Shows our four different plant groups after 3 weeks of growth (on top) and right before harvesting after 4 weeks (on bottom), respectively.

Methods

- *Setaria* seeds were planted into two different pot sizes which contained Sungro™ professional growing mix and were kept well-watered.
- Half of our plants were planted in large pots and half were planted in small pots. See **Table 5.**
- Treatments began at the end of week one. Half of the plants were treated with a complete nutrient solution and half were given nothing. Treated large pots were given 10 ml of solution once a week and treated small pots were given 1 ml once a week. These amounts were determined by soil volume.
- Each week measurements were taken and recorded. Height up to the end of the stem was measured in centimeters. Diameters of the stems were taken using a caliper and recorded in millimeters, except for the first week. Number of leaves and tillers were also recorded.
- After twenty-eight days, plants were removed from the pots and soil was rinsed away from the roots. They were allowed to dry for twenty-four hours. Shoot and root were separated and then each were weighed.
- SPSS was used for statistical analysis.

+ Fertilizer Big Pot	**+ Fertilizer Little Pot**
- Fertilizer Big Pot	**- Fertilizer Little Pot**

Figure 5: The general setup of our experiment.

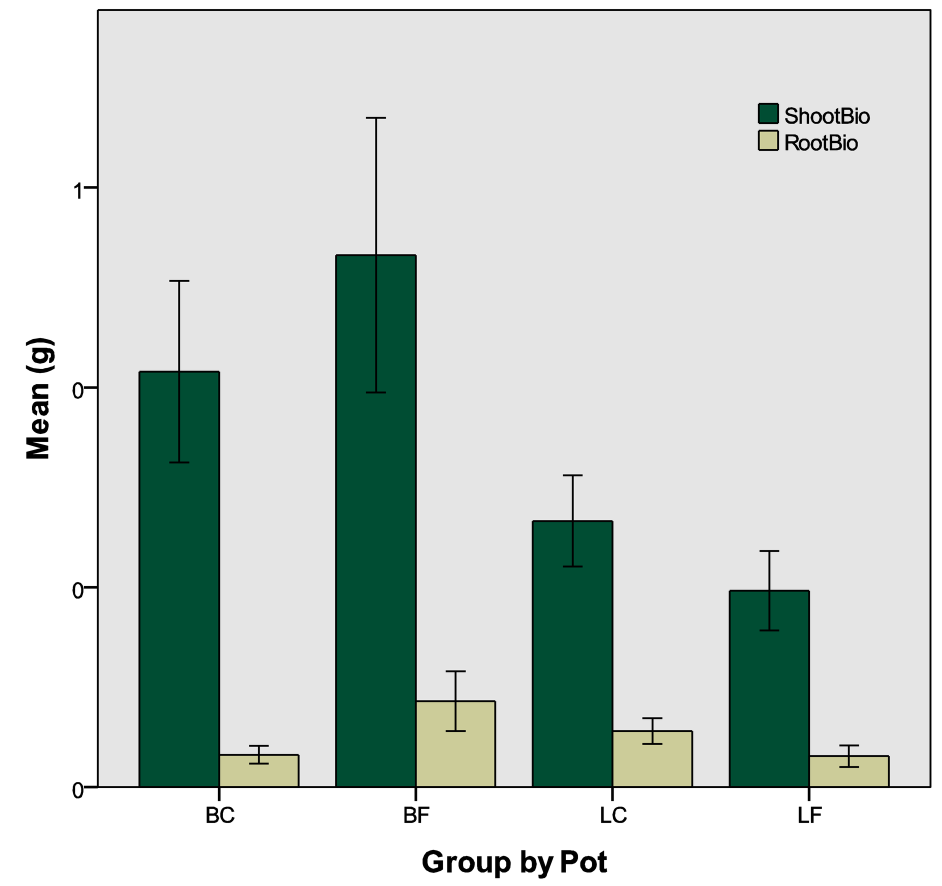

Figure 2: Depicts a significant interaction with a p-value of 0.00033 between pot size and fertilizer.

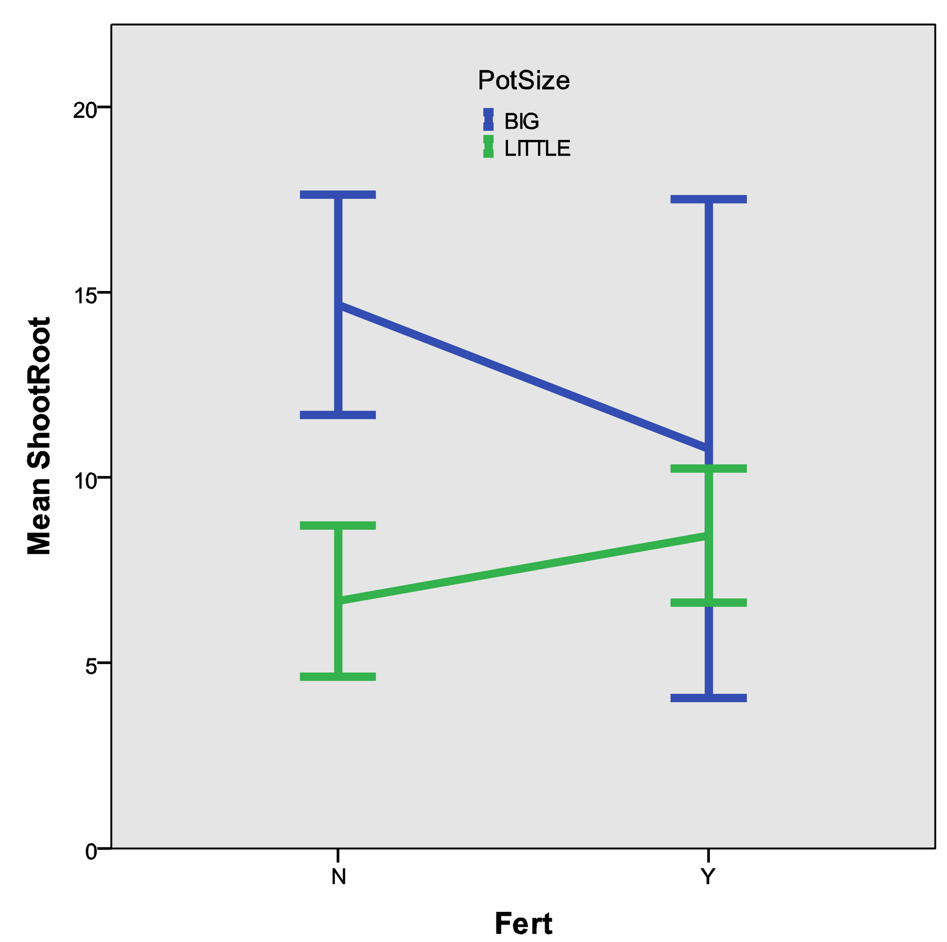

Figure 4: Shows week-by-week the comparison of leaf number among all of the groups. By the end of their growth, both large pot groups had significantly more leaves than the small pots

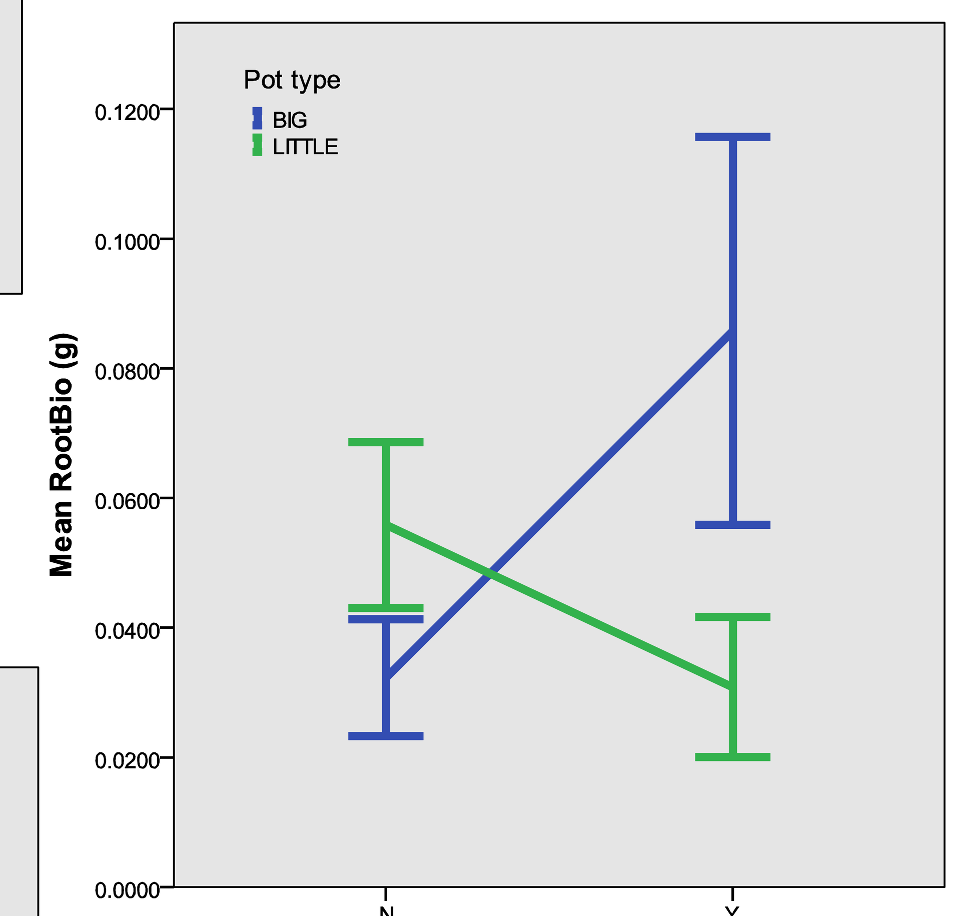

Figure 1: Illustrates the relationship between average root and shoot bio mass amongst all pot/fertilizer groups.

BC=Big no fertilizer
BF=Big with fertilizer
LC=Little no fertilizer
LF=Little with fertilizer

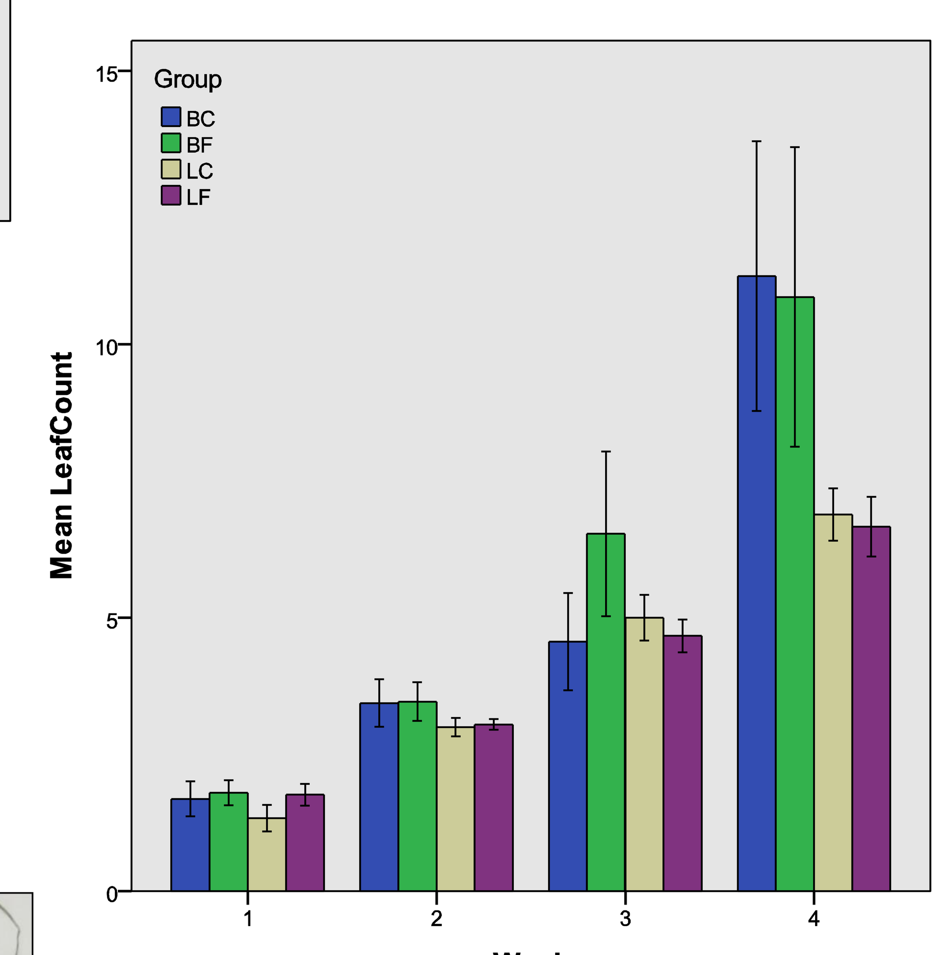

Figure 3: Depicts a significant effect of pot size on root/shoot biomass in the absence of fertilizer. (P-value= 0.0046)

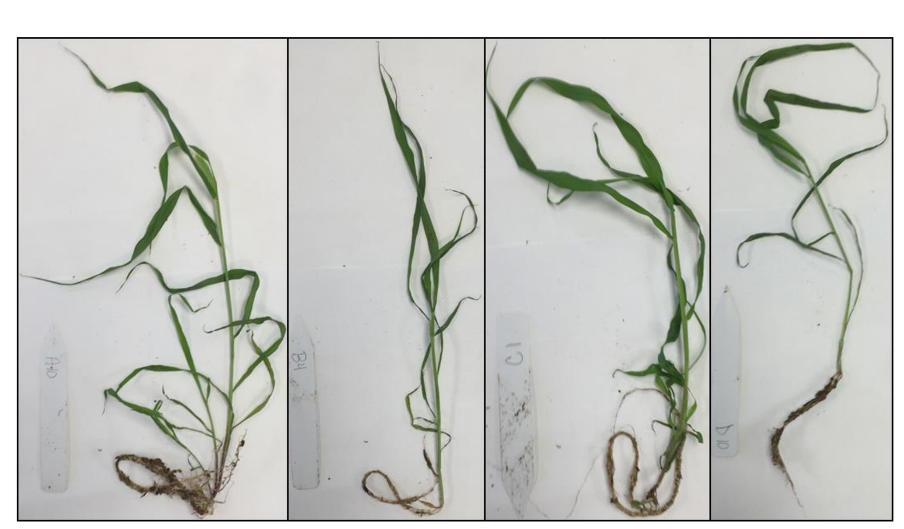

Image 2: Shows an image of our *Setaria* after four weeks of growth. Plants are about to be weighed after twenty-four hour drying period.

Results

- As expected, plants with the most root space and added nutrients showed the best overall growth.
- We found that plants in large pots with added fertilizer produced more root and shoot biomass.
- Little pots without fertilizer out performed the big pots without fertilizer when comparing root bio mass.
- There was a significant effect of pot size on the ratio of root to shoot biomass in the absence of fertilizer. When fertilizer was added, the pot size was insignificant.
- Plants with restricted root space and added nutrients showed improved growth over those with out added nutrients. They caught up to the non root restricted pots with out nutrients.
- Large pots showed more shoot biomass at the time of harvest.
- To an extent, the addition of fertilizer recovered the effects of restricted roots space.

Image 3: This marked the first time we saw an inflorescence develop. Picture was taken on day 27.

Discussion/Conclusion

We set out to test if we could overcome the restriction of root space and its effects on overall biomass with the addition of fertilizer. We originally hypothesized that we could not overcome root restrictions because a lower root biomass would equal a lower shoot biomass (4). Our results showed that with the addition of fertilizer to root restricted *Setaria* can improve overall biomass (figure 3). In addition the *Setaria* in smaller pots with fertilizer matched the root biomass of *Setaria* in larger pots without fertilizer. This could prove beneficial because planting a denser field of *Setaria* with the addition of nutrients could produce competitively to a less dense field. What we would like to research further is would these results hold throughout the plant's entire life cycle. Also it would be interesting to test different levels of restriction on roots and its outcome on overall biomass and different levels of nutrient supplementation.

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