Do Simulated Rainfall Events Induce Foliar Nutrient Leaching in Senescing Switchgrass?

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Introduction

Switchgrass (*Panicum virgatum* L.) is currently being considered as a source of biomass for either biofuel or combustion purposes[1]. Depending on the biomass conversion process used, mineral nutrients such as nitrogen (N) or potassium (K) can negatively contribute to ash and slagging[2].

Translocation is often cited as the main cause of active mineral nutrient movement from leaves during senescence[3]. Current research has found that standing biomass left in the field over winter continues to lose mineral nutrients after senescence[4]. Because translocation is not possible after full senescence, foliar nutrient leaching (FNL) may be a passive form of mineral nutrient loss during the transition into dormancy in perennial grasses[5].

We hypothesized that simulated rainfall would induce FNL on senescing or post-senescent switchgrass leaves.

Materials & Methods

Using a portable outdoor rainfall simulator (Figure 1), pH adjusted "rainfall" was applied to five plots for one hour (~120 mm hr^{-1} of rain) on five dates throughout September and October for two seasons (2014 and 2015). Five additional control plots did not receive simulated rainfall.

Figure 1. Rainfall simulator used in this experiment

Leaf samples were taken at 0 and 60 minutes from all plots. Leaves were dried at 60º C for 48 hours, ground to 1 mm, and analyzed for mineral nutrient content.

Preliminary Findings

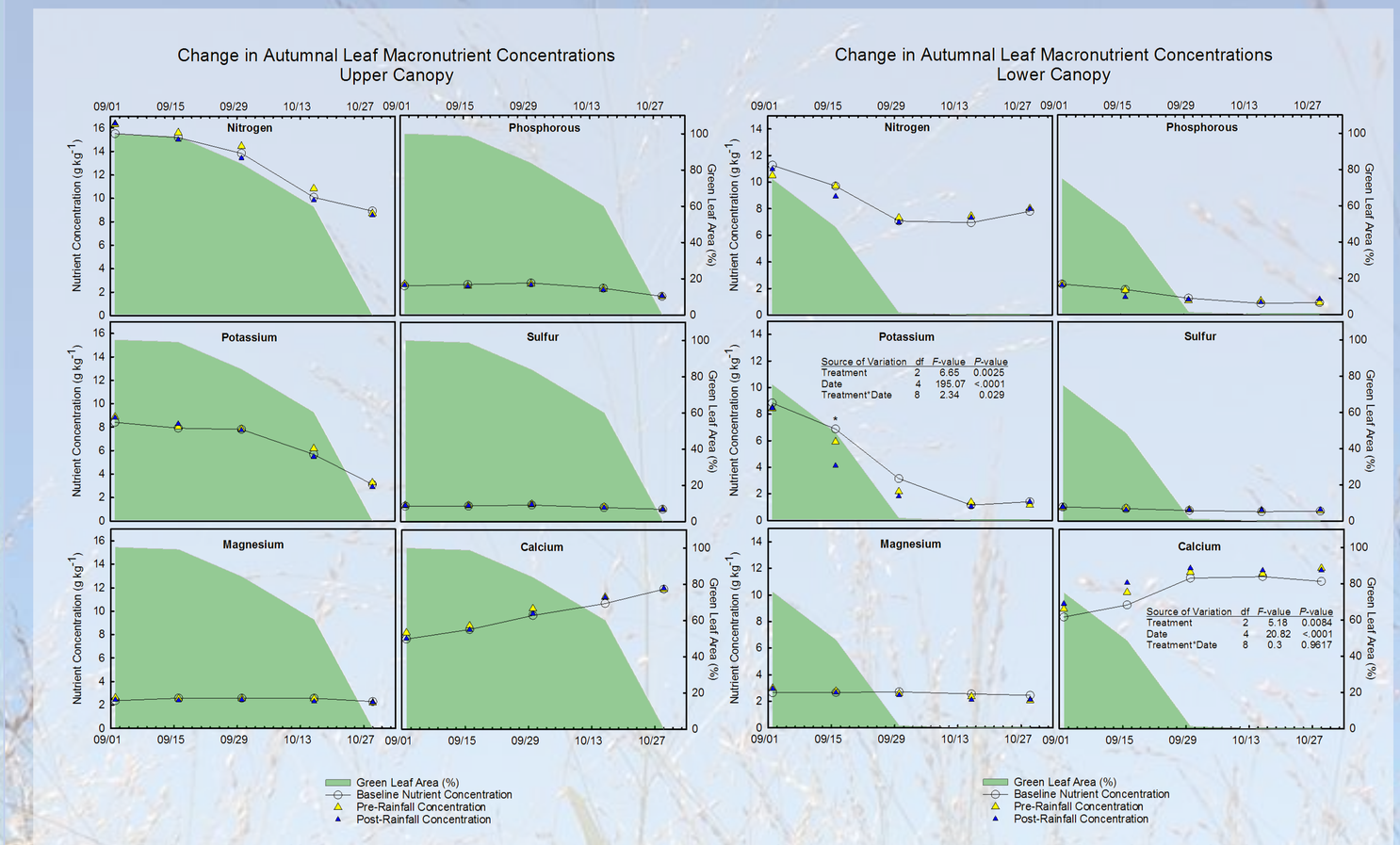

Figure 2a & 2b. Change in autumnal leaf macronutrient concentrations in upper canopy leaves (2a - left) and lower canopy leaves (2b - right). Green background corresponds with percent green leaf tissue as leaves senesce (right axis of graphs). Symbols and line represent treatment - control (circle), pre-rainfall (yellow triangle) and post-rainfall (blue triangle) treatments (left axis of graphs). *P* - values are included in graphs where significant differences were found.

Literature Estimates

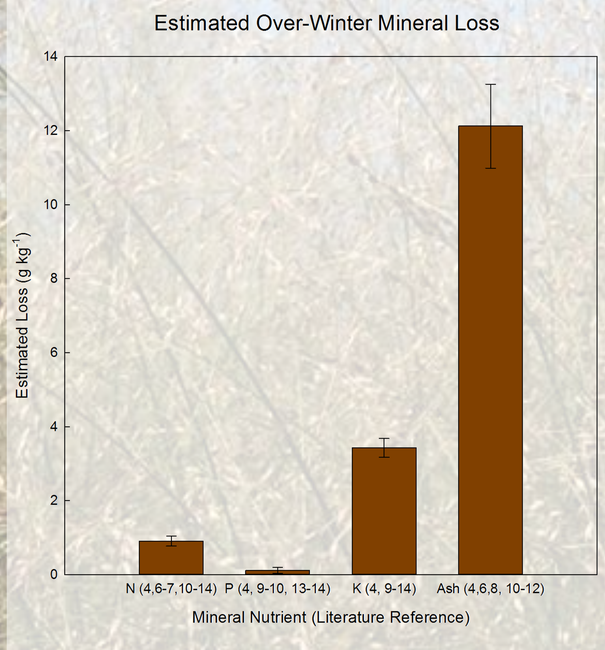

Figure 3. Estimates extracted from the literature regarding over-winter mineral nutrient loss from standing perennial grass biomass potentially due to FNL

- Date was significant for all nutrients in both upper and lower canopy (*P*-value <0.0001 at $\alpha = 0.05$) (Figure 2a and b).
- Declines in concentration with time were seen in N, P and K, while S and Mg remained steady, and Ca increased.
- Rainfall treatment slightly but significantly affected tissue concentrations for K and Ca in the lower canopy. However, both estimated differences were within the detection limit margin of error for the analysis equipment and were not deemed practically significant (Figure 2b).
- Current research regarding delayed harvest of perennial grass attributes over-winter nutrient loss to FNL, which contradicts these preliminary findings (Figure 3).
- Based on our preliminary findings, we hypothesize that over-winter changes to nutrient concentrations may be due in part to leaf drop or other passive processes.

Preliminary Conclusions

Analysis of first year data indicates that FNL does not seem to be a significant driver of nutrient loss from actively senescing or post-senescent leaves. This begs the question of how mineral nutrients continue to drop in senescent, over-wintered biomass if precipitation is not a major driver.

Because a concurrent drop in biomass yield occurs over winter alongside the additional loss of mineral nutrients, it is possible that over-winter leaf drop may be driving mineral nutrient loss.

Future Analysis

Over-winter samples of leaf, stem, and panicle biomass will be collected each month until March. These samples will be analyzed for macronutrient content and stem : leaf ratios will be tracked.

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