Traffic-Related Plant Damage, Not Soil Compaction, Influences Alfalfa Biomass Responses Under Simulated Conditions

Beatriz Bizzuti, University of Minnesota
Marta Moura Kohmann, University of Wisconsin-Madison
Brian Luck, University of Wisconsin-Madison
Francisco Arriaga, University of Wisconsin-Madison

Alfalfa (*Medicago sativa* L.) productivity can be negatively affected by machinery traffic, yet the relative contributions of soil compaction and direct plant damage, as well as the role of root system morphology, remain unclear. This study aims to evaluate the responses of two closely related alfalfa cultivars with contrasting root architectures (Branched vs. Tap Rooted) to simulated traffic under two soil moisture conditions (50 and 100% field capacity, FC). A greenhouse experiment was conducted using a factorial arrangement of cultivars, soil moisture, and four traffic regimens: No Traffic, Soil-only Traffic, Plant-only Traffic, and combined Soil + Plant Traffic. Measurements included aboveground and belowground biomass. At 50% FC, traffic reduced accumulated forage harvested (FH) by ~8%, with the greatest declines under treatments involving plant damage. Traffic generally decreased taproot and fine root biomass, with greater reductions as plant damage increased. At 100% FC, traffic effects were more pronounced, reducing FH by ~17% and up to 30% under plant-only traffic. Taproot biomass declined under Plant Traffic, indicating reduced allocation of reserves to belowground structures. Fine root responses differ by cultivar, with strong reductions in the branched rooted cultivar but minimal effects in the tap rooted one. Notably, treatments involving direct plant damage had stronger effects on biomass production than those affecting only the soil, suggesting that mechanical injury to shoots and crowns may be more detrimental to traffic-related forage harvested losses than soil compaction alone. Overall, our results show that harvest-related machinery traffic reduces above- and belowground biomass in alfalfa, with responses depending on the severity of plant damage, cultivar root architecture, and soil moisture conditions. These findings provide new insight into the mechanisms behind traffic effects in alfalfa and highlight the role of cultivar root architecture in mediating plant responses to mechanical disturbance.