Above- and below-ground grass growth responds to grazing management

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How is grass productivity above and below ground affected by grazing at different heights or by leaving different residuals after grazing? A study at UW-Madison found no simple answer to this question. Productivity of pasture grasses varies across grazing management strategies and species.

Study design

In 2009 and 2010, graduate student Nadia Alber with the UW-Madison Nelson Institute for Environmental Studies experimented with grazing management of different cool season grass species at the U.S. Dairy Forage Research Center farm near Prairie du Sac, Wisconsin. Alber was advised by Geoff Brink with the USDA Dairy Forage Research Center and Randy Jackson with the UW-Madison Department of Agronomy. This study took place in pastures seeded to monocultures in May 2006. The pastures consisted of two one-acre paddocks seeded to 'Bartura' meadow fescue and two one-acre paddocks seeded to 'Bronc' orchardgrass. Composite samples of soil in the upper six inches of all paddocks averaged 25 percent clay, 53 percent silt, and 22 percent sand. The soils had a mean pH of 6.5, 50 ppm phosphorus, and 200 ppm potassium. Paddocks were fertilized with granular ammonium nitrate (NH_4NO_3) at 50 lbs/a in late April and early August each year of the experiment. Each paddock was subdivided into experimental plots.

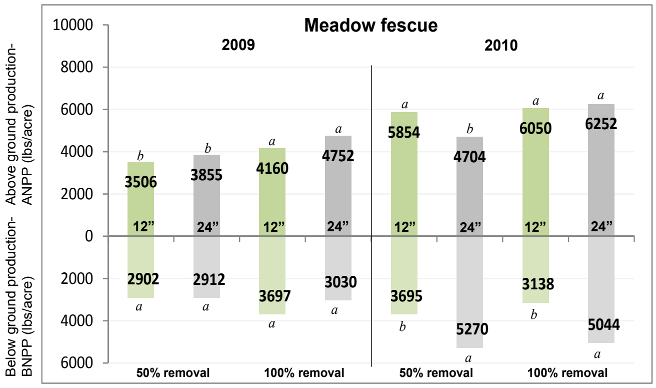
Holstein heifers weighing approximately 1,000 pounds grazed the plots, which were randomly assigned to grazing at either 12 inches tall or 24 inches tall. The heifers removed either 50 percent or 100 percent (down to 1.5 inches of stubble) of the above-ground biomass on a height basis. The plots were grazed from April to October. For each grazing event, plots were stocked with four to eight heifers for eight to 72 hours. Water was always available in the plots. Total annual precipitation was 26.5 inches in 2009 and 40 inches in 2010. Above- and below-ground biomass production for both grasses was greater in 2010, likely because of higher rainfall.

Alber estimated above-ground net primary production (ANPP) through random sampling with a rising plate meter. A rising plate meter is a device that has a central shaft with a weighted plate on it (see photo). To measure pasture with a rising plate meter, the researchers held the meter upright while letting the end of the shaft rest on the ground. Then they slid the plate down the shaft until the forage supported the weight of the plate. The distance between where the shaft rests on the ground to the top of the plate is the plate height, and this measurement is used to calculate forage mass. The researchers used this method to make five measurements of grass volume before and after each grazing event and calculated averages.

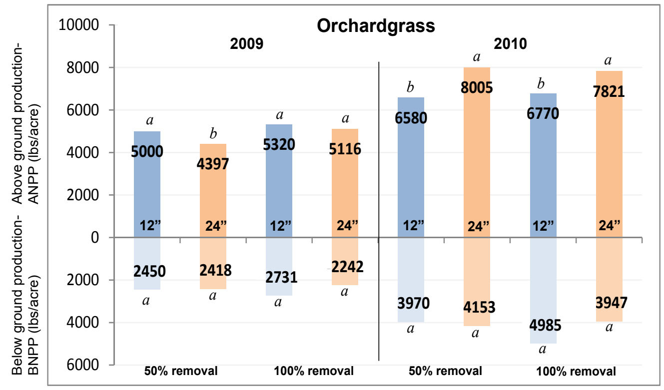
Below-ground net primary productivity (BNPP) was estimated using root cores installed at random locations within each experimental plot. The root cores were mesh cylinders two inches in diameter and five inches in length. Two root cores were installed at random locations within each experimental plot: soil was carefully removed from a hole in the pasture where the core was to be installed, cleaned of all visible roots, put into a mesh root core and inserted back into the hole. At the end of the season, Alber dug up the cores, washed out the soil and dried and weighed the remaining roots. The cores were installed in July 2009 and April 2010, and removed in November each year. Because the researchers were not able to install root cores right at the beginning of the 2009 growing season, they made conservative estimates of what the root growth would have been from April to June 2009 based on data from the remainder of the 2009 growing season.

USDA staff Jon Bleier measures forage with a rising plate meter.

Above and below ground production of grasses, grazed at 12 and 24 inches tall, 50 and 100 percent forage removal



Values with different letters within each grouping were statistically different from each other



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Findings

This study underscored the fact that rain is a critical input. Above- and below-ground production in 2010 was higher than that in 2009 due to higher rainfall in that year, for all but one scenario. The exception was that in the drier year (2009) meadow fescue below-ground production increased in the treatment in which 100 percent of forage was grazed at 12 inches. It is unclear why this was the case in this circumstance.

In both 2009 and 2010, orchardgrass produced more above-ground biomass than meadow fescue. In the drier year (2009), both grasses produced greater above-ground biomass with 100 percent defoliation at both 12- and 24-inch grazing heights than with 50 percent defoliation. In 2010, orchardgrass produced greater above-ground biomass when grazed at 24 inches than at 12 inches for both 50 and 100 percent defoliation levels, while few differences existed among grazing treatments imposed on meadow fescue in that year. Grazing at both 12- and 24-inches to remove 100 percent of biomass increased above-ground production of meadow fescue both years and orchardgrass only in 2009. But this type of grazing management also lengthens the grazing interval and may over time have a negative effect on grass persistence and nutritive value.

An interesting difference between meadow fescue and orchardgrass occurred below ground. While below-ground production of orchardgrass remained relatively constant regardless of treatment in both years, meadow fescue showed increased below-ground production when grazed at 24 inches in 2010. This was true at both the 50 and 100 percent defoliation levels. Alber says, “There was no relationship between grazing management and below-ground production for orchardgrass, so we can conclude that extent of defoliation and height at grazing may have less of an effect on below-ground growth and carbon storage potential of this species than that of meadow fescue.” Alber hypothesizes that the structure of orchardgrass allows it to maintain photosynthesis and a level of carbon supply sufficient to support growth without depleting below-ground carbon, unlike meadow fescue. More research is needed to test this theory.

The lack of consistent below-ground growth patterns for either grass in both years made it difficult for the researchers to develop grazing management recommendations that would link forage height at turn in or defoliation level to maximize root growth. There may be some interactions between rainfall amounts and growth patterns of these two grasses that caused the variations in the two years.

The results of this study show that there is no such thing as a simple, cookbook approach to grazing that will maximize production above- and below-ground for all cool-season grasses. Significant production differences were found not only between meadow fescue and orchardgrass, but also within each grass species in years with different precipitation levels. General recommendations on grazing interval length and extent of defoliation should, therefore, take into consideration a number of factors such as the grass species being managed as well as the weather and resulting growth patterns in a given year.

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