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Original Research

Recovery of Pasture Forage Production Following Winter Rest in Continuous and Rotational Horse Grazing Systems

Jennifer R. Weinert, Carey A. Williams*

Department of Animal Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ

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ABSTRACT

Winter rest is commonly recommended to aid in regrowth of spring forage in horse pastures. The purpose of this study was to determine the effect of previous grazing method (continuous [CON] vs. rotational [ROT]) on recovery of pasture production following a period of winter grazing exclusion. Pasture forage yield, persistence, and quality were assessed monthly in two horse pastures, one CON and one ROT, from April to August 2017. Herbage mass was greater in ROT in May (ROT 2,701.8 ± 176.0; CON 1,439.0 ± 155.06 kg/ha; $P = .0008$), June (ROT 3,778 ± 21.59; CON 2,507.0 ± 274.7 kg/ha; $P = .0007$), and July (ROT 4,755.8 ± 263.1; CON 3,627.8 ± 318.66 kg/ha; $P = .0053$), while sward height only differed by grazing system in May (ROT 21.87 ± 0.68; CON 13.02 ± 0.68 cm; $P < .0001$). Overall, prevalence of planted grass species was greater in ROT (35.17 ± 2.47%) than CON (22.67 ± 0.92%; $P = .0009$). Furthermore, there was an association between pasture forage composition and grazing management system at all sample points other than in August ($P < .05$). In addition, sward components were most affected by previous grazing system in April and May, with a greater proportion of live leaf in ROT than CON ($P < .03$). These results demonstrated that even after prolonged rest, previous management of pasture influenced forage regrowth. Findings of this study support the implementation of ROT grazing practices as a means of optimizing long-term pasture production.

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1. Introduction

Rotational grazing is often recommended as an alternative to traditional low-maintenance continuous horse grazing systems. This recommendation is based on purported economic and environmental advantages, most notably the potential of increasing forage availability and thereby lowering supplemental feed costs using rotational management. While available data for on-farm horse pasture management practices are limited, several surveys in Mid-Atlantic states have assessed implementation of pasture best management practices (BMPs), including rotational grazing. Fiorellino et al. [1] found that among horse producers surveyed in Maryland, only 20.8% reported always using rotational grazing. These surveys also demonstrated a lack of knowledge and failure to completely adopt practices necessary to optimize pasture production through rotational grazing [1–3]. Although surveys showed most horse producers report using rotational grazing at least some of the time, more targeted questions indicated that tenants of proper rotational grazing management, including use of sacrifice lots and allowing pasture to recover to the recommended grazing height, were not consistently implemented by most respondents [1,3].

To better define production, economic, and environmental benefits of rotational grazing in horse pastures, recent studies have compared forage yield, persistence, and quality in continuous and rotational horse grazing systems [4–7]. However, these studies have only evaluated pastures during periods of active grazing. Presumably, grazing management choices of horse producers may have longer-term effects on pasture production, influencing the capacity of pasture forage to survive and regrow in a subsequent grazing season. Winter rest of pastures is often recommended to ensure adequate availability of spring forage for grazing. However, rest alone may be insufficient to overcome deleterious effects of overgrazing commonly seen in continuously grazed pastures. While the influence of winter exclusion protocols on subsequent recovery of spring pasture production have been extensively studied in cattle and sheep, these effects have not been isolated or quantified in horse grazing systems.

Animal welfare/ethical statement: No animals were used.

Conflict of interest statement: The authors declare no conflicts of interest.

* Corresponding author at: Carey A. Williams, Department of Animal Sciences, Rutgers, The State University of New Jersey, 84 Lipman Dr., New Brunswick, NJ 08901.

E-mail address: carey.williams@rutgers.edu (C.A. Williams).

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It is well established that removing livestock animals from cool-season pasture in late fall or early winter has beneficial effects on early-season pasture production. Failing to implement or delaying winter rest of pastures results in lower pasture forage yield in the subsequent spring. Frame [8] found that winter grazing of sheep decreased early spring yields by an average of 38% when compared with an ungrazed control. These results are supported by findings in similar studies in both sheep- and cattle-grazed pastures showing positive responses to winter exclusion [9–12]. Delaying fall closing also affects the amount of available pasture forage the following spring [13,14], with early closed pastures having greater herbage mass and higher sward height in spring at first grazing [15]. However, differences in pasture yield attributable to winter rest protocols have been shown to diminish over the course of a subsequent grazing season [8,16,17], with several studies reporting no differences in annual yield [18,19].

While the impact of winter exclusion protocols in cattle and sheep grazing systems on pasture production is well understood, few studies in these species have isolated the effect of previous grazing management (continuous vs. rotational) on recovery of pasture production parameters following an extended period of rest. To the authors' knowledge, no pasture forage recovery studies exist in which pastures had been regularly managed in their respective grazing method (continuous or rotational) for multiple years prior to rest.

Furthermore, no recovery studies of this type have been conducted with horse grazing systems of any kind. Grazing data extrapolated from livestock studies may be of limited value in crafting horse grazing recommendations, as horse forage preference and grazing behaviors differ from those observed in other species [20,21]. In addition, forage species commonly grown in cattle and sheep pastures may not be desirable for equine grazing [22,23].

Factors such as timing and duration of previous grazing bouts and species-specific impacts potentially influence both yield and persistence of pasture forage. Therefore, the objective of this study was to quantify the effect of intense grazing in a CON and ROT horse grazing system on pasture condition and herbage composition in a subsequent growing season following winter exclusion.

2. Methods

2.1. Grazing Systems

The current pasture recovery study was conducted at the Ryder's Lane Environmental Best Management Practice Horse Farm (Rutgers, The State University of New Jersey) in New Brunswick, New Jersey (40.4862° N, 74.4518° W) from April to August 2017 using previously established cool-season grass horse pastures. A mix of Jesup MaxQ endophyte-friendly tall fescue (TF; *Festuca arundinacea;* 7.9 kg/ha), Potomac orchardgrass (OG; *Dactylis glomerata*; 8.2 kg/ha), and Camas Kentucky bluegrass (KB; *Poa pratensis*; 12.98 kg/ha) was planted in the fall of 2013, with subsequent interseeding of these grasses in 2014 (TF 3.6 kg/ha; OG 7.3 kg/ha; KB 14.5 kg/ha). Before this study, pastures had been managed in their respective grazing system type, continuous (CON) or rotational (ROT) for 27 months at a stocking rate of 0.52 ha/horse [7]. During this period, horses grazing CON had access to all areas of the pasture at all times without restriction. Horses were not removed from the CON field during the winter months (November through March) in this preceding 2-year period. Horses managed in the ROT grazing system were moved between ROT sections based on available forage. Grazing was initiated when available forage was assessed at a 15.2-cm sward height. Horses were allowed to graze a given section until pasture forage was reduced to a 7.6-cm sward height, at which time horses were moved to a new ROT section [7]. If adequate forage was not available, horses were confined in a stress lot and fed supplemental hay. In November 2016, all horses were removed from CON and ROT pastures. The condition of two 1.6-ha pastures—one CON and one ROT—were evaluated the following year, beginning in April 2017. Pastures were not subjected to any grazing activity after winter exclusion and throughout 2017, allowing for complete rest. In 2017, for the duration of the recovery study, pastures were managed solely with minimal mowing to control weeds and prevent the formation of seed heads.

The soil in both pastures used for this study was a silty clay loam primarily composed of FapA (Fallsington loams, 0%–2% slopes, Northern Coastal Plain), NknB (Nixon loam, 2%–5% slopes), and NkrA (Nixon moderately well drained variant loam, 0%–2% slopes) [7]. Before this study, nitrogen fertilizer was applied to all fields twice per year. Soil tests were performed biennially, with the most recent test conducted in the fall of 2016. Soil fertility was adjusted to optimum through application of lime and additional fertilizers, as needed, based on results of the soil tests. No amendments were applied to fields during the course of the present study in 2017.

2.2. Measurements

Initial measurements were collected in both the CON and ROT fields in early April 2017 (April 10–13, 2017). Due to rapid growth of pasture forage, a second set of measurements were taken in late April (April 24–27, 2017), two weeks after the initial collection. Subsequently, all measures of yield, persistence, and forage nutrient analysis were repeated in CON and ROT fields on a monthly basis during the second week of each month from May through August 2017. Samples for forage nutrient analysis were collected between 8:00 AM and 10:00 AM EST. Sward components (leaf, stem, and dead matter [D]) were determined monthly from April to June. Monthly average temperature and total precipitation were tracked for the month preceding each sample point. Weather data were obtained for the New Brunswick Station from the website for the Office of the New Jersey State Climatologist at Rutgers University through the Historical Monthly Station Data portal [24].

2.2.1. Yield

Yield was determined by measuring herbage mass and sward height. To measure herbage mass, a 0.5-m wooden square was randomly placed at 16 sites in each 1.6 ha pasture field, and forage in each square was clipped to ground level. Collected forage was dried at 60°C in a Thelco (Precision Scientific, Chicago, IL) oven to remove moisture content and obtain a dry matter (DM) weight. Herbage mass was then determined using the following equation: kg/ac = ¼ ([g/m^2 [collected sample] × [4,047/1,000] × 2.47) [7]. Sward height was measured by dropping a styrofoam plate down a meter stick and recording the height where the plate rested on the forage [25]. One hundred sward height measurements were taken per field at each time point.

2.2.2. Persistence

The step-point method was used to determine pasture forage composition [26,27]. A total of 100 observations per field were recorded, and all results are expressed as a percentage of the total in each field at each time point. Pasture forage composition was evaluated by grouping observations as either planted forage grass (G), nonplanted native grass weeds (GWs), nongrass species of weed (W), or other (O). Observations of bare ground, water, manure, dead plant matter, and litter were assigned to O. Vegetative cover (VC) was determined by subtracting observations grouped in O from 100%. Within G, individual plant species