Dry Matter Production and Cutting Interval for Perennial Grasses

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ABSTRACT

Cutting interval (or harvest frequency) is an important management factor in production of perennial grasses. Short intervals (for example 2 wk) produce lower dry matter with higher protein content while longer intervals (for example 12 wk) produce higher dry matter with lower protein content. In this article data from the literature are used to quantify the relationship between harvest interval and dry matter production for Midland and Tifton 44 cultivars of bermudagrass (Cynodon dactylon L.), a warm-season perennial. The results agree rather well with analysis of data for Coastal bermudagrass grown at Tifton, GA. The same functional relationship holds for bermudagrass, bahiagrass (Paspalum notatum Flügge), and perennial ryegrass (Lolium perenne L.).

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INTRODUCTION

A theorem has been published[1] which establishes the functional dependence of seasonal dry matter production of a perennial forage grass to harvest interval for the expanded growth model.[2] The linear-exponential equation relates to the linear-exponential intrinsic growth function assumed in the mathematical model. Analysis of field data has shown that this relationship holds[3] for bermudagrass[4] and perennial ryegrass,[5] as well as for bahiagrass.[6,7]

In this article analysis of additional field data is presented to lend additional support to the linear-exponential function for relating dry matter production to harvest interval.

MODEL

The linear-exponential function is given by

\[ Y = (\alpha + \beta \Delta t) \exp(-\gamma \Delta t) \] (1)

where \( Y \) = seasonal dry matter yield, Mg ha\(^{-1}\); \( \Delta t \) = harvest interval, wk; \( \alpha \) = intercept parameter, Mg ha\(^{-1}\); \( \beta \) = slope parameter, Mg ha\(^{-1}\) wk\(^{-1}\); \( \gamma \) = exponential parameter, wk\(^{-1}\). It can be shown mathematically that the harvest interval, \( \Delta t_p \), for peak production can be estimated from

\[ \Delta t_p = \frac{1}{\gamma} \left( \frac{\alpha}{\beta} \right) \] (2)

DATA ANALYSIS

Data for this analysis are taken from a field study at Stillwater, OK with Midland and Tifton 44 bermudagrass.[8] The soil was Kirkland silt loam (fine, mixed, superactive, thermic Udertic Paleustolls). Harvest intervals were 3, 6, and 12 wk. Data for 1994 are presented in Table 1 and Fig. 1. The challenge now is to calibrate Eq. (1) for the data. The first step is to calculate standardized yield, \( Y^* \), as defined by

\[ Y^* = Y \exp(\gamma \Delta t) \] (3)

Following previous analysis[3] we choose \( \gamma = 0.077 \) wk\(^{-1}\). The fourth column
in Table 1 is calculated with this parameter value. Since \( Y^\ast \) is very similar for the two cultivars for each harvest interval, these values are averaged as shown. Linear regression is then performed to obtain

\[
Y^\ast = Y \exp(0.077\Delta t) = \alpha + \beta\Delta t = 3.52 + 3.69\Delta t \quad r = 0.9976
\]

with a correlation coefficient of 0.9976. Results of the model analysis are shown in Fig. 1, where the line is drawn from Eq. (4) and the curve from

\[
Y = (3.52 + 3.69\Delta t) \exp(-0.077\Delta t)
\]

Agreement between the model and data appears quite reasonable.

Harvest interval for peak dry matter production can then be calculated from Eq. (2) to give

\[
\Delta t_p = \frac{1}{0.077} - \frac{3.52}{3.69} = 12.0 \text{ wk}
\]

This compares with a value of 10.4 wk for Coastal bermudagrass at Tifton, GA.\(^{[3]}\)

**SUMMARY AND CONCLUSIONS**

The linear-exponential equation appears to describe dependence of seasonal dry matter yield on harvest interval for bermudagrass at Stillwater, OK quite well. Results are in agreement with those for Coastal
bermudagrass at Tifton, GA. Peak harvest interval for perennial ryegrass grown in Belfast, Northern Ireland was 9.9 wk\cite{3} and for bahiagrass grown at Quincy, FL was 8.2 wk\cite{6}. Of course it must be understood that forage quality (protein content) declines with increased harvest interval. Choice of harvest interval is a tradeoff between dry matter and protein production. As plants age the fraction of biomass contained in the structural component (lower N content) increases over the fraction in the light-gathering component (higher N content).

Figure 1. Dependence of seasonal dry matter yield on harvest interval for Midland and Tifton 44 bermudagrass at Stillwater, OK. Data adapted from Taliaferro et al\cite{8}. Line drawn from Eq. (4); curve drawn from Eq. (5).
REFERENCES