Extended Daylength to Increase Fall/Winter Yields of Warm-Season Perennial Grasses

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EXTENDED DAYLENGTH TO INCREASE FALL/WINTER YIELDS OF WARM-SEASON PERENNIAL GRASSES

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Abstract

Low forage production in fall/winter months is a severe limitation for dairy and beef cattle producers in the southeastern U.S. It was hypothesized that shrt daylengths during these months induce a physiological dormancy in grasses. Four grasses [Pensacola bahiagrass, *Paspalum notatum* Flugge; Tifton 85 and Florakirk bermudagrass, *Cynodon dactylon* (L.); Florona stargrass, *C. nlemfuensis* Vanderyst var. *nlemfuensis*] were subjected to extended daylengths during the winter/fall months in a field test. Pensacola bahiagrass and Tifton 85 bermudagrass showed especially dramatic increases in forage yield during the fall/winter season under the extended daylength. Genetic elimination of daylength sensitivity in these grasses appears to be a viable option for increasing year-round forage production.

Keywords: daylength sensitivity, wintr growth, bahiagrass, bermudagrass, photoperiod

Introduction

Warm-season grasses produce little forage in the fall/winter months from October to February in southeastern U.S., which places a severe restriction on dairy and beef cattle production. The decrease in grass growth occurs in spite of the fact that both temperature and water availability remainadequate for substantial growth. It was hypothesized that the decrease in forage production might result from physiological dormancy induced by short daylengths. At the University of Florida, Range Cattle Research and Education Center, Ona, Florida where this field research was undertaken the daylength at the winter solstice is 10.4 hrs.

Surprisingly, very little research has been done on the photoperiod sensitivity of grasses. Two early studies indicated that grasses where sensitive to daylength with greater shoot growth when the daylength was extended (Allard and Evans, 1941; Lovvorn, 1945). In a preliminary study in growth chambers with warm-season grasses, Gaskins and Sleper (1974) found nightnterruption greatly increased dry matter production. No study has, apparently, investigated the possibility that daylength might influence forage yields under field conditions. The objective of this study was to resolve the hypothesis that warm-season grass production could be sustained during fall/winter months by subjecting the plants to an extended daylength.

Material and Methods

In the summer of 1997, pure stands of Pensacola bahiagrass, Tifton 85 and Florakirk bermudagrass, and Florona stargrass were established in four replicate plots (3 m x 30 m) of each grass. The experimental design was a split plot with grass entries as main plots and daylength as subplots.

Daylength was extended by mounting a 1500-W quartz-halogen lamp at 2.1 m above the soil in each plot. The lamp was positioned at a distance of 9 m from the end of the plot and the lamp housing was oriented to leave the 9-m section of the plot unexposed to the extended daylength while the remaining 21 m of the plot was subjected to an extended daylength of 15 h. The irradiance from the lamp was a maximum of 29 µmol m^{-2} s^{-1} immediately in front of the lamps decreasing to 0.1 µmol m^{-2} s^{-1} at 20 m from the lamps. (These levels of photosynthetic active radiation (PAR) are nearly two orders of magnitude less than that of midday PAR, so that there was virtually no capacity to increase CO2 assimilation.)

Timers turned the lamps on each evening at about 0.5 h before sunset and turned them off once the overall daylength had been extended to approximately 15 h. Therefore, in December and January during the shortest days the lights were turned on each evening for a total of 5.25 h. The extended daylength treatment was imposed between 19 August 1998 to 21 April 1999 and 18 August 1999 to 19 April 2000.

The plots were originally staged in July 1998 and harvested at 5-wk intervals thereafter. During the summer months the harvest interval was shortened to 4 wk to deal with the rapid growth of the grasses. Harvests were made at nine positions in each plot relative to the lamps: -8, -4, 1, 3, 5, 7, 10, 15, 20 m where the negative values indicate positions in the unexposed area of the plots. The data presented in this paper were cobined to give a mean of two harvest sites within each plot for the normal daylength area (-8 and -4 m) and the daylength-extended area (1 and 3 m).

An area of approximately 1 m^2 was harvested from each position by using a rotary plot harvester set at a 7.5-cm stubble height. A swath 0.5-m wide perpendicular to the length of the plot was cut with the harvester to determine dry matter yield. Since the borders were not harvested and plot widths varied slightly, the actual length of each harvested swath was measured. The harvested grass was weighed immediately in the field after cutting. A fresh subsample was also immediately collected, weighed, and subsequently dried to allow calculation of the dry weight of the original bulk grass sample.

After all plots were harvested the entire plot area was staged to 7.5-cm height by cutting a majority of the grass with a tractor drawn flail harvester followed by the individual plot harvesters. Prior to the initial harvest and following each harvest, fertilizer was applied to the plots in the following amounts: 70 kg N ha^{-1}, 15 kg P ha^{-1}, 55 kg K ha^{-1}, 5 kg S ha^{-1}, and 1.7 kg ha^{-1} each of Fe, Zn, Mn, Cu, and B. A total of approximately 130 mm irrigation water was applied during the two-year study to avoid drought stress. The insecticide carbonyl (1-naphthyl N-methylcarbamate) 10% bait was applied at 11 kg ha^{-1} to control mole crickets (*Scapteriscus vicinus* Scudder).

Results and Discussion

The area of each plot not exposed to the extended daylength had greatly decreased productivity during the fall/winter months. On the other hand, the area in which the daylength was extended had visually marked increases in plant growth. There was a sharp demarcation in plant growth under the lamps between the normal and extended daylength areas.

Growth of Pensacola bahiagrass, especially, was smulated during the fall/winter months by the extended daylength (Fig. 1). Forage yields subjected to the extended daylength were four times greater than the untreated areas at the 6 January 1999 harvest and five times greater for the 9 February 2000 harvest. No adverse consequences of the stimulated winter growth was observed in spring or summer production.

Forage yields for all grasses for the periods from 28 October 1998 to 17 March 1999 and from 27 October 1999 to 13 March 2000 are presented in Table 1. These data showed that there were substantial differences among the grasses in response to the extended daylength. Among the four grasses, the extended daylength resulted in the greatest forage yield increase for the total fall/winter period in Pensacola bahiagrass (167% in 98/99 and 78% in 99/00). Tifton 85 bermudagrass was also responsive to the extended daylength with fall/winter forage yield increases of 46% in 98/99 and 43% in 99/00. The other two grasses had fall/winter increases of 9 to 22% under the extended daylength in the two growing seasons. For these two less responsive grasses, however, there were still individual harvests where the yield increases were 50%.

Overall, these results offer strong evidence that decreased winter/fall dormancy of these warm-season grasses is regulated physiologically in response to daylength. The potential yield of these grasses, especialy bahiagrass, can be increased by decreasing daylength sensitivity through genetic selection of daylength-neutral genotypes, as has been done for many grass-type grain crops.

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Table 1 - Forage yield for grasses exposed to extended daylength for the 5 harvests in the fall/winter period from 28 October 1998 to 17 March 1999 and from 27 October 1999 to 13 March 2000.

	1998/1999		1999/2000	
Grass	Yield ($g\ m^2$)	% Increase	Yield ($g\ m^2$)	% Increase
Pensacola Bahiagrass	794	167	423	78
Tifton 85 Bermudagrass	1026	46	749	43
Florakirk Bermudagrass	876	17	613	12
Florona Stargrass	922	22	634	9

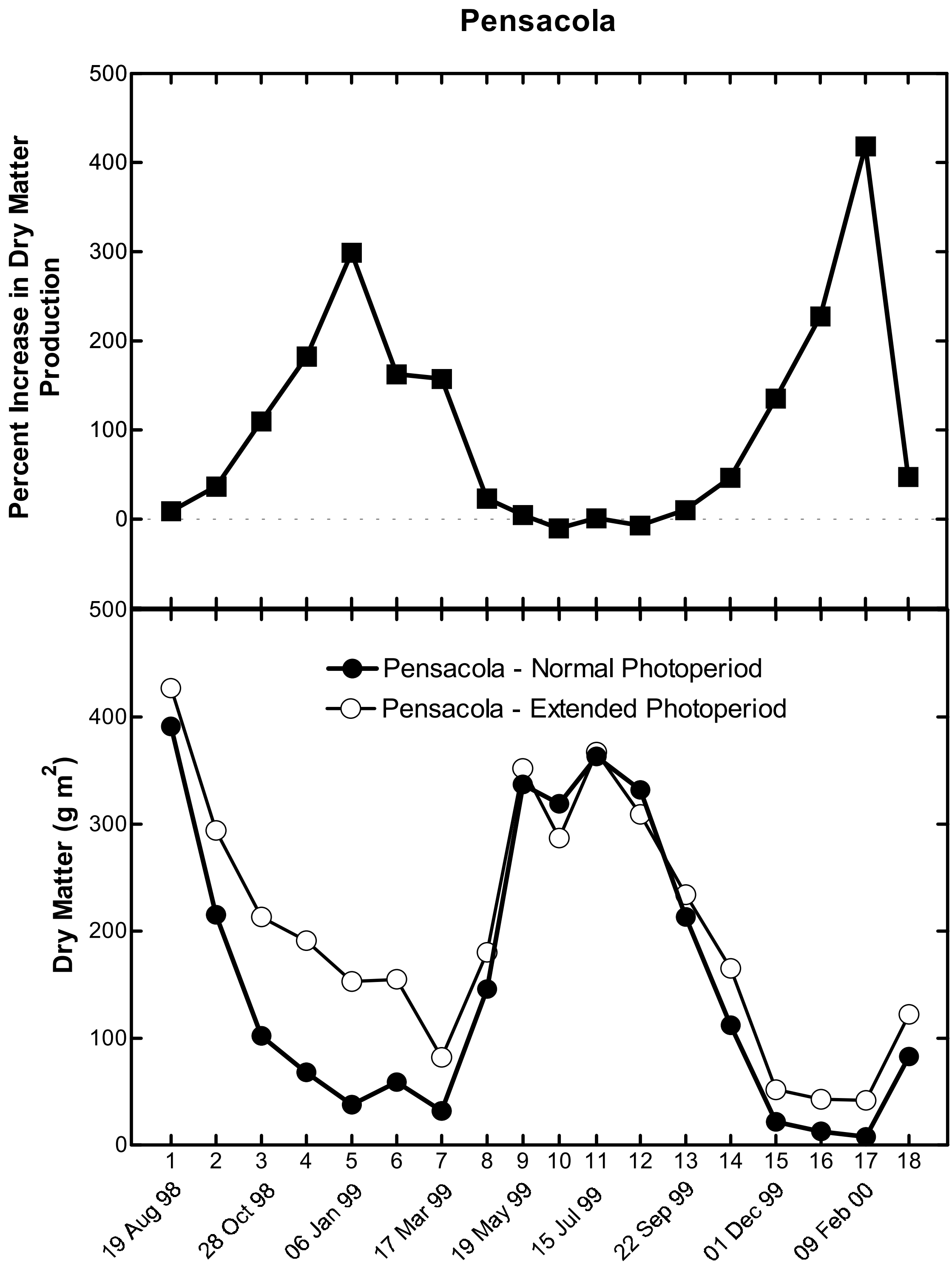

Figure 1. Response of Pensacola Bahiagrass to extended daylength. Top Panel: Percent forage yield of extended daylength plots as compared to plots not exposed to extended daylength. Bottom Panel: Absolute forage yield of grass at each harvest during experiment.