THE DIURNAL CYCLING OF SUGARS IN GRASSES IMPACT STRIP-GRAZE MANAGEMENT PLANS

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ABSTRACT

Soluble sugar concentrations increase in forage plants during the day and decrease at night. The objective of this study was to quantify the sugar concentrations in the upper and lower parts of the grass canopy at the end of a light and subsequent dark period and relate these changes in animal grazing behavior and production responses. Tall fescue (Festuca arundinacea) grown in controlled-environment chambers was cut after a 15-h light and a subsequent 9-h dark period, and tillers were separated into leaves and stems. Leaves, but not stems, demonstrated diurnal fluctuation in sugars. Leaf sugars concentrations, after 15-h of light, were 1.6 times greater than those in leaves following the 9-h dark period. It is suggested that animal production may benefit from afternoon vs. morning turnout onto fresh pastures because of the extra sugars accumulating in the leaves during the day.

INTRODUCTION

The accumulation of soluble sugars in forage plants during the day promotes an increased preference by cattle for afternoon- versus morning-cut hay (Fisher, et al.). Grazing sheep prefer forage growing in sunshine to forage that has been shaded because of the difference in sugar concentration (Cia Varella, et. al.). We wished to describe these diurnal changes in leaves and stems of grasses and speculate how theses changes might affect animal production in a strip graze program.

MATERIALS AND METHODS

Eight tall fescues, were established from clonal tillers and maintained in two growth chambers (22/17 °C and 15/7h day/night). Fertilizer NPK was added at regular intervals. Plants were clipped at about 45 day intervals through five cycles, producing vigorous tops and roots. After an additional 21-day regrowth to the 3 leaf-stage (10-20cm), plants were clipped and separated into leaves and stems. One-half of the plant in each pot was harvested after 14 to 18 h of light exposure (400umol m^{-2} sec^{-1}). Pots containing the other half of the plant were then returned to the chamber and the lights turned off. Remaining plant material was then subjected to 8-12 h of darkness after which remaining tillers were harvested.

Plant material was placed on dry ice, maintained in freezer until freeze dried, then ground to pass a 0.4 mm screen using a Wiley shear mill, and finally analyzed for soluble sugars. The sugars were assayed colorimetrically using an adaptation of a method (Pollock, C.J.) where samples were incubated in an acid-anthrone extractant at 85 °C for one-hour and absorbance measured at 620 nm in a SpectraMax Plus plate reader. A standard curve was prepared by simultaneously assaying known amounts of chicory inulin

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(Raftiline®). Data were subjected to analysis of variance (PROC GLM, v6.12, SAS Inc. Cary, NC, USA, 1990).

RESULTS

Leaves contained higher concentrations of sugars following the light period than when following the dark period (Table 1). However, there was no difference in soluble sugars in the stems of plants following light or dark periods. The difference in leaf soluble sugars is reflected by the difference in the relative mass of leaf to stem of plants in the light vs. dark treatments. Leaf sugar concentrations were different among cultivars (Table 2).

MANAGEMENT IMPLICATIONS

Leaves intercept light and accumulate sugar during the day. But, sugar concentrations in stems do not change. We conclude that grazing animals would have greater intake of soluble sugars (energy) when allowed to graze fresh forage in the afternoon and evening rather than in morning. This allows animals to access the leafy growth while it contains maximum energy, shown here as sugar. Thus, afternoon changing to new pasture would be beneficial. This is further encourage given the finding that cattle graze for a much longer period of time when turned onto new pasture in the afternoon than when turned onto new pasture in the morning (Orr, et. al.). Milk production will likely increase because of the greater intake of energy (Miller, et. al.). This potential increase in animal productivity, as a result of changes in management, can be achieved at no economic cost to the producer.

LITERATURE CITED

Cia Varella, T.A., Simpson, R.J., Dove, H. Leury, B.J., and Sims, I.M. (2000) Diurnal changes in the concentration of water-soluble carbohydrates in Phalaris aquatica L. pasture in spring, and the effect of short-term shading. *Australian Journal Agricultural Research* 51, 749-756.

Fisher, D.S., Mayland, H.F., and Burns, J.C. (1999) Variation in ruminants' preference for tall fescue hays cut either at sundown or at sunup. *Journal Animal Science,* 77, 762-768.

Miller, L.A., Theodorou, M.K., Macrae, J.C., Evans, R.T., Adesogan, A.T., Humphreys, M.O., Scollan, N.D., and Moorby, J.M. (1999) Milk production and N partitioning responses in dairy cows offered perennial ryegrass selected for high water soluble carbohydrate concentrations. *South African Journal Animal Science*, 29, 281-282.

Orr, R.J., Rutter, S.M., Penning, P.D., and Rook, A.J. (2001) Matching grass supply to grazing patterns for dairy cows. *Grass and Forage Science* .

Pollock, C.J. (1982) Patterns of turnover of fructans in leaves of Dactylis glomerata L. *New Phytologist*, 90, 645-650.

Table 1. Mean squares for leaf to stem ratio and soluble sugar concentrations.

Source	df	Leaf/stem Mass Ratio	Soluble Sugars	
			Leaves	Stems
Replication	5	0.70	4353**	8690**
Cultivar	6	1.86**	1613	12599**
Light vs. Dark Tmt.	1	13.72**	25746**	25
Cultivar x Tmt.	6	0.55	445	1972

Table 2. Leaf/sheath mass ratio and soluble sugars concentration in leaves and stems of tall fescue after exposure to light or dark periods.

Cultivar	Leaf/Stem Mass Ratio g/g		Soluble Sugars ($g\ kg^{-1}$ DM) Leaves		Stems	
	Light	Dark	Light	Dark	Light	Dark
Barcel	4.41	2.93	106	67	131	157
HiMag	3.56	2.51	86	52	128	103
Kenhy	2.69	2.21	95	65	188	225
KY-31	3.51	2.51	78	65	107	126
MO-96	3.01	2.37	108	66	173	168
Mozark	2.75	2.57	105	52	146	134
Stargrazer	3.4	2.58	71	37	151	136
Mean	3.33	2.53	93	58	146	150

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