2004 RUTGERS Turfgrass Proceedings

THE NEW JERSEY TURFGRASS ASSOCIATION

In Cooperation With

RUTGERS COOPERATIVE RESEARCH & EXTENSION
NEW JERSEY AGRICULTURAL EXPERIMENT STATION
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
NEW BRUNSWICK

2004 RUTGERS TURFGRASS PROCEEDINGS

of the

New Jersey Turfgrass Expo
December 7-9, 2004
Trump Taj Mahal
Atlantic City, New Jersey

The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, Cook College, Rutgers, The State University of New Jersey in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. Through this forum, these professionals also reach a more general audience, which includes the public.

This publication includes lecture notes of papers presented at the 2004 New Jersey Turfgrass Expo. Publication of these lectures provides a readily available source of information covering a wide range of topics and includes technical and popular presentations of importance to the turfgrass industry.

This proceedings also includes research papers that contain original research findings and reviews of selected subjects in turfgrass science. These papers are presented primarily to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

Special thanks are given to those who have submitted papers for this proceedings, to the New Jersey Turfgrass Association for financial assistance, and to those individuals who have provided support to the Rutgers Turfgrass Research Program at Cook College, Rutgers, The State University of New Jersey.

Dr. Ann Brooks Gould, Editor
Dr. Bruce B. Clarke, Coordinator

VARIABILITY IN PROTEIN AND MINERAL CONTENT OF PASTURE AND TURFGRASSES

Elaine M. Allen[1], William A. Meyer[2], and Sarah L. Ralston[1]

Protein, energy, and mineral intake dramatically impact bone growth and development in young horses (Jeffcott, 1991). Concentrations of non-structural carbohydrates (NSC) and water soluble sugars (WSS fraction: glucose, fructose, sucrose, and fructans) can fluctuate significantly between forage species and with changes in environment (Allen et al., 2005). However, diurnal and seasonal variations in protein and mineral content in common pasturegrass mixes and newer turfgrass species have not been documented (W. Meyer, *personal communication*). It was hypothesized that common pasture mixes used in the northeastern United States (i.e., timothy, bluegrass, fescue, orchard grass, and clover) and new turfgrass species being considered for use in horse pastures would have significant seasonal and possibly diurnal fluctuations in protein and minerals.

MATERIALS AND METHODS

Representative samples (at least ten sites per pasture at each collection for a total 500 g wet weight) of pasture grasses, clover, and occasional weeds actively grazed by horses were taken from four New Jersey farms with different soil types: Sandy marl (SM), marl, heavy loam/clay/marl (LCM), sand and loam on farms in Monmouth County (eastern shore/central region), and clay in Mercer County in the western part of the state. Samples were collected in May 2004 (late spring) and again at 4-week intervals from August to November (early to late fall) at 7 to 9 AM and 4 to 7 PM. Previous nighttime temperature, current weather conditions, and height and maturity of the samples were recorded, as was whether or not the pasture had been fertilized. Ground temperature was not recorded. Additional samples were taken after the first hard overnight freeze (13 Nov. 2004).

The same sampling protocol was used for pure stands of four turfgrass cultivars grown in Freehold sandy loam soil at the Rutgers Plant Science Research and Extension Farm at Adelphia, NJ (eastern Monmouth County): Colonial bentgrass (Tiger II) (*Agrostis tenuis* L.), Texas bluegrass x Kentucky bluegrass hybrid (Thermal) (*Poa aracinifera* L. X *Poa pratensis* L.), strong creeping fescue (SCFescue) (*Festuca rubra* subsp. *rubra* L.), and hard fescue (HFescue) (*Festuca brevipila* (Hack) Krajina). The latter two are fescue varieties with low or no levels of endophyte. In addition, a non-turf warm season grass, crabgrass (CG) (*Digitaria sanguiinalis* (L.) Scop), was sampled. Five to six pure cultivars of each species were sampled at each collection. The crabgrass samples were going to seed and into dormancy when collected.

Samples were immediately placed in dry ice and stored frozen pending freeze-drying. Freeze-dried samples were submitted for wet chemistry analysis of crude protein, NSC, acid detergent fiber (ADF), calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), manganese (Mn), copper (Cu), zinc (ZN), and iron (FE) (Equi-Analytical Laboratories, Ithaca, NY).

Pearson's correlation analysis was used to determine significant interactions. Linear regression analysis was used to test relationships between linear variables (i.e., nutrient contents, temperature, and date). Effects of discrete factors such as farm, col-

[1]Undergraduate Research Assistant and Associate Professor, Department of Animal Science, and [2]Professor, Department of Plant Biology and Pathology, Cook College, Rutgers, The State University of New Jersey, New Brunswick, NJ 08901-8520.

lection site, or grass type were assessed using ANOVA and LSD (Statistix 8.0, Ocala, FL).

RESULTS

Protein and mineral content did not show diurnal variations. There were nutrient differences ($P < 0.05$) among turfgrass species (Table 1a-c) and among pastures (Table 2a-c). Mature plants (full seed head) had lower Zn ($P < 0.05$) and higher ADF ($P < 0.05$) than immature, pre- seed head, or emerging seed head plants. There were seasonal variations ($P < 0.05$) in some of the nutrients (Table 3). Protein content of the grasses was correlated ($P < 0.05$) with sugar, K, Mn, Ca, and Zn, yet was inversely correlated ($P < 0.05$) with starch, NDF, ADF, previous night-time temperature, and the temperature when the sample was taken.

Table 1a. Turfgrass dry matter macromineral content (mean percent ± standard error). All cultivars were grown on the same soil type and sampled at the same times.

Grass type	N[Z]	Ca	P	K	Mg
			(%)		
Thermal[Y]	6	0.36 ± 0.06 a[X]	0.30 ± 0.01 b	2.38 ± 0.1 ab	0.21 ± 0.01 b
SCFescue	6	0.37 ± 0.02 a	0.37 ± 0.02 a	2.66 ± 0.13 a	0.20 ± 0.02 bc
HFescue	6	0.25 ± 0.02 b	0.28 ± 0.10 b	2.13 ± 0.15 b	0.13 ± 0.01 c
Tiger II	5	0.35 ± 0.02 a	0.31 ± 0.03 ab	2.39 ± 0.22 ab	0.26 ± 0.03 b
CG	4	0.30 ± 0.03 ab	0.32 ± 0.03 ab	2.10 ± 0.28 b	0.60 ± 0.14 a

Table 1b. Turfgrass dry matter micromineral content (mean ppm ± standard error).

Grass type	N	Cu	Fe	Mn	Zn
			(ppm)		
Thermal	6	11 ± 1 ab	635 ± 114 b	63 ± 9 a	26 ± 2
SCFescue	6	9 ± 0.4 b	771 ± 131 b	52 ± 6 ab	21 ± 1
HFescue	6	13 ± 1 a	1680 ± 345 a	49 ± 5 ab	25 ± 3
Tiger II	5	10 ± 1 ab	1032 ± 260 ab	65 ± 13 a	25 ± 6
CG	4	11 ± 1 ab	559 ± 515 b	33 ± 4 b	28 ± 3

Table 1c. Turfgrass dry matter protein, starch, NSC, and ADF (mean percent ± standard error).

Grass type	N	Protein	Starch	NSC	ADF
			(%)		
Thermal	6	20.8 ± 2.2	1.6 ± 0.1 b	14.5 ± 2.0 a	29.0 ± 1.4
SCFescue	6	21.5 ± 1.2	1.7 ± 0.5 b	10.4 ± 1.8 ab	29.4 ± 1.2
HFescue	6	19.0 ± 1.6	1.1 ± 0.2 b	9.0 ± 2.1 b	32.3 ± 2.0
Tiger II	5	20.4 ± 1.6	1.7 ± 0.2 b	9.9 ± 1.9 ab	36.1 ± 5.8
CG	4	13.7 ± 1.0	6.6 ± 0.8 a	13.3 ± 2.0 ab	34.6 ± 3.4

[Z] Sample size.
[Y] Thermal: Texas bluegrass X Kentucky bluegrass hybrid; SCFescue: strong creeping red fescue; HFescue: hard fescue; Tiger II: colonial bentgrass; CG: crabgrass.
[X] Means in a column followed by the same letter are not significantly different ($P = 0.05$) (LSD). Columns without letters indicate no significant differences between species.

Table 2a. Pasture mix dry matter macromineral content (mean percent ± standard error).

Farm	Pasture Soil Type	N[Z]	Ca	P	K	Mg
				(%)		
1a	Loam	5	0.61 ± 0.04 b[Y]	0.37 ± 0.02 cd	2.22 ± 0.11 b	0.33 ± 0.03 a
1b	Loam	5	0.48 ± 0.03 cd	0.53 ± 0.02 a	1.72 ± 0.06 d	0.24 ± 0.01 cd
1c	Loam	5	0.51 ± 0.03 c	0.47 ± 0.02 ab	2.18 ± 0.09 b	0.30 ± 0.01 ab
2	Sand	4	0.41 ± 0.04 de	0.33 ± 0.01 d	1.89 ± 0.05 cd	0.22 ± 0.01 d
3	Clay	5	0.74 ± 0.03 a	0.34 ± 0.01 d	2.14 ± 0.13 bc	0.28 ± 0.01 abc
4a	SM	4	0.32 ± 0.02 e	0.48 ± 0.03 ab	2.62 ± 0.12 a	0.29 ± 0.01 ab
4b	Marl	4	0.43 ± 0.04 cd	0.38 ± 0.03 cd	2.10 ± 0.10 bc	0.22 ± 0.01 d
4c	LCM	4	0.45 ± 0.02 cd	0.42 ± 0.03 bc	2.59 ± 0.12 a	0.25 ± 0.02 cd
4d	LCM	4	0.42 ± 0.02 cd	0.42 ± 0.03 bc	2.62 ± 0.07 a	0.24 ± 0.02 cd

Table 2b. Pasture mix dry matter micromineral content (mean ppm ± standard error).

Farm	Pasture Soil Type	N	Cu	Fe	Mn	Zn
					(ppm)	
1a	Loam	5	10 ± 0.4	1393 ± 271 abc	62 ± 0.5 bc	31 ± 2
1b	Loam	5	17 ± 1.0	2575 ± 1563 a	46 ± 10 cd	34 ± 5
1c	Loam	5	10 ± 2.0	473 ± 135 c	25 ± 3 d	28 ± 2
2	Sand	4	9 ± 1.0	162 ± 5 c	98 ± 2 a	31 ± 3
3	Clay	5	9 ± 0.5	569 ± 66 c	82 ± 15 ab	63 ± 21[X]
4a	SM	4	10 ± 1.0	664 ± 130 bc	30 ± 6 d	31 ± 2
4b	Marl	4	9 ± 1.0	725 ± 118 bc	95 ± 22 a	29 ± 2
4c	LCM	4	9 ± 1.0	1415 ± 186 abc	33 ± 2 cd	33 ± 2
4d	LCM	4	11 ± 1.0	2407 ± 228 ab	46 ± 4 cd	35 ± 4

Table 2c. Pasture mix dry matter protein, starch, NSC, and ADF content (mean percent ± standard error).

Farm	Pasture Soil Type	N	Protein	Starch	NSC	ADF
				(%)		
1a	Loam	5	23.8 ± 1.1 a	3.1 ± 0.6 ab	10.3 ± 1.3 b	28.6 ± 0.9 bc
1b	Loam	5	11.1 ± 1.3 e	5.7 ± 1.3 a	13.8 ± 1.9 ab	31.3 ± 1.1 a
1c	Loam	5	20.2 ± 1.1 abc	2.7 ± 0.5 b	12.3 ± 0.9 ab	30.3 ± 0.9 ab
2	Sand	4	14.3 ± 1.3 de	5.6 ± 0.5 a	14.9 ± 0.7 ab	29.8 ± 0.6 ab
3	Clay	5	19.8 ± 1.0 bc	2.5 ± 0.5 b	15.5 ± 2.6 ab	28.2 ± 1.1 bc
4a	SM	4	17.1 ± 2.8 cd	4.4 ± 2.2 ab	15.8 ± 2.5 ab	28.3 ± 0.6 bc
4b	Marl	4	16.5 ± 1.0 cd	2.1 ± 0.8 b	13.6 ± 2.6 ab	31.3 ± 1.1 a
4c	LCM	4	23.3 ± 1.0 ab	3.0 ± 0.8 ab	17.2 ± 1.9 a	26.5 ± 0.4 c
4d	LCM	4	21.4 ± 1.0 ab	3.3 ± 1.2 ab	16.3 ± 2.6 a	26.4 ± 1.2 c

[Z] Sample size.
[Y] Means in a column followed by the same letter are not significantly different (P = 0.05) (LSD). Columns without letters indicate no significant differences between pastures.
[X] Zinc content of 2 samples unusually high (77 and 142 ppm) - probable contamination.

Table 3. Seasonal variation in dry matter nutrient content of pasture mixes (means ± standard error).

	May	August	September	October	November[Y]
Protein (%)	19.9 ± 0.7[Z]	17.6 ± 1.4	17.5 ± 2.6	18.7 ± 1.7	20.7 ± 2.1
Starch (%)	2.0 ± 0.4 bc	4.8 ± 0.6 a	4.7 ± 0.6 a	3.5 ± 0.6 ab	0.78 ± 0.1 a
NSC (%)	13.2 ± 0.6 b	13.9 ± 1.1 b	11.2 ± 0.6 b	13.8 ± 1.3 b	20.9 ± 1.2 a
Ca (%)	0.53 ± 0.04 ab	0.43 ± 0.03 b	0.50 ± 0.03 b	0.65 ± 0.05 a	0.46 ± 0.07 b
P (%)	0.44 ± 0.03 a	0.43 ± 0.02 a	0.48 ± 0.03 a	0.34 ± 0.01 b	0.35± 0.02 b
Mg (%)	0.25 ± 0.02 b	0.26 ± 0.01 b	0.32 ± 0.02 a	0.27 ± 0.02 ab	0.21± 0.02 ab
K (%)	2.2 ± 0.1 b	2.3 ± 0.1 b	2.0 ± 0.1 b	2.0 ± 0.04 b	2.6 ± 0.2 a
Cu (ppm)	17.3 ± 5.5 a	9.3 ± 0.4 b	9.8 ± 0.6 b	9.8 ± 0.5 b	7.2 ± 0.4 b
Fe (ppm)	2015 ± 1124 a	998 ± 249 ab	1184 ± 218 ab	469 ± 101 b	1185 ± 305 ab
Mn (ppm)	51 ± 8 b	53 ± 9 b	44 ± 9 b	96 ± 13 a	45 ± 10 b
Zn (ppm)	32 ± 3 a	31 ± 1 a	33 ± 3 a	41 ± 7 a[X]	51 ± 23 a[X]

[Z] Means in a row followed by the same letter are not significantly different (*P* = 0.05) (LSD). Rows without letters indicate no significant differences between species.
[Y] Samples taken after an overnight freeze.
[X] Zinc content of samples from Farm 3 unusually high (77 and 142 ppm) - probable contamination.

DISCUSSION

Though the water-soluble sugars in these forages increased ($P < 0.05$) over the course of a day or after an overnight freeze (Allen et al., 2005), protein and minerals did not vary ($P > 0.05$) under the same circumstances, and starch actually decreased after an overnight freeze. Only NSC, which consists of water-soluble sugars plus starch (Watts and Chatterton, 2004) had significant variability over the course of a day or after a freeze. This is predominantly of concern to horses that are prone to laminitis.

Unexpectedly, Cu and Fe did not differ ($P < 0.05$) between farms (Table 2b), despite differences in soil type and grass species. There were, however, differences in other minerals, even between pastures on the same farm on the same soil type. For example, on Farm 1, pasture 1a was lightly grazed and adjacent to a heavily fertilized agricultural field, whereas pasture 1b was farther downhill, was overgrazed (grass height < 4 cm), and contained more than 10% clover. In contrast, pasture 1c, also downhill from 1a, was virtually unused (grass height > 15 cm) with more than 20% clover content. The Ca/P ratio was reversed in the hard fescue turfgrass and on pastures 1b and 4a; this latter site had very poor soil (sandy marl), was at the top of a hill, and contained less than 10% clover. All of the pastures on farms 1, 2, and 4 had been fertilized with Ca within the past year.

The protein content of all forages tested except crabgrass would meet or exceed the recommendations for both adult and growing horses (National Research Council, 1989). However Ca and P content of all the turfgrasses were deficient relative to the needs of rapidly growing foals (National Research Council, 1989), and only Tiger II and pasture 3 had adequate Zn. Use of pastures 1c, 4a, or any of the turfgrasses as the primary source of nutrition for growing horses would probably result in a high incidence of developmental orthopedic disease if additional minerals were not supplemented. All pastures except 1c contained adequate minerals to meet the needs of mature maintenance horses with free access to water and salt. There were significant seasonal variations in the mineral content of pasture mixes, with the month of August, after a period of very hot, dry weather, showing the least desirable mineral content.

CONCLUSIONS

It should not be assumed that adequate Ca is provided by commonly used pasture mixes under certain soil/growing conditions. Some turfgrass species selected for their hardiness may be appropriate for use in pastures for adult animals but may not be appropriate for breeding farms unless overseeded with a palatable legume or the horses are fed a mineral supplement.

ACKNOWLEDGMENTS

The authors acknowledge Kathryn Watts, Rocky Mountain Consulting, Inc., for her input and advice on this project.

REFERENCES

Jeffcott, L. B. 1991. Osteochondrosis in the horse - searching for the key to pathogenesis. Equine Veterinary Journal 23:331-338.

Allen, E. A., Meyer, W., Ralston, S. L., and Watts, K. A. 2005. Variation in soluble sugar content of pasture and turfgrasses. Pages 321-323 *in:* Proc. Equine Science Society Symposium, Tucson, AZ.

National Research Council. 1989. Nutrient Requirements of Horses. National Academy Press, Washington, DC.

Watts, K. A., and Chatterton, N. J. 2004. A review of factors affecting carbohydrate levels in forage. JEVS 24:84-86.