Mineral Concentrations of Annual Cool Season Pasture Forages in North Florida during the Winter-Spring Grazing Season: II. Trace Minerals

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Pasture forage species and blend, pasture establishment method, year, and month of grazing season can influence concentrations of copper (Cu), zinc (Zn), selenium (Se), cobalt (Co), and, in particular, manganese (Mn) and iron (Fe) in annual cool-season grass pasture forage.

Summary

Concentrations of selected trace minerals (Cu, Fe, Zn, Mn, Co, Se) were determined from annual cool-season grass pasture forages over four consecutive winter-spring grazing seasons (2001-2005). Twice monthly forage samples were taken from eight experimental pastures used in beef cattle grazing trials. Two, 2-yr experiments were conducted; animal and pasture data were reported previously. Each experiment was of a similar 2x2 design comparing clean-tilled vs. sod-seeded pastures with two annual forage combinations (Study 1, rye + oats vs. rye + oats + ryegrass; Study 2, oats + ryegrass vs. ryegrass only). Pastures were planted in Oct or Nov, and grazed (sampled) starting Nov, Dec, Jan or Feb and ending Apr or May. The overall mean concentrations of pasture forage for Exp. 1 and 2 respectively were (ppm of dry matter): Cu, 6.4 and 5.2; Fe, 88 and 68; Zn, 38 and 42; Mn, 105 and 114; Co, 0.06 and 0.06; and Se, 0.05 and 0.06. Year affected (P<0.05) forage Cu, Fe, Zn, and Se in Exp. 1 and Fe and Zn in Exp. 2. Pasture establishment method affected (P<0.05) Cu, Fe, Zn, and Mn in Exp. 1 and Mn and Se in Exp. 2. Forage treatment affected (P<0.05) Zn in Exp. 1 and Cu, Fe, Zn, Mn, and Co in Exp. 2. Sampling month affected (P<0.05) all minerals in both experiments except Cu and Zn in Exp. 2; monthly Se and Co were not evaluated due to limited analyses. Results indicate that forage type, pasture establishment method, year, and month of grazing season can affect concentrations of trace minerals of annual cool-season grass pasture forages in the southeastern USA.

Introduction

Cool-season annual grasses, such as oats (*Avena sativa*), rye (*Secale cereale*) and annual ryegrass (*Lolrum multifloram*) are commonly planted to provide forage for grazing by beef cattle during the late fall to spring period in the southeastern USA when permanent warm-season grass pastures are dormant. Depending on moisture and weather, the grazing period can start as early as late November and last until early June, but the start can be as late as February and can end as early as late April. The annual forages are planted during the fall (Oct or Nov), and can be seeded directly into dormant warm-season pasture (sod-seeding) or planted into a clean-tilled, prepared seedbed. These forages are highly digestible and high in energy and protein; however, there is limited information in regards to concentration of various nutritionally important minerals. The purpose of this study was to measure monthly concentrations of selected macro and trace minerals in annual cool-season grass pasture forage of various combinations that were either sod-seeded or planted into a clean-tilled, prepared seedbed during the late fall-winter-spring grazing season in north Florida.

This report will present the results of the trace minerals of Cu, Zn, Fe, Mn, Co and Se. A companion report (Chelliah et al., 2009) will present results of analyses of selected macro minerals and is presented elsewhere in the 2009 Florida Beef Report.

Procedures

Pasture forage mineral concentrations were determined as part of a grazing study. The study consisted of two cool-season beef cattle grazing experiments conducted at the North Florida Research and Education Center (NFREC) of the University of Florida located at Marianna (31 N Lat.). Each experiment lasted two yr, resulting in four consecutive yr of testing from 2001 to 2005 during the late fall-winter-spring grazing season. Trace (micro) mineral concentrations were determined from forage samples taken from eight, 3.2 ac experimental pastures per yr used in the two grazing experiments.

The two, two-year studies conducted were each of a similar 2x2 design comparing clean-tilled vs. sod-seeded pastures with two different forage combinations (simple vs. more complex blend; Exp. 1 small grains only – rye and oats vs. small grains plus ryegrass; Exp. 2, ryegrass only vs. ryegrass plus oats). There were two pastures per treatment combination per year within each experiment. Pastures were planted in October or November of each year, and grazed and sampled starting November, December, January or February, and ending April or May (the start and end varied between years due to weather conditions – pastures were grown under dry land conditions).

Pastures were sampled twice mo and samples were pooled by month for mineral analyses. Not all months were represented for each yr, however, the months of February, March and April were represented for each yr of each experiment and were used in statistical analyses to evaluate the effect of yr, forage type, and pasture establishment method. Due to high costs, only a limited number of samples, chosen at random, were analyzed for Se and Co for each yr in each experiment. Further information about planting, fertilization, and management of pastures is presented in a companion paper published elsewhere in the 2009 Florida Beef Report (Chelliah et al., 2009). Cattle were provided a free choice mineral supplement at all times while grazing (Purina Dixie H/M H/SE, Purina Mills, St. Louis, MO).

Data were analyzed as a 2x2 randomized complete block design. The models evaluated pasture forage treatment and pasture establishment method as fixed effects, and yr as random. Monthly mineral concentrations for each experiment also were analyzed using repeated measures model with mo as the repeated measure. The experimental unit was the individual pasture.

Results

Animal and pasture results were reported previously (Myer and Blount, 2005 and 2007). Cool-season annual grass species chosen reflect what is commonly grown in the Southern Coastal Plain region of the US. Most cool-season annual pastures planted, however, are mono-crops in this region. Average monthly rainfall and daily temperatures over the four study yr during October to May period were similar to the 30-yr average at Marianna, except for rainfall in January and May where amounts averaged 30 to 50% less over the four yrs. October, November, April and May tended to be warmer than the 30-yr average. As expected, there was yr to yr variation which probably affected pasture forage mineral concentrations noted for yr to yr. As such, results were averaged over yrs as most producers are interested in what may be expected for an average yr.

Pasture establishment method affected ($P<0.05$) forage concentrations of Cu, Zn, Fe, and Mn in Exp. 1, and Mn and Se in Exp. 2 (Table 1). Pasture forage treatment affected ($P<0.05$) forage concentrations of Zn in Exp. 1, and Cu, Zn, Fe, Mn, and Co in Exp. 2 (Table 1).

Year affected ($P<0.05$) Cu, Zn, Fe and Se pasture forage concentrations in Exp. 1, but only affected Zn and Fe in Exp. 2 (means are not shown). No pasture establishment method by forage treatment or year by treatment combination interactions (*P>0.05*) were noted.

Month within yr affected (*P<0.05*) pasture forage concentrations of Cu, Zn, Fe and, Mn in Exp. 1 but only Fe and Mn in Exp. 2 (Table 2). Month by mo results of Se and Co are incomplete due to limited number of samples analyzed. In general, forage concentrations of Fe decreased and Mn increased as the grazing season progressed (Table 2).Considerable variation in concentrations of the trace minerals in the pasture forage samples, however, were noted within experiments (Table 3).

Results indicated that annual cool-season pasture forage type, pasture establishment method, and, yr, while not consistent between the experiments, can influence pasture forage concentrations of Cu, Zn, Fe, Mn, Co and Se. The significant differences noted due to forage treatment and pasture establishment method; however, were small. Again, while not consistent, pasture forage trace mineral concentrations can also be influenced by mo during the grazing season, especially Fe and Mn. The high Fe early on in the grazing season noted in Exp. I but not Exp. 2 may have been the result of soil contamination. Soil, which is high in Fe, can splash on to the plant after a rain.

Overall mean pasture forage concentrations and variation noted for the trace minerals measured is summarized in Table 3. From the results obtained in both experiments, concentrations (mean ± one standard deviation; dry matter basis) in cool-season annual grass forages evaluated averaged 5.8 ± 0.8 ppm for Cu, 78 ± 14 ppm for Fe, 40 ± 4 ppm for Zn, 110 ± 14 ppm for Mn, 0.04 to 0.06 ± 0.02 ppm for Co, and 0.055 ± 0.01 ppm for Se. The ranges for Cu and Se are similar to those previously reported; Fe is at the low end, Zn at the high end, and Mn above (Table 3). However, it should be emphasized that there was much variation in the concentration of each mineral evaluated, especially, Fe.

Overall, for beef cattle grazing annual cool-season grass pastures, forage Cu, Se and Co would be deficient, Zn would be marginal, and Fe and Mn would be adequate (Table 3).

Literature Cited
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Table 1. Trace mineral concentrations of annual cool-season grass pasture forages during the late fall-winter-spring grazing season in north Florida (ppm of dry matter).

		Cultivation		Forage Trt.			Significance[g]		
Mineral	Exp.[a]	SS[b]	PS[c]	Simple[d]	Blend[e]	SEM[f]	Cult.[h]	Forage[i]	CxF[j]
Cu	1	6.6	5.7	5.9	6.4	0.02	**	NS	NS
	2	5.1	5.3	5.9	4.5	0.03	NS	**	NS
Fe	1	79	98	92	84	4	*	NS	NS
	2	70	67	78	58	3	NS	**	NS
Zn	1	31	45	36	41	2	**	*	NS
	2	41	44	47	38	2	NS	**	NS
Mn	1	120	91	100	110	6	**	NS	NS
	2	103	127	127	102	4	**	**	NS
Co	1	0.07	0.05	0.06	0.05	0.01	NS	NS	NS
	2	0.06	0.06	0.09	0.04	0.01	NS	*	NS
Se	1	0.05	0.05	0.05	0.05	0.003	NS	NS	NS
	2	0.04	0.07	0.06	0.05	0.005	**	NS	NS

[a]Exp. 1, 2001-2002 and 2002-2003 grazing seasons; and Exp. 2, 2003-2004 and 2004-2005.

[b]SS = sod-seeded pastures

[c]PS = prepared seedbed (clean-tilled) pastures.

[d]Simple blend or mono-culture of forage species in pastures (Exp. 1, small grains – rye and oats; Exp. 2, ryegrass only).

[e]Blend of forage species in pastures (Exp. 1, small grains plus ryegrass; Exp. 2, oats plus ryegrass).
[f]Standard error of the mean; n = 8.

[g]Significance of difference; ** = highly significantly different ($P<0.01$), * = significantly different ($P<0.05$), and NS = non-significant ($P>0.05$).

[h]Pasture establishment method (PS vs. SS).

[i]Pasture forage treatment (simple vs. blend).

[j]Establishment method by forage treatment interaction.

Table 2. Monthly concentrations of trace minerals in annual cool-season pasture forages during the late fall-winter-spring grazing season in north Florida (ppm of dry matter).

		Sampling month								
Mineral	Exp.[a]	Nov	Dec	Jan	Feb	Mar	Apr	May	SEM[b]	Significance[c]
Cu	1	5.8	7.7	8.2	6.1	6.0	6.4	5.5	0.4	**
	2	5.7	4.9	5.1	5.0	5.5	5.3	4.8	0.5	NS
Fe	1	190	126	178	98	75	92	105	13	**
	2	85	83	83	90	82	64	60	12	**
Zn	1	30	33	41	37	36	41	60	3	**
	2	41	39	42	48	40	42	46	5	NS
Mn	1	82	95	111	106	105	105	125	9	**
	2	78	107	96	91	108	112	124	10	**
Co	1	--	0.05	--	0.03	0.02	0.08	0.09	0.03	*
	2	--	--	--	--	0.07	0.07	0.12	0.05	NS
Se	1	--	0.05	--	0.05	0.04	0.06	0.06	0.02	NS
	2	--	--	--	--	0.07	0.05	0.06	0.01	NS

[a] Exp. 1, 2001-2002 and 2003-2003 grazing seasons; and Exp. 2, 2003-2004 and 2004-2005.

[b]Standard error of the mean; average n = 8 (average n = 3 for Co and Se).

[c]Significance due to month within experiment; ** = highly significant (*P<0.01*), * = significant (*P<0.05*), and NS = non-significant (*P>0.05*).

Table 3. Overall means and ranges of trace mineral concentrations of annual cool-season annual grass pasture forages from each two-year experiment (ppm, dry matter basis).

Mineral	Exp.[a]	Mean[b]	1S.D.[c]	Range[d]	Requirement[e]	Reported[f]
Cu	1	6.4	0.5	4.0 to 9.9	10	4 to 8
	2	5.2	0.9	4.0 to 9.4		
Fe	1	88	15	56 to 242	50	101 to 367
	2	68	13	68 to 156		
Zn	1	38	4	13 to 56	30	25 to 30
	2	42	4	29 to 74		
Mn	1	105	19	56 to 171	40	42 to 66
	2	114	9	62 to 160		
Co	1	0.06	0.02	0.02 to 0.10	0.10	--
	2	0.06	0.02	0.03 to 0.13		
Se	1	0.05	0.01	0.03 to 0.07	0.10	0.07
	2	0.06	0.01	0.04 to 0.08		

[a]Exp. 1, 2001-2002 and 2002-2003 grazing seasons; and Exp. 2, 2003-2004 and 2004-2005.

[b]Overall mean across all treatments (n = 24; 8 for Co and Se).

[c]One standard deviation.

[d]Lowest or highest monthly concentration obtained from a treatment within year within experiment (n = 2).

[e]Suggested requirement for growing beef cattle heifers (500 to 900 lb; NRC 2000).

[f]Other reported concentrations for rye, oats and ryegrass fresh forage (dry matter basis); data from Ensminger et al., 1990, and NRC, 2000.