EVALUATION OF BLOAT POTENTIAL OF CATTLE AS AFFECTED BY N AND K FERTILIZATION IN CONTINUOUS WINTER WHEAT

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Story in Brief

The effect of increasing levels of fertilizer nitrogen and potassium (potash) on the sodium, potassium and sodium:potassium ratio of wheat forage was measured. In addition, crude protein and mineral content of pastures where bloat was or was not a problem were measured. Both the sodium and potassium content of wheat forage increased linearly with increasing levels of nitrogen; the potassium content tended to increase with increasing amounts of potash. The potassium and sodium contents were higher from bloat provoking pastures, and the potassium:sodium ratio was lower. The data indicate that the sodium and potassium concentrations of wheat forage can be influenced by application levels of nitrogen and potash. However, the data do not support the suggestion that higher potassium:sodium ratios of wheat forage increase bloat.

(Key words: Soil Fertility, Mineral Content, Wheat Forage, Bloat.)

Introduction

Turner (1981) suggested that the potassium to sodium ratio (K:Na) of ryegrass, clover or mixed forage in New Zealand may be an important etiologic factor in bloat. The K:Na ratio was **higher** in forage from "high bloat" pastures than in forage from "low bloat" pastures. Results of a preliminary study examining effects of soil fertility (i.e, increasing amounts of nitrogen or potassium) on crude protein, sodium and potassium contents and K:Na ratio of wheat forage are reported herein. In addition, the mineral content of wheat forage from pastures where cattle died of bloat or in which bloat was not a problem was measured.

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Materials and Methods

Wheat forage samples were collected from Experiment #222 located at the OSU Agronomy Farm in Stillwater, OK. Experiment #222 was established in 1969 under conventional tillage on a Kirkland silt loam (fine, mixed, thermic Udertic Paleustoll) to evaluate various rates of annually applied N, P and K for continuous wheat production. Winter wheat has been planted for 24 continuous years in 10 inch rows at a seeding rate of 60 lb/acre. Nitrogen (N) and potassium (K) were added (as N-P_2O_5-K_2O) by applying ammonium nitrate (33.5-0-0) and potassium chloride (0-0-60), respectively. Treatment combinations included annual N-K_2O applications in lb/acre of 0-40, 40-40, 80-40, 80-0 and 80-80. Phosphorus was applied at a constant rate of 60 lb P_2O_5/acre/yr in all treatments. All fertilizers were broadcast and incorporated into the soil prior to planting wheat in the fall. Wheat forage samples were taken from 4 replications per treatment on March 9, 1992 by hand-clipping to ground level at Feekes Stage 6 (first node of stem visible at base of shoot). Forage samples dried in a forced-air oven at 60°C, were ground and analyzed for crude protein, sodium and potassium. Mineral analyses were done by atomic absorption spectroscopy using glassware that was washed in chromic-sulfuric acid cleaning solution for 48 hours. Samples for sodium and potassium analysis were diluted using double distilled, deionized water. Final dilutions were into polystyrene tubes. Calcium was determined in the presence of 1% lanthanum.

In addition, wheat forage samples were collected from four pastures in which 2 to 5% of the cattle had recently died of bloat and from 2 pastures nearby in which bloat was not a problem. These samples were collected on February 21, 1992 near Drummond, Oklahoma and were analyzed for minerals by Induction Coupled Plasma Atomic Emission Spectroscopy. Cattle of all pastures had free-choice access to a commercial mineral mixture that contained: salt, 20%; calcium, 16 %; phosphorus, 4 %; magnesium, 5.5%; vitamin A, 150,000 IU/lb and lasalocid, 720 mg/lb.

Results and Discussion

Soil test characteristics measured in 1981 and 1988 for 2 of the soil fertility treatments are shown in Table 1. From 1981 to 1988, surface soil (0-6 inches) P and K levels increased as a result of annual applications. Long-term applications of N, P and K provided differences in fertility that allows single site comparisons of plant nutrient levels. The effect of fertility on Na and K content and the Na:K ratio of wheat forage is shown in Table 2. The sodium content of wheat forage increased in a linear manner with greater application of nitrogen. However, application of 80 versus 0 lb of potassium/acre (Trt 5 vs 4),

Table 1. Soil test characteristics (0-6 inches) for selected treatments, Experiment #222 Stillwater, OK, 1981 and 1988.

Trt	Year	pH	BI[a]	NO_3-N ppm	P -- lb/acre --	K	NH_4-N ppm	Org C[b] %	CEC[c] meq/100 g	Ca --------- ppm --------	Mg	Na	Org N %
0-60-40	1981	5.15	6.7	13	89	357							
	1988	5.83	7.1	16	141	422	7.2	.95	16.5	2268	549	7.3	.99
80-60-40	1981	4.98	6.7	21	61	366							
	1988	5.45	7.0	33	77	418	7.8	1.13					1.01

[a] Buffer index.
[b] Organic carbon.
[c] Cation exchange capacity.

Table 2. Effect of fertility level on sodium (Na), Potassium (K) and Na:K ratio of wheat forage.

	Fertility level (lb/acre) and Treatment					Observed significance levels					
Trt #:	1	2	3	4	5						
N:	0	40	80	80	80						
P:	60	60	60	60	60	N		K		Trt	Trt
K:	40	40	40	0	80	Linear	Quad	Linear	Quad	1 vs 3	4 vs 5
Na, % of DM	.024	.033	.044	.040	.033	.015	.85	.36	.26	.02	.36
K, % of DM	2.27	2.38	2.62	2.31	2.53	.027	.58	.08	.06	.03	.08
K:Na	126	79	61	60	94	.11	.65	.14	.40	.11	.14
Ca, % DM	.24	.21	.23	.23	.20	.79	.17	.18	.37	.76	.18
Crude protein, % of DM	9.9	10.5	14.2	13.0	12.5	.0001	.0016	.38	.018	.0001	.36

in the presence of similar amounts of N and phosphorus did not affect the sodium content of wheat forage. Forage potassium demonstrated linear and quadratic responses to applied N and K, respectively. The K:Na ratio tended to decrease with increasing applied N. All calcium and crude protein concentrations were lower than normal due to the advanced stage of forage maturity. The calcium content of wheat forage was not influenced by level of applied N or K.

Crude protein, sodium and potassium contents and the concentrations of some other minerals of forage from pastures where bloat incidence differed are shown in Table 3. Crude protein content was higher from the bloat provoking pastures. This is consistent with previous data reported by Horn et al. (1977). The higher crude protein content of bloat-provocative pastures is believed to be related to higher concentrations of soluble proteins in wheat forage. Soluble proteins contribute to froth or foam formation in the rumen that entraps fermentation gases of bloated cattle. Both the potassium and sodium contents were higher from bloat provoking pastures. This resulted in a **lower** K:Na ratio in wheat forage of the bloat provoking pastures which is opposite that reported by Turner (1981). The K:Na ratios observed in these wheat forage samples

Table 3. Crude protein and mineral content of wheat forage[a] from pastures where bloat was or was not a problem.

	No bloat	Bloat[b]	Significance[c]
No. pastures	2	4	
Soil	Sandy Loam	Red Clay	
Crude protein, %	26.0	33.2	P<.02
Sodium, %	.0060	.0135	P<.06
Potassium, %	2.65	3.35	P<.001
K:Na ratio	442	269	P<.08
Calcium, %	.26	.35	NS
Phosphorus, %	.46	.40	NS
Magnesium, %	.22	.23	NS
Iron, ppm	292	236	P<.09
Zinc, ppm	23	24	NS
Copper, ppm	5.0	6.5	P<.03
Manganese, ppm	252	142	P<.04

[a] Clipped to a height to simulate grazing.

[b] 2 to 5% of the cattle had very recently died of bloat.

[c] NS = P>.20.

were much higher than those of about 20 to 40 reported by Turner (1981). This is due primarily to much lower Na values for our samples. Reasons for this large difference are not apparent.

Bloat of wheat pasture stocker cattle usually occurs in the fall and early spring grazing periods when cattle are grazing rapidly growing, immature forage. The winter of 1991-92 was a year in which record numbers of stocker cattle died of bloat on wheat pasture. Most of these deaths occurred in late-January and early-February because of the unusually mild winter which initiated regrowth of wheat at a time that wheat usually is growing slowly.

These data indicate the sodium and potassium concentrations of wheat forage can be influenced by levels of N and potassium fertility. However, the data do not support the suggestion of Turner (1981) that higher K:Na ratios of small grains pastures or clover increases the incidence of bloat of cattle.

Literature Cited

Horn, G.W., et al. 1977. Wheat pasture bloat of stockers. Okla. Agr. Exp. Sta. Res. Rep. MP-101:27.

Turner, M.A. 1981. Dietary potassium-sodium imbalance as a factor in the aetiology of primary ruminal tympany in dairy cows. Vet. Res. Comm. 5:159.