Grass Tetany Hazard of Cereal Forages Based upon Chemical Composition

H. F. Mayland, D. L. Grunes, and V. A. Lazar
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ABSTRACT

The occurrence of grass tetany in cattle grazing small grains pastures led us to examine the forage chemical composition and to suggest the relative risk of grass tetany to cattle grazing each forage.

Early spring vegetative growth of wheat (Triticum aestivum L.) and crested wheatgrass (Agropyron desertorum (Fisch.) Schult) was periodically sampled from 3 x 20 m plots established on a fertile Portneuf silt loam (Duriixerollic calcicorthid). In addition, wheat, oats (Avena sativa L.), barley (Hordeum vulgare L.), and rye (Secale cereale L.) were grown in pots containing Portneuf silt loam in the greenhouse and were harvested once while still vegetative.

Forage samples were freeze-dried and the following parameters determined: total N (Kjeldahl); NO (electrode); Na, K, Mg, and Ca (atomic absorption); S and Cl (x-ray); P (vanadomolybdate); aconitic acid (polarography); higher fatty acids and ash alkalinity (both by titration). Estimated blood-serum Mg values were calculated from a generally unavailable Dutch nomograph of forage N x K and Mg values. The nomograph is included in this paper to enhance its availability.

Wheat forage seemed to pose a greater tetany hazard than the wheatgrass because wheat had lower values for Ca and higher values for K, K/(Ca + Mg), aconitic acid, ash alkalinity, and HFA. The estimated tetany hazard of the cereal forages was wheat > oats = barley > rye. This ranking corresponded to the other of blood-serum Mg levels predicted from the Dutch nomograph. Wheat forage was lowest in Mg, while rye forage was highest in Mg and Ca, and lowest in K and N. Aconitic acid represented a large portion of the total organic acids in oats, rye, wheat, and wheatgrass, but only traces were found in barley.

The frequent occurrence of grass tetany in cattle grazing wheat forage may result because of lower Mg and Ca levels and higher K, N, ash alkalinity, and HFA levels in this forage compared to other cereal forages.

Methods and Procedure

'Nordan' crested wheatgrass (Agropyron desertorum (Fisch.) Schult) established the previous fall and 'Thatcher' hard red spring wheat seeded during mid-March, were grown in 3 x 20 m plots on a fertile Portneuf silt loam soil (Duriixerollic calcicorthid). Soil characteristics include: pH = 7.7; 3% CaCO3 equiv.; CEC = 20 meq/100 g; 1.5, and 15 meq/100 g K, Mg, and Ca, respectively by N1410Ac extraction. Forage from randomly selected clones was clipped at a 5-cm stubble at regular time intervals bracketing the early spring tetany period. The chemical composition of wheat was compared to that of wheatgrass because of the authors' familiarity with the composition of wheatgrass coincident to the occurrence of grass tetany (6, 7). Five-day moving means were calculated for average daily air temperatures [(min + max)/2] obtained from the Kimberly Climatological Stn. adjacent to the plots.

In a second experiment, three cultivars of wheat (Thatcher and 'Moran' hard red spring, and 'Lemhi' soft white spring), rye (Secale cereale L.), 'Vale' barley (Hordeum vulgare L.), and 'Overland' oats (Avena sativa L.) were seeded in pots containing 3-kg

Additional index words: Hypomagnesemia, Barley, Oats, Rye, Wheat, Crested wheatgrass.
Table 1. Mean air temperature, plant height, and chemical composition of Nordan crested wheatgrass and Thatcher wheat forages.

<table>
<thead>
<tr>
<th>Date sampled</th>
<th>Mean air temperature*</th>
<th>Plant height</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>P</th>
<th>N</th>
<th>Acetic acid§</th>
<th>Ash alkalinity</th>
<th>HFA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(mg/kg)</td>
<td>meq/kg</td>
<td></td>
</tr>
<tr>
<td>26 Mar. 1968</td>
<td>6.9</td>
<td>13</td>
<td>2.1</td>
<td>0.15</td>
<td>0.47</td>
<td>0.22</td>
<td>4.9</td>
<td>1.5</td>
<td>280</td>
<td>600</td>
</tr>
<tr>
<td>16 Apr. 1968</td>
<td>4.3</td>
<td>20</td>
<td>2.0</td>
<td>0.12</td>
<td>0.46</td>
<td>0.22</td>
<td>4.3</td>
<td>1.6</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>30 Apr. 1968</td>
<td>11.2</td>
<td>28</td>
<td>1.9</td>
<td>0.10</td>
<td>0.29</td>
<td>0.19</td>
<td>3.9</td>
<td>2.1</td>
<td>260</td>
<td>470</td>
</tr>
<tr>
<td>14 May 1968</td>
<td>11.8</td>
<td>30</td>
<td>1.8</td>
<td>0.10</td>
<td>0.28</td>
<td>0.19</td>
<td>3.8</td>
<td>2.1</td>
<td>260</td>
<td>470</td>
</tr>
<tr>
<td>28 May 1968</td>
<td>14.1</td>
<td>35</td>
<td>1.6</td>
<td>0.12</td>
<td>0.31</td>
<td>0.19</td>
<td>2.7</td>
<td>1.6</td>
<td>135</td>
<td>440</td>
</tr>
</tbody>
</table>

Nordan Crested Wheatgrass

Thatcher Hard Red Spring Wheat

† Calculated as moving 5-day mean. § Calculated on equivalent basis.

RESULTS AND DISCUSSION

Spring wheat forage produced under field conditions contained higher K levels but lower Ca levels than did crested wheatgrass (Table 1). The Mg levels were similar for the two forages but the K/(Ca + Mg) values of wheat were nearly twice those of wheatgrass and greater than the 2.2 ratio above which the incidence of tetany increases rapidly (3). Ash alkalinity, an indirect measure of organic acid content, was higher in wheat forage than in the perennial wheatgrass forage. The organic acids (e.g., citrate, aconitate) may be a contributing factor in the cause of tetany (7). Wheat contained higher organic acid levels than did wheatgrass. It should be noted that a larger fraction of the organic acids in wheat occurred as aconitic acid when compared to wheatgrass (Table 1).

Total N levels of wheat tended to be greater than those for wheatgrass. The high total N and nonprotein nitrogen (NPN) of wheat have been associated with grass tetany (1). Wheat in this study also had higher NO₃-N levels than did wheatgrass but these levels did not exceed 0.16%. Fatty acid (HFA) (e.g., palmitic, linolenic) concentrations were higher in wheat than in wheatgrass forage. HFA increases the tetany hazard by forming Mg and Ca soaps within the rumen, thereby reducing the availability of these cations to ruminants (2, 3). The forages provide adequate Ca but slightly marginal P levels for nursing beef cows (9).

Attempts to assess the grass tetany hazard of forage, based only on the chemical composition, have not been entirely adequate because of interacting factors that reduce dietary Mg availability. These factors in the forage include high N, K, and HFA, and low Mg, Ca, and soluble carbohydrates (see references 1 through 4 and 6 for more discussion). Hartmans (4),
Mayland et al.: Grass tetany hazard of cereals

Table 2. Yield and chemical composition of cereal forages grown in a greenhouse.*

<table>
<thead>
<tr>
<th>Forage cultivar</th>
<th>Yield</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>P</th>
<th>N</th>
<th>K+ (Ca + Mg)</th>
<th>Aconitic acid</th>
<th>C - A ‡</th>
<th>Serum Mg §</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thatcher wheat</td>
<td>3.7</td>
<td>4.7</td>
<td>b</td>
<td>0.21</td>
<td>b</td>
<td>0.80</td>
<td>0.22</td>
<td>2.9</td>
<td>740</td>
<td>1,410</td>
</tr>
<tr>
<td>Lemhi wheat</td>
<td>3.8</td>
<td>4.1</td>
<td>b</td>
<td>0.21</td>
<td>d</td>
<td>0.86</td>
<td>0.20</td>
<td>2.8</td>
<td>720</td>
<td>1,190</td>
</tr>
<tr>
<td>Moran wheat</td>
<td>3.8</td>
<td>3.7</td>
<td>b</td>
<td>0.21</td>
<td>b</td>
<td>0.68</td>
<td>0.21</td>
<td>2.8</td>
<td>780</td>
<td>1,100</td>
</tr>
<tr>
<td>Vale barley</td>
<td>3.3</td>
<td>5.0</td>
<td>a</td>
<td>0.27</td>
<td>a</td>
<td>0.61</td>
<td>0.22</td>
<td>2.8</td>
<td>20</td>
<td>1,560</td>
</tr>
<tr>
<td>Overland oats</td>
<td>3.9</td>
<td>4.9</td>
<td>ab</td>
<td>0.24</td>
<td>b</td>
<td>0.95</td>
<td>0.21</td>
<td>2.8</td>
<td>720</td>
<td>1,610</td>
</tr>
<tr>
<td>Rye</td>
<td>3.5</td>
<td>4.0</td>
<td>ab</td>
<td>0.29</td>
<td>a</td>
<td>1.13</td>
<td>0.28</td>
<td>2.0</td>
<td>840</td>
<td>1,470</td>
</tr>
</tbody>
</table>

* Column means not followed by the same letter are different at P < 0.05.
‡ Cations – anions = (Na + K + Mg + Ca) – (Cl + NO₃N + PO₄P + SO₄S).
§ Predicted from nomograph of Henkens (4).

...may not be important since the high Ca concentration has so much more influence on the ratio, in this case, than does the Mg concentration.

The predicted blood-serum Mg level for each forage is shown in Table 2. While the nomograph by Hartmans (4) was developed for high producing dairy cattle in The Netherlands, the relative ranking of the forages in Table 2 should still apply to beef cattle. Based on the data shown in Table 2, the estimated tetany hazard is wheat > oats = barley > rye.

LITERATURE CITED