Development of Methodologies to Reduce the DCAD of Hay Forages for Transition Dairy Cows

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Introduction

Ration formulation for dairy cows just prior to parturition must control the dietary cation-anion difference (DCAD) if hypocalcemia and milk fever are to be avoided. One key to reducing hypocalcemia is to avoid incorporation of high-K forages into the ration. The excessive K content of these forages can cause metabolic alkalosis in the cow and subsequently hypocalcemia and milk fever. Alfalfa and other cool-season grasses are often used in dairy rations. Reducing K content of forages can be achieved by restricting K fertilization so that soils do not support luxury consumption. Since K is the major cation contributing to high-DCAD diets, an obvious solution is to limit K fertilization of the forage crop to avoid luxury consumption of K. However, some forages may have reduced yield and increased winter kill if K concentrations are less than 2.0%, particularly alfalfa. Thus, producing alfalfa with less than 2% K may not be profitable, especially in northern regions. In addition to decreasing forage K, the producer can also increase the Cl content of the forages, and the resulting DCAD will be more favorable for the late-gestation cows.

This study tests the hypothesis that withholding K fertilization in combination with chloride fertilization of hays results in decreased K and increased Cl, which in turn results in a more favorable DCAD and acts as an aid in reducing hypocalcemia. DCAD in this study was defined as DCAD (meq/kg) = [K (meq/kg) + Na (meq/kg) – [Cl (meq/kg) + SO_4 (meq/kg)].

Materials and Methods

In August 2002, four forage species were seeded at a rate of 18 lb/acre (100 gm/plot) in four blocks of four 3 m × 16 m plots at the Northeast Research and Demonstration Farm. The four forage species to be evaluated were 1) Smooth Bromegrass – Barton (SB); 2) Orchardgrass – Napier (OG); 3) Reed Canarygrass – Palatine (RC); and 4) Alfalfa – Somerset (AF).

Starting in 2004, each grass plot was fertilized with nitrogen at a rate equivalent to 80 lb/acre prior to each cutting. Throughout the summer of 2003, plots were clipped in two cuttings to a height of 3 in.

In the spring of 2004 and 2005, each plot was divided into four subplots that were randomly treated with one of four potassium/chloride treatments including 0/0; 200/0; 0/100; and 200, 100 lb/acre of K_2O as K_2CO_3 and $CaC1_2$, respectively.

During the summer of 2004, each plot was harvested to a height of 3 in. with a Carter harvester in three cuttings at a date when the alfalfa was at the bud stage of maturity. Forage was weighed for determination of yield and further analyzed. Sampled forage was dried at 60^oC, ground, and analyzed for Ca, Mg. Na, K, Cl, P, and S to quantify the DCAD. In addition, samples were analyzed for neutral detergent fiber (NDF) and crude protein (CP).

Results and Discussion

One of the objectives of this experiment was to determine if withholding K fertilization would result in a decreased K content of the various hays. In the plots not receiving K fertilization (control and $CaCl_2$), the K content of the plants regardless of species and across all cuttings was lower (control, 1.92% and $CaCl_2$, 1.77%) relative to those receiving K (K_2O, 2.15% and KCl, 2.24%). Numerically the K content of plots fertilized with $CaCl_2$ had the lowest K concentration.

With regards to plant Cl content, the plots fertilized with $CaCl_2$ alone or in combination with K_2O resulted in a two- to three-fold elevation in tissue chloride in all the hays tested. This effect was observed for each of the three cuttings. Mean treatment values across all cutting and species were control, 0.32%; $CaCl_2$, 0.9%; K_2O, 0.34%; and KCl 0.34%. Hay species elevations (-Cl vs. +Cl) across all cutting were AF (0.26% vs. 0.63%); OG (0.30%, vs. 0.91), RC (0.41% vs. 1.05%) and SB (0.35 vs. 0.89%).

DCAD was also significantly reduced with $CaCl_2$ treatment alone and was reduced 50–75% (control vs. $CaCl_2$) in the OG (600 vs. 365), RC (438 vs. 105), and SB. (426 vs. 172) hays. The combination of K_2O and $CaCl_2$ resulted in an attenuation of this effect. Alfalfa DCAD appeared to be unaffected by Cl fertilization even in the face of elevated plant Cl (~two-fold) concentration (control=528 vs. CaCl=595). The effect of the elevated Cl content was negated by a compensatory increase in plant Na concentrations. This effect was also observed, albeit to a lesser extent, in OG.

Chloride treatment did not appear to have a detrimental effect on yield. The yield (tons/acre) across all treatments, cuttings, and species were control, 7.14; K_2O, 7.10; $CaCl_2$, 6.96; and KCl, 7.14).

Conclusion

These data suggest that withholding K fertilization in combination with Cl fertilization may be an effective means of increasing the Cl and ultimately decreasing the DCAD content of several species of hay without sacrificing yield. It was disappointing that this effect was not observed with alfalfa in this series of experiments. The elevated Na content in the $CaCl_2$-treated plots offset the beneficial effects of the elevated plant Cl on the DCAD. We have, however, shown in other experiments that we could lower the DCAD of alfalfa with $CaCl_2$ fertilization. We will continue to monitor the effects of K and Cl fertilization on plant parameters during the FY05 and FY06 growing seasons. In particular, the effects of Cl fertilization on hay quality and palatability is currently under investigation.