Development of Methodologies to Reduce the DCAD of Hays for Transition Dairy Cows

A.S. Leaflet R2201

Ronald Horst[1], Ken Pecinovsky[2], Ken Moore[2], Dale Thoreson[2], Jim Russell[2], E. Charles Brummer[2] and Jesse Goff[1; 1]National Animal Disease Center, Ames, IA, and [2]Iowa State University, Ames, IA

Summary and Implications

Hypocalcemia (clinical and subclinical) create a major economic loss in early postpartum dairy cows. Ration formulation for dairy cows just prior to parturition must control the diet cation-anion difference (DCAD) if hypocalcemia and milk fever are to be avoided. The purpose of this research was to evaluate the use of specific fertilizer regimes for forages and evaluate their impact on mineral and DCAD levels in hays, as well as forage yields. The experimental design involved four different species of hay (alfalfa, bromegrass, orchardgrass, and reed canarygrass) fertilized with either $CaCl_2$ or K_2CO_3 (designated K_2O) alone or a combination (designated KCl) of both.

In the plots not receiving K fertilization (Control and $CaCl_2$) the K content of the plants regardless of species was lower relative to those receiving K (K_2O and KCl). With regards to plant Cl content, the plots fertilized with $CaCl_2$ alone or in combination with K_2O resulted in substantial and at least a 2 fold elevations in tissue chloride in all the hays tested. DCAD was also significantly reduced with $CaCl_2$ treatment alone and was reduced 50-75% in the Orchardgrass, Reed Canarygrass and Orchardgrass hays. The combination of K_2O and $CaCl_2$ resulted in an attenuation of this effect. $CaCl_2$ treatment alone had no detrimental effect on yield when compared to Control plots. However, those plots fertilized with K (with or without Cl) had higher numerical yields than those not receiving K.

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. We will continue to monitor the effects of K and Cl fertilization on plant parameters during the FY05 and FY06 growing seasons. The effect of Cl fertilization on hay quality and palatability is currently under investigation.

Introduction

At the onset of lactation, the demands for milk production can induce a condition of low blood calcium (Ca) in the dairy cow. In some cases, the blood Ca concentration falls below the level necessary to support nerve and muscle function and the cow becomes recumbent, resulting in a condition known as hypocalcemia or "milk fever." Dietary cations, in particular potassium (K), inhibit the homeostatic mechanisms that ordinarily maintain blood Ca concentration within normal limits by inducing a metabolic alkalosis in the cow. This interferes with the function of parathyroid hormone, the primary Ca-regulating hormone. Increasing dietary anions, particularly chloride (Cl), can help overcome the effects of dietary cations because anions acidify the blood of the cow, enhancing target tissue sensitivity to parathyroid hormone and permitting Ca homeostasis.

Ration formulation for dairy cows just prior to parturition must control the diet 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. Unfortunately, dairy rations must incorporate some proportion of forage (usually at least 40%) to provide the effective fiber vital to the function of the cow's rumen. Alfalfa and other cool season grasses are often used in dairy rations. If K is present at high concentration in the soil these plants will often "luxury consume" K and concentrations can range from a low of 1.2-1.6% up to 3.6-4.2%. 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 to avoid luxury consumption of K by the forage crop. However, some forages may have reduced yield and increased winter kill if K concentrations are < 2.0%, particularly alfalfa. Thus, producing alfalfa with less than 2% K may not be profitable, especially in northern regions.

A recent NAHMS study indicates that more than half of the dairy cows in the country are fed late gestation rations that utilize low K forages to limit K intake. If, in addition to decreasing forage K, the producer can also increase the Cl content of the forages, the resulting DCAD will be more favorable for the late gestation cow.

This study tests the hypothesis that withholding K fertilization in combination with chloride fertilization of hays will result in decreased K and increased Cl resulting in a more favorable DCAD and act as an aid in reducing hypocalcemia. The experimental design involved 4 different species of hay fertilized with either $CaCl_2$ or K_2CO_3 (designated K_2O) alone or a combination (designated KCl) of both and measure the concentrations of the major cations and anions in the alfalfa tissue and to monitor forage yield.

Materials and Methods

In August, 2002, four forage species were seeded at a rate of 18 lb/ac (100 gm/plot) in four blocks of four 3 x 16 m plots at the Nashua Research and Demonstration Farm. Interrows between plots were seeded either with smooth bromegrass or Kentucky bluegrass. The four forage species to be evaluated were: 1) Smooth Bromegrass – Barton; 2) Orchardgrass – Napier; 3) Reed Canarygrass – Palatine; and 4) Alfalfa – Somerset.

In the spring of 2003 and each subsequent year, grass plots were fertilized with nitrogen at a rate equivalent to 100 lb/acre. Throughout the summer of 2003, plots were clipped in two cuttings to a height of 2 inches.

In the spring of 2004, 2005, and 2006, each plot was divided into four subplots that were randomly treated with one of four potassium/chloride treatments including:

K_2O as K_2CO_3, lb/ac	Chloride as $CaCl_2$, lb/ac
0	0
200	0
0	100
200	100

During the summer of 2004 each plot was harvested to a height of 1 inch 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 subsampled. Sampled forage was dried at 60 C, ground, and analyzed for Ca, Mg. Na, K, Cl, P, and S to quantify the Cation:Anion Balance. In addition, samples were analyzed for NDF and CP.

Results and Conclusions

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. Figure 1 summarizes the K content in the different hays as affected by the various fertilization regimes. In the plots not receiving K fertilization (Control and $CaCl_2$) the K content of the plants regardless of species was lower relative to those receiving K (K_2O and KCl). 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 substantial and at least a 2 fold elevations in tissue chloride in all the hays tested (Figure 2). This effect was observed for each of the three cuttings. The most dramatic elevations were observed with the Orchardgrass, Reed Canarygrass and Bromegrass hays.

DCAD was also significantly reduced with $CaCl_2$ treatment alone and was reduced 50-75% in the Orchardgrass, Reed Canarygrass and Orchardgrass hays (Figure 3). 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 (~2 fold) concentration. 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 Orchardgrass (data not shown).

$CaCl_2$ treatment alone had no detrimental effect on yield when compared to Control plots. However, those plots fertilized with K (with or without Cl) had higher numerical yields than those not receiving K.

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. The effect of Cl fertilization on hay quality and palatability is currently under investigation.

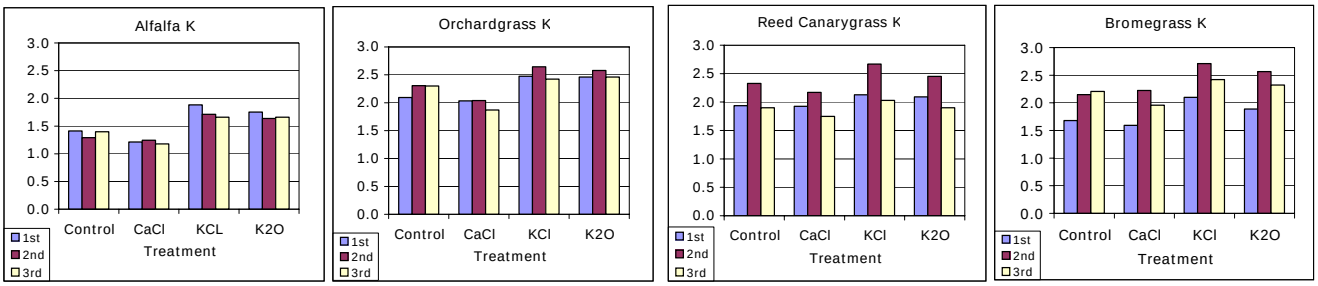

Figure 1. Plant K concentration as affected by the various fertilization regimes.

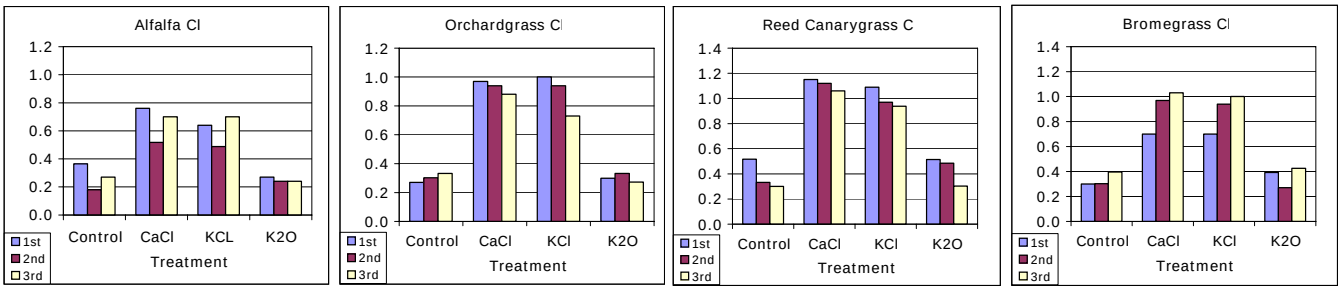

Figure 2. Plant Cl concentration as affected by the various fertilization regimes.

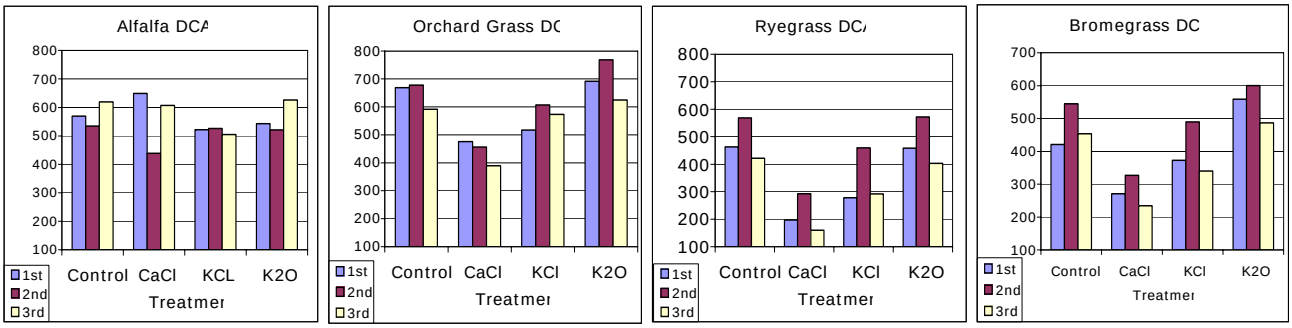

Figure 3. Plant DCAD concentration as affected by the various fertilization regimes.