Mineral Concentrations of Tall Fescue Fertilized With Different Swine Manure Treatments and Harvested On Four Dates

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Story in Brief

Various dietary and manure chemical treatments are being used in an attempt to reduce phosphorus runoff from fields fertilized with animal manure. These treatments may alter the concentration of plant-available nutrients. Our objective was to determine the impacts of fertilization with manure from different swine dietary or manure treatments on mineral concentrations of tall fescue (*Festuca arundinacea* Schreb.) harvested at four growth stages. Manure from pigs fed a normal growing and finishing diet (NORM) or a diet with added phytase (0.03%; PHY) was collected. This manure was applied to supply 113 lb N/acre to three of four experimental 1-ac tall fescue pastures. The four pastures received either no swine manure (negative control; CONT), NORM, PHY, or PHY+AL with the manure treated with aluminum chloride (0.75%) at application (PHY+AL) to bind manure phosphorus. Accumulated forage was clipped from each treatment on April 3, April 28, May 15, and June 23. Forage P concentrations declined linearly (P < 0.05) from NORM, PHY and PHY+AL but not from CONT. Concentrations of K decreased linearly (P < 0.05) and that of Fe, Cu, and Zn responded quadratically (P < 0.05) across harvest dates, but did not differ due to fertility treatment. Therefore, P concentrations may be impacted by dietary and chemical manipulations of the manure used for fertilizer.

Introduction

Phosphorus (P) levels in soil have become a major concern, because excessive soil phosphorus is blamed for increased P concentrations in water sources. Typically, animal manures are applied to meet plant N requirements, resulting in a build-up of P in the soil and potentially increasing the amount of runoff into lakes and streams. Manures may also be high in certain other minerals such as potassium, sulfur, and zinc, thereby affecting those mineral concentrations in forages (McGinley et al., 2004). Excessive P levels are excreted in swine manure because pigs lack the enzyme phytase needed to break down phytate, the complex in which plants store P. It is believed that adding phytase to swine diets (Smith et al., 2004) will improve utilization of P from grain and reduce the amount of supplemental P required in the feed. The combination of phytase and reduced dietary P should reduce excreted P, thereby reducing the amount of P applied with swine manure. Aluminum chloride binds chemically to P in manure and prevents it from being leached into the ground water. Our objective was to determine the impact of swine dietary (phytase) or manure (AlCl) treatments on concentrations of minerals from tall fescue fertilized with swine manure and harvested on four dates.

Experimental Procedures

Growing swine were fed a normal growing diet or a diet with added phytase (0.03%). Manure was collected separately from pigs on each diet, analyzed for N and P content, and then applied on March 14, 2003 to supply 113 lb N/acre to three of four experimental 1-ac pastures of ‘Jesup’ tall fescue infected with the Max Q™ endophyte. One pasture received no swine manure (negative control; CONT). Other pastures received: 1) normal swine manure (NORM); 2) manure from the pigs fed phytase (PHY); or 3) manure from the pigs fed phytase and treated with aluminum chloride (0.75%, wet basis) at the time of application (PHY+AL). Representative sites were selected randomly and protected from grazing with cattle panel enclosures. Forage samples were clipped to a 1-in stubble height with hand shears on April 3, April 28, May 15, and June 23, 2003 to correspond to vegetative, boot, full bloom, and soft dough stages of maturity. On April 3, samples were gathered at multiple locations prior to initiation of grazing. Thereafter, samples of accumulated forage were collected from one randomly-selected enclosure per pasture. Samples were dried in a forced-air oven (122°F) and ground to pass through a 2-mm screen. The forage was then digested in concentrated nitric acid, and mineral concentrations were determined as described by Galdámez-Cabrera et al. (2004) using inductively-coupled plasma spectroscopy. Mineral concentration data were analyzed by using SAS GLM procedures (SAS Inst., Inc., Cary, N.C.). Effects of manure treatment, linear and quadratic effects of harvest date, and their interactions were included in the model. Linear and quadratic coefficients were estimated using the solutions option. Orthogonal contrasts were used to compare effects of: 1) CONT with the mean of NORM, PHY, and PHY+AL; 2) NORM with PHY; and 3) PHY with PHY+AL when no interactions were detected.

Results and Discussion

The influence of fertility treatment on the concentrations of various minerals varied across harvest dates. Tall fescue Ca concentrations (Figure 1) were not affected (P > 0.10) by manure treatment or harvest date. The lowest Ca concentrations observed in these forages were above that required by lactating beef cows. Phosphorus concentrations (Figure 2) remained relatively stable across harvest dates from CONT, but declined linearly (P < 0.05) from NORM, PHY and PHY+AL. The P concentrations from PHY+AL mimicked those of CONT, particularly on the first two harvest dates, indicating that the aluminum chloride was successful in binding plant-available P. Forage P from PHY closely mimicked those of NORM for the first three harvest dates, indicating that although total dietary P was reduced in pigs fed phytase, the amount of soluble, plant-available P was likely not reduced.
Forage K (Figure 3) declined linearly (P < 0.05) across harvest dates from all four fertility treatments, and K concentration from CONT was lower (P < 0.05) than that from the fertilized forages when averaged across harvest dates. Forage Mg (Figure 4) was not affected (P > 0.10) by fertility treatment or harvest date. Forage S (Figure 5) concentrations declined quadratically (P < 0.05) through the May 15 harvest date from all fertility treatments, then increased. Likewise, forage Fe concentrations (Figure 6) declined quadratically (P < 0.05) through the May 15 harvest date from all fertility treatments, and then increased. Forage Cu (Figure 7) decreased (P < 0.05) and Zn (Figure 8) increased (P < 0.05) quadratically across harvest dates, regardless of fertility treatment. Average forage S, Fe, Cu, and Zn values did not differ (P > 0.10) among the different fertility treatments.

**Implications**

Changes in forage phosphorus concentration may be impacted rapidly by application of manures with soluble phosphorus. Reducing phosphorus concentration or solubility will likely reduce forage phosphorus concentrations. However, dietary and chemical manipulations to reduce phosphorus solubility and subsequent runoff may have little impact on other forage mineral concentrations.

**Literature Cited**

Fig. 5. Forage sulfur concentration (%) from unfertilized tall fescue (CONT) or tall fescue fertilized with swine manure from a normal finishing diet (NORM), a diet with phytase (PHY), or PHY with the manure treated with aluminum chloride.

Fig. 6. Forage iron concentration (%) from unfertilized tall fescue (CONT) or tall fescue fertilized with swine manure from a normal finishing diet (NORM), a diet with phytase (PHY), or PHY with the manure treated with aluminum chloride.

Fig. 7. Forage copper concentration (%) from unfertilized tall fescue (CONT) or tall fescue fertilized with swine manure from a normal finishing diet (NORM), a diet with phytase (PHY), or PHY with the manure treated with aluminum chloride.

Fig. 8. Forage zinc concentration (%) from unfertilized tall fescue (CONT) or tall fescue fertilized with swine manure from a normal finishing diet (NORM), a diet with phytase (PHY), or PHY with the manure treated with aluminum chloride.