Soil Phosphorus Removal by Stocker Cattle Grazing Winter Wheat

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Story in Brief

Six Santa-Cruz steers were harvested during the 2000/2001 wheat pasture season to determine phosphorus accretion of stocker cattle grazing winter wheat pasture. Phosphorus concentration of carcass and offal was determined and phosphorus accretion in carcass, offal, empty body, and live weight was determined by simple linear regression. Phosphorus accretion (g/kg) of carcass, empty body, and live weight was 7.5, 6.4, and 7.1, respectively. Phosphorus accretion (g/kg) of carcass and empty body protein was 32.6 and 26.7, respectively. Overall soil phosphorus removal by cattle is influenced by total weight gained, and is substantially less than phosphorus removed by forage biomass.

Key Words: Steers, Phosphorus, Carcass, Empty body, Live weight

Introduction

The primary method of soil phosphorus removal is by harvesting grain or forage crops. Another way that phosphorus can be removed is by grazing cattle. In order to determine the amount of phosphorus removed by winter wheat, phosphorus removal via wheat grain, hay, and grazing must be quantified. The data reported herein was obtained as part of a larger five-treatment study that was conducted to determine the amount of soil phosphorus removed in grain, hay, and grazing. Treatments included: 1) grazing during the winter, followed by grazing in the spring; 2) grazing during the winter, forage harvested as hay in the spring; 3) grazing during the winter, grain harvested in the spring; 4) no winter grazing, forage harvested as hay in the spring; and 5) no winter grazing, grain harvested in the spring. The objective of this study was to quantify the amount of phosphorus that is removed from soil as a result of winter grazing of stocker cattle on wheat pasture.

Materials and Methods

Six Santa Cruz steers were randomly selected from a group of steers used for another study. Three steers were harvested at the Oklahoma Food and Agricultural Products Research and Technology Center (FAPC) on January 15, 2001, prior to grazing wheat pasture, to determine initial phosphorus concentration in the whole body. Live weights of these steers were measured on January 10, when the steers were being withheld from feed and water. Steers that remained were introduced to pastures on January 10 until March 21, 2001 (winter grazing period, 70 d), and from March 21 to April 11 (grazeout period, 21 d). During the winter period, eight to 12 steers were assigned to each of four pastures (2.1 acres/steer), and during the grazeout period, stocking density was adjusted to eight to 14 steers in each pasture (.70 acres/steer). Three steers were harvested following completion of the grazeout period on April 16, to determine final phosphorus concentration in the whole body. Live weights of this group were measured on April 11 following an overnight shrink (approximately 16 hours) without feed or water.

Steers were harvested following normal operating procedures for FAPC. Once the steers were eviscerated, the visceral organs were removed, cleaned of their contents, and weighed individually. In addition to organs, head, hide, blood, mesenteric fat, and feet and ears were weighed. These weights were combined to determine total offal weight for each steer.

Offal was ground in a whole body grinder on the day of harvest. The right side of each carcass was ground in the same grinder following a 24-h chill. Triplicate samples, about 10 lb each, were collected from carcass and offal. Sub samples were collected to be lyophilized, and finely ground for subsequent laboratory analysis to determine nitrogen and phosphorus concentration. Samples were digested in 25% HCl, and analyzed spectrophotometrically to determine phosphorus concentration. Phosphorus concentration was then used to determine total phosphorus (g DM) in carcass and offal. Total phosphorus gain (g/kg) in carcass, empty body, and live weight was determined using simple linear regression analysis.

Nitrogen concentration was determined using a total combustion technique (NS-2000[â]; LECO, St. Joseph, MI). Nitrogen concentration was used to compute percent crude protein in carcass and offal, by multiplying percent nitrogen x 6.25. Phosphorus accretion per kg of protein in carcass and total empty body was determined by regression of total phosphorus (g) against total protein (kg) in carcass, and empty body.

Results and Discussion

Mean daily gain of the three steers harvested on April 16 was .90, 3.21, and 1.44 lb for winter, grazeout, and the overall trial (91 d), respectively. Phosphorus accretion in carcass, empty body, and live weight was 7.5, 6.4, and 7.1 g/kg and is shown graphically in Figures 1, 2, and 3, respectively. Phosphorus accretion in this study was within the range of 5 to 8 g P/kg live weight in pigs reported by Jongbloed (1987). Phosphorus concentrations in beef and swine tissue are similar (Anderson and Hoke, 1990; Anderson et al., 1992), and therefore, phosphorus accretion rates in cattle should be similar to that of the pig.

Figure 1. Total phosphorus vs. Carcass Weight

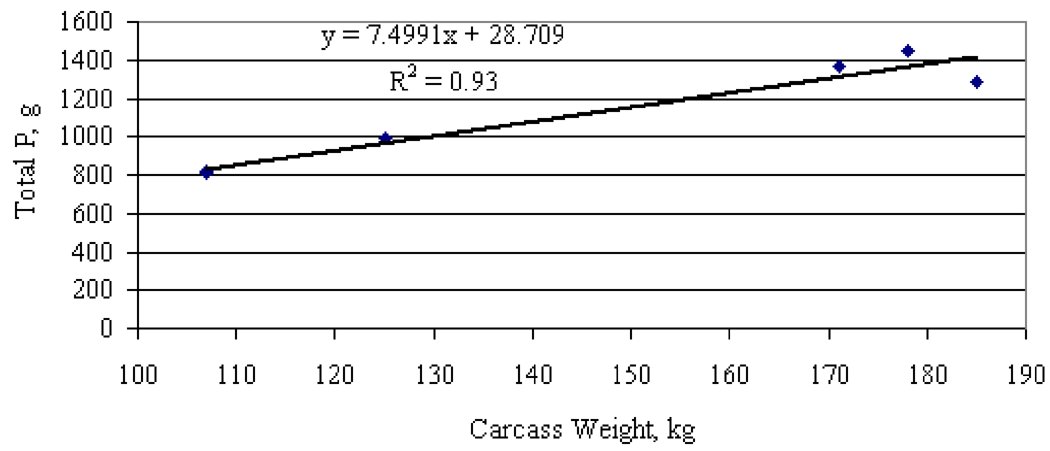


Figure 2. Total Phosphorus vs. Empty Body Weight.

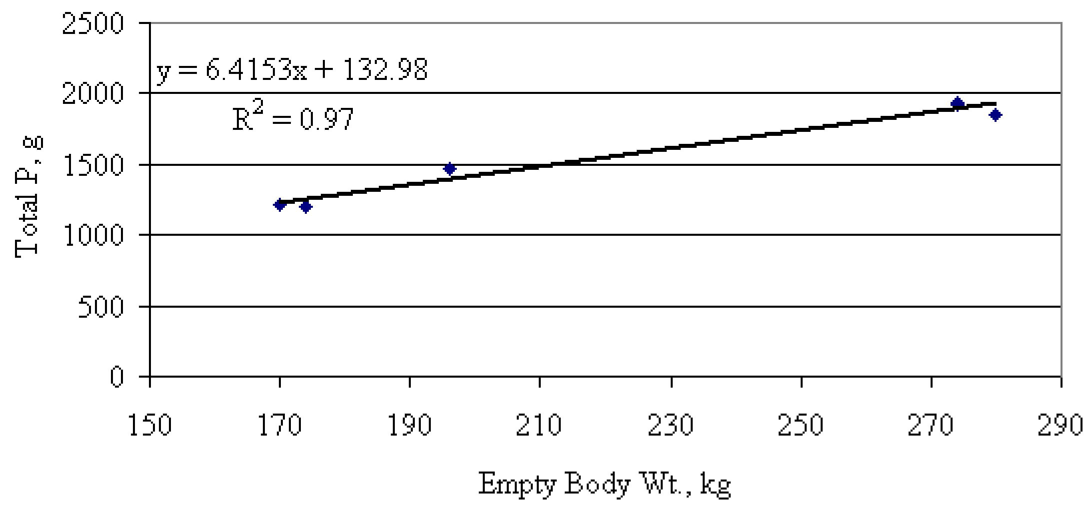
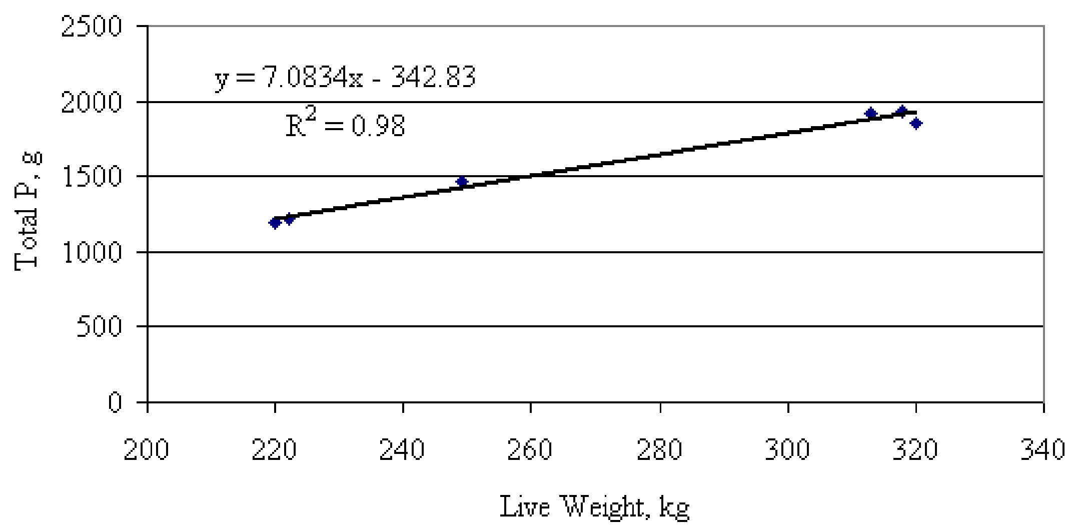
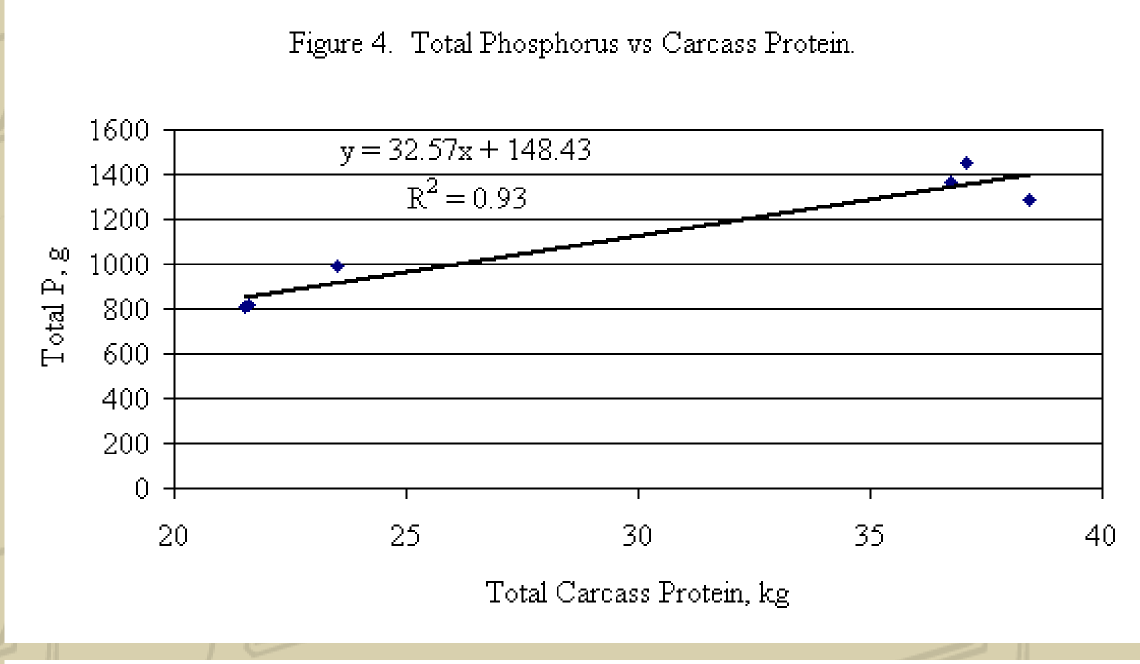
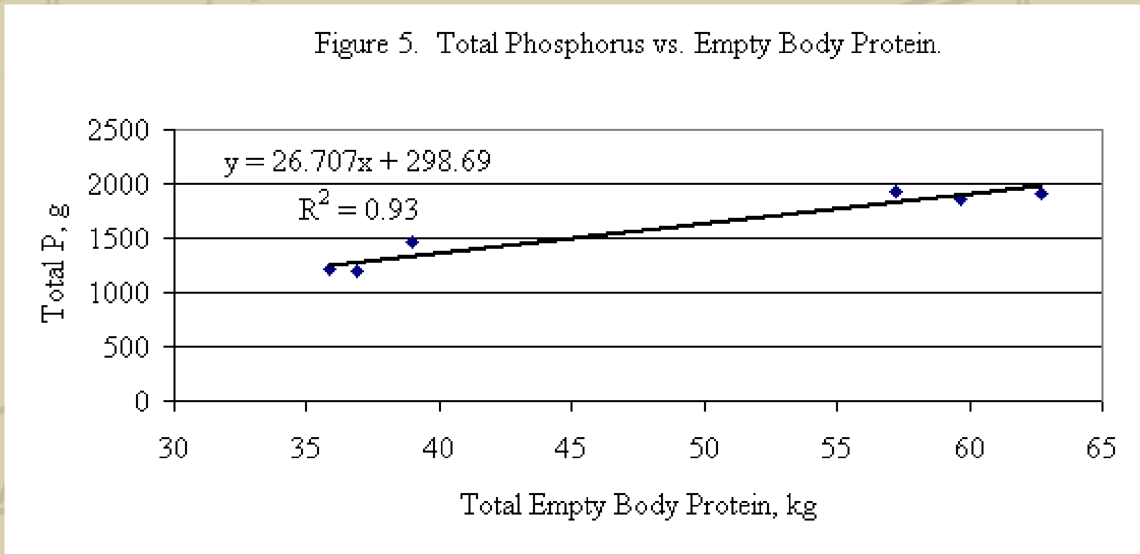


Figure 3. Total Phosphorus vs. Live Weight.



Phosphorus accretion rates in this study were 32.6, and 26.7 g/kg of protein in carcass and empty body, and are shown graphically in Figures 4 and 5, respectively. Rate of phosphorus accretion (g P/kg of protein) in this study was lower than the phosphorus requirement above maintenance of 39 g P/kg of protein reported by the 1996 Beef Cattle NRC.





Phosphorus removal was calculated as phosphorus removal per kg of live weight (g/kg), phosphorus removal per steer (g/steer), and phosphorus removal per acre (g/acre). Phosphorus removal per kg of live weight was 7.1 g/kg. Phosphorus removal per steer was dependant upon total gain of the steers, and averaged 354 g/steer. The wheat pasture year of 2000/2001 was poor for steer gains due to low standing crop and a short grazing season, which limited steer performance. Steers in this study gained only 50 kg over the entire (91-d) trial, therefore, phosphorus removal per acre was lower than expected at 370 g/acre.

Implications

Quantification of soil phosphorus removal from various sources is important in determining the amount of phosphorus that can be applied to the soil, in the form of animal manure, over a specific area. In the current study, the greatest amount of soil phosphorus was removed by forage biomass. At the Marshall location, 6,595 g P/acre was removed by harvesting the forage as hay, and 4,926 g P/acre was removed by harvesting grain. This is substantially greater than the amount of phosphorus removed by grazing cattle (370 g/acre).

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Phosphorus uptake and return in grazed, steep hill pastures. I. Above-ground components of the phosphorus cycle. New Zeal. J. Agr. Res., 23: 323â€“330. Haynes, R.J. 1982. Effects of lime on phosphate availability in acid soil: a critical review. Plant Soil., 68: 289â€“308.Â Effects of soil and fertilizer phosphorus on yields of potatoes, sugar beet, barley and winter wheat on a sandy clay loam soil at Saxmundham, Suffolk. J. Agr. Sci., 106: 155â€“167. Jungk, A. 1984. Phosphatdynamik in der Rhizosphare und Phosphatverfugbarkeit fur Pflanzen. Die Bodenkult., (Wien) 35: 99â€“107. Jungk, A. & Claassen, N. 1989. The soil cycle of phosphorus has several stages: first, organic substances mineralize; then, phosphorus is transferred to inorganic mineral compounds; after that, it is consumed by plants, and then it returns to the soil with organic plant waste. A soil scientist from RUDN University was the first to find out that global warming can deplete soil phosphorus reserves. To do so, he studied soil samples from the Tibetan Plateau, a place where temperature grows three times faster than on average across the planet.Â The team also believes that global warming can have a harmful impact on the cycle of phosphorus on the Tibetan Plateau. Wheatâ€“fallow has been the traditional cropping system but, with the adoption of conservation tillage that conserves soil moisture and pro-tects soil from erosion, more intensive cropping systems are being adopted to make the most efficient use of available water.Â sequester carbon: a framework to estimate incentive levels for reduced tillage. Environ Manage 3:S229â€“S237 Dinnes DL (2004) Assessments of practices to reduce nitrogen and phosphorus nonpoint source pollution of Iowaâ€™s surface waters, Iowa Department of Natural Resources, Des Moines, IA, and USDA-ARS National Soil Tilth Labouratory, Ames, p 376. Online: http://www.ars.usda. gov/News/News.htm?modecode=36-25-15-00. The build-up of soil phosphorus (P) beyond plant requirements can lead to a long-term legacy of P losses that could impair surface water quality. Using a database of âˆ¼4,50,000 samples collected from 2001â€“2015 we report the level of soil P enrichment by soil type, land use and region and the time it would take for Olsen P to decline to agronomic targets (20â€“0 mg Lâ€“1) if P fertilizer was stopped.Â Substrate and filter materials to enhance phosphorus removal in constructed wetlands treating diffuse farm runoff: a review. N. Z. J. Agric. Res.Â Sources of phosphorus lost from a grazed pasture receiving simulated rainfall. J. Environ. Qual.