Phosphorus distribution in fire managed grassland soils

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Abstract
Native warm season grasses are recommended for wildlife habitat and soil conservation. These areas are often managed with fire to control invasive species and reinvigorate the grasses. An area of the Department of Agriculture, Geosciences and Natural Resources field laboratory was planted to native warm season grasses in 2002. In 2004 the area was blocked into 50 x 60 foot plots to compare management practices of the grasses including mowing and fire. The soil of these plots have been sampled annually following the burn and analyzed for soil chemical (organic matter, nitrogen, phosphorus) and physical (bulk density) properties. The objective of this study was to evaluate the impact of an annual burn of grass plots on soil physico-chemical properties, specifically phosphorus. Forms of P to be evaluated include labile, organic, iron and aluminum bound, calcium bound, and residual fractions along with soil properties such as pH and organic matter. Thus far, annual burning of these grass plots has not significantly altered the soil stores of carbon and phosphorus. In soil dominated by Fe and Al chemistry fire has little influence on soil P stores. Knowing the impact of fire on the chemistry of phosphorus in soils is important in developing best management practices for this nutrient.

Key Words
Phosphorus, nutrients, carbon, grasslands, fire, loess.

Introduction

Native warm season grasses are recommended for wildlife habitat and soil conservation. These areas are often managed with fire to control invasive species and reinvigorate the grasses. An area of the Department of Agriculture, Geosciences and Natural Resources field laboratory was planted to native warm season grasses in 2002. In 2004 the area was blocked into 50 x 60 foot plots to compare management practices of the grasses including mowing and fire (Pelren *et al.* 2007). The soil of these plots have been sampled annually following the burn and analyzed for various physico-chemical properties. The results of these studies have been presented at several professional conferences (Gale 2008; Gale *et al.* 2006; Gale *et al.* 2005).

Conventional wisdom on the impact of fire has been that fire results in a decrease of volatile nutrients such as carbon and nitrogen but does not affect the availability of minerals such as potassium and phosphorus (Neff *et al.* 2005 and Samsonov *et al.* 2005). In contrast, Duguy *et al.* (2007) observed a decrease in total and available phosphorus following fire in eastern Spain. Studies in the New Jersey pine barrens suggest that the phosphates may form insoluble metal phosphates during combustion (Gray and Dighton 2006). All of these studies were conducted in forested ecosystems, raising the question of changes in phosphorus availability in grassland soils following fire.

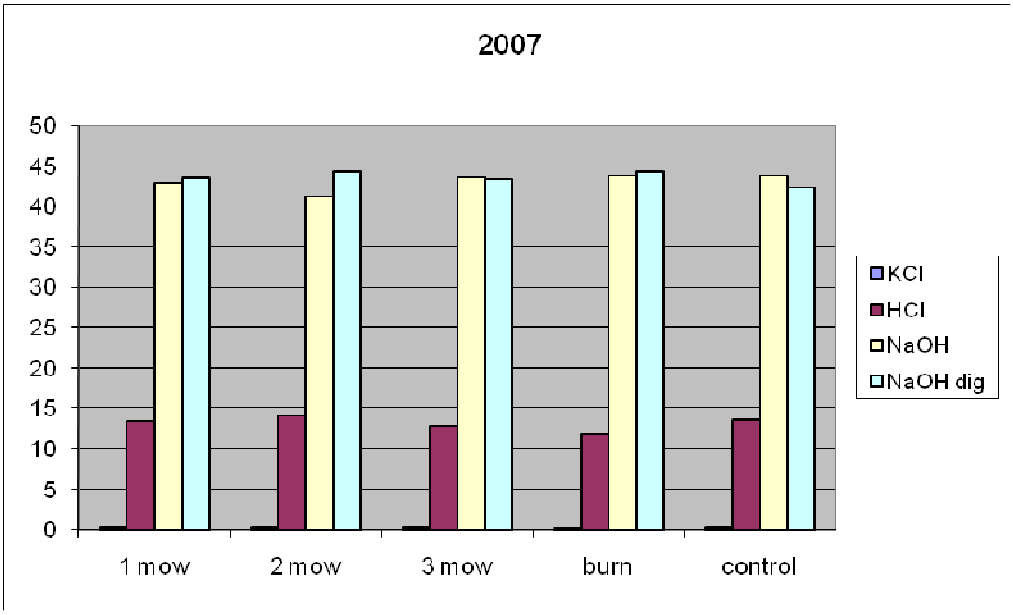
Phosphorus is an essential plant nutrient whose availability is often limited by the chemical reactions that occur in soil. The chemistry governing phosphorus behavior in soils is strongly influenced by both the presence of metal cations and dissolved organic matter (Gjettermann *et al.* 2007). Phosphorus is also a potential threat to water quality and land use is often the best indicator of its potential as a water pollutant (Dunne *et al.* 2007). Thus, knowing the impact of fire on the chemistry of phosphorus in soils is important in developing best management practices for this nutrient.

The objective of this study involved collecting soil samples from the native warm season grass plots on the UTM campus and analyzing them for various forms or fractions of phosphorus. These will include labile, organic, iron and aluminum bound, calcium bound, and residual phosphorus fractions. From these data we will be able to ascertain the affect of burning these plots on the chemistry of phosphorus in these soils.

Materials and methods
The experimental design of the native warm season grass plots is a randomized complete block with treatments that include burning and mowing to control the vegetation. There are four replications of each treatment. We have been collecting soil samples annually from these fields since the experiment was started in 2004.

The soil samples were analyzed for various forms of phosphorus using a sequential chemical extraction and phosphorus availability will be evaluated with an incubation technique both of which the PI has used before (Gale *et al.* 1994). The chemical fractionation technique involves sequentially extracting a soil sample with a weak salt solution, followed by a weak acid solution and then a weak base solution. Each extractant is then analyzed for phosphorus using a spectrophotometer to detect a phosphormolybdate complex. Phosphorus availability will be determined using an incubation technique in which the soils samples are flooded and incubated and the phosphorus released to the water column is analyzed.

Results and discussion
The figure below is illustrative of the types of data that have been collected in these experiments. In the figure the percent of the total phosphorus found in each extract is depicted as a function of grassland management (whether mowing or burning). As can be seen from the data the burning of the vegetation has little effect on the soil, if properly done.



Conclusions
Annual burning of these grass plots has not significantly altered the soil stores of carbon and phosphorus. In soils dominated by Fe and Al chemistry, fire seems to have little influence on P distribution. Knowing the impact of fire on the chemistry of Phosphorus in soils is important in developing best management practices for this nutrient.

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