PHOSPHORUS REMOVAL IN A DOUBLE CROPPED FORAGE SYSTEM

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INTRODUCTION

Public concern for water quality has led to adoption of Idaho regulations that require livestock producers to manage animal wastes as never before. Phosphorus (P) is the nutrient of greatest concern since it is the nutrient most responsible for nuisance aquatic growth such as algae. Currently adopted rules for dairy have established upper limits of soil test phosphorus (STP) of 40 ppm in the first foot. Exceeding this threshold would limit additional waste applications to the soil to the amount of P taken up by the cropping system.

Land resources with some dairies are limited and the loading of P from the waste applied to these lands is more than can possibly be removed with annual cropping. The STP under these conditions will sooner or later reach the P threshold, at which time dairies will either have to find additional lands for the waste to be applied or limit the production of waste by reducing herd size. Greater P removal by cropping would in turn increase the time for STP thresholds to be reached, postpone the need for capital improvements required for extending delivery systems, enable dairy herd expansion, and increase soil P loading capacity.

Double crop (winter cereal-corn) forage systems have potential for appreciably increasing the P removed by cropping over that removed with a single corn crop, as well as increasing forages that may be used in the dairy enterprise. Ideally, winter cereals harvested at the boot stage (rather than soft dough) provide additional forage without sacrificing corn production. Furthermore, winter cereal P accumulation, unlike total biomass, is largely completed by heading. Thus, a boot stage harvest does not sacrifice P removal nearly as much as it does biomass.

An additional advantage is that winter cereals grow well into the fall and earlier in the spring than warm season forages. This may justify waste applications during late fall or early spring when waste applications are normally disallowed. If so, less effluent would need to be stored. The objective of this study was to evaluate the potential for increased P removal with a winter cereal-corn silage double crop forage system.

METHODS

The first of a three year field study was conducted during the 1999 season at the Parma Research and Extension Center involving three winter (barley, wheat, and triticale) and two spring cereals (wheat and triticale) all fall planted (November 23) at seeding rates of 100, 150, or 200 lb/A. A non-planted fall treatment was also included. Treatments were arranged in a randomized complete block design with four replications.

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The field used for the study received 366 lb P<sub>2</sub>O<sub>5</sub>/A on October 21 and the small grain treatments were planted the same day. Nitrogen (100 lb/A) was topdressed April 16 to all plots. Winter forage biomass was harvested May 20 and subsampled for later dry matter and P content determinations. All forages were removed May 20 and corn (Pioneer 3395IR) was no till planted the same day using double disk openers and a conventional press wheel.

The corn was harvested for silage on September 23 and subsampled for dry matter and nutrient content. Silage yields were corrected to a moisture content of 67%.

RESULTS

Fall planted winter barley and spring wheat stands were reduced from winter kill and biomass was reduced at the late boot stage as compared to winter wheat and winter or spring triticale (fig. 1). Whereas spring wheat and winter barley produced 1-2 tons of dry matter per acre, the other small grain forages produced from 2 to over 3.7 tons of dry matter per acre. Winter and spring triticale were the most productive followed by winter wheat, winter barley and spring wheat. Higher seeding rates tended to increase harvested forage but the effects were not consistent among the forages. The 100 lb seeding rate resulted in less dry matter production for all winter forages except winter barley.

The phosphorus content of these forages ranged from a low of 10 lb/A for the winter damaged spring wheat to 28 lb/A for winter triticale. The forages ranked from the highest to lowest in P uptake were winter triticale > winter wheat and spring triticale > winter barley > spring wheat. Seeding rates had mixed effects on P uptake.

No-till planting resulted in excellent stands where no previous winter forage was grown, but stands were appreciably reduced after winter forages due to the difficulty of planting into stubble. Where winter kill had thinned winter forage stands, as in spring wheat and winter barley, corn population was greater than where winter forage stands had not been thinned.

Furthermore, corn following winter forages was less vigorous and stunted, with roots that appeared to be affected by stubby root nematode. Corn vigor was directly related to the loss of winter forage stand from winter kill. Apparently winter forages served as over-wintering hosts for the nematode which in turn infected the corn. Thinner stands of winter forages may have supported fewer nematodes and resulted in better corn vigor.

Corn production was directly related to corn stands and vigor (Fig. 2). The least productive corn (24 Tons/A) was preceded by winter forages and yield was reduced due to both lower plant populations and less vigor. The most productive corn (36 Tons/A) was where no winter forages were grown. Corn production was intermediate (33 Tons/A) where spring wheat or winter barley stands were reduced from winterkill.

Corn P uptake was directly related to production. As corn biomass or silage yield increased, P uptake increased. P uptake ranged from a high of 44 lb P/A in the most productive corn to a low of 32 lb P/A in corn following winter triticale. Total P uptake was greatest from the combined winter forage and corn double cropping and lowest from a single corn crop (Fig. 3). The greatest P uptake occurred with winter triticale and corn (68 lb P/A) followed by spring triticale and corn, winter wheat and corn, and winter barley and corn. Spring wheat and corn did not differ in total P uptake from corn alone and these were significantly less than other double crop forage treatments.
Potassium (K) uptake was also calculated from the biomass and nutrient content measures. Potassium uptake was as great in winter triticale as it was in the following corn. Potassium uptake ranged from a high of 470 lb K/A with winter triticale and corn to the low of 320 lb K/A with corn alone. Winter triticale removed more K than winter wheat.

Better planting conditions such as would result from an intervening tillage between the winter forage and corn would improve corn stands and corn production. Controlling the stubby root nematode would also improve corn vigor and production. Improved corn production after winter forages will likely increase total P uptake and removal by 10 lb/A for a total of nearly 70 lb P/A. P uptake with the double crop system was increased over 50% as compared to corn alone, even with reduced corn yield following winter forages. Increasing seeding rates above the 150 lb/A rate had marginal effects on P uptake of winter forages.

![Graph showing winter cereal forage dry matter and P uptake at late boot as affected by seeding rate](image-url)
Fig. 3. Combined uptake of P and K in winter forages and summer corn.