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Phosphorus Fertilization Strategies for Alfalfa Hay Production followed by Corn Harvested for Grain

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Abstract
A long-term experiment was conducted to evaluate phosphorus (P) fertilization strategies for alfalfa grown for hay and followed by corn harvested for grain.Alfalfa has greater P requirements than corn, and this is recognized in the ISU Extension publication PM-1688. The guidelines are based on previous research with pure alfalfa or alfalfa-grass mixtures. The information available is about 30 years old; however, there is insufficient information about alternative strategies for distributing P fertilization rates during the alfalfa crop years and for a following corn crop. This study evaluated several combinations of initial and top-dressed P fertilization rates for alfalfa and also evaluated effects of starter P and nitrogen (N) on corn following alfalfa.

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RFR-A9108

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Introduction

A long-term experiment was conducted to evaluate phosphorus (P) fertilization strategies for alfalfa grown for hay and followed by corn harvested for grain. Alfalfa has greater P requirements than corn, and this is recognized in the ISU Extension publication PM-1688. The guidelines are based on previous research with pure alfalfa or alfalfa-grass mixtures. The information available is about 30 years old; however, there is insufficient information about alternative strategies for distributing P fertilization rates during the alfalfa crop years and for a following corn crop. This study evaluated several combinations of initial and top-dressed P fertilization rates for alfalfa and also evaluated effects of starter P and nitrogen (N) on corn following alfalfa.

Materials and Methods

The study was conducted on an area of Webster soil that tested very low in P. The crop rotation included three years of alfalfa hay and one year of corn harvested for grain. Identical P treatments and management practices were used for adjacent field areas so that different crop phases could be evaluated the same year. Cornstalks were plowed in the fall and alfalfa was seeded in spring with an oats nurse crop. In the first year, forage was cut once when oat heads were visible. There was a second cutting in only one year when summer rainfall allowed for adequate alfalfa growth. There were three cuts from established stands in most years. Plots with third-year alfalfa were plowed in the fall, disked in spring, and corn was planted in spring using a 30-in. row spacing. Treatments were 12 P fertilization strategies (Table 1) replicated four times. Five strategies involved applying 0 to 300 lb P_2O_5/acre for alfalfa with the P distributed in different ways between initial and top-dressed applications. The plots were split in half to plant corn without P or with 20 lb P_2O_5/acre banded beside and below the seed with the planter. Two other strategies evaluated no fertilizer N for corn and a 50-lb rate by splitting plots of alfalfa that had received 300 lb P_2O_5/acre.

Results and Discussion

We summarized alfalfa and corn yields from two complete rotation cycles. By the end of the study, the P treatments applied to alfalfa had greatly affected soil-test P. Bray-1 P (6-in. sampling depth) was 3, 9, 21, 36, and 39 ppm for total P rates of 0, 120, 180, 240, and 300 lb P_2O_5/acre, respectively. ISU guidelines in PM-1688 suggest maintaining 21 to 25 ppm (optimum category) for established stands of alfalfa or alfalfa-grass mixtures.

A rate of 120 lb P_2O_5/acre maximized first-year yield but did not maximize second-year yield (Figure 1). This P rate produced a very large yield increase (1.76 ton/acre for 3-year averages), but additional top-dressed P further increased yield. The additional 3-year average yield increase ranged from 0.12 to 0.36 ton/acre for total rates of 180, 240, and 300 lb P_2O_5/acre, respectively. Top-dressing P for the second year resulted in a very small yield increase when the 120-lb rate was applied before the first year, but the response to top-dressed P became larger in the third year. The soil-test P and yield results confirmed that top-dressing P to maintain the Optimum soil-test class for alfalfa (21 to 25 ppm) is appropriate for sustained economic yield.

Corn grain yield was maximized by 180 lb P_2O_5/acre previously for alfalfa (Figure 2). Starter P at 20 lb P_2O_5/acre increased yield only where 0 or 120 lb P_2O_5/acre had been applied for the alfalfa and soil-test P was very low or low. Fertilizing corn with 50 lb N/acre resulted in a small average yield increase (4.3 bu/acre). Analyses for each year showed smaller or larger responses, so corn after alfalfa occasionally may need additional N. However, at prevailing prices ($4.00/bu corn, $0.40/lb N, and $4.50/acre application cost), the average yield increase would result in a net loss of $7.30/acre.

Conclusions

This study provided a useful research update about P management for alfalfa and corn after alfalfa. No research on P fertilization of alfalfa had been conducted since the 1970s. Results confirmed the adequacy of ISU guidelines for alfalfa in publication PM-1688 concerning P application rates for soils testing very low in P and the soil-test P level to be maintained. The study also showed that no P is needed for first-year corn after properly fertilized alfalfa, and that a small grain yield response to N fertilizer often may not offset additional costs.

Table 1. Treatments applied to alfalfa and corn.

	Alfalfa years					
Code	1st	2nd	3rd	Total	Corn †	
	---------- Nutrient rate (lb/acre) ----------					
	---------- P_2O_5 ----------					N
1	0	0	0	0	0/20	0
2	60	30	30	120	0/200	0
3	120	0	60	180	0/200	0
4	120	60	60	240	0/200	0
5	180	60	60	300	0/200	0
6	180	60	60	300	0/200	50

†Plots are split to apply no P or 20 lb P_2O_5/acre.

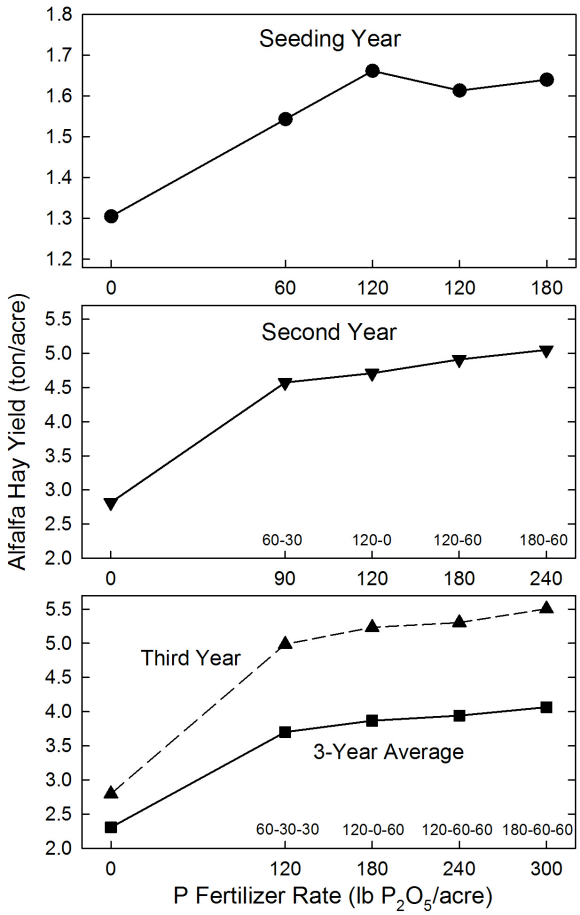

Figure 1. Fertilizer P effects on alfalfa hay yield.

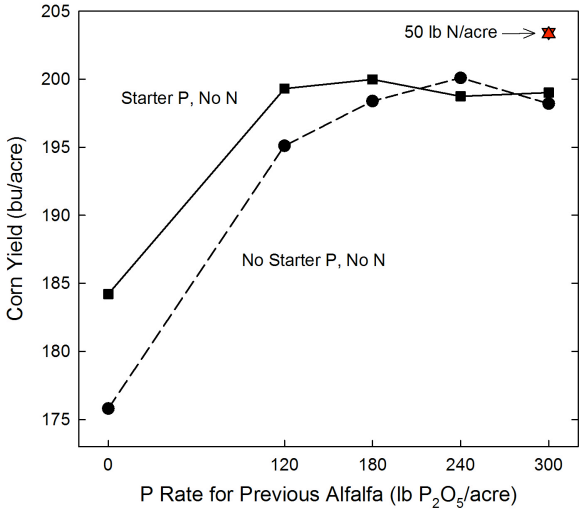

Figure 2. Residual and current P and N fertilizer effects on corn planted after alfalfa.