The Effects of Phosphate Fertilization upon the Yield and Composition of Oats and Alfalfa Grown on Phosphate-Deficient Iowa Soils

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STUNTED or short alfalfa and red clover is of frequent occurrence throughout north-central and northwestern Iowa. The stunting seldom extends over an entire field but has been estimated to affect legume hay production on possibly 10% of the total land area. Field investigations in 1943 and 1944 by C. A. Bower and E. S. Dyas demonstrated that the stunted condition was an extreme P deficiency. The phosphorus content of the alfalfa was often as low as 0.10 to 0.12%, a level reported to cause severe phosphorus malnutrition among livestock (5).

The stunted alfalfa and clover plants have short, brittle stems and small leaves, are usually about one-third as tall as the normal plants, and seldom yield more than 600 to 800 pounds of hay per acre per cutting. The sharp transition between stunted and near-normal growth often occurs within a distance of 2 to 4 feet.

The present study, undertaken in 1946 by the Iowa Agricultural Experiment Station in cooperation with the U. S. Plant, Soil, and Nutrition Laboratory, was limited to soils of north-central Iowa. The primary objectives were to study the effects of different rates of applied superphosphate upon the yield and phosphorus composition of crops grown upon the phosphorus-deficient soils, to evaluate the residual carryover of the initial applications of phosphate over a period of years, and to determine the total phosphorus content and yield of alfalfa growing on normal and phosphorus-deficient areas and correlate these with soil properties.

EXPERIMENTAL

Field Studies

Three sites for experiments were selected on phosphorus-deficient fields in north-central Iowa. The certain chemical data for each site are given in

Superphosphate at rates of 0, 30, 60, 120, and 240 pounds P2O5 per acre was applied broadcast and disked into the soil in the spring of 1946 prior to seeding alfalfa with oats as nurse crop. Uniform applications of 40 pounds of nitrogen and 100 pounds of K2O per acre was made to all plots, although potash usually does not benefit small grains and alfalfa. Three replications were used with phosphate treatments randomized in each replication.

Oat yields and samples of the straw and grain were taken at the three locations in 1946, and hay analysis samples were obtained at the first and second cuttings in 1947. After 1947, site III was lost because of an ownership change. Hay yields and samples of the first cuttings were obtained at sites I and II in 1948 and 1949. In 1948, site II was lost due to pasturing. Early bloom alfalfa harvests were made at the early bloom stage; all yields were calculated on the air-dry basis.

In addition, in 1947 an alfalfa sampling study was conducted in which paired yield and plant chemical samples of near-normal and deficient alfalfa were obtained from each of the three sites in north-central Iowa. The alfalfa from selected quadrats was harvested at the early bloom stage; at the same time, each quadrat was sampled to a 7-inch depth.