

The Prediction of Alfalfa Yields in Southern Indiana from Soil and Plant Analyses

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A series of experiments were conducted to determine the degree to which phosphate and potash levels in the soil control the yield of alfalfa. To do this it was necessary to attempt to produce yields which were only limited by factors other than plant nutrients so that they might be compared with yields where phosphate or potash was limiting. Soil and plant analyses were correlated with the degree of these phosphate and potash limitations on yield in order to attempt to obtain a procedure for prediction alfalfa yields on Southern Indiana soils.

The soil test procedure for predicting the response of alfalfa to potash additions was used by Chandler et al (2). From his experiments he was able to obtain a level below which a response might generally be expected. The use of plant analyses to predict fertilizer response has been investigated by Chandler et al (2), Bear (1), and Lundegaard (3). They obtained critical values for several nutrients above which a response to fertilizer application is not expected. These authors dealt mainly with critical levels and were not able from their experiments to predict the magnitude of response which might be obtained.

The plant nutrients which most seriously affect alfalfa growth in Southern Indiana are calcium, phosphate, potassium and boron. Any effects which might be due to insufficient calcium or boron were removed by supplying these elements in adequate amounts to all experimental plots. The limitation caused by the level of phosphate in the soil was determined by a comparison of the yield where adequate phosphate and potash were applied with that where adequate potash only was applied. Similarly the limitation caused by the soil potash level was determined by a comparison of the yield on the plot adequately fertilized with phosphate and potash with that fertilized with phosphate only. The yield on the phosphate-potash treatment was termed the maximum yield. The yields on the two other treatments were calculated as a percentage of the maximum yield. There were three treatments replicated three times. (Magnesium and boron treatments, not mentioned here, were also included in these experiments). These plots were located on twenty-six established alfalfa fields on farms of cooperating farmers across the southern part of the state. The various soils used included those that were derived from loessial deposits, Illinoian glacial deposits, residual limestone and river bottom sediments.

The fertilizer treatments were applied broadcast to the plots in March of 1950. Phosphate was applied at a rate of 200 pounds of P_2O_5 per acre, and potassium at a rate of 200 pounds of K_2O per acre. The soils were sampled before the fertilizer was applied. Three cuttings of hay were obtained from most of the plots and chemical determinations were made on the hay from the first cutting.

The soil samples were analyzed for available phosphate and potash by the procedures of the Purdue soil testing laboratory (4). This method consists of shaking 5 grams of soil with 15 ml of 0.75 N HCl solution for 2 minutes on a mechanical shaker. The extract is separated by filtration and an aliquot is used for determination of potassium by the flame photometer procedure. A second aliquot is analyzed for phosphorus by the colorimetric molybdc procedure. The plant samples were wet ashed by the nitric-sulfuric acid method. Phosphorus and potassium were determined on the solution by the same methods as those used for analysis of the soil extract.

The different locations used gave a wide distribution of both phosphate and potash levels in the soil. From this distribution it was possible to determine the limitation on yield as it was affected by the level of the nutrient in the soil. The results obtained from each location are expressed as a percentage of maximum yield so that all locations can be treated on a comparable basis.

The relation between the soil test for phosphate and the percent of maximum yield are shown in Figure 1. From this relationship we can

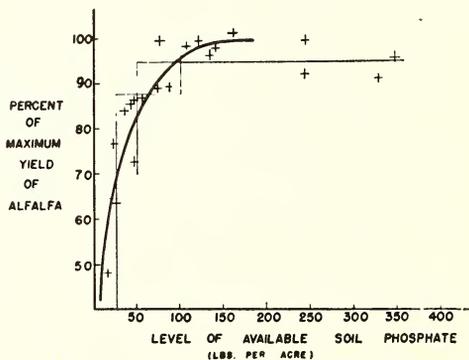


Fig. 1. The relationship between available soil phosphate and the percent of maximum yield of alfalfa hay.

predict that in order to get a maximum yield, the available soil phosphate level must be above 100 pounds P_2O_5 per acre. When it is between 50 and 100 pounds per acre we can expect a yield of between 88 and 95 percent of maximum. When it is between 25 and 30 pounds per acre we can expect a yield of 65 to 88 percent of maximum and when it is below 25 pounds per acre we cannot expect more than 65 percent of maximum yield.

A similar relationship between the soil test for potash and the percent of maximum yield obtained is shown in Figure 2. In order to obtain a maximum yield the potash level in the soil must be above 200 pounds per acre. When the level is between 150 and 200 pounds per acre we can expect a yield of 92.5 to 97.5 percent of maximum. With a level of 100 to 150 pounds per acre a yield of 80 to 92.5 percent of maximum could be expected.

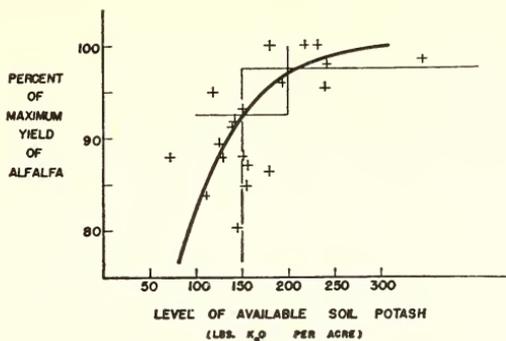


Fig. 2. The relationship between available soil potash and the percent of maximum yield of alfalfa hay.

There is a close relationship between the soil levels of available phosphate and potash and the production of alfalfa hay. From the levels found in any soil we can predict the limitation on yield caused by an insufficient supply of any one element and hence the need for fertilization. This experiment does not show the magnitude of interaction where both phosphate and potash are limiting.

The limitations of phosphate and potash on the production of alfalfa hay can be determined from the analysis of the hay for potassium and phosphorus. The relations between the percent phosphorus in the plant from the plots where no phosphate was applied and the percent of maximum yield obtained is shown in Figure 3. The phosphorus content of the hay from the plots where phosphate was applied is also shown. When the phosphorus content is above 0.3 percent we can not expect any appreciable increase due to phosphate application. The phosphorus content of the alfalfa from the plots believed to be adequately fertilized was between 0.3 and 0.4 percent. When the phosphorus content is between 0.2 and 0.3 percent we can expect a yield of only 80 to 95

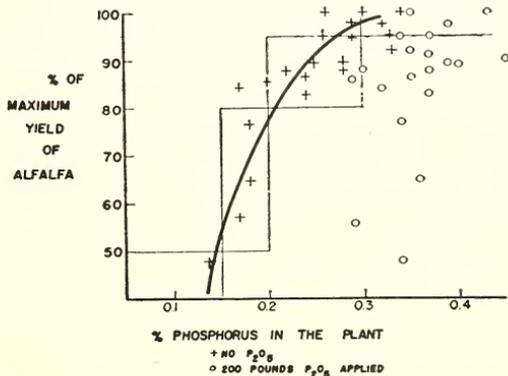


Fig. 3. The relationship of phosphorus content of alfalfa hay and the percent of maximum yield of alfalfa hay.

percent of the maximum yield. When the phosphorus level is between 0.15 and 0.2 percent we can expect a yield of 50 to 80 percent of maximum can be expected. When it is below 0.15 percent a yield of less than 50 percent can be expected.

Similarly, a relation between the level of potassium in the plant and the percent of maximum yield of alfalfa obtained is shown in Figure 4. Where the potassium content is above 2.0 percent the anticipated yield will be close to maximum. Where the content is 1.5 to 2.0 percent a yield of 90 to 95 percent of maximum may be expected. A potassium content below 1.5 percent will give an anticipated yield of less than 90 percent of maximum.

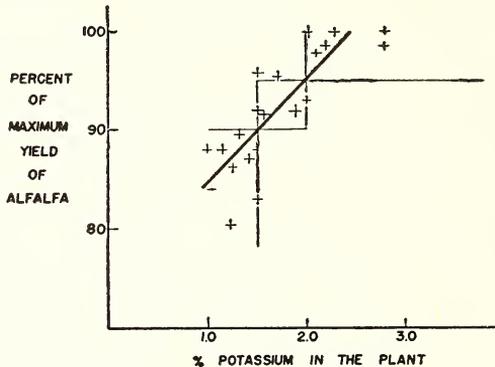


Fig. 4. The relationship of potassium content of alfalfa hay and the percent of maximum yield of alfalfa hay.

The values obtained here agree with those of Bear and Wallace (1). Their critical values for phosphorus in alfalfa is 0.27 percent and for potassium 2.0 percent. Chandler et al (2) obtained a figure of 1.25 percent for potassium below which a response of 20 percent or more could be expected.

These relationships show how it is possible to predict at what level an alfalfa field is producing either by testing the soil or the plant. This knowledge greatly facilitates the most economical use of fertilizer materials necessary to maximize crop yields.

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