Yield and Composition of Cotton and Kobe Lespedeza Grown at Different pH Levels

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An experiment was designed at Clemson, S. C., in 1937 to study the effects of various rates and combinations of potassium and sodium on the growth and chemical composition of cotton and other crops at different soil pH levels. Results obtained from extensive soil acidity investigations throughout the state, and from potassium-sodium experiments located on Norfolk sandy loam which were initiated in 1931, were responsible for the design of this experiment on Cecil sandy loam. A summary of the potassium-sodium experiments with cotton on Norfolk sandy loam was reported in 1942 by Cooper and Garman (7).

Thus far in the present experiment no yield response to the potassium and sodium treatments has occurred on Cecil sandy loam. However, there was a yield response to increasing pH of the soil. This paper is confined to presenting the data on the yields of cotton and Kobe lespedeza, and also the chemical composition of these crops grown at four different pH levels.

DESIGN OF EXPERIMENT

Small plots, 1/400 acre in size, contained in specially constructed concrete frames were used for this experiment. There are four series of 26 plots each, or a total of 104 plots. Before construction of the frames, which extend 12 inches into the subsoil and 8 inches above, the surface soil was removed to a uniform subsoil. Later this surface 8 inches was filled with uniformly mixed Cecil sandy loam surface soil.

The frames were filled in 1937 and a preliminary crop of cotton was grown on all plots in 1938, one year before experimental yields were to be taken. In the spring of 1939, the four series were adjusted to have pH values of approximately 5.0, 5.5, 6.0, and 6.5. The soil originally had a pH of 5.8. Sulfur and dolomitic limestone were used to obtain the desired reactions of which 560 and 160 pounds per acre of the latter were required to produce each of the pH values of 5.0 to 6.5, respectively. In the spring of 1944, it was found that the reactions of the plots which were intended to have pH values of 5.0 and 5.5 had raised and that it was necessary to add additional amounts of sulfur to lower the reactions to the desired levels. This required 500 and 160 pounds per acre, respectively.

FERTILIZER TREATMENT

The annual fertilizer treatment consisted of nitrogen and phosphorus applied in the rows to all plots at the rates of 24 pounds of N and 48 pounds of P₂O₅ per acre. Eighty-five percent of the nitrogen was derived from ammonium sulfate and the remainder from cottonseed meal. Superphosphate was used as the source of phosphorus. In addition to the nitrogen applied in the row before planting the cotton, 16 pounds of nitrogen derived from Cal-Nitro were applied per acre as side-dressing.

Potassium was applied at various rates from zero to 72 pounds of K₂O per acre with each rate being replicated twice and sodium were applied as the chloride and where used together the sum of the KCl plus NaCl was always equal to 72 pounds per acre.

Cotton was grown continuously for 6 years (1939-44) with rye as a winter cover crop. The rye was turned under in the spring for green manure. No growth response to potassium-sodium treatments was observed over the 6-year period. Under field conditions, Cecil sandy loam requires additions of potassium for the production of cotton. However, under the conditions of this experiment, where no surface runoff occurred and where the crop was ground in a hammer mill and returned to the field, there was very little potassium removed from the field, and the small amount contained in the cotton lint and seed was actually carried away in the harvested seed and amounted to approximately 10 pounds of potassium per year.

Continuous cotton grown in this manner with a winter cover crop of rye would probably require many pounds of potassium in the soil to get a yield response to the element. This experiment was designed to introduce a 2-year rotation system. The cotton was seeded between the cotton rows in the fall of 1944, the lespedeza seeded in the spring. The oats were harvested in 1944 with all of the grain and straw being removed to the plots. The lespedeza hay produced in 1945 was also removed. In 1946, the plots were again planted to cotton and plots continued this system of rotation. The practice of growing a cover crop of rye (for ease in hand cultivation) and returning the crop stalks to the plots will be continued. The whole system is intended to simulate a common rotation system now in practice in the South.

Because neither the cotton nor lespedeza showed a yield response to the potassium and sodium treatments, these data are not presented. Only the average yields of seed cotton and Kobe lespedeza obtained at the four different soil pH levels will be considered herein, along with the results relating to the chemical composition of these crops.

YIELDS OF SEED COTTON

The average yield of seed cotton in pounds per acre for the four pH levels is presented in Table 1.

It is seen that there was an average increase of 217 pounds of seed cotton per acre where limestone was applied to give a pH of approximately 6.0. This increase of 245 pounds per acre where sulfuric acid was used to give a pH of 6.5. In other words, this percentage increase over the yields of seed cotton grown at each of the four different soil pH levels is presented in Table 1.

<table>
<thead>
<tr>
<th>pH</th>
<th>Average yield, lbs.</th>
<th>Difference for each pH level, lbs.</th>
<th>Total increase for each pH level over pH 5.0, lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>1,199</td>
<td>+76</td>
<td>141</td>
</tr>
<tr>
<td>5.5</td>
<td>1,340</td>
<td>+141</td>
<td>217</td>
</tr>
<tr>
<td>6.0</td>
<td>1,416</td>
<td></td>
<td></td>
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</table>