Effect of Topdressing Permanent Pastures With Superphosphate on Beef Yields and Distribution of Available $P_2O_5$ in the Soil

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Most pasture soils of the humid region are deficient in available phosphate. Likewise, hundreds of soil tests in the Ozark Uplands of Arkansas, where soils range from stoney to gravelly silt loam in texture, indicate that over 75% of the soils tested are extremely low in phosphorus and can be expected to respond favorably to phosphorus fertilization. The soils are generally of moderate acidity. Significant increases in beef yields during several years of annual top dressings of 20% superphosphate on permanent Bermuda-legume pastures have been reported by Sandal, et al. (6). To further study the relationships between the observed pasture yields as indicated by the beef yields and the probable distribution of the applied $P_2O_5$ in the top-soil, a study was initiated to determine the available $P_2O_5$ at 1-inch intervals of the pasture soils to a depth of 6 inches. Root systems of the pasture species involved generally occupy this zone. Investigations were also made to determine if any observable variation in organic matter and soil structure stability could be related to the fertilizer practices. A knowledge of the distribution, effectiveness, and availability of $P_2O_5$ applied annually as top dressings on permanent pastures established on soils typical of north Arkansas would aid greatly in making pasture fertilization recommendations.

Variable results concerning the penetration of phosphate into the soil following top dressings have been reported. Midgley (4) studied the penetration of phosphates and their availability on a Miami silt loam in Wisconsin and found that most of the phosphate was retained in the surface inch of soil after an interval of 6 months with the amount available increasing as the rate of application increased. Robinson and Pierre (5) studied the residual available phosphorus in two different soils from a 300-pound application of 16% superphosphate applied 11 and 7 years previously. They found large increases in available phosphorus in the surface layer of treated pasture soils, but no significant effect in the 3- to 5-inch layer. Work by Schaller (7) in 1940 indicated that in West Virginia pasture studies, phosphorus from superphosphate top dressings remained almost entirely in the surface 1 1/2 inches with a slight penetration to 3 inches after 8 years. Brown and Munsell (1) obtained results under Connecticut conditions similar to those of Schaller.

Contrasting results from those previously mentioned are reported by Sell and Olson (8). Working with a Cecil sandy loam receiving varying rates of phosphate top-dressings, increases in available phosphorus were not found below 8 inches where less than 160 pounds $P_2O_5$ was applied 3 years earlier. With heavier rates, penetration of the available phosphorus was distinct in a soil depth of 12 inches. The authors concluded that with light textured soils in a high rainfall area, penetration of phosphorus is greater than in the heavy textured soils.

Materials and Methods

Bermuda-legume pastures receiving 0, 200, and 600 pounds of 20% superphosphate per acre annually as top dressings from 1946-52 were selected in the fall of 1953 to determine the penetration of $P_2O_5$ in a gravelly silt loam soil. These pastures are located at the Forestry and Livestock Branch Experiment Station, Batesville, Ark. Three replicates of soil samples were taken from each pasture with ten random borings taken per replication. Each sampling per replicate was separated at 1-inch intervals in the profile from 0 to 6 inches in depth to make a composite sample of soil from each 1-inch layer of soil. The samples were analyzed in the soil testing laboratory in duplicate for percent organic matter, pH, and pounds of available $P_2O_5$, Ca and K per acre. The phosphate was determined by extraction with NaHCO$_3$ at pH 8.0. Physical analysis for soil structure was made by the wet sieving technique with a modification of 35 strokes per minute for 10 minutes (2).

Results

The phosphate treatments, pounds of available $P_2O_5$ per acre 6 inches, and acre beef yields from 1946-52 are presented in table 1. Pastures not treated with phosphate produced an average of 61 pounds of beef per acre. In contrast, pastures topdressed annually with 200 and 600 pounds of superphosphate produced 275 and 382 pounds of beef per acre, respectively, a very significant increase.

Distribution of $P_2O_5$ in Soil

The average amount of available $P_2O_5$ in the soil of top-soil was found to be 11, 40 and 166 pounds, going from the check to 200 and 600 pounds of superphosphate per acre, respectively (table 1). Highly significant differences in the amounts of $P_2O_5$ in the soil were measured among the pastures. A significant increase is shown in the pasture receiving 600 pounds of superphosphate per acre at all depths, and in the top 2 inches for the 200-pound treatment, (figure 1). The 3- to 6-inch depths for the 200 pound treatment did not differ appreciably from each other or the check.

In the check pastures, the available $P_2O_5$ in the soil was very low and varied little at each 1-inch interval from the surface to the 6-inch depth. An application of 200 pounds of super per acre annually increased the pounds of available $P_2O_5$

<table>
<thead>
<tr>
<th>Rate of 20% superphosphate per acre (pounds)</th>
<th>Pounds available $P_2O_5$ per acre</th>
<th>Beef yield pounds per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11</td>
<td>61</td>
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<tr>
<td>200</td>
<td>40</td>
<td>275</td>
</tr>
<tr>
<td>600</td>
<td>166</td>
<td>382</td>
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