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University of Tennessee Agricultural Experiment Station

W. L. Parks

Robert D. Freeland

Reid Evans

Lawson Safley

***See next page for additional authors***

**Authors**
University of Tennessee Agricultural Experiment Station, W. L. Parks, Robert D. Freeland, Reid Evans, Lawson Safley, Tom McCutchen, and Marshall Smith

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W. L. PARKS is a professor emeritus of Plant and Soil Science, the University of Tennessee. ROBERT D. FREELAND is Superintendent at the Plateau Experiment Station, Crossville. REID EVANS is a former graduate research assistant at the Middle Tennessee Experiment Station, Spring Hill. LAWSON SAFLEY is a former Superintent at the Highland Rim Experiment Station, Springfield. The late TOM MCCUTCHEN was Superintendent at the Milan Experiment Station. MARSHALL SMITH is a research associate at the Ames Plantation, Grand Junction.

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# Effect of Residual and Fertilizer Phosphorus and Potassium on Yields of Corn, Soybeans, and Cotton Grown on Several Tennessee Soils[1]

W. L. Parks, Robert D. Freeland, Reid Evans,
Lawson Safley, Tom McCutchen, and Marshall Smith

The soils in Tennessee differ greatly in their chemical and physical properties. Some soils contain considerable amounts of phosphorus (P) and potassium (K), while others may contain only small amounts of these two essential plant nutrients. The level of these nutrients in a given soil is generally determined by the parent material, the degree of soil development, the fertilization history, the cropping system used, and the soil's relative position on the landscape. The crop yield potential of a soil is affected by several factors, including the residual fertility level.

It is essential that farm managers know the crop yield potential that a given soil test value will produce so that management decisions can be made during periods of a fertilizer shortage and periods of limited farm capital for purchase of fertilizers. It is also desirable to know how much fertilizer $P_2O_5$ or $K_2O$ should be applied to a given soil to significantly raise the soil test level and how long a one-time fertilizer application at a high rate will maintain a desirable soil test level in addition to sustaining crop yield.

To better address these concerns, 7-year field fertilizer experiments involving corn grown on Hartsells, Maury, and Dickson soils; soybeans grown on a Grenada soil; and cotton grown on a Loring soil were initiated in 1974.

## Materials and Methods

Conventional seedbed preparation was used for all crops; fertilizers were applied broadcast and disked into the soil before planting. Forty-inch rows were used for all crops. The corn variety was Pioneer Brand 3147. Forrest soybeans were used the first 3 years and Bedford soybeans were used during the last 4 years. The cotton variety was Hancock. In these experiments, $P_2O_5$ or $K_2O$ was applied initially at several rates, with no subsequent $P_2O_5$ or $K_2O$ being applied over the 7-crop-year period. In the treatments evaluating $P_2O_5$, a maintenance rate of $K_2O$ was applied each year. Likewise, a maintenance rate of $P_2O_5$ was applied to the treatments evaluating $K_2O$. Additional fertilizer treatments were included at

[1] Research partially supported by TVA Agreement No. Tenn 1131-93.

each location where no $P_2O_5$ or $K_2O$, only $P_2O_5$, only $K_2O$, and both $P_2O_5$ and $K_2O$ were applied each year. All fertilizer treatments in experiments involving corn and cotton received 120 and 60 pounds of nitrogen per acre per year, respectively, while no nitrogen was applied to soybeans.

Soil samples (0 to 6 inches) were taken from each experimental plot before any fertilizer application and once each year during the 7 years of the experiment. These samples were tested by the University of Tennessee Soil Testing Laboratory using 1% $(NH_4)_2SO_4$ in 0.05N $H_2SO_4$ extracting solution, with a 1 to 4 soil to solution ratio. The resulting P and K soil test values obtained may be classed as low, medium, or high levels as indicated in **Table 1**.

**Table 1. Range of soil P and K test levels for low-, medium-, and high-testing soils.**

| Nutrient | Soil Test Level | | |
|---|---|---|---|
| | Low | Medium | High |
| | ----------lb/Acre---------- | | |
| Phosphorus | 0 to 15 | 16 to 25 | 26 and above |
| Potassium | 0 to 110 | 120 to 190 | 200 and above |

## A. Effect of initial and annual rates of $P_2O_5$ and $K_2O$ on corn yields and soil test values on a Hartsells soil at the Plateau Experiment Station.

### 1. Corn Yields

Corn yields from initial and annual applications of $P_2O_5$ and/or $K_2O$ are summarized in **Table 2**. Initial $P_2O_5$ application rates ranged from 0 to 240 pounds per acre. The yield for these treatments over the 7-year period, with annual applications of 120 pounds N and 60 pounds $K_2O$ per acre with no additional $P_2O_5$, averaged 119 bushels per acre. The highest yields produced were in 1974 and the lowest in 1980. No significant yield differences among the initial $P_2O_5$ treatments were observed during any year or for the 7-year average of the experiment.

Initial $K_2O$ applications ranged from 0 to 240 pounds per acre. The yield over the 7-year period, with annual applications of 120 pounds N and 60 pounds $P_2O_5$ per acre but with no additional $K_2O$, averaged 91 bushels per acre. No significant yield differences among the initial $K_2O$ treatments were observed

**Table 2. Corn yields on a Hartsells soil at the Plateau Experiment Station as affected by initial and annual applications of $P_2O_5$ and $K_2O$.**

| Fertilization (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 7-yr. av. |
| N-$P_2O_5$-$K_2O$ | N-$P_2O_5$-$K_2O$ | ----------Bushels per acre---------- | | | | | | | |
| | | **Effect of Initial $P_2O_5$ Applications** | | | | | | | |
| 120-0-60 | 120-0-60 | 148 | 152 | 145 | 106 | 100 | 119 | 52 | 117 |
| 120-30-60 | 120-0-60 | 147 | 153 | 157 | 114 | 102 | 111 | 62 | 121 |
| 120-60-60 | 120-0-60 | 152 | 143 | 145 | 104 | 96 | 118 | 51 | 116 |
| 120-120-60 | 120-0-60 | 155 | 156 | 152 | 109 | 104 | 116 | 52 | 120 |
| 120-240-60 | 120-0-60 | 154 | 151 | 158 | 116 | 99 | 122 | 58 | 122 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Initial $K_2O$ Applications** | | | | | | | |
| 120-60-0 | 120-60-0 | 127 | 110 | 113 | 76 | 79 | 98 | 29 | 91 |
| 120-60-30 | 120-60-0 | 126 | 104 | 99 | 69 | 82 | 97 | 25 | 86 |
| 120-60-60 | 120-60-0 | 126 | 106 | 114 | 80 | 87 | 106 | 34 | 93 |
| 120-60-120 | 120-60-0 | 137 | 123 | 110 | 74 | 85 | 101 | 32 | 95 |
| 120-60-240 | 120-60-0 | 132 | 106 | 107 | 78 | 88 | 103 | 24 | 91 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Annual $P_2O_5$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 136 | 106 | 118 | 81 | 95 | 103 | 35 | 96 |
| 120-60-0 | 120-60-0 | 127 | 110 | 113 | 76 | 79 | 98 | 29 | 91 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Annual $K_2O$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 136 | 106 | 118 | 81 | 95 | 103 | 35 | 96 |
| 120-0-60 | 120-0-60 | 148 | 152 | 145 | 106 | 100 | 119 | 52 | 117 |
| | LSD(.05) | N.S. | 17 | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of $P_2O_5$ and $K_2O$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 136 | 106 | 118 | 81 | 95 | 102 | 35 | 96 |
| 120-60-60 | 120-60-60 | 148 | 143 | 150 | 104 | 105 | 113 | 57 | 117 |
| | LSD(.05) | N.S. | 34 | N.S. | N.S. | 7 | N.S. | N.S. | 17 |

during any year or for the 7-year average.

Annual applications of 60 pounds $P_2O_5$ per acre showed no significant yield response for any year, or for the 7-year average. An annual application of 60 pounds $K_2O$ per acre resulted in a significant yield increase in 1975, but not for the 7-year average. Annual applications of 60 pounds $P_2O_5$ and $K_2O$ per acre resulted in significant yield increases in 2 of the 7 years, and for the 7-year average.

**Figure 1** shows the corn isoyields for the different soil test P and K values obtained during the experiment. With low soil test P values around 15 to 16 and soil test K values around 130 to 142, a corn yield of 80 bushels per acre was obtained. However, on the higher end of soil test levels with soil K values around 285 to 300 and soil P values around 27 to 40, a corn yield of 112 bushels per acre was obtained. These ranges of isoyields represent corn yields expected on the Hartsells soil with adequate nitrogen, during climate conditions similar to those occurring during the 7-year experiment period.

### 2. Soil Test Values

Soil test values reported in **Table 3** are means for individual treatments by year. The soil pH was between 5.5 and 6.0 and generally remained in this range over the 7-year period, although 4 of the treatments dropped to pH 5.3.

The soil test P values were high (above 26 pounds per acre) prior to the initiation of $P_2O_5$ treatments. The zero $P_2O_5$ treatment dropped to medium after the third crop year and remained at a medium level for the rest of the experiment. After 5 years, soil test P values were medium for all initial $P_2O_5$ treatments.

For the treatments receiving no $P_2O_5$ during the 7 years, the soil test P values dropped to about the middle of the medium soil test range. The treatments receiving an annual application of 60 pounds $P_2O_5$ per acre remained at a high soil test level, but decreased some over the 7-year period. The rates of decline of the soil test P values for the different treatments ranged from 1.2 to 2.5 pounds P per acre per year and are illustrated in **Figure 2**.

The soil test K values for the initial $K_2O$ treatments were high (above 200 pounds per acre) at the start of the experiment and remained high for the first 2 years. Soil test values of the O and 30 pounds $K_2O$ per acre treatments dropped to medium after 2 years, and after 5 years, all initial $K_2O$ treatments tested medium. Generally, annual applications of 60 pounds $K_2O$ per acre maintained high soil test K values. However, for the treatments receiving no $K_2O$ during the 7 years, the soil test K values dropped to about the middle of the medium soil test range. The rates of decline of the soil test K values ranged from 9 to 16 pounds K per acre per year and are illustrated in **Figure 3**.

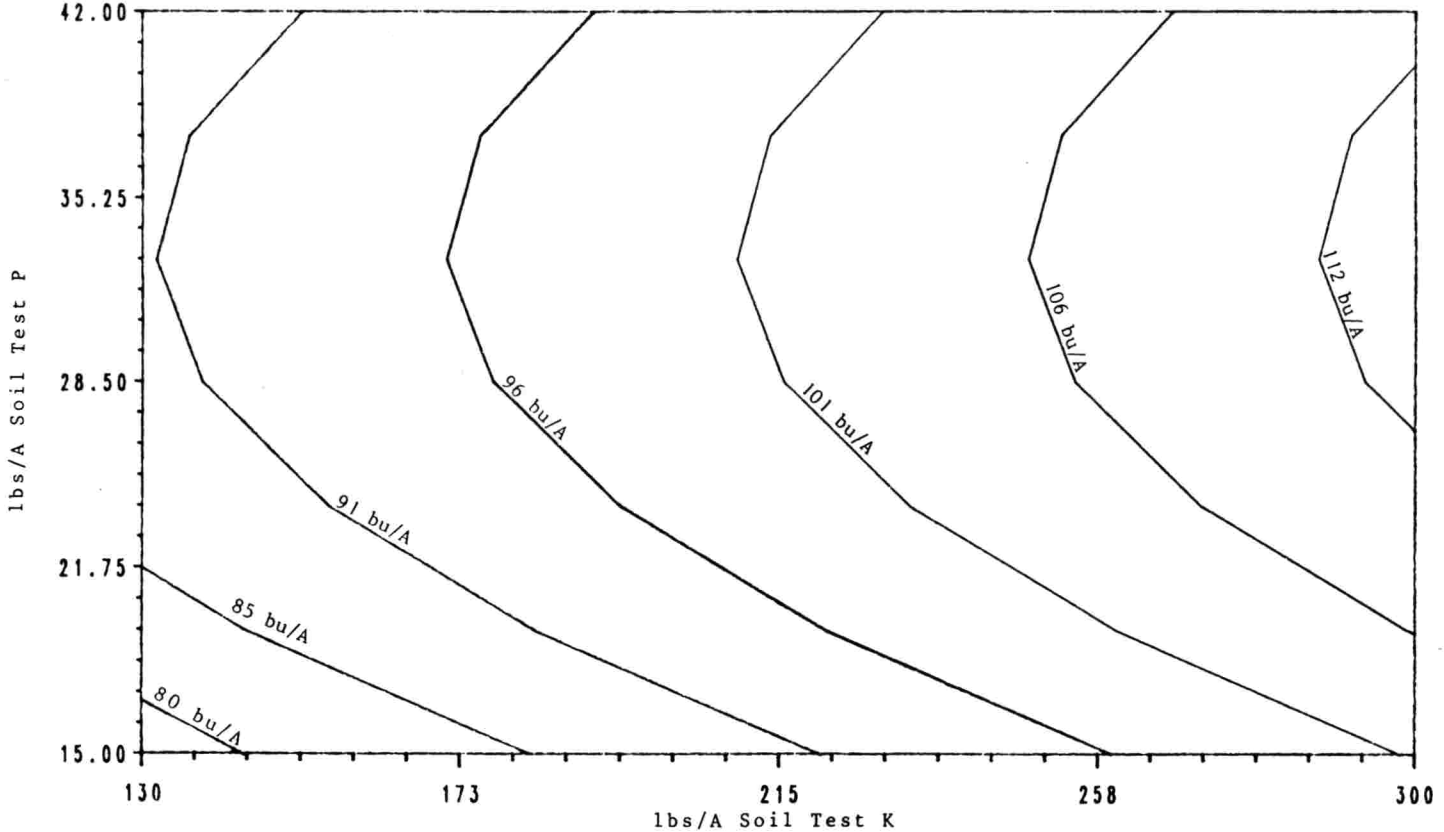


**Figure 1. Average corn yields obtained for different soil test levels of P and K on a Hartsells soil**

**Table 3. Soil test changes over time as affected by initial and annual applications of $P_2O_5$ and $K_2O$ on a Hartsells soil at the Plateau Experiment Station.**

| Fertilization (lb/A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Initial | Annual | Spr. 1974 | Spr. 1975 | Spr. 1976 | Spr. 1977 | Spr. 1978 | Spr. 1979 | Spr. 1980 |
| | | | | A. Soil Test Phosphorus | | | | |
| $N-P_2O_5-K_2O$ | $N-P_2O_5-K_2O$ | ----------Pounds of P Per Acre---------- | | | | | | |
| | | Effect of Initial $P_2O_5$ Applications | | | | | | |
| 120-0-60 | 120-0-60 | 37 | 32 | 27 | 25 | 26 | 23 | 22 |
| 120-30-60 | 120-0-60 | 39 | 26 | 30 | 29 | 26 | 23 | 22 |
| 120-60-60 | 120-0-60 | 40 | 33 | 28 | 35 | 26 | 23 | 21 |
| 120-120-60 | 120-0-60 | 32 | 35 | 29 | 31 | 26 | 24 | 22 |
| 120-240-60 | 120-0-60 | 36 | 32 | 37 | 35 | 29 | 25 | 26 |
| | | Effect of Initial $K_2O$ Applications | | | | | | |
| 120-60-0 | 120-60-0 | 27 | 27 | 26 | 28 | 27 | 25 | 29 |
| 120-60-30 | 120-60-0 | 27 | 28 | 24 | 30 | 28 | 28 | 35 |
| 120-60-60 | 120-60-0 | 26 | 24 | 25 | 31 | 27 | 21 | 29 |
| 120-60-120 | 120-60-0 | 29 | 28 | 28 | 30 | 29 | 28 | 32 |
| 120-60-240 | 120-60-0 | 34 | 27 | 31 | 34 | 35 | 26 | 36 |
| | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | | | |
| 120-0-0 | 120-0-0 | 24 | 29 | 20 | 27 | 21 | 16 | 20 |
| 120-60-0 | 120-60-0 | 27 | 27 | 26 | 28 | 27 | 25 | 29 |
| 120-0-60 | 120-0-60 | 37 | 32 | 27 | 25 | 26 | 23 | 22 |
| 120-60-60 | 120-60-60 | 46 | 36 | 31 | 39 | 33 | 28 | 31 |
| | | | | B. Soil Test Potassium | | | | |
| $N-P_2O_5-K_2O$ | $N-P_2O_5-K_2O$ | ----------Pounds of K Per Acre---------- | | | | | | |
| | | Effect of Initial $P_2O_5$ Applications | | | | | | |
| 120-0-60 | 120-0-60 | 265 | 235 | 220 | 245 | 233 | 280 | 258 |
| 120-30-60 | 120-0-60 | 318 | 205 | 238 | 310 | 248 | 273 | 265 |
| 120-60-60 | 120-0-60 | 335 | 243 | 240 | 278 | 240 | 273 | 253 |
| 120-120-60 | 120-0-60 | 293 | 243 | 218 | 285 | 243 | 263 | 255 |
| 120-240-60 | 120-0-60 | 265 | 253 | 230 | 288 | 245 | 270 | 275 |
| | | Effect of Initial $K_2O$ Applications | | | | | | |
| 120-60-0 | 120-60-0 | 238 | 213 | 183 | 195 | 180 | 163 | 160 |
| 120-60-30 | 120-60-0 | 210 | 235 | 178 | 213 | 155 | 163 | 148 |
| 120-60-60 | 120-60-0 | 265 | 250 | 238 | 253 | 218 | 180 | 200 |
| 120-60-120 | 120-60-0 | 243 | 238 | 228 | 223 | 180 | 173 | 180 |
| 120-60-240 | 120-60-0 | 235 | 250 | 228 | 243 | 198 | 173 | 180 |
| | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | | | |
| 120-0-0 | 120-0-0 | 228 | 238 | 163 | 248 | 178 | 153 | 165 |
| 120-60-0 | 120-60-0 | 238 | 213 | 183 | 195 | 180 | 163 | 160 |
| 120-0-60 | 120-0-60 | 265 | 235 | 220 | 245 | 233 | 280 | 258 |
| 120-60-60 | 120-60-60 | 265 | 273 | 243 | 298 | 245 | 288 | 260 |

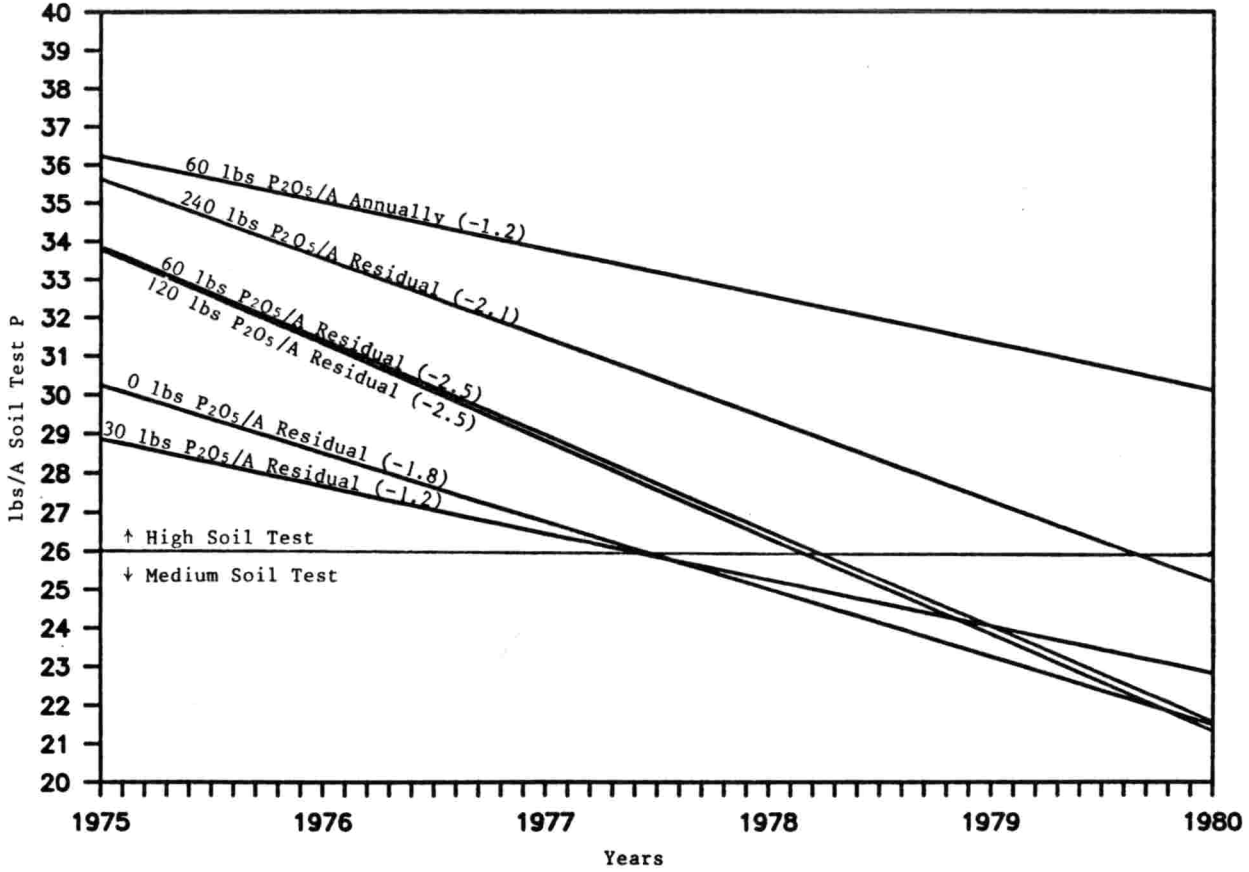


**Figure 2. Soil test P changes over time for 1 annual and 5 residual phosphate treatments**

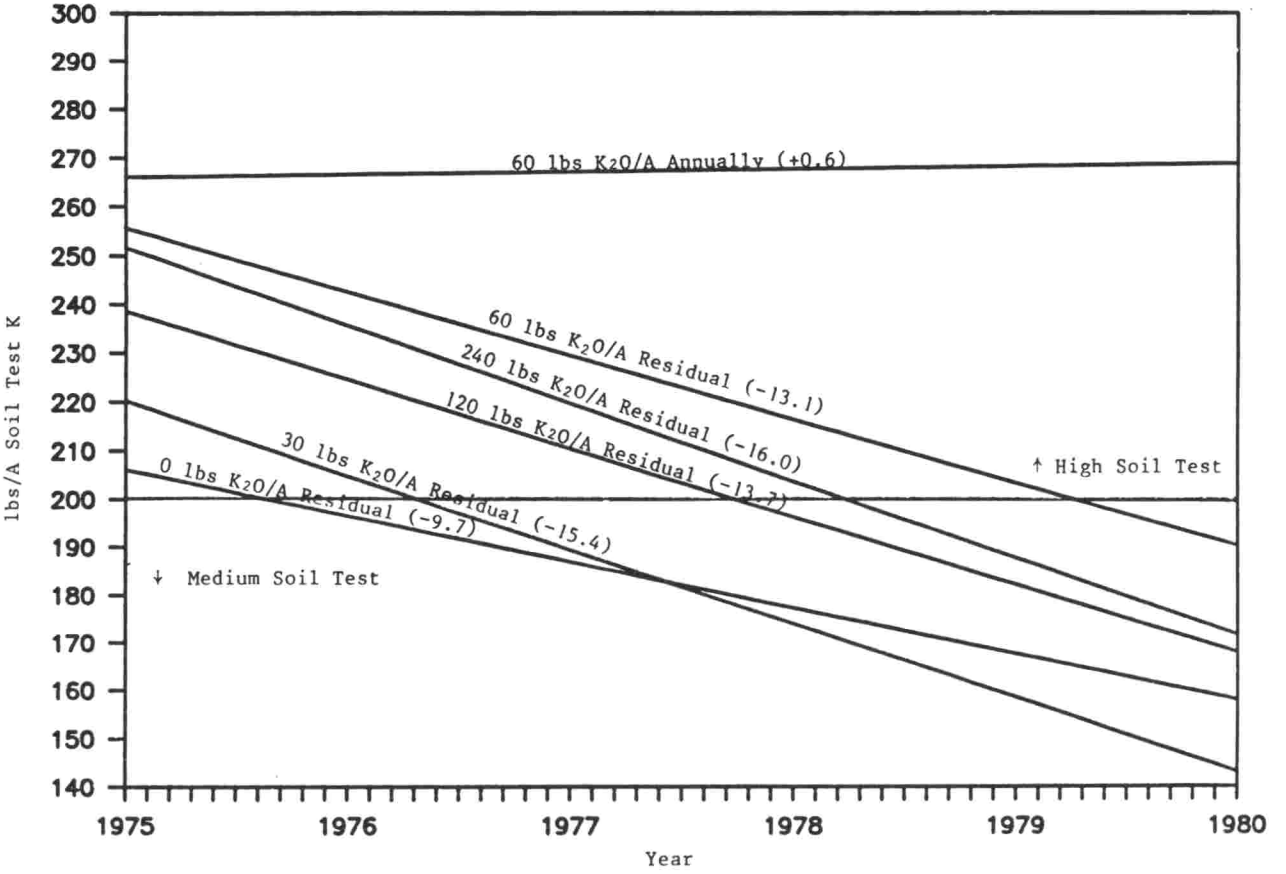


**Figure 3. Soil test K changes over time for 1 annual and 5 residual potash treatments**

## B. Effect of initial and annual rates of $P_2O_5$ and $K_2O$ on corn yields and soil test values on a Dickson soil at the Highland Rim Experiment Station.

### 1. Corn Yields

Corn yields from initial and annual applications of $P_2O_5$ and/or $K_2O$ are summarized in **Table 4**. The initial $P_2O_5$ application rates ranged from 0 to 240 pounds per acre. The yield for these treatments over the 7-year period, with annual applications of 120 pounds N per acre and 60 pounds $K_2O$ per acre but with no additional $P_2O_5$, averaged 76 bushels per acre. The highest yields were obtained in 1976 and the lowest in 1980. No significant yield differences among the initial $P_2O_5$ treatments were observed during any year or for the 7-year average.

The initial $K_2O$ application rates ranged from 0 to 240 pounds per acre. The yield for these treatments over the 7-year period, with annual applications of 120 pounds N and 60 pounds $P_2O_5$ per acre but with no additional $K_2O$, averaged 76 bushels per acre. A significant yield response to an initial application of 240 pounds $K_2O$ per acre was observed in 1979. For the 7-year average, no significant yield differences were observed among any of the initial $K_2O$ treatments.

The yield for the annual 60-pound $P_2O_5$ per acre treatment was significantly higher than the no phosphate treatment in 1976, but not for the 7-year average. Annual applications of 60 pounds $K_2O$ per acre resulted in a significant yield increase over no potash in 1979, but not for the 7-year average. Annual applications of 60 pounds of $P_2O_5$ and $K_2O$ per acre resulted in significant yield increases over no $P_2O_5$ and no $K_2O$ for 3 of the 7 years (1975, 1978, 1979), and for the 7-year average.

Corn isoyields relating corn yield to soil test levels of P and K are shown in **Figure 4**. These corn yields range from 50 bushels per acre at medium soil test P and low soil test K levels to 91 bushels per ace at medium soil test P and high soil test K levels.

### 2. Soil Test Values

Soil test values reported in **Table 5** are means for individual treatments by year. The soil pH ranged from near 5.0 to slightly above 6.0 for most of the treatments over the 7-year period. Two tons of lime per acre were applied after the 1977 crop; this raised the pH about 0.8 units.

The soil test P values were low prior to any fertilizer applications and remained in the low range throughout the 7 years. Even the initial 240 pounds $P_2O_5$ per acre treatment did not raise the soil test P above the low soil test level. Treatments receiving no $P_2O_5$ dropped to very low soil test P values, while those receiving 60 pounds $P_2O_5$ per acre each year generally remained near the same low

**Table 4. Corn yields on a Dickson soil at the Highland Rim Experiment Station as affected by initial and annual applications of $P_2O_5$ and $K_2O$.**

| Fertilization (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 7-yr. av. |
| $N\text{-}P_2O_5\text{-}K_2O$ | $N\text{-}P_2O_5\text{-}K_2O$ | ----------Bushels per acre---------- | | | | | | | |
| | | **Effect of Initial $P_2O_5$ Applications** | | | | | | | |
| 120-0-60 | 120-0-60 | 107 | 43 | 110 | 69 | 55 | 113 | 34 | 76 |
| 120-30-60 | 120-0-60 | 105 | 40 | 113 | 68 | 53 | 110 | 33 | 75 |
| 120-60-60 | 120-0-60 | 109 | 44 | 119 | 64 | 48 | 115 | 38 | 77 |
| 120-120-60 | 120-0-60 | 103 | 38 | 116 | 72 | 53 | 118 | 36 | 76 |
| 120-240-60 | 120-0-60 | 103 | 44 | 109 | 73 | 57 | 123 | 39 | 78 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Initial $K_2O$ Applications** | | | | | | | |
| 120-60-0 | 120-60-0 | 114 | 44 | 119 | 75 | 53 | 74 | 33 | 73 |
| 120-60-30 | 120-60-0 | 109 | 44 | 109 | 79 | 58 | 84 | 40 | 74 |
| 120-60-60 | 120-60-0 | 119 | 47 | 119 | 80 | 58 | 71 | 36 | 76 |
| 120-60-120 | 120-60-0 | 114 | 47 | 120 | 79 | 61 | 84 | 34 | 77 |
| 120-60-240 | 120-60-0 | 112 | 46 | 119 | 78 | 62 | 91 | 37 | 78 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Annual $P_2O_5$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 107 | 49 | 107 | 64 | 48 | 84 | 37 | 71 |
| 120-60-0 | 120-60-0 | 114 | 44 | 119 | 75 | 53 | 74 | 33 | 73 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Annual $K_2O$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 107 | 49 | 107 | 64 | 48 | 84 | 37 | 71 |
| 120-0-60 | 120-0-60 | 107 | 43 | 110 | 69 | 55 | 113 | 34 | 76 |
| | LSD(.05) | N.S. | N.S. | 6 | N.S. | N.S. | 26 | N.S. | N.S. |
| | | **Effect of $P_2O_5$ and $K_2O$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 107 | 49 | 107 | 64 | 48 | 84 | 37 | 71 |
| 120-60-60 | 120-60-60 | 103 | 41 | 120 | 78 | 65 | 125 | 32 | 80 |
| | LSD(.05) | N.S. | 8 | N.S. | N.S. | 13 | 37 | N.S. | N.S. |

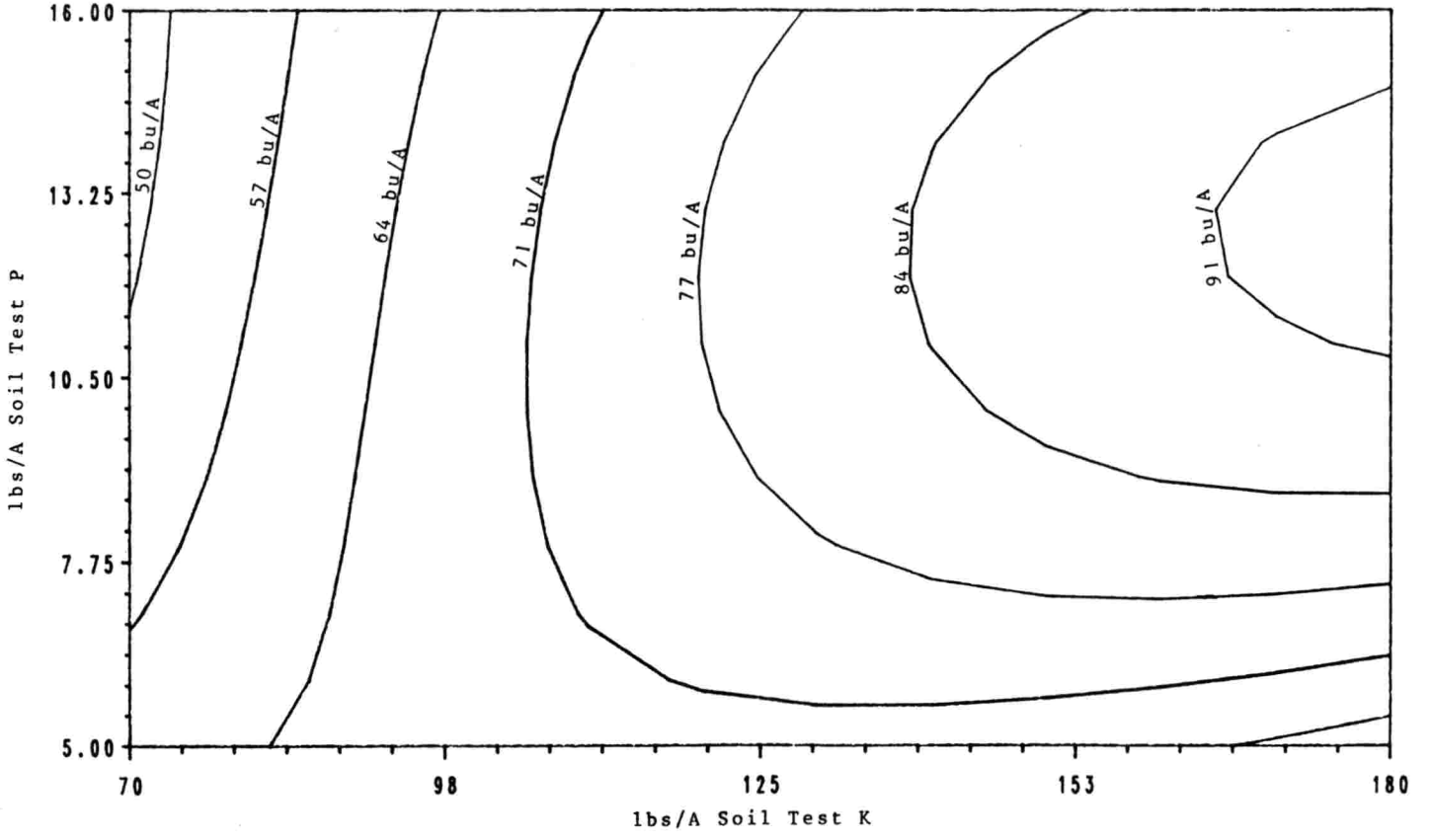


**Figure 4. Average corn yields obtained for different soil test levels of P and K on a Dickson soil**

**Table 5. Soil test changes over time as affected by initial and annual applications of $P_2O_5$ and $K_2O$ on a Dickson soil at the Highland Rim Exp.Sta.**

| Fertilization (lb/A) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | Spr. 1974 | Spr. 1975 | Spr. 1976 | Spr. 1977 | Fall 1977 | Spr. 1978 | Spr. 1979 | Spr. 1980 | Fall 1980 |
| | | | | | A. Soil Test Phosphorus | | | | | |
| $N-P_2O_5-K_2O$ | $N-P_2O_5-K_2O$ | ----------Pounds of P Per Acre---------- | | | | | | | | |
| | | | | | Effect of Initial $P_2O_5$ Applications | | | | | |
| 120-0-60 | 120-0-60 | 14 | 9 | 7 | 10 | 8 | 6 | 8 | 7 | 5 |
| 120-30-60 | 120-0-60 | 11 | 8 | 7 | 7 | 5 | 5 | 7 | 7 | 5 |
| 120-60-60 | 120-0-60 | 12 | 9 | 8 | 8 | 8 | 6 | 7 | 7 | 5 |
| 120-120-60 | 120-0-60 | 13 | 9 | 9 | 10 | 8 | 7 | 9 | 6 | 6 |
| 120-240-60 | 120-0-60 | 12 | 11 | 11 | 10 | 9 | 8 | 9 | 8 | 6 |
| | | | | | Effect of Initial $K_2O$ Applications | | | | | |
| 120-60-0 | 120-60-0 | 11 | 10 | 10 | 13 | 13 | 9 | 15 | 13 | 16 |
| 120-60-30 | 120-60-0 | 13 | 9 | 10 | 11 | 13 | 9 | 17 | 13 | 16 |
| 120-60-60 | 120-60-0 | 12 | 8 | 9 | 11 | 14 | 11 | 14 | 15 | 13 |
| 120-60-120 | 120-60-0 | 13 | 9 | 9 | 11 | 18 | 9 | 14 | 13 | 14 |
| 120-60-240 | 120-60-0 | 12 | 10 | 10 | 12 | 13 | 11 | 15 | 14 | 15 |
| | | | | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | | |
| 120-0-0 | 120-0-0 | 14 | 9 | 7 | 7 | 6 | 6 | 8 | 7 | 8 |
| 120-60-0 | 120-60-0 | 11 | 10 | 10 | 13 | 13 | 9 | 15 | 13 | 16 |
| 120-0-60 | 120-0-60 | 14 | 9 | 7 | 10 | 8 | 6 | 8 | 7 | 5 |
| 120-60-60 | 120-60-60 | 13 | 10 | 10 | 12 | 16 | 10 | 15 | 12 | 14 |
| | | | | | B. Soil Test Potassium | | | | | |
| $N-P_2O_5-K_2O$ | $N-P_2O_5-K_2O$ | ----------Pounds of K Per Acre ---------- | | | | | | | | |
| | | | | | Effect of Initial $P_2O_5$ Applications | | | | | |
| 120-0-60 | 120-0-60 | 188 | 133 | 150 | 140 | 185 | 155 | 165 | 143 | 160 |
| 120-30-60 | 120-0-60 | 158 | 113 | 148 | 113 | 155 | 145 | 145 | 143 | 170 |
| 120-60-60 | 120-0-60 | 155 | 130 | 153 | 118 | 190 | 150 | 148 | 145 | 165 |
| 120-120-60 | 120-0-60 | 180 | 133 | 153 | 135 | 175 | 140 | 153 | 148 | 170 |
| 120-240-60 | 120-0-60 | 180 | 125 | 138 | 130 | 165 | 153 | 163 | 148 | 168 |
| | | | | | Effect of Initial $K_2O$ Applications | | | | | |
| 120-60-0 | 120-60-0 | 163 | 108 | 98 | 88 | 105 | 93 | 93 | 80 | 88 |
| 120-60-30 | 120-60-0 | 160 | 103 | 103 | 95 | 115 | 98 | 103 | 88 | 95 |
| 120-60-60 | 120-60-0 | 158 | 93 | 105 | 95 | 108 | 95 | 93 | 80 | 85 |
| 120-60-120 | 120-60-0 | 145 | 113 | 120 | 98 | 123 | 100 | 88 | 88 | 90 |
| 120-60-240 | 120-60-0 | 143 | 128 | 130 | 108 | 115 | 113 | 108 | 100 | 98 |
| | | | | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | | |
| 120-0-0 | 120-0-0 | 170 | 115 | 103 | 85 | 105 | 98 | 95 | 90 | 90 |
| 120-60-0 | 120-60-0 | 163 | 108 | 98 | 88 | 105 | 93 | 93 | 80 | 88 |
| 120-0-60 | 120-0-60 | 188 | 133 | 150 | 140 | 185 | 155 | 165 | 143 | 160 |
| 120-60-60 | 120-60-60 | 145 | 118 | 148 | 123 | 173 | 145 | 143 | 123 | 153 |

soil test P level.

The soil test K levels were initially in the medium level and initial $K_2O$ applications did not seem to change these levels. All treatments, except the initial 240 pounds $K_2O$ per acre treatment, that received no annual $K_2O$ dropped to a low soil test K level (below 120 pounds K per acre) after the first corn crop and then continued to decline slowly. The initial 240 pounds per acre treatment dropped to a low soil test K level after 3 years. Annual applications of 60 pounds of $K_2O$ per acre did not maintain the soil test K levels during the 7 years of this experiment--there was a general decline in these soil test K values.

## C. Effect of initial and annual $K_2O$ applications on corn yields and soil test values on the high phosphate Maury soil at the Middle Tennessee Experiment Station.

### 1. Corn Yields

Corn yields as affected by the initial and annual $K_2O$ application rates are shown in **Table 6**. The initial $K_2O$ applications ranged from 0 to 240 pounds $K_2O$ per acre. The yield for these treatments over the 7-year period, with annual applications of 120 pounds N per acre but with no additional $K_2O$, averaged 104 bushels per acre. No significant yield differences among treatments were observed during any of the 7 years, or for the 7-year average. The treatment receiving 60 pounds $K_2O$ per acre each year produced significantly higher yields in 1979 and for the 7-year average. The Maury soil is naturally high in P, so no phosphate fertilizers were necessary.

### 2. Soil Test Values

Soil test values reported in **Table 7** are means for individual treatments by year. The soil pH was at 6.5 or slightly below during most of the years of the experiment, but dropped to 5.9 and 6.0 at the end of the experiment.

As expected, the soil test P values were high initially and remained high during the 7-year period, although the soil test values decreased at a rate of 4 pounds P per acre per year. The soil test K values were high initially, except for the treatment receiving no $K_2O$. This treatment remained in the medium soil test K range during all but 2 of the 7 years and had the lowest soil test K value (145 pounds K per acre) at the end of the 7 years. Generally, the soil test K values for all of the initial $K_2O$ treatments declined at a rate of 6 to 9 pounds K per acre per year over the 7 years and all tested medium at the end of the experiment. The treatment receiving 60 pounds $K_2O$ per acre annually remained in or near the high soil test range during the entire experiment. In the 150 to 300 pounds K per acre soil test range, each increase in soil test K of 40 pounds per acre increased corn yield 1 bushel per acre.

**Table 6. Corn yields on a Maury soil at the Middle Tennessee Experiment Station as affected by initial and annual applications of $K_2O$.**

| Fertilization (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 7-yr. av. |
| $N\text{-}P_2O_5\text{-}K_2O$ | $N\text{-}P_2O_5\text{-}K_2O$ | ----------Bushels per acre---------- | | | | | | | |
| | | **Effect of Initial $K_2O$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 120 | 133 | 123 | 94 | 76 | 108 | 46 | 100 |
| 120-0-30 | 120-0-0 | 119 | 137 | 132 | 83 | 71 | 108 | 42 | 99 |
| 120-0-60 | 120-0-0 | 126 | 136 | 135 | 97 | 80 | 117 | 48 | 106 |
| 120-0-120 | 120-0-0 | 129 | 144 | 148 | 101 | 84 | 119 | 52 | 111 |
| 120-0-240 | 120-0-0 | 119 | 134 | 134 | 98 | 80 | 122 | 41 | 104 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Effect of Annual $K_2O$ Applications** | | | | | | | |
| 120-0-0 | 120-0-0 | 120 | 133 | 123 | 94 | 76 | 108 | 46 | 100 |
| 120-0-60 | 120-0-60 | 118 | 133 | 139 | 106 | 82 | 120 | 49 | 107 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | 11 | N.S. | 5 |

**Table 7. Soil test changes over time as affected by initial and annual applications of $K_2O$ on a Maury Soil at the Middle Tennessee Experiment Station.**

| Fertilization (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | Spr. 1974 | Spr. 1975 | Spr. 1976 | Spr. 1977 | Spr. 1978 | Spr. 1979 | Spr. 1980 | Fall 1980 |
| $N\text{-}P_2O_5\text{-}K_2O$ | $N\text{-}P_2O_5\text{-}K_2O$ | | | | | | | | |
| | | **A. Soil pH** | | | | | | | |
| | | **Effect of Initial and Annual $K_2O$ Applications** | | | | | | | |
| 120-0-60 | 120-0-60 | 6.3 | 6.4 | 6.6 | 6.5 | 6.5 | 6.3 | 6.2 | 5.9 |
| 120-0-0 | 120-0-0 | 6.2 | 6.4 | 6.6 | 6.6 | 6.6 | 6.3 | 6.1 | 5.9 |
| 120-0-30 | 120-0-0 | 6.4 | 6.4 | 6.6 | 6.6 | 6.6 | 6.3 | 6.2 | 6.0 |
| 120-0-60 | 120-0-0 | 6.3 | 6.4 | 6.6 | 6.6 | 6.6 | 6.3 | 6.1 | 6.0 |
| 120-0-120 | 120-0-0 | 6.3 | 6.4 | 6.5 | 6.5 | 6.5 | 6.2 | 6.1 | 5.9 |
| 120-0-240 | 120-0-0 | 6.3 | 6.4 | 6.6 | 6.5 | 6.6 | 6.3 | 5.9 | 6.0 |
| | | **B. Soil Test Phosphorus** | | | | | | | |
| | | **Effect of Initial and Annual $K_2O$ Applications** | | | | | | | |
| | | **----------Pounds of P Per Acre----------** | | | | | | | |
| 120-0-60 | 120-0-60 | 54 | 61 | 58 | 53 | 56 | 45 | 38 | 41 |
| 120-0-0 | 120-0-0 | 48 | 59 | 50 | 56 | 55 | 44 | 44 | 39 |
| 120-0-30 | 120-0-0 | 55 | 66 | 65 | 49 | 60 | 50 | 44 | 41 |
| 120-0-60 | 120-0-0 | 50 | 58 | 54 | 45 | 53 | 46 | 39 | 35 |
| 120-0-120 | 120-0-0 | 48 | 60 | 51 | 56 | 55 | 44 | 43 | 40 |
| 120-0-240 | 120-0-0 | 50 | 58 | 54 | 53 | 55 | 46 | 43 | 39 |
| | | **C. Soil Test Potassium** | | | | | | | |
| | | **Effect of Initial and Annual $K_2O$ Applications** | | | | | | | |
| | | **----------Pounds of K Per Acre----------** | | | | | | | |
| 120-0-60 | 120-0-60 | 215 | 195 | 230 | 268 | 233 | 228 | 215 | 215 |
| 120-0-0 | 120-0-0 | 180 | 205 | 180 | 200 | 188 | 183 | 163 | 145 |
| 120-0-30 | 120-0-0 | 205 | 210 | 220 | 230 | 183 | 203 | 183 | 155 |
| 120-0-60 | 120-0-0 | 233 | 210 | 215 | 220 | 200 | 198 | 200 | 148 |
| 120-0-120 | 120-0-0 | 260 | 233 | 250 | 230 | 210 | 220 | 185 | 178 |
| 120-0-240 | 120-0-0 | 295 | 263 | 280 | 245 | 228 | 243 | 340 | 188 |

## D. Effect of initial and annual applications of $P_2O_5$ and $K_2O$ on soybean yields and soil test values on a Grenada soil at the Milan Experiment Station.

### 1. Soybean Yields

Soybean yields from initial and annual applications of $P_2O_5$ and $K_2O$ are summarized in **Table 8.** The initial $P_2O_5$ rates ranged from 0 to 160 pounds per acre. The yield for these treatments over the 7-year period, with annual applications of 20 pounds $K_2O$ per acre, averaged 39 bushels per acre. Yields ranged from a high of 53 bushels per acre in 1975 to a low of 15 bushels per acre in 1980 (a drought year). No significant differences among any of the initial $P_2O_5$ treatments were observed during any of the 7 years or for the 7-year average.

The initial $K_2O$ rates ranged from 0 to 160 pounds per acre. These treatments yielded an average of 36 bushels per acre over the 7-year period with yields ranging from a high of 49 bushels per acre in 1975 to a low of 17 bushels per acre in 1980. No significant yield differences among any of the treatments were observed during any year of the experiment or for the 7-year average.

A treatment receiving no $P_2O_5$ or $K_2O$ during the entire 7 years averaged 34 bushels per acre. The treatment receiving annual applications of 20 pounds $P_2O_5$ per acre produced significantly higher yields only in 1980 and not for the 7-year average. The treatment receiving 20 pounds of $K_2O$ per acre annually produced significantly higher yields in 4 of the 7 years (1976, 1977, 1978, 1979) and for the 7-year average. The treatment receiving 20 pounds per acre of $P_2O_5$ and $K_2O$ annually produced significantly higher yields in 1976 and 1977, but not for the 7-year average.

**Figure 5** shows the average isoyields expected from different soil test values of P and K during the course of the experiment. These yields ranged from 33 bushels per acre at low soil test P and K levels to a high of 39 bushels per acre at medium soil test P and high soil test K levels.

### 2. Soil Test Values

Soil test values reported in **Table 9** are means for individual treatments by year. The soil pH was near 6.5 or above and remained near these values during the course of the experiment.

The soil test P values were barely in the medium range at the beginning of the experiment. The initial applications of 80 and 160 pounds $P_2O_5$ per acre increased these soil test P values slightly the first year. After two crop years, all other initial $P_2O_5$ application rates tested low. The initial $P_2O_5$ fertilizer rate of 160 pounds tested medium in the fourth year and then dropped to low for the remaining crop years. The application of 20 pounds $P_2O_5$ annually did not maintain soil test P values and they also declined over time and were in the low soil

**Table 8. Soybean yields on a Grenada soil at the Milan Experiment Station as affected by initial and annual applications of $P_2O_5$ and $K_2O$.**

| Fertilization (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 7-yr. av. |
| $N\text{-}P_2O_5\text{-}K_2O$ | $N\text{-}P_2O_5\text{-}K_2O$ | ---------- | ---------- | Bushels per acre | ---------- | ---------- | ---------- | ---------- | ---------- |
| | | | | **Effect of Initial $P_2O_5$ Applications** | | | | | |
| 0-0-20 | 0-0-20 | 45 | 53 | 43 | 45 | 30 | 39 | 15 | 38 |
| 0-20-20 | 0-0-20 | 45 | 54 | 40 | 46 | 32 | 40 | 15 | 39 |
| 0-40-20 | 0-0-20 | 46 | 52 | 40 | 46 | 34 | 41 | 16 | 39 |
| 0-80-20 | 0-0-20 | 47 | 53 | 42 | 47 | 33 | 40 | 16 | 40 |
| 0-160-20 | 0-0-20 | 46 | 53 | 42 | 47 | 32 | 41 | 15 | 39 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | | | **Effect of Initial $K_2O$ Applications** | | | | | |
| 0-20-0 | 0-20-0 | 45 | 49 | 34 | 41 | 30 | 41 | 18 | 37 |
| 0-20-20 | 0-20-0 | 43 | 46 | 35 | 40 | 28 | 36 | 17 | 35 |
| 0-20-40 | 0-20-0 | 42 | 48 | 36 | 41 | 28 | 38 | 18 | 36 |
| 0-20-80 | 0-20-0 | 46 | 51 | 36 | 42 | 29 | 36 | 16 | 37 |
| 0-20-160 | 0-20-0 | 44 | 49 | 37 | 44 | 28 | 39 | 18 | 37 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | | | **Effect of Annual $P_2O_5$ Applications** | | | | | |
| 0-0-0 | 0-0-0 | 43 | 47 | 30 | 39 | 26 | 36 | 17 | 34 |
| 0-20-0 | 0-20-0 | 45 | 49 | 34 | 41 | 30 | 41 | 18 | 37 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | 1 | N.S. |
| | | | | **Effect of Annual $K_2O$ Applications** | | | | | |
| 0-0-0 | 0-0-0 | 43 | 47 | 30 | 39 | 26 | 36 | 17 | 34 |
| 0-0-20 | 0-0-20 | 45 | 53 | 42 | 45 | 30 | 39 | 15 | 38 |
| | LSD(.05) | N.S. | N.S. | 7 | 3 | 3 | 2 | N.S. | 4 |
| | | | | **Effect of Annual $P_2O_5$ and $K_2O$ Applications** | | | | | |
| 0-0-0 | 0-0-0 | 43 | 47 | 30 | 39 | 26 | 36 | 17 | 34 |
| 0-20-20 | 0-20-20 | 47 | 54 | 41 | 46 | 31 | 40 | 16 | 39 |
| | LSD(.05) | N.S. | N.S. | 10 | 6 | N.S. | N.S. | N.S. | N.S. |

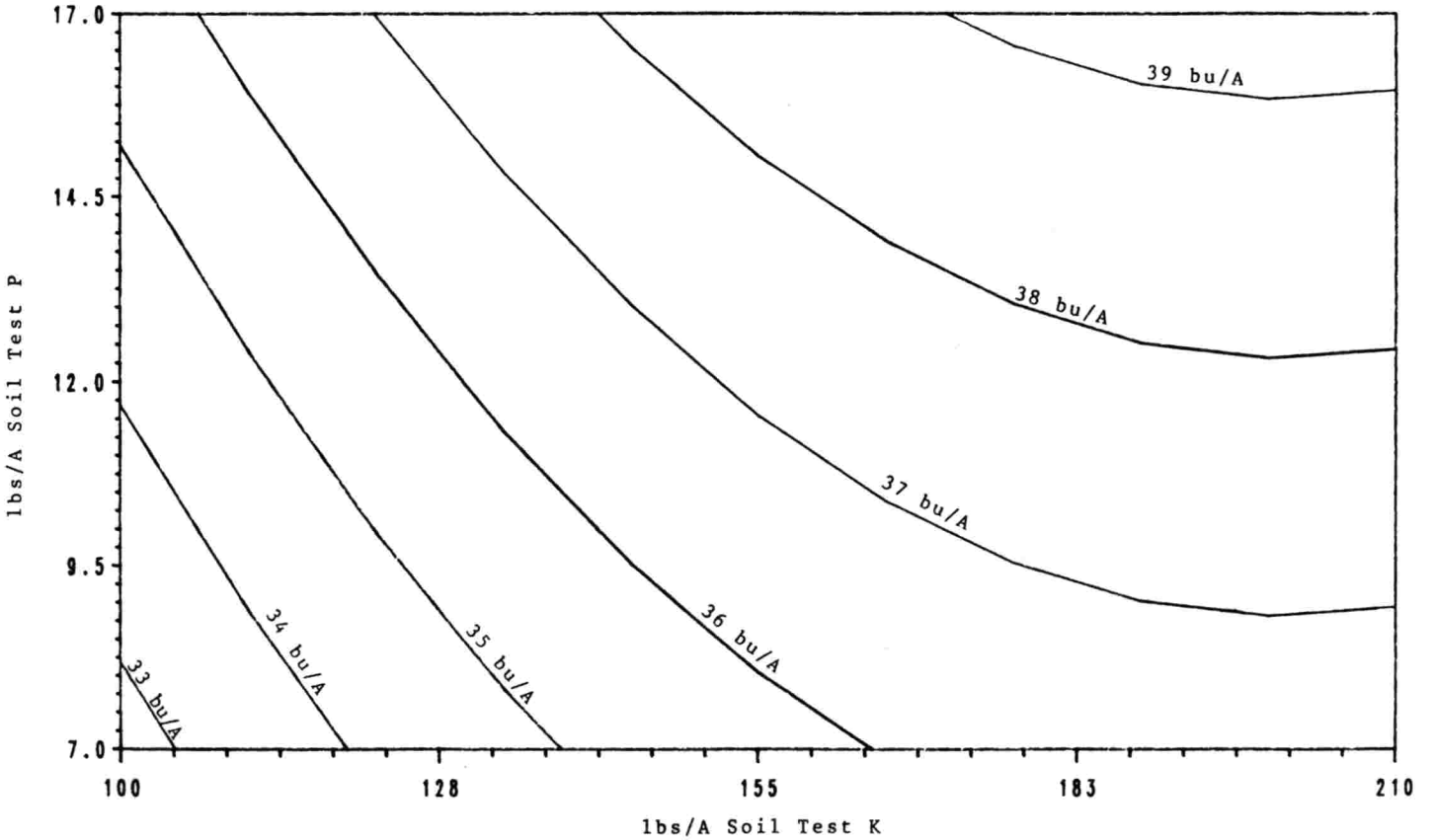


**Figure 5. Average soybean yields obtained at different soil test levels of P and K on a Grenada soil**

**Table 9. Soil test changes over time as affected by initial and annual applications of $P_2O_5$ and $K_2O$ on a Grenada soil at the Milan Experiment Station.**

| Fertilization (lb/A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Initial | Annual | Spr. 1974 | Fall 1974 | Fall 1975 | Fall 1976 | Fall 1977 | Fall 1978 | Fall 1979 |
| | | | | A. Soil Test Phosphorus | | | | |
| N-$P_2O_5$-$K_2O$ | N-$P_2O_5$-$K_2O$ | ----------Pounds of P Per Acre---------- | | | | | | |
| | | | | Effect of Initial $P_2O_5$ Applications | | | | |
| 0-0-20 | 0-0-20 | 18 | 12 | 12 | 12 | 11 | 8 | 8 |
| 0-20-20 | 0-0-20 | 16 | 13 | 11 | 11 | 9 | 8 | 7 |
| 0-40-20 | 0-0-20 | 17 | 15 | 12 | 13 | 11 | 8 | 8 |
| 0-80-20 | 0-0-20 | 17 | 18 | 12 | 13 | 11 | 9 | 7 |
| 0-160-20 | 0-0-20 | 16 | 23 | 15 | 16 | 12 | 9 | 9 |
| | | | | Effect of Initial $K_2O$ Applications | | | | |
| 0-20-0 | 0-20-0 | 16 | 13 | 11 | 12 | 11 | 9 | 10 |
| 0-20-20 | 0-20-0 | 16 | 12 | 10 | 13 | 11 | 9 | 10 |
| 0-20-40 | 0-20-0 | 17 | 12 | 11 | 13 | 11 | 9 | 9 |
| 0-20-80 | 0-20-0 | 15 | 13 | 11 | 13 | 12 | 10 | 9 |
| 0-20-160 | 0-20-0 | 17 | 12 | 11 | 14 | 10 | 10 | 10 |
| | | | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | |
| 0-0-0 | 0-0-0 | 17 | 12 | 10 | 12 | 10 | 8 | 6 |
| 0-20-0 | 0-20-0 | 16 | 13 | 11 | 12 | 11 | 9 | 10 |
| 0-0-20 | 0-0-20 | 18 | 12 | 12 | 12 | 11 | 8 | 8 |
| 0-20-20 | 0-20-20 | 19 | 14 | 11 | 14 | 11 | 9 | 9 |
| | | | | B. Soil Test Potassium | | | | |
| N-$P_2O_5$-$K_2O$ | N-$P_2O_5$-$K_2O$ | ----------Pounds of K Per Acre---------- | | | | | | |
| | | | | Effect of Initial $P_2O_5$ Applications | | | | |
| 0-0-20 | 0-0-20 | 200 | 163 | 130 | 163 | 158 | 130 | 148 |
| 0-20-20 | 0-0-20 | 180 | 148 | 115 | 148 | 148 | 128 | 135 |
| 0-40-20 | 0-0-20 | 223 | 170 | 133 | 153 | 148 | 123 | 148 |
| 0-80-20 | 0-0-20 | 225 | 168 | 135 | 158 | 155 | 135 | 130 |
| 0-160-20 | 0-0-20 | 200 | 163 | 125 | 150 | 140 | 118 | 133 |
| | | | | Effect of Initial $K_2O$ Applications | | | | |
| 0-20-0 | 0-20-0 | 195 | 160 | 113 | 138 | 125 | 100 | 123 |
| 0-20-20 | 0-20-0 | 210 | 188 | 128 | 150 | 138 | 119 | 138 |
| 0-20-40 | 0-20-0 | 215 | 255 | 170 | 198 | 175 | 118 | 135 |
| 0-20-80 | 0-20-0 | 200 | 200 | 130 | 153 | 140 | 108 | 125 |
| 0-20-160 | 0-20-0 | 220 | 240 | 150 | 180 | 155 | 128 | 138 |
| | | | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | |
| 0-0-0 | 0-0-0 | 213 | 168 | 125 | 153 | 140 | 123 | 138 |
| 0-20-0 | 0-20-0 | 195 | 160 | 113 | 138 | 125 | 100 | 123 |
| 0-0-20 | 0-0-20 | 200 | 163 | 130 | 163 | 158 | 130 | 148 |
| 0-20-20 | 0-20-20 | 198 | 168 | 125 | 145 | 150 | 113 | 128 |

test P range every year except the first year.

The soil test K values for all initial fertilizer rates were high or very close to high, but declined to the medium level over time. The rate of decline was slower in treatments receiving 20 pounds $K_2O$ per acre each year. The initial $K_2O$ applications raised some of the soil test K values slightly, but after two years the soil test values had dropped to medium. The treatment receiving no $K_2O$ during the 7 years tested in the lower quarter of the medium soil test K range at the end of the experiment.

## E. Effect of initial and annual rates of $P_2O_5$ and $K_2O$ on cotton yields and soil test values on a Loring soil at Ames Plantation.

At this Loring soil fertility evaluation site, the initial soil test P values were low and the soil test K values clustered around the break that divides the medium and low test ranges. The initial $P_2O_5$ and $K_2O$ rates raised the soil test values only slightly, and after 2 crop fertilization years, the values were back in the low range. For this reason, the initial range of rates (0 to 240 pounds per acre) of $P_2O_5$ and $K_2O$ were applied 3 times and the applications occurred before the 1974, 1976, and 1978 crop years. Thus, during the 7 years of the experiment, the range of total $P_2O_5$ and $K_2O$ applied was from 0 to 720 pounds per acre.

### 1. Cotton Yields

Cotton yields from the initial and annual applications of $P_2O_5$ and $K_2O$ are summarized in **Table 10**. The seed cotton yields for the treatments receiving 3 applications of the initial $P_2O_5$ rates over the 7 years averaged 1,737 pounds per acre and ranged from a low of 1,106 pounds per acre in 1979 to a high of 2,177 pounds per acre in 1974. Significant yield responses to these $P_2O_5$ applications were found in 4 of the 7 years and for the 7-year average.

The seed cotton yields for the treatments receiving 3 applications of the initial $K_2O$ rates over the 7 years averaged 1,556 pounds per acre and ranged from a low of 634 pounds per acre in 1979 to a high of 2,113 pounds per acre in 1974. A significant response to these applications of $K_2O$ was found only in the low yield year of 1979 but not for the 7-year average.

Yields from the treatment receiving no $P_2O_5$ or $K_2O$ but 60 pounds N per acre averaged only 849 pounds seed cotton per acre. Adding 60 pounds $P_2O_5$ each year increased this 7-year average to 1,232 pounds per acre and resulted in a significant yield increase in 4 of the 7 years (1974, 1975, 1976, 1978). The treatment receiving 60 pounds of N and $K_2O$ each year averaged 1,522 pounds seed cotton per acre and resulted in significant yield increases in each of the 7 years and for the 7-year average. The highest yielding treatment of the experiment received 60 pounds of N, $P_2O_5$, and $K_2O$ each year and averaged 1,975 pounds seed cotton per

**Table 10. Cotton yields on a Loring soil at Ames Plantation as affected by initial and annual applications of $P_2O_5$ and $K_2O$.**

| Fertilization (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 7-yr. av. |
| $N\text{-}P_2O_5\text{-}K_2O$ | $N\text{-}P_2O_5\text{-}K_2O$ | ----------Pounds Seed Cotton Per Acre---------- | | | | | | | |
| | | **Effect of Initial $P_2O_5$ Applications** | | | | | | | |
| 60-0-60 | 60-0-60 | 1823 | 967 | 1624 | 1783 | 1984 | 971 | 1499 | 1521 |
| 60-30-60 | 60-0-60 | 1932 | 1043 | 1684 | 1823 | 1913 | 1006 | 1383 | 1540 |
| 60-60-60 | 60-0-60 | 2382 | 1263 | 1899 | 2210 | 2164 | 1001 | 1546 | 1767 |
| 60-120-60 | 60-0-60 | 2338 | 1574 | 2028 | 2128 | 2439 | 1161 | 1542 | 1887 |
| 60-240-60 | 60-0-60 | 2412 | 1598 | 2044 | 2273 | 2368 | 1390 | 1582 | 1952 |
| | LSD(.05) | 461 | 342 | N.S. | 355 | N.S. | 237 | N.S. | 258 |
| | | **Effect of Initial $K_2O$ Applications** | | | | | | | |
| 60-60-0 | 60-60-0 | 1815 | 1048 | 1145 | 1556 | 1649 | 393 | 1021 | 1232 |
| 60-60-30 | 60-60-0 | 2376 | 1454 | 1570 | 1695 | 1774 | 474 | 1028 | 1482 |
| 60-60-60 | 60-60-0 | 2254 | 1399 | 1763 | 1981 | 1919 | 760 | 1343 | 1631 |
| 60-60-120 | 60-60-0 | 2118 | 1321 | 1957 | 2044 | 1987 | 785 | 1170 | 1626 |
| 60-60-240 | 60-60-0 | 2003 | 1511 | 1989 | 2292 | 2513 | 758 | 1592 | 1808 |
| | LSD(.05) | N.S. | N.S. | N.S. | N.S. | N.S. | 217 | N.S. | N.S. |
| | | **Effect of Annual $P_2O_5$ Applications** | | | | | | | |
| 60-0-0 | 60-0-0 | 1118 | 577 | 616 | 1259 | 1165 | 281 | 927 | 849 |
| 60-60-0 | 60-60-0 | 1815 | 1048 | 1145 | 1556 | 1649 | 393 | 1021 | 1232 |
| | LSD(.05) | 489 | 451 | 518 | N.S. | 444 | N.S. | N.S. | N.S. |
| | | **Effect of Annual $K_2O$ Applications** | | | | | | | |
| 60-0-0 | 60-0-0 | 1118 | 577 | 616 | 1259 | 1165 | 281 | 927 | 849 |
| 60-0-60 | 60-0-60 | 1823 | 967 | 1624 | 1783 | 1984 | 971 | 1499 | 1522 |
| | LSD(.05) | 494 | 162 | 481 | 468 | 444 | 332 | 493 | 150 |
| | | **Effect of Annual $P_2O_5$ and $K_2O$ Applications** | | | | | | | |
| 60-0-0 | 60-0-0 | 1118 | 577 | 616 | 1259 | 1165 | 281 | 927 | 849 |
| 60-60-60 | 60-60-60 | 2224 | 1702 | 1900 | 2390 | 2452 | 1538 | 1617 | 1975 |
| | LSD(.05) | 936 | 426 | 308 | 770 | 432 | 133 | 255 | 381 |

acre per year, with the highest yield of 2,452 pounds per acre obtained in 1978 and the lowest yield of 1,538 pounds per acre in 1979. This treatment also resulted in significant yield increases in each of the 7 years and for the 7-year average.

Seed cotton isoyields as a function of soil test levels of P and K over the course of the experiment are shown in **Figure 6**. At low soil test P and K levels, seed cotton yields were around 1,000 pounds per acre, but as soil test K levels increased to a high level, cotton yields more than doubled.

### 2. Soil Test Values

Soil test values reported in **Table 11** are means for individual treatments by year. The soil pH was generally between 5.5 and 6.0 during most of the years, but increased to 6.4 and above after liming in the fall of 1979.

The soil test P values were low during much of the experiment. The high $P_2O_5$ rate (240 pounds per acre) would raise the soil test level to medium for 1 or 2 crop years after each application but it would drop back to low over the next few years. Applying 60 pounds $P_2O_5$ per acre each year resulted in a slight increase in soil test P values over time, but the soil test values still remained in the low P test range throughout the 7 years.

The soil test K values were medium to low initially and the 3 applications of the initial $K_2O$ rates raised these soil test values after each application, but they declined over the following 2 crop years. Each time $K_2O$ was applied at the 240 pounds per acre rate, it raised the soil test K to a high level, but the level declined to medium soon thereafter. Applying 60 pounds $K_2O$ per acre each year gradually increased the soil test K values and resulted in high K soil test values at the end of the 7 years of the experiment. **Figures 7 and 8** are block charts of mean soil test P and K for the different fertility treatments over the years. **Figure 7** shows how the soil test P would rise the year after each application, only to decline the following year. **Figure 8** shows a similar trend in soil test K values relative to times of application, but not to the extremes as exhibited by the soil test P values. These results indicate that for cotton, smaller annual fertilizer additions were more effective than less frequent larger fertilizer applications.

## Summary

The average corn yields from the five initial $P_2O_5$ application rates were greater on the Hartsells soil (119 bu/A) than on the Dickson soil (76 bu/A). This was probably due to higher soil test P values and better rainfall distribution at the Hartsells location than at the Dickson location, where soil test P values were low. No significant response to initial $P_2O_5$ application rates was observed for any one of the 7 years or for the 7-year average. Annual applications of 60 pounds $P_2O_5$ per acre had no significant effect on corn yields during any year or for the 7-year average on the Hartsells soil, but did significantly increase corn yields on the Dickson soil in 1976.

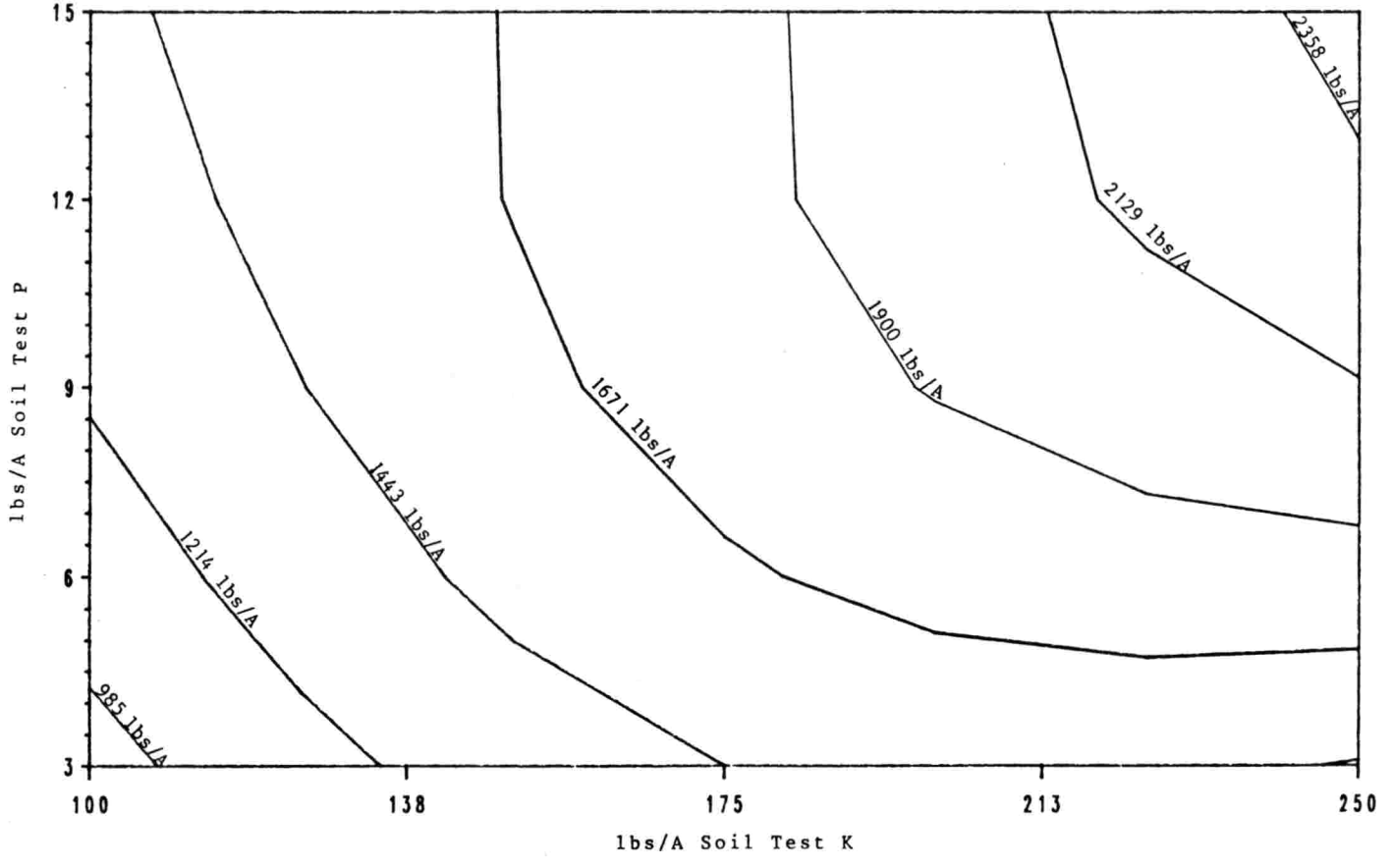


**Figure 6. Average seed cotton yields obtained at different soil test levels of P and K on a Loring soil**

**Table 11. Soil test changes over time as affected by initial and annual applications of $P_2O_5$ and $K_2O$ on a Loring soil at Ames Plantation.**

| Fertilization (lb/A) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial | Annual | Spr. 1974 | Fall 1974 | Spr. 1975 | Spr. 1976 | Fall 1976 | Fall 1977 | Fall 1978 | Fall 1979 | Spr. 1980 | Fall 1980 |
| | | | | | | A. Soil Test Phosphorus | | | | | |
| N-$P_2O_5$-$K_2O$ | N-$P_2O_5$-$K_2O$ | ----------Pounds P Per Acre---------- | | | | | | | | | |
| | | Effect of Initial Applications of $P_2O_5$ Applied in Spring of 1974, 1976, and 1978 | | | | | | | | | |
| 60-0-60 | 60-0-60 | 4 | 5 | 3 | 4 | 4 | 4 | 6 | 5 | 7 | 7 |
| 60-30-60 | 60-0-60 | 4 | 6 | 4 | 4 | 6 | 5 | 8 | 8 | 6 | 7 |
| 60-60-60 | 60-0-60 | 4 | 9 | 7 | 5 | 8 | 5 | 8 | 8 | 6 | 9 |
| 60-120-60 | 60-0-60 | 4 | 8 | 11 | 6 | 15 | 6 | 8 | 10 | 7 | 8 |
| 60-240-60 | 60-0-60 | 4 | 17 | 19 | 9 | 23 | 10 | 11 | 15 | 10 | 11 |
| | | Effect of Initial Applications of $K_2O$ Applied in Spring of 1974, 1976, and 1978 | | | | | | | | | |
| 60-60-0 | 60-60-0 | 3 | 8 | 6 | 5 | 8 | 7 | 9 | 13 | 10 | 13 |
| 60-60-30 | 60-60-0 | 2 | 8 | 5 | 6 | 9 | 7 | 8 | 13 | 10 | 13 |
| 60-60-60 | 60-60-0 | 2 | 7 | 5 | 6 | 8 | 6 | 7 | 11 | 9 | 13 |
| 60-60-120 | 60-60-0 | 4 | 7 | 5 | 6 | 8 | 7 | 8 | 15 | 10 | 14 |
| 60-60-240 | 60-60-0 | 2 | 7 | 5 | 7 | 9 | 6 | 9 | 14 | 11 | 13 |
| | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | | | | | | |
| 60-0-0 | 60-0-0 | 3 | 5 | 2 | 4 | 4 | 3 | 5 | 6 | 6 | 6 |
| 60-60-0 | 60-60-0 | 3 | 8 | 6 | 5 | 8 | 7 | 9 | 13 | 10 | 13 |
| 60-0-60 | 60-0-60 | 4 | 5 | 3 | 4 | 4 | 4 | 6 | 5 | 7 | 7 |
| 60-60-60 | 60-60-60 | 3 | 8 | 5 | 6 | 9 | 8 | 9 | 14 | 10 | 12 |
| | | | | | | B. Soil Test Potassium | | | | | |
| N-$P_2O_5$-$K_2O$ | N-$P_2O_5$-$K_2O$ | ----------Pounds K Per Acre---------- | | | | | | | | | |
| | | Effect of Initial Applications of $P_2O_5$ Applied in Spring of 1974, 1976, and 1978 | | | | | | | | | |
| 60-0-60 | 60-0-60 | 133 | 195 | 170 | 175 | 208 | 178 | 243 | 200 | 178 | 233 |
| 60-30-60 | 60-0-60 | 133 | 203 | 148 | 190 | 238 | 180 | 220 | 210 | 178 | 235 |
| 60-60-60 | 60-0-60 | 130 | 190 | 163 | 173 | 223 | 170 | 218 | 203 | 180 | 233 |
| 60-120-60 | 60-0-60 | 135 | 185 | 153 | 175 | 238 | 178 | 203 | 205 | 200 | 218 |
| 60-240-60 | 60-0-60 | 128 | 188 | 143 | 160 | 248 | 178 | 228 | 203 | 193 | 208 |
| | | Effect of Initial Applications of $K_2O$ Applied in Spring of 1974, 1976, and 1978 | | | | | | | | | |
| 60-60-0 | 60-60-0 | 98 | 133 | 95 | 108 | 128 | 90 | 135 | 110 | 85 | 103 |
| 60-60-30 | 60-60-0 | 118 | 150 | 130 | 123 | 155 | 98 | 148 | 118 | 88 | 128 |
| 60-60-60 | 60-60-0 | 103 | 160 | 120 | 135 | 158 | 88 | 148 | 130 | 93 | 125 |
| 60-60-120 | 60-60-0 | 115 | 195 | 155 | 138 | 218 | 123 | 170 | 143 | 105 | 130 |
| 60-60-240 | 60-60-0 | 100 | 248 | 203 | 170 | 308 | 173 | 228 | 178 | 153 | 173 |
| | | Effect of Annual $P_2O_5$ and $K_2O$ Applications | | | | | | | | | |
| 60-0-0 | 60-0-0 | 93 | 115 | 83 | 113 | 113 | 85 | 130 | 98 | 80 | 105 |
| 60-60-0 | 60-60-0 | 98 | 133 | 95 | 108 | 128 | 90 | 135 | 110 | 85 | 103 |
| 60-0-60 | 60-0-60 | 133 | 195 | 170 | 175 | 208 | 178 | 243 | 200 | 178 | 233 |
| 60-60-60 | 60-60-60 | 130 | 180 | 140 | 170 | 218 | 185 | 208 | 195 | 168 | 220 |

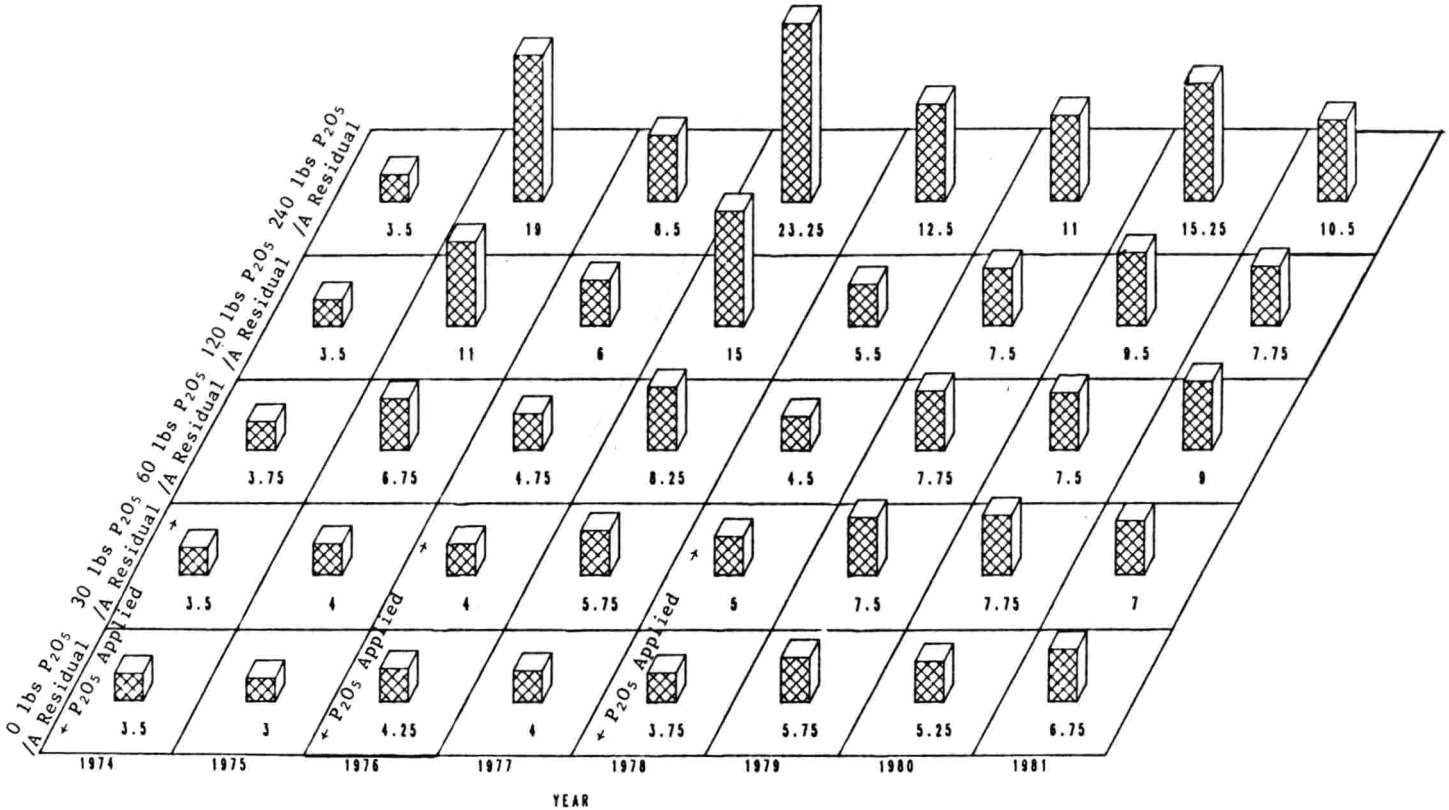


**Figure 7. The residual soil test values for 5 rates of $P_2O_5$ applied before each of the 1974, 1976, and 1978 crop years**

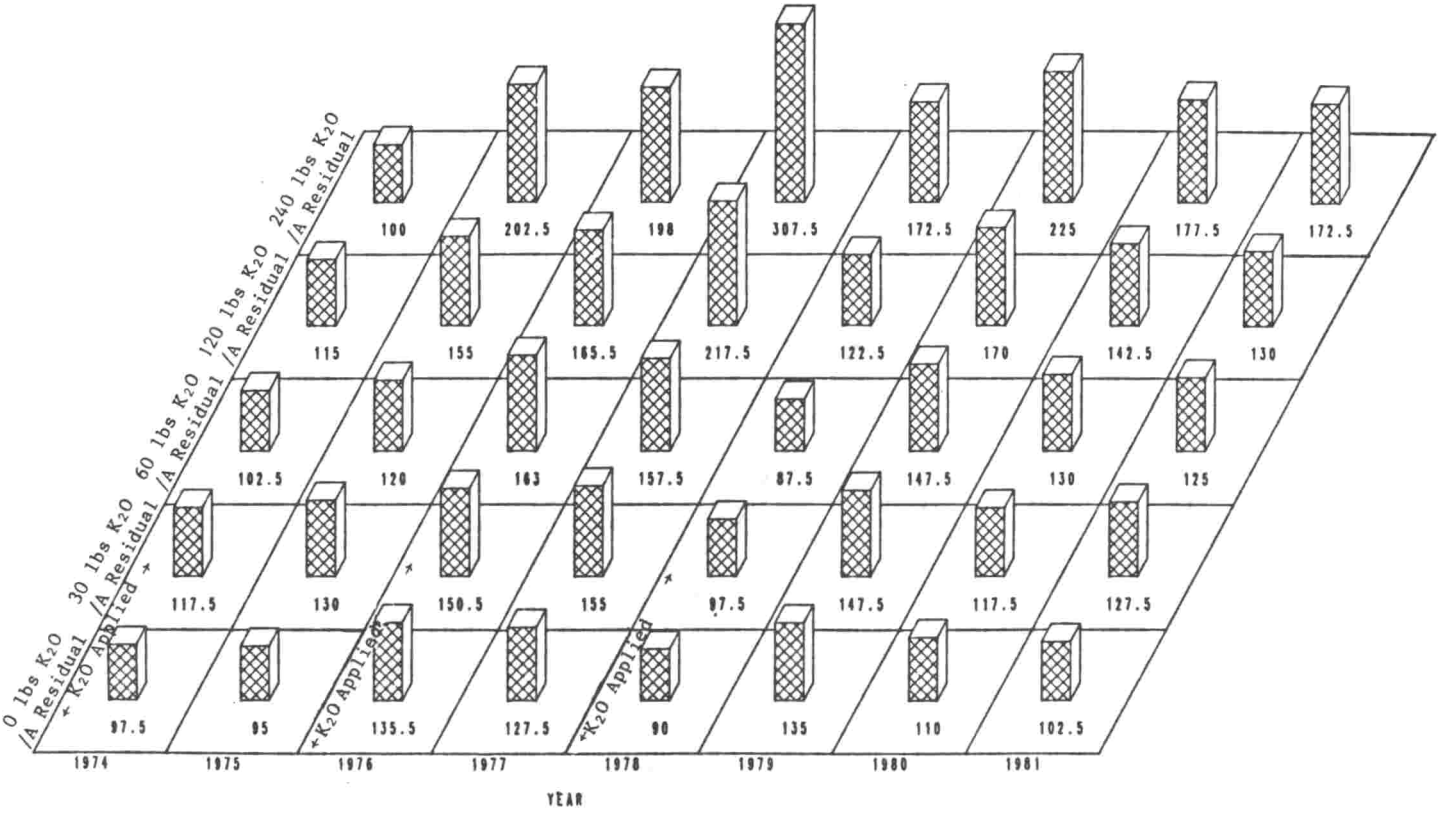


**Figure 8. The residual soil test values for 5 rates of $K_2O$ applied before each of the 1974, 1976, and 1978 crop years**

Initial rates of $K_2O$ produced higher corn yields on the Hartsells soil (91 bu/A) than on the Dickson soil (76 bu/A) but less than the yields produced on the Maury soil (104 bu/A). No significant yield response to initial $K_2O$ applications was observed for any of the 7 years or for the 7-year average on the Hartsells or Dickson soils. The 7-year average corn yield on the Maury soil showed a significant response to 120 pounds $K_2O$ per acre. Annual applications of 60 pounds $K_2O$ per acre significantly increased yield on the Hartsells soil in 1975 and for the 7-year average, but significantly increased yield on the Dickson soil in only 1979. This same annual 60 pounds $K_2O$ rate per acre significantly increased corn yields on the Maury soil in 1979 and for the 7-year average.

Soybean yields on the Grenada soil averaged 39 bu/A from initial $P_2O_5$ applications and 36 bu/A from initial $K_2O$ application rates. However, there was no significant response to either $P_2O_5$ or $K_2O$ during any one of the 7 years or for the 7-year average. Annual applications of 20 pounds $P_2O_5$ per acre resulted in significant yield increases only in 1980 and for the 7-year average. Annual applications of 20 pounds $K_2O$ per acre resulted in significant yield increases in 4 years (1976, 1977, 1978, 1979) and for the 7-year average. No fertilizer treatment was sufficient to keep the soil test P and K from decreasing each year of the experiment.

Seed cotton yields on the Loring soil averaged 1,737 lbs/A from initial $P_2O_5$ application rates and 1,556 lb/A from initial $K_2O$ application rates. The three initial $P_2O_5$ rates applied resulted in significant seed cotton yield increases in 4 years (1974, 1975, 1977, 1979) and for the 7-year average. The three initial $K_2O$ rates applied resulted in significant yield increases in 1979 and for the 7-year average. Annual applications of 60 pounds $P_2O_5$ per acre resulted in significant cotton yield increases in 4 years (1974, 1975, 1976, 1979) and for the 7-year average. Annual applications of 60 pounds $K_2O$ per acre resulted in significant yield increases every year and for the 7-year average.

The soil test values indicate that the soil test procedure used did not accurately measure the phosphorus levels in the soils containing loess, as the soil test values in these soils were much lower than expected for the fertilizer application rates used. The soil phosphorus in these loess soils was perhaps chemically fixed in such a way that the 0.05N $H_2SO_4$ plus 1% $(NH_4)_2SO_4$ extracting solution did not extract the phosphorus, or the soils contained enough bases to neutralize the extracting solution.

The crop yields and soil test values will provide producers with the average yield a crop will produce at given soil test values and the rate of soil test changes over time with and without additional fertilizer additions for the soils evaluated and other similar soils.

**THE UNIVERSITY OF TENNESSEE**
**AGRICULTURAL EXPERIMENT STATION**
**KNOXVILLE, TENNESSEE 37996-4500**

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