Levels and Changes in Soil Tests in Lower Michigan 1962-71
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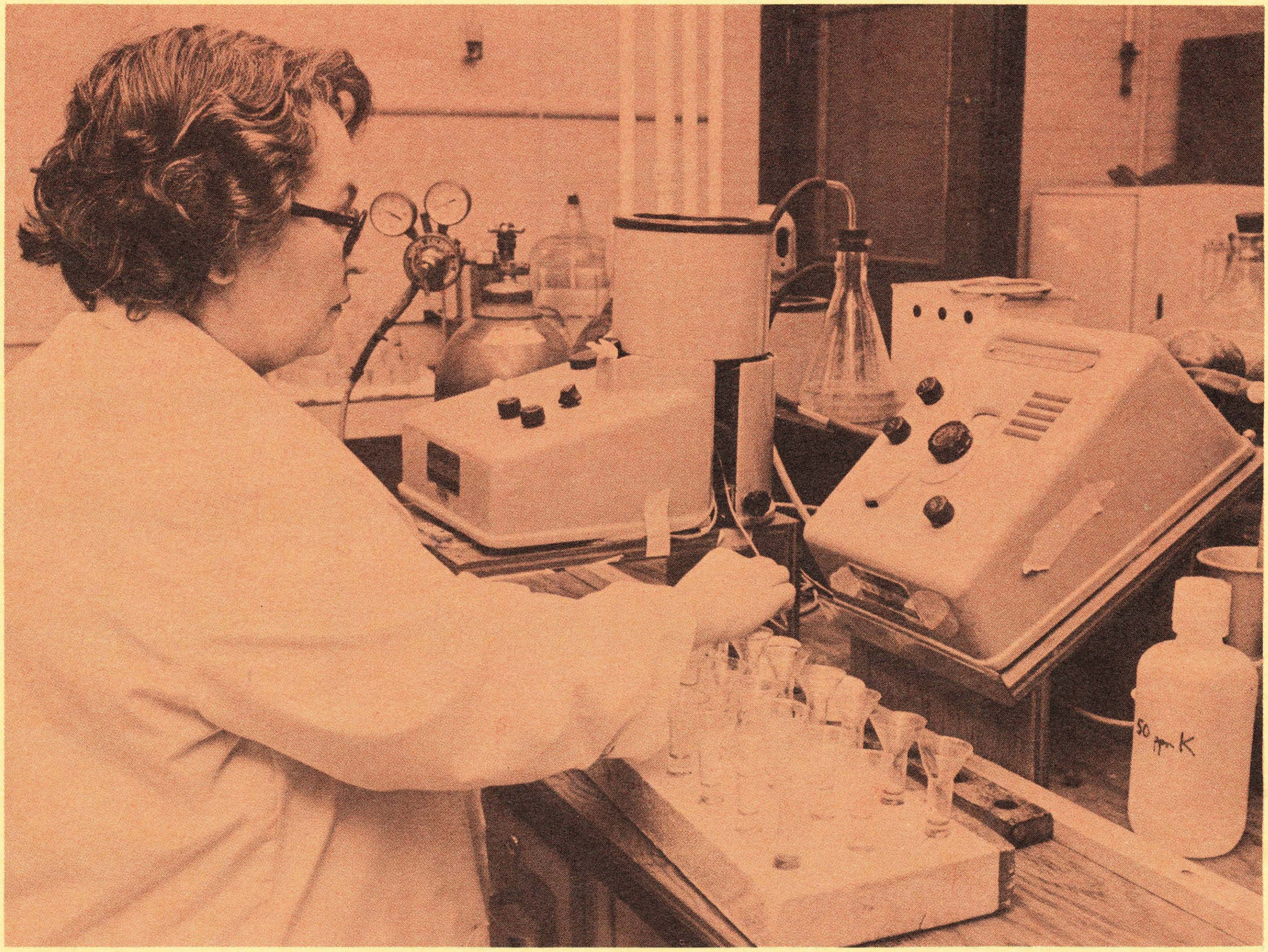

# Levels and Changes in Soil Tests in Lower Michigan 1962-71

*By*

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**COVER: Using a flame photometer, Mrs. Loreen Cedarstaff measures available potassium in soil samples in the Soil Testing Laboratory at Michigan State University.**

## INTRODUCTION

SOIL TEST SUMMARIES and changes in test levels over time give considerable information about soil fertility in the various parts of the state. Early summaries of soil test levels have been reported by Shickluna and Cook (3) and Shickluna (2). Because many reactions occur between the various components of the soil and applied fertilizer materials, changes in soil test levels due to fertilizer applications are often much less than generally anticipated. However, continued applications of fertilizer at recommended rates can materially increase soil test levels (5).

## PROCEDURE

The results summarized here are from soil samples tested in the central soil testing laboratory in the Crop and Soil Sciences Department at Michigan State University. In this laboratory, soil pH is determined with a glass electrode potentiometer using a 1:2 soil:water ratio; lime requirement by the Ohio SMP buffer procedure (4), "available" soil phosphorus by the Bray P1 procedure (1) and exchangeable potassium, calcium and magnesium by extraction with neutral normal ammonium acetate (1:8 soil:extractant ratio, shaken for 1 min.).

All soil test results from the central laboratory are processed by computer (Controlled Data Corporation Model 3600), and a permanent record of soil test results is stored on magnetic tape. Because of time and personnel limitations, results from only about 75% of the total samples tested from 1962-71 (see Table 1) were recorded for future reference. About 20 county soil testing laboratories are still operating, so that only about half of the soil samples tested in MSU laboratories are tested in the central laboratory.

**Table 1. Number of soil samples tested in Michigan State University's central soil testing laboratory and tonnages of nitrogen (N), phosphorus ($P_2O_5$), potassium ($K_2O$), and agricultural limestone applied each year from 1962-71**

| Year | Number of Soil Tests | Tons Applied Per Year N(b) | $P_2O_5$(b) | $K_2O$(b) | Limestone(c) |
|---|---|---|---|---|---|
| 1962 | 13,500(a) | 71,135 | 101,092 | 89,337 | 335,482 |
| 1963 | 14,500(a) | 82,590 | 115,691 | 109,899 | 396,740 |
| 1964 | 16,440 | 96,473 | 129,758 | 117,613 | 429,571 |
| 1965 | 21,537 | 92,243 | 120,649 | 112,604 | 423,173 |
| 1966 | 17,543 | 99,818 | 122,964 | 120,941 | 400,000 |
| 1967 | 14,587 | 106,846 | 131,879 | 131,240 | 447,360 |
| 1968 | 19,096 | 115,939 | 128,223 | 136,088 | 456,307 |
| 1969 | 17,197 | 111,522 | 122,309 | 137,966 | 447,180 |
| 1970 | 16,394 | 138,682 | 127,360 | 148,076 | 451,651 |
| 1971 | 17,269 | 161,083 | 151,291 | 173,023 | 451,650 |

(a) Estimated, actual figures not available.
(b) Data from Michigan Department of Agriculture, Plant Industry Division.
(c) Estimated from ASCS and Soil Science Department data.

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Soil test results stored on magnetic tape can be recovered for individual counties; however, these data are too voluminous to show general trends. Conversely, statewide averages mask many of the differences between areas of the state. Thus, southern Michigan was divided into 5 geographical regions (see Fig. 1) in each of which soil types and cropping practices were generally similar. However, the summary indicates that there are real and significant differences in soil test levels between geographical regions.

Summaries presented here are for 1962, 1967 and 1971; thus changes in soil test levels can be evaluated over a 10-year period. Soil test averages can be used to evaluate the mean soil test levels and trends over the 10-year period, but they give no information about the distribution of soil test levels for any one year or within any region. Also, the number of samples testing low compared to those testing high may differ significantly each year. Therefore, percentages of the total number of samples tested falling within various arbitrary limits were calculated to compare the distribution of the soil test levels within regions and between years.

The data presented here are for mineral soils from lower Michigan only; data for soils from the Upper Peninsula and for organic soils will be presented in subsequent reports.


**Fig. 1. Soil test summaries were prepared for these geographical regions in Michigan.**

## DISCUSSION

### Plant Nutrients and Limestone

The amount of fertilizer and limestone used increased markedly from 1962-71. The amount of nitrogen used increased 2.26 times; phosphorus, 1.5; potassium, 1.94; limestone, 1.35. These increases in usage occurred simultaneously with a decrease in the number of farms and in the acreage of harvested cropland. No census data are available for the 1962-71 period, but the U.S. Census of Agriculture data show that from 1959-69, the number of Michigan farms decreased from 104,712 to 70,605, and the harvested cropland decreased from 7,154,811 to 5,501,729 acres.

Most of the fertilizers sold today are applied to harvested cropland. Heavy rates of fertilizer are also aplied to home gardens, lawns, turf and other non-agricultural areas, but these comprise only a small percentage of the total sales. However, not all harvested cropland is fertilized each year, and different crops are fertilized at different rates. Assuming that the acreage of harvested cropland reported for 1959 was about equal to that in 1962, and that for 1969 was about equal to that of 1971, the average rate of nitrogen (N) application increased from 20 to 59 lb/A from 1962-71, phosphate ($P_2O_5$) from 29 to 55 lb, potash ($K_2O$) from 26 to 63 lb, and the average rate of limestone from 0.05 to 0.08 T/A.

### Soil pH and Lime Requirements

The soil pH tends to be highest in clay and clay loam soils and lowest in loamy sand and sand soils (Table 2). The average soil test by region shows the same trend; highest pH levels were in the Thumb and Eastern Michigan Region where clay and clay loam soils predominate and lowest pH levels were in western Michigan where the soils tend to be coarse sandy loams.

**Table 2. Average soil test values for each mineral soil management group for lower Michigan for 1962, 1967 and 1971**

| Soil Management Group (a) | Year | pH | Soil Test Levels: Lime Requirement T/A | Phosphorus | Potassium | Calcium | Magnesium |
|---|---|---|---|---|---|---|---|
| | | | | lb per acre | | | |
| 1 | 1962 | 6.7 | 0.5 | 20 | 143 | 3624 | 311 |
| | 1967 | 6.5 | 0.9 | 39 | 225 | 4205 | 473 |
| | 1971 | 6.4 | 1.1 | 41 | 215 | 3372 | 515 |
| 2 | 1962 | 6.8 | 0.5 | 24 | 149 | 3665 | 366 |
| | 1967 | 6.9 | 0.5 | 34 | 189 | 4200 | 465 |
| | 1971 | 6.6 | 0.9 | 51 | 200 | 3411 | 433 |
| 3 | 1962 | 6.5 | 0.8 | 41 | 125 | 2273 | 184 |
| | 1967 | 6.6 | 0.8 | 51 | 159 | 2867 | 277 |
| | 1971 | 6.4 | 1.1 | 87 | 193 | 2101 | 234 |
| 4 | 1962 | 6.4 | 0.9 | 56 | 118 | 1737 | 132 |
| | 1967 | 6.3 | 1.2 | 80 | 140 | 1674 | 151 |
| | 1971 | 6.3 | 1.2 | 101 | 169 | 1557 | 148 |
| 5 | 1962 | 6.2 | 1.2 | 59 | 91 | 1476 | 95 |
| | 1967 | 6.1 | 1.7 | 81 | 117 | 1330 | 119 |
| | 1971 | 6.1 | 1.3 | 116 | 144 | 987 | 104 |

(a) Soil management group 1 is comprised of clay soils; 2 is clay loams, loams, sandy clay loams, and similar soils; 3 is sandy loams; 4 is loamy sands; and 5 is sand soils.

The average soil pH tended to decrease from 1962-71 for all of lower Michigan and for each soil management group (Tables 2 and 3). Reflecting the decrease in pH values, the lime recommendations (lime requirement, Tables 2 and 3) increased during the 10-year period.

**Table 3. Average soil test values for each of the 5 regions and for all of lower Michigan for 1962, 1967 and 1971**

| Region | Year | pH | Soil Test Levels: Lime Rqmt T/A | Phosphorus | Potassium | Calcium | Magnesium |
|---|---|---|---|---|---|---|---|
| | | | | lb per acre | | | |
| Northern | 1962 | 6.4 | 0.7 | 40 | 103 | 1770 | 138 |
| Lower | 1967 | 6.4 | 1.0 | 55 | 128 | 1847 | 163 |
| Michigan | 1971 | 6.4 | 1.1 | 67 | 169 | 1887 | 215 |
| West | 1962 | 6.1 | 1.4 | 105 | 184 | 1684 | 167 |
| Central | 1967 | 6.2 | 1.6 | 75 | 177 | 2142 | 266 |
| Michigan | 1971 | 6.2 | 1.4 | 116 | 187 | 1432 | 173 |
| Thumb & | 1962 | 6.9 | 0.4 | 28 | 137 | 3637 | 334 |
| Eastern | 1967 | 6.9 | 0.5 | 40 | 174 | 4029 | 410 |
| Michigan | 1971 | 6.8 | 0.5 | 56 | 194 | 3602 | 431 |
| South | 1962 | 6.5 | 0.9 | 31 | 136 | 2568 | 253 |
| Central | 1967 | 6.6 | 0.8 | 45 | 171 | 3110 | 346 |
| Michigan | 1971 | 6.5 | 0.9 | 56 | 202 | 2798 | 342 |
| South | 1962 | 6.3 | 1.1 | 49 | 134 | 1716 | 145 |
| West | 1967 | 6.2 | 1.2 | 73 | 156 | 1755 | 169 |
| Michigan | 1971 | 6.1 | 1.2 | 90 | 181 | 1636 | 170 |
| Average | 1962 | 6.6 | 0.7 | 35 | 135 | 2902 | 270 |
| for the | 1967 | 6.7 | 0.8 | 49 | 168 | 3244 | 339 |
| 5 regions | 1971 | 6.4 | 1.0 | 75 | 190 | 2503 | 298 |

The percentage of samples tested that occurred within various arbitrary pH ranges is given in Table 4. Generally, the percentage of samples testing below pH 5.9 increased from 1962-71, while the percentage testing above pH 6.5 decreased.

**Table 4. Distribution of soil pH values between various pH levels in the different regions of lower Michigan for 1962, 1967 and 1971**

| Region | Year | Range in pH Values: Below 4.9 | 5.0-5.4 | 5.5-5.9 | 6.0-6.4 | 6.5-6.9 | 7.0-7.4 | Above 7.4 |
|---|---|---|---|---|---|---|---|---|
| | | % of samples | | | | | | |
| Northern | 1962 | 0.5 | 2.9 | 12.6 | 34.8 | 32.4 | 14.5 | 2.4 |
| Lower | 1967 | 1.1 | 3.9 | 15.2 | 30.0 | 31.3 | 14.0 | 4.4 |
| Michigan | 1971 | 1.3 | 5.8 | 15.4 | 28.7 | 25.9 | 16.8 | 5.1 |
| West | 1962 | 3.3 | 11.9 | 26.7 | 31.9 | 14.8 | 8.6 | 2.9 |
| Central | 1967 | 4.4 | 6.6 | 19.8 | 31.5 | 24.6 | 10.4 | 2.6 |
| Michigan | 1971 | 2.9 | 9.0 | 24.3 | 32.9 | 19.7 | 8.1 | 3.1 |
| Thumb & | 1962 | 0.2 | 1.0 | 4.6 | 16.4 | 29.0 | 33.1 | 15.7 |
| Eastern | 1967 | 0.1 | 1.8 | 5.7 | 16.2 | 23.3 | 28.2 | 24.7 |
| Michigan | 1971 | 0.3 | 2.3 | 9.5 | 18.6 | 21.5 | 26.3 | 21.5 |
| South | 1962 | 0.3 | 4.1 | 12.2 | 31.4 | 31.4 | 17.0 | 3.7 |
| Central | 1967 | 0.5 | 2.5 | 14.2 | 25.3 | 29.4 | 17.8 | 10.3 |
| Michigan | 1971 | 0.6 | 4.6 | 15.4 | 27.5 | 27.6 | 16.4 | 7.9 |
| South | 1962 | 0.6 | 7.1 | 17.0 | 34.8 | 29.7 | 9.4 | 1.4 |
| West | 1967 | 7.7 | 5.6 | 13.8 | 30.2 | 30.0 | 10.3 | 2.3 |
| Michigan | 1971 | 4.6 | 6.9 | 24.2 | 31.9 | 32.3 | 8.3 | 1.9 |
| Average | 1962 | 0.5 | 3.4 | 9.6 | 24.5 | 29.3 | 23.5 | 9.1 |
| for the | 1967 | 1.4 | 3.0 | 10.7 | 22.2 | 26.2 | 21.1 | 15.3 |
| 5 regions | 1971 | 1.8 | 5.7 | 17.8 | 27.5 | 23.5 | 15.3 | 8.4 |

The increase in soil acidity is probably due to more intensive cropping and increased rates of fertilizer application, since nitrogen and phosphorus fertilizers are acid-forming when applied to the soil. About 2 lb of agricultural limestone (1.8 lb of pure calcium carbonate) are needed to neutralize the acidity produced by 1 lb of nitrogen (N) in all commonly used sources of nitrogen except ammonium sulfate and the ammonium phosphates.

Therefore, more than 320,000 T of agricultural limestone would be needed to neutralize the acidity produced only by the nitrogen fertilizers used in 1971. This is equivalent to more than 70% of the agricultural lime actually used in 1971 (Table 1). These comparisons illustrate the need for frequent soil testing and a well balanced soil management and fertilization program under intensive cropping systems.

### Available Soil Phosphorus

Available soil phosphorus tended to increase as the soil became coarser (Table 2). White and Doll (5) reported that more phosphorus fertilizer was needed on soils high in clay than on those high in sand. Average soil phosphorus levels also tended to be lower in predominantly clay soils than in sandy soils (Table 3).

The average soil phosphorus level in lower Michigan increased from 35 to 75 lb/A from 1962-71 (Table 3). This increase was consistent for all soil management groups (Table 2) and for all regions (Table 3). Data indicate that for all soils about 10 lb of $P_2O_5$ per acre are required to increase phosphorus soil tests 1 lb (5). Thus, 400 lb of $P_2O_5$ would be needed to increase soil tests from 35 to 75 lb.

If the average acreage of harvested cropland was 6,250,000 acres between 1962 and 1971 (7,000,000 acres in 1962 and 5,500,000 acres in 1971), a total of approximately 1,250,000 T of $P_2O_5$ would be needed for a 40-lb increase in phosphorus on harvested cropland over the 10-year period. Total recorded sales of phosphate fertilizer for this period were 1,251,216 T (Table 1). Consequently, about a 40-lb increase in the average level of phosphorus in the soil was expected from 1962-71.

The percentage of soil tests falling within various levels in the different regions (Table 5) indicates that the number of low tests (from 0-9 and 10-19 lb/A) has decreased from 1962-71, and that the number of samples testing high in phosphorus (above 100 lb/A) has increased. These trends would be expected since the rates of phosphorus application also increased during the same period.

Results obtained in Michigan indicate that responses to phosphorus fertilizers are not obtained for most crops when the soil tests are above 40 lb/A, and rarely are responses obtained for any crops when the soil tests are above 100 lb/A. On some coarse-textured Michigan soils significant downward movements of phosphorus from the upper to the lower horizons has been noted when the level of available soil phosphorus is above 100 lb/A. Other studies show that when soil erosion occurs, the eroded sediments tend to be higher in available phosphorus than the uneroded soil.

Thus results illustrate the fact that testing soils for available phosphorus is more important under more intensive cropping systems than under less intensive systems. The phosphorus levels in many fields are still low enough that large responses to phosphorus fertilizers can be expected. However, many fields have high levels of available phosphorus, and the need for more phosphorus fertilizer must be carefully evaluated by means of soil tests. Continued heavy use of phosphorus fertilizers on soils testing high in available phosphorus is neither economical nor compatible with present programs aimed at maintaining a balanced environment.

**Table 5. Distribution of available phosphorus values within various levels in the different regions of lower Michigan for 1962, 1967 and 1971**

| | | Range in Phosphorus Tests (lb/A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Region | Year | 0-9 | 10-19 | 20-39 | 40-69 | 70-99 | 100-149 | 150-199 | 200-299 | Above 300 |
| | | % of samples | | | | | | | | |
| Northern | 1962 | 11.4 | 28.6 | 29.0 | 14.8 | 7.1 | 6.0 | 2.4 | 0.5 | 0.2 |
| Lower | 1967 | 6.0 | 17.8 | 27.3 | 23.3 | 10.9 | 6.8 | 6.1 | 1.5 | 0.3 |
| Michigan | 1971 | 6.8 | 14.9 | 26.3 | 19.3 | 10.7 | 12.1 | 4.1 | 4.1 | 1.7 |
| West | 1962 | 1.9 | 11.4 | 8.6 | 11.9 | 13.3 | 27.6 | 18.6 | 4.3 | 2.4 |
| Central | 1967 | 4.8 | 13.1 | 23.6 | 21.8 | 10.1 | 12.1 | 8.4 | 4.2 | 1.9 |
| Michigan | 1971 | 2.2 | 5.1 | 13.3 | 18.8 | 14.3 | 18.0 | 12.3 | 10.8 | 5.2 |
| Thumb and | 1962 | 21.3 | 30.6 | 29.6 | 10.5 | 3.6 | 3.2 | 1.0 | 0.2 | 0.1 |
| Eastern | 1967 | 9.0 | 23.5 | 34.6 | 21.2 | 5.9 | 2.8 | 1.7 | 0.7 | 0.5 |
| Michigan | 1971 | 6.1 | 18.0 | 29.0 | 24.7 | 10.1 | 5.8 | 2.5 | 2.2 | 1.7 |
| South | 1962 | 16.9 | 29.9 | 30.9 | 12.7 | 4.9 | 3.3 | 1.0 | 0.3 | 0.1 |
| Central | 1967 | 11.7 | 22.2 | 29.3 | 19.4 | 7.3 | 5.6 | 3.1 | 0.8 | 0.5 |
| Michigan | 1971 | 5.3 | 15.5 | 31.2 | 24.2 | 10.6 | 7.1 | 3.0 | 2.1 | 1.0 |
| South | 1962 | 4.4 | 13.8 | 31.7 | 30.5 | 10.3 | 6.3 | 2.9 | 0.1 | 0.0 |
| West | 1967 | 1.4 | 8.4 | 25.6 | 29.2 | 14.9 | 9.7 | 6.5 | 2.5 | 1.8 |
| Michigan | 1971 | 1.1 | 4.8 | 14.9 | 28.9 | 20.5 | 16.6 | 6.5 | 4.2 | 2.5 |
| Average | 1962 | 16.9 | 27.7 | 29.3 | 13.6 | 5.3 | 4.7 | 2.0 | 0.4 | 0.2 |
| for the | 1967 | 8.4 | 20.3 | 30.7 | 21.7 | 8.0 | 5.4 | 3.5 | 1.3 | 0.8 |
| 5 regions | 1971 | 4.3 | 12.3 | 23.8 | 23.3 | 12.9 | 11.0 | 5.5 | 4.5 | 2.5 |

## Available Soil Potassium

Available (or exchangeable) soil potassium tended to be higher in soils with a high clay content than in those with a high sand content (Table 2). This trend is apparent, but not as clearcut, when the levels of soil potassium in the various regions are compared (Table 3). The average level of soil potassium in lower Michigan increased from 135 to 190 lb potassium (K) per acre from 1962-71 (Table 3). This trend was apparent for every soil management group (Table 2) and for each region (Table 3).

Results indicate that about 4 lb potash ($K_2O$) is needed to increase the potassium soil test by 1 lb (5). Following the same calculations previously used for phosphorus, potassium soil tests should have increased by about 100 lb/A instead of only 55 lb. However, potassium fixation may be quite significant in some soils (2). Recent data by Dr. John C. Shickluna indicate that in some sandy soils significant amounts of potassium may be leached below the plow layer in a relatively short time.

Also, plants will absorb greater amounts of potassium than needed for maximum yields if it is available in the soil. These factors tend to result in a lower average increase in potassium soil tests from this type of summary than would be measured in carefully controlled field experiments of the type reported by White and Doll (5).

The distribution of potassium tests within the various ranges (Table 6) show that the number of low potassium tests (below 110 lb) decreased during the 10-year period (1962 to 1971), while the number of high tests (above 250 lb) increased. Thus, the distribution of tests from the low to the high levels is becoming more uniform. This means that the need for frequent soil testing is becoming greater as the use of potassium fertilizer is increased.

## Available Soil Calcium

The average levels of calcium are higher in soils high in clay than those high in sand (Tables 2 and 3). Since calcium is the dominant basic cation in soils, calcium levels generally decrease as the soil becomes more acid. The distribution of calcium within various levels is given in Table 7. Even though soils occur in Michigan which contain less than 300 lb/A of available calcium, no nutrient deficiencies of calcium have been identified in Michigan field crops. Plant requirements are low in relation to the amounts of potassium and magnesium. Thus soils usually become strongly acid and develop toxic levels of aluminum and manganese before the level of calcium becomes limiting.

Soil tests for calcium are used, however, to help determine the need for magnesium, since the ratio of potassium and calcium to the level of magnesium is a critical factor in determining the need for magnesium.

## Levels of Soil Magnesium

Levels of available magnesium are lower in sandy soils than in soils high in clay (Tables 2 and 3). The distribution of magnesium between various levels (Table 8) indicates that a number of samples in northern and western Michigan contain less than 75 lb of exchangeable magnesium. Recent studies in Michigan show that magnesium deficiency may develop on soils testing less than 75 lb magnesium, especially when potassium and calcium levels are high.

**Table 6. Distribution of available potassium values within various levels in the different Michigan regions for 1962, 1967 and 1971**

| | | Range in Potassium Tests (lb/A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Region | Year | Below 60 | 60-109 | 110-159 | 160-209 | 210-249 | 250-299 | 300-399 | 400-499 | Above 500 |
| | | % of samples | | | | | | | | |
| Northern | 1962 | 29.8 | 39.8 | 16.4 | 7.6 | 2.4 | 1.0 | 1.2 | 1.2 | 0.7 |
| Lower | 1967 | 12.4 | 37.7 | 25.6 | 12.4 | 5.3 | 3.7 | 1.9 | 0.6 | 0.4 |
| Michigan | 1971 | 3.9 | 25.2 | 30.7 | 19.7 | 7.2 | 5.3 | 4.4 | 1.8 | 1.9 |
| North | 1962 | 3.8 | 19.5 | 20.5 | 28.1 | 13.8 | 7.6 | 4.3 | 0.0 | 2.4 |
| Central | 1967 | 4.3 | 19.4 | 28.4 | 21.5 | 10.6 | 8.6 | 4.8 | 1.3 | 1.2 |
| Michigan | 1971 | 1.6 | 16.8 | 27.7 | 22.2 | 12.1 | 10.1 | 6.7 | 1.6 | 1.2 |
| Thumb and | 1962 | 10.6 | 35.0 | 24.4 | 16.9 | 6.1 | 3.2 | 2.8 | 0.7 | 0.5 |
| Eastern | 1967 | 1.8 | 18.7 | 33.6 | 21.6 | 9.8 | 7.5 | 4.2 | 1.5 | 1.3 |
| Michigan | 1971 | 2.6 | 12.2 | 30.9 | 24.0 | 10.9 | 8.1 | 6.4 | 2.4 | 2.6 |
| South | 1962 | 8.3 | 41.5 | 24.3 | 14.2 | 4.1 | 2.4 | 2.6 | 1.3 | 1.3 |
| Central | 1967 | 2.6 | 22.0 | 32.0 | 20.3 | 9.2 | 6.4 | 4.2 | 1.6 | 1.7 |
| Michigan | 1971 | 0.5 | 12.3 | 28.5 | 24.6 | 11.8 | 9.7 | 7.4 | 2.7 | 2.4 |
| South | 1962 | 12.3 | 44.1 | 19.4 | 14.8 | 3.0 | 1.7 | 2.4 | 0.4 | 1.9 |
| West | 1967 | 6.6 | 25.6 | 29.2 | 18.3 | 8.5 | 5.8 | 4.1 | 1.2 | 0.7 |
| Michigan | 1971 | 2.4 | 18.9 | 29.6 | 21.0 | 11.9 | 7.0 | 5.8 | 2.2 | 1.3 |
| Average | 1962 | 11.5 | 37.5 | 23.0 | 15.6 | 5.2 | 2.8 | 2.6 | 0.9 | 1.0 |
| for the | 1967 | 3.4 | 21.6 | 31.7 | 20.3 | 9.2 | 6.8 | 4.1 | 1.4 | 1.3 |
| 5 regions | 1971 | 1.9 | 15.9 | 29.0 | 22.7 | 11.3 | 8.5 | 6.5 | 2.2 | 2.0 |

**Table 7. Distribution of available calcium values within various levels in different Michigan regions for 1962, 1967 and 1971**

| | | Range in Calcium Tests (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Region** | **Year** | **Below 300** | **300-499** | **500-749** | **750-999** | **1000-1999** | **2000-3499** | **3500-5999** | **6000-8999** | **9000-11,999** | **Above 12,000** |
| | | % of samples | | | | | | | | | |
| Northern | 1962 | 0.7 | 1.7 | 5.5 | 12.4 | 51.7 | 19.8 | 7.4 | 1.0 | 0.0 | 0.0 |
| Lower | 1967 | 1.8 | 4.5 | 5.4 | 13.0 | 44.0 | 23.0 | 5.4 | 2.9 | 0.1 | 0.0 |
| Michigan | 1971 | 2.0 | 4.9 | 7.7 | 12.3 | 38.7 | 25.4 | 6.7 | 2.0 | 0.2 | 0.2 |
| West | 1962 | 3.8 | 7.1 | 16.2 | 19.0 | 29.5 | 12.4 | 8.1 | 3.3 | 0.5 | 0.0 |
| Central | 1967 | 5.0 | 4.3 | 6.8 | 6.6 | 30.9 | 31.6 | 13.2 | 1.4 | 0.2 | 0.2 |
| Michigan | 1971 | 5.5 | 9.4 | 10.7 | 19.3 | 34.1 | 16.4 | 3.6 | 0.7 | 0.3 | 0.1 |
| Thumb and | 1962 | 0.3 | 0.2 | 0.9 | 1.3 | 14.5 | 39.2 | 31.7 | 9.3 | 2.0 | 0.5 |
| Eastern | 1967 | 0.2 | 0.3 | 0.7 | 1.0 | 10.8 | 32.2 | 40.9 | 10.6 | 2.9 | 0.3 |
| Michigan | 1971 | 0.4 | 0.7 | 1.3 | 2.4 | 14.2 | 35.7 | 35.3 | 7.9 | 1.4 | 0.9 |
| South | 1962 | 0.2 | 0.5 | 2.3 | 3.6 | 35.4 | 39.7 | 13.4 | 4.0 | 0.7 | 0.0 |
| Central | 1967 | 0.5 | 1.3 | 2.4 | 4.2 | 24.0 | 35.5 | 23.9 | 6.4 | 1.3 | 0.4 |
| Michigan | 1971 | 0.5 | 1.1 | 1.9 | 6.5 | 29.0 | 34.7 | 19.7 | 5.2 | 1.3 | 0.1 |
| South | 1962 | 0.4 | 1.3 | 8.6 | 12.6 | 53.9 | 17.8 | 3.3 | 1.7 | 0.4 | 0.0 |
| West | 1967 | 5.9 | 3.5 | 6.4 | 5.8 | 49.1 | 22.3 | 6.0 | 1.0 | 0.2 | 0.0 |
| Michigan | 1971 | 4.3 | 4.3 | 8.7 | 16.9 | 42.6 | 16.0 | 4.8 | 1.3 | 0.4 | 0.3 |
| Average | 1962 | 0.9 | 0.9 | 3.0 | 4.5 | 27.8 | 34.8 | 20.6 | 6.1 | 1.2 | 0.3 |
| for the | 1967 | 1.4 | 1.6 | 2.6 | 3.7 | 22.0 | 31.3 | 28.2 | 7.2 | 1.8 | 0.3 |
| 5 regions | 1971 | 2.0 | 3.2 | 4.9 | 9.7 | 29.4 | 27.9 | 17.6 | 4.1 | 0.9 | 0.3 |

**Table 8. Distribution of available magnesium values within various levels in different Michigan regions for 1962, 1967 and 1971**

| | | Range in Magnesium Tests (lb/A) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Region** | **Year** | **Below 25** | **25-49** | **50-74** | **75-99** | **100-149** | **150-199** | **200-399** | **400-599** | **600-799** | **Above 800** |
| | | % of samples | | | | | | | | | |
| Northern | 1962 | 5.0 | 13.6 | 15.5 | 16.0 | 16.0 | 13.3 | 16.2 | 3.6 | 0.7 | 0.2 |
| Lower | 1967 | 0.2 | 10.3 | 19.4 | 9.8 | 21.7 | 13.5 | 18.7 | 3.7 | 2.0 | 0.6 |
| Michigan | 1971 | 0.8 | 8.4 | 9.0 | 14.8 | 14.3 | 10.8 | 28.7 | 8.9 | 3.3 | 1.1 |
| West | 1962 | 1.9 | 15.7 | 17.1 | 21.9 | 10.0 | 8.1 | 15.7 | 6.2 | 1.9 | 1.4 |
| Central | 1967 | 1.1 | 5.5 | 9.7 | 6.5 | 13.4 | 12.3 | 27.6 | 16.9 | 5.3 | 1.7 |
| Michigan | 1971 | 1.9 | 15.7 | 15.5 | 11.6 | 15.0 | 10.0 | 21.9 | 5.9 | 1.5 | 1.8 |
| Thumb and | 1962 | 0.6 | 1.9 | 2.0 | 3.2 | 6.4 | 10.9 | 43.8 | 23.3 | 5.4 | 2.6 |
| Eastern | 1967 | 0.1 | 0.7 | 1.6 | 2.0 | 4.5 | 5.5 | 35.8 | 35.0 | 11.5 | 3.4 |
| Michigan | 1971 | 0.2 | 1.9 | 1.6 | 1.7 | 5.1 | 4.7 | 33.1 | 32.5 | 12.7 | 6.5 |
| South | 1962 | 0.8 | 2.8 | 6.7 | 8.9 | 12.6 | 14.8 | 35.4 | 13.4 | 3.6 | 1.2 |
| Central | 1967 | 0.0 | 1.4 | 3.3 | 3.6 | 10.5 | 10.0 | 38.4 | 20.5 | 8.3 | 4.0 |
| Michigan | 1971 | 0.1 | 0.9 | 3.0 | 3.7 | 10.0 | 10.8 | 39.2 | 20.3 | 7.2 | 4.8 |
| South | 1962 | 3.0 | 10.3 | 13.0 | 18.8 | 19.3 | 14.3 | 17.8 | 2.6 | 0.6 | 0.4 |
| West | 1967 | 2.0 | 6.8 | 10.7 | 10.3 | 23.8 | 17.3 | 23.3 | 3.9 | 1.0 | 0.7 |
| Michigan | 1971 | 0.5 | 7.9 | 14.5 | 16.0 | 19.3 | 17.4 | 17.2 | 4.5 | 1.3 | 1.3 |
| Average | 1962 | 1.7 | 4.4 | 5.9 | 8.0 | 10.3 | 12.5 | 35.5 | 16.1 | 3.9 | 1.7 |
| for the | 1967 | 0.4 | 2.7 | 5.0 | 4.2 | 10.0 | 9.0 | 33.0 | 24.4 | 8.4 | 2.9 |
| 5 regions | 1971 | 0.6 | 5.3 | 7.2 | 7.7 | 11.5 | 10.3 | 29.8 | 17.6 | 6.4 | 3.7 |

Since 1965, the use of dolomitic limestone has been recommended to correct this situation on acid soils. Since that time, the number of soils testing low in magnesium has decreased markedly (Table 8). A complete soil test is needed for a proper diagnosis of the magnesium status.

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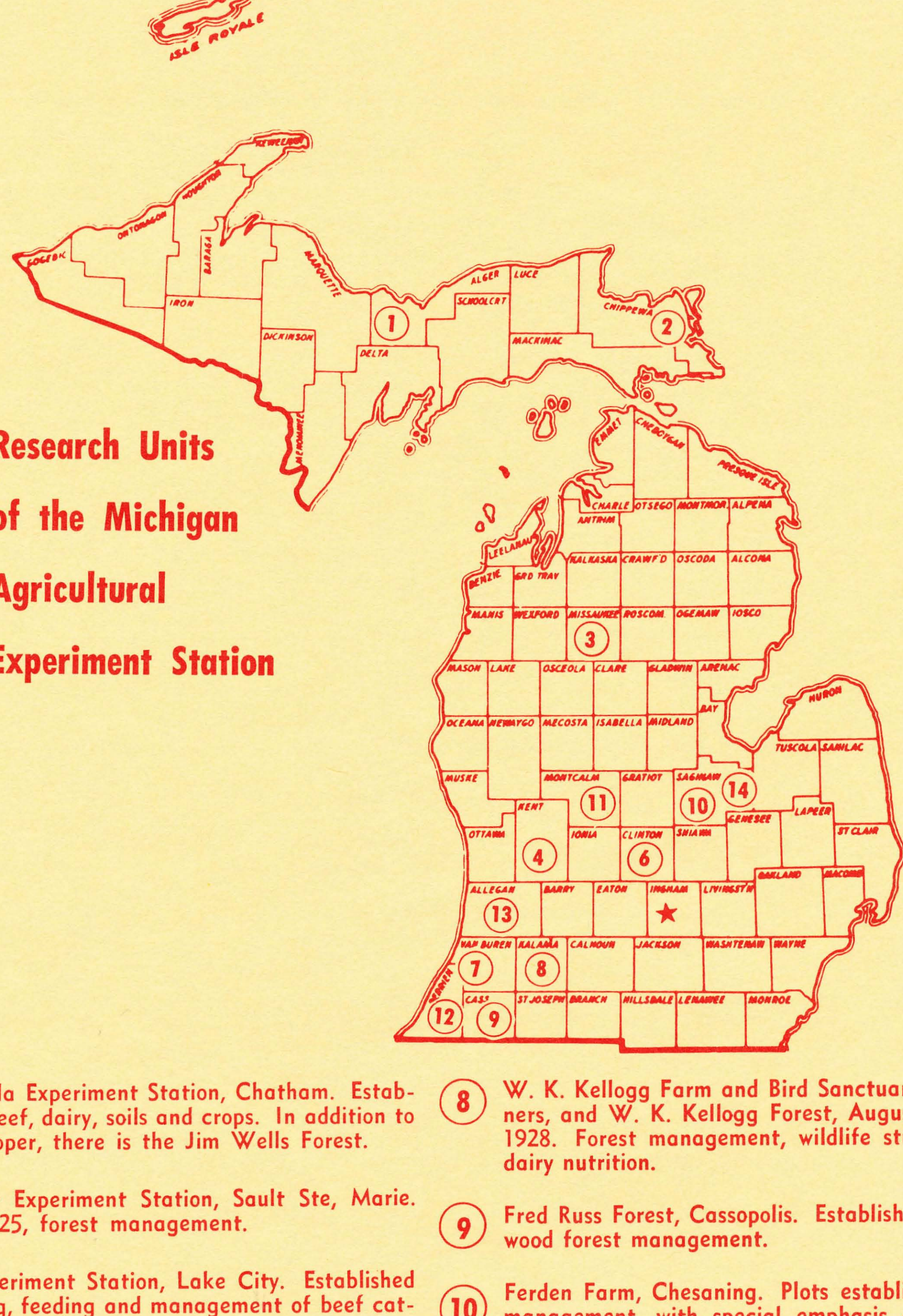


# Research Units of the Michigan Agricultural Experiment Station

(1) Upper Peninsula Experiment Station, Chatham. Established 1907. Beef, dairy, soils and crops. In addition to the station proper, there is the Jim Wells Forest.

(2) Dunbar Forest Experiment Station, Sault Ste, Marie. Established 1925, forest management.

(3) Lake City Experiment Station, Lake City. Established 1928. Breeding, feeding and management of beef cattle; and fish pond production studies.

(4) Graham Horticultural Experiment Station, Grand Rapids. Established 1919. Varieties, orchard soil management, spray methods.

★ Michigan Agricultural Experiment Station, Headquarters, 101 Agriculture Hall, MSU, East Lansing. Established 1888. Research work in all phases of Michigan agriculture and related fields.

(6) Muck Experimental Farm, Laingsburg. Plots established 1941, crop production practices on organic soils.

(7) South Haven Experiment Station, South Haven. Established 1890. Breeding peaches, blueberries, apricots. Small fruit management.

(8) W. K. Kellogg Farm and Bird Sanctuary, Hickory Corners, and W. K. Kellogg Forest, Augusta. Established 1928. Forest management, wildlife studies, mink and dairy nutrition.

(9) Fred Russ Forest, Cassopolis. Established 1942. Hardwood forest management.

(10) Ferden Farm, Chesaning. Plots established 1928. Soil management, with special emphasis on sugar beets. (Land Leased)

(11) Montcalm Experimental Farm, Entrican. Established 1966. Research on crops for processing, with special emphasis on potatoes. (Land Leased)

(12) Sodus Horticultural Experiment Station, Sodus. Established 1954. Production of small fruit and vegetable crops. (Land Leased)

(13) Trevor Nichols Experimental Farm, Fennville. Established 1967. Studies related to fruit crop production with emphasis on pesticides research.

(14) Saginaw Valley Beet and Bean Research Farm, Saginaw. Established 1971. Studies related to production of sugar beets and dry edible beans in rotation programs.

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