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# A Study of the Uniformity of Soil Types and of the Fundamental Differences Between the Different Soil Series

By

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For your Service -
L. G. Bracken

# A Study of the Uniformity of Soil Types and of the Fundamental Differences Between the Different Soil Series


By

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## ABSTRACT

In a laboratory and greenhouse study of the uniformity of soil types and of the fundamental differences between the different soil series of Alabama, experimental work was done on the following soils: twenty-two soils of the Norfolk series, 16 soils of the Greenville series, 4 soils of the Amite series, 3 soils of the Akron series, 22 soils of the Decatur series, 22 soils of the Hartsells series, 21 soils of the Cecil series, and one Davidson clay soil. Laboratory studies included the following determinations and analyses on both the surface and subsoils: (1) complete mechanical analyses, (2) colloidal clay content, (3) separation and chemical analyses of the colloidal clay fraction, (4) total base exchange capacity and exchangeable hydrogen, calcium, and magnesium, and (5) total $P_2O_5$ content, in addition to determinations of, (6) the organic matter content of the surface soil, (7) the hydrogen-ion concentration, (8) the lime required to bring the reaction to pH 6.50, and (9) the readily available $PO_4$ content by Truog's method and by a modification of his method of all surface soils and those subsoils on which greenhouse studies were made. Greenhouse studies included seven fertilizer treatments on duplicate pot cultures of all surface soils and on selected subsoils of each soil series. Three successive crops, one of Austrian winter peas (*Pisum arvense*) and two of sorghum (*Andropogon sorghum*), were grown on the pot cultures of all soils in the greenhouse. The greenhouse investigations were so designed that by comparing the yield in response to each of the different fertilizer treatments to the yield in response to the complete (N P K) fertilizer treatment on each of the soils, the crop response to each of the following fertilizer treatments could be determined: (1) potash, (2) phosphate, (3) lime, (4) residual phosphate without lime, (5) residual phosphate with lime, (6) minerals (phosphate and potash), and (7) nitrate on the limed cultures.

The characteristics of the soil profile of each of the different soil series are sufficiently distinct and different as observed in the field to warrant the classification as it exists.

The results of the mechanical analyses show that the subdivision of types, i. e., the classification into sandy loam, fine sandy loam, very fine sandy loam, etc., by field examination is often in error.

As determined in the laboratory, the physical and chemical properties of the soils of a given soil type were generally quite variable. In fact, the only physical and chemical properties of soils in which a significant difference existed between various soil types were those that could be directly attributed to wide differences in the textural properties of the soil type or to some more apparent difference between soil series such as (1) a varia-

tion in kind of materials from which the soils were derived, (2) an observable difference in the degree of maturity of the soil profile, (3) distinct differences in the climatic conditions under which the soils are formed.

Although crop adaptability and productiveness of soils are in general associated with soil type, within the limits of the series and types studied in this investigation the variation in the yields obtained in response to the various fertilizer treatments on the soils of a given soil type was greater than that occurring between the soils of the different soil series. In other words, the results of a fertilizer test conducted on one or a few soils of a given type are not necessarily more accurately applicable to other soils of the same type than they are to soils of other soil types.

## ACKNOWLEDGMENT

The work of this investigation in soils has been done on a co-operative project between the Alabama State Department of Agriculture and the Alabama Experiment Station. The author wishes to express his sincere appreciation for the kindly criticisms and helpful suggestions of Mr. J. F. Stroud of the State Soil Surveys and Dr. J. W. Tidmore of the Alabama Experiment Station, in cooperation with whom this work has been carried out. Appreciation for assistance or cooperation in this work is also expressed to Mr. L. G. Brackeen and Mr. M. E. Stevens, of the State Soil Surveys, who assisted in choosing and collecting the soils; to Prof. George D. Scarseth, Alabama Polytechnic Institute, and Mr. R. Y. Bailey, Alabama Experiment Station, who made the photographs of the greenhouse crops; and to Messrs. C. L. McIntyre, W. W. Jones, Foy C. Helms, Earl Solomon, and Charles F. Simmons, who as students in the Alabama Polytechnic Institute, assisted with the greenhouse work.

# A Study of the Uniformity of Soil Types and of the Fundamental Differences Between the Different Soil Series*

## INTRODUCTION

THE SOILS of the United States are classified and mapped in the field on the basis of the characteristics of the soil *in situ*. The character of the entire soil profile, from the surface to the underlying parent material from which the soil is derived, is considered in differentiating one soil series from another. The term "soil series" has been defined as "a category of soils having the same character of profile (the same general range in color, consistency, density, composition, reaction, and other features of each horizon and the same sequence of horizons), the same general conditions of relief and drainage, and usually a common or similar origin and mode of formation, which differs only in the texture of the surface soils." A soil type includes all those soils of a series whose surface soils fall within the same textural class (5)†.

Thus, all the soils of a type, in relation to those of another type, are uniform in those external characteristics directly observable in the field. In experimental fertilizer work it has often been assumed that the results of a fertilizer test on a given soil type are applicable to all the soils representing that type. If this is true it becomes a matter of considerable interest to know with what degree of accuracy recommendations for fertilizing practices on all the soils of a given type may be made from the results of fertilizer tests on one or a few soils of that type. It should be remembered that no attempt is made in the soil surveys to classify soils according to their fertility needs. These surveys report only the crops for which the soils are suited and the general average yields obtained.

The soils of any given series differ from those of other series in some one or more of the soil characteristics directly observable in the field other than the texture of the surface horizon. Thus within a given area some characteristic of the profile such as the color or the texture and consistency of the B horizon differentiates one series from another. Some series are found only on bottom lands, some only on river terraces, and some only on lands of greater altitude. Soils of two series whose differentiating characteristics are directly attributable to the difference in the parent materials from which they were developed are often found adjoining each other. The relation between certain soil characteristics as observed in the field and the soil's

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†Numbers in parentheses refer to Literature Cited.

fundamental characteristics seems quite obvious as, for example, the kind of materials from which the coastal plains soils are developed and their generally low level of fertility. Others are less well known. Certain differences in the fundamental properties of series differing widely in their field characteristics, such as the Decatur and Hartsells series, are generally well known. However, just what are the fundamental characteristics of more closely associated series, such as the Norfolk and Greenville series of the coastal plain, and just how they differ, is not so well known. In Alabama where the soils of practically the whole state (see Figure 1) have been surveyed, it would seem desirable to know more of the fundamental soil characteristics of the series which affect their fertility.

All the factors affecting plant growth that are influenced or determined by soil properties or conditions may be placed into one or another of the following classes: (1) water supply, (2) air supply, (3) temperature, (4) supply of plant nutrients, and (5) various injurious factors. Except where irrigation is practiced the first three of the factors listed are largely non-controllable. The last two classes include all those properties or conditions of the soil which constitute the factors of soil fertility. The effect of these factors upon the plant may result in differences in the rate of growth, the amount of yield obtained, or the type or other characteristics of growth. The rate of growth and the amount of yield obtained are both subject to quantitative measurement, and, with certain limitations upon their interpretation, are generally accepted as measures of soil fertility. Numerous laboratory methods for studying the soil properties which affect soil fertility have been developed. How closely the results of many of these laboratory methods are correlated to actual crop performance on the soil has not been determined. A comparison of the results of laboratory and greenhouse methods of studying the factors of soil fertility should be useful in evaluating the laboratory methods. The investigations herein reported were designed for the purpose of determining the fundamental characteristics of soil types, the degree of uniformity and the differences between important soil types in regard to these characteristics, and the relation between these characteristics and the factors limiting crop production.

## OBJECTIVES OF THE INVESTIGATION

The general objective of the investigation was to conduct fundamental chemical and greenhouse experiments on soils in order to obtain information bearing on soil formation, soil classification, and soil productivity. The detailed objectives were as follows:

(1) To determine the fundamental characteristics of the important soil types of the State.

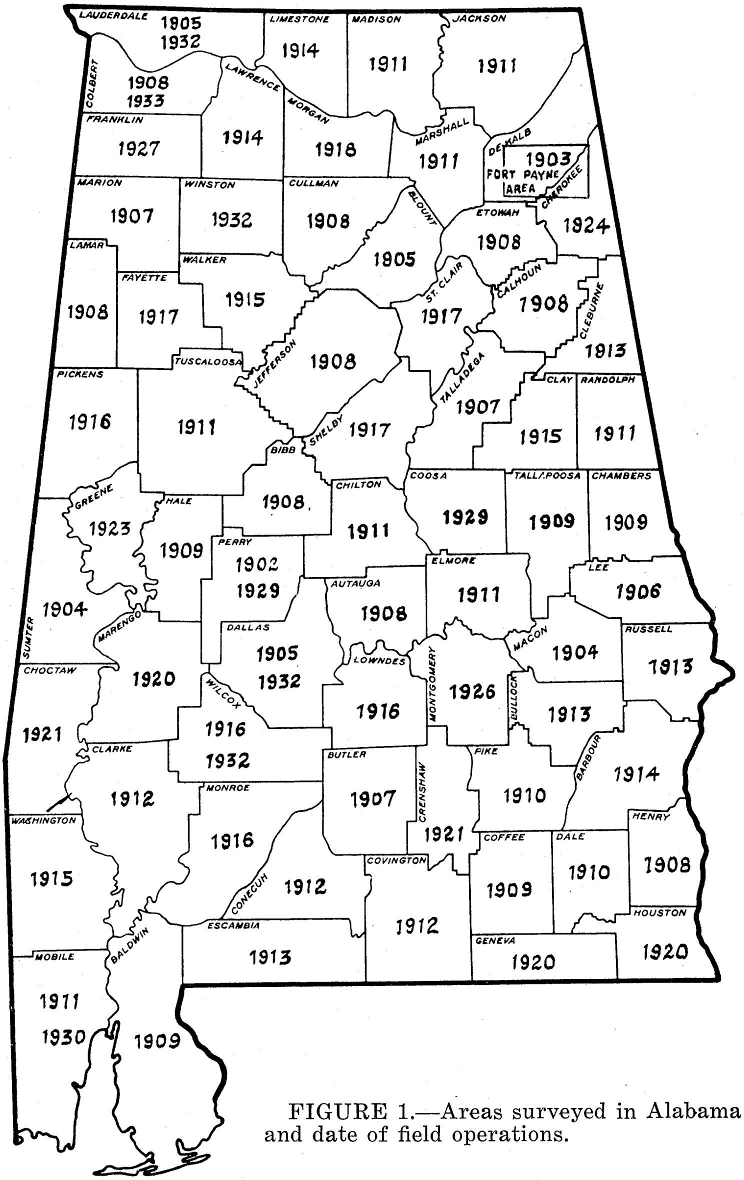



FIGURE 1.—Areas surveyed in Alabama and date of field operations.

(2) To study the uniformity of soils throughout given soil types.

(3) To study the many factors limiting crop production on important soil types.

The data obtained under the first of these objectives should show the important differences between the different soil types;

the second should show the degree of accuracy with which experimental results obtained on a given soil type in one locality may be applied to all the soils of that soil type; and the third which was largely greenhouse work provides an opportunity to determine the correlation between crop growth and the results of the various chemical studies in the laboratory.

## DESCRIPTION OF SOILS STUDIED

Based upon the widely different geological formations in the state, the soils of Alabama may be divided into five general soil provinces. They are as follows: (1) the coastal plains, (2) the Piedmont plateau, (3) the Appalachian mountains and plateaus, more commonly referred to as "Sand mountain," (4) the limestone valleys and uplands, and (5) the river terraces and flood plains. Within these five general areas there have been mapped in Alabama approximately two hundred soil types. Many of these are of little significance since they constitute non-agricultural lands. Others occur in such small areas that they are of little importance to the agriculture of the State. On the other hand, a relatively small number of these soil types make up the bulk of the important agricultural lands of the State. This is due to the fact that these soil types are always arable and productive soils and that they occur over comparatively large areas. The more important of these soil types were chosen for study in this investigation. Those on which the studies have been completed and are reported herein include the types of most agricultural value of the following soil series: (1) Norfolk, (2) Greenville, (3) Hartsells, (4) Decatur, and (5) Cecil. Short descriptions of these soils are given below.

**The Norfolk Series.**—The soils of the Norfolk series are the gray, well-drained, upland soils of the coastal plains having a yellow or pale-yellow subsoil. The textural composition of the soils of this series ranges through practically all the classes of sandy loams, sands, and loamy sands. The fine sandy loam, fine sand, and loamy fine sand occur over larger areas in the State than do other types of the Norfolk series. These three types constitute the largest portion of the agriculturally valuable soils of the Norfolk series in Alabama.

The surface soil of the Norfolk fine sandy loam is a gray, fine sandy loam passing at a depth of 4 to 8 inches into a pale-yellow loamy fine sand or fine sandy loam which extends to a depth of 10 to 15 inches. The typical subsoil is a yellow, friable, fine sandy clay.

The Norfolk fine sand consists of a gray fine sand to a depth of 4 to 8 inches. The subsoil is a pale-yellow, loose fine sand. Where this type occurs upon ridges the surface soil is usually light gray having a loose incoherent structure; on the lower lying areas it is darker and more loamy.

The Norfolk loamy fine sand is similar to the fine sand in profile but is differentiated from the fine sand on the basis of the textural composition of the surface soil. In some instances the subsoil may be very similar to that of the fine sandy loam.

**The Greenville Series.**—The Greenville series includes the red or reddish-brown, well-drained upland soils of the coastal plain which have a deep-red, friable sandy clay subsoil extending to a depth of 3 to 8 feet. These are probably the best cotton soils of the coastal plain and are practically all under cultivation. Except on relatively small areas from which the sandy loam surface has been eroded, the surface soil of the Greenville series is texturally sandy loam or loamy sand.

The surface soil of the Greenville fine sandy loam is a brownish-red or reddish-brown fine sandy loam to a depth of 6 to 10 inches. In wooded areas this surface soil is a dark-brown loamy fine sand to a depth of 3 or 4 inches underlain to an average depth of about 10 inches by reddish-yellow or yellowish-red fine sandy loam. The typical subsoil is a deep-red, friable, fine sandy clay or sandy clay loam of uniform color and texture to a depth of 3 to 8 feet. The sandy loam and loamy sand differ from the fine sandy loam only in the percentage of the various sand separates present.

Soils having a profile very similar to that of the Greenville series occur on the higher portions of the Alabama river terrace. The profile differs but little from that of the Greenville soils other than that there is more or less water-rounded gravel present in the various horizons. Occasionally, well-defined layers of this gravel occur in the substratum. In the more recent soil survey reports these soils have been separated and mapped as the Amite series.

The soils of the Akron series occur in the upper portion of the coastal plain and differ from the Greenville series in that their subsoils are distinctly heavier.

**The Hartsells Series.**—Soils of the Hartsells series occupy the broad plateaus, narrow crests of ridges, and small, narrow plateaus of the Appalachian mountains. These soils have been mapped as the Dekalb series in the earlier county surveys. Although they range in type from the stony loam through the finer sandy loams, the fine sandy loam is the prevailing type and the most extensively cultivable soil in the area.

The Hartsells fine sandy loam to a depth of 6 to 10 inches consists of a pale-yellowish to light-brownish gray, heavy, fine sandy loam. The subsoil is a yellow to yellowish-brown, friable, clay loam containing approximately 50 per cent or more of sand. The entire area of Hartsells soils is underlain at an average depth of 4 to 6 feet by a sandstone which outcrops in many places, particularly along the breaks developed along the small mountain streams and at the rim or edges of the plateaus and ridges.

The Hartsells soils are not naturally fertile soils, but due to a relatively intensive cultivation and the fairly liberal use of commercial fertilizer they support the densest rural population in Alabama.

**The Decatur Series.**—The soils of the Decatur series are the so-called "red-lands" of the limestone valleys. Their characteristic topography is gently rolling and both the surface and subsoil drainage is adequate. Although they occur only in the valleys of the area of limestone soils, they are subject to more or less erosion. Due to the extent to which they have been surface-eroded, many of these soils are texturally in the clay class, although they originally were predominantly clay loams.

Under cultivation the surface soil of the Decatur clay loam to a depth of from 4 to 6 inches is dark red or reddish-brown clay loam. In wooded areas the surface soil consists of a 2- to 3-inch layer of dark reddish-brown loam which grades into a reddish-brown clay loam extending to a depth ranging from 6 to 10 inches. This surface material is mellow and friable when dry, but it is sticky and heavy when wet. The subsoil to a depth ranging from 4 to 8 feet is a rather heavy and stiff deep-red or maroon-red clay. Under normal moisture conditions this subsoil has a typical irregular-shaped crumbly lump structure. Small rounded, soft iron or manganese pebbles are usually present throughout the soil profile but are most numerous in the upper subsoil.

**The Cecil Series.**—The Cecil series includes the mature soils of the Piedmont plateau which are derived from acid igneous rocks, principally gneiss and granite. On level to gently rolling uplands and ridges a sandy loam surface is always developed. Clay loams and stony loams naturally occur on the more rolling and rougher areas. Unless they are well terraced when brought under cultivation these soils are rapidly eroded. As a result of erosion the sandy loam surface of large portions of the area of Cecil soils has been removed. Where this has occurred the characteristic red clay subsoil is exposed to the surface and constitutes over large areas what is now termed Cecil clay.

The surface soil of Cecil sandy loam under cultivation is a light-gray, light-brown, or brownish-gray sandy loam having a depth of from 6 to 8 inches. To a depth of from 30 to 36 inches the subsoil is a characteristic stiff but brittle red clay containing appreciable quantities of quartz sand and small flakes of mica. Below this is a lighter red or yellowish-red friable and often micaceous clay of varying thickness which grades into the soft disintegrated gneiss or granite rock.

## EXPERIMENTAL PROCEDURE AND METHODS

**In the Field.**—As a source of soil material for the laboratory and greenhouse work, 500-pound samples of the soil series to be studied were collected in the field from each of twenty-two or twenty-three locations. These samples were taken from the main areas of occurrence of the soil in the State and were chosen as being representative of the area from which they were taken. Notes were made in the field regarding the location of the sample, the local topography, the nature of any nearby outcroppings of rock, and insofar as it was possible and convenient to obtain it, a record of the previous fertilizer applications to the soil.

In collecting the surface-soil samples the surface soil to a depth of from 4 to 8 inches, depending upon its depth, was taken. Care was taken to avoid collecting samples from places where local variations in the soil would affect the sample. The areas directly under crop rows where large, undisturbed fertilizer residues existed, as is often the case in cotton fields, or such localized areas as old stump holes, etc., were the most frequently encountered localized variations in the soil that were avoided. In addition to the 500-pound samples of twenty-two or twenty-three surface soils, 500 pounds of subsoil was collected from three of the locations for each series of soils. These large samples were taken for the greenhouse work. From those locations from which large amounts of subsoil were not taken, small samples of the subsoil were collected. These were to be used for the laboratory work. In order to avoid excessive drying, these small samples were placed directly into 2-quart fruit jars, capped, and transported to the laboratory. In taking the subsoil samples proportional quantities of the B or $B_1$ horizon to a depth of 24 inches were collected.

The soils of a single series, or of one or more similar series, were studied at the same time. Thus, the Norfolk soils were studied during the year from October 1, 1929 to September 30, 1930; the Greenville soils, 1930-1931; the Decatur soils, 1931-1932; the Hartsells soils, 1932-1933; and the Cecil soils, 1933-1934. The soils were usually collected in the field during the fall months. The samples chosen were bagged and shipped to Auburn. Preparation of the samples and laboratory and greenhouse studies of them were carried on throughout the remainder of the year.

**In the Laboratory.**—A representative quart sample of each soil was taken for the laboratory studies. These laboratory samples were passed through a 2-mm. screen and all particles of stone or gravel larger than fine gravel were removed. After partial air-drying, these samples were kept in quart fruit jars sealed with cap and jar ring and were used for all laboratory analyses with the exception of the extraction of the colloidal fraction. The samples for the extraction of the colloidal fraction were taken directly after the first screening. In the cases where large amounts of subsoils for greenhouse work had not been collected, the subsoil samples for laboratory analyses and extraction of the colloidal fraction were supplied by the samples collected in 2-quart fruit jars in the field.

The laboratory studies have included determinations of pH values, lime requirements, complete mechanical analyses and colloidal-clay content of surface and subsoils, organic-matter content of surface soils, extraction and chemical analysis of the colloidal fractions of both the surface and subsoils, total base exchange capacity of surface and subsoils, exchangeable hydrogen, calcium, and magnesium of surface and subsoils, readily available phosphate, and total phosphoric acid content.

The pH value, buffer capacity, and lime requirement were determined by the method developed by Pierre and Worley (18). In the laboratory work on the Hartsells and Cecil soils the use of the collodion bag was omitted from the method and the hydrogen-ion concentration was determined with the glass electrode.

The mechanical analyses of the Norfolk soils were made according to the method of the U. S. Bureau of Soils and conform to the standards for the classification of soils on the basis of mechanical analysis as given by Davis and Bennett (10). All the other mechanical analyses were made by the pipette method described by Olmstead, Alexander, and Middleton (16). In the latter method the organic-matter content was determined by hydrogen peroxide solution loss and the colloidal clay by sedimentation.

The colloidal material for chemical analysis was separated from the soil by the method usually followed in this laboratory. Between two and three kilograms of soil, depending upon the amount of clay present, was placed in an electrically driven, 10-gallon-capacity barrel churn. Five gallons of distilled water was added and the suspension made slightly alkaline with ammonia water. The suspension was "churned" for a period of seven to eight hours, usually from about 10:00 a. m. until 5:00 p. m. The churn was stopped in an upright position and the suspension allowed to stand overnight. The following morning the suspension was siphoned off and passed through the supercentrifuge. This usually provided an adequate quantity of colloidal material. Occasionally, however, it was found that satisfactory dispersion of the colloidal material had not been obtained. In these instances it was generally found that the reaction of the suspension was neutral or slightly acid after churning. This could be due to the fact that the total acidity of the soil was not immediately neutralized by the ammonia. When this condition occurred, the residue collected in the centrifuge bowl was returned to the churn and after adding another five gallons of distilled water and more ammonia water the churning was repeated. The centrifuged suspension was concentrated by filtering off part of the water with Pasteur-Chamberlain ultra-filters, and the whole sample finally reduced to dryness and dried in the oven at 110° C. These dried samples were ground to pass a 100-mesh screen and preserved for use in closed sample bottles.

Chemical analysis of the colloidal material was made by the fusion method as described by Robinson (19).

The total base exchange capacity and exchangeable hydrogen, calcium, and magnesium were determined by the method of Conrey and Schollenberger (7). The total electrodialysable bases and the electrodialysable calcium of the Norfolk soils were determined by dialysing for a 48-hour period in the Bradfield three-compartment type electrodialysis cell.

The readily available phosphate of all the soils on which greenhouse studies were made was determined by Truog's method (24) and by a modification of the method (9).

Total phosphoric acid was determined volumetrically by the magnesium nitrate fusion method.

In addition to the general physical and chemical studies of all soils made as outlined above, determinations by continuous water extraction were made of the water-soluble phosphate, calcium, and potassium of the Norfolk soils. In the water extraction procedure 80 grams of soil was placed inside a collodion bag and 200 cc. of distilled water was added inside the bag and 200 cc. outside. After standing for periods of 24 hours or multiples thereof the solution outside the bag was siphoned off and fresh distilled water added. The phosphate, calcium, and potassium in the solutions thus obtained were determined. The continuous water extraction was continued for a period of twenty days.

The data obtained on all the soils by these methods are given in full in the tables in the appendix.

**In the Greenhouse.**—In the greenhouse, the entire lot of each 500-pound sample of soil was shoveled over a coarse screen to remove plant debris and the coarser gravel and stone. When lumps were present, they were crushed and all the soil was passed through the screen. The screened soil was thoroughly mixed. Fourteen pot cultures of each soil were prepared by weighing out the soil into two-gallon glazed pots. Nine kilograms of the sand and sandy loam soils, and 8 kilograms of the clay and clay loam soils were used. Before planting the pot cultures the lime requirement of each soil was determined in the laboratory.

Three successive crops were grown on each soil. On all except the Greenville soils the first crop grown was Austrian winter peas (*Pisum arvense*) which was followed by two successive crops of sorghum (*Andropogon sorghum*). Due to the date when the Greenville soils were first prepared for planting, the order of planting had to be changed so as to have the Austrian winter peas growing on the pot cultures during the fall and winter months. In preparing the soil in the pot cultures for planting after a crop had been previously grown on them, the soil was taken from the pots, the roots removed, and the soil from each pot thoroughly mixed before the next crop was planted.

The fourteen pot cultures provided duplicate cultures of seven fertilizer treatments. The fertilizer treatments for the three consecutive crops can be schematically represented as follows:

| *Pot No.* | *First Crop Peas* | *Second Crop Sorghum* | *Third Crop Sorghum* |
|---|---|---|---|
| 1 and 2 | N | N | N |
| 3 and 4 | N P | N P | N P |
| 5 and 6 | N K | N K | N K |
| 7 and 8 | N P K | N P K | N P K |
| 9 and 10 | P K | N K (Residual P) | N K (Residual P) |
| 11 and 12 | N P K L | N P K (Residual L) | N P K (Residual L) |
| 13 and 14 | P K L | N K (Residual P and L) | N K (Residual P and L) |

For the first crop, which was peas on all except the Greenville group of soils, the symbols denote fertilizer treatments and rates of applications as follows:

N = 150 pounds of C.P. $NaNO_3$ per acre,

P = 400 pounds of an 18%, commercial grade of superphosphate per acre,

K = 50 pounds of C.P. KCl per acre, and

L = Precipitated $CaCO_3$ to pH 6.50.

The pH values of the soils and the amounts of calcium carbonate per acre required to bring the soils to pH 6.50, as determined by the lime-requirement method in the laboratory, are given in the tables in the appendix. All fertilizer treatments were calculated on the basis of 2,000,000 pounds of surface soil per acre.

On the Greenville soils on which the cropping sequence was sorghum, sorghum, and Austrian winter peas, the phosphate was applied to the first crop at the rate of 800 pounds of superphosphate per acre, and pot cultures Numbers 9, 10, 13, and 14 received nitrate at the same rate as the other pot cultures. The fertilizer treatments of the following crops were changed slightly in order to study the effect of residual phosphate with and without lime. Consequently, for the second and third crops the symbols denote fertilizer treatments and rates of applications as follows:

N = C.P. $NaNO_3$, 150 pounds per acre at planting time and a top dressing of 500 pounds per acre applied in solution four weeks after planting,

P = 800 pounds of an 18%, commercial grade of superphosphate per acre,

K = 50 pounds of C.P. KCl per acre,

Residual P = No phosphate added other than application made at planting of first crop, and

Residual L = Limed to pH 6.50 at planting of first crop.

On the Greenville soils where Austrian winter peas were grown as the third crop the phosphate was applied to the pot cultures receiving phosphate at the rate of 400 pounds of superphosphate per acre.

In all applications of the fertilizer to the soil in the pot cultures the soil was emptied from the pots into a tub and the lime and superphosphate carefully mixed into the soil. The soil was returned to the pot and the pot cultures planted. The nitrate of soda and muriate of potash were then applied in solution before the first watering.

When the plants were a few inches high, all cultures were thinned to a stand of ten plants to the pot for the Austrian winter pea crop and seven plants to the pot for the sorghum crops. The difficulty encountered in obtaining uniform stands of the crops was negligible.

The growing crops were given daily attention and were watered as often as was necessary to maintain the pot cultures at as near optimum moisture conditions as possible. Rainwater collected in a storage tank from the roof of a nearby building was used in watering the crops. The greenhouse was heated with a steam heating system during the coldest winter weather. During the summer it was painted and was ventilated through roof and wall ventilators to prevent excessively high temperatures.

Photographs were made of representative pot cultures of the sorghum crops on enough soils of each series to show the range of response to the various fertilizer treatments. Some of these are reproduced as plate illustrations in the discussion of the results of the greenhouse work.

The crops were harvested when the plants on the majority of fertilizer treatments ceased vegetative growth. Continuation of the growing period after this time would only increase the difference between the respective yields obtained from the different fertilizer treatments. A summary of the crops grown, the date of planting, the date of harvesting, and the number of days they were grown on each of the groups of soils is given in Table 1.

**TABLE 1.—Crops Grown in the Greenhouse—Date Planted, Date Harvested, and Number of Days Grown.**

| Soil | First crop*—Austrian winter peas | | | Second crop—sorghum | | | Third crop*—sorghum | | |
|---|---|---|---|---|---|---|---|---|---|
| | Date planted | Date harvested | Number of days grown | Date planted | Date harvested | Number of days grown | Date planted | Date harvested | Number of days grown |
| Norfolk | 12/13/29 | 3/18/30 | 96 | 4/25/30 | 6/21/30 | 57 | 7/ 5/30 | 8/23/30 | 49 |
| Greenville | 4/22/31 | 6/27/31 | 66 | 7/ 4/31 | 9/24/31 | 82 | 10/ 3/31 | 12/15/31 | 73 |
| Hartsells | 1/11/32 | 3/11/32 | 59 | 3/19/32 | 6/ 4/32 | 77 | 6/ 9/32 | 12/15/32 | 67 |
| Decatur | 11/ 5/32 | 1/18/33 | 74 | 2/ 2/33 | 5/ 8/33 | 96 | 5/25/33 | 8/10/33 | 77 |
| Cecil | 10/ 2/33 | 3/ 9/34 | 125 | 3/19/34 | 6/25/34 | 98 | 6/30/34 | 9/24/34 | 86 |

*Due to the date of the first planting, the first crop on the Greenville soils was sorghum and the third crop was Austrian winter peas.

## DISCUSSION OF RESULTS

### Laboratory Work

**Notes on Soil Classification.**—The principal constituent of inorganic soils is the mineral portion consisting of rock and mineral particles of various sizes. Inorganic soils also contain more or less incorporated organic matter, relatively small quantities of water combined by the finer particles as water of hydration, small amounts of soluble salts, and other constituents varying in quantity with the soil. In some soils large particles of rocks or rock minerals, such as gravel, stone, and boulders, are mixed with the soil; such soils are known as gravelly or stony. In most soils the bulk of the rock or mineral particles ordinarily consist mainly of sand, silt, and clay. For the purpose of making physical analyses of soils arbitrary size limits for the sands, silt, and clay have been designated. The particles falling within these designated-size classes are termed soil separates. These size classes or soil separates, on the basis of which the soils of the United States are usually classified, were designated in the early work of the U. S. Bureau of Soils and are as follows:

| *Conventional Name* | *Diameter in mm.* |
|---|---|
| Fine gravel | 2.0 — 1.0 |
| Coarse sand | 1.0 — 0.5 |
| Medium sand | 0.5 — 0.25 |
| Fine sand | 0.25 — 0.10 |
| Very fine sand | 0.10 — 0.05 |
| Silt | 0.05 — 0.005 |
| Clay | $<$0.005 |

Soils are classified texturally into ten main soil classes on the basis of the percentage composition of sand, silt, and clay. Those within the sandy loam, loamy sand, or sand class are further classified on the basis of the percentage content of the fine gravel and sand classes or separates. These soil classes were defined in detail by Davis and Bennett (10).

The locations in the state and the laboratory numbers of all the soils chosen for study in this work are shown in Figure 2. The laboratory number, the type as classified in the field, and the class of the surface soil and of the subsoil according to the mechanical analysis of each of the soils are given in Tables 2 to 6, inclusive. The soils which were studied simultaneously in the laboratory and greenhouse are grouped together in the tables as follows: the Norfolk series in Table 2, the Greenville series and associated soils in Table 3, the Decatur series in Table 4, the Hartsells series in Table 5, and the Cecil series and associated soils in Table 6.

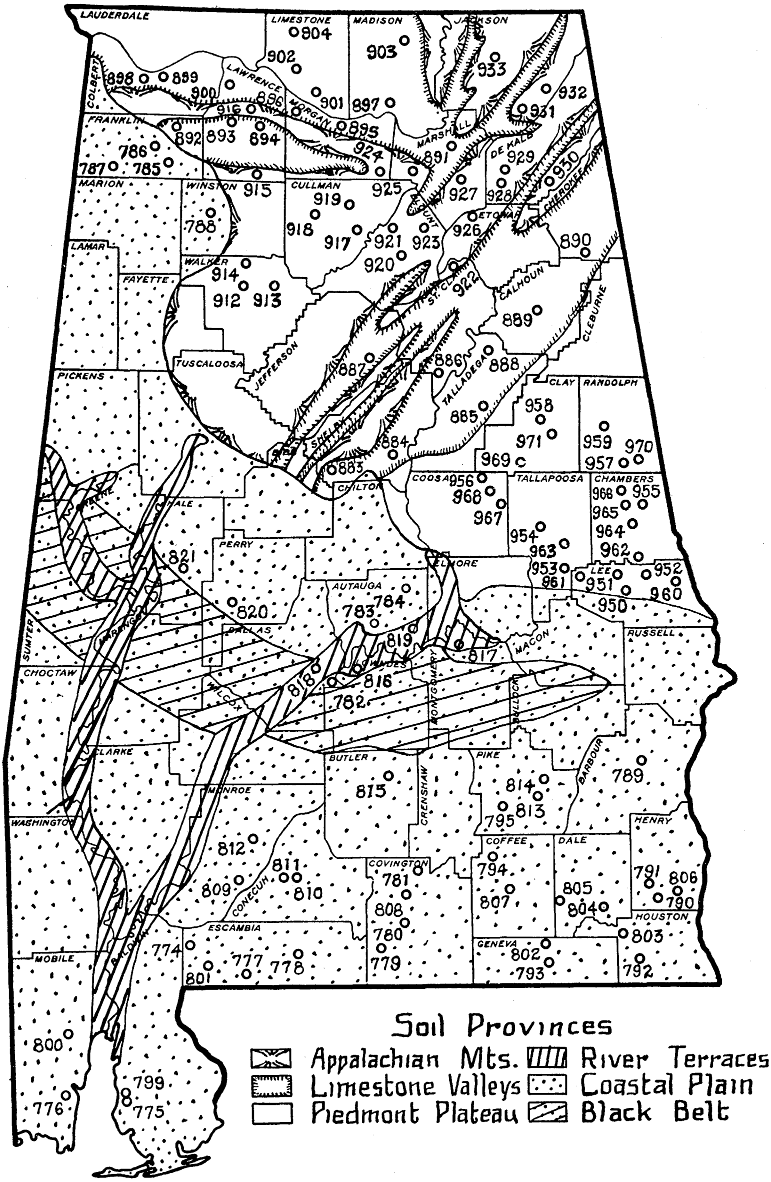



FIGURE 2.—Locations and laboratory numbers of the soils.

In a study of Tables 2 and 3 it will be observed that the surface soils of the coastal plain often contain a larger percentage of sand than is indicated by the soil type name as determined by classification in the field. This has been previously discussed

**TABLE 2.—Norfolk Series. Comparison of Soil Type by Field Classification to Soil Class of Surface Soil and Subsoil as Determined by Mechanical Analysis.**

| Soil No. | Soil type by field classification | Soil class of surface soil by mechanical analysis | Soil class of subsoil by mechanical analysis |
|---|---|---|---|
| 774 | Norfolk fine sandy loam | Fine sandy loam | Sandy clay loam |
| 775 | Norfolk fine sandy loam | Fine sandy loam | Sandy clay loam |
| 776 | Norfolk fine sandy loam | Fine sandy loam | Fine sandy loam |
| 777 | Norfolk fine sand | Sand | Sand |
| 778 | Norfolk loamy sand | Fine sand | Sandy loam |
| 779 | Norfolk loamy fine sand | Fine sand | Fine sand |
| 780 | Norfolk fine sandy loam | Loamy fine sand | Fine sandy loam |
| 781 | Norfolk fine sand | Fine sand | Loamy fine sand |
| 782 | Norfolk fine sandy loam | Fine sandy loam | Clay loam (43.4% sand) |
| 783 | Norfolk fine sandy loam | Fine sandy loam | Clay loam (48.9% sand) |
| 784 | Norfolk loamy sand | Sand | Loamy sand |
| 785 | Norfolk fine sandy loam | Sandy loam | Clay loam (37.8% sand) |
| 786 | Norfolk fine sandy loam | Loam (48.4% sand) | Clay loam (37.8% sand) |
| 787 | Norfolk fine sandy loam | Fine sandy loam | Clay loam (34.6% sand) |
| 788 | Norfolk fine sandy loam | Fine sandy loam | Clay loam (48.7% sand) |
| 789 | Norfolk fine sand | Fine sand | Fine sand |
| 790 | Norfolk fine sandy loam | Sandy loam | Sandy clay |
| 791 | Norfolk fine sandy loam | Loamy fine sand | Sandy clay loam |
| 792 | Norfolk fine sandy loam | Fine sand | Sandy clay |
| 793 | Norfolk fine sandy loam | Sandy loam | Sandy clay loam |
| 794 | Norfolk fine sand | Fine sand | Fine sand |
| 795 | Norfolk fine sandy loam | Loamy fine sand | Sandy clay loam |

**TABLE 3.—Greenville Series. Comparison of Soil Type by Field Classification to Soil Class of Surface Soil and Subsoil as Determined by Mechanical Analysis.**

| Soil No. | Soil type by field classification | Soil class of surface soil by mechanical analysis | Soil class of subsoil by mechanical analysis |
|---|---|---|---|
| 799 | Greenville sandy loam | Sandy loam | Sandy clay loam |
| 800 | Greenville fine sandy loam | Fine sandy loam | Sandy clay loam |
| 801 | Greenville fine sandy loam | Sandy loam | Sandy clay loam |
| 802 | Greenville sandy loam | Loamy sand | Sandy clay loam |
| 803 | Greenville sandy loam | Sandy loam | Sandy clay |
| 804 | Greenville fine sandy loam | Sandy loam | Sandy clay |
| 805 | Greenville sandy loam | Loamy sand | Sandy clay |
| 806 | Greenville fine sandy loam | Fine sandy loam | Sandy clay loam |
| 807 | Greenville sandy loam | Loamy sand | Sandy clay |
| 808 | Greenville sandy loam | Loamy sand | Sandy clay loam |
| 809 | Greenville sandy loam | Fine sandy loam | Sandy clay |
| 810 | Greenville fine sandy loam | Fine sandy loam | Sandy clay loam |
| 811 | Greenville fine sandy loam | Sandy loam | Sandy clay loam |
| 812 | Greenville sandy loam | Fine sandy loam | Sandy clay loam |
| 813 | Akron fine sandy loam | Loamy fine sand | Sandy clay |
| 814 | Greenville sandy loam | Sandy loam | Sandy clay |
| 815 | Greenville fine sandy loam | Fine sandy loam | Clay (48% sand) |
| 816 | Amite fine sandy loam | Fine sandy loam | Sandy clay loam |
| 817 | Amite fine sandy loam | Sandy loam | Sandy clay |
| 818 | Amite fine sandy loam | Loamy fine sand | Sandy clay loam |
| 819 | Amite fine sandy loam | Sandy loam | Sandy clay loam |
| 820 | Akron fine sandy loam | Fine sandy loam | Clay (39% sand) |
| 821 | Akron fine sandy loam | Loamy fine sand | Clay (37% sand) |

**TABLE 4.—Decatur Series. Comparison of Soil Type by Field Classification to Soil Class of Surface Soil and Subsoil as Determined by Mechanical Analysis.**

| Soil No. | Soil type by field classification | Soil class of surface soil by mechanical analysis | Soil class of subsoil by mechanical analysis* |
|---|---|---|---|
| 883 | Decatur clay loam | Clay | Clay |
| 884 | Decatur clay loam | Clay | Clay |
| 885 | Decatur sandy clay loam | Clay | Clay |
| 886 | Decatur clay loam | Clay | Clay |
| 887 | Decatur clay loam | Clay | Clay |
| 888 | Decatur clay loam | Clay loam | Clay |
| 889 | Decatur clay loam | Clay | Clay |
| 890 | Decatur clay loam | Clay | Clay |
| 891 | Decatur clay loam | Clay | Clay |
| 892 | Decatur clay loam | Clay | Clay |
| 893 | Decatur clay loam | Clay | Clay |
| 894 | Decatur clay loam | Clay | Clay |
| 895 | Decatur clay loam | Clay loam | Clay |
| 896 | Decatur clay loam | Clay loam | Clay |
| 897 | Decatur clay loam | Clay | Clay |
| 898 | Decatur clay loam | Clay | Clay |
| 899 | Decatur clay loam | Clay loam | Clay |
| 900 | Decatur clay loam | Clay | Clay |
| 901 | Decatur clay loam | Clay loam | Clay |
| 902 | Decatur clay loam | Clay | Clay |
| 903 | Decatur clay loam | Clay | Clay |
| 904 | Decatur clay loam | Clay | Clay |

*The subsoils ranged fairly uniformly from 40 to 55 per cent clay.

**TABLE 5.—Hartsells Series. Comparison of Soil Type by Field Classification to Soil Class of Surface Soil and Subsoil as Determined by Mechanical Analysis.**

| Soil No. | Soil type by field classification | Soil class of surface soil from mechanical analysis | Soil class of subsoil from mechanical analysis |
|---|---|---|---|
| 912 | Shale loam | Clay loam | Clay |
| 913 | Hartsells sandy loam | Fine sandy loam | Clay |
| 914 | Hartsells very fine sandy loam | Fine sandy loam | Clay |
| 915 | Hartsells sandy loam | Fine sandy loam | Clay loam |
| 916 | Hartsells fine sandy loam | Loam (46.6% sand) | Loam (19.6% clay) |
| 917 | Hartsells fine sandy loam | Loam (39.5% sand) | Clay |
| 918 | Hartsells fine sandy loam | Fine sandy loam | Clay loam |
| 919 | Hartsells fine sandy loam | Fine sandy loam | Clay loam |
| 920 | Hartsells fine sandy loam | Fine sandy loam | Loam (17.9% clay) |
| 921 | Hartsells fine sandy loam | Fine sandy loam | Clay loam |
| 922 | Hartsells sandy loam | Fine sandy loam | Sandy clay loam |
| 923 | Hartsells fine sandy loam | Loam (43.1% sand) | Clay loam |
| 924 | Hartsells fine sandy loam | Fine sandy loam | Clay loam |
| 925 | Hartsells fine sandy loam | Fine sandy loam | Clay loam |
| 926 | Hartsells sandy loam | Fine sandy loam | Sandy loam (18.3% clay) |
| 927 | Hartsells sandy loam | Sandy loam | Loam (18.8% clay) |
| 928 | Hartsells sandy loam | Fine sandy loam | Loam (18.9% clay) |
| 929 | Hartsells sandy loam | Sandy loam | Sandy loam (15.3% clay) |
| 930 | Hartsells sandy loam | Sandy loam | Sandy loam (18.0% clay) |
| 931 | Hartsells fine sandy loam | Fine sandy loam | Clay loam |
| 932 | Hartsells sandy loam | Fine sandy loam | Clay loam |
| 933 | Hartsells fine sandy loam | Loam (48.3% sand) | Clay loam |

**TABLE 6.—Cecil Series. Comparison of Soil Type by Field Classification to Soil Class of Surface Soil and Subsoil as Determined by Mechanical Analysis.**

| Soil No. | Soil type by field classification | Soil class of surface soil by mechanical analysis | Soil class of subsoil by mechanical analysis |
|---|---|---|---|
| 950 | Cecil Clay | Clay | Clay |
| 951 | Cecil clay loam | Clay loam | Clay |
| 952 | Cecil Clay | Clay loam | Clay |
| 953 | Cecil Clay | Clay | Clay |
| 954 | Cecil Clay | Sandy clay loam | Clay |
| 955 | Cecil Clay | Sandy clay loam | Clay |
| 956 | Cecil Clay | Clay | Clay |
| 957 | Cecil Clay | Clay loam | Clay |
| 958 | Davidson clay loam | Clay | Clay |
| 959 | Cecil clay loam | Clay | Clay |
| 960 | Cecil sandy loam | Sandy loam | Clay |
| 961 | Cecil sandy loam | Sandy loam | Clay |
| 962 | Cecil sandy loam | Sandy loam | Clay |
| 963 | Cecil sandy loam | Sandy loam | Clay |
| 964 | Cecil sandy loam | Loamy sand | Clay |
| 965 | Cecil sandy loam | Sandy loam | Clay |
| 966 | Cecil sandy loam | Sandy loam | Clay |
| 967 | Cecil sandy loam | Sandy loam | Clay |
| 968 | Cecil sandy loam | Sandy loam | Clay |
| 969 | Cecil sandy loam | Sandy loam | Clay |
| 970 | Cecil sandy loam | Loamy sand | Clay |
| 971 | Cecil sandy loam | Sandy clay loam | Clay |

by Carter (4). He calls attention to the fact that "there has long been a tendency to name and call certain sandy soils a sandy loam or fine sandy loam that are in fact, as shown by mechanical analyses, a sand or fine sand, or loamy fine sand, that is, the topsoil within the sand class instead of the sandy loam class." This is particularly true of the classification of the loamy sand and the sandy loam whose percentage content of sand is close to the upper limit of sand content of the sandy loam class.

It should be noted, as shown by Tables 2, 3, and 5 and the complete mechanical analyses given in the appendix, that the sandy loam and the fine sandy loam surface soils of the coastal plain and associated river terraces are much higher in percentage of sand than are the Hartsells sandy loam and fine sandy loam of the Appalachian mountains.

It is also noted in comparing the soil classes of the Decatur surface soils as determined by mechanical analyses with the soil types as obtained from field classification, shown in Table 4, that the soils almost universally contain larger percentages of clay than was estimated in the field. This discrepancy between field and laboratory classification of the soils may be due to the fact that the soils of the Decatur series are mature, well weathered, and highly flocculated. In a cursory field examination of such a soil for the purpose of judging its texture it would be impossible to obtain even a fair dispersion of its clay fraction. Consequently, the estimation of its clay content would naturally be low. Such difficulty is not encountered in examining less weathered and highly dispersed clay soils, such as the Lufkin or Eutaw of the Black Belt. In addition, much of the area of the Decatur soils is subject to more or less surface erosion. Over much of the area of Decatur soils enough of the surface soil has been removed by erosion that appreciable quantities of the subsoil have been turned into the cultivated surface. Such a condition would account for a gradual transformation of large areas of Decatur clay loam into a clay.

It has been previously pointed out that under virgin timbered conditions the Cecil sandy loam profile is normally developed on the more nearly level areas of Cecil soils. It is well known that unless erosion is rigidly controlled the surface of the Cecil sandy loam is rapidly eroded under cultivation. As a result the red clay subsoils are soon exposed to the surface. Such eroded areas make up the bulk of the soil that is now generally called Cecil clay. In all probability it can be safely said that the increase above 15 per cent in the clay content of the Cecil soils studied in this work is directly proportional to the amount of surface erosion to which the soil has been subjected. The distribution of the points for the Cecil surface soils and subsoils in Figures 11 and 12, showing their percentage composition of sand, silt, and clay, substantiates this concept.

The percentage compositions in sand, silt, and clay of the surface and subsoils of all the soils studied in this work are shown diagrammatically in Figures 3 to 12, inclusive. They are grouped in these figures as follows: the Norfolk surface soils in Figure 3, the Norfolk subsoils in Figure 4, the surface soils of the Greenville and associated soils in Figure 5, their corresponding subsoils in Figure 6, the Decatur surface soils in Figure 7, the Decatur subsoils in Figure 8, the Hartsells surface soils in Figure 9, the Hartsells subsoils in Figure 10, the surface soils of the Cecil and associated soils in Figure 11, and the subsoils of the Cecil and associated soils in Figure 12. Certain interesting observations may be made from a study of the distribution of the points in these figures which show the percentage composition in sand, silt, and clay of the various groups of soils and subsoils.

It will be seen in Figure 3 that the surface soils of the Norfolk series, particularly those of the sandy loam class, are relatively uniform in their content of clay. The percentage of clay is less in the loamy sand and sand class. The same general relationship is seen in the distribution of the percentage composition in sand, silt, and clay of the Greenville surface soils shown in Figure 5. In a comparison of Figures 3 and 5 it is seen that the sandy loam and loamy sand surface soils of the Greenville group contain appreciably larger quantities of clay than do those of the Norfolk series. The distribution of the points in Figure 6

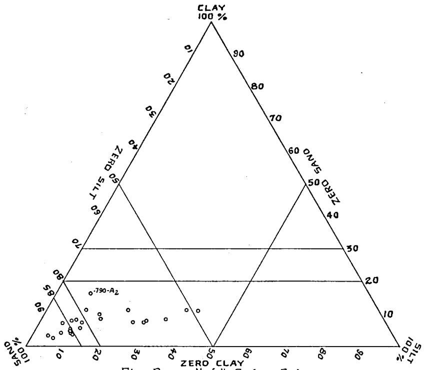



Fig 3 — Norfolk Surface Soils

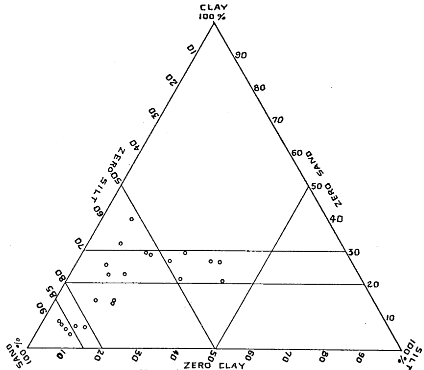



Fig 4 — Norfolk Subsoils

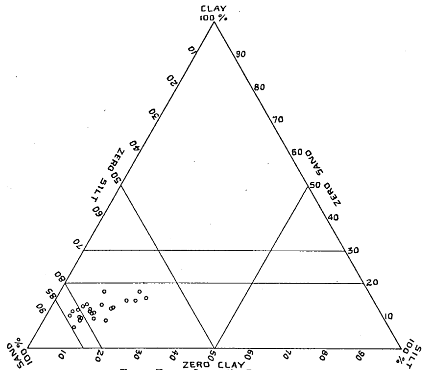



Fig 5 — Greenville Surface Soils

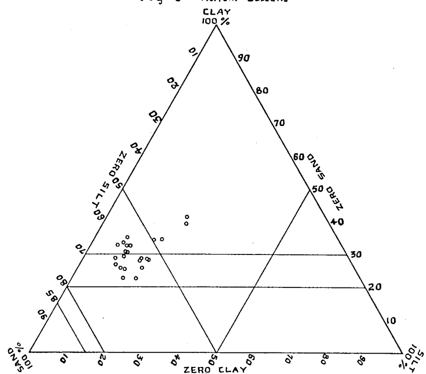



Fig 6 — Greenville Subsoils

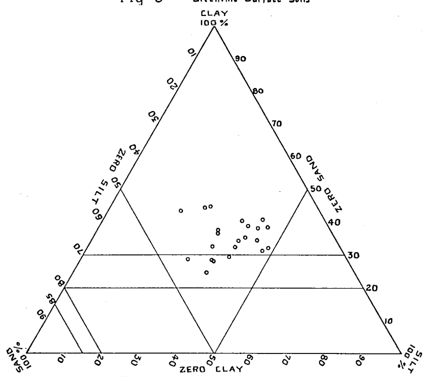



Fig 7 — Decatur Surface Soils.

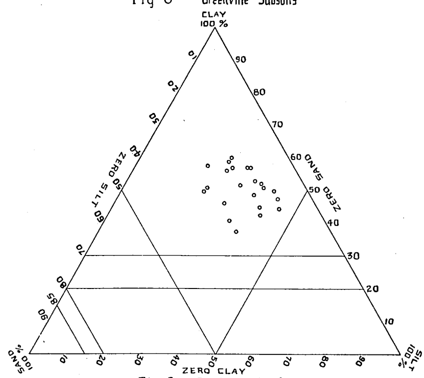
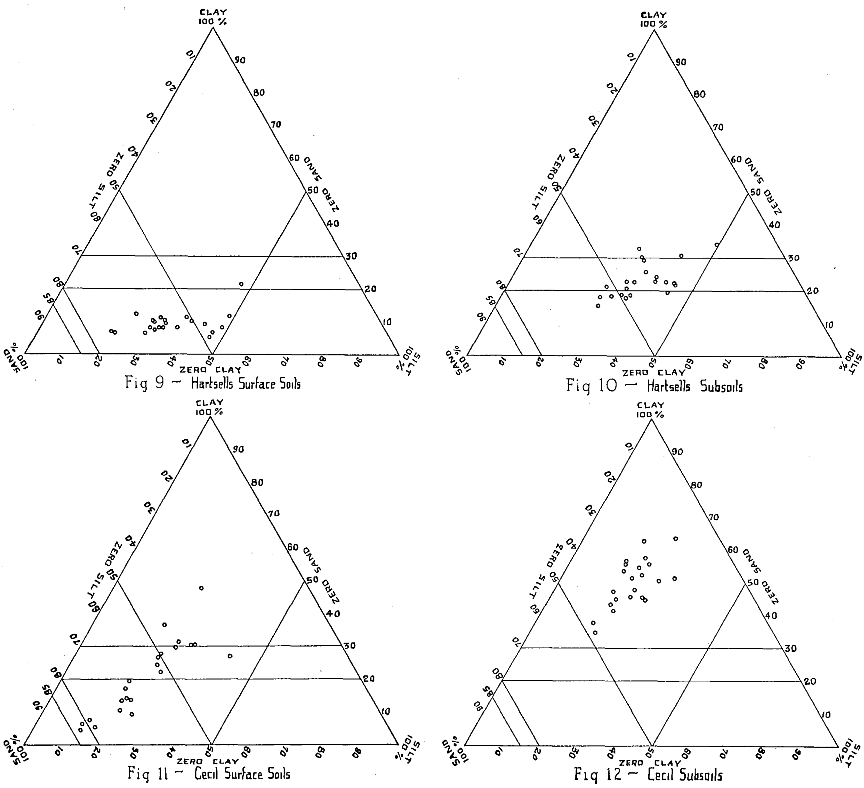



Fig 8 — Decatur Subsoils

FIGURES 3-8.—Percentage composition of sand, silt, and clay of the surface and subsoils.

shows that the subsoils of the Greenville and associated soils are very similar in their percentage composition of sand, silt, and clay. From a comparison of the textural composition of the surface and subsoils of the Greenville group of soils, shown




FIGURES 9-12.—Percentage composition of sand, silt, and clay of the surface and subsoils.

in Figures 5 and 6, it might be reasoned that the Greenville soils are not badly eroded, else the content of clay of some of the surface soils would be considerably increased.

Probably the most interesting of these figures is Figure 4 which shows the distribution of the subsoils of the Norfolk soils and the substrata of the Norfolk sands in percentage composition of sand, silt, and clay. They are extremely variable. The Norfolk subsoils range in texture from sand to sandy clay. Subsoils of each of these various textures, with the exception of sand, are found to occur under any or all of the various textural classes of the surface horizon. Since the moisture and agronomic characteristics of the entire solum are largely determined by the texture of the subsoil it would seem, from these analyses, that the importance of the texture of the subsoil or substratum cannot be emphasized too much in separating and mapping the soils and sands of the Norfolk series. There is little doubt from the viewpoint of land classification that it would be of considerable value if a greater differentiation between the members of the Norfolk series was made on the basis of the texture of the subsoil or substratum. Perhaps, there is even sufficient dissimilarity between the profile of the Norfolk fine sandy loam and that of the Norfolk fine sand or loamy fine sand to separate them into distinct and separate soil series.

Observations on the tendency toward uniformity in the content of sand, silt, or clay of the Decatur, Hartsells, or Cecil soils are of the greatest interest when one keeps in mind the kind of materials from which they are derived. The Decatur soils, which are derived from residual limestone material, are seen to have an interesting tendency toward uniformity in percentage of sand in the subsoil (Figure 8). The Hartsells sandy loams are developed from sandstone material of the Appalachian mountains. Both the surface soils and the subsoils of the Hartsells series tend toward uniformity in their contents of clay. (See Figures 9 and 10.) It is also interesting to note the relative uniformity in content of silt of the Cecil surface soils and subsoils, as shown in Figures 11 and 12. Especially is this so when one remembers that these soils are derived from the weathered materials of the acid igneous rocks of the Piedmont plateau.

**Notes on Soil Formation.**—With the exception of the soils developed on the soil-forming materials of the limestone valleys and uplands and the Black Belt of the coastal plain, the soils of Alabama normally develop a gray sandy loam surface horizon when they are not subject to excessive erosion. Hence, by observation and examination in the field they may appear to have been formed mainly by a podsolic type of weathering. A further and more detailed examination of the materials of which they are composed should make possible a more accurate analysis of the processes of weathering by which they have been developed.

The soil-forming materials and parent rock of the Appalachian mountains, the Piedmont plateau, and the sandy coastal plain contain large quantities of granular quartz. The quartz sand, silt, and gravel found in the soil horizons have remained in the solid physical state throughout the soil-forming process. Very little of it is ever reduced to the colloidal state in the soil-forming process. The fine material is rapidly eluviated from the surface horizon as a result of the relatively high rainfall. Consequently, the gray sandy loam surface horizon is inevitably developed in those portions of this area that are not seriously affected by erosion. The soil-forming materials of the limestone valleys and of the Black Belt section of the coastal plain contain very little granular quartz as coarse as that which is present in the soil-forming materials of the remainder of the State. Hence, a typical gray sandy loam surface horizon is rarely developed in these areas. The amount of quartz sand present in the soil profile seems to be mainly determined by the amount of quartz present in the parent material. The proportional amounts of iron, alumina, and silica found in the soil by a chemical analysis is largely dependent upon the amount of sand in the soil.

Of greater importance as an index of the processes of weathering is the chemical composition of the fine materials. The colloidal clay fraction of the soil is the true product of the chemical processes of soil weathering; it is the residue from the soil-forming minerals that have been decomposed or altered by weathering. From the chemical composition of the colloidal clay fraction it is determined what chemical constituents of the soil-forming material have been removed by the processes of weathering. Much of the larger fractions of the soil-forming material, such as the quartz sand, may remain inert and unchanged throughout the soil-forming processes. The chemical process of weathering may be characterized by the chemical constituents of the soil-forming minerals that are removed. Likewise, the kind of soil developed by the process of weathering is characterized by the chemical composition of the colloidal materials produced in the soil.

In more northern latitudes having a cooler climate high summer temperatures prevail only a small portion of the year and consequently organic matter accumulates in the soil to a greater extent than it does in the soils of southern latitudes. This accumulated organic matter is the source of organic acids that are leached downward through the surface horizons of the soil. They dissolve iron and aluminum and carry them downward through the soil horizons until the whole solution is sufficiently neutralized to precipitate the iron and alumina and part of the organic matter in the so-called "coffee-brown layer." This is known as the podsolic type of weathering or podsolization.

Under the influence of the prevailing high temperatures of warm climates soil organic matter is decomposed more rapidly, and seldom, if ever, accumulates in quantities sufficient to produce a mature podsol profile. Under the influence of prevailing high rainfall the weathering processes of soil-forming materials are characterized by the relatively rapid leaching of the soluble bases and a breaking down of those fractions of the soil possessing base exchange properties. Silica is removed from the soil materials along with the soluble bases, and the weathered material consequently has a higher proportionate content of iron and alumina. This weathering process is known as laterization.

Baver and Scarseth (3) placed the northern limit of the effect of the lateritic type of weathering at the 61° F. mean annual temperature line. They set this northern limit at this point upon the basis of the chemical analyses of the colloidal fraction of some Alabama soils, the relationship between the silica-alumina ratio and the mean annual temperature as shown by Jenny (14), and Harrassowitz' (11) definition of laterization. Harrassowitz defined the lateritic type of weathering as that type of weathering from which a $SiO_2/Al_2O_3$ of less than 2.0 results. From Jenny's data showing the relationship between the $SiO_2/Al_2O_3$ and temperature, silica-alumina ratios of 2.0 were found to occur at a mean annual temperature of 16° C. or about 61° F.

All the silica-alumina ratios of the colloidal fraction extracted from each of the surface soils are shown by location on an outline map of Alabama in Figure 13. These silicia-alumina ratios agree with the data and substantiate the ideas presented by Baver and Scarseth. It should be remembered, however, that high temperatures, equal to or greater than those of the South, occur north of the 61° F. mean annual temperature line during the summer season, and that there is always some organic matter present in southern soils. Consequently, the soils in this area are in a transitional zone between the zone in which true podsols are developed and the zone in which true laterites occur. They exhibit characteristics imparted to them by both the processes of weathering—laterization and podsolization. In the upper horizon, to which the influence of organic matter is limited by its rapid decomposition, they appear to be podsolized to some extent. At the same time the predominating process of chemical weathering is laterization as shown by the chemical composition of the colloidal fraction.

A summary of the silica-alumina ratios of the colloidal fraction and of the total base exchange capacity, exchangeable calcium, and percentage calcium saturation of these soils and of some Black Belt soils is given in Table 7.

The mean $SiO_2/Al_2O_3$ of the colloidal fraction isolated from the soils of the Norfolk series, the Cecil series and those grouped with the soils of the Greenville series are all very nearly the same although the range in silica-alumina ratios of the Norfolk and Greenville soils is considerably wider than the range in the Cecil series. The range in the latitudes from which they were taken is likewise greater. These mean values for the Hartsells and Decatur series, which occur in more northern latitudes, are correspondingly larger. For each of the groups or series of soils the mean $SiO_2/Al_2O_3$ of the surface soils is smaller than that of the corresponding subsoils. This same relationship is noted in the data of Holmes and Edgington (13) on the soils of the Cecil series taken from Troup County, Georgia, and from Chambers County, Alabama, although it is not true of the Cecil soils taken from more northern counties of Georgia and from North Carolina and Virginia. This decrease in the $SiO_2/Al_2O_3$ of the colloidal fraction of the surface horizons in comparison with that of the subsoils is especially pronounced in the profile of the more nearly mature of the Black Belt soils.

In general, the base exchange capacity of the soil is closely related to the colloidal clay content of the soil. The immature

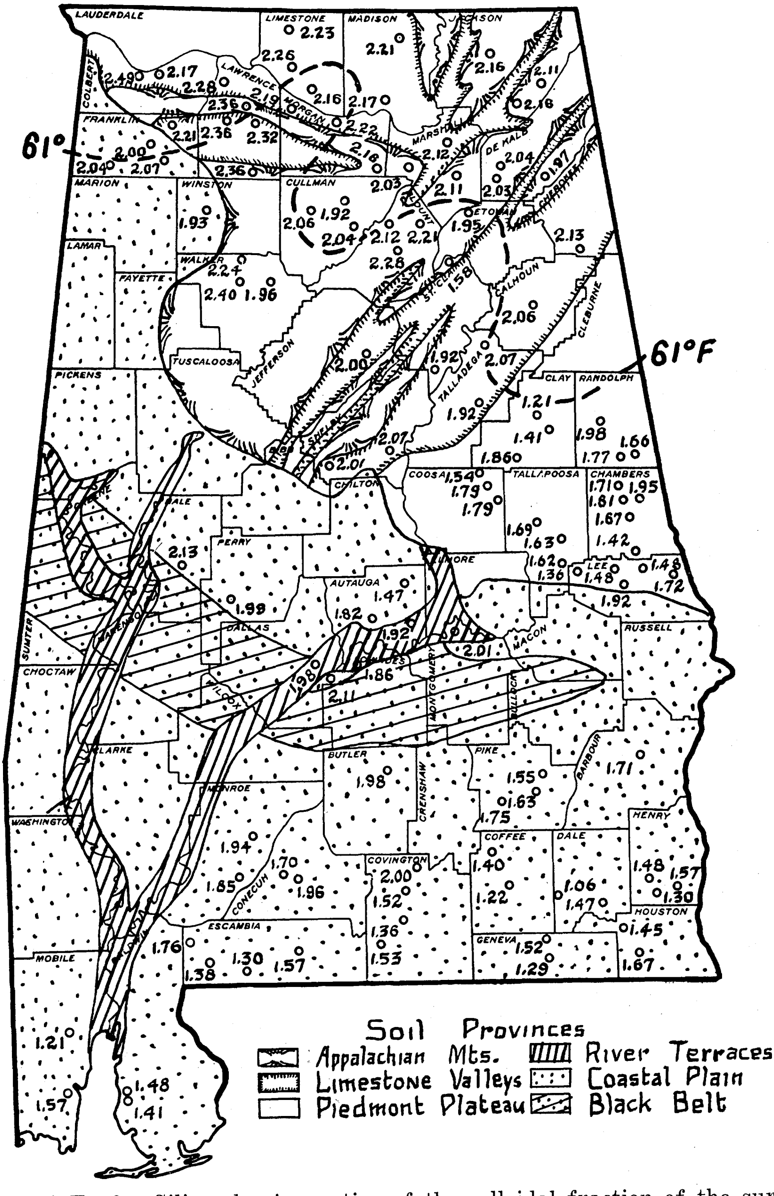



FIGURE 13.—Silica-alumina ratios of the colloidal fraction of the surface soil.

soils of the Black Belt, which have a very high percentage of colloidal clay, have very high base exchange capacities. The base exchange capacities of the soils of the Cecil series are remarkably small in comparison with those of the Norfolk and

TABLE 7.—Summary of the Silica-Alumina Ratios of the Colloidal Fraction, and of the Total Base Exchange Capacity, Exchangeable Calcium, and Percentage Calcium Saturation of Alabama Soils.

| Groups of soils by type | Number of soils averaged | Horizon | $SiO_2/Al_2O_3$ of colloidal fraction | | Total base exchange capacity of soil *M. E. per 100 gms.* | | Exchangeable calcium of soil *M. E. per 100 gms.* | | Percentage calcium saturation of soil *Per cent* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Norfolk sandy loam | 22 | A | 1.67 | 1.29-2.07 | 4.91 | 2.30- 7.43 | 1.09 | .10- 3.69 | 22.6 | 3.0-67.5 |
| | 22 | B | 1.70 | 1.29-2.32 | 6.01 | 1.66-10.69 | .91 | .03- 2.44 | 15.2 | 0.6-27.2 |
| Greenville sandy loam | 23 | A | 1.67 | 1.06-2.13 | 4.69 | 2.39-10.88 | 1.71 | .32- 3.03 | 44.8 | 3.9-90.1 |
| | 23 | B | 1.72 | 1.21-2.21 | 5.70 | 3.25-12.94 | 2.90 | 1.26- 6.92 | 50.8 | 29.9-67.1 |
| Cecil sandy loam | 11 | A | 1.66 | 1.41-1.86 | 3.04 | 1.14- 3.58 | 1.17 | .46- 2.64 | 38.5 | 25.0-58.0 |
| | 11 | B | 1.69 | 1.36-1.89 | 3.66 | 2.59- 5.04 | 1.28 | .28- 2.54 | 34.9 | 6.9-69.0 |
| Cecil clay loam | 10 | A | 1.71 | 1.48-1.98 | 5.62 | 3.27- 8.01 | 2.14 | 1.08- 3.76 | 38.1 | 18.2-56.5 |
| | 10 | B | 1.76 | 1.49-1.98 | 4.25 | 2.80- 7.20 | 1.39 | .22- 5.37 | 32.8 | 4.9-74.6 |
| Hartsells sandy loam | 22 | A | 2.10 | 1.58-2.40 | 4.03 | 2.21- 7.26 | 1.72 | .84- 5.21 | 43.6 | 19.7-51.6* |
| | 22 | B | 2.19 | 1.65-2.47 | 5.36 | 3.17- 8.96 | 1.19 | .48- 2.08 | 22.2 | 8.0-49.5 |
| Decatur clay loam | 22 | A | 2.16 | 1.92-2.36 | 8.94 | 4.03-12.06 | 4.19 | 2.25- 6.86 | 49.1 | 35.1-83.2 |
| | 22 | B | 2.20 | 1.88-2.43 | 12.13 | 8.68-14.71 | 4.51 | 2.22- 9.77 | 37.2 | 17.5-70.0 |
| Oktibbeha clay** | | A1 | 2.28 | (Only one sample of colloid analized) | | | | | | |
| | 5 | A2 | 2.25 | | 18.10 | 17.0 -20.5 | 7.86 | 5.30-11.0 | 43.4 | 31.2-61.1 |
| | | B1 | 3.42 | | | | | | | |
| Eutaw clay** | 3 | A1 | 2.67 | | 23.4 | 20.5 -27.2 | 9.13 | 7.6 -10.6 | 39.0 | 27.9-46.9 |
| | | A2 | 2.78 | | | | | | | |
| Lufkin clay** | 2 | A1 | 4.92 | | 35.0 | 34.0 -36.0 | 10.70 | 10.4 -11.0 | 30.6 | 30.5-30.7 |
| | | A2 | 4.91 | | | | | | | |

*One of the Hartsells sandy loams which had just been limed contained exchangeable calcium equivalent to 106% of its base exchange capacity.
**Data summarized from Tables 11 and 14 of Alabama Experiment Station Bulletin No. 237, listed in Literature Cited as No. (22).

Greenville series. This indicates that in addition to the apparent removal of $SiO_2$ by laterization in the Norfolk, Greenville, and Cecil soils there is a further effect of weathering on the older Cecil soil that has partially destroyed its base exchange capacity.

The kind of materials from which the soils have developed and their degree of weathering are reflected in their exchangeable calcium content. The immature and only slightly leached soils of the Black Belt, which have been developed from clay deposits above the Selma chalk, are relatively high in percentage calcium saturation of the base exchange complex. The subsoils of the Greenville and Decatur series, which have been developed from materials of a calcareous nature, have a high percentage saturation of calcium. The increase in the percentage of calcium saturation of the surface soil over that of the subsoil, especially noticeable in the Hartsells sandy loam soils, is explained as being attributable to fertilizer residues. In the mature profiles of the soils of the Cecil series the subsoils have a surprisingly high percentage saturation of exchangeable calcium. In this connection, it is interesting to note that in those soils in whose profiles red subsoils have been developed there is also a relatively high percentage calcium saturation of the base exchange complex.

**Notes on Soil Productivity.**—If soil productivity is defined in terms of the crops produced on the soil, and that is the true meaning of the term, it becomes almost impossible to enumerate all the factors that affect it. In this broadest meaning of the term, soil productivity is affected not only by factors of fertility or productivity inherent to the soil itself but also by all the external factors of climate and of man's efforts or activity that affect the crop produced by the soil. Russell (20) has quite fully discussed the soil conditions affecting plant growth. Of the five general soil conditions affecting plant growth which he lists, the water supply, air supply, and temperature are factors that are largely determined by external or climatic conditions. Of course, under given climatic conditions the texture and topography of the soil will have a secondary effect upon water supply, air supply, and temperature, in so far as the absorption and movement of the water in the soil are affected by soil texture and topography. The other two general soil conditions, the supply of plant nutrients and the presence of various injurious factors, are conditions that are truly inherent to the soil.

Due to the prevailing climate that provides a long growing season suitable to the production of a comparatively wide variety of crops and to the wide cultural adaptations of the soils, the soils of Alabama are potentially very productive. In fact, when the greatest use is made of man's knowledge and capacity for supplying the various plant nutrients and correcting or eliminating the occasional injurious factors together with the proper cultural management the soils can be made to produce surprisingly large yields. However, if the supply of plant nutrients of the soils themselves as they are normally found in the field is alone considered, these soils are comparatively low in fertility.

Although total chemical analyses of soils are of questionable value in estimating soil productivity, there are certain laboratory determinations and analyses of the physical and chemical properties of the soil that are related to the productivity of the soil. Some of these determinations and analyses provide data that are comparatively accurate measures of the inherent properties of the soil affecting soil productivity. In Table 8 is given a summary of the data obtained by the physical and chemical laboratory determinations and analyses made on the soils studied.

It is shown by the data in Table 8 that the reaction or pH of the soils of any one series, with the possible exception of the Akron series, is rather similar, both in the mean pH and in the range in reactions, to that of the soils of all the other series. The range in pH and the mean pH of the soils of the Akron series are relatively near the neutral point in comparison with the other soils, but the number of samples studied is too few to draw any general conclusions. The differences in the total titrable acidity of the soils of the various soil series as shown by the lime required to bring their reactions to pH 6.5 are considerably more distinct. The soils of the Amite and Akron series are very low in their lime requirement. The soils of the Greenville, Decatur, and Hartsells series and of the Cecil sandy loam type are very similar in both the mean and the range in the amount of lime required to bring the surface soil to pH 6.5. These soils as a group are relatively low in their lime requirement. The pH and the lime requirement of the subsoils of these series are widely variable within the limited number of subsoils of which the pH and lime requirement were determined.

The content of organic matter, by hydrogen perixode-solution loss, is uniformly low in the cultivated soils of all these series. The occasional relatively high percentage of organic matter of a few soils in some of the series generally occurred in those just recently brought into cultivation or in soils the cultivation of which had been abandoned for several years.

In a study of the soils of the Black Belt of Alabama, Scarseth (22) pointed out that the order of magnitude of the buffer and base exchange capacities varies inversely with the degree of weathering of the colloidal fraction. This observation is borne out by a comparison of the data on these properties of the soils of the Norfolk and Cecil series.

All of the soils are comparatively low in content of total $P_2O_5$. The soils of the Norfolk and Hartsells series and of the Cecil sandy loam type are all of the same order of magnitude in

**TABLE 8.—Summary of the Data Obtained by the Physical and Chemical Laboratory Determinations and Analyses Made on the Soils Studied.**

| Soil series, horizon, and number of soils | | Colloidal clay content *Per cent* | | Silica-alumina ratio of the colloidal fraction | | Total base exchange capacity *M.E. per 100 gms. soil* | |
|---|---|---|---|---|---|---|---|
| | | Mean | Range | Mean | Range | Mean | Range |
| Norfolk | Surface | —— | —— | 1.67 | 1.29-2.07 | 4.91 | 2.30- 7.43 |
| 22 samples | Subsoil | —— | —— | 1.70 | 1.29-2.32 | 6.01 | 1.66-10.69 |
| Greenville | Surface | 10.4 | 5.0-14.3 | 1.55 | 1.06-1.98 | 5.35 | 2.45-10.88 |
| 16 samples | Subsoil | 26.0 | 18.4-31.2 | 1.60 | 1.21-2.10 | 4.57 | 3.25- 6.64 |
| Amite | Surface | 9.1 | 7.3-10.6 | 1.96 | 1.86-2.01 | 3.03 | 2.39- 3.97 |
| 4 samples | Subsoil | 25.0 | 20.9-29.8 | 2.00 | 1.92-2.10 | 7.07 | 5.76- 9.48 |
| Akron | Surface | 8.8 | 7.9-10.6 | 1.92 | 1.63-2.13 | 3.42 | 2.85- 3.97 |
| 3 samples | Subsoil | 32.9 | 26.1-37.6 | 2.00 | 1.77-2.21 | 9.94 | 5.94-12.94 |
| Decatur | Surface | 30.4 | 21.2-39.4 | 2.16 | 1.92-2.36 | 8.94 | 4.03-12.06 |
| 22 samples | Subsoil | 44.1 | 30.7-54.8 | 2.20 | 1.88-2.43 | 12.13 | 8.68-14.71 |
| Hartsells | Surface | 6.3 | 3.5-14.4 | 2.10 | 1.58-2.40 | 4.03 | 2.21- 7.26 |
| 22 samples | Subsoil | 17.2 | 9.9-27.5 | 2.19 | 1.65-2.47 | 5.36 | 3.17- 8.96 |
| Cecil | Surface | 9.4 | 4.1-18.0 | 1.66 | 1.41-1.86 | 3.04 | 1.14- 3.58 |
| 11 sandy loams | Subsoil | 40.0 | 30.2-50.6 | 1.69 | 1.36-1.89 | 3.52 | 2.59- 5.04 |
| Cecil | Surface | 22.6 | 11.1-33.1 | 1.71 | 1.48-1.98 | 5.62 | 4.60- 8.01 |
| 10 clay loams | Subsoil | 47.1 | 34.6-58.0 | 1.76 | 1.49-1.98 | 4.40 | 3.27- 7.20 |
| Davidson | Surface | 42.4 | —— | 1.21 | —— | 5.50 | —— |
| 1 clay | Subsoil | 44.4 | —— | 1.13 | —— | 3.54 | —— |

*Data given on subsoils were obtained on only those subsoils on which crops were grown in the greenhouse.

**Arithmetic mean of pH values.

| Exchangeable hydrogen *M.E. per 100 gms. soil* | | Exchangeable calcium *M.E. per 100 gms. soil* | | Exchangeable magnesium *M.E. per 100 gms. soil* | |
|---|---|---|---|---|---|
| Mean | Range | Mean | Range | Mean | Range |
| 2.99 | 0.92-5.00 | 1.09 | 0.10-3.69 | .229 | .044- .612 |
| 2.55 | 0.16-4.70 | 0.91 | 0.03-2.44 | .286 | .131- .524 |
| 3.13 | None-5.91 | 1.47 | 0.56-3.03 | .305 | .137- .566 |
| 2.25 | 1.14-3.15 | 2.31 | 1.26-3.50 | .525 | .302-1.027 |
| 1.76 | 1.29-2.25 | 2.16 | 1.50-2.69 | .263 | .129- .364 |
| 2.78 | 2.58-3.27 | 3.39 | 2.44-4.87 | .653 | .423- .878 |
| 1.62 | 1.50-1.71 | 2.35 | 2.29-2.45 | .382 | .315- .493 |
| 2.63 | 1.59-3.24 | 5.40 | 3.27-6.92 | 1.337 | .523-1.854 |
| 4.12 | 1.92-7.74 | 4.19 | 2.25-6.86 | .921 | .388-1.996 |
| 5.63 | 2.61-8.31 | 4.51 | 2.22-9.77 | 1.516 | .606-2.640 |
| 1.83 | 0.27-5.16 | 1.72 | 0.84-5.21 | .209 | .105- .458 |
| 2.52 | None-5.82 | 1.19 | 0.48-2.08 | .341 | .040-1.916 |
| —— | —— | 1.17 | 0.46-2.64 | .184 | .083- .374 |
| —— | —— | 1.33 | 0.28-2.54 | .572 | .302- .866 |
| —— | —— | 2.14 | 1.30-3.76 | .564 | .205-1.446 |
| —— | —— | 1.33 | 0.22-5.37 | 1.184 | .494-2.048 |
| —— | —— | 2.09 | —— | .645 | —— |
| —— | —— | 0.32 | —— | .512 | —— |

Cut off along this line.

| Hydrogen ion concentration* *pH* | | Lime required to bring the reaction to pH 6.50* *Lbs. lime per 2,000,000 lbs. soil* | | Organic matter content *Per cent* | |
|---|---|---|---|---|---|
| Mean** | Range | Mean | Range | Mean | Range |
| 5.52 | 4.78-6.50 | 2343 | None-5130 | —— | —— |
| 5.20 | 4.93-5.48 | 2224 | 2122-2325 | —— | —— |
| 5.46 | 5.20-5.80 | 1623 | 487-3375 | 1.57 | 0.26-3.82 |
| 5.20 | —— | 750 | —— | —— | —— |
| 5.79 | 5.30-6.45 | 703 | 300-1275 | 0.68 | 0.35-0.82 |
| 6.00 | —— | 375 | —— | —— | —— |
| 6.20 | 6.00-6.50 | 251 | None- 414 | 0.54 | 0.48-0.62 |
| 6.40 | —— | 112 | —— | —— | —— |
| 5.48 | 4.95-6.30 | 1635 | 225-3000 | 0.60 | 0.25-1.20 |
| 5.40 | 5.00-5.90 | 2000 | 1500-2630 | —— | —— |
| 5.76 | 5.23-6.25 | 1626 | 450-3570 | 1.45 | 0.93-2.14 |
| 4.97 | 4.90-5.05 | 7570 | 3510-15000 | —— | —— |
| 5.55 | 5.20-6.25 | 1608 | 1080-2430 | 0.91 | 0.11-2.14 |
| 5.40 | —— | 2100 | —— | —— | —— |
| 5.45 | 4.68-5.98 | 2673 | 1500-6000 | 1.48 | 0.33-4.77 |
| 4.97 | 4.80-5.13 | 2167 | 1770-2565 | —— | —— |
| 5.20 | —— | 3000 | —— | 0.26 | —— |
| —— | —— | —— | —— | —— | —— |

| Total $P_2O_5$ *Lbs. $P_2O_5$ per 2,000,000 lbs. soil* | | Available $PO_4$ by Truog's method* *Lbs. $PO_4$ per 2,000,000 lbs. soil* | | Available $PO_4$ by Truog's method modified* *Lbs. $PO_4$ per 2,000,000 lbs. soil* | |
|---|---|---|---|---|---|
| Mean | Range | Mean | Range | Mean | Range |
| 408 | 261- 916 | 55 | 12-162 | 107 | 22-312 |
| 366 | 160- 504 | 14 | 12- 16 | 19 | 18- 20 |
| 1192 | 750-1725 | 94 | 25-216 | 157 | 16-324 |
| —— | —— | 24 | —— | 24 | —— |
| 1425 | 1075-1800 | 165 | 63-296 | 289 | 152-480 |
| —— | —— | 47 | —— | 47 | —— |
| 1408 | 1000-1750 | 129 | 36-166 | 241 | 142-336 |
| —— | —— | 28 | —— | 28 | —— |
| 1381 | 975-1800 | 72 | 22-136 | 87 | 19-142 |
| 1257 | 900-1950 | 24 | 18- 29 | 24 | 18- 28 |
| 857 | 700-1300 | 36 | 8- 94 | 70 | 9-142 |
| 659 | 500-1200 | 7 | 6- 8 | 6 | 5- 7 |
| 930 | 450-1530 | 55 | 14-114 | 106 | 20-328 |
| 873 | 100-1600 | 10 | —— | 12 | —— |
| 1595 | 1200-2100 | 39 | 22- 61 | 55 | 26- 78 |
| 1863 | 1100-2650 | 8 | 6- 10 | 11 | 9- 13 |
| 2050 | —— | 31 | —— | 43 | —— |
| 1900 | —— | —— | —— | —— | —— |

content of $P_2O_5$, and are very low. The other soils contain somewhat larger amounts of total $P_2O_5$ and are quite variable in content of total $P_2O_5$ in both the soil series and soil type. The content of readily available phosphate of the soils discussed is connected with the yields of sorghum obtained on the soils in the greenhouse.

The colloidal-clay content, total base exchange capacity, and exchangeable calcium and magnesium are, in general, associated with and determined by soil texture and the kind of materials from which the soils are derived. As such they vary somewhat from one soil type to another. These soil properties also vary considerably within the soil type.

From the data presented in Table 8 it is apparent that the soils of a given type are not definitely and distinctly different from those of another type. This is especially true of soils having mature profiles and occurring in the same locality. Naturally, soils of considerable difference in the degree of weathering or occurring in widely separated sections will be quite different in their properties. The variation in soil properties within a given type is greater than the variation in properties between the soil types for most of the properties studied in this work. Only those properties that are definitely associated with or determined by soil texture are quite different from one type to another, and only then when the soil types also have surface soils of different texture.

## Greenhouse Work

**Reliability of Greenhouse Yields.**—All measurements in experimental work are subject to more or less uncontrollable error that is commonly termed *experimental error*. The magnitude of the experimental error can be determined by duplicating or replicating the measurements made in the experimental work. The exact effect of the experimental error upon the reliability of the data can be mathematically calculated from the magnitude of the experimental error in a series of measurements. Ordinarily, the greater the number of determinations of any experimental value, the greater is the reliability of the mean value obtained. However, the greater the number of determinations made, the greater is the amount of labor involved. In most experimental work the number of observations made of the experimental values is determined: (1) by the degree of accuracy desired, and (2) by the labor involved in making a single observation.

In greenhouse work, most pot-culture tests of soils and fertilizers are made in duplicate or triplicate. All yields reported in this work were obtained from duplicate pot cultures in the greenhouse. Since three consecutive crops were grown on fourteen pot cultures of each of one hundred and eleven different soils and fourteen different subsoils, there were available a total of over five thousand individual yields from which to calculate the variation between duplicate-pot-culture yields. A study of the variation of the yields from duplicate pot cultures of the two crops of sorghum on the first four groups of soils studied in this work has been reported (8). The data on the variation between yields reported herein represent the yields of all the crops obtained on the surface soils.

Since the variation between the yields obtained on any two duplicate-pot-cultures is just as good a measure of the variation between duplicate-pot-culture yields as the variation between the yields obtained on any other two duplicate pot cultures, the yields and the variation between duplicate yields were analyzed by class groups. This method of analysis of the variation between duplicate yields has advantages over other statistical methods of analysis in that: (1) it is quite simple, (2) it is not extremely laborious, and (3) it makes possible the determination of the relationship of the variation between duplicate yields to the size of the yield.

The yields and the variation between duplicate yields of each of the three crops on each of the five groups of soils were analyzed separtely. In each instance the yields were arranged in an array, i. e., in order with regard to size. The plus or minus deviation ($\pm d$) of each yield from the average of that yield with its duplicate and the square of the deviations ($\pm d^2$)'s were tabulated in corresponding columns. From these tabulated data an average deviation, a standard deviation, and a standard error for any sized group of yields can be readily calculated by treating the deviations just as a number of deviations from a single average. The Austrian winter pea yields are summarized in class groups of 1.0 gram intervals, and the sorghum yields, in class groups of 5.0 gram intervals. For both crops the class interval gives convenient class limits with which to work. In a range of yields of peas from 0.1 to 21.3 grams the class interval of 1.0 gram provides 22 classes, and in a range of yields of sorghum from 0.1 gram to 75.0 grams the class interval of 5.0 grams provides 15 classes.

As previously reported (8) there was no significant or uniform difference in the magnitude of the average or standard deviation of duplicates of the first crop of sorghum on any of the groups of soils studied. There was, however, a significantly uniform difference between the first crops and the second crop on each of the soil groups. Consequently, the yields on all soils were summarized by crops. A summary by class groups of the yields and of the average and standard deviation of the duplicate yields of each of the three crops is given as follows: the Austrian winter peas in Table 9, the first crop of sorghum in Table 10, and the second crop of sorghum in Table 11. The relation by class groups of the average deviation and of the standard deviation to the yield of the first crop of sorghum is shown graphically in Figure 15, and to the yield of the second crop of sorghum in Figure 16. In these graphs, a broken line is used to connect the co-ordinates of both the average and standard deviation and the average yield in those class groups having so small a number of observations that the experimental points do not agree with the general curve of relationship.

Both the average and standard deviation of the yield of the three crops are expressed in terms of percentage of the average yields of their respective class groups in Tables 9, 10, and 11, respectively. These are shown graphically in Figures 14 and 17.

As shown in Table 9 and Figure 14 the average deviation of the yield of Austrian winter peas in percentage of the average yield decreases from a maximum of 11.7 per cent to a minimum of 3.0 per cent. In yields of peas as large as 8.0 grams or more per pot the average deviation has an average magnitude of 5.8 per cent of the yield and the standard deviation has an average magnitude of 7.8 per cent. In percentage of the yield these deviations of duplicate-pot-culture yields of peas are somewhat larger than the deviations of the yields of corresponding magnitude of either the first or the second crop of sorghum. This difference is explained as being attributable to the difference in the feeding habits of the two crops,—Austrian winter peas and sorghum. The peas, being more readily adaptable to less fertile soils than the sorghum, do not require as high levels of nutritional fertility in the soil. Consequently, their yields are probably less closely determined by the amount of nutrient elements in soils of medium fertility than those of the sorghum, and are more easily affected by factors external to the pot culture. These effects result in an increased variation in the duplicate pot culture yields.

As shown in Table 9 and Figure 14, the deviation in percentage of the yield of peas increases as the yield decreases to less than 2.0 grams. In the two class groups of yields averaging less than 2.0 grams, the curve of relationship between percentage deviation and yield seems to break definitely toward a percentage deviation of zero at or near zero yield. In these class groups the deviations are a measure of the variation between utter crop failures, in which the yield obtained approaches the weight of the seed planted, and the percentage deviation consequently approaches not only a theoretical zero but an actual zero when the weight of the seed is uniform. In those yields in which the amount of growth or yield was sufficient to have been determined by the soil and the deviation between duplicates is a true measure of the variation between duplicate-pot culture yields, the percentage deviation between duplicate yields approaches 100 per cent as the yield resulting from actual growth approaches zero.

It is shown in Tables 10 and 11 and Figures 15 and 16, that as the yield of sorghum increases, the standard deviation of the

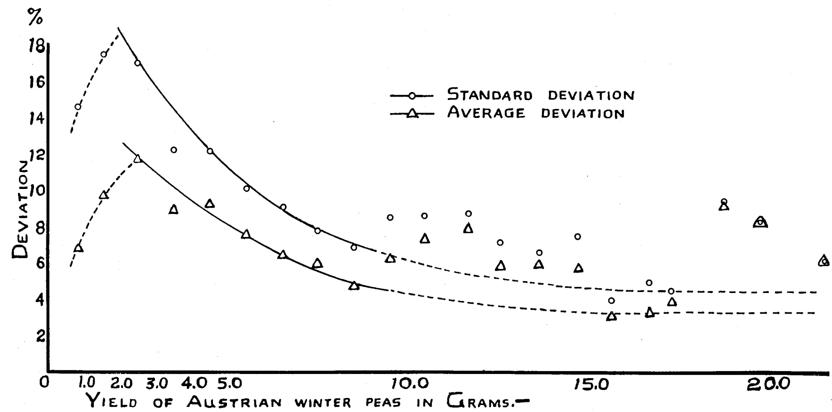



FIGURE 14.—Average and standard deviation of duplicates in percentage of yield and mean class yield of Austrian winter peas on all soils by class groups.

**TABLE 9.—A Summary by Class Groups of Pot Culture Yields and Deviation from Average of Duplicate Yield of Austrian Winter Peas on All Soils.**

| Class size (grams yield) | Number in class | Average class yield | Average deviation | | Standard deviation | |
|---|---|---|---|---|---|---|
| | | | $\frac{\Sigma(\pm d)}{N}$ | Percentage of yield | $\sqrt{\frac{\Sigma(\pm d^2)}{N}}$ | Percentage of yield |
| | | *grams* | *grams* | *per cent* | *grams* | *per cent* |
| 0 - 0.9 | 30 | 0.79 | ±0.05 | 6.8 | ±0.12 | 14.6 |
| 1.0- 1.9 | 175 | 1.49 | .14 | 9.7 | .26 | 17.5 |
| 2.0- 2.9 | 176 | 2.43 | .29 | 11.7 | .41 | 17.0 |
| 3.0- 3.9 | 183 | 3.44 | .31 | 8.9 | .42 | 12.2 |
| 4.0- 4.9 | 185 | 4.44 | .41 | 9.2 | .54 | 12.1 |
| 5.0- 5.9 | 200 | 5.45 | .42 | 7.5 | .55 | 10.0 |
| 6.0- 6.9 | 205 | 6.47 | .42 | 6.4 | .58 | 9.0 |
| 7.0- 7.9 | 142 | 7.41 | .44 | 5.9 | .57 | 7.7 |
| 8.0- 8.9 | 100 | 8.39 | .39 | 4.7 | .57 | 6.8 |
| 9.0- 9.9 | 76 | 9.41 | .58 | 6.2 | .79 | 8.4 |
| 10.0-10.9 | 35 | 10.36 | .76 | 7.3 | .88 | 8.5 |
| 11.0-11.9 | 19 | 11.54 | .89 | 7.8 | .99 | 8.6 |
| 12.0-12.9 | 18 | 12.46 | .72 | 5.8 | .88 | 7.1 |
| 13.0-13.9 | 4 | 13.52 | .80 | 5.9 | .88 | 6.5 |
| 14.0-14.9 | 7 | 14.57 | .83 | 5.7 | 1.08 | 7.4 |
| 15.0-15.9 | 3 | 15.50 | .47 | 3.0 | .60 | 3.9 |
| 16.0-16.9 | 4 | 16.55 | .53 | 3.2 | .82 | 4.9 |
| 17.0-17.9 | 2 | 17.15 | .65 | 3.8 | .74 | 4.3 |
| 18.0-18.9 | 2 | 18.60 | 1.70 | 9.1 | 1.73 | 9.3 |
| 19.0-19.9 | 1 | 19.60 | 1.60 | 8.2 | 1.60 | 8.2 |
| 20.0-20.9 | — | — | — | — | — | — |
| 21.0-21.9 | 1 | 21.40 | 1.40 | 6.5 | 1.40 | 6.5 |
| Total or average | 1,568 | 5.340 | .382 | 7.16 | .547 | 10.24 |

**TABLE 10.—A Summary by Class Groups of Pot Culture Yields and Deviation from Average of Duplicate Yield of First Successive Crop of Sorghum on All Soils.**

| Class size (grams yield) | Number in class | Average class yield | Average deviation | | Standard deviation | |
|---|---|---|---|---|---|---|
| | | | $\frac{\Sigma(\pm d)}{N}$ | Percentage of yield | $\sqrt{\frac{\Sigma(\pm d^2)}{N}}$ | Percentage of yield |
| | | *grams* | *grams* | *per cent* | *grams* | *per cent* |
| 0- 4.9 | 107 | 2.57 | 0.51 | 19.9 | 0.94 | 36.6 |
| 5.0- 9.9 | 106 | 7.45 | 1.13 | 15.2 | 1.55 | 20.8 |
| 10.0-14.9 | 119 | 12.55 | 1.44 | 11.4 | 1.97 | 15.7 |
| 15.0-19.9 | 163 | 17.45 | 1.77 | 10.1 | 2.45 | 14.0 |
| 20.0-24.9 | 152 | 22.44 | 1.81 | 8.1 | 2.36 | 10.5 |
| 25.0-29.9 | 182 | 27.57 | 2.02 | 7.3 | 2.63 | 9.5 |
| 30.0-34.9 | 173 | 32.40 | 1.71 | 5.3 | 2.17 | 6.7 |
| 35.0-39.9 | 200 | 37.26 | 2.00 | 5.4 | 2.63 | 7.1 |
| 40.0-44.9 | 156 | 42.42 | 1.57 | 3.7 | 2.12 | 5.0 |
| 45.0-49.9 | 99 | 47.36 | 2.02 | 4.3 | 2.62 | 5.5 |
| 50.0-54.9 | 53 | 52.16 | 1.84 | 3.5 | 2.43 | 4.7 |
| 55.0-59.9 | 30 | 56.74 | 1.89 | 3.3 | 2.34 | 4.1 |
| 60.0-64.9 | 6 | 61.43 | 4.50 | 7.3 | 5.06 | 8.2 |
| 65.0-69.9 | 8 | 66.88 | 3.16 | 4.7 | 4.11 | 6.1 |
| Total or average | 1,554 | 28.04 | 1.69 | 6.03 | 2.30 | 8.21 |

**TABLE 11.—A Summary by Class Groups of Pot Culture Yields and Deviation from Average of Duplicate Yield of Second Successive Crop of Sorghum on All Soils.**

| Class size (grams yield) | Number in class | Average class yield | Average deviation | | Standard deviation | |
|---|---|---|---|---|---|---|
| | | | $\frac{\Sigma(\pm d)}{N}$ | Percentage of yield | $\sqrt{\frac{\Sigma(\pm d^2)}{N}}$ | Percentage of yield |
| | | *grams* | *grams* | *per cent* | *grams* | *per cent* |
| 0- 4.9 | 155 | 2.35 | 1.05 | 44.7 | 1.86 | 79.2 |
| 5.0- 9.9 | 137 | 7.59 | 1.47 | 19.4 | 1.92 | 25.3 |
| 10.0-14.9 | 129 | 12.53 | 2.07 | 16.5 | 2.98 | 23.8 |
| 15.0-19.9 | 148 | 17.56 | 1.91 | 10.9 | 2.54 | 14.5 |
| 20.0-24.9 | 131 | 22.35 | 2.30 | 10.3 | 3.14 | 14.1 |
| 25.0-29.9 | 131 | 27.57 | 2.14 | 7.8 | 2.86 | 10.4 |
| 30.0-34.9 | 165 | 32.38 | 2.12 | 6.5 | 2.84 | 8.8 |
| 35.0-39.9 | 151 | 37.49 | 2.25 | 6.0 | 2.98 | 7.9 |
| 40.0-44.9 | 123 | 42.30 | 2.38 | 5.6 | 3.18 | 7.5 |
| 45.0-49.9 | 98 | 47.27 | 2.62 | 5.5 | 3.39 | 7.2 |
| 50.0-54.9 | 84 | 52.34 | 2.25 | 4.3 | 3.21 | 6.1 |
| 55.0-59.9 | 50 | 57.25 | 2.38 | 4.2 | 3.08 | 5.4 |
| 60.0-64.9 | 33 | 62.10 | 2.72 | 4.4 | 3.43 | 5.5 |
| 65.0-69.9 | 14 | 67.34 | 2.58 | 3.8 | 3.38 | 5.0 |
| 70.0-74.9 | 5 | 73.24 | 6.30 | 8.6 | 7.29 | 9.9 |
| Total or average | 1,554 | 28.07 | 2.06 | 7.33 | 2.86 | 10.19 |

duplicate yield of the first crop approaches a maximum of about 2.5 grams, and likewise the standard deviation of the second crop approaches a maximum of about 3.0 grams. This is true of the class groups having a relatively large number of observations. Both the average and standard deviation of both crops of sorghum are expressed in percentage of the average class yield in Tables 10 and 11 and are presented graphically in Figure 17. These data and curves are in very close agreement with the data and curves previously published on this work (8).

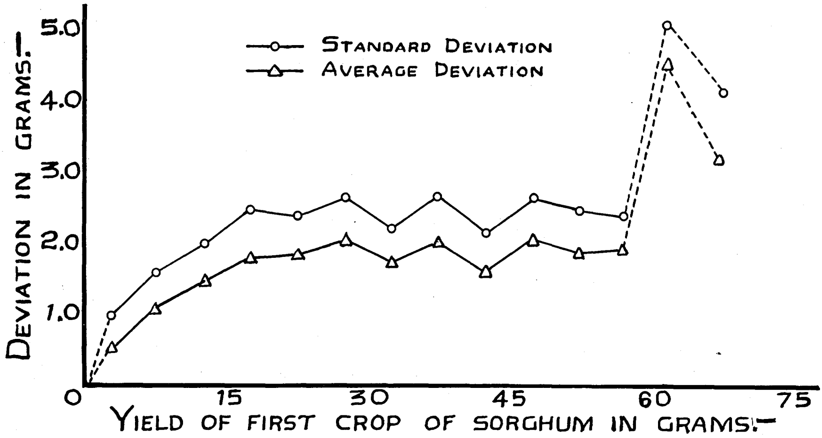



FIGURE 15.—Summary by class groups of average and standard deviations of duplicates and average yield of first crop of sorghum on all soils.

The average deviation between duplicates of those yields of the first crop of sorghum as large as 30.0 grams or more per pot averages 4.53 per cent of the average yield, and of the second crop, 5.42 per cent. Likewise, the standard deviation between duplicates of those yields of the first crop of sorghum as large as 30.0 grams or more per pot averages 5.97 per cent of the average yield, and of the second crop 7.25 per cent. The increase in the variation between duplicate pot yields of the second crop of sorghum over that of the first crop is without doubt due to the magnification of the differences between the duplicate pot culture by the growth of the previous crops.

It should be remembered that the average deviation expresses the mean of a group of deviations in just the same manner as the arithmetic mean expresses the average of any group of values. The standard deviation is the square root of the mean of the squares of the deviation. For a fairly normal or regular distribution of observations about the mean, about 68 per cent of the observations will fall within the range of the distance of

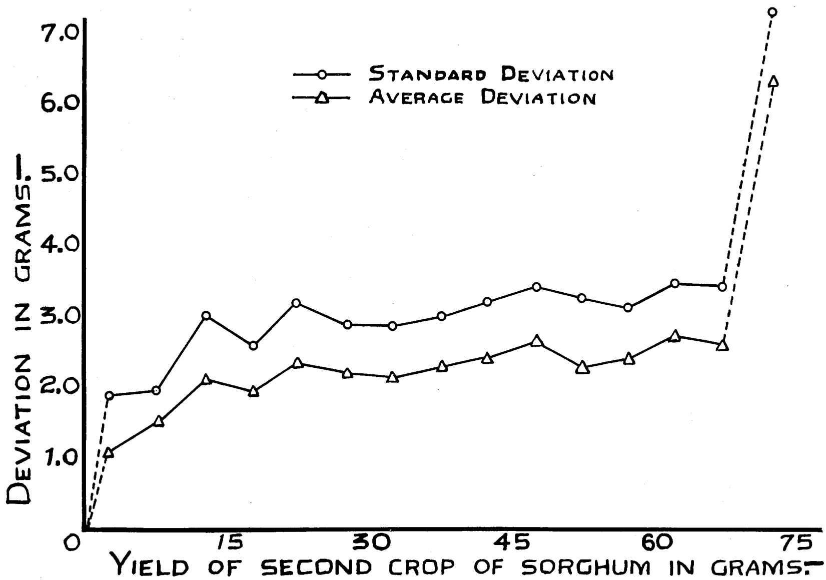



FIGURE 16.—Summary by class groups of average deviations and standard deviation of duplicates and average yield of second crop of sorghum on all soils.

the standard deviation below the mean to the distance of the standard deviation above the mean. On the basis of the relationships expressed by the average and standard deviation, the significance of the differences between yields of these crops obtained in response to the various fertilizer treatments can be evaluated.

**The Uniformity of Soil Types in Crop Response to Fertilizing Elements.**—Tests of the fertilizer needs of soils are generally carried out by actual cropping the soil with various fertilizer treatments. This experimental cropping of the soil may be done in the field or in the greenhouse. For the purpose of making recommendations for fertilizer practices directly to the farmer, field fertilizer tests are preferable to greenhouse work because the field tests more nearly approach the conditions encountered by the farmer. For the purpose of making fertilizer tests of a group of soils in order to determine their degree of uniformity of response to given fertilizer treatments, greenhouse fertilizer experiments may be preferable to field tests.

Field work, in order to be satisfactory, requires a field of the desired soil type uniform over a sufficient area to provide the required number of plots. Even in field work, uncontrollable experimental error is encountered. That is to say, that if the entire area is given exactly the same treatment, planted to the same crop, given the same cultivation, and harvested in units of small plots or areas, the yield will vary somewhat from plot to plot or from area to area regardless of the care taken in giving the entire area uniform treatment. This variation in results from plot to plot that cannot be accounted for by any apparent or reasonable cause is experimental error. The experimental error expressed in terms of deviation between duplicate pot culture yields of the greenhouse work reported herein has been shown to be less than that generally encountered in field plot work.

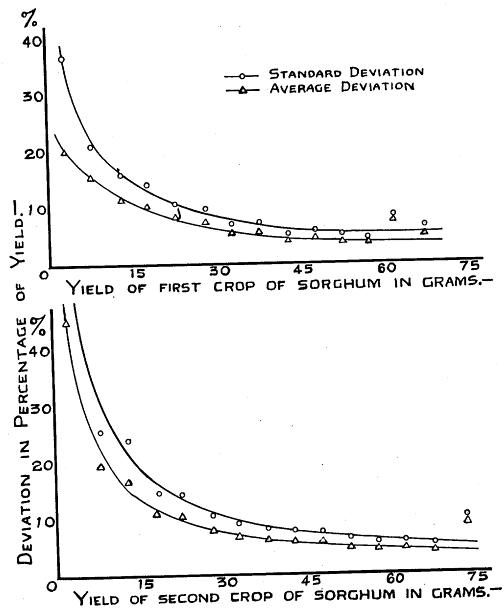



FIGURE 17.—Average and standard deviation of duplicates in percentage of yield and mean class yield of first and second crops of sorghum by class groups.

Field work has the advantage over greenhouse tests in that in the field the tests are made on the undisturbed soil and any desired crop can be grown. In greenhouse work, the soil is generally potted and not all crops are adapted to growth on pot cultures. Consequently, greenhouse tests are limited to those crops that are adapted to greenhouse growing conditions. The data obtained, however, in regard to the experimental variation may be more reliable than those obtained on field plots. This is due to the fact that all the soils may be tested under similar conditions. The variations in temperature, rainfall, and other climatic factors, such as exist from one locality to another in the field, are eliminated in greenhouse work. Furthermore, greenhouse work permits a large number of soils to be tested at the same time with a minimum amount of labor as compared with that required in field work. Thus, for the purpose of making fertilizer tests of a group of soils in order to determine the degree of uniformity of their response to given fertilizer treatments, greenhouse tests are preferable to field experiments.

The fertilizer tests in this work were designed to determine the deficiency of the soils, or their needs, for various fertilizing elements or treatments. No tests were made of the effects of rates of fertilizing the different soils. On treatments receiving phosphorus a quantity of phosphate calculated to supply sufficient phosphorus to produce a maximum crop was applied. Likewise, the amount of potash applied in treatments receiving potassium was sufficient to supply sufficient potassium to produce a maximum growth, i. e., to eliminate the need for potassium as a limiting factor of plant growth. The effect of the additions of nitrates, or of the need for nitrogen of the soils was not studied on any of the crops other than on the first crop of Austrian winter peas. Quantities of nitrate sufficient to eliminate nitrogen as a limiting factor of plant growth were supplied to the cultures of all other crops. The fact that different amounts of lime were applied to the different soils does not mean that rate of liming was studied. Since the amount of lime applied to the limed pots of each soil was the amount required to bring the reaction of the soil to pH 6.5, this treatment is a measure of the needs of the various soils for lime. Thus, we see that the results of the fertilizer tests in the greenhouse are measures of the deficiency of the soil, or of its need for that fertilizing element or treatment.

The difference in the yield obtained from the pot cultures receiving the complete fertilizer treatments (N P K) as compared with the yield of the pot cultures receiving only nitrogen and potash (N K) is a measure of increase in yield obtained by supplying phosphorus. Similarly, a comparison of the yields obtained from each of the other treatments to the yield of the N P K treatment shows the need of the soils for each of the various fertilizing treatments used. An analysis of the fertilizer treatments used in the greenhouse shows that from the yields of the first crop the following information may be obtained: (1) the yield when only nitrogen is supplied, (2) the yield without potash fertilization, (3) the yield without phosphate fertilization, (4) the yield of the soil when a complete fertilizer (N P K) is supplied, (5) the increase in yield of Austrian winter peas obtained from liming, and (6) and (7) the yield of Austrian winter peas with mineral fertilizers only, both without and with lime. Likewise, a comparison of the yields of the second crop shows the following in regard to yields of sorghum: (1) the yield without mineral fertilizers, (2) the increase in yield resulting from applications of phosphorus, (3) the increase in yields resulting from applications of potash, (4) the yield on the soils in response to a complete fertilizing treatment, (5) the effect upon yields of residual phosphate, (6) the yield in response to liming to pH 6.5 before the preceding crop, and (7) the effect upon yields of residual phosphate with lime. The fertilizer treatments of the third crop were the same as those for the second crop, and consequently provide the same comparisons. These data, however, show further the effect upon yield of the continued "cropping out" of the soil's supply of the fertilizing elements. They are of especial interest in studying the various soil's reserve supply of potash and phosphorus and in noting the decreasing residual effects of applications of phosphate.

The average yields on duplicate pot cultures of all treatments for the three crops on all soils and subsoils are given in the appendix. The yields, in grams of dry matter, are of greater value in studying the fertility of the various soils. For studying the uniformity of the soil types in response to applications of the various fertilizing elements, they are, however, unintelligible because the yield in response to the complete fertilizer (N P K) treatment varies from soil to soil. If the average yield on the duplicate pot cultures receiving the nitrogen and potash (N K) treatment for each and every soil the yield of the N K treatment is expressed in terms of percentage of the N P K treatment. Expressed in this fashion the N P K yield of each soil is 100 per cent. The difference in the percentage yield obtained from the N K treatment and 100 per cent, which represents the yield of the N P K treatment, is the percentage yield obtained from an application of phosphate and is due to phosphorus. Thus, the yield of each treatment can be expressed in percentage or parts per hundred of the N P K yield of that soil. The yields are thereby expressed in comparable terms and are adapted to direct observation and study of the uniformity of soil types in crop response to fertilizing elements.

The average yield on the duplicate pot cultures receiving the complete fertilizer (N P K) treatment and the yield of all the other treatments in percentage of the N P K yield for all crops on each and every soil are tabulated in the appendix.

The yields for all treatments have been likewise summarized by soil types. The number of samples represented in each type, the mean N P K yield in grams, and the mean yields of each of the other treatments in percentage of the mean N P K yield for each soil type included in this study are given in Tables 12, 13, and 14. The yields of the first crop are summarized in Table 12, the second crop in Table 13, and the third crop in Table 14.

In comparing the percentage average yields of the various treatments for the soil types as given in Tables 12, 13, and 14, respectively for each of the three successive crops to the percentage yields of the various treatments for each of the individual soils of each type as given in the appendix, it will be noted that the percentage average yields for the soil type given in Tables 12, 13, and 14 do not often coincide with the mean percentage yields for the soil types given in the tables in the appendix. It should be remembered that mean percentage yields given for the soil type in appendix tables are the arithmetic means of the percentage yields by treatment for all the soils of that type. Mathematically, all percentages are *rates,* i. e., *parts* *per hundred,* and as such their average is not properly expressed by the arithmetic mean. The averages of rates or ratios are suitably expressed by either of the averages, the geometric mean or the harmonic mean. Distinctively characterized, the averages of the mean yields by treatments for the soil types given in Tables 12, 13, and 14 are *percentage mean yields,* and the averages of the percentage yields by treatments given for the soil type in the appendix tables are *mean percentage yields.* They have the same value only (1) when all the percentage yields that are averaged have the same value as is the case of the percentage yield of the N P K-residual L yields of the second crop on the Amite sandy loam soils, or (2) when all the N P K-yields of the soils whose percentage yields by treatments to be averaged are the same as is the case of the yields of the second crop on the soils of the Akron loamy fine sand. In all other instances the arithmetic mean of a group of percentage yields in which one or more of the percentage yields are unusually high or low in comparison with others is correspondingly higher or lower than the *percentage average yield* of the same yields. This is especially evident in a comparison of the percentage mean yield to the mean percentage yield of the N P K L treatment for the first crop on the Norfolk fine sandy loam soils.

*The differences between various soil types in crop response to the fertilizing elements and treatments are shown by the percentage average yields for the soil types given in Tables 12, 13 and 14.*

*The differences between the various soils of the same type in crop response to the fertilizing elements and treatments are shown by the percentage yields of the soils of each type as given in the tables in the appendix.*

To evaluate the significance of the difference between types in crop response to the various fertilizer treatments as shown by the data in Tables 12, 13, and 14, the variation of the soils within the type as shown in the tables in the appendix should be consulted. For example, the average yield of the three soils of Norfolk sandy loam without potash treatment (N P) is 87.2 per cent of their average yield when potash was applied (yield of N P K treatment = 100 per cent). The corresponding average yield of seven Norfolk fine sandy loam soils is 73.9 per cent of their average yield when potash was applied. By simple comparison of these two soil types in their average response to potash, there is quite a difference between the types, but an examination of the tables of the percentage yields for the individual soils given in the appendix show that the percentage yields of the N P treatment on the separate soils of the Norfolk sandy loam ranged from 77.9 per cent to 96.3 per cent of their respective N P K yields, and on the Norfolk fine sandy loam they ranged from 55.4 per cent to over a hundred per cent of the

TABLE 12.—Summary by Soil Type of Percentage Average Yields of First Crop—Austrian Winter Peas. (Mean N P K yield = 100%)

| Soil type | Number of samples | Fertilizer treatment and yield | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mean N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | P K *per cent* | N P K L *per cent* | P K L *per cent* |
| Norfolk sandy loam | 3 | 9.27 | 59.4 | 98.2 | 60.1 | 79.9 | 114.4 | 109.0 |
| Norfolk fine sandy loam | 7 | 8.67 | 64.9 | 92.4 | 66.9 | 82.4 | 119.4 | 120.2 |
| Norfolk loamy fine sand | 3 | 9.47 | 62.5 | 99.6 | 74.0 | 92.4 | 100.7 | 91.7 |
| Norfolk fine sand | 6 | 7.93 | 61.1 | 96.8 | 63.2 | 77.5 | 110.7 | 102.1 |
| Norfolk sand | 2 | 5.65 | 24.8 | 100.9 | 25.7 | 68.1 | 91.1 | 84.1 |
| Norfolk loam | 1 | 16.60 | 77.7 | 75.3 | 74.1 | 85.5 | 100.0 | 81.9 |
| Greenville sandy loam* | 6 | 32.63 | 59.4 | 101.3 | 55.1 | xx | 103.0 | xx |
| Greenville fine sandy loam* | 6 | 34.92 | 57.6 | 93.9 | 60.1 | xx | 104.8 | xx |
| Greenville loamy sand* | 4 | 32.55 | 74.6 | 94.8 | 72.0 | xx | 101.1 | xx |
| Amite sandy loam* | 2 | 36.55 | 92.6 | 98.1 | 101.4 | xx | 104.8 | xx |
| Amite fine sandy loam* | 1 | 43.00 | 90.4 | 100.2 | 87.7 | xx | 100.2 | xx |
| Amite loamy fine sand* | 1 | 61.40 | 75.4 | 92.0 | 79.0 | xx | 94.3 | xx |
| Akron fine sandy loam* | 1 | 52.90 | 89.8 | 100.0 | 86.2 | xx | 97.4 | xx |
| Akron loamy fine sand* | 2 | 48.70 | 84.9 | 99.9 | 78.7 | xx | 102.4 | xx |
| Decatur clay loam | 5 | 7.34 | 76.8 | 103.3 | 79.3 | 90.5 | 125.1 | 108.7 |
| Decatur clay | 17 | 6.66 | 68.8 | 96.5 | 69.0 | 83.6 | 119.5 | 103.3 |
| Hartsells sandy loam | 3 | 2.07 | 62.9 | 89.7 | 67.7 | 54.8 | 167.7 | 121.0 |
| Hartsells fine sandy loam | 14 | 2.22 | 65.3 | 97.1 | 67.5 | 62.4 | 159.8 | 109.3 |
| Hartsells loam | 4 | 3.05 | 68.0 | 87.7 | 68.9 | 74.6 | 130.3 | 109.0 |
| Hartsells clay loam | 1 | 3.30 | 45.4 | 90.9 | 48.4 | 63.6 | 112.1 | 112.1 |
| Cecil sandy loam | 9 | 7.41 | 69.0 | 94.3 | 72.6 | 63.3 | 115.9 | 93.6 |
| Cecil loamy sand | 2 | 8.95 | 76.5 | 93.9 | 72.1 | 74.3 | 107.8 | 62.0 |
| Cecil sandy clay loam | 3 | 5.37 | 76.4 | 122.4 | 73.9 | 72.7 | 126.7 | 114.3 |
| Cecil clay loam | 3 | 7.30 | 74.9 | 101.4 | 68.0 | 97.3 | 122.8 | 91.8 |
| Cecil clay | 4 | 6.20 | 70.2 | 98.8 | 60.1 | 72.2 | 113.3 | 101.6 |
| Davidson clay | 1 | 4.20 | 59.5 | 92.9 | 69.0 | 71.4 | 123.8 | 116.7 |

*First crop was sorghum.
xx Sorghum was not grown on treatments not containing nitrogen.

**TABLE 13.—Summary by Soil Type of Percentage Average Yield of Second Crop—Sorghum. (Mean N P K yield = 100%)**

| Soil type | Number of samples | Fertilizer treatment and yield: Mean N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
|---|---|---|---|---|---|---|---|---|
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Norfolk sandy loam | 3 | 27.90 | 50.1 | 87.2 | 55.4 | 80.0 | 119.7 | 88.8 |
| Norfolk fine sandy loam | 7 | 23.39 | 47.8 | 73.9 | 52.9 | 76.5 | 132.4 | 106.5 |
| Norfolk loamy fine sand | 3 | 29.07 | 54.2 | 84.7 | 57.3 | 76.1 | 133.0 | 118.3 |
| Norfolk fine sand | 6 | 34.50 | 34.4 | 61.8 | 41.2 | 70.8 | 109.0 | 92.4 |
| Norfolk sand | 2 | 26.40 | 2.1 | 62.5 | 2.1 | 31.6 | 107.0 | 28.4 |
| Norfolk loam | 1 | 34.40 | 34.3 | 82.3 | 32.0 | 70.3 | 100.9 | 68.3 |
| Greenville sandy loam | 6 | 35.37 | 36.7 | 50.0 | 60.4 | 64.5 | 105.6 | 66.7 |
| Greenville fine sandy loam | 6 | 44.43 | 43.2 | 61.4 | 58.2 | 65.3 | 97.2 | 83.9 |
| Greenville loamy sand | 4 | 28.33 | 20.6 | 25.1 | 42.7 | 41.0 | 89.8 | 70.1 |
| Amite sandy loam | 2 | 58.65 | 54.3 | 73.7 | 66.4 | 81.3 | 103.5 | 82.4 |
| Amite fine sandy loam | 1 | 40.20 | 29.6 | 18.2 | 66.2 | 61.9 | 93.3 | 82.1 |
| Amite loamy fine sand | 1 | 48.30 | 69.8 | 49.7 | 86.1 | 82.8 | 130.4 | 126.5 |
| Akron fine sandy loam | 1 | 49.50 | 73.9 | 91.7 | 70.1 | 78.4 | 119.6 | 109.3 |
| Akron loamy fine sand | 2 | 49.45 | 55.7 | 35.0 | 81.3 | 79.7 | 116.6 | 93.1 |
| Decatur clay loam | 5 | 40.86 | 34.9 | 92.7 | 35.8 | 58.7 | 96.1 | 79.1 |
| Decatur clay | 17 | 37.54 | 26.8 | 100.1 | 26.9 | 54.4 | 110.6 | 63.7 |
| Hartsells sandy loam | 3 | 28.87 | 34.4 | 77.9 | 34.2 | 61.3 | 112.6 | 84.6 |
| Hartsells fine sandy loam | 14 | 24.06 | 27.6 | 95.2 | 33.7 | 52.9 | 111.2 | 75.9 |
| Hartsells loam | 4 | 29.70 | 41.7 | 83.2 | 33.3 | 67.5 | 120.1 | 86.4 |
| Hartsells clay loam | 1 | 51.00 | 3.5 | 86.3 | 3.5 | 37.4 | 99.4 | 39.2 |
| Cecil sandy loam | 9 | 46.56 | 46.6 | 83.3 | 54.3 | 83.1 | 115.5 | 94.6 |
| Cecil loamy sand | 2 | 43.30 | 50.7 | 60.4 | 70.0 | 80.1 | 124.7 | 100.2 |
| Cecil sandy clay loam | 3 | 46.53 | 36.6 | 96.3 | 43.3 | 71.8 | 114.9 | 88.0 |
| Cecil clay loam | 3 | 47.63 | 50.7 | 96.6 | 67.7 | 84.3 | 111.1 | 93.1 |
| Cecil clay | 4 | 47.18 | 28.3 | 87.3 | 25.2 | 64.4 | 117.7 | 82.5 |
| Davidson clay | 1 | 53.40 | 41.4 | 94.8 | 36.1 | 60.7 | 125.4 | 91.0 |

**TABLE 14.—Summary by Soil Type of Percentage Average Yields of Third Crop—Sorghum. (Mean N P K yield = 100%)**

| Soil type | Number of samples | Fertilizer treatment and yield | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mean N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | N K Residual P *per cent* | N P K Residual L *per cent* | N K Residual P L *per cent* |
| Norfolk sandy loam | 3 | 32.90 | 22.2 | 47.1 | 42.3 | 48.8 | 90.5 | 41.9 |
| Norfolk fine sandy loam | 7 | 26.11 | 35.4 | 55.7 | 46.2 | 63.6 | 125.5 | 68.8 |
| Norfolk loamy fine sand | 3 | 27.80 | 31.5 | 65.9 | 36.8 | 45.9 | 137.6 | 93.5 |
| Norfolk fine sand | 6 | 22.52 | 24.8 | 30.6 | 36.4 | 67.3 | 126.4 | 75.9 |
| Norfolk sand | 2 | 29.40 | 1.0 | 35.0 | 0.9 | 21.4 | 89.8 | 15.0 |
| Norfolk loam | 1 | 39.00 | 5.4 | 62.6 | 11.3 | 30.3 | 102.1 | 29.7 |
| Greenville sandy loam* | 6 | 5.78 | 40.1 | 66.3 | 53.0 | 63.7 | 96.0 | 72.0 |
| Greenville fine sandy loam* | 6 | 5.28 | 46.1 | 72.9 | 64.0 | 73.2 | 107.3 | 78.5 |
| Greenville loamy sand* | 4 | 4.70 | 48.4 | 75.0 | 49.4 | 78.7 | 117.6 | 79.3 |
| Amite sandy loam* | 2 | 6.95 | 54.0 | 59.0 | 85.6 | 95.7 | 105.8 | 99.3 |
| Amite fine sandy loam* | 1 | 6.20 | 25.8 | 54.8 | 37.1 | 66.1 | 93.5 | 58.1 |
| Amite loamy fine sand* | 1 | 8.10 | 37.0 | 59.3 | 49.4 | 84.0 | 88.9 | 81.4 |
| Akron fine sandy loam* | 1 | 6.80 | 45.6 | 66.2 | 75.0 | 75.0 | 100.0 | 79.4 |
| Akron loamy fine sand* | 2 | 6.70 | 55.2 | 67.2 | 75.4 | 86.6 | 104.5 | 86.6 |
| Decatur clay loam | 5 | 46.18 | 36.7 | 77.0 | 38.9 | 58.6 | 104.9 | 83.5 |
| Decatur clay | 17 | 48.28 | 27.6 | 86.0 | 31.9 | 47.6 | 106.4 | 57.5 |
| Hartsells sandy loam | 3 | 45.43 | 62.7 | 71.0 | 92.1 | 88.1 | 113.9 | 113.7 |
| Hartsells fine sandy loam | 14 | 50.87 | 40.8 | 62.3 | 54.3 | 72.7 | 111.7 | 88.0 |
| Hartsells loam | 4 | 50.18 | 30.6 | 73.9 | 41.6 | 50.6 | 109.7 | 73.1 |
| Hartsells clay loam | 1 | 46.20 | 5.2 | 83.8 | 3.2 | 22.9 | 134.8 | 59.1 |
| Cecil sandy loam | 9 | 33.70 | 26.3 | 45.5 | 56.2 | 72.0 | 111.5 | 84.4 |
| Cecil loamy sand | 2 | 24.45 | 13.5 | 38.8 | 60.3 | 100.6 | 140.5 | 125.8 |
| Cecil sandy clay loam | 3 | 32.80 | 13.8 | 75.5 | 21.7 | 42.0 | 107.4 | 77.0 |
| Cecil clay loam | 3 | 38.03 | 36.8 | 42.1 | 48.7 | 79.2 | 105.3 | 105.0 |
| Cecil clay | 4 | 39.13 | 17.7 | 75.2 | 15.0 | 54.7 | 111.5 | 54.8 |
| Davidson clay | 1 | 33.10 | 16.0 | 62.5 | 25.4 | 29.4 | 109.1 | 80.7 |

*Third crop was Austrian winter peas.

N P K yield. The percentage average yields of the soils of the Norfolk sandy loam in response to potash all fall within the range of the corresponding percentage average yields of the soils of the Norfolk fine sandy loam. Consequently, although there is quite a difference in the percentage average yields of the two soil types in response to potash *the difference is not in the least uniform for the soil type.* It will be noted that, almost without exception, the variation within a soil type in crops response to the fertilizer treatments is greater than the variation or difference between the different soil types. In fact, the variation between the soils of the same type in response to the various treatments is so great that no attempt is made to statistically evaluate the variation. Its magnitude is apparent in the most cursory examination of the data.

Of the few instances in which the percentage average yields for any treatment on the soils of any type are quite uniform for the soils of that type, the number of soils of the type are insufficient to permit the drawing of any sound conclusions regarding the uniformity of the type. This variation of the soils of a given type in response to various fertilizing elements has been previously observed and commented upon by Lyon (15). His results with a relatively limited number of soils showed a variation of the soil type quite comparable to those found in this study.

The variation in soils of the same type in response to phosphorus is illustrated by the photographs of both the first and second crops of sorghum on the two Greenville sandy loam soils reproduced in Plates I and II. The illustration in Plate II shows, not only the difference in response to phosphorus, but also a difference in the response to lime and to the residual effect of phosphorus with lime. From a comparison of the yields of the second crop of sorghum on the Greenville sandy loam soils Nos. 799-A and 801-A as shown in Plate II and given in the tables in the appendix, it seems that the response of the sorghum to liming is best explained by the effect of the lime upon the phosphate in the soil. Scarseth (23) has recently published data showing that either an increased yield or a "liming injury" obtained in response to an application of lime may be due to the effect of the lime upon soil phosphate.

Differences in the response to the various fertilizing elements and fertilizer treatments of soils of the following soil types, Hartsells loam, Decatur clay, and Norfolk sand, are shown in Plates III, IV, V, and VI. The differences in response shown are substantiated by the yields of the crops as tabulated in the appendix.

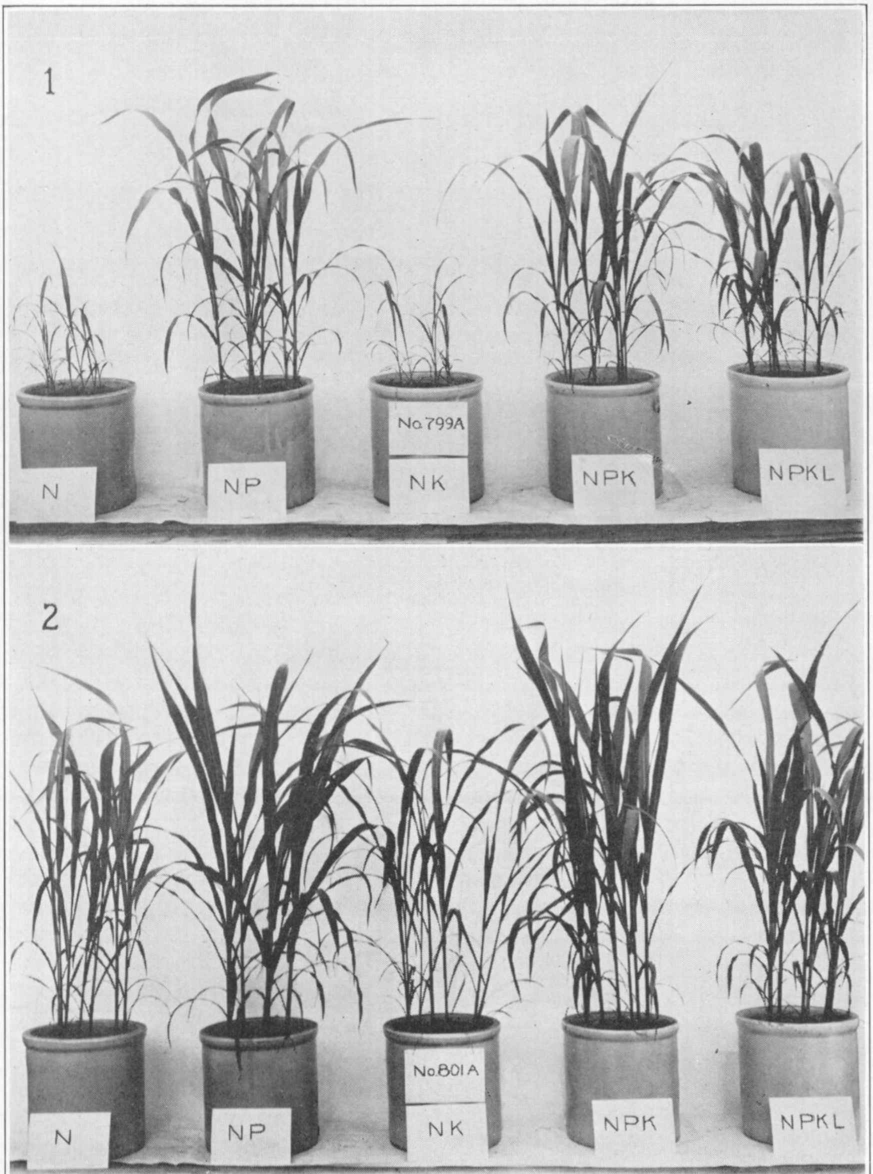
The growth of the third consecutive crop on the soils was of greater value in indicating the reserve supply of potassium and phosphorus of the soil, and in studying the residual effect of phosphate applications. On the cultures receiving only nitrogen and phosphorus (N P treatment), the yield of the crops in comparison with the N P K yield is a measure of the soil's need or supply of potassium. On many of the sandier soils there was a progressive decrease of the N P yield of the second and third crops. On a few of the soils the type of growth obtained on the N P cultures was that of typical potash starvation. It is nicely illustrated in photographs reproduced in Plates V and VI. The growth shown in Plate V shows a moderate potash starvation while that shown in Plate VI is typical of the extreme potash shortage found in some soils.

This shortage of potash that developed in some of the soils and was evident in the growth and yields of the second and third crops was not uniform throughout the soils of a given type. However, there were certain interesting relations between the soil type and particularly the soil series and the growth obtained on the N P- and N K-treated cultures. These will be pointed out and discussed in the discussion of the differences between different soil series.

The variation of the soils within the soil type in their response to all the fertilizing elements and fertilizer treatments tested in this work is beyond doubt attributable to the cultural and fertility practices to which they had been subjected in the field. It is a generally recognized practice of agricultural experimental work to make some determination or test of the soil acidity as a basis for recommendations for liming. No one entertains the thought that all the soils of the same type would require equal amounts of lime to bring them all to the same condition of optimum productivity. In the agricultural area represented by the soils included in this study the cultural, fertilizer, and farm management practices followed on the farm affect the soil's natural level of fertility to an extent comparable to the extent to which the soil acidity is affected. Under these conditions it should require no greater stretch of the imagination to perceive that the soils of a soil type may be equally as variable in their response to any specific fertilizer treatment or fertilizing element as they are to an application of lime.

**The Differences Between Soil Series and Between Soil Types in Crop Response to Fertilizing Elements.**—It has been pointed out that the soils of the soil type are not uniform in their crop response to fertilizing elements. In view of this fact alone it appears that there should be no significant difference between the various types within a soil series in crop response to fertilizing elements unless the behavior of the element considered is such that it is affected by the textures of the types within that series. This being the case, the difference in the crop response of the soil types of a series to any fertilizing element should in

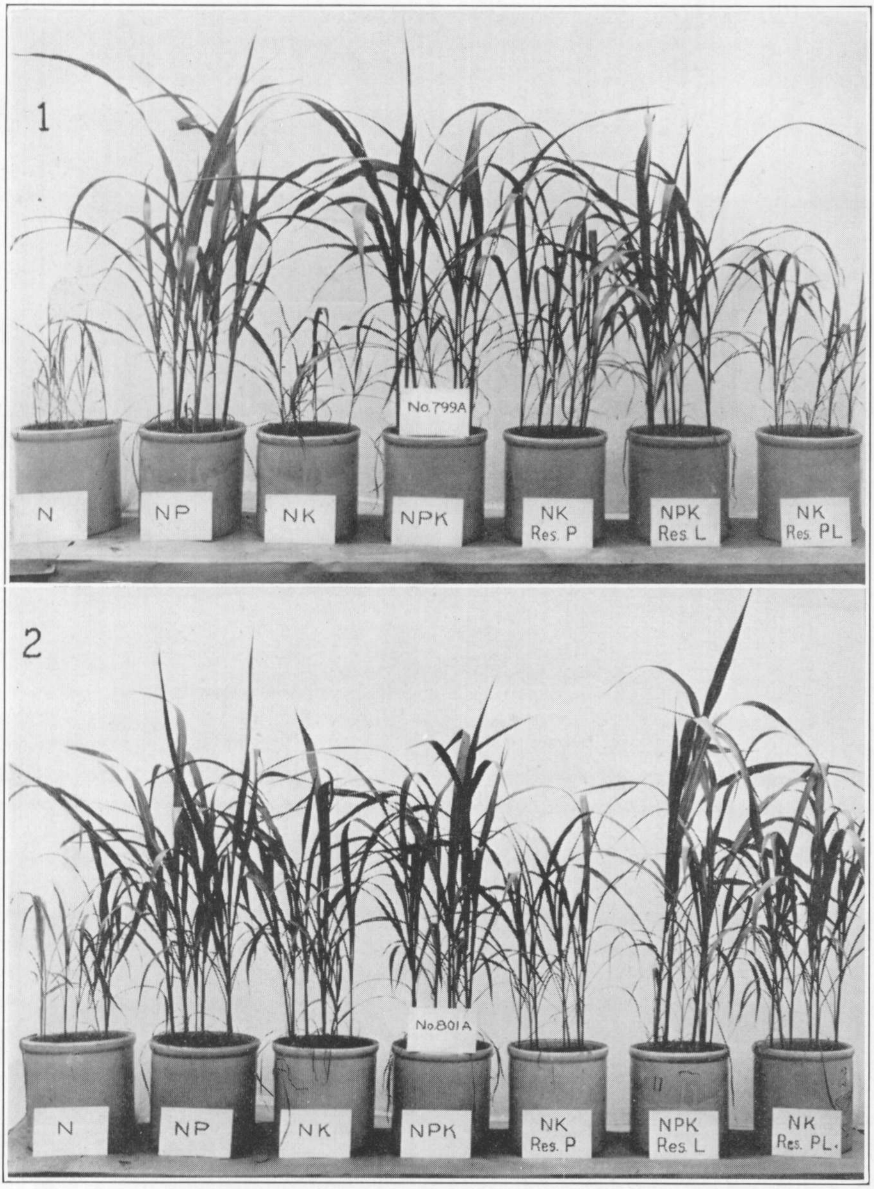
**PLATE I**




**1. First Crop Sorghum—Soil No. 799-A**
**2. First Crop Sorghum—Soil No. 801-A**

Showing the differences in response to phosphorus of soils of the same type—Greenville sandy loam.

## PLATE II




**1. Second Crop Sorghum—Soil No. 799-A**
**2. Second Crop Sorghum—Soil No. 801-A**

Showing the differences in response to (1) phosphorus, (2) lime, and (3) residual effect of phosphorus with lime on soils of the same type—Greenville sandy loam.

PLATE III


**1. Second Crop Sorghum—Soil No. 916-A**
**2. Second Crop Sorghum—Soil No. 917-A**

Showing the differences in response to (1) phosphorus, and (2) residual phosphorus both with and without lime on soils of the same type—Hartsells loam.

PLATE IV


**1. Third Crop Sorghum—Soil No. 916-A**
**2. Third Crop Sorghum—Soil No. 917-A**

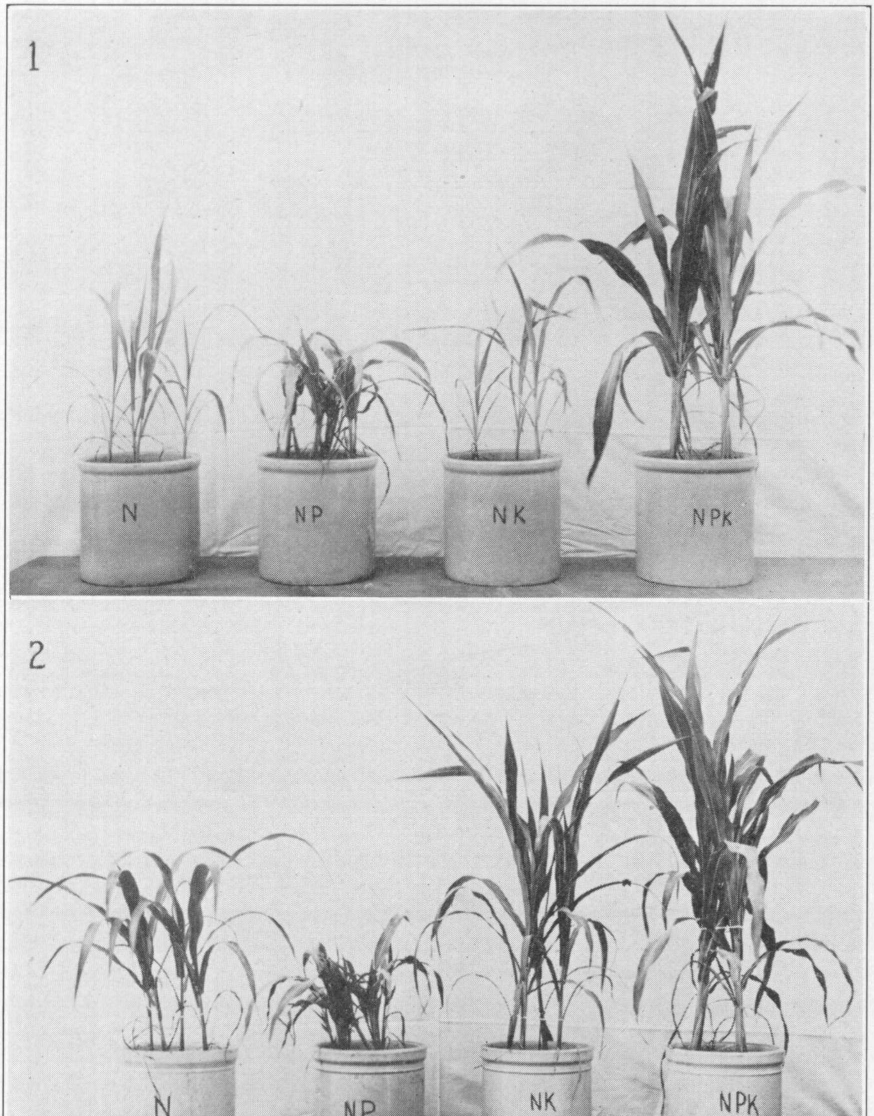
Showing the differences in response to (1) potassium, (2) phosphorus, (3) lime, (4) residual phosphate without lime, and (5) residual phosphate with lime on soils of the same type—Hartsells loam.

## PLATE V


**1. Third Crop Sorghum—Soil No. 887-A**
**2. Third Crop Sorghum—Soil No. 888-A**

Showing the differences in response to (1) phosphorus, (2) lime, (3) residual phosphate both with and without lime and the difference in reserve supply of potassium as shown by continued cropping without potassium treatment on soils of the same type—Decatur clay.

## PLATE VI




**1. Third Crop Sorghum—Soil No. 781**
**2. Third Crop Sorghum—Soil No. 794**

Showing the difference in the response to phosphorus of different samples of Norfolk sand and the extreme potash shortage evidenced by the growth of the third crop with no application of potash.

general be predictable from a knowledge of the nature of the behavior of the element in the soil. In other words, the differences between the various types of the same soil series in their crop response should be explainable on the basis of the behavior of the element in relation to soil texture. For the most part this is true of the results obtained in this work. It is possible, however, that the crop adaptiveness of a soil type might have so affected the cropping and fertilizing practices followed on the majority of that type as to result in the soils of the type being quite different from the soils of other types in their crop response to some fertilizer treatments.

Since the characteristics upon which the soil series are differentiated one from another may have resulted from any one or several of quite a variety of causes or factors affecting these characteristics, it is logical to expect that there are certain broad general differences between different soil series in crop response to fertilizing elements. This is found to be true. As has been previously pointed out, the variation of the soils within a type is so great as to make questionable the significance of the difference between different soil types. Nevertheless, certain general differences between soil types and between soil series in their crop response to fertilizer treatments are apparent in the results of the greenhouse work and will be pointed out herein. The fact that the data showing these differences might not be significant if subjected to statistical methods for measuring significance, does not necessarily invalidate all the significance of such differences. The differences pointed out are seldom, if ever, universally uniform for all the members of the soil series or soil types compared. They are usually true of only a part of the soils involved in the comparison, but true of a sufficient number to make the tendency worth noting.

The summary of the greenhouse yields by soil types for the three successive crops has been given in Tables 12, 13, and 14, respectively. A similar summary of the greenhouse yields by soil series is given in Table 15.

The percentage yields (N P K yield for each soil = 100 per cent) of each crop in response to certain of the treatments are shown in Figures 18 to 28, inclusive. In view of the generally wide variation of the soils within the type and also within the series in their response to fertilizing elements and treatments, they have been grouped without regard to type in these figures. Only soils of the Hartsells series are included in the Hartsells group. Likewise, all soils shown in both the Norfolk and Decatur groups are of the Norfolk and Decatur series, respectively. The Davidson clay is included in the Cecil group and all soils of the Amite, Akron, and Greenville series are ranked in the group designated as the Greenville group. In these Figures, 18 to 28, inclusive, all the percentage yields for a given crop and treatment on each of the soils within the group, are shown graphically arranged by rank. The graphs not only show the variation in percentage yield on the soils by groups or series, but also show quite plainly the general differences between the different soil series or groups in response to the various fertilizer treatments. Reference will be made to these figures in connection with the discussion of the point which they illustrate.

*Potassium.*—As shown in Table 15 (N P treatment) there was no great need for applications of potash by the first crop on any of the soil series (See Figures 18* and 29). The natural supply of available potassium in some of the soils is, however, very limited as shown by the response obtained by the two successive crops. The yields of the second crop as shown in Table 15 show definitely that the soils can be separated into two distinct groups in regard to their response to potash. The yields of the second crop on the Decatur, Davidson, Hartsells, and Cecil soils held up remarkably well, while those on the Norfolk and Greenville soils were considerably decreased in comparison with the average of the others. This relationship is fully and distinctly shown in Figure 19. The yields of the third crop without potash substantiates the trend shown by the second. The average percentage yield without potash on the Decatur soils shows a significant decrease and examination of the data shows that in general the soils having the greatest potash deficiency are those of the lower valleys, i. e., valleys other than the Tennessee River valley.

In regard to the response to the types within the series, it is interesting to note that without potash treatment the Norfolk sand gave practically a crop failure and the Greenville loamy sand yields were significantly decreased. The response of the Hartsells clay loam in comparison with the other soils of the Hartsells series is without doubt explainable on the basis of its previous cultural treatment.

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*Note: In Figures 18 to 28, inclusive, the experimental values for the percentage yields of the soil samples taken from the Experimental Substations and Fields are denoted as follows:

| Soil No. | Field or Substation | Location | Symbol | Soil Series |
|---|---|---|---|---|
| 775 | Gulf Coast Substation | Fairhope, Ala. | GC | Norfolk |
| 778 | Brewton Field | Brewton, Ala. | B | Norfolk |
| 780 | Andalusia Field | Andalusia, Ala. | An | Norfolk |
| 790 | Wiregrass Substation | Headland, Ala. | WG | Norfolk |
| 799 | Gulf Coast Substation | Fairhope, Ala. | GC | Greenville |
| 819 | Prattville Field | Prattville, Ala. | P | Greenville |
| 889 | Alexandria Field | Alexandria, Ala. | A | Decatur |
| 901 | Tennessee Valley Substation | Belle Mina, Ala. | TV | Decatur |
| 928 | Sand Mountain Substation | Crossville, Ala. | SM | Hartsells |
| 950 | Dept. of Horticulture bins | Auburn, Ala. | H | Cecil |

**TABLE 15.—Summary by Soil Series of Percentage Average Yields of All Crops.**

**(Mean N P K yield = 100%)**

| Soil series | Number of samples | Fertilizer treatment and yield of first crop—Austrian winter peas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mean N P K yield *grams* | N First crop *per cent* | N P First crop *per cent* | N K First crop *per cent* | P K First crop *per cent* | NPKL First crop *per cent* | P K L First crop *per cent* |
| Norfolk | 22 | 8.76 | 61.6 | 94.5 | 64.3 | 81.7 | 110.4 | 104.5 |
| Greenville* | 16 | 33.47 | 62.4 | 96.8 | 61.1 | xx | 103.2 | xx |
| Amite* | 4 | 44.38 | 86.1 | 96.5 | 90.3 | xx | 100.1 | xx |
| Akron* | 3 | 50.10 | 86.6 | 99.9 | 81.4 | xx | 100.6 | xx |
| Decatur | 22 | 6.82 | 70.8 | 98.1 | 71.5 | 85.3 | 120.9 | 104.6 |
| Hartsells | 22 | 2.40 | 64.4 | 98.6 | 66.7 | 64.4 | 150.9 | 110.8 |
| Cecil | 21 | 7.02 | 71.8 | 99.1 | 69.9 | 72.2 | 116.7 | 93.1 |
| Davidson | 1 | 4.20 | 59.5 | 92.9 | 69.0 | 71.4 | 123.8 | 116.7 |

| Soil series | Number of samples | Fertilizer treatment and yield of second crop—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mean N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | N K Resid-ual P *per cent* | N P K Resid-ual L *per cent* | N K Resid-ual PL *per cent* |
| Norfolk | 22 | 28.58 | 40.0 | 72.7 | 44.6 | 70.9 | 119.3 | 92.5 |
| Greenville | 16 | 37.01 | 36.6 | 50.3 | 56.0 | 60.3 | 98.8 | 75.1 |
| Amite | 4 | 51.45 | 53.1 | 57.2 | 71.0 | 77.9 | 107.8 | 92.7 |
| Akron | 3 | 49.47 | 61.8 | 53.9 | 77.6 | 85.9 | 117.6 | 98.5 |
| Decatur | 22 | 38.29 | 28.8 | 98.3 | 29.0 | 55.4 | 107.1 | 67.4 |
| Hartsells | 22 | 26.97 | 29.4 | 89.5 | 31.1 | 55.8 | 112.2 | 76.3 |
| Cecil | 21 | 46.51 | 42.6 | 85.9 | 50.5 | 77.8 | 116.0 | 91.6 |
| Davidson | 1 | 53.40 | 41.4 | 94.8 | 36.1 | 60.8 | 125.5 | 91.0 |

| Soil series | Number of samples | Fertilizer treatment and yield of third crop—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mean N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | N K Resid-ual P *per cent* | N P K Resid-ual L *per cent* | N K Resid-ual PL *per cent* |
| Norfolk | 22 | 27.17 | 25.0 | 48.5 | 35.3 | 53.2 | 116.6 | 61.6 |
| Greenville** | 16 | 5.33 | 44.1 | 70.5 | 56.3 | 70.5 | 104.9 | 76.1 |
| Amite** | 4 | 7.05 | 42.9 | 58.2 | 64.5 | 85.8 | 98.2 | 85.1 |
| Akron** | 3 | 6.73 | 52.0 | 66.8 | 75.2 | 87.7 | 103.0 | 84.2 |
| Decatur | 22 | 47.80 | 29.6 | 84.0 | 33.4 | 50.1 | 106.1 | 63.2 |
| Hartsells | 22 | 49.79 | 40.2 | 66.4 | 54.5 | 68.5 | 112.6 | 87.3 |
| Cecil | 21 | 34.34 | 23.5 | 55.0 | 41.7 | 67.2 | 111.9 | 83.1 |
| Davidson | 1 | 33.10 | 16.0 | 62.5 | 25.4 | 28.4 | 109.1 | 80.7 |

*The first crop on the Greenville, Amite, and Akron soils was sorghum.

xx Sorghum was not grown on treatments not containing nitrogen.

**The third crop on the Greenville, Amite, and Akron soils was Austrian winter peas.

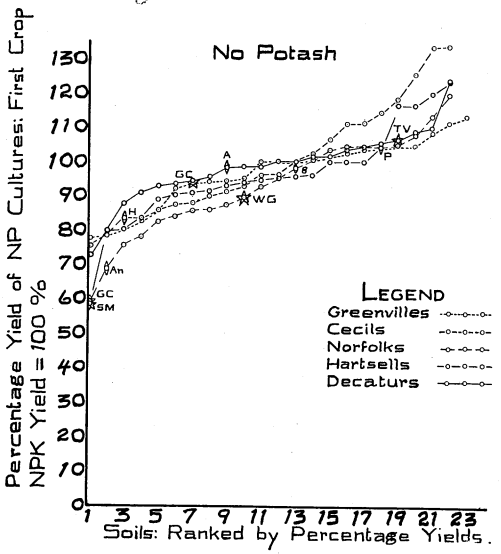


FIGURE 18.—Variation in soil series.

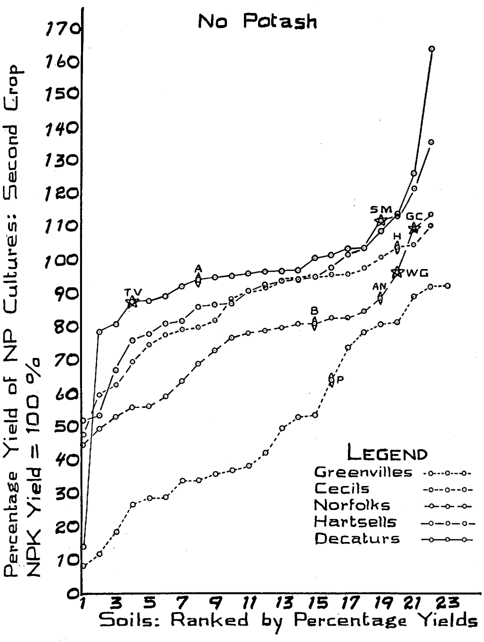


FIGURE 19.—Variation in soil series.

*Phosphorus.* — The need of the soils for phosphorus is shown by comparing the yields obtained on the N K treatment with those obtained in response to the N P K treatment. A need for phosphorus is shown on many of the soils with the first crop. The soils of all series other than those of the Amite and Akron gave about the same average response to phosphate for the first crop (Figure 20). The limited response to phosphorus on the soils of the Amite and Akron series is probably due to previous cultural practices. The response of the second and third crop to phosphorus shows interesting differences in the soil series. The greatest drops in yield as a result of continuous cropping without applications of phosphorus occurred on the soils of the Decatur and Hartsells series. This decrease was appreciable on the Greenville and Cecil but nevertheless it was considerably less than that on the Decatur and Hartsells. The Norfolks occupy an intermediate position (see Figures 21 and 30).

The differences in the various soil types in their average response to phosphate is quite characteristic (see Tables 13 and 14). The average yield without phosphorus on the Greenville fine sandy loam is well maintained in comparison with the corresponding yields on the Greenville sandy loam and loamy sand. This would indicate that the fine sandy loam has on the average a greater reserve supply of phosphorus. The yields of the second and third crops in response to phosphorus on the soils of the Amite and Akron series is entirely too variable to even permit a generalization. The same is true of all the types of the Norfolk and Hartsells series other than the Norfolk sand and Hartsells clay loam. The yield on both these types without phosphorus is quite low.

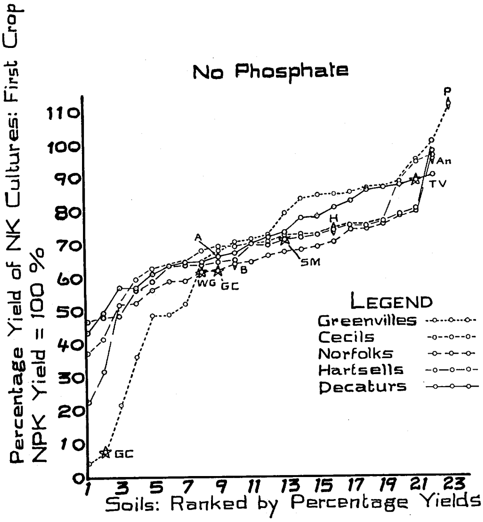


FIGURE 20.—Variation in soil series.

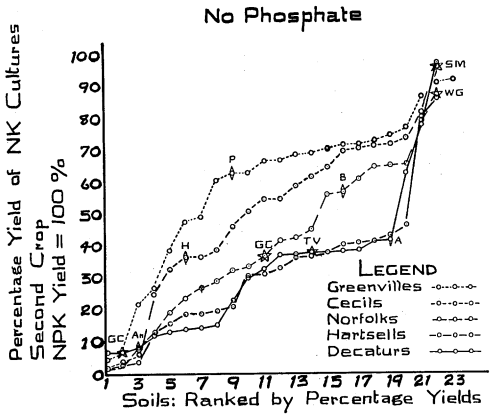


FIGURE 21.—Variation in soil series.

Probably the most interesting comparison of the response of the soil types to phosphorus is that of the Decatur and Cecil clay loams to the Decatur and Cecil clays, respectively. This comparison characterizes the nature of the behavior of phosphate in the soil and also the needs of the soils for phosphate fertilization. It will be noted that in both instances the yields of the clay soils without phosphorus treatment is considerably less than that of the clay loams. If the textures of the soils of the Cecil and Decatur series are being changed to clay as the result of surface erosion of the normally lighter-textured surface material, a greater need for phosphorus would be expected. The surface horizon of an undisturbed soil is usually higher in available-phosphate content than the subsoil horizons. This fact is most conclusively established by the responses obtained on all subsoils. Typical

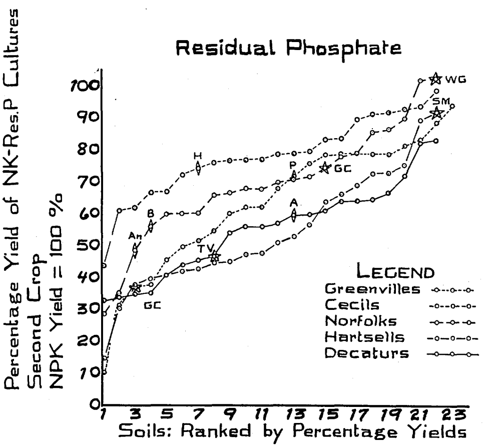


FIGURE 22.—Variation in soil series.

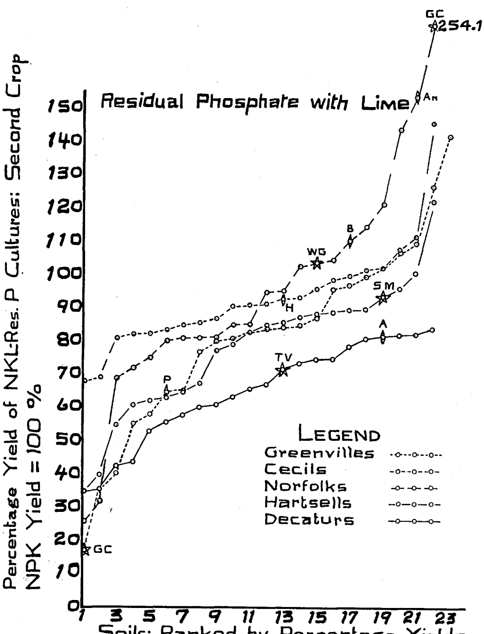


FIGURE 23.—Variation in soil series.

of all subsoils is the response illustrated in Plate VII.

*Residual Effect of Phosphorus.* — The response of the soils to the effect of residual phosphate is shown in the yields of the second and third crops. The response of both soil series and types to residual phosphate is just what would be expected from their response to phosphorus as shown by the yields from the treatments receiving no phosphate (N K treatment). The greatest information is gathered from these data by a comparison of the responses obtained from residual phosphate without lime to the responses obtained from residual phosphate with lime. These are shown for all soils in Figures 22, 23, and 32.

The yield in response to the effect of residual phosphate is the largest on the Amite and Akron series; the yields of the Cecil and Norfolk are somewhat higher than those of the Davidson, Greenville, Hartsells, and Decatur. This results in the soils of the Cecil, Norfolk, and Greenville groups giving comparatively greater yields in response to residual phosphate than the soils of the Decatur and Hartsells groups as shown in Figure 22.

The yields in response to the effect of residual phosphate when lime is applied are quite remarkable in comparison with

## PLATE VII


**1. Second Crop Sorghum—Soil No. 901-A**
**2. Second Crop Sorghum—Soil No. 901-B**

Showing the characteristic response of all subsoils to the fertilizer treatments in comparison to response of the surface soil. Decatur clay loam.

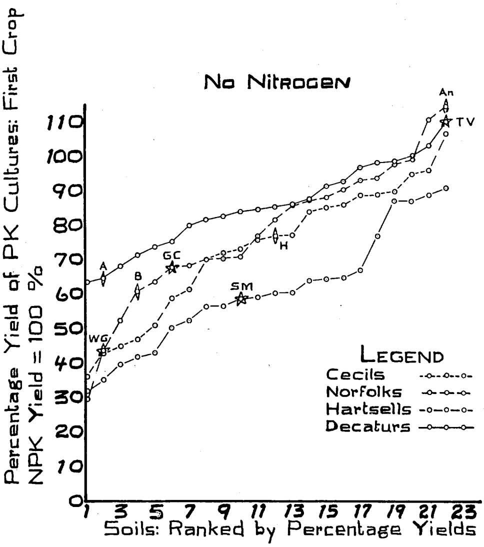


FIGURE 24.—Variation in soil series.

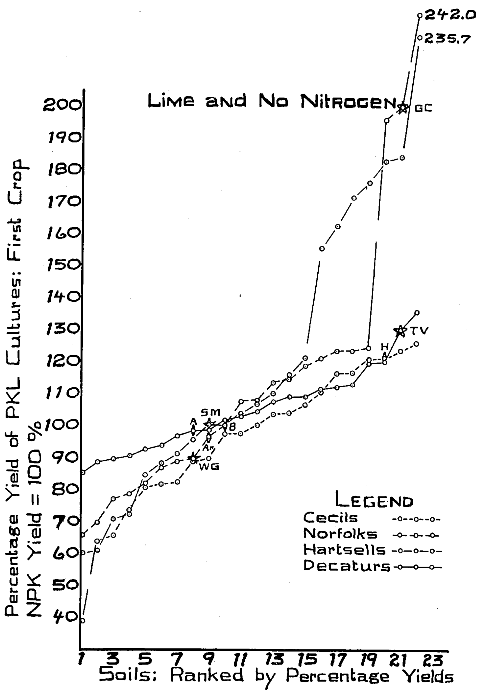


FIGURE 25.—Variation in soil series.

those of the soils without lime on all soils. (Compare Figures 22 and 23.) The increase of the yields in response to residual phosphate and lime in comparison with the residual phosphate without lime is least on those soils derived from limestone or calcareous deposits; namely, the Decatur and Greenville series.

Variation in the response to residual phosphate with lime as compared with residual phosphate without lime is so great within the soil type that there is no consistent difference between types.

*Nitrogen.*—No study was made of the response of the soils to nitrogen other than on the first crop grown and then only when the crop was Austrian winter peas. Consequently, there are no data on the response of the soils of the Greenville, Amite, and Akron series to nitrogen. The percentage yields from the P K and P K L treatments on the soils of the Norfolk, Cecil, Hartsells, and Decatur series are shown graphically in Figures 24 and 25, respectively. A comparison of the two figures and of the corresponding data given in Table 15 demonstrates that the yields obtained on the P K treat-

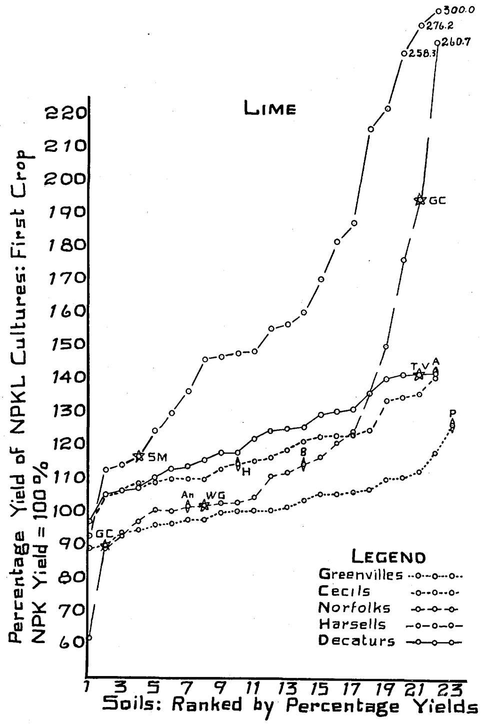

FIGURE 26.—Variation in soil series.

ment are determined by the need of the soils for lime rather than nitrogen. That is to say, that, as the limiting factor of plant growth or crop yield of Austrian winter peas, the lime overshadows nitrogen.

*Lime.* — The percentage yields of the first and second crops on the N P K L-treated cultures of all soils are shown in Figures 26 and 27. A glance at them shows the response of the soils of the various groups are nicely delineated by the yields of the first crops. These yields of the first crop will be of value in determining what laboratory analysis of soils most correctly indicates the need of the soil for lime. The yields of the second and third crops on the limed cultures are generally larger than those of the unlimed cultures.

The variation within the various soil types in response to lime is so great that no comparisons can be made of the response of soil type to lime. The average responses of the soil types to lime are shown in Figure 31.

The most useful information from the data is most likely that which can be obtained by analysis of the results regardless of soil type. The number and percentage of the soils which produced increased yields in response to liming to pH 6.5 are summarized in Table 16. Seventy-five per cent of the soils studied gave an increase of 9.0 per cent or more in the yield of Austrian winter peas in response to lime. The number of soils on which the difference between the yield of Austrian winter peas with lime and without lime was so great as to indicate a practical crop failure when not limed; this was 12.5 per cent of the total number of soils studied. A study of the percentage yields given in appendix tables and of Figures 26 and 27 shows that a sharp decrease in yield from the application of lime resulted on only three or four soils. It is believed that these results indicate

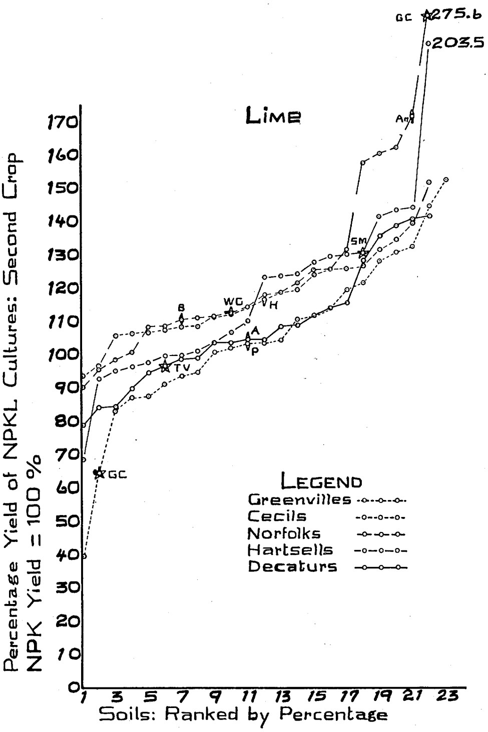


FIGURE 27.—Variation in soil series.

fairly accurately the need of the soils of the state for lime under field conditions.

*Complete Fertilizer (N P K).*—Whether in the greenhouse or in the field, the yields obtained on a number of different soils, given exactly the same fertilizer treatment and handled in the same manner, will vary from one soil to another. This variation is not the normal experimental error of yields obtained on duplicate or replicate treatments of the same soil. Its magnitude is much greater than that of ordinary experimental variation. It can be attributed only to the factors that affect the productiveness of the soils. These factors are innumerable, and although they could be classified in a completed classification, it is certain that they are not as yet all known to science.

This variation in yields of the cultures receiving a complete fertilizer (N P K treatment) is shown by soil series or groups of series in Figure 28.

**Fertility Deficiencies of Subsoils as Shown by Crop Response.**—The averages of duplicate yields for the various fertilizer treatments on the subsoils studied in this work are given in the tables in the appendix. The main points of interest in regard to the subsoil yields are: (1) the tremendous response of sorghum to phosphate applications when nitrogen is supplied, (2) the generally large increase in yields of both peas and sorghum resulting from liming where nitrogen, phosphorus, and potassium are supplied, (3) the complete failure of sorghum on the subsoil of soil No. 914 on all cultures except those receiving lime, and (4) the increased yields of the successive crops of sorghum on the cultures receiving complete (N P K) fertilization.

From these observations concerning the yields on the subsoils the following generalizations may be made regarding the fertility deficiencies of subsoil: (1) normally, subsoils are extremely deficient in available phosphate, (2) they are moderately deficient in available potassium, (3) the reaction of subsoils may be so acid as to result in complete failure of such crops as sorghum, (4) applications of lime almost invariably result in increased yields of crops when complete fertilizer was also used, (5) the productiveness of subsoils is increased from crop to crop when each crop received an application of a complete fertilizer, and (6) the phosphorus supplied by applications of superphosphate is made unavailable to plants to much greater extent by subsoils than it is by surface soils.

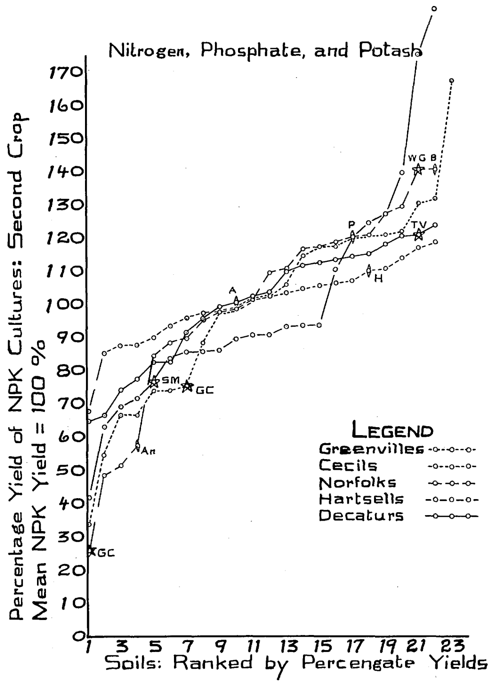


FIGURE 28.—Variation in soil series.

The characteristic growth of sorghum in response to the various fertilizer treatments on the subsoil and surface soil of a Decatur clay loam is illustrated in Plate VII. The response to the various fertilizer treatments shown in Plate VII is characteristic of the response obtained on all subsoils.

## Relation Between Greenhouse Yields and Laboratory Determinations

Laboratory methods for measuring the relative amounts of available plant food elements of soils have received considerable attention during the last few years. These methods have been developed for the determination especially of those plant food elements which are either constituents of the more or less unweathered mineral portion of the soil or are strongly held by the partially changed soil complex. Potassium and phosphorus are such elements. Potassium is a constituent of the soil-forming minerals, orthoclase feldspar and biotite mica. Phosphorus is a constituent of soil-forming minerals also, but is usually present in the soil chiefly in the form of inorganic phosphate which is strongly held by the soil-absorbing complex. The amount

**TABLE 16.—The Number and Percentage of the Soils Producing Increased Yields in Response to Lime.**

| Crop | Soil series | Total number of soils studied | Soils giving 9.0% or more increase in yield from lime | | Soils with sufficient increase in yield from lime to indicate virtual crop failure without lime | |
|---|---|---|---|---|---|---|
| | | | *Number* | *Per cent* | *Number* | *Per cent* |
| First crop of Austrian winter peas | Norfolk | 22 | 11 | 50.0 | 6 | 27.3 |
| | Decatur | 22 | 18 | 81.8 | — | 0 |
| | Hartsells | 22 | 21 | 95.4 | 5 | 22.7 |
| | Cecil and Davidson | 22 | 17 | 77.3 | — | 0 |
| Total for crop on all series | | 88 | 67 | 76.1 | 11 | 12.5 |
| Second crop—sorghum | Norfolk | 22 | 16 | 72.7 | 1 | 4.5 |
| | Greenville, Amite, and Akron | 23 | 10 | 43.5 | 1 | 4.5 |
| | Decatur | 22 | 9 | 40.9 | — | 0 |
| | Hartsells | 22 | 12 | 54.5 | 1 | 4.5 |
| | Cecil and Davidson | 22 | 14 | 63.6 | — | 0 |
| Total for crop on all series | | 111 | 61 | 55.0 | 3 | 2.7 |
| Third crop—sorghum. Peas on Greenville, Amite, and Akron | Norfolk | 22 | 11 | 50.0 | 3 | 13.6 |
| | Greenville, Amite, and Akron | 23 | 9 | 40.9 | — | 0 |
| | Decatur | 22 | 9 | 40.9 | 1 | 4.5 |
| | Hartsells | 22 | 12 | 54.5 | — | 0 |
| | Cecil and Davidson | 22 | 13 | 59.1 | 1 | 4.5 |
| Total for crop on all series | | 111 | 54 | 48.6 | 5 | 4.5 |

of these two elements that can be obtained from the soil by simple water extraction is not thought to be an accurate index of the amount of the elements that may be available to the growing plant. The laboratory methods for "testing" the soil for its content of "available" elements are attempts to obtain relative values for the amounts of the elements in the soil that are available to plants.

The actual numerical values obtained by such methods are not of very great significance since they are inherent to the method and to the particular units in which the results are expressed. The ratios between such values for various soils are of greater importance. The ultimate test of the amount of any plant food element available to the growing plant is the growth or yield of that plant as it reflects the amount of that element delivered by the soil. The values for the soil's content of an "available" element should be proportional to the actual yields of the crops grown on the soils when all other necessary elements are supplied. The best laboratory method for estimating the deficiency of an element in the soil is that method, the results of which are most closely related to the actual crop yields on the soils. Thus, the best criterion for evaluating any labora-

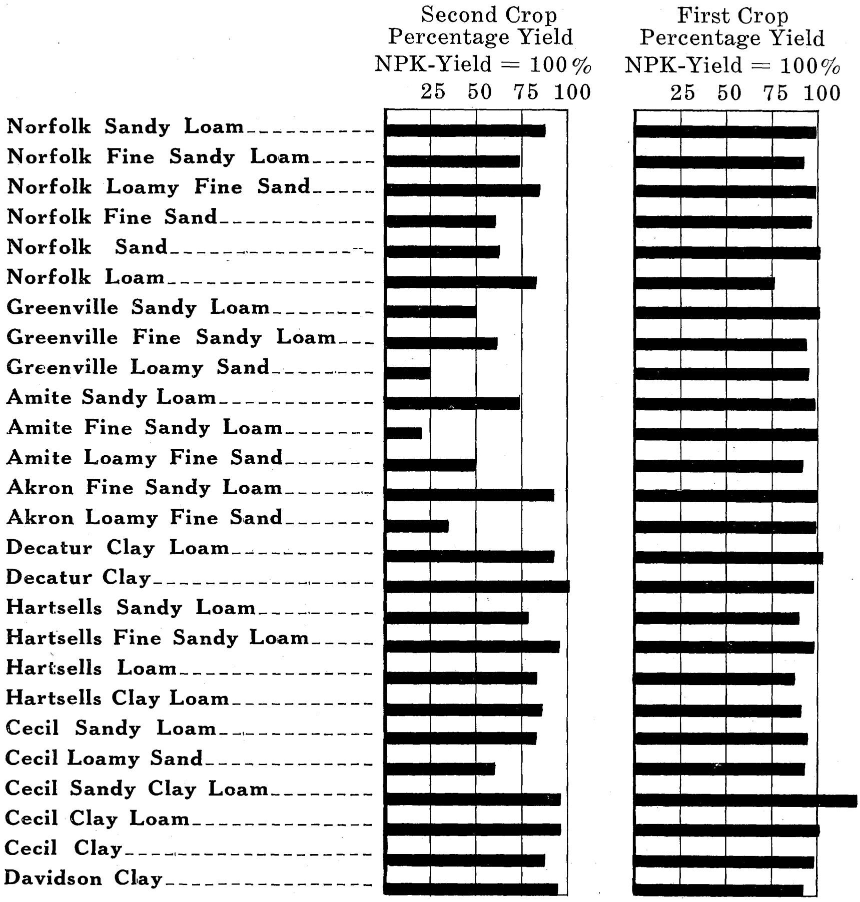


FIGURE 29.—Potash deficiency by soil type as shown by the percentage average yields on the NP-cultures.

tory method of testing soils for available content of an element is the degree to which its results are proportional to the actual crop performances on the different soils.

There are several ways by which such comparisons between soils tests and crop performances may be made. An idea of the relationship may be obtained by a simple comparison of the data. A graphical representation of these plotted on coordinate paper will permit an estimation of the closeness of the association. Furthermore, the nature of the relationship of the variables will often be indicated in such a graphical representation of the data. When these are statistically correlated, the relationship may be evaluated mathematically.

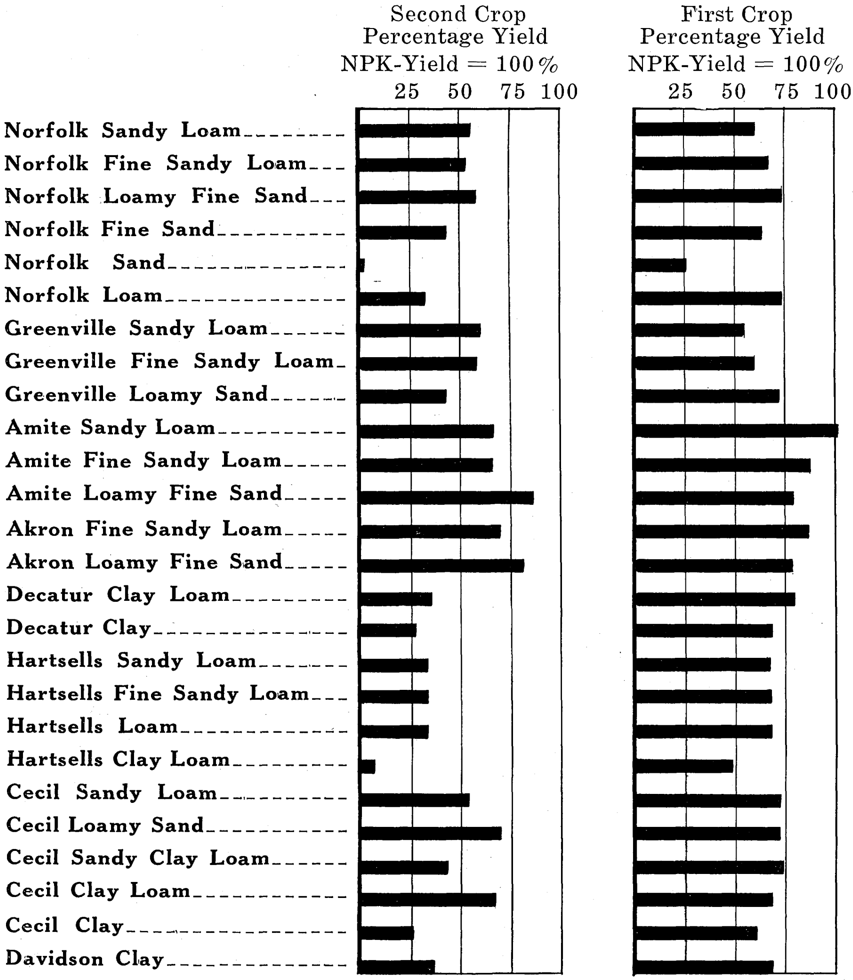


FIGURE 30.—Phosphate deficiency by soil type as shown by the percentage average yields on the NK-cultures.

Correlation is simply one of several ways of discovering and evaluating relationships. A correlation coefficient between two variables is simply a measure of degree with which they tend to be associated. Correlation is especially suitable for evaluating the relationship existing in data of biological origin. A large number of crop yields such as are obtained in greenhouse work may be most clearly analyzed by biometric methods. Statistical correlation is used herein as a means of evaluating the closeness of the relationships existing between the greenhouse yields and the results of various laboratory determinations.

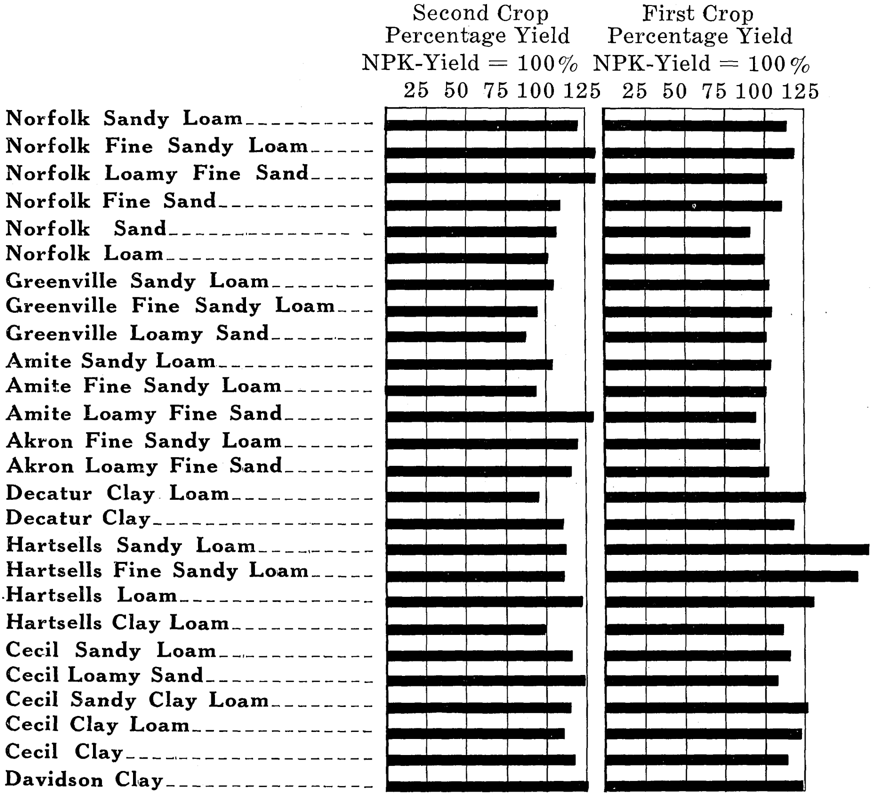


FIGURE 31.—Response to lime by soil type as shown by the percentage average yields on the NPKL-cultures.

**The Relation of the Yield of Sorghum to Available Phosphate as Determined by Truog's Method.**—The response by the soils to phosphate fertilization is shown by a comparison of the yields on the pot cultures receiving the nitrogen, phosphorus, and potassium treatment, with those from the pots receiving only nitrogen and potassium. On soils deficient in readily available phosphorus, the yields on the pot cultures receiving nitrogen and potassium only, are limited by the supply of available phosphorus. Under these conditions the actual crop yields themselves are measures of available phosphate. Obviously then, the amounts of readily available phosphorus in the soils as determined by a laboratory method should be closely correlated to the actual yields if the results of the laboratory method of testing soils are to be interpreted as determinations of "available phosphorus."

In an earlier study (9) of the correlation between the yields of the first crop of sorghum and the "readily available" phos-

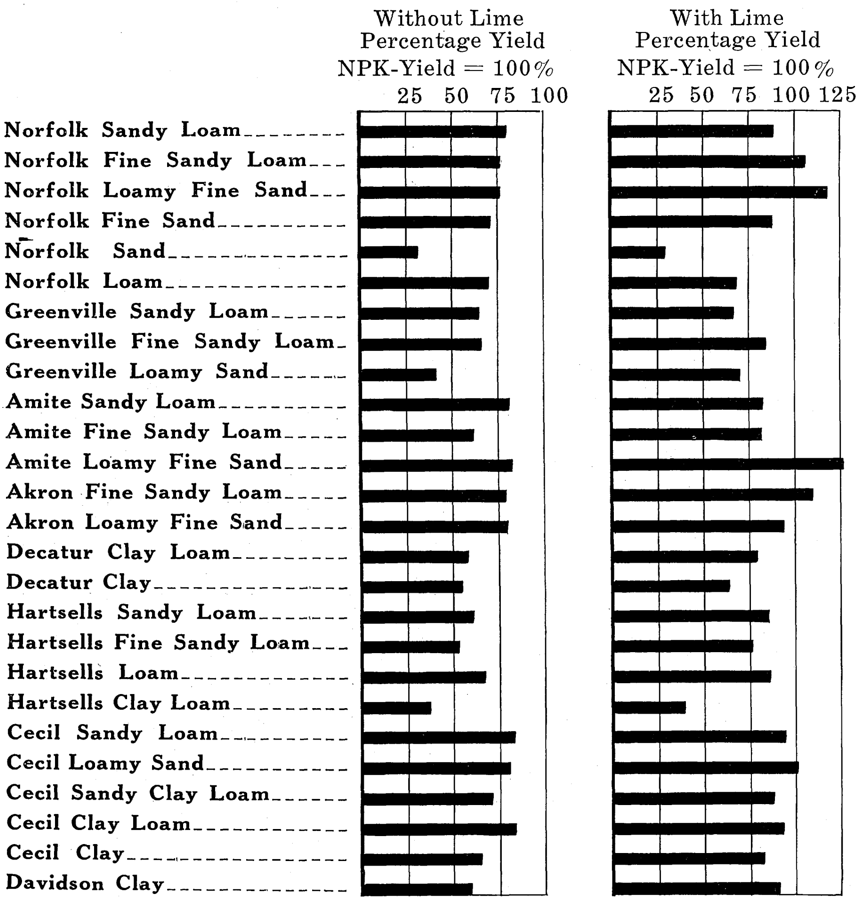


FIGURE 32.—Effect of residual phosphate with and without lime as shown by the percentage average yields of the soil types.

phorous in soils as determined by Truog's method (24) a fairly close relationship was found. Similar studies of the correlation between the amounts of soluble phosphate extracted by this method and the yields of the first crop of sorghum on the other groups of soils have been made. They also showed a fairly close association between yield and available phosphorus.

In making these studies the amounts of phosphate extracted by the method were first plotted against the yields produced on the pot cultures receiving nitrogen and potassium fertilization. In practically every case, the data clearly indicated a curvilinear relationship. For each group of soils a second degree parabola was fitted to the data by the method of least squares. The type equation for this curve is $y = a + bx + cx^2$.

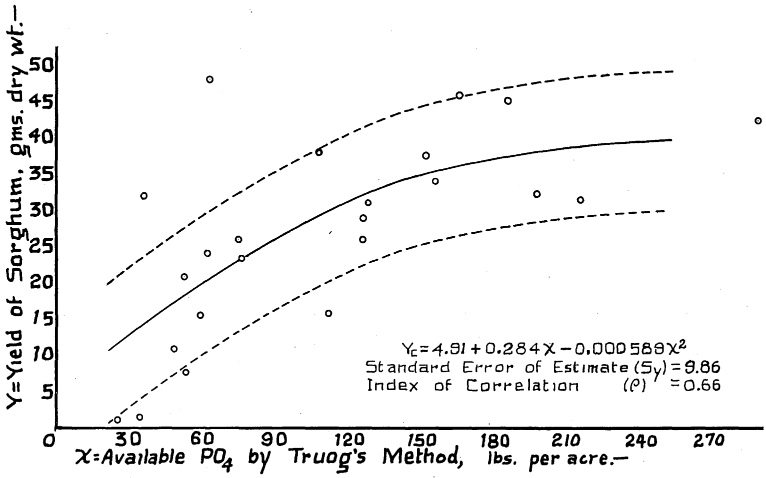


FIGURE 33.—The relation between yield and available phosphate on the Greenville soils.

The most probable curve fitting the data is obtained by calculating the values of the numerical constants—a, b, and c—and substituting them into the type equation. The index of correlation, ($\rho$), is an evaluation of the degree to which the yields are associated with soluble phosphate along the line, $Yc = a + bx + cx^2$. The standard error of estimate, (Sy), is an average of the actual and estimated yields as expressed by the line of relationships.

Although this equation is subject to the criticism that its expression of this relationship is empirical, nevertheless, it provides a better expression of the relationship than does the linear equation. The variations of the data from a perfect relationship are so wide that the use of a more complex equation is hardly justified even though it might mathematically express the true relationship.

The yields of sorghum plotted against the amounts of soluble phosphate extracted by Truog's method are shown in Figures 33, 34, and 35. The data for the Greenville, Decatur, and Cecil groups of soils are shown in the three figures. The general relationship of yield to soluble phosphate for the Hartsells soils is similar to that for the Cecil soils. Likewise, the data and relationship of yield to soluble phosphate on the Norfolk soils are comparable to those of the Greenville group. These same figures show the variations in the data from the different soil groups.

The irregular distribution of the experimental values in Figures 33, 34, and 35 represents variation in the relation of yield of sorghum to soluble phosphate within the soil series. Obviously, this variation is most likely due to the effect of factors

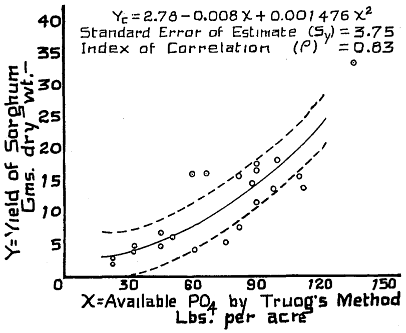


FIGURE 34.—The relation between yield and available phosphate on the Decatur soils.

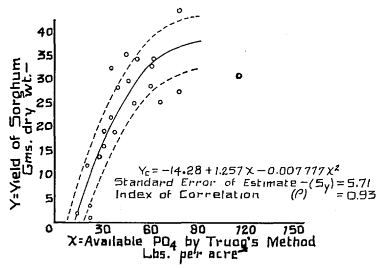


FIGURE 35.—The relation between yield and available phosphate on the Cecil soils.

other than readily available phosphate upon the yield. If several samples of the same soil were supplied with varying amounts of available phosphorus and all other limiting factors of plant growth were removed, a very close relationship between yield and readily available phosphorus would be expected. When a number of different soils are used other factors are introduced. The extent to which the relationship between yield and readily available phosphorus is affected by other factors depends upon the degree to which they affect yield. That different soils with the same content of readily available phosphorus should necessarily produce identical yields is not normally expected. Consequently, one would not expect that the relationship between readily available phosphorus as determined in the laboratory and crop yield will be perfect.

In data in which yield is closely associated with soluble phosphate, the ratios of the yields obtained on different soils will be closely proportional to the ratios of the amounts of soluble phosphate extracted from the soils. It has been previously observed in this work (9) that increasing the time of extraction results in different quantities of phosphate being extracted. This has also been observed by other investigators (21) (6). From all but a few soils, larger amounts of soluble phosphate were obtained by an increased period of extraction. A few of the soils yielded significantly smaller quantities of soluble phosphate from an increased period of extraction. Obviously, any change in the ratios of the amounts of soluble phosphate extracted will disturb the relationship between yield and soluble phosphate. This type of variation in the results of this laboratory method establishes the fact that the amounts of soluble phosphate extracted by the method may not be an accurate measure of the amount, nor even of the proportional amounts, of phosphate that are available to plants.

Another factor possibly affecting the relationship between yield and available phosphate is that of seasonal variation in the amount of phosphorus absorbed by the plant. In connection with this phase of plant physiology the following is quoted from Hoagland and Davis (12): "The mineral nutrition of plants involves much more than the question of cell permeability. We must account for the concentrating powers of the cell which cannot be understood without reference to energy exchanges, the ultimate source of energy being the sunlight. The plant cell is considered to possess the power of causing the movement of various solutes from solutions of low concentrations to solutions (sap) of higher concentrations, probably involving energy exchanges." Each of the crops of sorghum, the yields of which are plotted in Figures 33, 34, and 35, respectively, were grown during different seasons. It is possible that differences in the absorption of phosphorus by plants due to seasonal conditions are in part the cause of the differences in the relation of yield to soluble phosphate as shown in these figures.

Before a completely satisfactory explanation can be made of the relationship between crop yields and the soluble phosphate of soils, further information is needed. A study of the data included herein shows the need of further investigations of the following:

(1) The possible relation and effect of the deficiency of other nutrient elements upon the absorption and efficient utilization of phosphorus by plants;

(2) The possible relation and effect of seasonal conditions upon the absorption and utilization of phosphorus by plants;

(3) The character of the surface and the nature and magnitude of the surface forces of soil colloidal material involved in the retention of phosphorus by soils; and

(4) The nature and the extent of the effect of the various mineral constituents of soils which affect the phosphorus-holding capacity of soils.

**The Relation Between the Yield of Austrian Winter Peas and Soil Acidity.**—That soil acidity is an important factor in the growth of legumes has long been recognized. It has been shown that satisfactory nodulation of soybeans may be obtained on acid soils having a reaction of pH 5.0 to 5.5 by supplying a soluble form of calcium without apparently changing the hydrogen-ion concentration (2). This has lead to the investigation of the importance of calcium as a nutrient element in the growth and nodulation of legumes. It has been recently shown by Albrecht (1) that the degree of acidity as an environmental factor may be responsible for the failure of nodulation of soybeans at reactions of pH 5.0 or below. At reactions less acid than pH 5.0 the nodulation failure was determined to a greater extent by the amount of available calcium present than by the hydrogen-ion concentration. The failure of nodule formation at reactions of pH 5.5 and above was apparently brought about only by a deficiency of calcium.

With these results in mind it was thought that a study of the yields of the Austrian winter peas in relation to pH, exchangeable calcium, and lime requirements of the soils used in this work might throw some light on this question. The degrees of correlation between several of the variables were determined. The values obtained and other related data are summarized in Table 17.

The value of the correlation coefficient, r, between two variables is a measure of the extent to which they are associated or tend to move together.

The data obtained are not an adequate basis for differentiating the effect of the hydrogen-ion concentration upon growth from that of available calcium. They are in agreement, however, with the isolation of the effects of these two factors of soil acidity as made by Albrecht, who worked with purified colloidal clay-sand cultures.

If all the observed values of a variable fall outside the range in which it affects another variable, the data would not be expected to show a significant correlation between the two variables. If, on the other hand, the values of the independent variable fall within the range to which it affects a dependent variable, then the two variables would be expected to be associated, i. e., to show a significent correlation. The values of the various correlation coefficients given in Table 17 have greater meaning when considered in the light of these possible relationships.

The yield of peas was not associated with the exchangeable calcium of the Decatur soils on which the percentage saturation by this element ranged from 31.1 per cent to 83.2 per cent. On the Greenville group of soils which ranged from 3.9 per cent to 90.1 per cent saturated by calcium, there was a significant association between the yield of peas and the nutrient in the exchangeable form. Among the different groups of soils, the Norfolks are the lowest in exchangeable calcium. They showed rather close correlations between the growth of peas, and either exchangeable calcium, or pH. This is to be expected since the supply of calcium in soils may become so low as to be deficient as a nutrient element.

As the exchangeable calcium of soils, expressed as percentage saturation, becomes less the more closely is it associated with hydrogen-ion concentration, or pH. In every group of soils, other than the Hartsells, the hydrogen-ion concentration was more closely correlated with the degree of calcium saturation than was the yield of peas to either of them.

In every case in which the significant value of r was obtained the yield of peas was found to be more closely related to both hydrogen-ion concentration and exchangeable calcium than to the lime requirement. The lime requirements were determined by titration of the soil in suspension with a solution of $Ba(OH)_2$, and consequently is based upon the total titrable acidity of the soil. It follows from these data that the hydrogen-ion concentration and exchangeable calcium provide a better index of the need of the soil for liming than does the lime requirement method used.

## GENERAL DISCUSSION

It is to be expected that the soils within a soil type should be variable in fertility. Soils do not occur in separate and distinct genera and species. On the contrary, the soil is a continuous body with ever-present variations and gradations in fertility, texture, and other characteristics. Furthermore, the soil is not static. Its properties, especially those affecting fertility, are not fixed or constant but are subject to continual change by natural and artificial agencies. This is recognized as readily by the farmer as by the experiment station worker who must select an area which is sufficiently uniform to be suitable for plot work. Areas in the field grade more or less gradually from one type to another or from one series to another, and seldom, if ever, exhibit clean-cut boundaries.

The character of a series may vary preceptibly with the latitude in which it is found. Variations of this sort can be lessened by the recognition of more or less definite latitudinal limits for the various soil series. Even when so confined, certain characteristics of the series may vary imperceptibly with latitude as shown by the silica-alumina and silica-sesquioxide ratios obtained in this work.

There are likewise variations within the type since soil types merge, the one into another. This introduces the human element in mapping. The place at which the boundary between types is located depends upon the observations and judgment of the surveyor. Even within the textural class the type may vary considerably in physical properties. Moreover, soil types are represented by more or less "typical" areas and often by larger areas of variations of phases, especially near the borders.

Because of the great complexity of soil factors affecting fertilizer response, it is questionable whether absolute uniformity of the type in response to fertilizer treatment would ever be obtained even after many similar previous treatments. Certain general differences in the responses to fertilizer by the different types are to be expected. It is only normal that the range in fertilizer response by a number of samples of two different types should over-lap each other. The greatest differences occur between series. Even there they are only of a general nature with considerable variations within each series.

**TABLE 17.—Data on the Relationships between the Yield of Austrian Winter Peas and the Factors of Soil Acidity.**

| Determination | Norfolk soils | Green-ville soils | Decatur soils | Hart-sells soils | Cecil soils |
|---|---|---|---|---|---|
| Exchangeable calcium (Mean) | 1.10 | 1.71 | 4.19 | 1.72 | 1.65 |
| M.e./100 gms. soil (Range) | 0.10-3.69 | 0.32-3.03 | 2.25-6.86 | 0.84-5.21 | 0.46-3.76 |
| Degree of Ca-saturation (Mean) | 22.6% | 44.8% | 49.1% | 43.6% | 38.3% |
| Ex.Ca/Base Ex. Capacity (Range) | 3.0 -67.5 | 3.9 -90.1 | 35.1-83.2 | 19.7-91.7 | 18.2-58.0 |
| pH (Arithmetic mean) | 5.52 | 5.62 | 5.48 | 5.78 | 5.50 |
| ( Range ) | 4.8 - 6.5 | 5.2 - 6.5 | 4.9 - 6.3 | 5.2 - 7.4 | 4.7 - 6.3 |
| Linear correlations | (r) | (r) | (r) | (r) | (r) |
| Yield of peas to exchangeable Ca | 0.76 | 0.73 | 0.22 | 0.85 | —0.56 |
| Yield of peas to degree Ca-saturation | 0.80 | 0.61 | 0.18 | 0.80 | 0.13 |
| Yield of peas to pH | 0.79 | 0.33 | 0.47 | 0.82 | 0.26 |
| Yield of peas to lime requirement | —0.61 | —0.16 | —0.13 | —0.50 | —0.30 |
| Degree of Ca-saturation to pH | 0.81 | 0.75 | 0.62 | 0.75 | 0.74 |
| Least significant value of (r) | 0.413 | 0.404 | 0.413 | 0.413 | 0.413 |

In view of the results of these experiments it does not appear that the fertilizer needs of all the soils of a given soil type can always be accurately determined by experiments on one or a few samples of that type. If recommendations for fertilizer practices are made according to soil type they should be based upon the results of experiments on a relatively large number of soils. The fertilizer response of "typical" samples of a soil type may be rather uniform. On the other hand, it may often be advisable for the farmer to work out his own detailed fertilizer treatments as determined by his cropping system and by the peculiarities of the phases of the soil type which the different areas of his farm represent.

The general differences in fertilizer needs exhibited by soil types are beyond doubt important in formulating fertilizer practices. Differentiating soils to the point of consistent responses to varying composition of a fertilizer is a refinement that in many instances is beyond that possible in soil type classification. The greatest importance of the soil type in agronomic work, after all, is probably its value as a basis for determining: (1) crop adaptations, (2) systems of farming, and (3) land utilization and conservation.

## SUMMARY

Typical samples of the main types of eight soil series were collected for laboratory and greenhouse study from the principal areas of their occurrence in the State of Alabama. The field appearance of the soil profile of each sample collected was representative of the area from which it was taken and sufficiently typical of the soil type to warrant its classification.

## Physical Relationships

(1) The mechanical analyses by the Bureau of Soils method show that forty-two of the one hundred and eleven soils studied were not true to their type names as classified in the field.

(2) The differences between mechanical analysis and soil class as determined by examination in the field, in most instances, involved only minor discrepancies. Most of the discrepancies between texture as indicated by the soil type and the actual mechanical analysis come within one or the other of the two following categories of error: (1) the surface soils of the coastal plain often contain a larger percentage content of sand than is indicated by the soil type name, and (2) the surface horizons of the soils of the Decatur series almost universally contained larger percentages of clay than are permissible for the soil type.

(3) Although an interesting tendency toward uniformity in certain characteristics of soil texture was evident in most of the soil types, the texture of the soils within the type varied considerably.

## Chemical Relationships

(1) The variation in the silica-alumina ratio of the colloidal fraction of the soils within the types studied in this work is larger than the variation between the different types or the different soil series. In comparison to corresponding values of soils occurring in other sections of the United States, the silica-alumina ratio of the colloidal fraction is relatively constant and characteristic. From one soil series to another the silica-alumina ratio varies with the maturity of the profile, and within the soil type it varies with the latitude in which the soil occurs.

(2) The silica-alumina and the silica-sesquioxide ratios of the colloidal fraction of the soils occurring south of the Appalachian mountain region of Alabama indicate the predominance of lateritic type of weathering over the podsolic type.

(3) The base exchange capacity was closely associated with soil texture.

(4) A comparison of the base exchange capacities and of the silica-sesquioxide ratios of the colloidal fraction of the soils of the Norfolk, Greenville, and Cecil series shows that although the colloidal fraction of these three series has been weathered to the same comparatively constant silica-sesquioxide ratio, the Cecil soils have been subjected to a further effect of weathering that has resulted in a partial destruction of its base exchange complex.

(5) The exchangeable calcium of the soil varies widely within the soil type. The exchangeable calcium content of the subsoil horizons of the soils derived from calcareous parent material was significantly higher than that of the soils derived from non-calcareous parent material.

(6) The soil types are not uniform in their content of exchangeable magnesium.

(7) In content of organic matter the types are neither distinct nor are the soils within the type closely similar.

(8) Practically the same range in hydrogen-ion concentration was found in all the soil types of which there was a sufficient number of samples to allow generalization.

(9) Although lime requirement is affected by texture, nature of the soil colloids, and organic matter content, it is not closely associated with soil type.

(10) The average total $P_2O_5$ content is relatively distinct for types of different soil series, but the significance of the differences is minimized by the wide range within the type.

### Productivity Relationships

The impossibility in this work of growing the same crops on all the soils during the same season does not permit a direct comparison on the basis of actual crop yields of the soil types of the different series, nor of the different crops on the same soil. The comparison of several samples of a given soil type on the basis of actual crop yields, and the comparison of various soil types on the basis of percentage yields (N P K-yield = 100%) in response to the different fertilizer treatments show that:

(1) Different representative samples of the same soil type are not the same in crop productive capacity.

(2) The difference in the fertility level of samples of a given soil type for a given fertilizing element may vary considerably with the crop used in the greenhouse.

(3) Considering the average production of all the soils of a given type, the different soil types differ from one another in general as follows:

(a) The lighter the texture of the soil, the lower is the level of fertility in potash.

(b) The heavier the texture of the soil, the more rapidly are yields from continued cropping without phosphate fertilization decreased.

(c) The heavier the texture of the soil, the less is the residual effect of phosphate fertilization.

(d) In conjunction with applications of lime (limed to pH 6.5) the residual effect of phosphate fertilization is least from those soils derived from limestone or calcareous materials,—namely, the Decatur and Greenville series.

(e) Yields on cultures receiving lime are generally larger than those not receiving lime.

(4) Variation in the yield obtained in response to any fertilizing treatment on the soils of any soil type is greater than the variation between the types.

# APPENDIX

## Complete Tables of All Laboratory and Greenhouse Data*

### TABLE I-A.—Mechanical Analyses of Surface Soils of the Norfolk Series.

| Soil No. | Coarse sand 1.0-0.5 m. m. *per cent* | Medium sand 0.5-0.25 m. m. *per cent* | Fine sand 0.25-0.10 m. m. *per cent* | Very fine sand 0.10-0.05 m. m. *per cent* | Total sand 1.0-0.05 m. m. *per cent* | Silt 0.05-0.005 m. m. *per cent* | Clay <0.005 m. m. *per cent* |
|---|---|---|---|---|---|---|---|
| 774 | 3.1 | 6.8 | 33.2 | 31.0 | 74.1 | 15.9 | 10.0 |
| 775 | 2.6 | 7.5 | 32.0 | 24.9 | 67.0 | 21.9 | 11.1 |
| 776 | 2.6 | 17.4 | 32.4 | 23.3 | 75.7 | 15.6 | 8.7 |
| 777 | 19.4 | 26.4 | 30.4 | 9.7 | 85.9 | 10.1 | 4.0 |
| 778 | 15.2 | 17.6 | 39.6 | 13.5 | 85.8 | 9.3 | 4.9 |
| 779 | 7.8 | 19.7 | 43.7 | 17.1 | 88.3 | 7.5 | 4.2 |
| 780 | 7.0 | 13.8 | 43.6 | 16.8 | 81.2 | 11.2 | 7.6 |
| 781 | 7.7 | 14.4 | 40.9 | 21.6 | 85.6 | 10.6 | 3.8 |
| 782 | 1.1 | 4.3 | 27.4 | 34.9 | 67.7 | 24.9 | 7.4 |
| 783 | 0.5 | 2.8 | 38.7 | 21.9 | 63.9 | 28.1 | 8.0 |
| 784 | 10.6 | 34.5 | 30.8 | 9.8 | 85.3 | 9.6 | 5.1 |
| 785 | 5.8 | 20.7 | 14.1 | 10.7 | 51.3 | 37.4 | 11.3 |
| 786 | 3.6 | 16.2 | 16.0 | 12.6 | 48.4 | 40.6 | 11.0 |
| 787 | 1.4 | 7.6 | 24.0 | 25.2 | 58.2 | 33.2 | 8.6 |
| 788 | 0.6 | 12.0 | 38.0 | 14.1 | 64.7 | 27.7 | 7.6 |
| 789 | 5.4 | 8.8 | 58.6 | 18.6 | 91.4 | 6.0 | 2.6 |
| 790-$A_1$ | 12.2 | 25.9 | 37.0 | 8.5 | 83.6 | 8.4 | 8.0 |
| 790-$A_2$ | 11.1 | 20.6 | 32.6 | 10.3 | 74.6 | 9.3 | 16.1 |
| 791 | 6.8 | 15.3 | 21.4 | 18.8 | 82.3 | 9.4 | 8.3 |
| 792 | 10.3 | 20.6 | 37.3 | 18.5 | 86.7 | 6.1 | 7.2 |
| 793 | 10.8 | 18.3 | 31.7 | 17.3 | 78.1 | 10.8 | 11.1 |
| 794 | 7.0 | 19.6 | 54.0 | 11.7 | 92.3 | 4.3 | 3.4 |
| 795 | 2.3 | 5.6 | 41.5 | 33.1 | 82.5 | 11.8 | 5.7 |

*The data on the Norfolk soils were obtained by W. W. Pate, formerly assistant soil chemist, in charge of the project.

**TABLE I-B.—Mechanical Analyses of Subsoils of the Norfolk Series.**

| Soil No. | Coarse sand 1.0-0.5 m. m. *per cent* | Medium sand 0.5-0.25 m. m. *per cent* | Fine sand 0.25-0.10 m. m. *per cent* | Very fine sand 0.10-0.05 m. m. *per cent* | Total sand 1.0-0.05 m. m. *per cent* | Silt 0.05-0.005 m. m. *per cent* | Clay <0.005 m. m. *per cent* |
|---|---|---|---|---|---|---|---|
| 774 | 2.1 | 5.4 | 24.7 | 25.7 | 52.9 | 18.3 | 28.8 |
| 775 | 1.6 | 5.5 | 22.2 | 24.6 | 53.9 | 17.0 | 29.1 |
| 776 | 2.2 | 12.9 | 30.3 | 24.2 | 69.6 | 15.6 | 14.8 |
| 777 | 18.6 | 25.6 | 30.4 | 12.6 | 87.2 | 5.6 | 7.2 |
| 778 | 13.3 | 14.8 | 28.6 | 13.6 | 70.3 | 15.8 | 13.9 |
| 779 | 5.1 | 18.8 | 44.8 | 18.5 | 87.2 | 4.4 | 8.4 |
| 780 | 5.9 | 14.3 | 39.9 | 14.1 | 74.2 | 10.9 | 14.9 |
| 781 | 8.5 | 15.1 | 38.7 | 19.3 | 81.6 | 12.1 | 6.3 |
| 782 | 1.0 | 2.6 | 15.5 | 24.3 | 43.4 | 27.4 | 29.2 |
| 783 | 0.5 | 1.8 | 25.6 | 21.0 | 48.9 | 24.4 | 26.7 |
| 784 | 8.0 | 27.3 | 35.8 | 12.7 | 83.8 | 9.3 | 6.9 |
| 785 | 4.7 | 14.3 | 11.1 | 7.7 | 37.8 | 35.4 | 26.8 |
| 786 | 2.8 | 11.9 | 12.8 | 10.3 | 37.8 | 41.5 | 20.7 |
| 787 | 1.0 | 3.9 | 11.2 | 18.5 | 34.6 | 39.0 | 26.4 |
| 788 | 0.4 | 6.0 | 10.3 | 32.0 | 48.7 | 30.0 | 21.3 |
| 789 | 5.8 | 8.5 | 45.4 | 26.8 | 86.5 | 9.2 | 4.3 |
| 790 | 9.7 | 4.2 | 22.9 | 22.3 | 59.1 | 8.9 | 32.0 |
| 791 | 3.7 | 9.0 | 33.0 | 21.4 | 67.1 | 10.2 | 22.7 |
| 792 | 9.1 | 14.1 | 22.4 | 6.7 | 52.3 | 8.0 | 39.7 |
| 793 | 9.2 | 17.9 | 26.4 | 12.6 | 66.1 | 8.3 | 25.6 |
| 794 | 4.9 | 14.6 | 53.7 | 13.7 | 86.9 | 7.2 | 5.9 |
| 795 | 1.8 | 4.6 | 26.5 | 29.8 | 62.7 | 14.7 | 22.6 |

**TABLE II-A.—Mechanical Analyses of Surface Soils of the Greenville, Amite, and Akron Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. *per cent* | Coarse sand 1.0-0.5 m. m. *per cent* | Medium sand 0.5-0.25 m. m. *per cent* | Fine sand 0.25-0.10 m. m. *per cent* | Very fine sand 0.10-0.05 m. m. *per cent* | Total sand 2.0-0.05 m. m. *per cent* | Silt 0.05-0.005 m. m. *per cent* | Total clay <0.005 m. m. *per cent* | Colloidal clay <0.002 m. m. *per cent* |
|---|---|---|---|---|---|---|---|---|---|
| 799 | 0.2 | 4.1 | 23.7 | 36.5 | 7.2 | 71.7 | 16.3 | 12.0 | 8.9 |
| 800 | 0.6 | 5.5 | 18.1 | 36.0 | 10.8 | 71.1 | 16.7 | 12.2 | 10.3 |
| 801 | 3.9 | 8.3 | 14.1 | 24.4 | 8.6 | 61.3 | 21.5 | 17.2 | 14.3 |
| 802 | 2.9 | 12.1 | 23.7 | 34.0 | 11.1 | 83.9 | 6.1 | 10.0 | 8.8 |
| 803 | 2.8 | 9.9 | 18.2 | 31.4 | 8.5 | 70.8 | 12.0 | 17.2 | 13.8 |
| 804 | 4.3 | 14.1 | 22.7 | 29.6 | 8.0 | 78.7 | 8.4 | 12.9 | 10.6 |
| 805 | 5.4 | 14.2 | 23.1 | 29.8 | 8.8 | 80.3 | 7.8 | 11.9 | 10.3 |
| 806 | 1.6 | 5.3 | 12.8 | 46.6 | 11.0 | 77.3 | 11.6 | 11.1 | 8.1 |
| 807 | 1.7 | 11.9 | 26.0 | 37.9 | 6.7 | 84.2 | 9.6 | 6.2 | 5.0 |
| 808 | 3.2 | 17.0 | 26.4 | 28.7 | 6.8 | 82.1 | 6.7 | 11.2 | 10.0 |
| 809 | 1.6 | 7.3 | 15.7 | 25.9 | 15.6 | 66.2 | 19.2 | 14.6 | 8.6 |
| 810 | 1.7 | 6.6 | 13.6 | 40.1 | 11.5 | 73.5 | 13.3 | 13.2 | 11.6 |
| 811 | 1.9 | 12.2 | 24.8 | 32.1 | 6.7 | 77.7 | 13.2 | 9.1 | 7.9 |
| 812 | 1.4 | 6.0 | 11.4 | 32.4 | 9.4 | 60.6 | 24.1 | 15.3 | 12.4 |
| 813 | 0.6 | 5.3 | 12.0 | 51.1 | 12.0 | 81.0 | 9.8 | 9.2 | 7.9 |
| 814 | 0.5 | 10.0 | 29.4 | 29.7 | 7.8 | 77.4 | 9.3 | 13.3 | 11.4 |
| 815 | 0.6 | 3.7 | 10.4 | 27.8 | 21.3 | 63.8 | 21.4 | 14.8 | 12.7 |
| 816 | 0.2 | 2.1 | 12.2 | 44.8 | 15.3 | 74.6 | 16.8 | 8.6 | 7.3 |
| 817 | 3.0 | 6.9 | 18.8 | 30.7 | 18.0 | 77.4 | 11.3 | 11.3 | 10.6 |
| 818 | 0.5 | 4.6 | 19.0 | 33.4 | 23.6 | 81.1 | 9.2 | 9.7 | 8.3 |
| 819 | 0.9 | 8.5 | 24.2 | 35.4 | 7.7 | 76.7 | 12.3 | 11.0 | 10.0 |
| 820 | 0.1 | 0.4 | 5.8 | 53.5 | 17.3 | 77.1 | 10.9 | 12.0 | 10.6 |
| 821 | 0.1 | 0.4 | 5.0 | 58.2 | 17.8 | 81.5 | 9.7 | 8.8 | 8.0 |

**TABLE II-B.—Mechanical Analyses of Subsoils of the Greenville, Amite, and Akron Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. | Coarse sand 1.0-0.5 m. m. | Medium sand 0.5-0.25 m. m. | Fine sand 0.25-0.10 m. m. | Very fine sand 0.10-0.05 m. m. | Total sand 2.0-0.05 m. m. | Silt 0.05-0.005 m. m. | Total clay <0.005 m. m. | Colloidal clay <0.002 m. m. |
|---|---|---|---|---|---|---|---|---|---|
| | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| 799 | 0.2 | 2.5 | 17.7 | 33.1 | 9.3 | 62.8 | 11.4 | 25.8 | 22.3 |
| 800 | 0.5 | 4.7 | 14.5 | 28.9 | 13.3 | 61.9 | 12.8 | 25.3 | 23.0 |
| 801 | 2.0 | 6.4 | 12.6 | 24.8 | 10.7 | 56.5 | 15.5 | 28.0 | 24.9 |
| 802 | 1.9 | 7.0 | 15.9 | 28.2 | 9.5 | 62.5 | 8.9 | 28.6 | 25.1 |
| 803 | 2.5 | 9.7 | 15.7 | 23.9 | 5.8 | 57.6 | 9.9 | 32.5 | 27.7 |
| 804 | 2.4 | 7.3 | 12.2 | 24.0 | 10.2 | 56.1 | 8.9 | 35.0 | 31.3 |
| 805 | 2.8 | 8.8 | 14.1 | 24.3 | 10.0 | 60.0 | 7.1 | 32.9 | 30.9 |
| 806 | 1.8 | 4.9 | 10.9 | 32.3 | 10.3 | 60.2 | 10.7 | 29.1 | 25.7 |
| 807 | 1.8 | 8.0 | 15.8 | 24.4 | 6.7 | 56.7 | 10.8 | 32.5 | 28.2 |
| 808 | 2.6 | 10.4 | 19.1 | 25.2 | 6.9 | 64.2 | 9.2 | 26.6 | 23.0 |
| 809 | 0.7 | 5.1 | 13.2 | 21.8 | 18.2 | 59.0 | 10.1 | 30.9 | 27.7 |
| 810 | 1.6 | 5.6 | 11.9 | 32.7 | 11.8 | 63.6 | 13.9 | 22.9 | 19.6 |
| 811 | 2.1 | 9.5 | 17.0 | 21.0 | 4.8 | 54.4 | 17.0 | 28.5 | 24.1 |
| 812 | 0.9 | 5.1 | 10.6 | 30.0 | 13.7 | 60.3 | 17.1 | 22.6 | 18.4 |
| 813 | 0.6 | 3.9 | 7.8 | 35.5 | 11.0 | 58.8 | 10.9 | 30.3 | 26.1 |
| 814 | 0.8 | 8.7 | 22.4 | 20.9 | 5.2 | 58.0 | 8.4 | 33.6 | 31.2 |
| 815 | 0.3 | 2.8 | 8.0 | 20.0 | 16.3 | 47.4 | 18.1 | 34.5 | 30.5 |
| 816 | 0.3 | 1.6 | 9.3 | 34.7 | 11.2 | 57.1 | 17.0 | 25.9 | 20.9 |
| 817 | 1.9 | 5.4 | 14.1 | 18.5 | 9.8 | 49.7 | 16.1 | 34.2 | 29.8 |
| 818 | 0.4 | 4.1 | 14.5 | 21.8 | 13.4 | 54.2 | 17.7 | 28.1 | 24.0 |
| 819 | 1.0 | 7.5 | 18.6 | 23.3 | 6.2 | 55.9 | 15.5 | 28.6 | 25.3 |
| 820 | 0.1 | 0.3 | 4.0 | 25.2 | 9.0 | 38.6 | 22.1 | 39.3 | 34.9 |
| 821 | 0.2 | 0.2 | 3.3 | 26.8 | 6.6 | 37.1 | 21.7 | 41.2 | 37.6 |

**TABLE III-A.—Mechanical Analyses of Surface Soils of the Decatur Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. *per cent* | Coarse sand 1.0-0.5 m. m. *per cent* | Medium sand 0.5-0.25 m. m. *per cent* | Fine sand 0.25-0.10 m. m. *per cent* | Very fine sand 0.10-0.05 m. m. *per cent* | Total sand 2.0-0.05 m. m. *per cent* | Silt 0.05-0.005 m. m. *per cent* | Total clay <0.005 m. m. *per cent* | Colloidal clay <0.002 m. m. *per cent* |
|---|---|---|---|---|---|---|---|---|---|
| 883 | 1.1 | 3.9 | 7.6 | 15.7 | 5.9 | 34.2 | 33.1 | 32.7 | 30.0 |
| 884 | 1.9 | 1.5 | 2.3 | 9.2 | 4.2 | 19.1 | 42.9 | 38.0 | 33.0 |
| 885 | 1.8 | 3.6 | 5.6 | 13.9 | 5.2 | 30.1 | 32.1 | 37.8 | 34.4 |
| 886 | 1.5 | 4.1 | 9.3 | 12.9 | 9.4 | 37.2 | 19.4 | 43.4 | 38.0 |
| 887 | 1.3 | 1.8 | 3.2 | 13.4 | 3.0 | 22.7 | 37.2 | 40.1 | 35.3 |
| 888 | 1.4 | 3.2 | 9.1 | 20.7 | 3.5 | 39.9 | 35.6 | 24.5 | 21.2 |
| 889 | 1.3 | 2.1 | 3.8 | 11.5 | 3.1 | 21.8 | 39.3 | 38.9 | 34.5 |
| 890 | 1.4 | 2.1 | 3.3 | 16.3 | 3.4 | 28.5 | 26.7 | 44.8 | 30.0 |
| 891 | 1.5 | 2.6 | 4.8 | 12.8 | 8.9 | 30.4 | 25.2 | 44.4 | 39.4 |
| 892 | 0.5 | 1.5 | 5.4 | 9.5 | 9.7 | 26.6 | 39.3 | 34.1 | 29.1 |
| 893 | 1.3 | 1.6 | 2.1 | 12.9 | 3.5 | 21.4 | 47.4 | 31.2 | 26.0 |
| 894 | 0.9 | 1.0 | 2.7 | 14.3 | 2.2 | 21.1 | 44.5 | 34.4 | 30.0 |
| 895 | 0.3 | 0.6 | 4.3 | 19.6 | 11.4 | 36.2 | 35.0 | 28.8 | 22.8 |
| 896 | 0.2 | 0.5 | 3.4 | 26.6 | 15.0 | 42.7 | 28.5 | 28.8 | 25.3 |
| 897 | 0.4 | 0.9 | 2.3 | 14.3 | 12.9 | 30.8 | 32.9 | 36.3 | 31.4 |
| 898 | 0.2 | 0.3 | 1.2 | 6.1 | 15.4 | 25.2 | 39.6 | 37.2 | 31.3 |
| 899 | 0.1 | 0.2 | 2.5 | 22.4 | 11.3 | 36.5 | 35.2 | 28.3 | 36.2 |
| 900 | 0.3 | 0.5 | 1.9 | 8.5 | 12.0 | 24.2 | 40.8 | 35.0 | 29.0 |
| 901 | 0.5 | 0.9 | 2.2 | 10.6 | 17.3 | 31.5 | 39.0 | 29.5 | 24.4 |
| 902 | 0.3 | 0.5 | 1.2 | 6.2 | 8.6 | 16.8 | 42.9 | 40.3 | 34.5 |
| 903 | 0.3 | 0.7 | 1.1 | 6.5 | 8.0 | 16.6 | 45.2 | 38.2 | 30.5 |
| 904 | 0.7 | 1.2 | 1.2 | 3.5 | 12.9 | 19.5 | 48.6 | 31.9 | 23.4 |

**TABLE III-B.—Mechanical Analyses of Subsoils of the Decatur Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. | Coarse sand 1.0-0.5 m. m. | Medium sand 0.5-0.25 m. m. | Fine sand 0.25-0.10 m. m. | Very fine sand 0.10-0.05 m. m. | Total sand 2.0-0.05 m. m. | Silt 0.05-0.005 m. m. | Total clay <0.005 m. m. | Colloidal clay <0.002 m. m. |
|---|---|---|---|---|---|---|---|---|---|
| | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| 883 | 1.1 | 1.8 | 4.1 | 8.2 | 3.5 | 18.7 | 25.3 | 56.0 | 52.3 |
| 884 | 2.1 | 1.2 | 1.5 | 4.7 | 1.9 | 11.4 | 36.7 | 51.9 | 45.0 |
| 885 | 1.0 | 1.7 | 2.8 | 4.6 | 2.8 | 12.9 | 30.2 | 56.9 | 50.1 |
| 886 | 1.5 | 3.0 | 6.7 | 8.4 | 6.9 | 26.5 | 22.9 | 50.6 | 39.0 |
| 887 | 1.6 | 1.4 | 2.7 | 8.6 | 2.7 | 17.0 | 26.6 | 56.4 | 50.6 |
| 888 | 0.5 | 1.8 | 5.4 | 10.9 | 5.6 | 24.2 | 29.8 | 46.0 | 40.1 |
| 889 | 1.4 | 1.2 | 2.2 | 6.0 | 4.2 | 15.0 | 36.4 | 48.6 | 42.0 |
| 890 | 4.2 | 3.5 | 5.6 | 11.9 | 2.9 | 28.1 | 22.6 | 49.3 | 44.5 |
| 891 | 2.5 | 2.8 | 4.1 | 8.2 | 5.5 | 23.1 | 19.7 | 57.2 | 51.9 |
| 892 | 0.6 | 1.6 | 3.9 | 5.5 | 3.9 | 15.5 | 39.7 | 44.8 | 38.2 |
| 893 | 0.9 | 1.0 | 1.3 | 6.8 | 1.4 | 11.4 | 38.0 | 50.6 | 44.2 |
| 894 | 2.7 | 1.0 | 2.2 | 9.8 | 2.0 | 17.7 | 31.2 | 51.1 | 46.3 |
| 895 | 0.4 | 0.6 | 3.8 | 14.8 | 6.2 | 25.8 | 37.1 | 37.1 | 30.7 |
| 896 | 0.2 | 0.6 | 2.1 | 10.9 | 11.7 | 25.5 | 33.6 | 40.9 | 33.6 |
| 897 | 1.2 | 0.9 | 1.5 | 6.9 | 5.7 | 16.1 | 24.4 | 59.5 | 53.2 |
| 898 | 0.5 | 0.8 | 1.0 | 4.2 | 4.2 | 10.7 | 45.2 | 44.1 | 38.2 |
| 899 | 0.1 | 0.2 | 2.2 | 12.0 | 2.2 | 16.7 | 24.5 | 58.8 | 54.8 |
| 900 | 0.3 | 0.6 | 1.8 | 6.9 | 7.2 | 16.8 | 41.0 | 42.2 | 35.8 |
| 901 | 0.6 | 0.9 | 1.1 | 4.7 | 4.6 | 11.9 | 31.3 | 56.8 | 51.2 |
| 902 | 0.5 | 0.7 | 0.9 | 3.5 | 3.4 | 9.0 | 41.1 | 49.9 | 42.8 |
| 903 | 1.0 | 1.2 | 0.8 | 2.1 | 4.3 | 9.4 | 43.6 | 47.0 | 39.1 |
| 904 | 0.4 | 0.6 | 0.8 | 4.3 | 6.5 | 12.6 | 34.1 | 52.3 | 45.8 |

**TABLE IV-A.—Mechanical Analyses of Surface Soils of the Hartsells Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. *per cent* | Coarse sand 1.0-0.5 m. m. *per cent* | Medium sand 0.5-0.25 m. m. *per cent* | Fine sand 0.25-0.10 m. m. *per cent* | Very fine sand 0.10-0.05 m. m. *per cent* | Total sand 2.0-0.05 m. m. *per cent* | Silt 0.05-0.005 m. m. *per cent* | Total clay <0.005 m. m. *per cent* | Colloidal clay <0.002 m. m. *per cent* |
|---|---|---|---|---|---|---|---|---|---|
| 912 | 3.3 | 2.3 | 1.3 | 15.9 | 8.8 | 31.6 | 47.0 | 21.4 | 14.4 |
| 913 | 0.3 | 0.2 | 7.3 | 49.8 | 7.2 | 64.8 | 28.6 | 6.6 | 4.4 |
| 914 | 0.2 | 0.2 | 0.5 | 40.4 | 9.7 | 51.0 | 37.2 | 11.8 | 8.8 |
| 915 | 0.1 | 0.1 | 6.8 | 48.1 | 6.3 | 61.4 | 30.7 | 7.9 | 4.7 |
| 916 | 1.0 | 1.0 | 4.1 | 32.4 | 8.1 | 46.6 | 46.6 | 6.8 | 3.9 |
| 917 | 1.1 | 0.7 | 3.0 | 27.6 | 7.0 | 39.5 | 48.9 | 11.6 | 7.7 |
| 918 | 0.0 | 0.1 | 1.5 | 56.6 | 4.4 | 62.6 | 29.1 | 8.3 | 5.4 |
| 919 | 0.2 | 0.2 | 4.8 | 32.1 | 7.5 | 50.8 | 39.1 | 10.1 | 7.5 |
| 920 | 0.1 | 0.5 | 18.8 | 33.8 | 4.2 | 57.4 | 32.0 | 10.6 | 7.1 |
| 921 | 0.2 | 0.3 | 2.0 | 39.4 | 5.7 | 47.6 | 43.1 | 9.3 | 4.5 |
| 922 | 0.8 | 1.6 | 17.8 | 40.5 | 3.3 | 64.0 | 23.9 | 12.1 | 9.2 |
| 923 | 0.1 | 0.3 | 6.6 | 28.8 | 7.3 | 43.1 | 48.6 | 8.3 | 4.9 |
| 924 | 0.1 | 0.2 | 15.1 | 37.6 | 7.1 | 60.1 | 31.7 | 8.2 | 6.3 |
| 925 | 0.2 | 0.2 | 6.6 | 37.5 | 10.7 | 55.2 | 36.5 | 8.3 | 4.9 |
| 926 | 0.1 | 0.6 | 17.7 | 35.8 | 3.9 | 58.1 | 30.8 | 11.1 | 6.9 |
| 927 | 0.1 | 2.9 | 31.2 | 19.4 | 5.5 | 59.1 | 32.7 | 8.2 | 4.9 |
| 928 | 0.1 | 0.6 | 17.3 | 38.3 | 4.6 | 60.9 | 28.9 | 10.2 | 7.5 |
| 929 | 0.1 | 0.9 | 32.1 | 37.7 | 2.7 | 73.5 | 19.5 | 7.0 | 4.5 |
| 930 | 0.0 | 1.9 | 39.0 | 27.8 | 3.8 | 72.6 | 20.8 | 6.6 | 4.9 |
| 931 | 0.2 | 0.6 | 11.6 | 41.9 | 3.5 | 57.8 | 32.3 | 9.9 | 5.5 |
| 932 | 0.0 | 0.5 | 17.3 | 39.9 | 3.1 | 60.8 | 29.1 | 10.1 | 6.9 |
| 933 | 0.0 | 0.1 | 2.2 | 41.7 | 4.3 | 48.3 | 46.4 | 5.3 | 3.5 |

**TABLE IV-B.—Mechanical Analyses of the Subsoils of the Hartsells Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. | Coarse sand 1.0-0.5 m. m. | Medium sand 0.5-0.25 m. m. | Fine sand 0.25-0.10 m. m. | Very fine sand 0.10-0.05 m. m. | Total sand 2.0-0.05 m. m. | Silt 0.05-0.005 m. m. | Total clay <0.005 m. m. | Colloidal clay <0.002 m. m. |
|---|---|---|---|---|---|---|---|---|---|
| | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| 912 | 2.0 | 0.9 | 0.7 | 6.3 | 6.3 | 16.2 | 49.8 | 34.0 | 23.0 |
| 913 | 0.3 | 0.2 | 3.1 | 28.9 | 5.2 | 37.7 | 29.4 | 32.9 | 27.5 |
| 914 | 0.2 | 0.3 | 0.4 | 27.4 | 9.8 | 38.1 | 32.7 | 30.2 | 22.6 |
| 915 | 0.1 | 0.2 | 4.3 | 30.3 | 3.6 | 38.5 | 32.3 | 29.2 | 24.0 |
| 916 | 1.8 | 0.9 | 3.6 | 24.7 | 5.5 | 36.5 | 43.9 | 19.6 | 14.8 |
| 917 | 0.8 | 0.4 | 2.3 | 20.2 | 3.5 | 27.2 | 41.9 | 30.9 | 22.6 |
| 918 | 0.1 | 0.1 | 1.2 | 41.4 | 3.3 | 46.1 | 31.1 | 22.8 | 17.6 |
| 919 | 0.3 | 0.2 | 3.4 | 23.4 | 6.6 | 33.9 | 44.0 | 22.1 | 20.3 |
| 920 | 0.1 | 0.2 | 9.4 | 34.2 | 5.1 | 49.0 | 33.1 | 17.9 | 13.3 |
| 921 | 0.1 | 0.3 | 1.5 | 30.6 | 6.0 | 38.5 | 38.0 | 22.5 | 16.4 |
| 922 | 0.3 | 2.0 | 14.9 | 30.0 | 4.9 | 52.2 | 26.8 | 21.0 | 16.1 |
| 923 | 0.2 | 0.2 | 5.3 | 21.1 | 7.0 | 33.8 | 44.3 | 21.9 | 16.5 |
| 924 | 0.5 | 1.6 | 7.1 | 21.5 | 6.6 | 37.3 | 38.6 | 24.1 | 18.4 |
| 925 | 0.2 | 0.2 | 3.9 | 24.2 | 6.9 | 35.4 | 41.8 | 22.8 | 16.2 |
| 926 | 0.5 | 0.8 | 18.0 | 30.4 | 2.7 | 52.4 | 29.3 | 18.3 | 13.1 |
| 927 | 0.1 | 3.2 | 25.1 | 15.1 | 3.6 | 47.1 | 34-1 | 18.8 | 13.2 |
| 928 | 0.1 | 0.6 | 14.7 | 30.3 | 3.5 | 49.2 | 31.9 | 18.9 | 14.8 |
| 929 | 0.1 | 0.7 | 24.8 | 28.8 | 3.1 | 57.5 | 27.2 | 15.3 | 9.9 |
| 930 | 0.2 | 2.6 | 34.1 | 16.7 | 1.9 | 55.5 | 26.5 | 18.0 | 13.2 |
| 931 | 0.2 | 0.7 | 8.8 | 31.8 | 2.7 | 44.2 | 32.9 | 22.9 | 14.7 |
| 932 | 0.1 | 0.7 | 17.6 | 28.8 | 1.9 | 47.3 | 32.0 | 20.7 | 13.4 |
| 933 | 0.1 | 0.2 | 2.5 | 33.5 | 3.1 | 39.4 | 34.9 | 25.7 | 19.5 |

**TABLE V-A.—Mechanical Analyses of Surface Soils of Cecil and Davidson Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. | Coarse sand 1.0-0.5 m. m. | Medium sand 0.5-0.25 m. m. | Fine sand 0.25-0.10 m. m. | Very fine sand 0.10-0.05 m. m. | Total sand 2.0 0.05 m. m. | Silt 0.05-0.005 m. m. | Total clay <0.005 m. m. | Colloidal clay <0.002 m. m. |
|---|---|---|---|---|---|---|---|---|---|
| | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| 950 | 5.4 | 6.2 | 8.1 | 19.4 | 5.2 | 44.3 | 19.4 | 36.3 | 33.1 |
| 951 | 2.5 | 5.1 | 13.7 | 24.7 | 2.8 | 48.8 | 22.4 | 27.8 | 23.3 |
| 952 | 4.2 | 5.9 | 9.4 | 21.8 | 3.6 | 44.9 | 25.3 | 29.8 | 23.7 |
| 953 | 2.8 | 4.5 | 7.6 | 20.3 | 3.8 | 39.1 | 30.3 | 30.6 | 22.5 |
| 954 | 3.5 | 6.4 | 10.4 | 25.3 | 6.4 | 52.0 | 23.5 | 24.5 | 19.0 |
| 955 | 2.7 | 7.4 | 13.1 | 24.0 | 3.5 | 50.7 | 22.6 | 26.7 | 19.3 |
| 956 | 2.6 | 2.4 | 3.8 | 25.8 | 5.6 | 40.2 | 29.4 | 30.4 | 24.8 |
| 957 | 1.4 | 2.0 | 3.3 | 18.5 | 6.3 | 31.5 | 41.5 | 27.0 | 22.1 |
| 958 | 2.2 | 3.4 | 5.6 | 15.2 | 2.5 | 28.9 | 23.4 | 47.7 | 42.4 |
| 959 | 2.5 | 2.9 | 5.5 | 27.2 | 4.9 | 43.0 | 25.7 | 31.3 | 26.9 |
| 960 | 6.5 | 9.8 | 16.4 | 29.0 | 4.2 | 65.9 | 20.2 | 13.9 | 11.1 |
| 961 | 3.9 | 11.0 | 17.5 | 29.4 | 4.1 | 65.9 | 24.3 | 9.9 | 7.6 |
| 962 | 4.6 | 10.5 | 18.3 | 25.3 | 3.3 | 62.0 | 18.4 | 19.6 | 15.7 |
| 963 | 5.5 | 11.2 | 16.5 | 29.4 | 4.6 | 67.2 | 19.3 | 13.5 | 10.4 |
| 964 | 4.1 | 14.2 | 22.5 | 36.0 | 4.3 | 81.1 | 12.6 | 6.3 | 4.8 |
| 965 | 5.7 | 15.1 | 18.6 | 34.2 | 4.9 | 78.5 | 16.2 | 5.3 | 4.1 |
| 966 | 12.8 | 17.2 | 13.1 | 17.5 | 4.2 | 64.8 | 21.6 | 13.6 | 8.5 |
| 967 | 15.6 | 13.9 | 12.4 | 23.2 | 4.2 | 69.3 | 20.1 | 10.6 | 9.6 |
| 968 | 11.1 | 13.5 | 13.2 | 22.4 | 4.2 | 64.4 | 18.5 | 17.1 | 14.6 |
| 969 | 8.5 | 13.4 | 17.0 | 34.5 | 5.0 | 78.4 | 13.9 | 7.7 | 6.4 |
| 970 | 12.3 | 16.8 | 19.1 | 29.8 | 4.5 | 82.5 | 13.0 | 4.5 | 4.2 |
| 971 | 4.7 | 7.4 | 10.6 | 23.3 | 6.4 | 52.4 | 25.5 | 22.1 | 18.0 |

**TABLE V-B.—Mechanical Analyses of the Subsoils of the Cecil and Davidson Series.**

| Soil No. | Fine gravel 2.0-1.0 m. m. *per cent* | Coarse sand 1.0-0.5 m. m. *per cent* | Medium sand 0.5-0.25 m. m. *per cent* | Fine sand 0.25-0.10 m. m. *per cent* | Very fine sand 0.10-0.05 m. m. *per cent* | Total sand 2.0-0.05 m. m. *per cent* | Silt 0.05-0.005 m. m. *per cent* | Total clay <0.005 m. m. *per cent* | Colloidal clay <0.002 m. m. *per cent* |
|---|---|---|---|---|---|---|---|---|---|
| 950 | 2.7 | 3.6 | 4.6 | 11.3 | 3.8 | 26.0 | 19.3 | 54.7 | 49.2 |
| 951 | 1.7 | 2.4 | 6.7 | 10.5 | 1.5 | 22.8 | 19.5 | 57.7 | 50.5 |
| 952 | 1.9 | 3.5 | 4.3 | 11.3 | 1.8 | 22.8 | 21.5 | 55.7 | 48.0 |
| 953 | 1.5 | 3.4 | 5.8 | 15.1 | 3.9 | 29.7 | 24.8 | 45.5 | 36.7 |
| 954 | 4.1 | 5.6 | 6.8 | 12.3 | 4.0 | 32.8 | 21.3 | 45.9 | 39.2 |
| 955 | 3.9 | 5.1 | 7.0 | 10.2 | 3.2 | 29.4 | 25.9 | 44.7 | 34.6 |
| 956 | 2.7 | 2.1 | 2.3 | 10.0 | 3.1 | 20.2 | 16.9 | 62.9 | 58.0 |
| 957 | 0.8 | 1.2 | 1.9 | 8.5 | 5.7 | 18.1 | 30.4 | 51.5 | 43.1 |
| 958 | 2.4 | 3.1 | 4.5 | 9.7 | 3.1 | 22.8 | 26.8 | 50.4 | 44.4 |
| 959 | 0.6 | 0.8 | 1.3 | 5.7 | 3.4 | 11.8 | 24.8 | 63.4 | 59.8 |
| 960 | 3.9 | 5.5 | 6.7 | 10.4 | 1.9 | 28.4 | 14.9 | 56.7 | 51.4 |
| 961 | 2.8 | 7.0 | 12.5 | 20.3 | 3.7 | 46.3 | 16.3 | 37.4 | 32.3 |
| 962 | 4.3 | 7.0 | 11.7 | 14.8 | 2.0 | 39.8 | 19.0 | 41.2 | 34.6 |
| 963 | 3.1 | 6.5 | 9.2 | 15.1 | 3.2 | 37.1 | 18.0 | 44.9 | 37.2 |
| 964 | 2.5 | 7.7 | 13.6 | 20.3 | 3.6 | 47.7 | 17.6 | 34.7 | 30.2 |
| 965 | 3.8 | 6.6 | 5.8 | 10.8 | 2.2 | 29.2 | 15.0 | 55.8 | 50.6 |
| 966 | 5.5 | 6.4 | 5.4 | 10.1 | 3.2 | 30.6 | 15.9 | 53.5 | 49.6 |
| 967 | 5.7 | 5.1 | 5.0 | 10.4 | 3.4 | 29.6 | 19.0 | 51.4 | 43.6 |
| 968 | 8.2 | 8.9 | 7.5 | 9.5 | 2.6 | 36.7 | 16.0 | 47.3 | 40.6 |
| 969 | 7.2 | 5.3 | 4.6 | 7.1 | 2.3 | 26.5 | 21.4 | 52.3 | 42.1 |
| 970 | 6.5 | 8.3 | 7.9 | 13.7 | 3.0 | 39.4 | 17.4 | 43.2 | 37.4 |
| 971 | 3.2 | 4.3 | 6.5 | 12.7 | 3.8 | 30.5 | 21.5 | 48.0 | 41.7 |

**TABLE VI-A.—Chemical Analyses of Colloidal Material Separated from the Surface Soils of the Norfolk Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 774 | 32.64 | 31.44 | 10.56 | 0.35 | 1.45 | 1.76 |
| 775 | 28.68 | 34.44 | 11.36 | 0.90 | 1.16 | 1.41 |
| 776 | 31.20 | 33.74 | 10.64 | 0.72 | 1.30 | 1.57 |
| 777 | 22.92 | 29.84 | 10.56 | 0.66 | 1.06 | 1.30 |
| 778 | 30.28 | 32.70 | 10.20 | 0.66 | 1.31 | 1.57 |
| 779 | 28.90 | 32.16 | 9.82 | 0.66 | 1.27 | 1.53 |
| 780 | 28.52 | 35.68 | 10.20 | 0.78 | 1.10 | 1.36 |
| 781 | 34.16 | 29.06 | 9.12 | 0.60 | 1.65 | 2.00 |
| 782 | 36.68 | 29.50 | 9.22 | 0.76 | 1.75 | 2.11 |
| 783 | 33.98 | 31.62 | 9.76 | 0.58 | 1.59 | 1.82 |
| 784 | 27.36 | 32.04 | 9.08 | 0.58 | 1.22 | 1.47 |
| 785 | 36.06 | 29.46 | 10.32 | 0.48 | 1.69 | 2.07 |
| 786 | 35.82 | 30.38 | 10.02 | 0.46 | 1.65 | 2.00 |
| 787 | 36.04 | 30.00 | 11.42 | 0.58 | 1.63 | 2.04 |
| 788 | 33.66 | 29.60 | 11.10 | 0.50 | 1.64 | 1.93 |
| 789 | 30.42 | 30.14 | 9.00 | 0.58 | 1.43 | 1.71 |
| 790-$A_1$ | 29.38 | 38.22 | 9.08 | 0.76 | 1.13 | 1.30 |
| 790-$A_2$ | 32.98 | 37.00 | 9.38 | 0.54 | 1.30 | 1.51 |
| 791 | 31.46 | 36.04 | 9.86 | 0.78 | 1.26 | 1.48 |
| 792 | 33.46 | 33.98 | 11.26 | 0.96 | 1.37 | 1.67 |
| 793 | 29.26 | 38.62 | 8.52 | 0.70 | 1.12 | 1.29 |
| 794 | 29.12 | 35.42 | 11.88 | 0.68 | 1.14 | 1.40 |
| 795 | 33.90 | 32.88 | 10.86 | 0.60 | 1.44 | 1.75 |

**TABLE VI-B.—Chemical Analyses of Colloidal Material Separated from the Subsoils of the Norfolk Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 774 | 33.48 | 34.14 | 10.64 | 0.80 | 1.47 | 1.76 |
| 775 | 30.88 | 32.10 | 11.64 | 1.14 | 1.32 | 1.63 |
| 776 | 31.34 | 35.76 | 12.44 | 0.66 | 1.24 | 1.49 |
| 777 | 25.92 | 33.18 | 11.88 | 0.56 | 1.08 | 1.33 |
| 778 | 33.70 | 32.14 | 11.42 | 0.72 | 1.45 | 1.78 |
| 779 | 30.46 | 37.08 | 10.72 | 0.60 | 1.17 | 1.39 |
| 780 | 30.52 | 35.30 | 10.32 | 0.78 | 1.23 | 1.47 |
| 781 | 35.00 | 33.64 | 8.76 | 0.60 | 1.51 | 1.77 |
| 782 | 37.88 | 32.18 | 9.24 | 0.62 | 1.68 | 2.00 |
| 783 | 36.56 | 31.60 | 9.62 | 0.60 | 1.64 | 1.96 |
| 784 | 29.58 | 33.70 | 10.74 | 0.52 | 1.23 | 1.49 |
| 785 | 37.66 | 27.58 | 10.32 | 0.44 | 1.86 | 2.32 |
| 786 | 37.44 | 28.90 | 11.10 | 0.46 | 1.78 | 2.20 |
| 787 | 37.10 | 29.64 | 11.10 | 0.46 | 1.71 | 2.12 |
| 788 | 37.58 | 31.14 | 9.70 | 0.46 | 1.70 | 2.05 |
| 789 | 31.40 | 33.28 | 10.40 | 0.54 | 1.33 | 1.60 |
| 790 | 32.88 | 37.58 | 9.08 | 0.48 | 1.28 | 1.48 |
| 791 | 32.56 | 37.56 | 10.70 | 0.56 | 1.24 | 1.47 |
| 792 | 36.30 | 36.68 | 9.92 | 0.74 | 1.43 | 1.68 |
| 793 | 31.28 | 38.06 | 11.44 | 0.78 | 1.17 | 1.39 |
| 794 | 27.54 | 36.20 | 12.98 | 0.50 | 1.05 | 1.29 |
| 795 | 34.12 | 34.96 | 12.20 | 0.46 | 1.35 | 1.66 |

**TABLE VII-A.—Chemical Analyses of Colloidal Material Separated from the Surface Soils of the Greenville, Amite, and Akron Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 799 | 31.59 | 36.25 | 10.06 | 0.80 | 1.26 | 1.48 |
| 800 | 26.93 | 37.73 | 8.38 | 0.89 | 1.06 | 1.21 |
| 801 | 28.99 | 35.67 | 10.14 | 0.92 | 1.17 | 1.38 |
| 802 | 31.58 | 35.29 | 14.21 | 0.97 | 1.21 | 1.52 |
| 803 | 32.54 | 38.17 | 8.54 | 0.88 | 1.27 | 1.45 |
| 804 | 32.59 | 37.56 | 10.78 | 0.87 | 1.24 | 1.47 |
| 805 | 25.23 | 40.44 | 11.82 | 0.96 | 0.89 | 1.06 |
| 806 | 32.62 | 35.36 | 12.30 | 0.84 | 1.28 | 1.57 |
| 807 | 26.91 | 37.43 | 12.60 | 0.85 | 1.00 | 1.22 |
| 808 | 32.39 | 36.16 | 12.78 | 0.70 | 1.24 | 1.52 |
| 809 | 36.09 | 33.06 | 9.50 | 0.80 | 1.57 | 1.85 |
| 810 | 37.05 | 32.06 | 13.81 | 0.83 | 1.54 | 1.96 |
| 811 | 34.41 | 34.32 | 10.06 | 0.74 | 1.43 | 1.70 |
| 812 | 36.41 | 31.90 | 11.20 | 0.72 | 1.58 | 1.94 |
| 813 | 33.08 | 34.35 | 12.54 | 0.68 | 1.33 | 1.63 |
| 814 | 31.39 | 34.36 | 13.97 | 0.71 | 1.23 | 1.55 |
| 815 | 36.48 | 31.31 | 13.65 | 0.75 | 1.55 | 1.98 |
| 816 | 36.67 | 33.46 | 9.82 | 0.75 | 1.57 | 1.86 |
| 817 | 39.32 | 33.19 | 7.99 | 0.68 | 1.74 | 2.01 |
| 818 | 36.89 | 31.67 | 9.02 | 0.68 | 1.67 | 1.98 |
| 819 | 38.57 | 34.04 | 8.61 | 0.73 | 1.66 | 1.92 |
| 820 | 38.37 | 32.70 | 9.83 | 0.56 | 1.67 | 1.99 |
| 821 | 39.36 | 31.30 | 11.12 | 0.68 | 1.74 | 2.13 |

**TABLE VII-B.—Chemical Analyses of Colloidal Material Separated from the Subsoils of the Greenville, Amite, and Akron Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 799 | 27.72 | 38.91 | 11.82 | 0.82 | 1.01 | 1.21 |
| 800 | 28.51 | 38.97 | 11.74 | 0.82 | 1.14 | 1.24 |
| 801 | 33.76 | 38.19 | 11.10 | 0.75 | 1.26 | 1.50 |
| 802 | 32.98 | 35.37 | 13.42 | 0.75 | 1.27 | 1.58 |
| 803 | 33.95 | 38.58 | 9.58 | 0.83 | 1.29 | 1.49 |
| 804 | 34.66 | 38.32 | 10.06 | 0.31 | 1.31 | 1.54 |
| 805 | 34.27 | 40.70 | 12.62 | 0.96 | 1.19 | 1.43 |
| 806 | 33.84 | 38.19 | 10.38 | 0.68 | 1.28 | 1.50 |
| 807 | 27.98 | 38.60 | 13.34 | 0.84 | 1.01 | 1.23 |
| 808 | 34.00 | 35.95 | 10.46 | 0.59 | 1.35 | 1.61 |
| 809 | 38.85 | 34.86 | 10.06 | 0.72 | 1.59 | 1.89 |
| 810 | 38.51 | 31.06 | 11.98 | 0.67 | 1.69 | 2.10 |
| 811 | 34.22 | 36.60 | 9.22 | 0.60 | 1.37 | 1.59 |
| 812 | 39.70 | 32.88 | 10.86 | 0.64 | 1.69 | 2.05 |
| 813 | 36.24 | 34.76 | 12.78 | 0.60 | 1.43 | 1.77 |
| 814 | 34.00 | 33.90 | 15.29 | 0.86 | 1.32 | 1.70 |
| 815 | 38.61 | 33.97 | 12.62 | 0.66 | 1.56 | 1.93 |
| 816 | 39.37 | 34.29 | 9.26 | 0.66 | 1.66 | 1.95 |
| 817 | 41.16 | 33.23 | 9.10 | 0.67 | 1.79 | 2.10 |
| 818 | 40.13 | 33.29 | 9.10 | 0.54 | 1.74 | 2.05 |
| 819 | 38.81 | 34.38 | 8.86 | 0.71 | 1.65 | 1.92 |
| 820 | 39.24 | 32.74 | 10.14 | 0.56 | 1.70 | 2.03 |
| 821 | 40.54 | 31.11 | 10.54 | 0.58 | 1.82 | 2.21 |

**TABLE VIII-A.—Chemical Analyses of Colloidal Material Separated from the Surface Soils of the Decatur Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 883 | 38.55 | 32.62 | 11.74 | 0.75 | 1.62 | 2.01 |
| 884 | 38.98 | 32.00 | 12.14 | 0.62 | 1.66 | 2.07 |
| 885 | 37.23 | 32.85 | 11.82 | 0.70 | 1.57 | 1.92 |
| 886 | 37.79 | 33.48 | 11.90 | 0.65 | 1.56 | 1.92 |
| 887 | 39.59 | 33.53 | 11.66 | 0.65 | 1.64 | 2.00 |
| 888 | 39.94 | 32.75 | 11.45 | 0.78 | 1.69 | 2.07 |
| 889 | 39.44 | 32.43 | 11.58 | 0.78 | 1.68 | 2.06 |
| 890 | 36.66 | 29.28 | 12.14 | 0.56 | 1.68 | 2.13 |
| 891 | 38.81 | 31.03 | 12.30 | 0.61 | 1.69 | 2.12 |
| 892 | 40.07 | 30.81 | 11.26 | 0.66 | 1.79 | 2.21 |
| 893 | 41.49 | 29.87 | 11.98 | 0.73 | 1.88 | 2.36 |
| 894 | 41.02 | 29.95 | 11.50 | 0.72 | 1.87 | 2.32 |
| 895 | 40.83 | 31.20 | 10.30 | 0.61 | 1.83 | 2.22 |
| 896 | 40.85 | 31.73 | 10.06 | 0.69 | 1.82 | 2.19 |
| 897 | 40.04 | 31.31 | 11.02 | 0.67 | 1.77 | 2.17 |
| 898 | 42.61 | 29.09 | 12.38 | 0.74 | 1.95 | 2.49 |
| 899 | 41.00 | 32.08 | 10.62 | 0.70 | 1.79 | 2.17 |
| 900 | 41.03 | 30.58 | 10.38 | 0.69 | 1.87 | 2.28 |
| 901 | 40.06 | 31.55 | 10.38 | 0.67 | 1.78 | 2.16 |
| 902 | 41.48 | 31.09 | 10.38 | 0.67 | 1.87 | 2.26 |
| 903 | 39.65 | 30.45 | 10.54 | 0.64 | 1.81 | 2.21 |
| 904 | 40.35 | 30.70 | 10.38 | 0.68 | 1.83 | 2.23 |

**TABLE VIII-B.—Chemical Analyses of Colloidal Material Separated from the Subsoils of the Decatur Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 883 | 39.68 | 34.93 | 10.54 | 0.60 | 1.58 | 1.88 |
| 884 | 40.53 | 31.95 | 11.90 | 0.54 | 1.74 | 2.15 |
| 885 | 38.04 | 33.02 | 13.10 | 0.72 | 1.56 | 1.96 |
| 886 | 38.55 | 33.20 | 12.22 | 0.61 | 1.60 | 1.97 |
| 887 | 39.63 | 31.11 | 12.14 | 0.66 | 1.73 | 2.16 |
| 888 | 40.44 | 29.54 | 11.26 | 0.67 | 1.87 | 2.32 |
| 889 | 40.26 | 31.96 | 12.06 | 0.67 | 1.72 | 2.14 |
| 890 | 40.32 | 30.18 | 13.26 | 0.53 | 1.77 | 2.27 |
| 891 | 40.10 | 30.31 | 13.26 | 0.68 | 1.76 | 2.25 |
| 892 | 40.61 | 31.01 | 11.34 | 0.45 | 1.80 | 2.22 |
| 893 | 41.50 | 30.27 | 13.10 | 0.70 | 1.82 | 2.33 |
| 894 | 41.81 | 31.82 | 10.54 | 0.87 | 1.84 | 2.23 |
| 895 | 41.40 | 30.50 | 11.66 | 0.63 | 1.85 | 2.30 |
| 896 | 41.01 | 31.58 | 11.82 | 0.73 | 1.78 | 2.20 |
| 897 | 40.65 | 32.39 | 11.34 | 0.74 | 1.74 | 2.13 |
| 898 | 43.03 | 30.09 | 11.18 | 0.75 | 1.96 | 2.43 |
| 899 | 41.83 | 32.10 | 10.86 | 0.64 | 1.82 | 2.21 |
| 900 | 42.45 | 30.46 | 11.02 | 0.74 | 1.92 | 2.37 |
| 901 | 40.86 | 31.61 | 11.58 | 0.73 | 1.78 | 2.19 |
| 902 | 42.30 | 31.85 | 11.26 | 0.84 | 1.84 | 2.25 |
| 903 | 40.06 | 31.54 | 11.26 | 0.64 | 1.76 | 2.16 |
| 904 | 40.15 | 29.91 | 12.06 | 0.63 | 1.81 | 2.28 |

**TABLE IX-A.—Chemical Analyses of Colloidal Material Separated from the Surface Soils of the Hartsells Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 912 | 36.10 | 25.56 | 19.00 | 0.61 | 1.62 | 2.40 |
| 913 | 34.32 | 29.78 | 11.98 | 0.66 | 1.56 | 1.96 |
| 914 | 38.89 | 29.40 | 12.30 | 0.68 | 1.77 | 2.24 |
| 915 | 40.61 | 29.22 | 10.38 | 0.66 | 1.92 | 2.36 |
| 916 | 33.22 | 23.85 | 16.61 | 0.78 | 1.64 | 2.36 |
| 917 | 35.32 | 29.33 | 15.65 | 0.65 | 1.52 | 2.04 |
| 918 | 37.12 | 30.59 | 11.58 | 0.77 | 1.66 | 2.06 |
| 919 | 37.98 | 33.61 | 9.66 | 0.63 | 1.62 | 1.92 |
| 920 | 38.07 | 28.33 | 12.62 | 0.67 | 1.78 | 2.28 |
| 921 | 38.73 | 31.04 | 10.54 | 0.60 | 1.74 | 2.12 |
| 922 | 32.16 | 34.62 | 12.30 | 0.86 | 1.29 | 1.58 |
| 923 | 37.99 | 29.19 | 10.62 | 0.65 | 1.79 | 2.21 |
| 924 | 39.20 | 30.77 | 9.90 | 0.62 | 1.79 | 2.16 |
| 925 | 36.05 | 30.16 | 11.58 | 0.68 | 1.63 | 2.03 |
| 926 | 35.95 | 31.22 | 11.02 | 0.70 | 1.60 | 1.95 |
| 927 | 37.82 | 30.44 | 11.02 | 0.58 | 1.71 | 2.11 |
| 928 | 37.31 | 31.13 | 11.42 | 0.64 | 1.65 | 2.03 |
| 929 | 34.03 | 28.29 | 10.78 | 0.64 | 1.64 | 2.04 |
| 930 | 36.77 | 31.76 | 10.38 | 0.67 | 1.63 | 1.97 |
| 931 | 37.02 | 29.14 | 10.14 | 0.66 | 1.76 | 2.16 |
| 932 | 36.42 | 29.30 | 10.46 | 0.61 | 1.72 | 2.11 |
| 933 | 37.76 | 29.64 | 10.70 | 0.68 | 1.76 | 2.16 |

**TABLE IX-B.—Chemical Analyses of Colloidal Material Separated from the Subsoils of the Hartsells Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 912 | 41.93 | 28.78 | 12.77 | 0.54 | 1.93 | 2.47 |
| 913 | 38.92 | 31.54 | 13.57 | 0.76 | 1.64 | 2.09 |
| 914 | 40.31 | 30.72 | 13.97 | 0.64 | 1.73 | 2.23 |
| 915 | 41.37 | 30.15 | 11.58 | 0.64 | 1.87 | 2.33 |
| 916 | 40.59 | 30.25 | 12.30 | 0.63 | 1.81 | 2.28 |
| 917 | 39.57 | 30.55 | 14.29 | 0.61 | 1.69 | 2.20 |
| 918 | 39.12 | 31.47 | 12.14 | 0.71 | 1.69 | 2.11 |
| 919 | 39.24 | 30.77 | 12.34 | 0.64 | 1.72 | 2.17 |
| 920 | 41.39 | 29.93 | 11.82 | 0.66 | 1.87 | 2.35 |
| 921 | 39.28 | 31.58 | 10.62 | 0.62 | 1.74 | 2.11 |
| 922 | 33.45 | 34.48 | 12.30 | 0.78 | 1.34 | 1.65 |
| 923 | 40.65 | 30.69 | 11.66 | 0.61 | 1.81 | 2.25 |
| 924 | 42.32 | 30.62 | 10.70 | 0.58 | 1.92 | 2.34 |
| 925 | 39.56 | 30.88 | 11.58 | 0.63 | 1.75 | 2.17 |
| 926 | 38.75 | 30.90 | 11.98 | 0.65 | 1.70 | 2.13 |
| 927 | 40.11 | 29.37 | 13.09 | 0.59 | 1.80 | 2.32 |
| 928 | 39.25 | 30.24 | 12.06 | 0.69 | 1.76 | 2.20 |
| 929 | 34.98 | 34.14 | 9.10 | 0.58 | 1.49 | 1.74 |
| 930 | 38.94 | 30.80 | 10.54 | 0.60 | 1.76 | 2.14 |
| 931 | 40.17 | 31.06 | 10.86 | 0.50 | 1.79 | 2.19 |
| 932 | 39.92 | 29.14 | 11.66 | 0.63 | 1.85 | 2.33 |
| 933 | 41.08 | 29.21 | 11.82 | 0.70 | 1.90 | 2.39 |

**TABLE X-A.—Chemical Analyses of Colloidal Material Separated from the Surface Soils of the Cecil and Davidson Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 950 | 35.69 | 31.52 | 16.45 | 1.26 | 1.44 | 1.92 |
| 951 | 31.32 | 36.01 | 13.02 | 0.62 | 1.20 | 1.48 |
| 952 | 32.18 | 36.88 | 11.90 | 0.68 | 1.23 | 1.48 |
| 953 | 33.28 | 34.99 | 12.54 | 0.41 | 1.32 | 1.62 |
| 954 | 34.69 | 34.98 | 12.86 | 0.48 | 1.36 | 1.69 |
| 955 | 35.02 | 30.47 | 15.73 | 0.55 | 1.47 | 1.95 |
| 956 | 31.16 | 34.46 | 13.42 | 0.62 | 1.23 | 1.54 |
| 957 | 35.68 | 34.36 | 12.30 | 0.56 | 1.44 | 1.77 |
| 958 | 27.43 | 38.54 | 13.42 | 0.65 | 0.99 | 1.21 |
| 959 | 36.14 | 31.11 | 16.53 | 0.67 | 1.47 | 1.98 |
| 960 | 34.40 | 34.06 | 13.65 | 0.57 | 1.37 | 1.72 |
| 961 | 31.44 | 34.28 | 14.37 | 0.56 | 1.23 | 1.56 |
| 962 | 31.86 | 38.19 | 10.70 | 0.52 | 1.20 | 1.42 |
| 963 | 33.19 | 34.71 | 12.38 | 0.58 | 1.32 | 1.63 |
| 964 | 35.45 | 36.09 | 9.50 | 0.68 | 1.43 | 1.67 |
| 965 | 36.81 | 34.62 | 8.38 | 0.62 | 1.57 | 1.81 |
| 966 | 36.18 | 36.06 | 6.07 | 0.40 | 1.54 | 1.71 |
| 967 | 37.09 | 35.21 | 9.18 | 0.51 | 1.54 | 1.79 |
| 968 | 36.69 | 34.91 | 9.82 | 0.55 | 1.51 | 1.79 |
| 969 | 36.57 | 33.45 | 11.10 | 0.59 | 1.54 | 1.86 |
| 970 | 34.66 | 35.44 | 10.38 | 0.46 | 1.40 | 1.66 |
| 971 | 30.39 | 36.54 | 12.86 | 0.84 | 1.15 | 1.41 |

**TABLE X-B.—Chemical Analyses of Colloidal Material Separated from the Subsoils of the Cecil and Davidson Series.**

| Soil No. | $SiO_2$ *per cent* | $Al_2O_3$ *per cent* | $Fe_2O_3$ *per cent* | $TiO_2$ *per cent* | Mols $SiO_2$ / $R_2O_3$ | Mols $SiO_2$ / $Al_2O_3$ |
|---|---|---|---|---|---|---|
| 950 | 31.87 | 36.22 | 14.13 | 0.87 | 1.20 | 1.49 |
| 951 | 34.68 | 31.56 | 17.25 | 1.03 | 1.38 | 1.87 |
| 952 | 32.70 | 36.45 | 13.34 | 0.75 | 1.25 | 1.52 |
| 953 | 33.66 | 35.65 | 13.34 | 0.45 | 1.29 | 1.60 |
| 954 | 36.20 | 33.75 | 14.69 | 0.36 | 1.42 | 1.82 |
| 955 | 37.93 | 32.52 | 14.93 | 0.55 | 1.55 | 1.98 |
| 956 | 32.48 | 31.73 | 19.40 | 0.70 | 1.25 | 1.74 |
| 957 | 36.21 | 34.00 | 14.05 | 0.75 | 1.43 | 1.81 |
| 958 | 25.72 | 38.79 | 14.05 | 0.67 | 0.91 | 1.13 |
| 959 | 35.65 | 30.86 | 17.73 | 0.74 | 1.43 | 1.96 |
| 960 | 35.08 | 33.71 | 15.65 | 0.55 | 1.36 | 1.77 |
| 961 | 32.58 | 35.04 | 15.41 | 0.56 | 1.23 | 1.58 |
| 962 | 32.65 | 37.69 | 11.18 | 0.47 | 1.24 | 1.47 |
| 963 | 35.07 | 35.41 | 13.10 | 0.55 | 1.36 | 1.68 |
| 964 | 34.95 | 36.35 | 11.82 | 0.63 | 1.35 | 1.63 |
| 965 | 38.95 | 35.23 | 10.86 | 0.75 | 1.57 | 1.88 |
| 966 | 37.08 | 37.31 | 9.50 | 0.66 | 1.45 | 1.69 |
| 967 | 39.11 | 35.02 | 10.38 | 0.66 | 1.59 | 1.89 |
| 968 | 39.06 | 36.12 | 9.50 | 0.60 | 1.57 | 1.84 |
| 969 | 38.29 | 34.57 | 11.90 | 0.67 | 1.54 | 1.88 |
| 970 | 35.64 | 35.72 | 11.34 | 0.60 | 1.41 | 1.69 |
| 971 | 29.55 | 36.80 | 13.73 | 0.80 | 1.10 | 1.36 |

**TABLE XI-A.—Norfolk Surface Soils. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching With Neutral, Normal Ammonium Acetate and Total Bases and Calcium Determined by Electrodialysis.**

| Soil No. | Milliequivalents per 100 grams soil | | | | | | Degree of calcium saturation |
|---|---|---|---|---|---|---|---|
| | Total base exchange capacity | Exchangeble hydrogen | Exchangeable calcium | Exchangeble magnesium | Total electrodialyzed bases | Electrodialyzed calcium | *per cent* |
| 774 | 6.87 | 3.80 | 0.90 | 0.189 | 1.36 | 1.21 | 13.1 |
| 775 | 7.43 | 5.00 | 0.86 | 0.065 | 1.08 | 0.83 | 11.6 |
| 776 | 5.74 | 3.00 | 0.58 | 0.160 | 1.20 | 0.87 | 10.1 |
| 777 | 6.20 | 3.80 | 0.88 | 0.058 | 0.88 | 0.82 | 14.2 |
| 778 | 4.54 | 2.92 | 0.65 | 0.211 | 0.82 | 0.66 | 14.3 |
| 779 | 4.31 | 2.96 | 0.43 | 0.131 | 0.48 | 0.36 | 10.0 |
| 780 | 5.13 | 2.96 | 0.51 | 0.058 | 0.48 | 0.42 | 9.9 |
| 781 | 3.23 | 2.00 | 0.93 | 0.051 | 0.80 | 0.76 | 28.8 |
| 782 | 5.62 | 2.72 | 0.97 | 0.044 | 0.68 | 0.68 | 17.3 |
| 783 | 4.89 | 2.60 | 1.76 | 0.051 | 2.04 | 1.84 | 36.0 |
| 784 | 3.38 | 2.80 | 0.10 | 0.313 | 0.22 | 0.03 | 3.0 |
| 785 | 5.45 | 3.32 | 1.44 | 0.320 | 2.28 | 1.46 | 26.4 |
| 786 | 5.47 | 1.96 | 3.69 | 0.313 | 4.08 | 3.86 | 67.5 |
| 787 | 5.24 | 1.56 | 3.43 | 0.349 | 4.44 | 3.74 | 65.5 |
| 788 | 3.03 | 2.80 | 0.88 | 0.328 | 1.00 | 0.73 | 29.0 |
| 789 | 2.30 | 2.26 | 0.50 | 0.146 | 0.16 | 0.03 | 21.7 |
| 790-$A_1$ | 6.00 | 3.76 | 1.93 | 0.189 | 2.16 | 1.88 | 32.2 |
| 790-$A_2$ | 4.25 | 2.96 | 0.97 | 0.233 | 1.48 | 1.14 | 22.8 |
| 791 | 4.37 | 3.48 | 0.68 | 0.612 | 1.12 | 1.05 | 15.6 |
| 792 | 5.01 | 4.44 | 0.82 | 0.379 | 0.92 | 0.88 | 16.4 |
| 793 | 8.36 | 4.44 | 1.17 | 0.437 | 1.00 | 1.11 | 14.0 |
| 794 | 2.65 | 0.92 | 0.72 | 0.291 | 0.84 | 0.84 | 27.2 |
| 795 | 3.47 | 2.00 | 0.45 | 0.335 | 0.80 | 0.68 | 13.0 |

**TABLE XI-B.—Norfolk Subsoils. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching With Neutral, Normal Ammonium Acetate, and Total Bases and Calcium Determined by Electrodialysis.**

| Soil No. | Milliequivalents per 100 grams soil | | | | | |
|---|---|---|---|---|---|---|
| | Total base exchange capacity | Ex-change-able hydrogen | Ex-change-able calcium | Exchange-able magnesium | Total electro-dialized bases | Electro-dialyzed calcium |
| 774 | 7.16 | 3.96 | 0.95 | 0.357 | 0.80 | 0.65 |
| 775 | 7.34 | 3.92 | 1.36 | 0.262 | 1.38 | 1.23 |
| 776 | 4.54 | 2.12 | 0.03 | 0.182 | 0.56 | 0.25 |
| 777 | 2.01 | 0.80 | 0.25 | 0.160 | 0.38 | 0.04 |
| 778 | 4.08 | 1.36 | 1.11 | 0.218 | 1.32 | 1.07 |
| 779 | 2.53 | 1.92 | 0.36 | 0.277 | 0.28 | 0.26 |
| 780 | 4.14 | 2.44 | 0.46 | 0.160 | 0.80 | 0.69 |
| 781 | 2.18 | 1.20 | 0.56 | 0.197 | 0.52 | 0.46 |
| 782 | 9.84 | 4.60 | 0.86 | 0.430 | 1.24 | 0.75 |
| 783 | 8.36 | 2.40 | 1.75 | 0.408 | 1.96 | 1.56 |
| 784 | 2.71 | 0.40 | 0.32 | 0.160 | 0.32 | 0.29 |
| 785 | 10.69 | 3.90 | 2.44 | 0.422 | 2.76 | 2.32 |
| 786 | 7.92 | 3.70 | 0.81 | 0.269 | 1.08 | 0.79 |
| 787 | 10.57 | 4.70 | 1.00 | 0.524 | 1.40 | 0.79 |
| 788 | 8.01 | 3.50 | 1.11 | 0.415 | 1.28 | 0.84 |
| 789 | 1.66 | 0.16 | 0.12 | 0.233 | 0.20 | 0.01 |
| 790 | 7.37 | 1.20 | 1.81 | 0.284 | 2.08 | 1.88 |
| 791 | 6.93 | 3.00 | 0.69 | 0.218 | 1.12 | 0.91 |
| 792 | 8.53 | 4.20 | 1.00 | 0.277 | 1.20 | 1.05 |
| 793 | 5.97 | 2.70 | 0.75 | 0.298 | 1.08 | 0.82 |
| 794 | 2.30 | 1.30 | 0.22 | 0.131 | 0.48 | 0.22 |
| 795 | 7.34 | 2.90 | 2.08 | 0.422 | 2.48 | 2.18 |

**TABLE XII-A.—Surface Soils of the Greenville, Amite, and Akron Series. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching With Neutral Normal Ammonium Acetate.**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | | Degree of calcium saturation |
|---|---|---|---|---|---|
| | Total base exchange capacity | Ex-changeable hydrogen | Ex-changeable calcium | Ex-changeable magnesium | *per cent* |
| 799 | 8.00 | 5.22 | 0.32 | 0.566 | 3.9 |
| 800 | 7.28 | 6.15 | 1.16 | 0.436 | 15.9 |
| 801 | 9.71 | 5.91 | 1.90 | 0.453 | 19.5 |
| 802 | 3.17 | 2.25 | 0.65 | 0.137 | 20.5 |
| 803 | 8.14 | 4.95 | 2.22 | 0.323 | 27.2 |
| 804 | 4.14 | 2.64 | 0.56 | 0.183 | 13.6 |
| 805 | 4.08 | 2.46 | 1.00 | 0.210 | 24.4 |
| 806 | 4.45 | 2.70 | 1.23 | 0.251 | 27.7 |
| 807 | 3.66 | 2.48 | 1.07 | 0.151 | 29.1 |
| 808 | 3.51 | 0.72 | 0.90 | 0.213 | 25.6 |
| 809 | 10.88 | 4.56 | 3.03 | 0.566 | 27.8 |
| 810 | 4.07 | 0.00 | 1.72 | 0.353 | 42.3 |
| 811 | 2.45 | 1.56 | 1.73 | 0.216 | 70.7 |
| 812 | 4.18 | 2.73 | 2.44 | 0.377 | 58.3 |
| 813 | 3.44 | 1.65 | 2.45 | 0.315 | 71.1 |
| 814 | 3.03 | 1.92 | 1.83 | 0.210 | 60.4 |
| 815 | 4.83 | 3.75 | 1.83 | 0.242 | 37.9 |
| 816 | 2.39 | 1.50 | 1.50 | 0.129 | 62.8 |
| 817 | 2.98 | 1.29 | 2.69 | 0.339 | 90.1 |
| 818 | 3.97 | 2.25 | 2.10 | 0.364 | 52.9 |
| 819 | 2.78 | 2.01 | 2.34 | 0.221 | 84.2 |
| 820 | 3.97 | 1.71 | 2.32 | 0.493 | 83.5 |
| 821 | 2.85 | 1.50 | 2.29 | 0.337 | 80.2 |

**TABLE XII-B.—Subsoils of the Greenville, Amite, and Akron Series. Total Base Exchange Capacity, and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching With Neutral, Normal Ammonium Acetate**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | |
|---|---|---|---|---|
| | Total base exchange capacity | Exchangeable hydrogen | Exchangeable calcium | Exchangeable magnesium |
| 799 | 3.73 | 1.65 | 1.67 | 0.636 |
| 800 | 4.21 | 3.15 | 1.26 | 0.337 |
| 801 | 4.10 | 2.40 | 1.87 | 0.854 |
| 802 | 3.47 | 2.34 | 2.06 | 0.377 |
| 803 | 4.39 | 2.16 | 1.95 | 0.420 |
| 804 | 5.09 | 2.97 | 2.28 | 0.393 |
| 805 | 3.25 | 2.25 | 1.91 | 0.380 |
| 806 | 3.25 | 1.44 | 2.18 | 0.410 |
| 807 | 3.80 | 2.46 | 2.07 | 0.302 |
| 808 | 4.36 | 1.20 | 2.50 | 0.391 |
| 809 | 4.93 | 2.19 | 2.08 | 0.788 |
| 810 | 5.15 | 1.14 | 3.50 | 0.458 |
| 811 | 6.06 | 2.70 | 2.75 | 0.595 |
| 812 | 6.64 | 2.88 | 3.06 | 0.620 |
| 813 | 5.94 | 1.59 | 3.27 | 0.523 |
| 814 | 5.10 | 2.25 | 3.01 | 0.415 |
| 815 | 5.56 | 2.79 | 2.81 | 1.027 |
| 816 | 5.76 | 3.27 | 2.44 | 0.423 |
| 817 | 9.48 | 2.58 | 4.87 | 0.828 |
| 818 | 6.96 | 2.64 | 2.97 | 0.776 |
| 819 | 6.09 | 2.61 | 3.26 | 0.536 |
| 820 | 10.94 | 3.24 | 6.02 | 1.633 |
| 821 | 12.94 | 3.06 | 6.92 | 1.854 |

**TABLE XIII-A.—Decatur Surface Soils. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching With Neutral, Normal Ammonium Acetate.**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | | Degree of calcium saturation |
|---|---|---|---|---|---|
| | Total base exchange capacity | Ex-changeable hydrogen | Ex-changeable calcium | Ex-changeable magnesium | *per cent* |
| 883 | 7.01 | 4.83 | 3.14 | 0.851 | 44.7 |
| 884 | 5.32 | 4.68 | 4.43 | 1.097 | 83.2 |
| 885 | 8.61 | 4.07 | 4.11 | 0.652 | 47.8 |
| 886 | 8.80 | 4.20 | 2.91 | 0.568 | 33.1 |
| 887 | 10.12 | 3.75 | 5.10 | 1.118 | 50.4 |
| 888 | 4.03 | 2.95 | 2.25 | 0.388 | 55.9 |
| 889 | 6.09 | 3.90 | 2.63 | 0.679 | 43.1 |
| 890 | 11.43 | 3.24 | 5.01 | 1.126 | 43.8 |
| 891 | 11.07 | 4.17 | 4.04 | 1.059 | 36.5 |
| 892 | 9.51 | 2.01 | 4.47 | 1.253 | 47.0 |
| 893 | 9.31 | 1.92 | 6.86 | 0.992 | 73.6 |
| 894 | 9.89 | 2.79 | 5.70 | 1.115 | 57.7 |
| 895 | 7.87 | 4.44 | 4.39 | 0.391 | 55.8 |
| 896 | 7.09 | 5.04 | 3.79 | 0.644 | 53.6 |
| 897 | 9.89 | 6.00 | 4.64 | 0.948 | 46.9 |
| 898 | 10.96 | 7.74 | 4.65 | 1.996 | 42.4 |
| 899 | 9.32 | 3.36 | 4.78 | 1.239 | 51.3 |
| 900 | 9.60 | 3.06 | 5.92 | 0.736 | 61.6 |
| 901 | 10.10 | 4.50 | 3.63 | 0.800 | 35.9 |
| 902 | 9.76 | 4.65 | 4.31 | 0.803 | 44.1 |
| 903 | 8.75 | 4.92 | 3.08 | 0.983 | 35.1 |
| 904 | 12.06 | 4.35 | 4.41 | 0.833 | 36.6 |

TABLE XIII-B.—Decatur Subsoils. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching With Neutral, Normal Ammonium Acetate.

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | |
|---|---|---|---|---|
| | Total base exchange capacity | Exchangeable hydrogen | Exchangeable calcium | Exchangeable magnesium |
| 883 | 10.61 | 6.96 | 2.85 | 1.088 |
| 884 | 11.21 | 5.16 | 3.99 | 1.878 |
| 885 | 11.10 | 8.31 | 2.42 | 0.606 |
| 886 | 9.96 | 6.51 | 2.61 | 1.468 |
| 887 | 11.78 | 5.49 | 5.79 | 1.013 |
| 888 | 9.13 | 6.72 | 3.06 | 0.787 |
| 889 | 8.68 | 7.53 | 4.59 | 2.640 |
| 890 | 10.86 | 7.98 | 3.14 | 1.053 |
| 891 | 14.25 | 6.06 | 4.46 | 1.083 |
| 892 | 12.33 | 6.27 | 3.30 | 1.751 |
| 893 | 13.95 | 2.85 | 9.77 | 0.900 |
| 894 | 14.43 | 4.56 | 6.79 | 2.110 |
| 895 | 8.64 | 2.61 | 5.09 | 0.873 |
| 896 | 11.27 | 3.60 | 4.73 | 1.929 |
| 897 | 14.71 | 3.84 | 5.78 | 2.368 |
| 898 | 13.29 | 5.88 | 4.27 | 2.169 |
| 899 | 15.74 | 3.60 | 7.89 | 1.746 |
| 900 | 12.13 | 5.25 | 4.83 | 2.069 |
| 901 | 14.04 | 6.00 | 3.45 | 1.498 |
| 902 | 12.71 | 8.19 | 2.22 | 1.016 |
| 903 | 13.14 | 6.75 | 2.88 | 1.423 |
| 904 | 12.96 | 3.84 | 5.25 | 1.889 |

**TABLE XIV-A.—Hartsells Surface Soils. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching with Neutral, Normal Ammonium Acetate.**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | | Degree of calcium saturation |
|---|---|---|---|---|---|
| | Total base exchange capacity | Ex-changeable hydrogen | Ex-changeable calcium | Ex-changeable magnesium | *per cent* |
| 912 | 7.26 | 5.16 | 2.10 | 0.458 | 28.9 |
| 913 | 2.56 | .57 | 1.32 | 0.137 | 51.6 |
| 914 | 5.30 | 2.04 | 2.55 | 0.315 | 48.1 |
| 915 | 2.63 | .63 | 1.31 | 0.135 | 49.8 |
| 916 | 4.91 | .27 | 5.21 | 0.348 | 106.1 |
| 917 | 4.49 | 3.12 | 1.04 | 0.140 | 23.2 |
| 918 | 3.02 | 1.74 | 1.25 | 0.148 | 41.4 |
| 919 | 3.10 | .90 | 1.53 | 0.224 | 49.4 |
| 920 | 4.30 | 1.50 | 2.18 | 0.283 | 50.7 |
| 921 | 4.75 | 2.25 | 1.97 | 0.331 | 41.5 |
| 922 | 3.94 | 2.37 | 1.37 | 0.159 | 34.8 |
| 923 | 3.84 | 1.83 | 1.59 | 0.170 | 44.3 |
| 924 | 3.59 | 1.47 | 1.44 | 0.191 | 40.1 |
| 925 | 3.09 | 1.05 | 1.35 | 0.132 | 43.7 |
| 926 | 4.79 | 2.01 | 2.09 | 0.191 | 43.6 |
| 927 | 3.44 | 1.02 | 1.76 | 0.223 | 51.2 |
| 928 | 3.42 | 1.06 | 1.70 | 0.174 | 49.7 |
| 929 | 3.22 | 1.35 | 1.20 | 0.129 | 37.3 |
| 930 | 2.21 | .60 | .93 | 0.105 | 42.1 |
| 931 | 4.26 | 2.73 | .84 | 0.145 | 19.7 |
| 932 | 4.51 | 2.31 | 1.89 | 0.189 | 41.9 |
| 933 | 6.06 | 4.38 | 1.20 | 0.278 | 19.8 |
| Average | 4.03 | 1.83 | 1.72 | 0.209 | 43.58 |

**TABLE XIV-B.—Hartsells Subsoils. Total Base Exchange Capacity and Exchangeable Hydrogen, Calcium, and Magnesium Determined by Leaching with Neutral, Normal Ammonium Acetate.**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | |
|---|---|---|---|---|
| | Total base exchange capacity | Exchangeable hydrogen | Exchangeable calcium | Exchangeable magnesium |
| 912 | 8.96 | 3.21 | 1.93 | 1.916 |
| 913 | 7.29 | 3.03 | 1.36 | 0.679 |
| 914 | 6.01 | 2.58 | .48 | 0.218 |
| 915 | 6.99 | 1.77 | 1.83 | 0.679 |
| 916 | 4.32 | None | 1.50 | 0.232 |
| 917 | 5.86 | 2.07 | .78 | 0.221 |
| 918 | 5.24 | 1.41 | 1.23 | 0.275 |
| 919 | 4.71 | .90 | 1.18 | 0.197 |
| 920 | 4.36 | None | .73 | 0.428 |
| 921 | 5.14 | 3.15 | 1.08 | 0.434 |
| 922 | 4.41 | 2.43 | .78 | 0.108 |
| 923 | 5.11 | 2.70 | 1.14 | 0.218 |
| 924 | 6.36 | 4.05 | 1.06 | 0.127 |
| 925 | 5.32 | 2.70 | 1.39 | 0.461 |
| 926 | 4.54 | 1.29 | 1.18 | 0.094 |
| 927 | 4.38 | 3.25 | 1.26 | 0.256 |
| 928 | 4.45 | 3.90 | 1.20 | 0.110 |
| 929 | 3.17 | 2.07 | 1.17 | 0.040 |
| 930 | 4.20 | 1.44 | 2.08 | 0.280 |
| 931 | 4.91 | 3.63 | .96 | 0.094 |
| 932 | 5.51 | 4.05 | 1.12 | 0.137 |
| 933 | 6.76 | 5.82 | .81 | 0.296 |
| Average | 5.36 | 2.52 | 1.19 | 0.341 |

**TABLE XV-A.—Surface Soils of the Cecil and Davidson Series. Total Base Exchange Capacity and Exchangeable Calcium and Magnesium Determined by Leaching with Neutral, Normal Ammonium Acetate.**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | | Degree of calcium saturation |
|---|---|---|---|---|
| | Total base exchange capacity | Exchangeable calcium | Exchangeable magnesium | *per cent* |
| 950 | 5.28 | 1.45 | 1.446 | 27.4 |
| 951 | 5.25 | 2.12 | 0.553 | 40.4 |
| 952 | 5.05 | 2.02 | 0.334 | 40.0 |
| 953 | 7.43 | 3.54 | 0.581 | 47.6 |
| 954 | 4.69 | 1.74 | 0.417 | 37.1 |
| 955 | 6.04 | 2.66 | 0.395 | 44.0 |
| 956 | 8.01 | 1.46 | 0.546 | 18.2 |
| 957 | 4.60 | 1.60 | 0.384 | 34.8 |
| 958 | 5.50 | 2.09 | 0.645 | 38.0 |
| 959 | 6.65 | 3.76 | 0.647 | 56.5 |
| 960 | 5.20 | 1.30 | 0.205 | 25.0 |
| 961 | 3.13 | 1.30 | 0.223 | 41.5 |
| 962 | 2.59 | 1.02 | 0.190 | 39.4 |
| 963 | 3.58 | 1.48 | 0.183 | 41.3 |
| 964 | 1.14 | .46 | 0.083 | 40.3 |
| 965 | 1.58 | .50 | 0.086 | 31.6 |
| 966 | 4.55 | 2.64 | 0.374 | 58.0 |
| 967 | 3.39 | .94 | 0.172 | 27.7 |
| 968 | 3.01 | .82 | 0.162 | 27.2 |
| 969 | 2.78 | 1.22 | 0.219 | 43.9 |
| 970 | 2.47 | 1.18 | 0.129 | 47.8 |
| 971 | 3.27 | 1.08 | 0.259 | 33.0 |
| Average for clay and C. L. | 5.616 | 2.138 | 0.564 | 38.1 |
| Average for sandy loam | 3.038 | 1.169 | 0.184 | 38.5 |

**TABLE XV-B.—Subsoils of the Cecil and Davidson Series. Total Base Exchange Capacity and Exchangeable Calcium and Magnesium Determined by Leaching with Neutral, Normal Ammonium Acetate.**

| Soil No. | Milliequivalents per 100 grams oven-dry soil | | |
|---|---|---|---|
| | Total base exchange capacity | Exchangeable calcium | Exchangeable magnesium |
| 950-B | 5.22 | 0.63 | 2.048 |
| 951 | 3.77 | .26 | 1.579 |
| 952 | 3.27 | 1.40 | 0.745 |
| 953 | 3.48 | 1.70 | 0.605 |
| 954 | 4.43 | .22 | 1.397 |
| 955 | 4.26 | .90 | 1.080 |
| 956 | 4.22 | .22 | 0.999 |
| 957 | 3.84 | 1.70 | 1.184 |
| 958 | 3.54 | .32 | 0.512 |
| 959 | 7.20 | 5.37 | 1.710 |
| 960 | 4.31 | .92 | 0.494 |
| 961 | 2.75 | 1.54 | 0.302 |
| 962 | 2.65 | 1.80 | 0.546 |
| 963 | 2.87 | 1.98 | 0.313 |
| 964 | 2.59 | 1.52 | 0.471 |
| 965 | 5.04 | .40 | 0.693 |
| 966 | 4.06 | .28 | 0.747 |
| 967 | 4.24 | .88 | 0.510 |
| 968 | 3.89 | .92 | 0.747 |
| 969 | 4.46 | 2.54 | 0.866 |
| 970 | 3.36 | 1.28 | 0.564 |
| 971 | 2.80 | 1.54 | 0.532 |
| Average | 3.920 | 1.287 | 0.847 |

**TABLE XVI.—Phosphorus Studies on the Soils of the Norfolk Series.**

| Soil No. | $P_2O_5$ per 2,000,000 pounds of soil | | |
|---|---|---|---|
| | Total phosphorus of surface soils *Lbs.* | Total phosphorus of subsoils *Lbs.* | Water-soluble phosphorus of surface soil obtained by continuous extraction for 20 days *Lbs.* |
| 774 | 916 | 504 | 2.01 |
| 775 | 779 | 458 | 1.18 |
| 776 | 733 | 343 | Trace |
| 777 | 261 | 378 | Trace |
| 778 | 623 | 481 | 13.20 |
| 779 | 442 | 424 | 0.20 |
| 780 | 603 | 447 | 0.08 |
| 781 | 362 | 343 | 0.04 |
| 782 | 382 | 447 | 0.08 |
| 783 | 563 | 504 | 1.42 |
| 784 | 322 | 309 | Trace |
| 785 | 523 | 436 | 0.04 |
| 786 | 523 | 366 | Trace |
| 787 | 583 | 458 | 0.39 |
| 788 | 382 | 298 | 0.04 |
| 789 | 458 | 160 | 1.62 |
| 790-$A_1$ | 847 | 366 | 25.18 |
| 790-$A_2$ | 458 | — | 1.73 |
| 791 | 733 | 424 | 0.12 |
| 792 | 572 | 436 | 8.04 |
| 793 | 733 | 493 | 0.51 |
| 794 | 779 | 309 | 17.06 |
| 795 | 893 | 469 | 4.69 |

**TABLE XVII.—Organic Matter and Total Phosphorus of Surface Soils of the Greenville, Amite, and Akron Series.**

| Soil No. | Organic matter content by $H_2O_2$-solution loss *per cent* | Total $P_2O_5$ per 2,000,000 pounds of surface soil *Lbs.* |
|---|---|---|
| 799 | 3.40 | 750 |
| 800 | 2.83 | 850 |
| 801 | 3.82 | 850 |
| 802 | 1.00 | 950 |
| 803 | 2.64 | 1700 |
| 804 | 1.43 | 1300 |
| 805 | 0.51 | 1000 |
| 806 | 1.03 | 1200 |
| 807 | 0.96 | 1300 |
| 808 | 0.29 | 1500 |
| 809 | 3.23 | 1300 |
| 810 | 0.26 | 1250 |
| 811 | 0.59 | 750 |
| 812 | 1.23 | 1150 |
| 813 | 0.62 | 1750 |
| 814 | 0.74 | 1725 |
| 815 | 1.14 | 1500 |
| 816 | 0.35 | 1075 |
| 817 | 0.76 | 1800 |
| 818 | 0.82 | 1275 |
| 819 | 0.70 | 1550 |
| 820 | 0.51 | 1475 |
| 821 | 0.48 | 1000 |

**TABLE XVIII.—Organic Matter and Total Phosphorus Content of the Decatur Series.**

| Soil No. | Organic matter content by $H_2O_2$-solution loss *per cent* | Total $P_2O_5$ per 2,000,000 pounds of surface soil *Lbs.* | Total $P_2O_5$ per 2,000,000 pounds of subsoil *Lbs.* |
|---|---|---|---|
| 883 | 0.56 | 1250 | 1200 |
| 884 | 0.25 | 1150 | 1000 |
| 885 | 1.07 | 1625 | 1100 |
| 886 | 0.52 | 1800 | 1550 |
| 887 | 1.20 | 1100 | 1150 |
| 888 | 0.35 | 975 | 900 |
| 889 | 0.33 | 1075 | 900 |
| 890 | 0.85 | 1350 | 1750 |
| 891 | 0.46 | 1650 | 1950 |
| 892 | 0.87 | 1550 | 1100 |
| 893 | 0.86 | 1500 | 1250 |
| 894 | 0.57 | 1200 | 1050 |
| 895 | 0.62 | 1150 | 900 |
| 896 | 0.48 | 1500 | 1000 |
| 897 | 0.43 | 1650 | 1850 |
| 898 | 0.25 | 1150 | 1200 |
| 899 | 0.69 | 1600 | 1650 |
| 900 | 1.04 | 1250 | 1050 |
| 901 | 0.41 | 1400 | 1300 |
| 902 | 0.33 | 1400 | 900 |
| 903 | 0.79 | 1450 | 1400 |
| 904 | 0.37 | 1600 | 1500 |
| Average | 0.605 | 1380.7 | 1256.8 |

**TABLE XIX.—Organic Matter and Total Phosphorus Content of the Hartsells Series.**

| Soil No. | Organic matter content by $H_2O_2$-solution loss *per cent* | Total $P_2O_5$ per 2,000,000 pounds of surface soil *Lbs.* | Total $P_2O_5$ per 2,000,000 pounds of subsoil *Lbs.* |
|---|---|---|---|
| 912 | 2.14 | 1300 | 1200 |
| 913 | 1.06 | 700 | 650 |
| 914 | 2.01 | 750 | 800 |
| 915 | 1.18 | 450 | 700 |
| 916 | 1.82 | 900 | 550 |
| 917 | 1.46 | 950 | 800 |
| 918 | 1.10 | 850 | 650 |
| 919 | 1.09 | 850 | 600 |
| 920 | 1.56 | 850 | 750 |
| 921 | 1.67 | 800 | 650 |
| 922 | 1.18 | 850 | 700 |
| 923 | 1.36 | 800 | 500 |
| 924 | 1.30 | 700 | 600 |
| 925 | 1.28 | 950 | 550 |
| 926 | 1.68 | 1050 | 550 |
| 927 | 1.30 | 800 | 550 |
| 928 | .93 | 875 | 650 |
| 929 | 1.17 | 925 | 500 |
| 930 | 1.10 | 800 | 600 |
| 931 | 1.78 | 900 | 550 |
| 932 | 1.68 | 950 | 700 |
| 933 | 2.11 | 850 | 700 |
| Average | 1.45 | 857 | 659 |

**TABLE XX.—Organic Matter and Total Phosphorus Content of the Soils of the Cecil and Davidson Series.**

| Soil No. | Organic matter content by $H_2O_2$-solution loss *per cent* | Total $P_2O_5$ per 2,000,000 pounds of surface soil *Lbs.* | Total $P_2O_5$ per 2,000,000 pounds of subsoil *Lbs.* |
|---|---|---|---|
| 950 | 0.63 | 1600 | 2200 |
| 951 | 1.31 | 1350 | 1700 |
| 952 | 1.45 | 1800 | 1800 |
| 953 | .90 | 2100 | 1350 |
| 954 | .91 | 1500 | 2550 |
| 955 | .33 | 1650 | 2350 |
| 956 | 4.77 | 1850 | 2650 |
| 957 | 1.16 | 1200 | 1100 |
| 958 | .26 | 2050 | 1900 |
| 959 | 1.60 | 1450 | 1350 |
| 960 | 1.74 | 1450 | 1600 |
| 961 | .76 | 1200 | 900 |
| 962 | .11 | 1250 | 400 |
| 963 | 1.12 | 1550 | 1150 |
| 964 | .58 | 450 | 1200 |
| 965 | .64 | 1050 | 100 |
| 966 | 2.14 | 700 | 350 |
| 967 | 1.32 | 850 | 1600 |
| 968 | .75 | 900 | 950 |
| 969 | 1.05 | 750 | 600 |
| 970 | 1.08 | 450 | 1100 |
| 971 | .45 | 1100 | 1250 |
| Average | 1.14 | 1284 | 1370 |

**TABLE XXI.—Soluble Phosphorus and Yields of the First Crop of Sorghum on the N K- and N P K-Cultures of the Norfolk Series.**

| Soil No. | $PO_4$ per 2,000,000 pounds soil | | Yield of sorghum | | Yield of N K x 100 / Yield of N P K |
|---|---|---|---|---|---|
| | By Truog's method | By modified Truog's method | On N K cultures | On N P K cultures | |
| | *Lbs.* | *Lbs.* | *Gms.* | *Gms.* | *per cent* |
| 774 | 115.9 | 147.7 | 15.7 | 24.1 | 65.1 |
| 775 | 126.5 | 173.0 | 2.7 | 7.4 | 36.5 |
| 776 | 49.5 | 111.3 | 4.6 | 13.9 | 33.1 |
| 777 | 16.4 | 21.5 | 1.7 | 25.6 | 6.6 |
| 778 | 131.9 | 200.2 | 22.6 | 40.2 | 56.2 |
| 779 | 11.6 | 53.3 | 6.4 | 33.6 | 19.0 |
| 780 | 26.4 | 53.0 | 5.7 | 19.3 | 29.5 |
| 781 | 21.1 | 31.0 | 4.0 | 31.3 | 12.8 |
| 782 | 23.8 | 46.4 | 12.7 | 28.2 | 45.0 |
| 783 | 41.2 | 115.1 | 22.4 | 37.0 | 60.5 |
| 784 | 19.6 | 21.5 | 0.5 | 27.2 | 1.8 |
| 785 | 30.2 | 55.3 | 8.3 | 29.0 | 28.6 |
| 786 | 53.2 | 75.3 | 11.0 | 34.4 | 32.0 |
| 787 | 53.4 | 129.0 | 18.1 | 27.9 | 64.9 |
| 788 | 28.5 | 57.4 | 10.4 | 25.2 | 41.3 |
| 789 | 27.2 | 65.0 | 13.3 | 31.5 | 42.2 |
| 790-$A_1$ | 162.1 | 312.4 | 34.7 | 40.1 | 86.5 |
| 790-$A_2$ | 19.6 | 26.6 | 1.0 | 27.6 | 3.6 |
| 791 | 70.6 | 215.6 | 27.0 | 34.5 | 78.3 |
| 792 | 32.6 | 64.0 | 9.9 | 36.4 | 27.2 |
| 793 | 48.6 | 113.4 | 3.4 | 14.6 | 23.3 |
| 794 | 63.2 | 179.0 | 29.0 | 34.0 | 85.3 |
| 795 | 46.7 | 116.8 | 21.5 | 33.4 | 64.4 |
| Average | 53.0 | 103.6 | 12.5 | 28.5 | 43.7 |
| 790-B | 15.8 | 18.7 | 0.3 | 3.5 | 8.6 |
| 791-B | 12.5 | 18.5 | 0.5 | 6.8 | 7.4 |

**TABLE XXII.—Soluble Phosphorus and Yields of the First Crop of Sorghum on the N K- and N P K-Cultures of the Greenville, Amite, and Akron Series.**

| Soil No. | $PO_4$ per 2,000,000 pounds soil | | Yield of sorghum | | Yield of N K x 100 / Yield of N P K |
|---|---|---|---|---|---|
| | By Truog's method | By modified Truog's method | On N K cultures | On N P K cultures | |
| | *Lbs.* | *Lbs.* | *Gms.* | *Gms.* | *per cent* |
| 799 | 34 | 16 | 1.3 | 17.4 | 7.4 |
| 800 | 25 | 16 | 1.0 | 24.7 | 4.0 |
| 801 | 48 | 40 | 10.7 | 29.7 | 36.0 |
| 802 | 59 | 108 | 15.4 | 31.7 | 48.5 |
| 803 | 216 | 324 | 31.4 | 37.5 | 83.7 |
| 804 | 112 | 179 | 15.5 | 32.0 | 48.4 |
| 805 | 62 | 124 | 24.0 | 33.8 | 71.0 |
| 806 | 126 | 212 | 26.2 | 38.6 | 67.9 |
| 807 | 126 | 216 | 28.7 | 33.9 | 81.7 |
| 808 | 75 | 200 | 25.6 | 30.8 | 83.1 |
| 809 | 128 | 140 | 30.9 | 32.6 | 94.8 |
| 810 | 53 | 104 | 7.5 | 34.7 | 21.6 |
| 811 | 51 | 140 | 20.6 | 39.9 | 51.5 |
| 812 | 76 | 200 | 23.1 | 36.1 | 64.0 |
| 813 | 186 | 336 | 44.8 | 53.3 | 84.0 |
| 814 | 156 | 240 | 33.8 | 39.3 | 80.0 |
| 815 | 152 | 246 | 37.2 | 42.8 | 86.9 |
| 816 | 108 | 194 | 37.7 | 43.0 | 87.7 |
| 817 | 296 | 480 | 42.1 | 44.3 | 95.0 |
| 818 | 63 | 152 | 48.0 | 61.4 | 78.1 |
| 819 | 198 | 328 | 32.0 | 28.8 | 111.1 |
| 820 | 166 | 244 | 45.6 | 52.9 | 86.1 |
| 821 | 36 | 142 | 31.9 | 44.1 | 72.3 |
| Average | 110.8 | 190.5 | 26.7 | 37.5 | 71.2 |
| 813-B | 28.0 | 28.0 | 1.2 | 25.4 | 4.7 |
| 815-B | 24.0 | 24.0 | 0.7 | 22.6 | 3.1 |
| 819-B | 47.2 | 47.4 | 2.4 | 35.0 | 6.8 |

**TABLE XXIII.—Soluble Phosphorus and Yields of the First Crop of Sorghum on the N K- and N P K-Cultures of the Decatur Series.**

| Soil No. | $PO_4$ per 2,000,000 pounds soil | | Yield of sorghum | | Yield of N K x 100 / Yield of N P K |
|---|---|---|---|---|---|
| | By Truog's method | By modified Truog's method | On N K cultures | On N P K cultures | |
| | *Lbs.* | *Lbs.* | *Gms.* | *Gms.* | *per cent* |
| 883 | 50.4 | 51.2 | 5.9 | 46.2 | 12.8 |
| 884 | 44.8 | 60.8 | 6.5 | 43.4 | 15.0 |
| 885 | 112.0 | 118.0 | 13.5 | 42.1 | 32.1 |
| 886 | 110.0 | 124.0 | 15.2 | 39.7 | 38.3 |
| 887 | 22.4 | 19.2 | 1.6 | 25.6 | 6.2 |
| 888 | 90.0 | 134.0 | 16.3 | 44.1 | 37.0 |
| 889 | 66.4 | 90.0 | 15.9 | 38.4 | 41.4 |
| 890 | 22.4 | 28.0 | 2.5 | 39.1 | 6.4 |
| 891 | 44.8 | 53.6 | 4.4 | 31.5 | 14.0 |
| 892 | 60.8 | 54.4 | 3.9 | 28.3 | 13.8 |
| 893 | 136.0 | 142.0 | 33.3 | 43.1 | 77.3 |
| 894 | 98.0 | 110.0 | 13.3 | 45.2 | 29.4 |
| 895 | 100.0 | 126.0 | 18.0 | 47.5 | 37.8 |
| 896 | 88.0 | 98.0 | 14.3 | 34.9 | 41.0 |
| 897 | 60.0 | 90.0 | 15.8 | 42.8 | 36.9 |
| 898 | 75.2 | 76.0 | 3.0 | 36.7 | 13.6 |
| 899 | 82.0 | 120.0 | 7.1 | 31.5 | 22.5 |
| 900 | 90.0 | 94.0 | 11.2 | 29.6 | 37.8 |
| 901 | 90.0 | 120.0 | 17.4 | 46.3 | 37.6 |
| 902 | 82.0 | 114.0 | 15.5 | 24.8 | 62.5 |
| 903 | 32.0 | 42.0 | 3.5 | 43.8 | 8.0 |
| 904 | 32.8 | 40.0 | 4.4 | 38.0 | 11.6 |
| Average | 71.82 | 86.60 | 11.11 | 38.28 | 28.98 |
| 898-B | 18.0 | 0.4 | 0.4 | 28.8 | 1.4 |
| 901-B | 24.8 | 0.5 | 0.5 | 32.8 | 1.5 |
| 903-B | 28.8 | 0.6 | 0.6 | 24.6 | 2.4 |

**TABLE XXIV.—Soluble Phosphorus and Yields of the First Crop of Sorghum on the N K- and N P K-Cultures of the Hartsells Series.**

| Soil No. | $PO_4$ per 2,000,000 pounds soil | | Yield of sorghum | | Yield of N K x 100 / Yield of N P K |
|---|---|---|---|---|---|
| | By Truog's method | By modified Truog's method | On N K cultures | On N P K cultures | |
| | *Lbs.* | *Lbs.* | *Gms.* | *Gms.* | *per cent* |
| 912 | 9.2 | 9.2 | 1.8 | 51.0 | 3.5 |
| 913 | 25.0 | 44.0 | 4.3 | 23.2 | 18.5 |
| 914 | 19.6 | 32.0 | 4.9 | 25.3 | 19.4 |
| 915 | 8.4 | 10.0 | .7 | 33.6 | 2.1 |
| 916 | 53.0 | 80.0 | 19.3 | 47.3 | 40.8 |
| 917 | 20.8 | 49.0 | 4.1 | 22.5 | 18.2 |
| 918 | 38.0 | 87.0 | 6.0 | 18.6 | 32.3 |
| 919 | 31.0 | 81.0 | 13.7 | 34.3 | 39.9 |
| 920 | 39.0 | 80.0 | 7.9 | 19.3 | 40.9 |
| 921 | 21.2 | 36.0 | 5.2 | 25.1 | 20.7 |
| 922 | 25.2 | 43.0 | 8.9 | 24.5 | 36.3 |
| 923 | 42.0 | 88.0 | 16.0 | 37.7 | 42.4 |
| 924 | 34.0 | 59.0 | 7.7 | 25.2 | 30.6 |
| 925 | 57.0 | 130.0 | 6.9 | 23.0 | 30.0 |
| 926 | 45.0 | 90.0 | 8.3 | 23.1 | 35.9 |
| 927 | 56.0 | 124.0 | 12.2 | 32.4 | 37.7 |
| 928 | 47.0 | 90.0 | 17.7 | 20.6 | 85.9 |
| 929 | 54.0 | 118.0 | 13.7 | 29.8 | 46.0 |
| 930 | 36.0 | 70.0 | 3.7 | 24.4 | 15.2 |
| 931 | 33.0 | 68.0 | 2.2 | 17.0 | 12.9 |
| 932 | 94.0 | 142.0 | 19.3 | 24.1 | 80.1 |
| 933 | 10.0 | 10.4 | .2 | 11.3 | 1.8 |
| Average | 36.3 | 70.0 | 8.4 | 27.0 | 31.4 |
| 914-B | 6.0 | 4.8 | 0.1 | 0.1 | 100.0 |
| 928-B | 8.1 | 7.2 | 0.2 | 4.2 | 4.8 |
| 931-B | 7.2 | 6.4 | 0.2 | 1.6 | 12.5 |

**TABLE XXV.—Soluble Phosphorus and Yields of the First Crop of Sorghum on the N K- and N P K-Cultures of the Cecil and Davidson Series.**

| Soil No. | $PO_4$ per 2,000,000 pounds soil | | Yield of sorghum | | Yield of N K x 100 / Yield of N P K |
|---|---|---|---|---|---|
| | By Truog's method | By modified Truog's method | On N K cultures | On N P K cultures | |
| | *Lbs.* | *Lbs.* | *Gms.* | *Gms.* | *per cent* |
| 950 | 37.6 | 43.2 | 18.6 | 51.5 | 36.1 |
| 951 | 44.8 | 57.6 | 35.1 | 47.6 | 73.7 |
| 952 | 60.8 | 78.0 | 32.6 | 45.8 | 71.2 |
| 953 | 49.6 | 65.0 | 24.9 | 45.5 | 34.7 |
| 954 | 28.0 | 36.8 | 13.5 | 42.0 | 32.1 |
| 955 | 35.2 | 62.0 | 21.9 | 47.9 | 45.7 |
| 956 | 22.4 | 31.2 | .7 | 39.8 | 1.8 |
| 957 | 46.4 | 78.0 | 29.0 | 49.5 | 58.6 |
| 958 | 31.2 | 43.2 | 19.3 | 53.4 | 36.1 |
| 959 | 22.0 | 25.6 | 3.4 | 51.9 | 6.6 |
| 960 | 39.2 | 68.0 | 28.1 | 43.7 | 64.3 |
| 961 | 51.2 | 94.0 | 34.1 | 55.7 | 61.2 |
| 962 | 78.0 | 116.0 | 27.1 | 50.1 | 54.1 |
| 963 | 62.0 | 118.0 | 34.4 | 49.0 | 70.2 |
| 964 | 35.2 | 88.0 | 32.1 | 45.5 | 70.5 |
| 965 | 114.0 | 328.0 | 30.4 | 31.7 | 95.9 |
| 966 | 30.4 | 64.0 | 15.8 | 40.9 | 38.6 |
| 967 | 14.4 | 20.0 | 1.6 | 44.8 | 3.6 |
| 968 | 20.0 | 29.6 | 11.9 | 48.3 | 24.6 |
| 969 | 78.0 | 134.0 | 44.5 | 54.8 | 81.2 |
| 970 | 60.0 | 84.0 | 28.5 | 41.1 | 69.3 |
| 971 | 66.0 | 86.0 | 25.0 | 49.7 | 50.3 |
| Average | 46.6 | 79.6 | 23.3 | 46.8 | 49.7 |
| 952-B | 10.4 | 12.8 | 1.0 | 43.5 | 2.3 |
| 957-B | 6.4 | 8.8 | 0.4 | 49.9 | 0.8 |
| 964-B | 9.6 | 12.0 | 0.5 | 48.5 | 1.0 |

**TABLE XXVI.—Soils of the Norfolk Series. Original pH Values, Lime Requirement, and pH Values of Soils After Liming.**

| Soil No. | 0.1N $Ba(OH)_2$ per 20 gms. soil | | | | Lime requirement to pH 6.50 | | Reaction six weeks after liming |
|---|---|---|---|---|---|---|---|
| | None | 1.0 cc. | 3.0 cc. | 5.0 cc. | 0.1N $Ba(OH)_2$ per 20 gms. soil | $CaCO_3$ per 2,000,000 lbs. soil | |
| | *pH* | *pH* | *pH* | *pH* | *c. c.* | *Lbs.* | *pH* |
| 774 | 5.03 | 5.50 | 5.95 | 6.38 | 6.17 | 4627 | 6.55 |
| 775 | 4.78 | 5.10 | 5.85 | 6.25 | 6.84 | 5130 | 6.50 |
| 776 | 5.00 | 5.55 | 6.20 | 6.50 | 5.30 | 3975 | 6.60 |
| 777 | 5.50 | 5.88 | 6.30 | 6.60 | 4.34 | 3255 | 6.50 |
| 778 | 5.55 | 5.93 | 6.45 | 6.90 | 3.34 | 2505 | 6.50 |
| 779 | 5.20 | 5.93 | 6.50 | 7.00 | 3.00 | 2287 | 6.50 |
| 780 | 5.10 | 5.58 | 6.28 | 6.63 | 4.42 | 3315 | 6.70 |
| 781 | 5.88 | 6.33 | 7.00 | 7.60 | 1.53 | 1147 | 6.45 |
| 782 | 5.58 | 5.98 | 6.50 | 6.90 | 3.34 | 2505 | 6.45 |
| 783 | 5.90 | 6.40 | 7.05 | 7.50 | 1.30 | 975 | 6.45 |
| 784 | 5.08 | 5.85 | 6.45 | 6.88 | 3.10 | 2325 | 6.45 |
| 785 | 5.83 | 6.08 | 6.48 | 6.90 | 3.35 | 2512 | 6.50 |
| 786 | 6.50 | 6.90 | 7.63 | 7.85 | 0.00 | 0000 | 6.40 |
| 787 | 5.90 | 6.30 | 7.00 | 7.60 | 1.58 | 1200 | 6.10 |
| 788 | 5.70 | 6.30 | 7.00 | 7.58 | 1.63 | 1222 | 6.45 |
| 789 | 5.53 | 6.28 | 7.00 | 7.90 | 1.76 | 1320 | 6.45 |
| 790-$A_1$ | 5.58 | 6.05 | 6.60 | 7.00 | 2.66 | 1995 | 6.40 |
| 790-$A_2$ | 5.40 | 6.08 | 6.88 | 7.35 | 2.80 | 2100 | 6.70 |
| 791 | 5.48 | 5.90 | 6.60 | 7.00 | 2.95 | 2325 | 6.45 |
| 792 | 5.55 | 6.03 | 6.55 | 6.95 | 2.93 | 2197 | 6.45 |
| 793 | 5.40 | 5.75 | 6.25 | 6.50 | 5.00 | 4097 | 6.50 |
| 794 | 5.90 | 6.70 | 7.60 | 8.01 | 0.83 | 622 | 6.45 |
| 795 | 5.50 | 6.25 | 6.90 | 7.68 | 2.74 | 2055 | 6.70 |
| 790-B | 5.48 | 5.93 | 6.68 | 7.10 | 2.83 | 2122 | 6.90 |
| 791-B | 4.93 | 5.50 | 6.60 | 7.40 | 3.10 | 2325 | 6.50 |

**TABLE XXVII.—Soils of the Greenville, Amite, and Akron Series. Original pH Values, Lime Requirement, and pH Values of Soils After Liming.**

| Soil No. | Amount of 0.1N $Ba(OH)_2$ per 20 gms. soil | | | | | Lime requirement to pH 6.50 | | Re-action nine weeks after liming |
|---|---|---|---|---|---|---|---|---|
| | None | 1.0 cc. | 2.0 cc. | 3.0 cc. | 4.0 cc. | 0.1 N $Ba(OH)_2$ per 20 gms. soil | $CaCO_3$ per 2,000,000 pounds soil | |
| | *pH* | *pH* | *pH* | *pH* | *pH* | *c. c.* | *Lbs.* | *pH* |
| 799 | 5.60 | 6.00 | 6.30 | 6.80 | 7.00 | 2.50 | 1875 | 6.25 |
| 800 | 5.50 | 5.80 | 6.00 | 6.35 | 6.80 | 3.55 | 2662 | 6.30 |
| 801 | 5.20 | 5.50 | 5.70 | 5.90 | 6.30 | 4.50 | 3375 | 6.25 |
| 802 | 5.20 | 6.10 | 6.80 | 7.10 | 7.30 | 1.52 | 1140 | 6.40 |
| 803 | 5.20 | 5.85 | 6.20 | 6.50 | 6.65 | 3.00 | 2250 | 6.50 |
| 804 | 5.50 | 6.30 | 6.55 | 7.10 | 7.30 | 1.90 | 1425 | 6.50 |
| 805 | 5.70 | 6.45 | 7.00 | 7.10 | 7.50 | 1.10 | 825 | 6.35 |
| 806 | 5.20 | 5.90 | 6.50 | 7.00 | 7.40 | 2.00 | 1500 | 6.55 |
| 807 | 5.40 | 6.50 | 6.60 | 7.30 | 7.80 | 1.00 | 750 | 6.35 |
| 808 | 5.20 | 6.30 | 6.50 | 7.00 | 7.30 | 2.00 | 1500 | 6.60 |
| 809 | 5.50 | 5.80 | 6.20 | 6.30 | 6.40 | 5.00 | 3750 | 6.45 |
| 810 | 5.80 | 6.90 | 7.10 | 7.40 | 7.60 | 0.65 | 488 | 6.65 |
| 811 | 5.65 | 6.85 | 7.05 | 7.60 | 8.00 | 0.70 | 525 | 6.50 |
| 812 | 5.60 | 6.00 | 6.30 | 7.10 | 7.40 | 2.35 | 1763 | 6.55 |
| 813 | 6.10 | 6.95 | 7.20 | 7.50 | 8.00 | 0.55 | 413 | 6.50 |
| 814 | 5.70 | 6.50 | 6.90 | 7.20 | 7.45 | 1.00 | 750 | 6.65 |
| 815 | 5.50 | 6.00 | 6.60 | 7.00 | 7.05 | 1.85 | 1388 | 6.45 |
| 816 | 5.60 | 6.45 | 6.95 | 7.25 | 7.50 | 1.10 | 825 | 6.55 |
| 817 | 6.45 | 6.90 | 7.20 | 7.50 | 7.85 | 0.40 | 300 | 6.50 |
| 818 | 5.30 | 6.20 | 6.60 | 6.95 | 7.50 | 1.70 | 1275 | 6.35 |
| 819 | 5.80 | 7.00 | 7.60 | 7.80 | 8.00 | 0.55 | 413 | 6.50 |
| 820 | 6.50 | 7.10 | 7.40 | 7.65 | 8.0+ | 0.00 | 00 | 6.65 |
| 821 | 6.00 | 7.10 | 7.60 | 8.00 | 8.0+ | 0.45 | 337 | 6.60 |
| 813-B | 6.40 | 7.20 | 7.40 | 7.60 | 8.00 | 0.15 | 112 | 6.70 |
| 815-B | 5.20 | 6.50 | 7.10 | 7.30 | 7.50 | 1.00 | 750 | 6.50 |
| 819-B | 6.00 | 6.90 | 7.20 | 7.45 | 7.60 | 0.50 | 375 | 6.55 |

**TABLE XXVIII.—Soils of the Decatur Series. Original pH Values, Lime Requirement, and pH Values of Soils After Liming.**

| Soil No. | Amount of 0.1N $Ba(OH)_2$ per 20 gms. soil | | | | | Lime requirement to pH 6.50 | | Re-action six weeks after liming |
|---|---|---|---|---|---|---|---|---|
| | None | 1.0 cc. | 2.0 cc. | 3.0 cc. | 4.0 cc. | 0.1 N $Ba(OH)_2$ per 20 gms. soil | $CaCO_3$ per 2,000,000 pounds soil | |
| | *pH* | *pH* | *pH* | *pH* | *pH* | *c. c.* | *Lbs.* | *pH* |
| 883 | 5.50 | 5.95 | 6.20 | 6.75 | 7.10 | 2.55 | 1912 | 6.56 |
| 884 | 5.70 | 6.30 | 6.80 | 7.20 | 7.65 | 1.44 | 1080 | 6.40 |
| 885 | 5.80 | 6.35 | 6.85 | 6.95 | 7.05 | 1.32 | 990 | 6.35 |
| 886 | 5.30 | 5.70 | 6.10 | 6.60 | 7.20 | 2.64 | 1980 | 6.25 |
| 887 | 5.50 | 6.00 | 6.50 | 6.90 | 7.15 | 2.00 | 1500 | 6.45 |
| 888 | 5.00 | 6.00 | 6.50 | 6.90 | 7.30 | 2.00 | 1500 | 6.35 |
| 889 | 5.00 | 5.50 | 6.00 | 7.00 | 8.0+ | 2.50 | 1875 | 6.55 |
| 890 | 5.40 | 6.00 | 6.25 | 6.90 | 7.00 | 2.30 | 1725 | 6.20 |
| 891 | 5.40 | 5.90 | 6.20 | 6.30 | 6.50 | 4.00 | 3000 | 6.60 |
| 892 | 5.60 | 6.20 | 6.65 | 6.95 | 7.15 | 1.72 | 1290 | 6.45 |
| 893 | 6.30 | 7.00 | 7.20 | 7.70 | 8.0+ | 0.32 | 225 | 6.50 |
| 894 | 5.90 | 6.70 | 7.10 | 7.40 | 7.60 | 0.84 | 630 | 6.40 |
| 895 | 5.80 | 6.80 | 7.10 | 7.15 | 7.65 | 0.80 | 600 | 6.30 |
| 896 | 5.55 | 6.30 | 7.00 | 7.30 | 7.55 | 1.32 | 990 | 6.40 |
| 897 | 5.45 | 6.05 | 6.50 | 6.75 | 6.90 | 2.00 | 1500 | 6.20 |
| 898 | 5.00 | 5.50 | 5.95 | 6.40 | 6.80 | 3.32 | 2490 | 6.60 |
| 899 | 5.50 | 5.80 | 6.30 | 6.90 | 7.10 | 2.26 | 1695 | 6.20 |
| 900 | 5.80 | 6.40 | 6.70 | 7.30 | 7.50 | 1.33 | 1797 | 6.55 |
| 901 | 5.40 | 5.90 | 6.20 | 6.70 | 7.10 | 2.68 | 2010 | 6.20 |
| 902 | 5.20 | 5.80 | 6.30 | 6.70 | 7.20 | 2.44 | 1830 | 6.45 |
| 903 | 4.95 | 5.50 | 5.95 | 6.40 | 6.80 | 3.32 | 2490 | 6.20 |
| 904 | 5.50 | 6.10 | 6.30 | 6.55 | 7.00 | 2.80 | 2850 | 6.40 |
| 898-B | 5.30 | 5.90 | 6.20 | 6.70 | 7.10 | 2.50 | 1870 | 6.35 |
| 901-B | 5.90 | 6.15 | 6.50 | 6.85 | 7.30 | 2.00 | 1500 | 6.10 |
| 903-B | 5.00 | 5.50 | 5.95 | 6.30 | 6.70 | 3.50 | 2630 | 6.40 |

**TABLE XXIX.—Soils of the Hartsells Series. Original pH Values, Lime Requirement, and pH Values of Soils After Liming.**

| Soil No. | Amount of 0.1N $Ba(OH)_2$ per 20 gms. soil | | | | | Lime requirement to pH 6.50 | | Re-action nine weeks after liming |
|---|---|---|---|---|---|---|---|---|
| | None | 1.0 cc. | 2.0 cc. | 3.0 cc. | 4.0 cc. | 0.1 N $Ba(OH)_2$ per 20 gms. soil | $CaCO_3$ per 2,000,000 pounds soil | |
| | *pH* | *pH* | *pH* | *pH* | *pH* | *c. c.* | *Lbs.* | *pH* |
| 912 | 5.42 | 5.72 | 6.10 | 6.37 | 6.67 | 3.46 | 2595 | 6.20 |
| 913 | 5.81 | 6.27 | 6.58 | 6.58 | 7.38 | 1.73 | 1297 | 6.48 |
| 914 | 5.98 | 6.45 | 6.55 | 6.55 | 7.00 | 1.50 | 1125 | 6.20 |
| 915 | 5.90 | 6.90 | 7.03 | 7.33 | 8.12 | 0.60 | 450 | 6.25 |
| 916 | 7.35 | 7.62 | 8.10 | 8.10 | 8.75 | None | None | 7.38 |
| 917 | 5.23 | 5.56 | 5.90 | 6.23 | 6.47 | 4.20 | 3150 | 6.62 |
| 918 | 5.42 | 5.83 | 6.40 | 6.67 | 7.00 | 2.35 | 1762 | 6.53 |
| 919 | 5.65 | 6.15 | 6.50 | 6.94 | 7.22 | 2.00 | 1500 | 6.53 |
| 920 | 5.30 | 6.55 | 6.90 | 7.12 | 7.25 | 0.97 | 727 | 6.34 |
| 921 | 5.91 | 6.30 | 6.35 | 6.83 | 7.07 | 2.35 | 1762 | 6.67 |
| 922 | 5.62 | 6.00 | 6.42 | 6.58 | 6.88 | 2.50 | 1875 | 6.53 |
| 923 | 5.75 | 5.91 | 6.25 | 6.75 | 7.10 | 2.40 | 1800 | 6.67 |
| 924 | 6.00 | 6.40 | 6.70 | 6.95 | 7.00 | 1.35 | 1012 | 6.15 |
| 925 | 5.56 | 5.70 | 6.40 | 6.87 | 7.15 | 2.20 | 1750 | 6.70 |
| 926 | 6.25 | 6.47 | 6.70 | 7.00 | 7.24 | 1.12 | 840 | 6.20 |
| 927 | 6.00 | 6.33 | 6.68 | 7.00 | 7.47 | 1.52 | 1140 | 6.90 |
| 928 | 5.75 | 6.10 | 6.43 | 6.70 | 6.90 | 2.30 | 1725 | 6.68 |
| 929 | 5.70 | 6.17 | 6.43 | 6.86 | 7.07 | 2.20 | 1650 | 6.63 |
| 930 | 5.42 | 6.02 | 6.55 | 6.88 | 7.27 | 1.90 | 1425 | 6.58 |
| 931 | 5.50 | 5.80 | 6.02 | 6.20 | 6.50 | 4.00 | 3000 | 6.98 |
| 932 | 5.90 | 6.17 | 6.47 | 6.70 | 6.90 | 2.15 | 1612 | 6.45 |
| 933 | 5.40 | 5.60 | 5.82 | 6.10 | 6.36 | 4.76 | 3570 | 6.58 |
| 914-B | 4.90 | 5.06 | 5.17 | 5.30 | 5.35 | 20.00 | 15000 | 7.55 |
| 928-B | 5.05 | 5.28 | 5.57 | 5.90 | 6.27 | 4.68 | 3510 | 7.35 |
| 931-B | 4.95 | 5.13 | 5.40 | 5.80 | 6.05 | 5.60 | 4200 | 6.84 |

**TABLE XXX.—Soils of the Cecil and Davidson Series. Original pH Values, Lime Requirement, and pH Values of Soils After Liming.**

| Soil No. | Amount of 0.1N $Ba(OH)_2$ per 20 gms. soil | | | | | Lime requirement to pH 6.50 | | Re-action six weeks after liming |
|---|---|---|---|---|---|---|---|---|
| | None | 1.0 cc. | 2.0 cc. | 3.0 cc. | 4.0 cc. | 0.1 N $Ba(OH)_2$ per 20 gms. soil | $CaCO_3$ per 2,000,000 pounds soil | |
| | *pH* | *pH* | *pH* | *pH* | *pH* | *c. c.* | *Lbs.* | *pH* |
| 950 | 5.15 | 5.48 | 5.76 | 6.15 | 6.85 | 3.50 | 2625 | 6.95 |
| 951 | 5.67 | 5.92 | 6.12 | 6.58 | 6.88 | 2.83 | 2123 | 6.65 |
| 952 | 5.74 | 6.01 | 6.22 | 6.47 | 6.80 | 3.10 | 2325 | 6.45 |
| 953 | 5.98 | 6.15 | 6.27 | 6.47 | 6.62 | 3.10 | 2325 | 6.63 |
| 954 | 5.25 | 5.75 | 6.12 | 6.64 | 6.92 | 2.73 | 2048 | 6.27 |
| 955 | 5.66 | 6.10 | 6.50 | 6.93 | 7.30 | 2.00 | 1500 | 6.30 |
| 956 | 5.24 | 5.36 | 5.45 | 5.57 | 5.72 | 8.00 | 6000 | 6.64 |
| 957 | 5.15 | 5.50 | 5.86 | 6.38 | 6.50 | 4.00 | 3000 | 6.50 |
| 958 | 5.20 | 5.48 | 5.70 | 6.24 | 6.50 | 4.00 | 3000 | 6.15 |
| 959 | 5.94 | 6.22 | 6.47 | 6.80 | 7.00 | 2.10 | 1575 | 6.55 |
| 960 | 4.68 | 5.23 | 5.64 | 5.96 | 6.38 | 4.28 | 3210 | 6.15 |
| 961 | 6.00 | 6.30 | 6.64 | 7.40 | 7.74 | 1.56 | 1170 | 6.64 |
| 962 | 5.36 | 6.18 | 6.74 | 7.20 | 7.20 | 1.60 | 1200 | 6.40 |
| 963 | 5.46 | 5.75 | 6.08 | 6.62 | 6.90 | 2.80 | 2100 | 6.67 |
| 964 | 5.32 | 5.96 | 7.20 | 8.18 | 9.06 | 1.44 | 1080 | 6.85 |
| 965 | 5.60 | 6.11 | 6.62 | 7.05 | 7.55 | 1.77 | 1328 | 6.20 |
| 966 | 6.25 | 6.41 | 6.56 | 6.81 | 6.96 | 1.60 | 1200 | 6.06 |
| 967 | 5.36 | 5.70 | 6.04 | 6.40 | 6.82 | 3.24 | 2430 | 6.35 |
| 968 | 5.22 | 5.54 | 6.00 | 6.50 | 6.82 | 3.00 | 2250 | 6.64 |
| 969 | 5.20 | 5.90 | 6.35 | 6.70 | 6.84 | 2.43 | 1823 | 6.55 |
| 970 | 5.90 | 6.30 | 6.66 | 7.40 | 6.80 | 1.55 | 1163 | 6.28 |
| 971 | 5.36 | 5.74 | 6.24 | 6.68 | 7.06 | 2.62 | 1965 | 6.10 |
| 952-B | 4.80 | 5.28 | 5.80 | 6.25 | 6.85 | 3.42 | 2565 | 6.35 |
| 957-B | 5.13 | 5.70 | 6.24 | 6.95 | 7.77 | 2.36 | 1770 | 6.35 |
| 964-B | 5.40 | 5.74 | 6.18 | 6.60 | 7.22 | 2.80 | 2100 | 6.55 |

**TABLE XXXI.—Quantities of Calcium, Potassium, and Phosphorus Removed from the Norfolk Soils by Continuous Water Extraction for 20 Days.**

| Soil No. | Pounds per 2,000,000 pounds of soil | | |
|---|---|---|---|
| | Ca *Lbs.* | K *Lbs.* | $P_2O_5$ *Lbs.* |
| 774 | 49.5 | 45.5 | 2.01 |
| 775 | 48.0 | 49.5 | 1.18 |
| 776 | 38.6 | 80.3 | Trace |
| 777 | 49.9 | 23.7 | Trace |
| 778 | 30.7 | 28.6 | 13.20 |
| 779 | 28.3 | 20.3 | 0.20 |
| 780 | 35.1 | 33.7 | 0.08 |
| 781 | 52.2 | 18.8 | 0.04 |
| 782 | 28.3 | 29.7 | 0.08 |
| 783 | 111.6 | 27.3 | 1.42 |
| 784 | 20.4 | 13.3 | Trace |
| 785 | 72.2 | 45.5 | 0.04 |
| 786 | 194.0 | 41.3 | Trace |
| 787 | 102.8 | 34.6 | 0.39 |
| 788 | 60.7 | 19.5 | 0.04 |
| 789 | 19.8 | 16.0 | 1.62 |
| 790-$A_1$ | 71.2 | 47.5 | 25.18 |
| 790-$A_2$ | 61.6 | 45.7 | 1.73 |
| 790-B | 71.6 | 41.0 | 0.12 |
| 791-A | 48.4 | 33.3 | 0.12 |
| 791-B | 47.0 | 23.9 | 0.08 |
| 792 | 52.2 | 59.1 | 8.04 |
| 793 | —— | —— | 0.51 |
| 794 | 57.2 | 16.7 | 17.06 |
| 795 | 42.5 | 62.1 | 4.69 |

**TABLE XXXII-A.—Greenhouse Yields of Austrian Winter Peas on Norfolk Soils. Grams Dry Matter (first crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N *Gms.* | N P *Gms.* | N K *Gms.* | N P K *Gms.* | P K *Gms.* | N P K L *Gms.* | P K L *Gms.* |
| 774 | 4.0 | 7.7 | 6.3 | 9.0 | 6.9 | 9.4 | 11.2 |
| 775 | 2.5 | 2.6 | 2.1 | 3.4 | 2.3 | 6.6 | 6.8 |
| 776 | 2.1 | 2.3 | 1.9 | 2.8 | 2.6 | 7.2 | 6.8 |
| 777 | 1.6 | 7.1 | 1.7 | 7.5 | 5.3 | 4.6 | 4.9 |
| 778 | 5.6 | 9.7 | 6.5 | 9.9 | 6.0 | 11.3 | 9.9 |
| 779 | 4.1 | 7.3 | 4.1 | 6.1 | 5.7 | 5.9 | 5.4 |
| 780 | 3.9 | 8.1 | 5.7 | 8.3 | 9.5 | 8.4 | 8.0 |
| 781 | 6.8 | 10.8 | 6.5 | 12.6 | 11.0 | 11.2 | 9.9 |
| 782 | 5.2 | 7.5 | 6.4 | 9.3 | 6.5 | 10.3 | 10.0 |
| 783 | 9.0 | 11.0 | 8.1 | 12.6 | 8.8 | 11.7 | 9.7 |
| 784 | 1.2 | 4.3 | 1.2 | 3.8 | 2.4 | 5.7 | 4.6 |
| 785 | 7.2 | 12.0 | 6.5 | 11.6 | 11.5 | 13.5 | 14.3 |
| 786 | 12.9 | 12.5 | 12.3 | 16.6 | 14.2 | 16.6 | 13.6 |
| 787 | 12.2 | 16.9 | 11.9 | 16.1 | 15.7 | 18.0 | 20.0 |
| 788 | 4.4 | 8.1 | 3.9 | 7.5 | 7.2 | 9.3 | 8.5 |
| 789 | 3.3 | 3.9 | 2.8 | 5.0 | 2.6 | 8.8 | 9.8 |
| 790-$A_1$ | 6.4 | 9.5 | 6.5 | 10.6 | 4.6 | 10.8 | 9.5 |
| 791 | 6.3 | 9.4 | 6.8 | 9.0 | 8.1 | 9.2 | 10.7 |
| 792 | 2.8 | 4.9 | 3.1 | 5.3 | 3.6 | 6.4 | 5.7 |
| 793 | 2.9 | 5.8 | 3.7 | 5.6 | 6.1 | 7.5 | 6.5 |
| 794 | 6.5 | 9.5 | 7.1 | 9.1 | 8.0 | 9.1 | 7.9 |
| 795 | 7.8 | 11.2 | 8.8 | 11.1 | 9.0 | 11.4 | 7.7 |
| 790-$A_2$ | 1.3 | 4.5 | 1.3 | 3.9 | 3.2 | 4.1 | 3.2 |
| 790-B | 0.6 | 1.1 | 1.1 | 1.3 | 1.3 | 2.1 | 2.4 |
| 791-B | 0.6 | 1.4 | 0.5 | 1.2 | 0.8 | 2.8 | 2.7 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 118.7 | 182.1 | 123.9 | 192.8 | 157.6 | 212.9 | 201.4 |
| Mean yield | 5.40 | 8.28 | 5.63 | 8.76 | 7.16 | 9.68 | 9.15 |
| Per cent average yield (N P K=100%) | 61.6% | 94.5% | 64.3% | 100.0% | 81.7% | 110.4% | 104.5% |

**TABLE XXXII-B.—Greenhouse Yields of Sorghum on Norfolk Soils. Grams Dry Matter (second crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 774 | 13.0 | 19.0 | 15.7 | 24.1 | 16.3 | 38.0 | 34.6 |
| 775 | 3.8 | 8.1 | 2.7 | 7.4 | 5.5 | 20.4 | 18.8 |
| 776 | 5.3 | 15.8 | 4.6 | 13.9 | 8.3 | 22.3 | 11.1 |
| 777 | 0.6 | 18.6 | 0.6 | 25.6 | 7.2 | 24.4 | 6.5 |
| 778 | 25.7 | 32.5 | 22.6 | 40.2 | 22.4 | 44.4 | 44.2 |
| 779 | 6.7 | 19.8 | 6.4 | 33.6 | 22.2 | 36.5 | 27.0 |
| 780 | 2.9 | 17.1 | 1.5 | 19.3 | 9.3 | 33.1 | 29.6 |
| 781 | 3.9 | 17.3 | 4.0 | 31.3 | 21.2 | 35.8 | 25.2 |
| 782 | 12.9 | 19.4 | 12.7 | 28.2 | 21.9 | 31.3 | 21.1 |
| 783 | 18.3 | 20.5 | 22.4 | 37.0 | 31.9 | 36.4 | 31.1 |
| 784 | 0.5 | 14.4 | 0.5 | 27.2 | 9.5 | 32.1 | 8.5 |
| 785 | 7.6 | 22.6 | 8.3 | 29.0 | 17.4 | 31.4 | 20.7 |
| 786 | 11.8 | 28.3 | 11.0 | 34.4 | 24.2 | 34.7 | 23.5 |
| 787 | 17.3 | 22.2 | 18.1 | 27.9 | 23.8 | 36.7 | 33.8 |
| 788 | 7.7 | 16.0 | 10.4 | 25.2 | 17.5 | 31.7 | 23.8 |
| 789 | 9.3 | 13.9 | 13.3 | 31.5 | 22.4 | 38.3 | 32.9 |
| 790-$A_1$ | 31.7 | 38.6 | 34.7 | 40.1 | 40.9 | 45.1 | 41.3 |
| 791 | 23.1 | 28.5 | 27.0 | 34.5 | 27.2 | 40.9 | 39.4 |
| 792 | 11.5 | 27.8 | 9.9 | 36.4 | 23.8 | 40.6 | 34.3 |
| 793 | 2.6 | 11.8 | 3.4 | 14.6 | 8.7 | 23.7 | 12.5 |
| 794 | 14.1 | 16.7 | 29.0 | 34.0 | 34.5 | 30.6 | 27.5 |
| 795 | 21.3 | 28.3 | 21.5 | 33.4 | 29.9 | 42.0 | 34.2 |
| 790-$A_2$ | 2.0 | 28.2 | 1.0 | 27.6 | 13.0 | 34.1 | 16.6 |
| 790-B | 0.3 | 2.6 | 0.3 | 3.5 | 1.0 | 19.1 | 8.4 |
| 791-B | 0.5 | 10.7 | 0.5 | 6.8 | 4.6 | 17.3 | 6.8 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 251.6 | 457.2 | 280.3 | 628.8 | 446.0 | 750.4 | 581.6 |
| Mean yield | 11.44 | 20.78 | 12.74 | 28.58 | 20.27 | 34.11 | 26.44 |
| Per cent average yield (N P K=100%) | 40.0% | 72.7% | 44.6% | 100.0% | 70.9% | 119.3% | 92.5% |

**TABLE XXXII-C.—Greenhouse Yields of Sorghum on Norfolk Soils. Grams Dry Matter (third crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 774 | 6.8 | 16.6 | 8.7 | 22.1 | 8.8 | 32.4 | 19.5 |
| 775 | 4.7 | 10.1 | 5.7 | 18.1 | 13.9 | 16.5 | 6.9 |
| 776 | 1.4 | 4.0 | 2.9 | 6.6 | 5.3 | 28.9 | 13.6 |
| 777 | 0.4 | 10.1 | 0.3 | 29.7 | 9.9 | 23.5 | 2.3 |
| 778 | 10.9 | 4.4 | 11.4 | 20.0 | 24.4 | 29.5 | 27.0 |
| 779 | 3.0 | 8.1 | 11.4 | 16.1 | 10.6 | 15.1 | 3.6 |
| 780 | 0.6 | 17.4 | 3.6 | 27.6 | 3.7 | 35.0 | 20.8 |
| 781 | 2.9 | 7.0 | 4.0 | 30.4 | 13.5 | 30.0 | 11.4 |
| 782 | 7.4 | 13.7 | 7.9 | 31.6 | 15.4 | 33.6 | 10.4 |
| 783 | 15.8 | 18.2 | 21.6 | 34.4 | 27.8 | 38.9 | 29.2 |
| 784 | 0.2 | 10.5 | 0.2 | 29.1 | 2.7 | 29.3 | 6.5 |
| 785 | 3.8 | 23.0 | 6.7 | 34.4 | 13.7 | 34.7 | 4.4 |
| 786 | 2.1 | 24.4 | 4.4 | 39.0 | 11.8 | 39.8 | 11.6 |
| 787 | 19.9 | 23.8 | 24.7 | 37.6 | 27.5 | 42.1 | 28.1 |
| 788 | 8.8 | 15.4 | 13.0 | 32.4 | 17.6 | 37.1 | 18.0 |
| 789 | 2.0 | 4.9 | 2.8 | 4.2 | 6.9 | 24.2 | 20.3 |
| 790-$A_1$ | 14.2 | 7.1 | 28.1 | 33.3 | 30.3 | 36.1 | 32.9 |
| 791 | 8.2 | 14.8 | 11.0 | 20.2 | 15.3 | 40.5 | 29.3 |
| 792 | 1.6 | 8.1 | 2.2 | 29.0 | 7.8 | 34.8 | 13.7 |
| 793 | 3.9 | 16.4 | 6.9 | 31.0 | 4.2 | 18.5 | 4.1 |
| 794 | 13.1 | 8.9 | 17.4 | 35.4 | 27.7 | 37.2 | 26.6 |
| 795 | 17.5 | 22.8 | 16.1 | 35.6 | 19.3 | 39.3 | 27.9 |
| 790-$A_2$ | 0.4 | 27.7 | 0.4 | 27.5 | 6.1 | 16.8 | 1.6 |
| 790-B | 0.2 | 11.5 | 0.3 | 15.1 | 0.3 | 21.2 | 2.5 |
| 791-B | 0.2 | 20.6 | 0.3 | 31.7 | 0.5 | 18.9 | 1.6 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 149.2 | 289.7 | 211.0 | 597.8 | 318.1 | 697.0 | 368.1 |
| Mean yield | 6.78 | 13.17 | 9.59 | 27.17 | 14.46 | 31.68 | 16.73 |
| Per cent average yield (N P K=100%) | 25.0% | 48.5% | 35.3% | 100.0% | 53.2% | 116.6% | 61.6% |

**TABLE XXXIII-A.—Greenhouse Yields of Sorghum on the Greenville, Amite, and Akron Soils. Grams Dry Matter (first crop).**

| Soil No. | Fertilizer treatment | | | | |
|---|---|---|---|---|---|
| | N *Gms.* | N P *Gms.* | N K *Gms.* | N P K* *Gms.* | N P K L* *Gms.* |
| 799 | 1.4 | 16.3 | 1.3 | 17.4 | 15.6 |
| 800 | 1.4 | 21.1 | 1.0 | 24.7 | 24.7 |
| 801 | 14.6 | 23.2 | 10.7 | 29.7 | 26.3 |
| 802 | 18.5 | 25.3 | 15.4 | 31.7 | 29.5 |
| 803 | 35.4 | 37.5 | 26.3 | 37.5 | 38.8 |
| 804 | 13.7 | 33.5 | 15.5 | 32.0 | 40.4 |
| 805 | 20.2 | 33.9 | 24.0 | 33.8 | 32.4 |
| 806 | 19.2 | 31.8 | 26.2 | 38.6 | 40.6 |
| 807 | 30.8 | 31.9 | 28.7 | 33.9 | 35.7 |
| 808 | 27.6 | 32.3 | 25.6 | 30.8 | 34.0 |
| 809 | 30.3 | 36.3 | 30.9 | 32.6 | 35.8 |
| 810 | 8.6 | 26.9 | 7.5 | 34.7 | 34.7 |
| 811 | 18.8 | 45.2 | 20.6 | 39.9 | 42.5 |
| 812 | 27.7 | 36.6 | 23.1 | 36.1 | 40.5 |
| 813 | 46.2 | 55.4 | 44.8 | 53.3 | 53.0 |
| 814 | 32.4 | 42.6 | 33.4 | 29.3 | 38.1 |
| 815 | 33.4 | 44.0 | 37.2 | 42.8 | 43.3 |
| 816 | 38.9 | 43.1 | 37.7 | 43.0 | 43.1 |
| 817 | 40.6 | 41.6 | 42.1 | 44.3 | 42.6 |
| 818 | 46.3 | 56.5 | 48.5 | 61.4 | 57.9 |
| 819 | 27.1 | 30.1 | 32.0 | 28.8 | 34.0 |
| 820 | 47.5 | 52.9 | 45.6 | 52.9 | 51.5 |
| 821 | 36.5 | 41.9 | 31.9 | 44.1 | 46.7 |
| 813-B | 1.1 | 32.1 | 1.2 | 25.4 | 28.2 |
| 815-B | 0.8 | 24.1 | 0.7 | 22.6 | 25.6 |
| 819-B | 3.2 | 28.3 | 2.4 | 35.0 | 42.4 |
| | Summary of yields of 23 surface soils | | | | |
| Total yield | 617.1 | 839.9 | 610.0 | 863.3 | 881.7 |
| Mean yield | 26.83 | 36.52 | 26.52 | 37.53 | 38.33 |
| Per cent average yield (N P K=100%) | 71.5% | 97.3% | 70.7% | 100.0% | 102.1% |

*Average of four replicate yields.

**TABLE XXXIII-B.—Greenhouse Yields of Sorghum on the Greenville, Amite, and Akron Soils. Grams Dry Matter (second crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 799 | 1.4 | 27.5 | 2.0 | 30.9 | 11.4 | 19.9 | 5.0 |
| 800 | 1.4 | 16.2 | 1.3 | 30.4 | 18.2 | 37.0 | 19.7 |
| 801 | 2.6 | 17.5 | 14.1 | 22.4 | 8.4 | 28.7 | 12.9 |
| 802 | 1.6 | 1.6 | 9.5 | 13.9 | 4.3 | 21.2 | 19.7 |
| 803 | 15.4 | 21.3 | 29.9 | 40.3 | 31.5 | 45.8 | 35.0 |
| 804 | 12.5 | 11.5 | 10.6 | 27.4 | 12.4 | 39.6 | 27.2 |
| 805 | 2.5 | 8.7 | 6.5 | 30.4 | 18.1 | 33.6 | 16.7 |
| 806 | 8.4 | 11.2 | 20.0 | 42.4 | 26.2 | 38.6 | 35.3 |
| 807 | 1.1 | 2.2 | 7.3 | 27.4 | 2.7 | 10.8 | 9.5 |
| 808 | 18.1 | 15.9 | 25.1 | 41.6 | 21.3 | 36.2 | 33.5 |
| 809 | 22.5 | 39.9 | 38.7 | 54.2 | 36.7 | 50.6 | 45.7 |
| 810 | 17.3 | 29.4 | 17.8 | 36.3 | 19.7 | 37.8 | 28.8 |
| 811 | 18.3 | 13.3 | 31.4 | 47.2 | 35.7 | 41.1 | 18.9 |
| 812 | 37.9 | 49.3 | 41.1 | 53.6 | 26.5 | 44.5 | 41.0 |
| 813 | 28.3 | 16.4 | 45.0 | 49.4 | 38.7 | 49.8 | 50.5 |
| 814 | 27.8 | 14.9 | 40.2 | 44.0 | 37.5 | 48.9 | 42.6 |
| 815 | 27.7 | 17.6 | 36.2 | 49.7 | 46.7 | 50.7 | 53.1 |
| 816 | 11.9 | 7.3 | 26.6 | 40.2 | 24.9 | 37.5 | 33.0 |
| 817 | 46.5 | 55.5 | 47.5 | 68.9 | 60.8 | 71.3 | 65.6 |
| 818 | 33.7 | 24.0 | 41.6 | 48.3 | 40.0 | 63.0 | 61.1 |
| 819 | 17.2 | 31.0 | 30.4 | 48.4 | 34.6 | 50.1 | 31.0 |
| 820 | 36.6 | 45.4 | 34.7 | 49.5 | 48.7 | 59.2 | 54.1 |
| 821 | 26.8 | 18.2 | 35.4 | 49.5 | 40.1 | 65.5 | 41.6 |
| 813-B | 1.6 | 51.3 | 1.1 | 71.2 | 37.8 | 66.8 | 16.2 |
| 815-B | 0.5 | 31.6 | 0.9 | 37.6 | 10.7 | 48.1 | 6.1 |
| 819-B | 8.6 | 17.7 | 11.9 | 44.0 | 33.8 | 53.8 | 39.7 |
| Summary of yields of 23 surface soils | | | | | | | |
| Total yield | 417.5 | 495.8 | 593.2 | 946.3 | 645.1 | 941.4 | 781.5 |
| Mean yield | 18.15 | 21.56 | 25.78 | 41.14 | 28.05 | 42.67 | 33.98 |
| Per cent average yield (N P K=100%) | 44.1% | 52.4% | 62.7% | 100.0% | 68.2% | 103.7% | 82.6% |

**TABLE XXXIII-C.—Greenhouse Yields of Austrian Winter Peas on the Greenville, Amite, and Akron Soils. Grams Dry Weight (third crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 799 | 2.0 | 4.2 | 2.5 | 4.9 | 2.5 | 5.4 | 3.4 |
| 800 | 1.8 | 3.9 | 2.5 | 4.8 | 3.6 | 5.7 | 2.2 |
| 801 | 1.7 | 3.1 | 1.9 | 6.4 | 3.2 | 6.0 | 5.7 |
| 802 | 2.1 | 3.6 | 2.2 | 4.5 | 2.4 | 4.0 | 2.5 |
| 803 | 3.5 | 4.0 | 4.9 | 7.4 | 5.5 | 6.5 | 5.9 |
| 804 | 1.3 | 4.7 | 1.7 | 4.0 | 2.3 | 5.1 | 2.9 |
| 805 | 2.3 | 3.4 | 2.6 | 4.8 | 4.7 | 5.5 | 3.9 |
| 806 | 2.5 | 3.7 | 4.0 | 5.6 | 3.7 | 5.8 | 4.9 |
| 807 | 2.6 | 4.1 | 2.0 | 4.5 | 3.9 | 6.2 | 3.7 |
| 808 | 2.1 | 3.0 | 2.5 | 5.0 | 3.8 | 6.4 | 4.8 |
| 809 | 2.6 | 3.9 | 3.8 | 6.3 | 5.0 | 5.9 | 5.5 |
| 810 | 1.9 | 4.0 | 2.7 | 5.2 | 2.8 | 4.1 | 2.7 |
| 811 | 1.9 | 3.2 | 2.1 | 5.8 | 3.4 | 4.5 | 2.4 |
| 812 | 2.8 | 4.1 | 3.6 | 5.8 | 4.5 | 6.6 | 4.8 |
| 813 | 4.1 | 4.6 | 6.0 | 6.3 | 6.6 | 6.9 | 6.3 |
| 814 | 3.5 | 3.8 | 5.3 | 6.2 | 5.2 | 5.8 | 4.7 |
| 815 | 3.0 | 3.5 | 3.7 | 4.0 | 3.6 | 5.9 | 4.8 |
| 816 | 1.6 | 3.4 | 2.3 | 6.2 | 4.1 | 5.8 | 3.6 |
| 817 | 5.3 | 4.4 | 8.4 | 7.4 | 8.2 | 9.9 | 8.8 |
| 818 | 3.0 | 4.8 | 4.0 | 8.1 | 6.8 | 7.2 | 6.6 |
| 819 | 2.2 | 3.8 | 3.5 | 6.5 | 5.1 | 4.8 | 5.0 |
| 820 | 3.1 | 4.5 | 5.1 | 6.8 | 5.1 | 6.8 | 5.4 |
| 821 | 3.3 | 4.4 | 4.1 | 7.1 | 5.0 | 7.1 | 5.3 |
| 813-B | 1.7 | 2.9 | 2.1 | 5.7 | 3.1 | 5.8 | 4.6 |
| 815-B | 1.7 | 2.4 | 1.1 | 2.6 | 1.0 | 3.8 | 1.6 |
| 819-B | 2.1 | 3.9 | 1.7 | 6.8 | 4.3 | 6.2 | 6.1 |
| Summary of yields of 23 surface soils | | | | | | | |
| Total yield | 60.2 | 90.1 | 81.4 | 133.6 | 101.0 | 137.9 | 105.8 |
| Mean yield | 2.62 | 3.92 | 3.54 | 5.81 | 4.39 | 6.00 | 4.60 |
| Per cent average yield (N P K=100%) | 45.1% | 67.4% | 60.9% | 100.0% | 75.6% | 103.2% | 79.2% |

**TABLE XXXIV-A.—Greenhouse Yields of Austrian Winter Peas on the Decatur Soils. Grams Dry Weight (first crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N *Gms.* | N P *Gms.* | N K *Gms.* | N P K *Gms.* | P K *Gms.* | N P K L *Gms.* | P K L *Gms.* |
| 883 | 5.1 | 6.3 | 5.0 | 7.2 | 5.4 | 8.3 | 7.4 |
| 884 | 3.6 | 6.2 | 4.1 | 6.5 | 6.5 | 7.9 | 7.8 |
| 885 | 8.0 | 8.7 | 8.3 | 9.6 | 8.4 | 9.3 | 9.0 |
| 886 | 3.8 | 5.0 | 3.8 | 5.3 | 3.6 | 7.2 | 4.9 |
| 887 | 4.3 | 4.4 | 3.0 | 6.1 | 5.9 | 6.9 | 6.8 |
| 888 | 4.0 | 5.9 | 4.1 | 5.6 | 5.5 | 7.9 | 6.7 |
| 889 | 4.2 | 5.2 | 3.5 | 5.3 | 3.4 | 7.5 | 5.2 |
| 890 | 2.8 | 6.1 | 3.4 | 6.0 | 5.1 | 6.6 | 5.1 |
| 891 | 4.2 | 6.6 | 4.2 | 6.5 | 4.1 | 8.5 | 6.4 |
| 892 | 5.0 | 7.3 | 4.5 | 7.4 | 5.9 | 8.7 | 7.5 |
| 893 | 5.8 | 6.9 | 5.7 | 6.9 | 5.6 | 7.3 | 6.1 |
| 894 | 4.2 | 6.2 | 4.5 | 5.0 | 4.9 | 6.5 | 5.6 |
| 895 | 7.3 | 8.5 | 6.8 | 7.8 | 7.1 | 8.3 | 8.5 |
| 896 | 4.6 | 6.5 | 5.0 | 6.2 | 5.1 | 7.7 | 7.0 |
| 897 | 4.0 | 6.3 | 4.4 | 6.8 | 5.7 | 8.5 | 7.3 |
| 898 | 5.5 | 6.6 | 5.2 | 6.7 | 6.2 | 8.4 | 7.3 |
| 899 | 5.2 | 8.5 | 6.1 | 9.1 | 6.7 | 10.7 | 8.8 |
| 900 | 6.5 | 8.5 | 6.4 | 8.2 | 6.9 | 8.6 | 7.4 |
| 901 | 7.1 | 8.5 | 7.1 | 8.0 | 8.8 | 11.3 | 10.4 |
| 902 | 5.4 | 6.4 | 5.5 | 6.4 | 5.5 | 7.2 | 5.7 |
| 903 | 3.1 | 5.5 | 3.0 | 6.9 | 4.9 | 8.9 | 7.2 |
| 904 | 2.5 | 7.1 | 3.7 | 6.5 | 6.7 | 9.1 | 8.8 |
| 898-B | 1.6 | 5.0 | 1.7 | 5.2 | 3.3 | 5.9 | 3.6 |
| 901-B | 1.8 | 3.1 | 1.9 | 3.1 | 3.1 | 3.3 | 3.1 |
| 903-$B_6$ | 1.7 | 4.3 | 1.8 | 4.2 | 3.1 | 4.7 | 3.5 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 106.2 | 147.2 | 107.3 | 150.0 | 127.9 | 181.3 | 156.9 |
| Mean yield | 4.83 | 6.69 | 4.88 | 6.82 | 5.81 | 8.24 | 7.13 |
| Per cent average yield (N P K=100%) | 70.8% | 98.1% | 71.5% | 100.0% | 85.3% | 120.9% | 104.6% |

**TABLE XXXIV-B.—Greenhouse Yields of Sorghum on the Decatur Soils. Grams Dry Weight (second crop).**

| Soil No. | Fertilizer treatment N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
|---|---|---|---|---|---|---|---|
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 883 | 4.9 | 41.1 | 5.9 | 46.2 | 27.3 | 51.7 | 30.8 |
| 884 | 8.5 | 44.9 | 6.5 | 43.4 | 23.3 | 50.1 | 27.3 |
| 885 | 23.1 | 38.7 | 13.5 | 42.1 | 27.9 | 45.6 | 32.9 |
| 886 | 14.9 | 41.0 | 15.2 | 39.7 | 22.1 | 39.3 | 29.0 |
| 887 | 1.9 | 32.0 | 1.6 | 25.4 | 8.5 | 34.4 | 8.7 |
| 888 | 15.2 | 34.5 | 16.3 | 44.1 | 28.1 | 41.6 | 32.8 |
| 889 | 13.2 | 36.0 | 15.9 | 38.4 | 22.8 | 40.1 | 31.1 |
| 890 | 2.0 | 34.3 | 2.5 | 39.1 | 12.7 | 32.9 | 13.7 |
| 891 | 4.3 | 25.4 | 4.4 | 31.5 | 12.8 | 44.3 | 20.5 |
| 892 | 4.0 | 27.4 | 3.9 | 28.3 | 9.9 | 29.3 | 11.9 |
| 893 | 32.1 | 41.0 | 33.3 | 43.1 | 35.5 | 61.0 | 35.1 |
| 894 | 12.7 | 43.6 | 13.3 | 45.2 | 27.9 | 46.8 | 36.4 |
| 895 | 19.9 | 45.5 | 18.0 | 47.5 | 30.5 | 37.5 | 28.6 |
| 896 | 9.8 | 33.0 | 14.3 | 34.9 | 22.3 | 29.3 | 29.2 |
| 897 | 16.6 | 46.5 | 15.8 | 42.8 | 30.5 | 48.8 | 31.7 |
| 898 | 4.3 | 36.8 | 5.0 | 36.7 | 12.6 | 40.0 | 21.9 |
| 899 | 10.1 | 35.9 | 7.1 | 31.5 | 17.5 | 43.7 | 38.0 |
| 900 | 9.5 | 28.5 | 11.2 | 29.6 | 16.8 | 26.6 | 15.5 |
| 901 | 16.2 | 40.4 | 17.4 | 46.3 | 21.5 | 44.3 | 32.9 |
| 902 | 9.2 | 40.6 | 15.5 | 24.8 | 20.3 | 31.8 | 20.3 |
| 903 | 5.3 | 42.4 | 3.5 | 43.8 | 19.1 | 45.8 | 18.9 |
| 904 | 4.8 | 38.5 | 4.4 | 38.0 | 17.2 | 37.5 | 20.9 |
| 898-B | 0.7 | 25.9 | 0.4 | 28.8 | 2.1 | 30.3 | 3.7 |
| 901-B | 0.5 | 25.9 | .5 | 32.8 | 9.9 | 36.5 | 8.1 |
| 903-B | 0.4 | 37.5 | .6 | 24.6 | 7.3 | 37.6 | 13.3 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 242.5 | 828.0 | 244.5 | 842.4 | 467.1 | 902.4 | 568.1 |
| Mean yield | 11.02 | 37.64 | 11.11 | 38.29 | 21.23 | 41.02 | 25.82 |
| Per cent average yield (N P K=100%) | 28.8% | 98.3% | 29.0% | 100.0% | 55.4% | 107.1% | 67.4% |

**TABLE XXXIV-C.—Greenhouse Yields of Sorghum on the Decatur Soils. Grams Dry Weight (third crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 883 | 0.3 | 10.7 | 1.4 | 35.5 | 5.3 | 33.1 | 4.3 |
| 884 | 18.2 | 44.2 | 21.9 | 51.2 | 36.3 | 54.1 | 29.7 |
| 885 | 11.3 | 45.0 | 15.6 | 45.4 | 21.1 | 49.5 | 34.3 |
| 886 | 16.9 | 38.0 | 20.8 | 41.6 | 19.7 | 43.7 | 36.3 |
| 887 | 4.8 | 33.3 | 3.2 | 52.9 | 11.3 | 62.3 | 18.9 |
| 888 | 5.8 | 18.4 | 10.9 | 44.5 | 23.3 | 44.7 | 31.9 |
| 889 | 14.0 | 35.5 | 18.3 | 57.3 | 23.0 | 55.7 | 34.6 |
| 890 | 1.1 | 44.3 | 1.2 | 53.3 | 8.3 | 49.5 | 6.4 |
| 891 | 3.8 | 31.3 | 3.9 | 31.2 | 11.5 | 42.5 | 12.6 |
| 892 | 2.7 | 32.3 | 8.8 | 47.7 | 16.7 | 43.2 | 11.9 |
| 893 | 35.6 | 54.7 | 41.2 | 48.6 | 47.4 | 50.9 | 44.0 |
| 894 | 8.8 | 44.7 | 20.6 | 55.5 | 20.6 | 49.4 | 30.6 |
| 895 | 34.3 | 45.4 | 24.2 | 64.3 | 33.5 | 47.8 | 43.8 |
| 896 | 7.1 | 44.5 | 9.4 | 38.1 | 25.4 | 49.5 | 33.2 |
| 897 | 26.7 | 52.9 | 26.1 | 46.1 | 39.0 | 53.1 | 45.2 |
| 898 | 13.9 | 41.5 | 16.5 | 45.7 | 21.7 | 45.1 | 39.4 |
| 899 | 16.4 | 30.6 | 19.5 | 36.9 | 25.8 | 43.1 | 45.2 |
| 900 | 27.3 | 50.4 | 21.8 | 52.3 | 33.1 | 53.0 | 43.8 |
| 901 | 21.1 | 39.0 | 25.9 | 47.1 | 27.4 | 57.2 | 38.8 |
| 902 | 27.0 | 46.0 | 22.3 | 53.3 | 37.2 | 63.0 | 41.5 |
| 903 | 8.9 | 52.3 | 10.1 | 51.0 | 16.5 | 67.2 | 20.7 |
| 904 | 5.7 | 48.9 | 8.0 | 52.2 | 22.4 | 58.7 | 17.9 |
| 898-B | 0.5 | 46.4 | 0.5 | 40.9 | 4.6 | 43.0 | 6.2 |
| 901-B | 0.6 | 21.0 | 0.6 | 31.0 | 4.4 | 40.5 | 11.1 |
| 903-B | 0.5 | 38.6 | 0.6 | 40.9 | 3.5 | 38.4 | 4.4 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 311.7 | 883.9 | 351.6 | 1051.7 | 526.5 | 1116.3 | 665.0 |
| Mean yield | 14.17 | 40.18 | 15.98 | 47.8 | 23.93 | 50.74 | 30.23 |
| Per cent average yield (N P K=100%) | 29.6% | 84.0% | 33.4% | 100.0% | 50.0% | 106.1% | 63.2% |

**TABLE XXXV-A.—Greenhouse Yields of Austrian Winter Peas on the Hartsells Soils. Grams Dry Weight (first crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N *Gms.* | N P *Gms.* | N K *Gms.* | N P K *Gms.* | P K *Gms.* | N P K L *Gms.* | P K L *Gms.* |
| 912-A | 1.5 | 3.0 | 1.6 | 3.3 | 2.1 | 3.7 | 3.7 |
| 913 | 1.9 | 3.5 | 1.9 | 3.0 | 2.6 | 4.4 | 3.1 |
| 914 | 1.9 | 3.5 | 1.9 | 3.0 | 2.6 | 3.4 | 3.3 |
| 915 | 1.2 | 2.4 | 1.2 | 2.5 | 1.5 | 3.4 | 1.8 |
| 916 | 5.3 | 6.3 | 5.4 | 7.8 | 6.9 | 7.2 | 7.1 |
| 917 | 1.4 | 1.8 | 1.2 | 1.9 | 0.6 | 2.8 | 1.6 |
| 918 | 1.4 | 2.1 | 1.6 | 2.1 | 1.9 | 5.8 | 3.7 |
| 919 | 1.6 | 2.2 | 1.7 | 2.3 | 0.9 | 4.3 | 1.4 |
| 920 | 1.6 | 1.7 | 1.7 | 1.7 | 1.0 | 2.2 | 1.2 |
| 921 | 1.5 | 2.5 | 1.4 | 2.4 | 1.0 | 3.5 | 2.4 |
| 922 | 1.2 | 1.5 | 1.1 | 1.6 | 0.9 | 2.9 | 2.6 |
| 923 | 0.9 | 1.6 | 0.9 | 1.3 | 1.0 | 2.8 | 2.4 |
| 924 | 1.4 | 1.9 | 1.3 | 2.0 | 1.2 | 3.4 | 3.1 |
| 925 | 1.2 | 1.8 | 0.7 | 1.5 | 1.0 | 2.4 | 1.6 |
| 926 | 1.4 | 2.2 | 1.8 | 2.5 | 1.4 | 3.1 | 2.2 |
| 927 | 1.6 | 2.1 | 1.8 | 2.3 | 1.2 | 3.6 | 2.2 |
| 928 | 1.8 | 1.8 | 2.2 | 3.1 | 1.8 | 3.6 | 3.1 |
| 929 | 1.3 | 2.0 | 1.4 | 2.5 | 1.6 | 3.7 | 2.9 |
| 930 | 1.0 | 1.4 | 1.0 | 1.4 | 0.6 | 3.1 | 2.4 |
| 931 | 0.9 | 1.3 | 0.9 | 1.4 | 0.9 | 4.2 | 3.3 |
| 932 | 1.3 | 1.8 | 1.6 | 2.0 | 0.7 | 3.1 | 1.2 |
| 933 | 0.7 | 1.0 | 0.9 | 1.2 | 0.6 | 3.1 | 2.2 |
| 914-B | 0.7 | 0.8 | 0.8 | 0.8 | 0.5 | 1.9 | 1.8 |
| 928-B | 0.9 | 1.0 | 0.9 | 1.0 | 0.8 | 2.0 | 1.7 |
| 931-B | 0.6 | 0.6 | 0.7 | 0.7 | 0.5 | 1.6 | 1.4 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 34.0 | 49.4 | 35.2 | 52.8 | 34.0 | 79.7 | 58.5 |
| Mean yield | 1.54 | 2.24 | 1.60 | 2.40 | 1.54 | 3.62 | 2.66 |
| Per cent average yield (N P K=100%) | 64.39% | 93.56% | 66.66% | 100.00% | 64.39% | 150.94% | 110.79% |

**TABLE XXXV-B.—Greenhouse Yields of Sorghum on the Hartsells Soils. Grams Dry Weight (second crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 912-A | 1.8 | 44.0 | 1.8 | 51.0 | 19.1 | 50.7 | 21.0 |
| 913 | 2.4 | 22.0 | 4.3 | 23.2 | 15.3 | 33.2 | 14.3 |
| 914 | 6.1 | 24.7 | 4.9 | 25.3 | 10.6 | 26.1 | 22.4 |
| 915 | .6 | 29.2 | .7 | 33.6 | 15.0 | 31.1 | 11.7 |
| 916 | 32.5 | 35.9 | 19.3 | 47.3 | 42.1 | 54.3 | 47.5 |
| 917 | 2.8 | 17.5 | 4.1 | 22.5 | 10.6 | 28.7 | 12.2 |
| 918 | 6.2 | 22.6 | 6.0 | 18.6 | 11.8 | 26.3 | 22.7 |
| 919 | 8.4 | 32.1 | 13.7 | 34.3 | 17.4 | 32.6 | 21.4 |
| 920 | 7.5 | 15.6 | 7.9 | 19.3 | 10.9 | 25.0 | 17.3 |
| 921 | 3.7 | 25.9 | 5.2 | 25.1 | 10.1 | 24.9 | 21.2 |
| 922 | 7.2 | 22.4 | 8.9 | 24.5 | 9.6 | 30.3 | 18.8 |
| 923 | 14.0 | 34.8 | 16.0 | 37.7 | 25.9 | 36.7 | 36.1 |
| 924 | 5.6 | 20.5 | 7.7 | 25.2 | 13.3 | 17.2 | 16.9 |
| 925 | 6.8 | 26.0 | 6.9 | 23.0 | 10.9 | 28.6 | 20.5 |
| 926 | 6.7 | 15.4 | 8.3 | 23.1 | 9.8 | 24.7 | 14.8 |
| 927 | 13.1 | 17.2 | 12.2 | 32.4 | 24.3 | 35.8 | 27.6 |
| 928 | 15.5 | 23.0 | 17.7 | 20.6 | 18.8 | 26.9 | 19.2 |
| 929 | 11.3 | 25.6 | 13.7 | 29.8 | 21.5 | 30.1 | 24.5 |
| 930 | 5.4 | 24.7 | 3.7 | 24.4 | 7.3 | 31.6 | 21.2 |
| 931 | 2.0 | 8.8 | 2.2 | 17.0 | 7.5 | 24.5 | 13.4 |
| 932 | 14.4 | 32.6 | 19.3 | 24.1 | 17.4 | 23.2 | 21.2 |
| 933 | .2 | 10.6 | .2 | 11.3 | 1.6 | 23.0 | 6.8 |
| 914-B | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 3.4 | 2.1 |
| 928-B | .2 | 3.8 | .2 | 4.2 | .2 | 4.5 | 1.5 |
| 931-B | .2 | 3.1 | .2 | 1.6 | .3 | 12.8 | 8.6 |
| | Summary of yields of 22 surface soils | | | | | | |
| Total yield | 174.2 | 531.1 | 184.7 | 593.3 | 330.8 | 665.5 | 452.7 |
| Mean yield | 7.92 | 24.14 | 8.40 | 26.97 | 15.04 | 30.25 | 20.58 |
| Per cent average yield (N P K=100%) | 29.36% | 89.52% | 31.13% | 100.00% | 55.76% | 112.7% | 76.30% |

**TABLE XXXV-C.—Greenhouse Yields of Sorghum on the Hartsells Soils. Grams Dry Weight (third crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 912-A | 2.4 | 38.7 | 1.5 | 46.2 | 10.6 | 62.3 | 27.3 |
| 913 | 17.2 | 34.1 | 15.5 | 50.5 | 34.4 | 52.1 | 44.6 |
| 914 | 22.7 | 50.7 | 25.4 | 63.1 | 43.4 | 58.6 | 39.8 |
| 915 | 3.2 | 23.2 | 1.4 | 47.0 | 18.2 | 48.5 | 22.3 |
| 916 | 38.7 | 52.9 | 45.9 | 67.4 | 59.1 | 65.1 | 64.6 |
| 917 | 7.0 | 24.0 | 1.7 | 27.1 | 7.7 | 43.0 | 31.7 |
| 918 | 29.7 | 21.2 | 40.9 | 50.2 | 44.2 | 62.1 | 57.8 |
| 919 | 36.1 | 18.2 | 43.6 | 54.1 | 50.4 | 63.5 | 59.9 |
| 920 | 24.7 | 48.1 | 35.8 | 61.1 | 52.7 | 55.6 | 47.2 |
| 921 | 9.0 | 32.1 | 11.1 | 51.0 | 28.0 | 60.2 | 23.9 |
| 922 | 8.2 | 28.4 | 10.1 | 35.6 | 19.1 | 43.2 | 26.2 |
| 923 | 15.5 | 18.9 | 35.7 | 47.4 | 31.2 | 50.1 | 39.9 |
| 924 | 19.8 | 24.1 | 23.9 | 40.7 | 35.7 | 52.9 | 45.7 |
| 925 | 28.1 | 30.9 | 36.6 | 45.6 | 38.6 | 55.3 | 52.4 |
| 926 | 34.3 | 46.4 | 37.2 | 57.5 | 51.2 | 61.7 | 51.0 |
| 927 | 43.7 | 51.2 | 54.2 | 49.5 | 47.1 | 58.1 | 56.3 |
| 928 | 22.6 | 25.0 | 36.9 | 50.1 | 36.2 | 59.5 | 59.4 |
| 929 | 30.1 | 32.9 | 40.0 | 49.3 | 42.5 | 53.6 | 56.7 |
| 930 | 11.7 | 12.7 | 31.3 | 37.5 | 30.5 | 42.6 | 42.0 |
| 931 | 7.0 | 29.8 | 13.7 | 39.3 | 14.2 | 60.4 | 38.9 |
| 932 | 28.3 | 31.3 | 54.6 | 66.4 | 51.6 | 63.1 | 57.8 |
| 933 | .3 | 52.5 | .3 | 58.8 | 3.6 | 62.0 | 10.5 |
| 914-B | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 31.8 | 9.5 |
| 928-B | 0.4 | 32.3 | 0.4 | 57.1 | 5.3 | 58.4 | 17.0 |
| 931-B | 0.2 | 16.7 | 0.2 | 10.3 | 1.9 | 63.1 | 8.5 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 440.3 | 727.3 | 597.3 | 1095.4 | 750.2 | 1233.5 | 955.9 |
| Mean yield | 20.01 | 33.06 | 27.15 | 47.79 | 34.10 | 56.07 | 43.45 |
| Per cent average yield (N P K=100%) | 40.2% | 66.4% | 54.5% | 100.0% | 68.5% | 112.6% | 87.3% |

**TABLE XXXVI-A.—Greenhouse Yields of Austrian Winter Peas on the Cecil and Davidson Soils. Grams Dry Weight (first crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N *Gms.* | N P *Gms.* | N K *Gms.* | N P K *Gms.* | P K *Gms.* | N P K L *Gms.* | P K L *Gms.* |
| 950-A | 6.3 | 6.4 | 5.7 | 7.7 | 5.9 | 8.8 | 9.3 |
| 951 | 5.3 | 9.2 | 4.3 | 6.9 | 6.1 | 9.2 | 6.7 |
| 952 | 4.4 | 5.9 | 4.9 | 7.1 | 6.8 | 8.0 | 5.2 |
| 953 | 5.8 | 6.2 | 4.5 | 6.2 | 5.5 | 6.7 | 5.5 |
| 954 | 3.9 | 7.1 | 3.3 | 5.3 | 4.5 | 6.1 | 6.4 |
| 955 | 3.2 | 5.6 | 3.4 | 4.9 | 4.2 | 6.0 | 5.7 |
| 956 | 2.3 | 7.8 | 2.3 | 6.2 | 2.9 | 7.5 | 6.2 |
| 957 | 6.7 | 7.1 | 5.7 | 7.9 | 8.4 | 9.7 | 8.2 |
| 958 | 2.5 | 3.9 | 2.9 | 4.2 | 3.0 | 5.2 | 4.9 |
| 959 | 3.0 | 4.1 | 2.4 | 4.7 | 3.6 | 5.1 | 4.2 |
| 960 | 3.9 | 5.1 | 4.2 | 6.5 | 4.7 | 8.1 | 5.3 |
| 961 | 7.0 | 7.5 | 7.0 | 10.0 | 6.1 | 10.5 | 8.2 |
| 962 | 4.6 | 7.0 | 4.7 | 6.3 | 2.7 | 6.1 | 4.0 |
| 963 | 6.0 | 9.0 | 5.9 | 8.1 | 6.1 | 9.6 | 7.9 |
| 964 | 6.9 | 7.1 | 5.3 | 7.8 | 7.4 | 8.2 | 3.0 |
| 965 | 7.7 | 7.9 | 8.8 | 9.2 | 3.3 | 10.1 | 6.0 |
| 966 | 5.0 | 8.1 | 4.5 | 7.6 | 6.8 | 10.3 | 9.4 |
| 967 | 1.8 | 5.1 | 2.4 | 5.8 | 2.6 | 7.8 | 7.3 |
| 968 | 3.0 | 4.7 | 3.1 | 4.9 | 4.1 | 5.7 | 5.1 |
| 969 | 7.0 | 8.5 | 7.8 | 8.3 | 5.8 | 9.1 | 9.2 |
| 970 | 6.8 | 9.7 | 7.6 | 10.1 | 5.9 | 11.1 | 8.1 |
| 971 | 5.2 | 7.0 | 5.2 | 5.9 | 3.0 | 8.3 | 6.3 |
| 952-B | 2.2 | 3.8 | 2.2 | 4.7 | 3.9 | 7.8 | 7.5 |
| 957-B | 2.5 | 4.6 | 2.0 | 8.6 | 5.5 | 6.9 | 8.7 |
| 964-B | 1.8 | 4.5 | 1.7 | 3.7 | 3.6 | 5.9 | 4.0 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 108.3 | 150.0 | 105.9 | 151.6 | 109.4 | 177.2 | 142.1 |
| Mean yield | 4.92 | 6.81 | 4.81 | 6.89 | 4.97 | 8.05 | 6.45 |
| Per cent average yield (N P K=100%) | 71.44% | 98.94% | 69.85% | 100.00% | 72.16% | 116.89% | 93.73% |

**TABLE XXXVI-B.—Greenhouse Yields of Sorghum on the Cecil and Davidson Soils. Grams Dry Weight (second crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 950-A | 21.7 | 53.5 | 18.6 | 51.5 | 38.1 | 60.1 | 47.9 |
| 951 | 31.4 | 49.7 | 35.1 | 47.6 | 39.5 | 56.4 | 51.2 |
| 952 | 14.0 | 43.2 | 32.6 | 45.8 | 41.6 | 49.6 | 31.4 |
| 953 | 25.9 | 42.7 | 24.9 | 45.5 | 34.7 | 48.3 | 38.5 |
| 954 | 13.9 | 46.2 | 13.5 | 42.0 | 32.2 | 53.2 | 41.3 |
| 955 | 18.0 | 48.7 | 21.9 | 47.9 | 37.7 | 53.3 | 39.3 |
| 956 | 2.4 | 27.6 | .7 | 39.8 | 26.4 | 55.4 | 34.5 |
| 957 | 27.0 | 45.2 | 29.0 | 49.5 | 39.3 | 52.8 | 50.5 |
| 958 | 22.1 | 50.6 | 19.3 | 53.4 | 32.4 | 67.0 | 48.6 |
| 959 | 3.4 | 41.0 | 3.4 | 51.9 | 22.4 | 58.3 | 34.8 |
| 960 | 23.2 | 33.9 | 28.1 | 43.7 | 36.3 | 57.4 | 41.8 |
| 961 | 34.3 | 32.9 | 34.1 | 55.7 | 42.8 | 58.8 | 45.6 |
| 962 | 26.9 | 45.2 | 27.1 | 50.1 | 33.4 | 48.2 | 40.3 |
| 963 | 30.8 | 46.7 | 34.4 | 49.0 | 37.2 | 56.3 | 44.5 |
| 964 | 20.9 | 21.7 | 32.1 | 45.5 | 32.7 | 56.4 | 41.0 |
| 965 | 14.2 | 19.8 | 30.4 | 31.7 | 31.1 | 42.6 | 46.1 |
| 966 | 15.6 | 36.0 | 15.8 | 40.9 | 37.7 | 44.0 | 37.8 |
| 967 | 2.4 | 42.8 | 1.6 | 44.8 | 41.0 | 67.8 | 45.4 |
| 968 | 13.2 | 47.0 | 11.9 | 48.3 | 37.8 | 57.7 | 40.1 |
| 969 | 34.5 | 44.8 | 44.5 | 54.8 | 51.0 | 51.1 | 54.6 |
| 970 | 23.0 | 30.6 | 28.5 | 41.1 | 36.7 | 51.6 | 45.8 |
| 971 | 19.2 | 39.6 | 25.0 | 49.7 | 30.4 | 53.9 | 42.3 |
| 952-B | 0.9 | 42.1 | 1.0 | 43.5 | 22.1 | 55.9 | 38.7 |
| 957-B | 0.3 | 43.8 | 0.4 | 49.9 | 21.6 | 62.6 | 29.2 |
| 964-B | 1.3 | 40.6 | 0.5 | 48.5 | 26.4 | 55.5 | 38.7 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 438.0 | 889.4 | 512.5 | 1030.2 | 792.4 | 1200.2 | 943.3 |
| Mean yield | 19.91 | 40.43 | 23.30 | 46.83 | 36.02 | 54.55 | 42.88 |
| Per cent average yield (N P K=100%) | 42.52% | 86.33% | 49.75% | 100.00% | 76.92% | 116.50% | 91.56% |

**TABLE XXXVI-C.—Greenhouse Yields of Sorghum on the Cecil and Davidson Soils. Grams Dry Weight (third crop).**

| Soil No. | Fertilizer treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | N P | N K | N P K | N K Residual P | N P K Residual L | N K Residual P L |
| | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* | *Gms.* |
| 950-A | 8.8 | 40.6 | 8.8 | 37.8 | 17.7 | 42.9 | 22.3 |
| 951 | 17.3 | 21.9 | 20.1 | 46.6 | 36.6 | 49.0 | 45.1 |
| 952 | 16.9 | 9.9 | 20.4 | 32.7 | 23.5 | 36.9 | 32.9 |
| 953 | 10.6 | 31.2 | 12.8 | 40.8 | 33.2 | 42.8 | 33.2 |
| 954 | 1.8 | 23.0 | 3.7 | 32.4 | 6.9 | 33.5 | 18.9 |
| 955 | 6.6 | 29.5 | 8.2 | 35.1 | 18.4 | 35.7 | 23.5 |
| 956 | 4.7 | 33.9 | 0.5 | 42.1 | 17.4 | 52.0 | 22.7 |
| 957 | 7.8 | 16.2 | 15.1 | 34.8 | 30.3 | 34.2 | 41.8 |
| 958 | 5.3 | 20.7 | 8.4 | 33.1 | 9.4 | 36.1 | 26.7 |
| 959 | 3.6 | 12.0 | 1.3 | 35.8 | 17.3 | 36.8 | 7.6 |
| 960 | 6.5 | 10.0 | 11.5 | 33.3 | 21.9 | 32.1 | 25.4 |
| 961 | 6.2 | 6.9 | 25.1 | 30.3 | 28.6 | 35.8 | 32.4 |
| 962 | 24.8 | 28.0 | 29.2 | 37.7 | 31.7 | 39.0 | 32.6 |
| 963 | 18.0 | 25.9 | 32.5 | 41.1 | 38.4 | 47.0 | 37.4 |
| 964 | 1.6 | 14.9 | 12.3 | 21.1 | 25.8 | 34.6 | 30.4 |
| 965 | 6.8 | 2.8 | 21.5 | 19.1 | 19.8 | 29.0 | 27.8 |
| 966 | 10.7 | 14.0 | 25.5 | 44.6 | 20.7 | 41.3 | 20.5 |
| 967 | 2.0 | 14.8 | 2.3 | 35.5 | 20.9 | 42.2 | 17.9 |
| 968 | 0.5 | 24.6 | 1.4 | 31.0 | 12.7 | 35.0 | 33.3 |
| 969 | 4.4 | 11.0 | 21.6 | 30.7 | 23.8 | 36.8 | 28.9 |
| 970 | 5.0 | 4.1 | 17.2 | 27.8 | 23.4 | 34.1 | 31.1 |
| 971 | 5.2 | 21.8 | 9.5 | 30.9 | 16.0 | 36.5 | 33.4 |
| 952-B | 0.5 | 8.0 | 0.6 | 27.9 | 2.4 | 36.3 | 8.0 |
| 957-B | 0.7 | 25.9 | 0.4 | 38.0 | 3.0 | 40.5 | 13.7 |
| 964-B | 0.7 | 12.6 | 0.4 | 28.1 | 4.1 | 36.8 | 12.1 |
| Summary of yields of 22 surface soils | | | | | | | |
| Total yield | 175.1 | 417.7 | 308.9 | 754.3 | 494.4 | 843.3 | 625.8 |
| Mean yield | 7.96 | 18.99 | 14.04 | 34.29 | 22.47 | 38.33 | 28.44 |
| Per cent average yield (N P K=100%) | 23.21% | 55.33% | 40.95% | 100.0% | 64.69% | 111.80% | 82.96% |

**TABLE XXXVII-A.—Percentage Yields of Soils by Fertilizer Treatment and Summary by Soil Type of Percentage Yields of First Crop.—(N P K yield = 100%)**

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—Austrian winter peas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | P K *per cent* | N P K L *per cent* | P K L *per cent* |
| Norfolk sandy loam | 785 | 11.6 | 62.1 | 104.3 | 58.7 | 99.1 | 116.4 | 123.3 |
| | 790 | 10.6 | 41.5 | 89.6 | 61.3 | 43.4 | 101.9 | 89.6 |
| | 793 | 5.6 | 51.8 | 103.6 | 66.1 | 110.8 | 135.7 | 114.3 |
| Mean for soil type | 3 | 9.27 | 51.8 | 99.2 | 62.0 | 84.4 | 118.0 | 109.1 |
| Norfolk fine sandy loam | 774 | 9.0 | 44.4 | 85.5 | 70.0 | 76.7 | 104.4 | 123.3 |
| | 775 | 3.4 | 73.5 | 58.8 | 61.8 | 67.6 | 194.1 | 200.0 |
| | 776 | 2.8 | 75.0 | 82.1 | 67.9 | 92.9 | 260.7 | 242.9 |
| | 782 | 9.3 | 55.9 | 83.9 | 68.8 | 69.9 | 110.8 | 107.5 |
| | 783 | 12.6 | 71.4 | 87.3 | 64.3 | 69.8 | 92.8 | 77.0 |
| | 787 | 16.1 | 75.8 | 105.0 | 73.9 | 97.5 | 111.8 | 124.2 |
| | 788 | 7.5 | 58.7 | 108.0 | 52.0 | 29.3 | 124.0 | 113.3 |
| Mean for soil type | 7 | 8.67 | 65.0 | 87.2 | 65.5 | 72.0 | 142.7 | 141.2 |
| Norfolk loamy fine sand | 780 | 8.3 | 47.0 | 68.7 | 97.6 | 114.5 | 101.2 | 96.4 |
| | 791 | 9.0 | 70.0 | 104.4 | 75.6 | 90.0 | 102.2 | 118.8 |
| | 795 | 11.1 | 70.3 | 100.9 | 79.3 | 81.1 | 102.7 | 69.4 |
| Mean for soil type | 3 | 9.47 | 62.4 | 91.3 | 84.2 | 95.2 | 102.0 | 94.9 |
| Norfolk fine sand | 778 | 9.9 | 56.6 | 98.0 | 63.6 | 60.6 | 114.1 | 100.0 |
| | 779 | 6.1 | 67.2 | 119.7 | 67.2 | 93.4 | 96.7 | 88.5 |
| | 781 | 12.6 | 54.0 | 85.7 | 51.6 | 87.3 | 88.9 | 78.6 |
| | 789 | 5.0 | 66.0 | 78.0 | 56.0 | 52.0 | 176.0 | 196.0 |
| | 792 | 5.3 | 52.8 | 92.5 | 58.5 | 67.9 | 120.8 | 107.5 |
| | 794 | 9.1 | 71.4 | 104.4 | 78.0 | 87.9 | 100.0 | 86.8 |
| Mean for soil type | 6 | 8.00 | 61.3 | 96.4 | 62.5 | 74.9 | 116.1 | 109.6 |
| Norfolk sand | 777 | 7.5 | 21.3 | 94.7 | 22.7 | 70.7 | 61.3 | 65.3 |
| | 784 | 3.8 | 31.6 | 113.2 | 31.6 | 63.2 | 150.0 | 121.1 |
| Mean for soil type | 2 | 5.65 | 26.5 | 104.9 | 27.2 | 66.9 | 105.7 | 93.2 |
| Norfolk loam | 786 | 16.6 | 77.7 | 75.3 | 74.1 | 85.5 | 100.0 | 81.9 |

**TABLE XXXVII-A. (Continued)**

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | NPK yield *grams* | N *per cent* | NP *per cent* | NK *per cent* | PK | NPKL *per cent* | PKL |
| Greenville sandy loam | 799 | 17.4 | 8.0 | 93.7 | 7.5 | Sorghum was not grown on treatments not containing nitrogen. | 89.7 | Sorghum was not grown on treatments not containing nitrogen. |
| | 801 | 29.7 | 49.2 | 78.1 | 36.0 | | 88.6 | |
| | 803 | 37.5 | 94.4 | 100.0 | 70.1 | | 103.5 | |
| | 804 | 32.0 | 42.8 | 104.7 | 48.4 | | 126.3 | |
| | 811 | 39.9 | 47.1 | 113.3 | 51.6 | | 106.5 | |
| | 814 | 39.3 | 82.4 | 108.4 | 85.0 | | 97.4 | |
| Mean for soil type | 6 | 32.63 | 54.0 | 99.7 | 49.8 | | 102.0 | |
| Greenville fine sandy loam | 800 | 24.7 | 5.7 | 85.4 | 4.0 | | 100.0 | |
| | 806 | 38.6 | 49.7 | 82.4 | 67.9 | | 105.2 | |
| | 809 | 32.6 | 92.9 | 111.3 | 94.8 | | 109.8 | |
| | 810 | 34.7 | 24.8 | 77.5 | 21.6 | | 100.0 | |
| | 812 | 36.1 | 76.7 | 101.4 | 64.0 | | 112.2 | |
| | 815 | 42.8 | 78.0 | 102.8 | 86.9 | | 101.2 | |
| Mean for soil type | 6 | 34.92 | 54.6 | 93.5 | 56.5 | | 104.7 | |
| Greenville loamy sand | 802 | 31.7 | 58.4 | 79.8 | 48.6 | | 93.1 | |
| | 805 | 33.8 | 59.8 | 100.3 | 71.0 | | 95.9 | |
| | 807 | 33.9 | 90.9 | 94.1 | 84.7 | | 105.3 | |
| | 808 | 30.8 | 89.6 | 104.9 | 83.1 | | 110.4 | |
| Mean for soil type | 4 | 32.55 | 74.7 | 94.8 | 71.9 | | 101.2 | |
| Amite sandy loam | 817 | 44.3 | 91.6 | 93.9 | 95.0 | | 96.2 | |
| | 819 | 28.8 | 94.1 | 104.5 | 111.1 | | 118.0 | |
| Mean for soil type | 2 | 36.55 | 92.9 | 99.2 | 103.1 | | 107.1 | |
| Amite fine sandy loam | 816 | 43.0 | 90.4 | 100.2 | 87.7 | | 100.2 | |
| Amite loamy fine sand | 818 | 61.4 | 75.4 | 92.0 | 79.0 | | 94.3 | |
| Akron fine sandy loam | 820 | 52.9 | 89.8 | 100.0 | 86.2 | | 97.4 | |
| Akron loamy fine sand | 813 | 53.3 | 86.7 | 103.9 | 84.1 | | 99.4 | |
| | 821 | 44.1 | 82.8 | 95.0 | 72.3 | | 105.9 | |
| Mean for soil type | 2 | 48.70 | 84.8 | 99.5 | 78.2 | | 102.7 | |

TABLE XXXVII-A. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—Austrian winter peas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | P K *per cent* | N P K L *per cent* | P K L *per cent* |
| Decatur clay loam | 888 | 5.6 | 71.4 | 105.4 | 73.2 | 98.2 | 141.0 | 119.6 |
| | 895 | 7.8 | 93.6 | 109.0 | 87.2 | 91.0 | 106.4 | 109.0 |
| | 896 | 6.2 | 74.2 | 104.8 | 80.6 | 82.3 | 124.2 | 112.9 |
| | 899 | 9.1 | 57.1 | 93.4 | 67.0 | 73.6 | 117.6 | 96.7 |
| | 901 | 8.0 | 88.7 | 106.3 | 88.7 | 110.0 | 141.3 | 130.0 |
| Mean for soil type | 5 | 7.34 | 77.0 | 103.8 | 79.3 | 91.0 | 126.1 | 113.6 |
| Decatur clay | 883 | 7.2 | 70.8 | 87.5 | 69.4 | 75.0 | 115.3 | 102.8 |
| | 884 | 6.5 | 55.4 | 95.4 | 63.1 | 100.0 | 121.5 | 120.0 |
| | 885 | 9.6 | 83.3 | 90.6 | 86.4 | 87.5 | 96.9 | 93.8 |
| | 886 | 5.3 | 71.7 | 94.3 | 71.7 | 67.9 | 135.8 | 92.4 |
| | 887 | 6.1 | 70.5 | 72.1 | 49.2 | 96.7 | 113.1 | 111.4 |
| | 889 | 5.3 | 79.2 | 98.1 | 66.0 | 64.2 | 141.5 | 98.1 |
| | 890 | 6.0 | 46.7 | 101.7 | 56.7 | 85.0 | 110.0 | 85.0 |
| | 891 | 6.5 | 64.6 | 101.5 | 64.6 | 63.1 | 130.8 | 98.4 |
| | 892 | 7.4 | 67.6 | 98.6 | 60.8 | 79.7 | 117.6 | 101.4 |
| | 893 | 6.9 | 84.1 | 100.0 | 82.6 | 81.2 | 105.8 | 88.4 |
| | 894 | 5.0 | 84.0 | 124.0 | 90.0 | 98.0 | 130.0 | 112.0 |
| | 897 | 6.8 | 58.8 | 92.6 | 64.7 | 83.8 | 125.0 | 107.4 |
| | 898 | 6.7 | 82.1 | 98.5 | 77.6 | 92.5 | 125.4 | 109.0 |
| | 900 | 8.2 | 79.3 | 103.7 | 78.0 | 84.1 | 104.9 | 90.2 |
| | 902 | 6.4 | 84.4 | 100.0 | 85.9 | 85.9 | 112.5 | 89.0 |
| | 903 | 6.9 | 44.9 | 79.7 | 43.4 | 71.0 | 129.0 | 104.3 |
| | 904 | 6.5 | 38.4 | 109.2 | 56.9 | 103.1 | 140.0 | 135.4 |
| Mean for soil type | 17 | 6.66 | 68.6 | 96.9 | 68.6 | 83.5 | 120.9 | 102.3 |

TABLE XXXVII-A. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—Austrian winter peas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | NPK yield *grams* | N *per cent* | NP *per cent* | NK *per cent* | PK *per cent* | NPKL *per cent* | PKL *per cent* |
| Hartsells sandy loam | 927 | 2.3 | 69.6 | 91.3 | 78.3 | 52.1 | 156.5 | 95.6 |
| | 929 | 2.5 | 52.0 | 80.0 | 56.0 | 64.0 | 148.0 | 116.0 |
| | 930 | 1.4 | 71.4 | 100.0 | 71.4 | 42.9 | 221.4 | 171.4 |
| Mean for soil type | 3 | 2.07 | 64.3 | 90.4 | 68.6 | 53.0 | 175.3 | 127.7 |
| Hartsells fine sandy loam | 913 | 3.0 | 63.3 | 116.7 | 63.3 | 86.7 | 146.7 | 103.3 |
| | 914 | 3.0 | 63.3 | 116.7 | 63.3 | 86.7 | 113.3 | 110.0 |
| | 915 | 2.5 | 48.0 | 96.0 | 48.0 | 60.0 | 136.0 | 70.0 |
| | 918 | 2.1 | 66.7 | 100.0 | 76.2 | 90.4 | 276.2 | 176.2 |
| | 919 | 2.3 | 69.6 | 95.6 | 73.9 | 39.1 | 187.0 | 60.9 |
| | 920 | 1.7 | 94.1 | 100.0 | 100.0 | 58.8 | 129.4 | 70.6 |
| | 921 | 2.4 | 62.5 | 104.2 | 58.3 | 41.7 | 145.8 | 100.0 |
| | 922 | 1.6 | 68.8 | 93.8 | 75.0 | 56.3 | 181.3 | 162.5 |
| | 924 | 2.0 | 70.0 | 95.0 | 65.0 | 60.0 | 170.0 | 155.0 |
| | 925 | 1.5 | 80.0 | 120.0 | 46.7 | 66.7 | 160.0 | 106.7 |
| | 926 | 2.5 | 56.0 | 88.0 | 72.0 | 56.0 | 124.0 | 88.0 |
| | 928 | 3.1 | 58.1 | 58.1 | 71.1 | 58.1 | 116.1 | 100.0 |
| | 931 | 1.4 | 64.3 | 92.9 | 64.3 | 64.3 | 300.0 | 235.7 |
| | 932 | 2.0 | 65.0 | 90.0 | 80.0 | 35.0 | 155.0 | 60.0 |
| Mean for soil type | 14 | 2.22 | 66.4 | 97.6 | 68.4 | 61.4 | 167.2 | 114.2 |
| Hartsells loam | 916 | 7.8 | 67.9 | 80.0 | 69.2 | 88.4 | 92.3 | 91.1 |
| | 917 | 1.9 | 73.7 | 94.7 | 63.2 | 31.6 | 147.4 | 84.2 |
| | 923 | 1.3 | 69.2 | 123.1 | 69.2 | 76.9 | 215.4 | 184.6 |
| | 933 | 1.2 | 58.3 | 83.3 | 75.0 | 50.0 | 258.3 | 183.0 |
| Mean for soil type | 4 | 3.05 | 67.3 | 95.3 | 69.2 | 61.7 | 178.4 | 135.7 |
| Hartsells clay loam | 912 | 3.30 | 45.4 | 90.9 | 48.4 | 63.6 | 112.1 | 121.1 |

TABLE XXXVII-A. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—Austrian winter peas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield *grams* | N *per cent* | N P *per cent* | N K *per cent* | P K *per cent* | N P K L *per cent* | P K L *per cent* |
| Cecil sandy loam | 960 | 6.5 | 60.0 | 78.4 | 64.6 | 72.3 | 124.6 | 81.5 |
| | 961 | 10.0 | 70.0 | 75.0 | 70.0 | 61.0 | 105.0 | 82.0 |
| | 962 | 6.3 | 73.0 | 111.1 | 74.6 | 42.8 | 96.8 | 63.4 |
| | 963 | 8.1 | 74.1 | 111.1 | 72.8 | 75.3 | 118.5 | 97.5 |
| | 965 | 9.2 | 83.7 | 85.8 | 95.7 | 35.8 | 109.8 | 65.2 |
| | 966 | 7.6 | 65.8 | 106.6 | 59.2 | 89.4 | 135.5 | 123.7 |
| | 967 | 5.8 | 31.0 | 87.9 | 41.4 | 44.8 | 134.4 | 125.9 |
| | 968 | 4.9 | 61.2 | 95.9 | 63.3 | 83.7 | 116.3 | 104.0 |
| | 969 | 8.3 | 84.3 | 102.8 | 94.0 | 69.9 | 109.6 | 110.8 |
| Mean for soil type | 9 | 7.41 | 67.0 | 95.0 | 70.6 | 63.9 | 116.7 | 94.9 |
| Cecil loamy sand | 964 | 7.8 | 88.4 | 91.0 | 67.9 | 94.8 | 105.1 | 38.4 |
| | 970 | 10.1 | 67.3 | 96.0 | 75.2 | 58.4 | 109.9 | 80.2 |
| Mean for soil type | 2 | 8.95 | 77.9 | 93.5 | 71.6 | 71.6 | 107.5 | 59.3 |
| Cecil sandy clay loam | 954 | 5.3 | 73.6 | 133.9 | 62.3 | 84.9 | 115.1 | 120.8 |
| | 955 | 4.9 | 65.3 | 114.3 | 69.4 | 85.7 | 122.4 | 116.3 |
| | 971 | 5.9 | 88.1 | 118.6 | 88.1 | 50.8 | 140.7 | 106.8 |
| Mean for soil type | 3 | 5.37 | 75.7 | 122.3 | 73.3 | 73.8 | 126.1 | 114.6 |
| Cecil clay loam | 951 | 6.9 | 62.3 | 133.3 | 76.8 | 88.4 | 133.3 | 97.1 |
| | 952 | 7.1 | 62.0 | 83.1 | 69.0 | 95.8 | 112.7 | 73.2 |
| | 957 | 7.9 | 84.8 | 89.9 | 72.2 | 106.3 | 122.8 | 103.8 |
| Mean for soil type | 3 | 7.30 | 69.7 | 102.1 | 72.7 | 96.8 | 122.9 | 91.4 |
| Cecil clay | 950 | 7.7 | 81.8 | 83.1 | 74.0 | 76.6 | 114.3 | 120.8 |
| | 953 | 6.2 | 93.5 | 100.0 | 72.6 | 88.7 | 108.1 | 88.7 |
| | 956 | 6.2 | 37.1 | 125.8 | 37.1 | 46.8 | 121.0 | 100.0 |
| | 959 | 4.7 | 63.8 | 87.2 | 51.1 | 76.6 | 108.5 | 89.4 |
| Mean for soil type | 4 | 6.20 | 69.1 | 99.0 | 58.7 | 72.2 | 113.0 | 99.7 |
| Davidson clay | 958 | 4.20 | 59.5 | 92.9 | 69.0 | 71.4 | 123.8 | 116.7 |

**TABLE XXXVII-B.—Percentage Yields of Soils by Fertilizer Treatment and Summary by Soil Type of Percentage Yields of Second Crop.—(N P K yield = 100%)**

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Norfolk sandy loam | 785 | 29.0 | 26.2 | 77.9 | 28.6 | 60.0 | 108.3 | 71.4 |
| | 790 | 40.1 | 79.1 | 96.3 | 86.5 | 102.0 | 112.5 | 103.5 |
| | 793 | 14.6 | 17.8 | 80.8 | 23.3 | 59.6 | 162.3 | 84.2 |
| Mean for soil type | 3 | 27.90 | 41.0 | 85.0 | 45.1 | 73.9 | 127.7 | 86.4 |
| Norfolk fine sandy loam | 774 | 24.1 | 53.9 | 78.8 | 65.1 | 67.6 | 157.7 | 143.6 |
| | 775 | 7.4 | 51.4 | 109.5 | 36.5 | 74.3 | 275.6 | 254.1 |
| | 776 | 13.9 | 38.1 | 113.7 | 33.1 | 59.7 | 160.4 | 79.1 |
| | 782 | 28.2 | 45.7 | 68.8 | 45.0 | 77.7 | 111.0 | 74.8 |
| | 783 | 37.0 | 49.5 | 55.4 | 60.5 | 86.2 | 98.4 | 84.1 |
| | 787 | 27.9 | 62.0 | 79.6 | 64.9 | 85.3 | 131.5 | 121.1 |
| | 788 | 25.2 | 30.6 | 63.5 | 41.3 | 69.4 | 125.8 | 94.4 |
| Mean for soil type | 7 | 23.39 | 47.3 | 81.3 | 49.5 | 74.3 | 151.5 | 121.6 |
| Norfolk loamy fine sand | 780 | 19.3 | 15.0 | 88.6 | 7.8 | 48.2 | 171.5 | 153.4 |
| | 791 | 34.5 | 67.0 | 82.6 | 78.3 | 78.8 | 118.6 | 114.2 |
| | 795 | 33.4 | 63.8 | 84.7 | 64.4 | 89.5 | 125.7 | 102.4 |
| Mean for soil type | 3 | 29.07 | 48.6 | 85.3 | 50.2 | 72.2 | 138.6 | 123.3 |
| Norfolk fine sand | 778 | 40.2 | 63.9 | 80.8 | 56.2 | 55.7 | 110.4 | 110.0 |
| | 779 | 33.6 | 19.9 | 58.9 | 19.0 | 66.1 | 108.6 | 80.4 |
| | 781 | 31.3 | 12.5 | 55.3 | 12.8 | 67.7 | 114.4 | 80.5 |
| | 789 | 31.5 | 29.5 | 44.1 | 42.2 | 71.1 | 121.6 | 104.4 |
| | 792 | 36.4 | 31.6 | 76.4 | 27.2 | 65.4 | 111.5 | 94.8 |
| | 794 | 34.0 | 41.5 | 49.1 | 55.9 | 101.5 | 90.0 | 80.9 |
| Mean for soil type | 6 | 34.50 | 33.2 | 60.8 | 35.6 | 71.3 | 109.4 | 91.8 |
| Norfolk sand | 777 | 25.6 | 2.3 | 72.7 | 2.3 | 28.1 | 95.3 | 25.4 |
| | 784 | 27.2 | 1.8 | 52.9 | 1.8 | 34.9 | 118.0 | 31.2 |
| Mean for soil type | 2 | 26.40 | 2.1 | 62.8 | 2.1 | 31.5 | 106.7 | 28.3 |
| Norfolk loam | 786 | 34.40 | 34.3 | 82.3 | 32.0 | 70.3 | 100.9 | 68.3 |

TABLE XXXVII-B. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Greenville sandy loam | 799 | 30.9 | 4.5 | 89.0 | 6.4 | 36.9 | 64.4 | 16.2 |
| | 801 | 22.4 | 11.6 | 78.1 | 62.9 | 37.4 | 128.1 | 57.6 |
| | 803 | 40.3 | 38.2 | 52.9 | 74.2 | 78.2 | 113.6 | 86.8 |
| | 804 | 27.4 | 45.6 | 42.0 | 38.7 | 45.3 | 144.5 | 99.3 |
| | 811 | 47.2 | 38.8 | 28.2 | 66.5 | 75.6 | 87.1 | 40.0 |
| | 814 | 44.0 | 63.2 | 33.9 | 91.4 | 85.2 | 111.1 | 96.8 |
| Mean for soil type | 6 | 35.37 | 33.7 | 54.0 | 56.7 | 59.8 | 108.1 | 66.1 |
| Greenville fine sandy loam | 800 | 30.4 | 4.9 | 53.3 | 4.3 | 59.9 | 121.7 | 64.8 |
| | 806 | 42.4 | 19.8 | 26.4 | 47.2 | 61.8 | 91.0 | 83.3 |
| | 809 | 54.2 | 41.5 | 73.6 | 71.4 | 67.7 | 93.4 | 84.3 |
| | 810 | 36.3 | 47.7 | 81.0 | 49.0 | 54.3 | 104.1 | 79.3 |
| | 812 | 53.6 | 70.7 | 92.0 | 76.7 | 49.4 | 83.0 | 76.4 |
| | 815 | 49.7 | 55.7 | 35.4 | 72.8 | 93.9 | 102.0 | 106.8 |
| Mean for soil type | 6 | 44.43 | 40.1 | 60.3 | 53.6 | 64.5 | 99.2 | 82.5 |
| Greenville loamy sand | 802 | 13.9 | 11.5 | 11.5 | 68.3 | 30.9 | 152.5 | 141.7 |
| | 805 | 30.4 | 8.2 | 28.6 | 21.4 | 59.5 | 110.5 | 54.9 |
| | 807 | 27.4 | 4.0 | 8.0 | 26.6 | 9.9 | 39.4 | 34.7 |
| | 808 | 41.6 | 43.5 | 38.2 | 60.3 | 51.2 | 87.0 | 80.5 |
| Mean for soil type | 4 | 28.33 | 16.8 | 21.6 | 44.2 | 37.9 | 97.4 | 77.9 |
| Amite sandy loam | 817 | 68.9 | 67.4 | 80.6 | 68.9 | 88.2 | 103.5 | 95.2 |
| | 819 | 48.4 | 35.5 | 64.0 | 62.8 | 71.4 | 103.5 | 64.0 |
| Mean for soil type | 2 | 58.65 | 51.5 | 72.3 | 65.9 | 79.8 | 103.5 | 79.6 |
| Amite fine sandy loam | 816 | 40.2 | 29.6 | 18.2 | 66.2 | 61.9 | 93.3 | 82.1 |
| Amite loamy fine sand | 818 | 48.3 | 69.8 | 49.7 | 86.1 | 82.8 | 130.4 | 126.5 |
| Akron fine sandy loam | 820 | 49.5 | 73.9 | 91.7 | 70.1 | 78.4 | 119.6 | 109.3 |
| Akron loamy fine sand | 813 | 49.4 | 57.3 | 33.2 | 91.1 | 78.3 | 100.8 | 102.2 |
| | 821 | 49.5 | 54.1 | 36.8 | 71.5 | 81.0 | 132.3 | 84.0 |
| Mean for soil type | 2 | 49.45 | 55.7 | 35.0 | 81.3 | 79.7 | 116.6 | 93.1 |

TABLE XXXVII-B. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Decatur clay loam | 888 | 44.1 | 34.4 | 78.2 | 37.0 | 63.7 | 94.3 | 74.4 |
| | 895 | 47.5 | 41.9 | 95.8 | 37.9 | 64.2 | 78.9 | 60.2 |
| | 896 | 34.9 | 28.1 | 94.6 | 41.0 | 63.9 | 84.0 | 83.7 |
| | 899 | 31.5 | 32.1 | 113.9 | 22.5 | 55.6 | 138.7 | 57.1 |
| | 901 | 46.3 | 35.0 | 87.2 | 37.6 | 46.4 | 95.7 | 71.1 |
| Mean for soil type | 5 | 40.86 | 34.3 | 93.9 | 35.2 | 58.8 | 98.3 | 69.3 |
| Decatur clay | 883 | 46.2 | 10.6 | 89.0 | 12.8 | 59.1 | 111.9 | 66.7 |
| | 884 | 43.4 | 19.6 | 103.5 | 15.0 | 53.7 | 115.4 | 62.9 |
| | 885 | 42.1 | 54.9 | 91.9 | 32.1 | 66.3 | 108.3 | 78.1 |
| | 886 | 39.7 | 37.5 | 103.3 | 38.3 | 55.7 | 99.0 | 73.0 |
| | 887 | 25.4 | 7.5 | 126.0 | 6.3 | 33.5 | 135.4 | 34.3 |
| | 889 | 38.4 | 34.4 | 93.8 | 41.4 | 59.4 | 104.4 | 81.0 |
| | 890 | 39.1 | 5.1 | 87.7 | 6.4 | 32.4 | 84.1 | 35.0 |
| | 891 | 31.5 | 13.7 | 80.6 | 14.0 | 40.6 | 140.6 | 65.1 |
| | 892 | 28.3 | 14.1 | 13.8 | 96.8 | 35.0 | 103.5 | 42.0 |
| | 893 | 43.1 | 74.4 | 95.0 | 77.3 | 82.4 | 141.5 | 81.4 |
| | 894 | 45.2 | 28.1 | 96.4 | 29.4 | 61.7 | 103.5 | 80.5 |
| | 897 | 42.8 | 38.8 | 108.6 | 36.9 | 71.3 | 114.0 | 74.1 |
| | 898 | 36.7 | 11.7 | 100.3 | 13.6 | 34.3 | 109.0 | 59.7 |
| | 900 | 29.6 | 32.1 | 96.3 | 37.8 | 56.8 | 89.9 | 52.4 |
| | 902 | 24.8 | 37.1 | 163.7 | 62.5 | 81.9 | 128.2 | 81.9 |
| | 903 | 43.8 | 12.1 | 96.8 | 8.0 | 43.6 | 104.6 | 43.1 |
| | 904 | 38.0 | 12.6 | 101.3 | 11.6 | 45.3 | 98.7 | 55.1 |
| Mean for soil type | 17 | 37.54 | 26.1 | 96.9 | 31.8 | 53.7 | 111.3 | 62.7 |

TABLE XXXVII-B. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Hartsells sandy loam | 927 | 32.4 | 40.0 | 53.1 | 37.3 | 75.0 | 110.0 | 85.2 |
| | 929 | 29.8 | 37.9 | 85.9 | 46.0 | 72.1 | 101.0 | 82.2 |
| | 930 | 24.4 | 22.1 | 101.2 | 15.2 | 30.0 | 130.0 | 86.9 |
| Mean for soil type | 3 | 28.87 | 33.3 | 80.1 | 32.8 | 59.0 | 113.7 | 84.8 |
| Hartsells fine sandy loam | 913 | 23.2 | 10.3 | 94.8 | 18.5 | 65.9 | 143.1 | 61.6 |
| | 914 | 25.3 | 24.1 | 97.6 | 19.4 | 41.9 | 103.2 | 88.5 |
| | 915 | 33.6 | 1.8 | 86.9 | 2.1 | 44.6 | 92.6 | 34.8 |
| | 918 | 18.6 | 33.3 | 121.5 | 32.6 | 63.4 | 141.4 | 122.0 |
| | 919 | 34.3 | 24.4 | 93.6 | 40.0 | 50.7 | 95.0 | 62.4 |
| | 920 | 19.3 | 38.9 | 80.8 | 40.9 | 56.4 | 129.0 | 89.6 |
| | 921 | 25.1 | 14.7 | 103.1 | 20.7 | 40.2 | 99.2 | 84.4 |
| | 922 | 24.5 | 29.4 | 91.4 | 36.3 | 39.2 | 123.7 | 76.7 |
| | 924 | 25.2 | 22.2 | 81.3 | 30.0 | 52.8 | 68.3 | 67.0 |
| | 925 | 23.0 | 29.6 | 113.0 | 30.0 | 47.4 | 124.3 | 89.1 |
| | 926 | 23.1 | 29.0 | 66.7 | 35.9 | 42.4 | 106.9 | 64.1 |
| | 928 | 20.6 | 75.2 | 111.7 | 85.9 | 91.3 | 130.6 | 93.2 |
| | 931 | 17.0 | 11.8 | 51.8 | 12.9 | 44.1 | 144.1 | 78.8 |
| | 932 | 24.1 | 59.8 | 135.3 | 80.1 | 72.2 | 96.3 | 88.0 |
| Mean for soil type | 14 | 24.06 | 28.9 | 95.0 | 34.7 | 53.8 | 114.1 | 78.6 |
| Hartsells loam | 916 | 47.3 | 68.7 | 75.9 | 40.8 | 89.0 | 123.3 | 100.4 |
| | 917 | 22.5 | 12.4 | 77.8 | 18.2 | 47.0 | 127.6 | 54.2 |
| | 923 | 37.7 | 37.1 | 92.3 | 42.4 | 68.3 | 97.3 | 95.7 |
| | 933 | 11.3 | 1.8 | 93.8 | 1.8 | 14.2 | 203.5 | 60.2 |
| Mean for soil type | 4 | 29.70 | 30.0 | 85.0 | 25.8 | 54.6 | 137.9 | 77.6 |
| Hartsells clay loam | 912 | 51.00 | 3.5 | 86.3 | 3.5 | 37.4 | 99.4 | 39.2 |

TABLE XXXVII-B. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Cecil sandy loam | 960 | 43.7 | 53.1 | 77.6 | 64.3 | 83.1 | 131.4 | 95.7 |
| | 961 | 55.7 | 61.6 | 59.1 | 61.2 | 76.8 | 105.6 | 81.9 |
| | 962 | 50.1 | 53.7 | 90.2 | 54.1 | 66.7 | 96.2 | 80.4 |
| | 963 | 49.0 | 62.9 | 95.3 | 70.2 | 75.9 | 114.9 | 90.8 |
| | 965 | 31.7 | 44.8 | 62.4 | 95.9 | 98.1 | 134.4 | 145.4 |
| | 966 | 40.9 | 38.1 | 88.0 | 38.6 | 92.2 | 107.6 | 92.4 |
| | 967 | 44.8 | 5.4 | 95.5 | 3.6 | 91.5 | 151.3 | 101.3 |
| | 968 | 48.3 | 27.3 | 97.3 | 24.6 | 78.3 | 119.4 | 83.0 |
| | 969 | 54.8 | 63.0 | 81.8 | 81.2 | 93.1 | 93.2 | 99.6 |
| Mean for soil type | 9 | 46.56 | 45.5 | 83.0 | 54.8 | 84.0 | 117.1 | 96.7 |
| Cecil loamy sand | 964 | 45.5 | 45.9 | 47.7 | 70.5 | 71.9 | 124.0 | 90.1 |
| | 970 | 41.1 | 56.0 | 74.4 | 69.3 | 89.3 | 125.5 | 111.4 |
| Mean for soil type | 2 | 43.30 | 51.0 | 61.1 | 69.9 | 80.6 | 124.8 | 100.8 |
| Cecil sandy clay loam | 954 | 42.0 | 33.1 | 110.0 | 32.1 | 76.7 | 126.7 | 98.3 |
| | 955 | 47.9 | 37.6 | 101.7 | 45.7 | 78.7 | 111.7 | 82.0 |
| | 971 | 49.7 | 38.6 | 79.7 | 50.3 | 61.2 | 108.4 | 85.1 |
| Mean for soil type | 3 | 46.53 | 36.4 | 97.1 | 42.7 | 72.2 | 115.6 | 88.5 |
| Cecil clay loam | 951 | 47.6 | 66.0 | 104.4 | 73.7 | 83.0 | 118.4 | 107.6 |
| | 952 | 45.8 | 30.6 | 94.3 | 71.2 | 90.8 | 108.3 | 68.6 |
| | 957 | 49.5 | 54.5 | 91.3 | 58.6 | 79.4 | 106.7 | 102.0 |
| Mean for soil type | 3 | 47.63 | 50.4 | 96.7 | 67.8 | 84.4 | 111.1 | 62.6 |
| Cecil clay | 950 | 51.5 | 42.1 | 103.9 | 36.1 | 74.0 | 116.7 | 93.0 |
| | 953 | 45.5 | 56.9 | 93.8 | 54.7 | 76.3 | 102.2 | 84.6 |
| | 956 | 39.8 | 6.0 | 69.3 | 1.8 | 66.3 | 139.2 | 86.7 |
| | 959 | 51.9 | 6.6 | 79.0 | 6.6 | 43.2 | 112.3 | 67.1 |
| Mean for soil type | 4 | 47.18 | 27.9 | 86.5 | 24.8 | 65.0 | 117.6 | 82.9 |
| Davidson clay | 958 | 53.40 | 41.4 | 94.8 | 36.1 | 60.7 | 125.8 | 91.0 |

**TABLE XXXVII-C.—Percentage Yields of Soils by Fertilizer Treatment and Summary by Soil Type of Percentage Yields of Third Crop.—(N P K yield = 100%)**

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Norfolk sandy loam | 785 | 34.4 | 11.0 | 66.9 | 19.5 | 39.8 | 100.9 | 12.8 |
| | 790 | 33.3 | 42.6 | 21.3 | 84.4 | 91.0 | 108.4 | 92.8 |
| | 793 | 31.0 | 12.6 | 52.9 | 22.3 | 13.5 | 59.7 | 13.2 |
| Mean for soil type | 3 | 32.90 | 22.1 | 47.0 | 42.1 | 48.1 | 89.7 | 41.6 |
| Norfolk fine sandy loam | 774 | 22.1 | 30.8 | 75.1 | 39.4 | 39.8 | 146.6 | 88.2 |
| | 775 | 18.1 | 26.0 | 55.8 | 31.5 | 76.8 | 91.2 | 38.1 |
| | 776 | 6.6 | 21.2 | 60.6 | 43.9 | 80.3 | 437.9 | 206.1 |
| | 782 | 31.6 | 23.4 | 43.4 | 25.0 | 48.7 | 106.3 | 32.9 |
| | 783 | 34.4 | 45.9 | 52.9 | 62.8 | 80.8 | 113.1 | 84.9 |
| | 787 | 37.6 | 52.9 | 63.3 | 65.7 | 73.1 | 112.0 | 74.7 |
| | 788 | 32.4 | 27.2 | 47.5 | 40.1 | 54.3 | 114.5 | 55.6 |
| Mean for soil type | 7 | 26.11 | 32.5 | 56.9 | 44.1 | 64.8 | 160.2 | 82.9 |
| Norfolk loamy fine sand | 780 | 27.6 | 2.2 | 63.0 | 13.0 | 13.4 | 126.8 | 75.4 |
| | 791 | 20.2 | 40.6 | 73.3 | 54.5 | 75.7 | 200.5 | 145.0 |
| | 795 | 35.6 | 49.2 | 64.0 | 45.2 | 54.2 | 110.4 | 78.4 |
| Mean for soil type | 3 | 27.80 | 30.7 | 66.8 | 37.6 | 47.8 | 145.9 | 99.6 |
| Norfolk fine sand | 778 | 20.0 | 54.5 | 22.0 | 57.0 | 122.0 | 147.5 | 135.0 |
| | 779 | 16.1 | 18.6 | 50.3 | 70.8 | 65.8 | 93.8 | 22.4 |
| | 781 | 30.4 | 9.5 | 23.0 | 13.2 | 44.4 | 98.7 | 37.5 |
| | 789 | 4.2 | 29.0 | 71.0 | 40.6 | 100.0 | 350.7 | 294.2 |
| | 792 | 29.0 | 5.5 | 27 9 | 7.6 | 26 9 | 120.0 | 47.2 |
| | 794 | 35.4 | 37.0 | 25.1 | 49.2 | 78.2 | 105.1 | 75.1 |
| Mean for soil type | 6 | 22.52 | 25.7 | 36.6 | 39.7 | 72.9 | 152.6 | 101.9 |
| Norfolk sand | 777 | 29.7 | 1.3 | 34.0 | 1.0 | 33.3 | 79.1 | 7.7 |
| | 784 | 29.1 | .7 | 36.1 | 0.7 | 9.3 | 100.7 | 22.3 |
| Mean for soil type | 2 | 29.40 | 1.00 | 35.1 | 0.9 | 21.3 | 89.9 | 15.0 |
| Norfolk loam | 786 | 39.00 | 5.4 | 62.6 | 11.3 | 30.3 | 102.1 | 29.7 |

TABLE XXXVII-C. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—Austrian winter peas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Greenville sandy loam | 799 | 4.9 | 40.8 | 85.7 | 51.0 | 51.0 | 110.2 | 69.4 |
| | 801 | 6.4 | 26.6 | 48.4 | 29.7 | 50.0 | 93.8 | 89.1 |
| | 803 | 7.4 | 47.3 | 54.1 | 66.2 | 74.3 | 87.8 | 79.7 |
| | 804 | 4.0 | 32.5 | 117.5 | 42.5 | 57.5 | 127.5 | 72.5 |
| | 811 | 5.8 | 32.8 | 55.2 | 36.2 | 58.6 | 77.6 | 41.4 |
| | 814 | 6.2 | 56.4 | 61.3 | 85.4 | 83.9 | 93.5 | 75.8 |
| Mean for soil type | 6 | 5.78 | 39.4 | 70.3 | 51.8 | 62.6 | 98.4 | 71.3 |
| Greenville fine sandy loam | 800 | 4.8 | 37.4 | 81.2 | 52.1 | 75.0 | 118.7 | 45.8 |
| | 806 | 5.6 | 44.6 | 66.1 | 71.4 | 66.1 | 103.6 | 87.5 |
| | 809 | 6.3 | 41.3 | 61.9 | 60.3 | 79.4 | 93.7 | 87.3 |
| | 810 | 5.2 | 36.5 | 76.9 | 51.9 | 53.8 | 78.8 | 51.9 |
| | 812 | 5.8 | 48.3 | 70.7 | 62.1 | 77.6 | 113.8 | 82.8 |
| | 815 | 4.0 | 75.0 | 87.5 | 92.5 | 90.0 | 147.5 | 120.0 |
| Mean for soil type | 6 | 5.28 | 47.2 | 74.1 | 65.1 | 73.6 | 109.3 | 79.2 |
| Greenville loamy sand | 802 | 4.5 | 46.7 | 80.0 | 48.9 | 53.3 | 88.9 | 55.6 |
| | 805 | 4.8 | 47.9 | 70.8 | 54.2 | 97.9 | 114.6 | 81.2 |
| | 807 | 4.5 | 57.8 | 91.1 | 44.4 | 86.7 | 137.8 | 82.2 |
| | 808 | 5.0 | 42.0 | 60.0 | 50.0 | 76.0 | 128.0 | 96.0 |
| Mean for soil type | 4 | 4.70 | 48.6 | 75.4 | 49.3 | 78.4 | 117.3 | 78.7 |
| Amite sandy loam | 817 | 7.4 | 71.6 | 59.4 | 113.5 | 110.8 | 133.8 | 118.9 |
| | 819 | 6.5 | 33.8 | 58.4 | 53.8 | 78.4 | 73.8 | 76.9 |
| Mean for soil type | 2 | 6.95 | 52.7 | 58.9 | 83.6 | 94.6 | 103.8 | 97.9 |
| Amite fine sandy loam | 816 | 6.20 | 25.8 | 54.8 | 37.1 | 66.1 | 93.5 | 58.1 |
| Amite loamy fine sand | 818 | 8.10 | 37.0 | 59.3 | 49.4 | 84.0 | 88.9 | 81.4 |
| Akron fine sandy loam | 820 | 6.80 | 45.6 | 66.2 | 75.0 | 75.0 | 100.0 | 79.4 |
| Akron loamy fine sand | 813 | 6.30 | 65.1 | 73.0 | 95.2 | 104.8 | 109.5 | 100.0 |
| | 821 | 7.00 | 46.4 | 62.0 | 57.7 | 70.4 | 100.0 | 74.6 |
| Mean for soil type | 2 | 6.70 | 55.7 | 67.5 | 76.4 | 87.6 | 104.7 | 87.3 |

TABLE XXXVII-C. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | NPK yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Decatur clay loam | 888 | 44.5 | 13.0 | 41.3 | 24.4 | 52.3 | 97.2 | 71.7 |
| | 895 | 64.3 | 53.3 | 70.6 | 37.6 | 52.1 | 74.3 | 68.1 |
| | 896 | 38.1 | 18.6 | 116.8 | 24.7 | 66.7 | 130.0 | 87.1 |
| | 899 | 36.9 | 44.4 | 82.9 | 52.8 | 69.9 | 116.8 | 122.4 |
| | 901 | 47.1 | 44.8 | 82.8 | 55.0 | 58.2 | 121.4 | 82.4 |
| Mean for soil type | 5 | 46.18 | 34.8 | 78.9 | 38.9 | 59.8 | 107.9 | 86.3 |
| Decatur clay | 883 | 35.5 | 0.8 | 30.1 | 3.9 | 14.9 | 93.2 | 12.1 |
| | 884 | 51.2 | 35.5 | 86.3 | 42.8 | 71.0 | 105.7 | 58.0 |
| | 885 | 45.4 | 24.9 | 34.4 | 99.1 | 46.4 | 109.0 | 75.6 |
| | 886 | 41.6 | 40.6 | 91.3 | 50.0 | 47.4 | 105.0 | 87.3 |
| | 887 | 52.9 | 9.1 | 62.9 | 6.0 | 21.4 | 117.8 | 35.7 |
| | 889 | 57.3 | 24.4 | 62.0 | 31.9 | 40.1 | 97.2 | 60.4 |
| | 890 | 53.3 | 2.1 | 83.1 | 2.3 | 15.6 | 93.0 | 12.0 |
| | 891 | 31.2 | 12.2 | 100.3 | 12.5 | 36.9 | 136.2 | 40.4 |
| | 892 | 47.7 | 5.7 | 67.7 | 18.4 | 35.0 | 90.6 | 24.9 |
| | 893 | 48.6 | 73.3 | 112.8 | 84.8 | 97.5 | 104.7 | 90.5 |
| | 894 | 55.5 | 15.9 | 80.5 | 37.1 | 37.1 | 89.0 | 55.1 |
| | 897 | 46.1 | 57.9 | 114.8 | 56.6 | 84.6 | 115.2 | 98.0 |
| | 898 | 45.7 | 30.4 | 90.8 | 36.1 | 47.4 | 98.7 | 86.2 |
| | 900 | 52.3 | 52.2 | 96.4 | 41.7 | 63.3 | 101.3 | 83.7 |
| | 902 | 53.3 | 50.7 | 86.3 | 41.8 | 69.8 | 118.2 | 77.9 |
| | 903 | 51.0 | 17.4 | 102.5 | 19.8 | 32.4 | 131.7 | 40.6 |
| | 904 | 52.2 | 10.9 | 93.7 | 15.3 | 42.9 | 112.4 | 34.3 |
| Mean for soil type | 17 | 48.28 | 27.3 | 82.1 | 35.3 | 47.3 | 107.0 | 57.2 |

**TABLE XXXVII-C. (Continued)**

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Hartsells sandy loam | 927 | 49.5 | 88.3 | 109.4 | 103.4 | 95.2 | 117.4 | 113.7 |
| | 929 | 49.3 | 61.0 | 66.7 | 81.1 | 86.2 | 108.7 | 115.0 |
| | 930 | 37.5 | 31.2 | 33.9 | 83.4 | 81.3 | 113.6 | 112.0 |
| Mean for soil type | 3 | 45.43 | 60.2 | 70.0 | 89.3 | 87.6 | 113.2 | 113.6 |
| Hartsells fine sandy loam | 913 | 50.5 | 34.1 | 67.5 | 30.7 | 68.1 | 103.2 | 88.3 |
| | 914 | 63.1 | 36.0 | 80.3 | 40.2 | 71.9 | 92.9 | 63.1 |
| | 915 | 47.0 | 6.8 | 49.4 | 3.0 | 38.2 | 103.2 | 47.4 |
| | 918 | 50.2 | 59.2 | 42.2 | 81.4 | 88.0 | 123.7 | 115.1 |
| | 919 | 54.1 | 66.7 | 33.6 | 80.6 | 93.2 | 117.4 | 110.7 |
| | 920 | 61.1 | 40.4 | 78.7 | 58.6 | 86.3 | 91.0 | 77.3 |
| | 921 | 51.0 | 17.6 | 62.9 | 21.8 | 54.9 | 118.0 | 46.9 |
| | 922 | 35.6 | 23.0 | 79.8 | 28.4 | 53.7 | 121.3 | 73.6 |
| | 924 | 40.7 | 48.6 | 59.2 | 58.7 | 87.7 | 130.0 | 112.3 |
| | 925 | 45.6 | 61.6 | 67.8 | 80.3 | 84.6 | 121.3 | 115.0 |
| | 926 | 57.5 | 59.7 | 80.7 | 64.7 | 89.0 | 107.3 | 88.7 |
| | 928 | 50.1 | 45.1 | 50.0 | 73.7 | 72.3 | 118.8 | 118.6 |
| | 931 | 39.3 | 17.8 | 75.8 | 34.9 | 36.1 | 153.7 | 99.0 |
| | 932 | 66.4 | 42.6 | 47.1 | 82.2 | 77.7 | 95.0 | 87.0 |
| Mean for soil type | 14 | 50.87 | 39.9 | 62.5 | 52.8 | 71.6 | 114.1 | 88.8 |
| Hartsells loam | 916 | 67.4 | 57.4 | 78.4 | 68.1 | 87.7 | 96.6 | 95.8 |
| | 917 | 27.1 | 25.8 | 88.6 | 6.3 | 28.4 | 158.7 | 117.0 |
| | 923 | 47.4 | 32.7 | 39.9 | 75.3 | 65.8 | 105.7 | 84.2 |
| | 933 | 58.8 | .5 | 89.3 | .5 | 6.1 | 105.4 | 17.8 |
| Mean for soil type | 4 | 50.18 | 29.1 | 74.1 | 37.6 | 47.0 | 116.6 | 78.7 |
| Hartsells clay loam | 912 | 46.20 | 5.2 | 83.8 | 3.2 | 22.9 | 134.8 | 59.1 |

TABLE XXXVII-C. (Continued)

| Soil type | Laboratory number of soil | Fertilizer treatment and yield—sorghum | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | N P K yield | N | N P | N K | N K Residual P | N P K Residual L | N K Residual P L |
| | | *grams* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Cecil sandy loam | 960 | 33.3 | 19.5 | 30.0 | 34.5 | 65.8 | 96.4 | 76.3 |
| | 961 | 30.3 | 20.5 | 22.8 | 82.8 | 94.4 | 118.2 | 106.9 |
| | 962 | 37.7 | 65.8 | 74.3 | 77.5 | 84.1 | 103.4 | 86.5 |
| | 963 | 41.1 | 43.8 | 63.0 | 79.1 | 93.4 | 114.4 | 91.0 |
| | 965 | 19.1 | 35.6 | 14.7 | 112.6 | 103.7 | 151.8 | 145.5 |
| | 966 | 44.6 | 24.0 | 31.4 | 57.2 | 46.4 | 92.6 | 46.0 |
| | 967 | 35.5 | 5.6 | 41.7 | 6.5 | 58.9 | 118.9 | 50.0 |
| | 968 | 31.0 | 1.6 | 79.4 | 4.5 | 41.0 | 112.9 | 107.4 |
| | 969 | 30.7 | 14.3 | 35.8 | 70.4 | 77.5 | 119.9 | 94.1 |
| Mean for soil type | 9 | 33.70 | 25.6 | 43.7 | 58.3 | 73.9 | 114.3 | 89.3 |
| Cecil loamy sand | 964 | 21.1 | 7.6 | 70.6 | 58.3 | 122.3 | 164.0 | 144.1 |
| | 970 | 27.8 | 18.0 | 14.7 | 61.9 | 84.2 | 122.7 | 111.9 |
| Mean for soil type | 2 | 24.45 | 12.8 | 42.7 | 60.1 | 103.3 | 143.4 | 128.0 |
| Cecil sandy clay loam | 954 | 32.4 | 5.6 | 71.0 | 11.4 | 21.3 | 103.4 | 58.3 |
| | 955 | 35.1 | 18.8 | 84.0 | 23.4 | 52.4 | 101.7 | 67.0 |
| | 971 | 30.9 | 16.8 | 70.5 | 30.7 | 51.8 | 118.1 | 108.1 |
| Mean for soil type | 3 | 32.80 | 13.7 | 75.2 | 21.8 | 41.8 | 107.7 | 77.8 |
| Cecil clay loam | 951 | 46.6 | 37.1 | 47.0 | 43.1 | 78.5 | 105.1 | 96.8 |
| | 952 | 32.7 | 51.9 | 30.3 | 62.4 | 71.9 | 112.8 | 100.6 |
| | 957 | 34.8 | 22.4 | 46.6 | 43.4 | 87.1 | 98.3 | 120.1 |
| Mean for soil type | 3 | 38.03 | 37.1 | 41.3 | 49.6 | 79.2 | 105.4 | 105.8 |
| Cecil clay | 950 | 37.8 | 23.3 | 107.4 | 23.3 | 46.8 | 113.5 | 59.0 |
| | 953 | 40.8 | 26.0 | 76.5 | 31.4 | 81.4 | 104.9 | 81.4 |
| | 956 | 42.1 | 11.2 | 80.5 | 1.2 | 41.3 | 123.5 | 53.9 |
| | 959 | 35.8 | 10.1 | 33.5 | 3.6 | 48.3 | 102.8 | 21.2 |
| Mean for soil type | 4 | 39.13 | 17.7 | 74.5 | 14.9 | 54.5 | 111.2 | 53.9 |
| Davidson clay | 958 | 33.1 | 16.0 | 62.5 | 25.4 | 28.4 | 109.1 | 80.7 |

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