May 15, 1963

To the Graduate Council:

I am submitting herewith a thesis written by Burgess Franklin Guinn entitled "The Productivity of Dickson, Waynesboro and Huntington Soils for Corn at Selected Levels of Nitrogen and Plant Population." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

Frank G Bell
Major Professor

We have read this thesis
and recommend its acceptance:

W L Parks
William M Walker
Charles R. Graves

Accepted for the Council:

Hilton A. Smith
Dean of the Graduate School

THE PRODUCTIVITY OF DICKSON, WAYNESBORO AND HUNTINGTON SOILS FOR CORN AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

A Thesis
Presented To
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

---

by

Burgess Franklin Guinn

June 1963

20
33

ACKNOWLEDGMENTS

The author wishes to express his gratitude and appreciation to:

Dr. Frank F. Bell for directing the study,

Dr. W. L. Parks, Dr. William M. Walker and Mr. Charles R. Graves for serving on the author's graduate committee,

Dr. Henry A. Fribourg for his advice and suggestions concerning the statistical analyses of the data,

Dr. Elmer Gray for his encouragement, assistance and suggestions during the course of this study,

Mr. Robert G. Palmer and Mr. Rural A. Peace for their assistance with the field work,

The National Plant Food Institute and the University of Tennessee Agricultural Experiment Station for making this study possible,

Other members of the University of Tennessee staff for their cooperation and assistance,

Agricultural workers and farmers of Putnam County who cooperated in this study.

544040

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	LITERATURE REVIEW	3
III.	DESCRIPTION OF AREA AND SOILS	10
IV.	METHODS AND PROCEDURES	13
	Experimental Design and Treatments	13
	Collection of Soil Samples and Laboratory Analysis	15
	Collection of Rainfall Data	16
	Root Depth Measurement	16
	Method of Harvest	17
	Barren Plants, Lodging and Number of Ears	17
V.	RESULTS AND DISCUSSION	18
	Statistical Analysis	18
	Nitrogen-Population Study	18
	Dickson Silt Loam	18
	Waynesboro Silt Loam	27
	Huntington Silt Loam	35
	Yield Comparisons Among Dickson, Waynesboro and Huntington Soils	43
	Residual Study	47
	Yield Comparisons, 1960 Fertilizer Treatments Plus No Additional Fertilizer In 1961.	47
	Yield Comparisons, 1960 Fertilizer Treatments Plus Additional Fertilizer In 1961.	50

CHAPTER PAGE

Rainfall Data 59

Rooting Depth 59

Ears Per Plant and Per Cent Barren Plants 60

Lodging 61

VI. SUMMARY AND CONCLUSIONS 62

LITERATURE CITED 64

APPENDICES 68

APPENDIX A. Description of Huntington Silt Loam . . 69

APPENDIX B. Description of Waynesboro Silt Loam. . 70

APPENDIX C. Description of Dickson Silt Loam . . . 71

APPENDIX D. Farm Owners, Site Number and Soil Series Used in the 1961 Corn Study in Putnam County 73

APPENDIX E. Soil Test Values (pH, Available P and Exchangeable K) on Dickson, Waynesboro and Huntington Soils in Putnam County, 1961 74

APPENDIX F. An Example of the Calculation of the Yield in Bushels Per Acre from a Harvest Sample. 77

APPENDIX G. Inches of Rainfall at the Different Sites from May 8 Through August 31, 1961, in Putnam County 78

APPENDIX H. Rooting Depth at Selected Levels of N, P and K on Dickson, Waynesboro and Huntington Soils in Putnam County, 1961. 79

CHAPTER PAGE

APPENDIX I. Ears Per Plant at a Population of Eight, Twelve, Sixteen, Twenty and Twenty-four Thousand Plants Per Acre Using 120, 220 and 320 Pounds of Nitrogen Per Acre for Dickson, Waynesboro and Huntington Soils. 80

APPENDIX J. Per Cent Barren Plants at a Population of Eight, Twelve, Sixteen, Twenty and Twenty-four Thousand Plants Per Acre Using 120, 220 and 320 Pounds of Nitrogen Per Acre for Dickson, Waynesboro and Huntington Soils. 81

APPENDIX K. Per Cent Lodged Plants at a Population of Eight, Twelve, Sixteen, Twenty and Twenty-four Thousand Plants Per Acre Using 120, 220 and 320 Pounds of Nitrogen Per Acre for Dickson, Waynesboro and Huntington Soils. 82

APPENDIX L. Corn Yields Obtained at Three Plant Populations and Five 1960 Fertilizer Treatments with no Additional Fertilizer in 1961. 83

LIST OF TABLES

TABLE		PAGE
IA.	Corn Yields on Dickson Silt Loam, Site Number 1, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population	19
IB.	Analysis of variance of Corn Yield on Dickson Silt Loam, Site Number 1, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population.	20
IIA.	Corn Yields on Dickson Silt Loam, Site Number 2, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population.	21
IIB.	Analysis of Variance of Corn Yields on Dickson Silt Loam, Site Number 2, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population.	22
IIIA.	Corn Yields on Dickson Silt Loam, Site Number 3 in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population.	23
IIIB.	Analysis of Variance of Corn Yields on Dickson Silt Loam, Site Number 3, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population.	24
IVA.	Corn Yields on Waynesboro Silt Loam, Site Number 4, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population.	28

TABLE PAGE

IVB. Analysis of Variance of Corn Yields on Waynesboro Silt Loam, Site Number 4, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 29

VA. Corn Yields on Waynesboro Sitl Loam, Site Number 5, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 30

VB. Analysis of Variance of Corn Yields on Waynesboro Silt Loam, Site Number 5, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 31

VC. Comparison of Mean Corn Yields on Waynesboro Silt Loam, Site Number 5, at Four Plant Population Levels in Putnam County, 1961. . . . 32

VIA. Corn Yields on Waynesboro Silt Loam, Site Number 6, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 33

VIB. Analysis of Variance of Corn Yields on Waynesboro Silt Loam, Site Number 6, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 34

VIIA. Corn Yields on Huntington Silt Loam, Site Number 7, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 37

TABLE PAGE

VIIB. Analysis of Variance of Corn Yields on Huntington Silt Loam, Site Number 7, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 38

VIIIA. Corn Yields on Huntington Silt Loam, Site Number 8, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 39

VIIIB. Analysis of Variance of Corn Yields on Huntington Silt Loam, Site Number 8, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 40

IXA. Corn Yields on Huntington Silt Loam, Site Number 9, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 41

IXB. Analysis of Variance of Corn Yields on Huntington Silt Loam, Site Number 9, in Putnam County in 1961 at Selected Levels of Nitrogen and Plant Population. 42

XA. Analysis of Variance of Corn Yields from Comparable Treatment on Dickson, Waynesboro and Huntington Silt Loam in Putnam County, 1961. 45

XB. Comparison of Mean Corn Yields from Comparable Treatments on Dickson, Waynesboro and Huntington Silt Loam in Putnam County, 1961. 46

XIA. Analysis of Variance of 1961 Corn Yields in Putnam County Using Three Plant Populations on Dickson, Waynesboro and Huntington Silt Loam Where Selected Levels of N, P and K Were Applied to the Corn Crop in 1960 with No N, P and K Application in 1961. 48

TABLE PAGE

XIB. Comparison of 1961 Mean Corn Yields in Putnam County Using Three Plant Populations Where Selected Levels of N, P and K Were Applied in 1960 With No Additional Application in 1961. . . 49

XIIA. Analysis of Variance of 1961 Corn Yields in Putnam County Using Three Plant Populations on Dickson Silt Loam, Site Number 1, Where Selected Levels of N, P and K Were Applied to the Corn Crop in 1960 With 100 Pounds of N, 87 Pounds of P and 166 Pounds of K Applied in 1961. 51

XIIB. Corn Yields on Dickson Silt Loam, Site Number 1, Where Selected Levels of N, P and K Were Applied to the Corn Crop in 1960 With 100 Pounds of N, 87 Pounds of P and 166 Pounds of K Applied in 1961. 52

XIIIA. Analysis of Variance of 1961 Corn Yields in Putnam County Using Three Plant Populations on Waynesboro Silt Loam, Site Number 5, Where Selected Levels of N, P and K Were Applied to the Corn Crop in 1960 With 100 Pounds of N, 87 Pounds of P and 166 Pounds of K Applied in 1961. 54

XIIIB. Comparison of Mean Corn Yields on Waynesboro Silt Loam, Site Number 5, at Three Plant Population Levels in Putnam County, 1961. . . . 55

XIVA. Analysis of Variance of 1961 Corn Yields in Putnam County Using Three Plant Populations on Huntington Silt Loam, Site Number 9, Where Selected Levels of N, P and K Were Applied

TABLE PAGE

to the Corn Crop in 1960 With 100 Pounds of N, 87 Pounds of P and 166 Pounds of K Applied in 1961. 56

XIVB. Comparison of Mean Corn Yields on Huntington Silt Loam, Site Number 9, Where Selected Levels of N, P and K Were Applied in 1960 With 100 Pounds of N, 87 Pounds of P and 166 Pounds of K Applied in 1961. 57

XIVC. Comparison of Mean Corn Yields on Huntington Silt Loam, Site Number 9, at Three Plant Populations in Putnam County, 1961. 58

LIST OF FIGURES

FIGURE PAGE

1. Average Corn Yields on the Dickson Silt Loam Sites at Three Plant Populations and Two Levels of Nitrogen, 1961. 26
2. Average Corn Yields on the Waynesboro Silt Loam Sites at Four Plant Populations and Two Levels of Nitrogen, 1961. 36
3. Average Corn Yields on the Huntington Silt Loam Sites at Four Plant Populations and Three Levels of Nitrogen, 1961. 44

CHAPTER I

INTRODUCTION

The need for more information about the yield of various crops under defined levels of management inputs has been recognized for several years. If this information were available for all soils, the probability of making better decisions involving the use of farm land, labor and capital would be greatly enhanced.

To obtain the yields of various crops under defined levels of management for all soils would be an impractical task at this time. Therefore, some representative soil types with high, average and low productive capacities in respect to a given crop have been selected for study. An intensive study of these representative soil types will help in predicting responses from different levels of inputs on these soil types and others with similar characteristics.

This study and preliminary studies by Graves[1] (1958-59) and Peace[2] (1960) were conducted on Huntington, Waynesboro and Dickson soils in Putnam County, Tennessee. The 1958 study of the productivity of these soils showed that they have different productive capacities for corn at low to moderate levels of management and do not respond alike to given inputs, thus requiring different management practices for optimum corn production.

---

[1] Graves, Charles R. The productivity of Huntington, Waynesboro and Dickson soils for corn. Unpub. M.S. thesis, University of Tennessee, Knoxville, Tennessee. 1959.

[2] Peace, Rural Allen. The productivity of Huntington, Waynesboro and Dickson soils for corn under high levels of management. Unpub. M.S. thesis, University of Tennessee, Knoxville, Tennessee. 1961.

Research in 1960 showed that the productive capacities of these soils were brought closer together under high levels of management, fertility and adequate moisture. The response to added fertilizer increased as the level of fertility decreased.

The objectives of the 1961 study were: (1) to determine the productive capacity of these soils for corn at selected levels of nitrogen and plant population; (2) to determine the residual effects of fertilizer applied in 1960 on these soils when no additional fertilizer was applied in 1961; and (3) to determine the effects of fertilizer applied in 1960 on these soils when an additional one thousand pounds per acre of 10-20-20 fertilizer was broadcast prior to planting in 1961.

CHAPTER II

LITERATURE REVIEW

There are many different kinds of soils and some of them vary greatly in their productivity for specific crops. Although this difference in productivity has been theorized for many soils, there has been a relatively small amount of research data that would identify differences in the productive capacity of individual soil types.

According to Odell (23) soil productivity variations are due in part to differences in the physical, chemical, and biological characteristics within the soil. These characteristics are influenced by the inherent properties of the soil and management practices introduced by man and his agricultural operations. In addition, the climatic environment and the adaptation of the crop to its environment affects the productive capacity of a soil.

Although many factors contribute to soil productivity variations, Bauer et al. (3) stated that extreme soil differences can be greatly reduced by appropriate chemical treatments. Smith (30) indicated that the classification of soils based on their capacity to produce corn is closely associated with their capacity to supply essential nutrients. In many cases, if the necessary elements are made available, soils formerly considered unsuited to this crop can produce profitable yields.

Odell (24) indicated that cropping systems and soil treatments should be considered for determining levels of management to be used when measuring and comparing soil productivity. Although Ableiter (1) worked with "poor" and "better than average" levels of

management to show the value of productivity ratings of soils, he indicated that there was an even greater need for obtaining yield data at a high level of management.

Smith and Smith (29) indicated that with sufficient yield data and at a given management level, the productivity of a given soil can be predicted with a reasonable degree of accuracy. Farm records studied by Odell and Smith (25) showed a "distinct tendency for a long-time average farm yields to cluster about the mean of the soil type and management group to which each belongs," thus indicating the possibility of using farm records to predict yields.

Soil productivity in terms of yield differences has been difficult to measure due to the influence of management inputs upon crop yields. The inter-relations of moisture supply and plant population with fertilization must be considered for an accurate interpretation of soil productivity data.

The application of nitrogen fertilizer resulted in statistically significant increases in corn yields in ten of thirteen experiments conducted by Hunter and Yungen (11). They also found that the yield response to nitrogen on different sites varied over a wide range. In general, the higher yields were produced with the greater population, but the magnitudes of the yield increases resulting from the several levels of nitrogen were not related to plant population. Maximum or near maximum yields were produced in most cases by the application of 100 pounds of nitrogen per acre.

Smith (30), working with six, eight, twelve and eighteen thousand plants per acre at different fertility levels, found that increases in yields occurred up to a level of eighteen thousand plants per acre. As a result of these experiments, he concluded that it is necessary to increase the rates of planting to obtain maximum benefits from higher fertilizer levels.

Jordan, Laird, and Ferguson (13) found that the production of dry matter increased with increasing nitrogen applications and with thicker stands. They did indicate, however, that at low fertility levels, heavy stands might be expected to depress growth, but not where adequate nutrients are available.

Using eight, ten, twelve and sixteen thousand plants per acre, Osgood (26) found that the higher population produced significantly higher yields, where the soil fertility was sufficient to produce above the sixty-bushel level. Duncan (6) found that yields were increased by using plant populations above twelve thousand plants per acre where the fertility level was adequate.

Hinkle (10) found that significantly higher yields were obtained at the sixteen thousand than at the twelve thousand plants per acre rate with four out of five hybrids tested using 180 pounds of nitrogen per acre. Jordon (12) reports that as an average of several locations, the yield of corn was increased from twenty-two bushels per acre with no nitrogen and four thousand plants to seventy-two bushels per acre with 120 pounds of nitrogen and twelve thousand plants.

Muhr and Rost (21) found that when controllable growth factors such as fertility and moisture were brought nearer optimum, plant population definitely affected the yield of field corn. The maximum yield was obtained at the densest population (31, 360 plants per acre). Long (18) stated that the optimum planting rate of corn largely depends on the fertility of the soil and its capacity to deliver water. He also suggests that stands not exceeding twelve thousand plants per acre appear to be best in Tennessee.

In order to obtain optimum response to fertilizer, moisture conditions in the soil must be favorable. Kiesselbach (15) found that the manner in which corn plants respond to drought is dependent upon the stage of growth when the moisture deficiency occurs. Several workers (6, 16, 17, 27, 31, 34, 35) have reported that the period of

highest water requirement for corn appears to be from tasseling through silking.

MacGregor (19) found that a shortage of soil moisture during the growing season can reduce or eliminate fertilizer effects. Even though it is possible for moisture stress to reduce or eliminate fertilizer response, numerous experiments (9, 14, 20) have shown that plants growing on fertile soils generally make more efficient use of the available soil moisture than plants growing on soils low in fertility.

As early as 1924, Weaver (32) felt that the extent and distribution of root systems were very important factors in determining the economic value of different strains of corn and their adaptability to varying conditions. He also indicated that a lateral spread of three and one-half feet on all sides of the plant is not uncommon even early in its development, and a depth of penetration of five to six feet is usual.

Fehrenbacher and Rust (7) conducted corn root penetration studies on four Brunizem soils, Ringwood, Saybrook, Elliot and Clarence, derived from various textures of Wisconsin-age glacial till in northeastern Illinois. The greatest rooting depths of four to four and one-half feet were observed in Ringwood derived from sandy loam till and in Saybrook derived from loam till. Not many roots were found below three feet on Elliot derived from silty clay loam till and in Clarence derived from clay till. They suggested that the main factors responsible for differences in long-time average corn yields on these soils were the differences in the depth of root penetration and the available soil moisture in the rooting zone.

Restricted root development in the subsoil was observed by Winters and Simonson (34). They attributed the difficulties in root penetration to one or more of the following soil characteristics; high bulk density, low porosity, restricted aeration, or low fertility. Wiersum (33) concluded that mechanical resistance to root growth is a factor limiting root development in fine and densely compacted soil layers.

Weaver (32) observed marked effects upon root development by applied fertilizers. Nitrates inhibited root penetration and promoted increased branching. Phosphates were successfully used in promoting deep rooting. Fehrenbacher and Snider (8) showed that soil treatment on Cisne silt loam, a soil low in native fertility, induced corn root penetration and development into the lower soil horizons, which made it possible for the corn plant to reach and use moisture at greater depths.

Lodging of corn results in harvesting difficulties especially when mechanical harvesters are used since the ears are sometimes too low to pick-up. Considerable work has been done on the effect of population and nitrogen fertilizer on lodging of corn.

Krantz and Chandler (17) found that lodging of corn increased with higher plant populations in experiments using 4, 000 to 17, 500 plants per acre. Nelson (22) found that lodging increased progressively with plant populations ranging from 9, 300 to 26, 200 plants per acre. Bryan and co-workers (4) concluded that there was no yield advantage in having more than fourteen thousand plants per acre and lodging increased materially from ten to twenty thousand plants per acre. Long (12), working with eight to sixteen thousand plants per acre, found that lodging became worse with higher plant populations.

Nelson (22) found that early in the fall mechanical breakage indicated the stalks from the nitrogen fertilization treatments were

more resistant to breakage. However, in late fall the increased ear weight and stalk and plant height more than overbalanced the resistance gained. Therefore he concluded that nitrogen fertilization increased lodging. Long (18) found that lodging increased with higher nitrogen rates. Krantz and Chandler (16) reported that increased nitrogen rates had only a slight tendency to increase lodging.

Pesek (27) suggests that two of the most important problems associated with the study of nutrient carry over from one crop to another are: (a) measuring and evaluating quantities of the residual nutrient, and (b) determining the form and location of the residual nutrient in the soil.

Pesek and Dumenil (28) observed that nitrogen, particularly in the nitrate form, is the most mobile of the major fertilizer elements. However, under certain conditions, a considerable part of the fertilizer nitrogen may remain in the root zone for following crops to utilize. Adams, Pearson and Morris (2) studied residual effects from fall- and spring-applied nitrogen by measuring the yields of oat and corn crops following the fertilized corn. They found that when nitrogen was applied at a rate of ninety pounds per acre or higher, marked increases in yields of oat forage and corn grain were obtained as a result of the residual nitrogen. Pesek (27) estimated effects of residual soil nitrogen on spring oats to be equivalent to quantities as large as 40 per cent of the application made to corn the preceding year. Pesek and Dumenil (28) state that residual effects of nitrogen will vary considerably from one area to another and from season to season within a given area. In areas where rainfall is high and in wetter seasons of the same area, the residual, in general, will be lower.

Pesek (27) states that quantitative data on residual nitrogen

are needed to: (a) estimate optimum levels of nitrogen fertilization, (b) allow for a lower rate of discounting for uncertainty of profitable returns to adverse conditions, and (c) establish a basis for compensation for residual nitrogen benefits in leasing arrangements.

Pesek and Dumenil (28) found that the carry over benefit of phosphorous after the first year seemed to vary from 40 to 60 per cent. They suggest that the residual potassium in the soil will be about 60 per cent if the straw or stover is left on the field, and around 35 per cent if it is removed. They also indicate that the risks connected with fertilizer use and cropping are reduced materially by the residual effects.

CHAPTER III

DESCRIPTION OF AREA AND SOILS

This study was conducted in Putnam County, Tennessee, which is in the northeastern part of Middle Tennessee. It is bordered on the north by Jackson and Overton Counties, on the east by Fentress and Cumberland Counties, on the south by White and DeKalb Counties, and on the west by Smith County. Putnam County is about forty miles long in an east-west direction, and it measures about fourteen miles from north to south in the widest part. The total land area of the county is 259, 448 acres, or 405 square miles. Cookeville, the county seat, is about eighty-seven miles east of Nashville on U. S. Highway 70 N.

The county is largely agricultural. In 1959, there were 1, 997 farms averaging about eighty-six acres. The principal crops were corn, tobacco, oats, wheat, and soybeans.

The county has within its boundries three physiographic regions; Cumberland Plateau, Highland Rim and Outer Basin. The three soils studied; Dickson, Waynesboro and Huntington occur on the Highland Rim and all of the experimental sites were located in this region, although the Huntington soil also occurs in the Outer Basin. The location of all sites on the Highland Rim was not a necessity, but desirable since the distance between sites would have been much greater if both regions had been included in this study and variation between sites might have been greater.

The Huntington soils are deep, friable, and well drained and consist primarily of sediments that were recently deposited. These deposits are on level to gently sloping flood plains, in narrow strips along small drainageways, and at the base of slopes.

These soils have a dark-brown surface layer and a friable, dark-brown to dark yellowish-brown subsoil. Beneath the subsoil are stratified layers of different texture that contain fine chert gravel, pebbles, and sand. A profile description of Huntington is presented in Appendix A.

These soils are slightly acid to medium acid in reaction and are high in natural fertility and organic matter.

Huntington soils are not extensive in Putnam County, but they are important agriculturally. Most of the acreage has been cleared and is planted to corn. Some areas are flooded occasionally.

The Waynesboro soils consist of deep to very deep well-drained soils on medium and high terraces. These soils have formed in old general alluvium that washed from uplands where the soils were derived from limestone, shale, and to some extent from sandstone. The alluvium extends to a depth of four to twenty feet and overlies residuum from limestone.

Uneroded areas of these soils have a surface layer of dark grayish-brown to brown, friable silt loam. The subsoil is yellowish red to dark-red, friable silty clay loam or clay loam and is redder in the lower part. A few quartzite pebbles are scattered on the surface and throughout the profile. A profile description of Waynesboro is presented in Appendix B. Slope ranges from 2 to 20 per cent, but in most places is 2 to 10 per cent.

These soils are strongly acid in reaction and their content of organic matter is about 1 to 2 per cent. The soil supply of phosphorus is very low to low, but the supply of available potassium is medium to high.

The Dickson soils consists of moderately well-drained upland soils. These soils are formed in a mantle of loess about three feet thick that is underlain by residuum from cherty limestone.

Dickson soils have a surface layer of yellowish-brown silt loam and a subsoil of yellowish-brown, friable silt loam or silty clay loam. A fragipan occurs at a depth of about twenty-four inches. The fragipan of Dickson soils is not a zone of clay cementation, for the clay content is low and the soil material is compact but is not cemented. The underlying material has varied degrees of permeability, and above this material the fragipan varies in thickness. It is thicker above the less permeable silty clay than it is above the more permeable clay loam or silty clay loam. A profile description of Dickson is presented in Appendix C. The depth to limestone is six feet or more. The slope ranges from 2 to 5 per cent.

These soils are low in organic matter and in natural fertility. They are very strongly acid in reaction throughout the profile.

CHAPTER IV

METHODS AND PROCEDURES

This study was conducted in Putnam County in 1961 in cooperation with the National Plant Food Institute.

The soils studied were: Dickson silt loam, a moderately well-drained upland soil with a fragipan; Waynesboro silt loam, a well-drained terrace soil; and, Huntington silt loam, a well-drained bottom soil. These soils vary greatly in their chemical and physical properties and have been subjected to varying levels of management in the past. Graves[3] found that they differ greatly in their productivity under low to moderate levels of management. Peace[4] found that the productivity of these soils did not greatly differ under high levels of management and adequate moisture.

In order to determine the effect of fertilizer applied in 1960 on the yield of corn in 1961, both with and without an additional application, it was necessary to select sites used in the 1960 study. Nine sites were selected, three on each of the three soil types, with the entire area on the same soil mapping unit. The site numbers, farm owners and soil series are presented in Appendix D.

I. EXPERIMENTAL DESIGN AND TREATMENTS

In this experiment, the site area varied with the soil type since a greater range of population was used on Waynesboro and Huntington than on Dickson. There were also more nitrogen treatments on

---

[3] Graves, op. cit.

[4] Peace, op. cit.

Huntington than on Waynesboro or Dickson. All nine sites were divided into two sections. One section was used for the residual fertilizer study and the remaining section was used for the nitrogen-population study. The section used for the residual study was an area 72 feet wide and 400 feet long on each of the nine sites. The section used for the nitrogen-population study was an area 72 feet wide and 400 feet long on Dickson, 96 feet wide and 400 feet long on Waynesboro, and 144 feet wide and 400 feet long on Huntington. Treatments and populations were randomized and replicated in both of the sections. (Each sub-plot consisted of four rows three feet apart and fifty feet long on the section used for the residual study and on the nitrogen-population study, each sub-plot consisted of four rows three feet apart and 100 feet long.)

The fertilizer treatments of N, P and K applied per acre on each site in the 1960 study were as follows: 220 pounds of N and 183 pounds of P and 349 pounds of K; 420 pounds of N, 183 pounds of P and 349 pounds of K; 220 pounds of N, 96 pounds of P and 183 pounds of K; and 420 pounds of N and 96 pounds of P and 183 pounds of K. Most of the fertilizer was applied with a fertilizer distributor with the exception of 20 pounds of N, 9 pounds of P and 17 pounds of K applied as 10-10-10 in a band about 2 inches to the side and 2 inches below the seed. In 1961, three plant populations of eight, twelve and sixteen thousand plants per acre were used on each site. No fertilizer was applied to six of these sites. One thousand pounds of 10-20-20 fertilizer was applied broadcast to the remaining three sites.

In the nitrogen-population study nine sites adjacent to the sites used for the residual study were selected. Two levels of nitrogen (120 and 220 pounds per acre) were applied on each of the nine sites. An additional level (320 pounds per acre) was applied on each of the

Huntington sites. The amount of applied phosphorus and potassium, respectively, was 96 and 183 pounds per acre on each of the nine sites. On Dickson, plant populations were eight, twelve and sixteen thousand; on Waynesboro, eight, twelve, sixteen and twenty thousand; and on Huntington, twelve, sixteen, twenty and twenty-four thousand plants per acre.

Dixie 29, a full-season prolific hybrid, was the variety used in this study. It was planted with a two-row, tractor mounted planter at a rate 15 per cent higher than the maximum plant population desired. The planting operation began May 5 and was completed by May 8.

Weeds were controlled by applying Atrazine immediately after planting at the rate of two pounds of active material per acre.

To obtain the desired plant population, the corn was thinned to the desired plant population when the plants were about ten inches high. An attempt was made to obtain a distance between plants of 21.8, 14.5, 10.9, 8.7 and 7.3 inches respectively, for eight, twelve, sixteen, twenty, and twenty-four thousand plants per acre. The distance between rows was thirty-six inches.

II. COLLECTION OF SOIL SAMPLES AND LABORATORY ANALYSIS

Soil samples were taken in the spring of 1961 on each of the nine sites used in this study. Five samples were taken on each site with each sample containing approximately seven borings. Of the five samples collected at each site, four were taken from the area used in the 1960 study, viz., one from each 1960 fertilizer treatment. One sample was taken from the area which was used in the nitrogen-population study on Dickson, Waynesboro and Huntington soils in 1961. The soil test values are presented in Appendix E. The

samples were tested for pH, available phosphorus and exchangeable potassium. Using a soil paste, the pH was determined by means of a Beckman pH meter. The samples were analyzed by the University of Tennessee Soil Testing Laboratory.

III. COLLECTION OF RAINFALL DATA

Rain gauges were placed near each of the nine sites and readings were made and recorded from May through August. Oil was added to prevent evaporation of water from the rain gauges and the readings were made every two weeks. Rainfall information obtained by the author was supplemented by the U. S. Weather Bureau Station located in Cookeville near the center of the experimental area.

IV. ROOT DEPTH MEASUREMENT

To determine the depth of root penetration, pits were dug on six of the nine sites, two on each soil used in this study. Rooting depth data were obtained from five different fertility treatments with the population of twelve thousand plants per acre being used across all treatments. The fertilizer treatments sampled are presented in Appendix H.

A pit approximately twenty-four inches wide and forty-eight inches long was dug between the rows. Approximately six inches was left on each side of the pit and the corn plants. An attempt was made to observe the roots of three plants on each side of the pit. Two measurements were taken at each pit, one where about ninety-five per cent of the roots stopped and the other where all roots stopped.

V. METHOD OF HARVEST

Twenty-five feet of the two inside rows near the center of each sub-plot were harvested. The corn from each sub-plot was shucked, weighed and the number of ears recorded. Four ears from each sub-plot were selected at random and two rows of kernels were removed from each ear and placed in plastic bags for moisture determination at the laboratory. A Steinlite Moisture Meter was used for the moisture determination. All corn yields were expressed in bushels per acre adjusted to 15.5 per cent moisture.

The procedure used to calculate the corn yield per acre is shown in Appendix F.

VI. BARREN PLANTS, LODGING AND NUMBER OF EARS

At the time of harvest the number of barren plants, lodged plants and total ears per sample were recorded. From this the number of ears per stalk and the weight per ear were calculated. Although two types of lodging are generally recognized, only those plants broken below the attachment of the main ear and those leaning more than 45 degrees were counted as being lodged.

CHAPTER V

RESULTS AND DISCUSSION

I. STATISTICAL ANALYSIS

Yield data for the nitrogen-population study were subjected to statistical analysis as outlined by Snedecor (31) for a split-plot design. Analysis of variance of yield data on individual sites on each soil was calculated to determine variations due to nitrogen levels, replications, plant populations and their interactions. The yield data on all sites using comparable nitrogen levels and plant populations were analyzed to determine the variations due to soils, nitrogen levels, replications, plant populations and their interactions.

An analysis of variance was computed using the yield data obtained in the residual study to determine the variation due to soils, 1960 fertilizer treatments, replications, plant populations and their interactions.

An L. S. D. test (31) was used to determine the significance of the difference between two means. However, Duncan's multiple range test (5) was used when more than two means were being compared. When using the tables for the multiple range tests, any two means underscored by the same line are not significantly different from each other at the .05 level of probability.

II. NITROGEN-POPULATION STUDY

Dickson Silt Loam

Yield data and the analysis of variance, respectively, for individual sites located on Dickson silt loam are presented in Tables IA, IB, IIA, IIB, IIIA and IIIB.

TABLE IA

CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 1, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	Average of 2 nitrogen levels
	Yield (Bu./A)		
8,000	91.2	112.1	101.7
12,000	77.0	106.5	91.7
16,000	83.3	110.2	96.8
Average of all plant populations	83.8	109.6	

L.S.D. - .10 for nitrogen means = 19.6 bu.

Differences among population means were not significant

TABLE IB

ANALYSIS OF VARIANCE OF CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 1, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	1	2544.92	6.11 ++
Replications	3	30.93	0.07 NS
Error (a)	3	416.66	
Population	2	48.34	0.43 NS
Nitrogen x Population	2	83.96	0.74 NS
Error (b)	12	113.32	

** In this and/or future tables, the double asterick will indicate a probability level less than or equal to 0.01.

* In this and/or future tables, the single asterick will indicate a probability level less than or equal to 0.05.

++ In this and/or future tables, the double plus sign will indicate a probability level less than or equal to 0.10.

+ In this and/or future tables, the single plus sign will indicate a probability level less than or equal to 0.20.

NS In this and/or future tables, NS will indicate no significance at a probability level of 0.20.

TABLE IIA

CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 2, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.)		Average of 2 nitrogen levels
	120	220	
	Yield (Bu./A)		
8,000	85.6	97.9	91.7
12,000	91.0	102.4	96.6
16,000	99.4	98.0	98.7
Average of all plant populations	92.0	99.4	

TABLE IIB

ANALYSIS OF VARIANCE OF CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 2, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	1	329.08	1.22 NS
Replications	3	53.45	0.59 NS
Error (a)	3	90.23	
Population	2	102.58	1.71 NS
Nitrogen x Population	2	115.70	1.93+
Error (b)	12	59.85	

TABLE IIIA

CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 3, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	Average of 2 nitrogen levels
	Yield (Bu./A.)		
8,000	75.2	86.5	80.9
12,000	75.1	101.6	88.4
16,000	82.6	108.3	95.4
Average of all plant populations	77.8	98.8	

L.S.D. - .05 for nitrogen means = 14.1 bu.

Differences among population means were not significant at the .05 level of probability

CRANES CREST

TABLE IIIB

ANALYSIS OF VARIANCE OF CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 3, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	1	2685.84	22.62 *
Replications	3	529.60	4.46 +
Error (a)	3	118.74	
Population	2	424.85	2.04 +
Nitrogen x Population	2	146.33	0.70 NS
Error (b)	12	208.21	

Yield differences due to applied nitrogen were significant at the .05 level of probability only at site 3 (Table IIIB). However, a significant difference at the .10 level of probability was obtained at site 1 (Table IB). Plant population effects were not significant at the selected levels of probability on sites 1 and 2 (Tables IB and IIB). Yield differences due to the effect of plant population were significant at the .20 level of probability at site 3 (Table IIIB).

Yields were highest on each of the Dickson sites where the high rate (220 pounds per acre) of nitrogen was applied. It appears that this rate of nitrogen would give maximum yield under management similar to that used in this experiment, but it may not be economically feasible.

The maximum yield of 112.1 bushels per acre was obtained with eight thousand plants per acre and 220 pounds of nitrogen per acre on site number 1, but was not significantly different from the yields obtained at twelve and sixteen thousand plants per acre. The maximum yield for site 1 occurred at a plant population of eight thousand plants per acre at both nitrogen levels. Maximum yield for site 2 occurred at sixteen thousand plants per acre using 120 pounds of nitrogen per acre and at twelve thousand plants per acre using 220 pounds of nitrogen per acre. Maximum yield for site 3 occurred at sixteen thousand plants per acre at both nitrogen levels. The average yield on all three sites for each nitrogen level and plant population is presented in figure 1.

There was little difference in the yields obtained at the three populations used on the Dickson sites. It appears that a population of eight thousand plants per acre on the Dickson soil would give the greatest yield per acre under management similar to that used in this experiment.

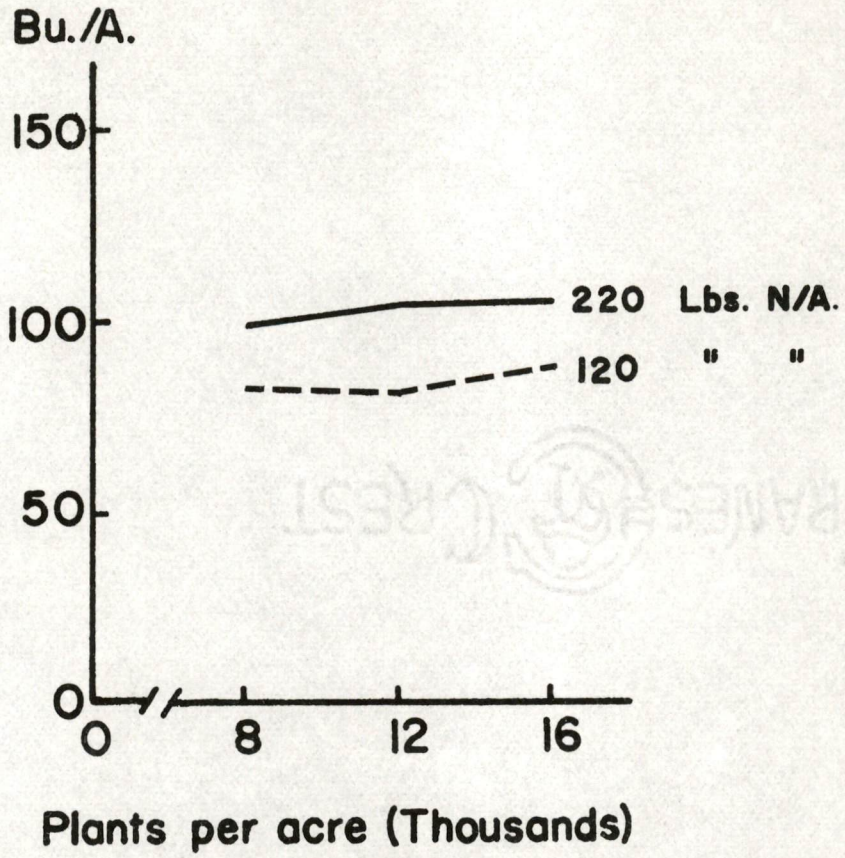


FIGURE 1

AVERAGE CORN YIELDS ON THE DICKSON SILT LOAM SITES AT THREE PLANT POPULATIONS AND TWO LEVELS OF NITROGEN, 1961

Waynesboro Silt Loam

Yield data and the analysis of variance, respectively, for individual sites located on Waynesboro silt loam are presented in Tables IVA, IVB, VA, VB, VC, VIA, and VIB.

Yield differences due to applied nitrogen were significant at the .01 level of probability only at site 4 (Table IVB). However, a significant difference at the .20 level of probability was obtained at site 5 (Table VB). Yield differences due to the effect of plant population were significant at the .05 level of probability at site 5 (Table VB) and at the .20 level at site 4 (Table IVB). The interaction effect of nitrogen and plant population was significant at the .05 level of probability on site 5 (Table VB). None of the effects tested on site 6 were significant at the selected levels of probability.

On site 5, the yield obtained using eight thousand plants per acre was significantly less than that obtained using twelve and twenty thousand plants per acre at the .05 level of probability (Table VC). Yields obtained using sixteen thousand plants per acre were significantly less than those obtained using twenty thousand plants per acre. Although there was a positive difference in yield obtained using eight and sixteen, twelve and sixteen, and twelve and twenty thousand plants per acre, they were not significant at the .05 level of probability.

The effect of nitrogen on yield was not as pronounced on the Waynesboro sites as the Dickson sites. This is probably due to the fact that the Waynesboro soil has more desirable physical and chemical properties than the Dickson soil.

The maximum yield of 173.7 bushels per acre was obtained with twenty thousand plants per acre and 220 pounds of nitrogen per acre on site number 5.

TABLE IVA

CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 4, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	Average of 2 nitrogen levels
	Yield (Bu./A.)		
8,000	116.9	123.6	120.2
12,000	123.9	138.6	131.2
16,000	109.6	135.9	122.7
20,000	122.5	142.8	132.6
Average of all plant populations	118.2	135.2	

L.S.D. - .01 for nitrogen means = 14.1 bu.

Differences among population means were not significant at the .05 level of probability

TABLE IVB

ANALYSIS OF VARIANCE OF CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 4, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	1	2288.94	49.16 **
Replications	3	28.67	0.62 NS
Error (a)	3	46.56	
Population	3	297.11	2.01 +
Nitrogen x Population	3	133.00	0.90 NS
Error (b)	18	147.70	

TABLE VA

CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 5, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.)		Average of 2 nitrogen levels
	120	220	
	Yields (Bu./A.)		
8,000	133.0	135.9	134.5
12,000	152.9	150.6	151.7
16,000	120.9	154.3	137.6
20,000	134.1	173.7	153.9
Average of all plant populations	135.2	153.6	

TABLE VB

ANALYSIS OF VARIANCE OF CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 5, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	1	2647.74	4.81 +
Replications	3	453.32	0.82 NS
Error (a)	3	550.19	
Population	3	753.70	3.82 *
Nitrogen x Population	3	880.12	4.46 *
Error (b)	18	197.10	

TABLE VC

COMPARISON OF MEAN CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 5, AT FOUR PLANT POPULATION LEVELS IN PUTNAM COUNTY, 1961

Multiple Range Test

Plants per acre (thousands):	8	16	12	20
Yield per acre (bushels):	134.5	137.6	151.7	153.9

TABLE VIA

CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 6, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	Average of 2 nitrogen levels
	Yield (Bu./A.)		
8,000	127.8	117.9	122.8
12,000	125.9	130.6	128.3
16,000	127.8	134.5	131.2
20,000	133.1	140.8	137.0
Average of all plant populations	128.6	131.0	

TABLE VIB

ANALYSIS OF VARIANCE OF CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 6, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	1	43.88	0.11 NS
Replications	3	32.66	0.08 NS
Error (a)	3	412.92	
Population	3	278.58	1.60 NS
Nitrogen x Population	3	136.05	0.78 NS
Error (b)	18	174.35	

The maximum yield for sites 4 and 5 occurred at a plant population of twelve thousand plants per acre using 120 pounds of nitrogen per acre and at twenty thousand plants per acre using 220 pounds of nitrogen per acre, respectively. Maximum yield for site 6 occurred at twenty thousand plants per acre at both levels of nitrogen. The average yield on all three sites for each nitrogen level and plant population is presented in figure 2.

The effect of population on yield was more apparent on the Waynesboro sites than on the Dickson and Huntington sites. The population of eight thousand plants per acre was probably too low for optimum utilization of fertilizer and moisture. However, a population of twelve thousand plants per acre appears to be adequate for maximum yield under management similar to that used in this experiment.

Huntington Silt Loam

Yield data and the analysis of variance, respectively, for individual sites located on Huntington silt loam are presented in tables VIIA, VIIB, VIIIA, VIIIB, IXA and IXB.

Yield differences due to applied nitrogen were significant at the .01 level of probability on site 8 (Table VIIIB) and at the .10 level on site 9 (Table IXB). Yield differences due to the effect of plant population and the interaction effect of plant population and nitrogen were not significant at the selected levels of probability on any of the sites located on Huntington soils.

The high rates of nitrogen (220 and 320 pounds per acre) gave significantly higher yields than the low rate (120 pounds per acre). Although the average yield obtained at the 320 pound rate was higher than that obtained at the 220 pound rate, the difference was not enough to warrant the use of 320 pounds of nitrogen per acre.

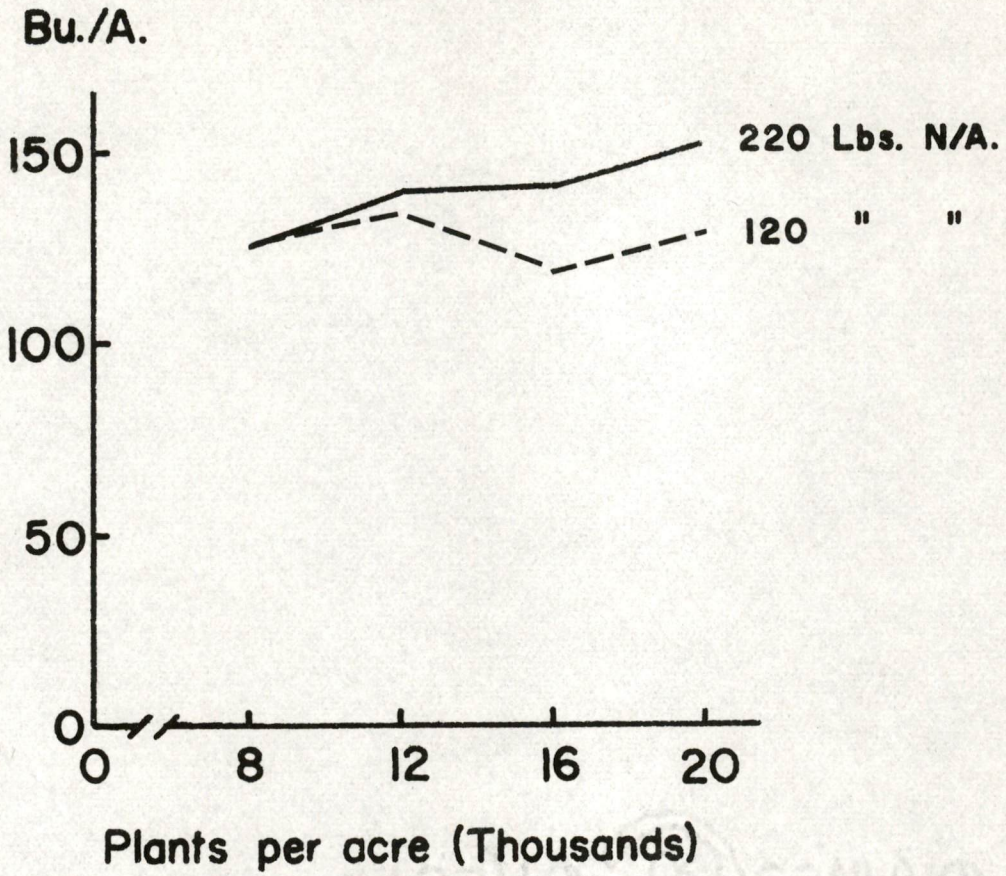


FIGURE 2

AVERAGE CORN YIELDS ON THE WAYNESBORO SILT LOAM SITES AT FOUR PLANT POPULATIONS AND TWO LEVELS OF NITROGEN, 1961

TABLE VIIA

CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 7, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	320	Average of all nitrogen levels
	Yield (Bu./A.)			
12,000	122.2	126.2	126.5	124.9
16,000	126.0	134.7	130.7	130.5
20,000	100.3	128.8	114.9	114.7
24,000	125.4	127.1	117.8	123.4
Average of all plant populations	118.5	129.2	122.4	

TABLE VIIB

ANALYSIS OF VARIANCE OF CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 7, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	2	384.50	0.64 NS
Replications	3	40.13	0.08 NS
Error (a)	6	598.99	
Population	3	522.80	0.79 NS
Nitrogen x Population	6	196.03	0.30 NS
Error (b)	27	662.12	

TABLE VIIIA

CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 8, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	320	Average of all nitrogen levels
	Yield (Bu./A.)			
12,000	86.8	128.7	137.2	117.6
16,000	101.2	104.8	125.3	110.4
20,000	92.1	119.7	126.6	112.8
24,000	97.2	121.2	133.1	117.2
Average of all plant populations	94.3	118.6	130.6	

L.S.D - .01 for nitrogen means = 16.6 bu.

Differences among population means were not significant

TABLE VIIIB

ANALYSIS OF VARIANCE OF CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 8, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	2	4911.81	30.94 **
Replications	3	449.24	2.83 +
Error (a)	6	158.72	
Population	3	98.50	0.32 NS
Nitrogen x Population	6	253.01	0.82 NS
Error (b)	27	306.37	

TABLE IXA

CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 9, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Plants per acre	Nitrogen (Lbs./A.) 120	220	320	Average of all nitrogen levels
	Yield (Bu./A.)			
12,000	109.4	117.9	124.5	117.3
16,000	121.2	127.0	127.6	125.2
20,000	116.4	130.5	133.5	126.8
24,000	122.0	131.2	133.7	129.0
Average of all plant populations	117.2	126.6	129.8	

L.S.D. - .10 for nitrogen means = 8.9

Differences among population means were not significant.

TABLE IXB

ANALYSIS OF VARIANCE OF CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 9, IN PUTNAM COUNTY IN 1961 AT SELECTED LEVELS OF NITROGEN AND PLANT POPULATION

Source of variation	Degrees of freedom	Mean squares	F
Nitrogen	2	697.40	4.16++
Replications	3	165.60	0.99 NS
Error (a)	6	167.64	
Population	3	294.09	0.96 NS
Nitrogen x Population	6	25.15	0.08 NS
Error (b)	27	305.58	

The maximum yield for site 7 was obtained at a plant population of sixteen thousand plants per acre and 220 pounds of nitrogen per acre. The maximum yield for site 8 occurred at twelve thousand plants per acre and 320 pounds of nitrogen and the maximum yield for site 9 occurred at twenty-four thousand plants per acre and 320 pounds of nitrogen per acre. The average yield on all three sites for each nitrogen level and plant population is presented in figure 3.

Plant population had little effect on the yield obtained on the Huntington sites. A population of sixteen thousand plants per acre appears to be adequate for maximum yield under management similar to that used in this experiment.

Yield Comparisons Among Dickson, Waynesboro and Huntington Soils

An analysis of variance was calculated to determine the significance of the effects of soils, nitrogen levels, plant populations and their interactions. The analysis of variance and multiple range test for soils, respectively, are presented in tables XA and XB.

For the purpose of comparing soils, only those treatments which occurred across all soils were considered. Thus two plant populations of twelve and sixteen thousand plants per acre and two levels of nitrogen (120 pounds and 220 pounds per acre) were used in the comparisons.

Soil effects and nitrogen effects were significantly different at the .01 level of probability (Table XA). The interaction effect of plant population, nitrogen and locations within soils was significant at the .10 level of probability. The interaction effect of plant population, nitrogen and soils was significant at the .20 level of probability. Yield differences due to the effect of plant population and all of the other interaction effects were not significant at the selected levels of probability.

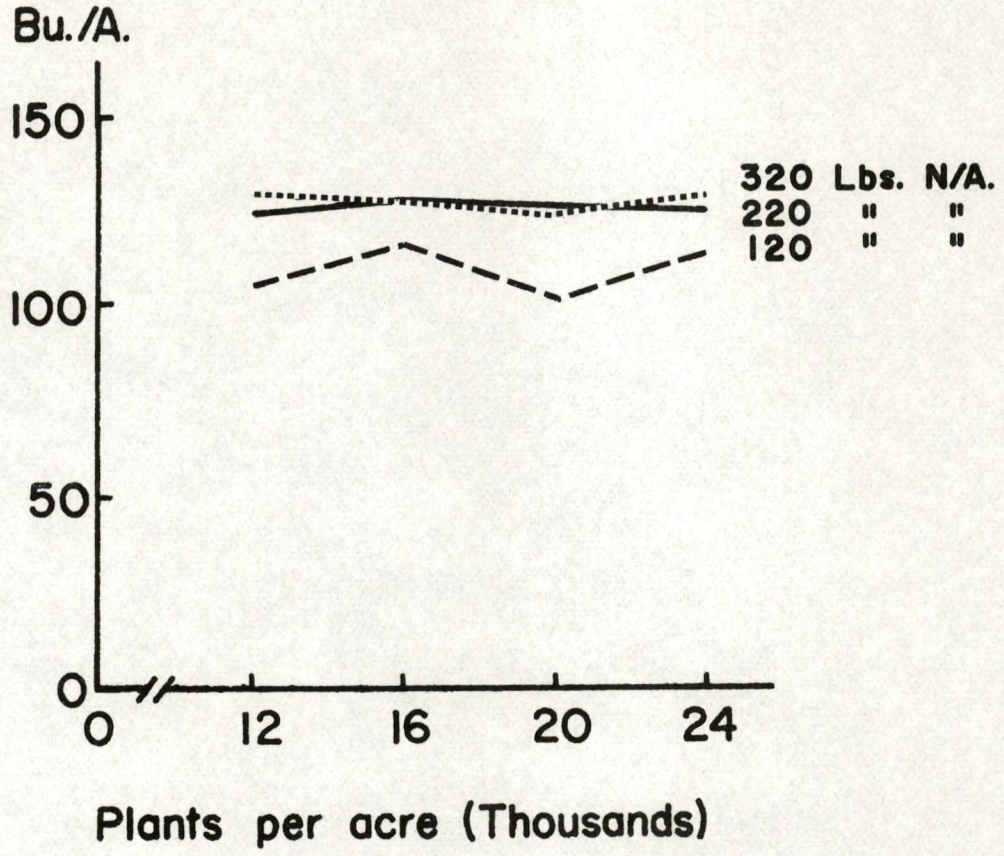


FIGURE 3

AVERAGE CORN YIELDS ON THE HUNTINGTON SILT LOAM SITES AT FOUR PLANT POPULATIONS AND THREE LEVELS OF NITROGEN, 1961

TABLE XA

ANALYSIS OF VARIANCE OF CORN YIELDS FROM COMPARABLE TREATMENTS ON DICKSON, WAYNESBORO AND HUNTINGTON SILT LOAM IN PUTNAM COUNTY, 1961

Source of variation	Degrees of freedom	F
Soils	2	15.53 **
Locations within Soils	6	
Nitrogen	1	30.64 **
Nitrogen x Soils	2	.39 NS
Nitrogen x Locations within Soils	6	1.38 NS
Replications within Locations within Soils	27	
Nitrogen x Replications within Locations within Soils	27	
Population	1	.21 NS
Population x Nitrogen	1	.07 NS
Population x Soils	2	.82 NS
Population x Locations within Soils	6	1.28 NS
Population x Nitrogen x Soils	2	1.96 +
Population x Nitrogen x Locations within Soils	6	2.30 ++
Population x Replications within Locations within Soils	27	
Population x Nitrogen x Replications within Locations within Soils	27	

TABLE XB

COMPARISON OF MEAN CORN YIELDS FROM COMPARABLE TREATMENTS ON DICKSON, WAYNESBORO AND HUNTINGTON SILT LOAM IN PUTNAM COUNTY, 1961

Multiple Range Test

Soils:	Dickson	Huntington	Waynesboro
Yield (Bu./A.):	95.9	117.3	134.5

Yields obtained on the Dickson sites were significantly lower than those on Huntington and Waynesboro. Higher yields were obtained on the Waynesboro sites than on Huntington, but the difference was not significant at the .05 level of probability (Table XB). Yields on the Huntington soil may have been reduced because of inadequate weed control on two of the three sites. The amount of rainfall recorded on the Huntington sites was approximately one inch less than on Waynesboro and two inches less than on Dickson.

Yield differences due to applied nitrogen were significant at the .01 level of probability. The average yields obtained at the low (120 pounds per acre) and high (220 pounds per acre) rates of applied nitrogen, respectively, were 109 and 123 bushels per acre.

III. RESIDUAL STUDY

Yield Comparisons, 1960 Fertilizer Treatments Plus No Additional Fertilizer In 1961

An analysis of variance was used to determine the significance of the effects of soils, treatments, plant populations and their interactions. The analysis of variance and multiple range tests for soils and treatments, respectively, are presented in Tables XIA and XIB.

Three soils, three plant populations and five fertilizer treatments were used in the comparisons. Yield data are presented in Appendix L.

Differences in yield among soils and treatments were significant at the .01 level of probability (Table XIA). The interaction effect of treatments and soils was significant at the .01 level of probability as was the interaction effect of treatments and locations within soils. The interaction effect of population and locations within soils was significant at the .10 level of probability. All other effects tested

TABLE XIA

ANALYSIS OF VARIANCE OF 1961 CORN YIELDS IN PUTNAM COUNTY USING THREE PLANT POPULATIONS ON DICKSON, WAYNESBORO AND HUNTINGTON SILT LOAM WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED TO THE CORN CROP IN 1960 WITH NO N, P AND K APPLICATION IN 1961

Source of variation	Degrees of freedom	F
Soils	2	29.22 **
Locations within Soils	3	
Treatments	4	27.02 **
Treatments x Soils	8	5.54 **
Treatments x Locations within Soils	12	4.17 **
Replications within Locations within Soils	12	.32 NS
Treatments x Replications within Locations within Soils	48	
Population	2	.24 NS
Population x Treatments	8	.48 NS
Population x Soils	4	1.31 NS
Population x Locations within Soils	6	2.17 ++
Population x Treatments x Soils	16	.70 NS
Population x Treatments x Locations within Soils	24	1.12 NS
Population x Replications within Locations within Soils	24	
Population x Treatments x Replications within Locations within Soils	96	

TABLE XIB

COMPARISON OF 1961 MEAN CORN YIELDS IN PUTNAM COUNTY USING THREE PLANT POPULATIONS WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED IN 1960 WITH NO ADDITIONAL APPLICATION IN 1961

Multiple Range Test

Soil:	Dickson		Huntington		Waynesboro
Yield (Bu./A.)	30.2		97.4		68.4
Treatments:	5	2	1	3	4
Yield (Bu./A.):	54.5	68.8	71.7	72.2	74.3

Legend: Treatment 1 (lbs./A.) = 220 N, 183 P and 349 K, 1960
0 N, P and K, 1961

" 2 (lbs./A.) = 220 N, 96 P and 183 K, 1960
0 N, P and K, 1961

" 3 (lbs./A.) = 420 N, 96 P and 183 K, 1960
0 N, P and K, 1961

" 4 (lbs./A.) = 420 N, 183 P and 349 K, 1960
0 N, P and K, 1961

" 5 (lbs./A.) = 18 N, 16 P and 30 K, 1960
0 N, P and K, 1961

were not significant at the selected levels of probability.

The highest mean yield was obtained on Waynesboro and it was significantly greater than that obtained on Huntington which was significantly greater than that obtained on Dickson (Table XIB).

Yields at the lowest fertilizer of 1960, 18 pounds of N, 16 pounds of P and 30 pounds of K, were significantly lower than all other treatments at the .05 level of probability (Table XIB). Yields obtained on the plots which received 220 pounds of N, 96 pounds of P and 183 pounds of K were significantly lower than those obtained at 420 pounds of N, 183 pounds of P and 349 pounds of K. The remaining yield differences among treatments were not significant.

Yield Comparisons 1960 Fertilizer Treatments Plus Additional Fertilizer In 1961

An analysis of variance was calculated to determine the significance of the effects of plant populations, 1960 fertilizer treatments plus an additional one thousand pounds of 10-20-20 fertilizer broadcast prior to planting and their interactions.

Three plant populations were used on each of the three sites. Five fertilizer treatments were used at site 1, but only four were used at sites 5 and 9. The treatment left out at sites 5 and 9 was the check because no fertilizer was applied to the check plot area, therefore it was not a true check of the other treatments.

The analysis of variance and LSD test for treatments respectively, for site 1 located on Dickson silt loam is presented in Tables XIIA and XIIB.

Differences in yield among treatments were significant at the .10 level of probability, but none of the other effects tested were significant at the selected levels of probability. There was not a

TABLE XIIA

ANALYSIS OF VARIANCE OF 1961 CORN YIELDS IN PUTNAM COUNTY USING THREE PLANT POPULATIONS ON DICKSON SILT LOAM, SITE NUMBER 1, WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED TO THE CORN CROP IN 1960 WITH 100 POUNDS OF N, 87 POUNDS OF P AND 166 POUNDS OF K APPLIED IN 1961

Source of variation	Degrees of freedom	Mean squares	F
Treatments	4	796.77	3.05 ++
Replications	2	462.59	1.77 NS
Error (a)	8	260.88	
Population	2	67.46	0.31 NS
Treatment x Population	8	116.68	0.53 NS
Error (b)	20	219.06	

TABLE XIIB

CORN YIELDS ON DICKSON SILT LOAM, SITE NUMBER 1, WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED TO THE CORN CROP IN 1960 WITH 100 POUNDS OF N, 87 POUNDS OF P AND 166 POUNDS OF K APPLIED IN 1961

Plants/A. (Thousands)	Treatments					Average of all treatments
	1	2	3	4	5	
	Yield (Bu./A.)					
8	97.4	84.0	77.4	105.6	82.4	89.4
12	87.0	79.3	84.8	100.1	98.4	89.9
16	95.2	81.9	70.9	98.8	83.2	86.0
	93.2	81.7	77.7	101.5	88.0	

L. S. D. - .10 for treatment means = 14.2 bu.

Differences among population means were not significant

Legend: Treatment 1 (lb./A.) = 220 N, 183 P and 349 K, 1960
100 N, 87 P and 166 K, 1961

" 2 (lb./A.) = 220 N, 96 P and 183 K, 1960
100 N, 87 P and 166 K, 1961

" 3 (lb./A.) = 420 N, 96 P and 183 K, 1960
100 N, 87 P and 166 K, 1961

" 4 (lb./A.) = 420 N, 183 P and 349 K, 1960
100 N, 87 P and 166 K, 1961

" 5 (lb./A.) = 18 N, 16 P and 30 K, 1960
100 N, 87 P and 166 K, 1961

significant difference between the check plot yield (treatment 5) and the other treatments (Table XIIB). The residual effects of fertilizer applied in 1960 were masked by the heavy application of fertilizer in 1961.

The analysis of variance and multiple range test for plant populations, respectively, for site 5 located on Waynesboro silt loam is presented in Tables XIIIA and XIIIB.

Differences in yield among treatments or replications were not significant at the selected levels of probability (Table XIIIA). The effect of plant population on yield was significant at the .01 level of probability. The interaction effect of treatment and plant population was not significant.

The yield obtained at a population of eight thousand plants per acre was significantly lower than the yield at both twelve and sixteen thousand plants per acre (Table XIIIB). The yield obtained at a population of sixteen thousand plants per acre was greater than that obtained at twelve thousand plants per acre, but the difference was not significant at the .05 level of probability.

The analysis of variance and multiple range test for treatments and plant populations, respectively, for site 9 located on Huntington silt loam is presented in Tables XIVA, XIVB and XIVC.

Differences in yield among treatments and plant populations were significant at the .05 level of probability (Table XIVA). None of the other effects tested were significant at the selected levels of probability.

Yield on the plot which received the lowest amounts of N and the highest amount of P and K in 1960 was significantly lower than the yield obtained on the plot which received the highest amount of N, P and K in 1960. However, all other comparisons were not significant at the .05 level of probability (Table XIVB).

TABLE XIIIA

ANALYSIS OF VARIANCE OF 1961 CORN YIELDS IN PUTNAM COUNTY USING THREE PLANT POPULATIONS ON WAYNESBORO SILT LOAM, SITE NUMBER 5, WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED TO THE CORN CROP IN 1960 WITH 100 POUNDS OF N, 87 POUNDS OF P AND 166 POUNDS OF K APPLIED IN 1961

Source of variation	Degrees of freedom	Mean squares	F
Treatments	3	103.63	0.93 NS
Replications	2	201.19	1.80 NS
Error (a)	6	111.90	
Population	2	991.93	7.37 **
Treatment x Population	6	84.83	0.63 NS
Error (b)	16	134.68	

TABLE XIIIB

COMPARISON OF MEAN CORN YIELDS ON WAYNESBORO SILT LOAM, SITE NUMBER 5, AT THREE PLANT POPULATION LEVELS IN PUTNAM COUNTY, 1961

Multiple Range Test

Plants per acre (thousands):	8	12	16
Yield per acre (bushels):	116.7	128.8	134.5

TABLE XIVA

ANALYSIS OF VARIANCE OF 1961 CORN YIELDS IN PUTNAM COUNTY USING THREE PLANT POPULATIONS ON HUNTINGTON SILT LOAM, SITE NUMBER 9, WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED TO THE CORN CROP IN 1960 WITH 100 POUNDS OF N, 87 POUNDS OF P AND 166 POUNDS OF K APPLIED IN 1961

Source of variation	Degrees of freedom	Mean squares	F
Treatments	3	388.75	5.19 *
Replications	2	15.87	0.21 NS
Error (a)	6	74.85	
Population	2	385.40	5.64 *
Treatment x population	6	9.42	0.14 NS
Error (b)	16	68.31	

TABLE XIVB

COMPARISON OF MEAN CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 9, WHERE SELECTED LEVELS OF N, P AND K WERE APPLIED IN 1960 WITH 100 POUNDS OF N, 87 POUNDS OF P AND 166 POUNDS OF K APPLIED IN 1961

Multiple Range Test

Treatments:	1	2	3	4
Yield per acre (bushels):	107.0	116.6	116.9	122.8

Legend: Treatment 1 (lbs./A.) = 220 N, 183 P and 349 K, 1960
100 N, 87 P and 166 K, 1961

" 2 (lbs./A.) = 220 N, 96 P and 183 K, 1960
100 N, 87 P and 166 K, 1961

" 3 (lbs./A.) = 420 N, 96 P and 183 K, 1960
100 N, 87 P and 166 K, 1961

" 4 (lbs./A.) = 420 N, 183 P and 349 K, 1960
100 N, 87 P and 166 K, 1961

TABLE XIVC

COMPARISON OF MEAN CORN YIELDS ON HUNTINGTON SILT LOAM, SITE NUMBER 9, AT THREE PLANT POPULATIONS IN PUTNAM COUNTY, 1961

Multiple Range Test

Plants per acre (thousands):	8	12	16
Yield per acre (bushels):	109.6	117.2	120.6

The yield at a population of eight thousand plants per acre was significantly lower than the yield at both twelve and sixteen thousand plants per acre. The yield obtained at a population of sixteen thousand plants per acre was greater than that obtained at twelve thousand plants per acre, but the difference was not significant at the .05 level of probability (Table XIVC).

Rainfall Data

Rainfall data for the period between May 8 through August 31, 1961, were obtained for each of the nine sites. The total rainfall for this period is presented in Appendix G. The lowest amount of rainfall, 15.4 inches, was recorded at site 9 and the highest, 18.1 inches, at site 3. In general, the amount of rainfall recorded at the Dickson sites exceeded that which occurred at the Waynesboro sites. The amount recorded at the Waynesboro sites exceeded the amount recorded at the Huntington sites. Rainfall data for this same period were obtained from the Cookeville Weather Station (located near the center of the experimental sites). The total amount recorded was 18.5 inches.

The month having greatest amount of precipitation during this period was June with approximately four inches occurring after June 15. From the latter part of June to the first part of July was a critical period during the growing season in regard to moisture since the corn was tasseling and silking.

Rooting Depth

An attempt was made to determine the rooting depth of corn on each of three soils at five levels of fertility using the same plant population (twelve thousand plants per acre) across

all soils and treatments. The data are presented in Appendix H. In general, shallower rooting depths were obtained on Dickson than on Waynesboro and Huntington. Rooting depths were somewhat greater on Huntington than Waynesboro. In regard to fertility, shallower rooting was noted on the plots which received an application of 120 pounds of N, 96 pounds of P and 183 pounds of K in 1961 than on any of the other treatments across all three soils. The rooting depths obtained on the plots which received 220 pounds of N, 96 pounds of P and 183 pounds of K in 1960 and 100 pounds of N, 87 pounds of P and 166 pounds of K in 1961 were similar to those of the residual plots and the check plot.

Ears Per Plant and Per Cent Barren Plants

The average number of ears per plant for the three levels of nitrogen and the five plant populations on each soil used in the nitrogen-population study is presented in Appendix I. At comparable plant populations and levels of nitrogen, the plants on the Dickson sites had a smaller number of ears per plant than the plants on the Waynesboro sites. There appeared to be little difference in the Waynesboro and Huntington sites. At comparable plant populations, the number of ears per plant on Dickson and Waynesboro increased as the amount of applied nitrogen increased. However, there appeared to be little difference in the number of ears per plant among the three nitrogen levels used on Huntington.

The number of ears per plant was calculated by dividing the total number of ears by the total number of plants. Since the total number of plants included barren plants, this should be considered in studying the ears per plant data. The per cent barren stalks is

presented in Appendix J.

Lodging

The mean per cent lodged plants for the three levels of nitrogen and five plant populations on each soil used in the nitrogen-population study is presented in Appendix K. At comparable plant populations, there appeared to be little difference in per cent lodged plants among Dickson, Waynesboro and Huntington and at different levels of nitrogen. In general, there appeared to be greater differences among populations than among nitrogen levels. The highest amount of lodging (16 per cent) occurred on Waynesboro using twenty thousand plants per acre and 120 pounds of nitrogen per acre.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The productive capacity of Dickson, Waynesboro and Huntington soils for corn was measured at selected levels of nitrogen and plant populations. Yields per acre ranged from 75 to 112 bushels on Dickson, 109 to 174 bushels on Waynesboro, and 87 to 137 bushels on Huntington. The average yields per acre obtained on these three soils (including all nitrogen levels and plant populations) were: Dickson, 94 bushels; Waynesboro, 134 bushels; and Huntington, 121 bushels.

Although Dickson, Waynesboro and Huntington soils differ physically and chemically, appropriate chemical treatments and adequate moisture greatly reduced soil productivity differences among these soils.

Two rates of nitrogen (120 and 220 pounds per acre) were applied on the Dickson and Waynesboro sites and three rates (120, 220 and 320 pounds per acre) were applied on the Huntington sites. In general, higher yields were obtained on the Dickson and Waynesboro sites at the high nitrogen rate. There was little difference between the yields obtained at the 220 and 320 pound rate of nitrogen on the Huntington sites. However, yields obtained at the 120 pound rate of nitrogen were significantly lower than those obtained at the high rates.

Significance for plant population effects occurred only on one of the nine sites. A plant population of eight to sixteen thousand plants per acre seems adequate for each of the nitrogen levels used in this study on Dickson, eight to twenty thousand on Waynesboro and twelve to twenty-four thousand on Huntington. In this year of adequate rainfall, the number of plants per acre may be of less importance than in a year with an inadequate amount of moisture or a poor

distribution of rainfall.

Higher yields were produced with the greater plant population and the higher levels of nitrogen, but the magnitudes of the yield increases between the low and high rates of nitrogen were not related to plant population.

The amount of lodging increased somewhat as the plant population increased. The effect of applied nitrogen on lodging was slight.

The per cent barren stalks increased as the plant population increased. On Dickson and Waynesboro, the per cent barren stalks decreased as the amount of applied nitrogen increased. However, on Huntington, the per cent barren stalks increased as the amount of applied nitrogen increased. This was probably due to the inadequate control of Johnsongrass and cockleburrs on two of the three sites.

The average number of ears per stalk decreased as the plant population increased on all three soils. The high rate of nitrogen increased the number of ears per stalk on the Dickson and Waynesboro sites, but did not seem to effect the number of ears on the Huntington sites.

In general, shallower rooting occurred on the Dickson soil than on the Waynesboro and Huntington soils. Shallower rooting was noted on the plots which received an application of 120 pounds of nitrogen, 96 pounds of P and 183 pounds of K per acre in 1961 than on any of the residual treatments across all three soils.

Marked increases in yields were obtained as a result of residual nutrients in the soil when no additional fertilizer was applied. However, residual effects were almost completely masked by heavy applications of fertilizer. Further study is needed before valid estimates regarding optimum fertilization can be made.

LITERATURE CITED

LITERATURE CITED

1. Ableiter, J. K. Productivity ratings in the soil survey report. Soil Sci. Soc. Amer. Proc. 2:415-422. 1937.

2. Adams, W. E., Pearson, R. W. and Morris, H. D. Residual effects of fall and spring nitrogen application in the Georgia Piedmont. Georgia Agricultural Research, Vol. 2, No. 3 Winter 1961.

3. Bauer, F. C., Lang, A. L., Badger, C. J., Miller, L. B., Farnham, C. H., Johnson, P. E., Marriott, L. F. and Nelson, M. H. Effects of soil treatment on soil productivity. Univ. of Ill. Agr. Exp. Sta. Bul. 516.

4. Bryan, A. A., Eckhardt, R. C. and Sprague, G. F. Spacing experiments with corn. J. Am. Soc. Agron. 32:707-715. 1940.

5. Duncan, David R. Multiple Range and Multiple F Tests. Biometrics 11:1-42. 1955.

6. Duncan, E. R. Interrelations of plant population, fertility levels and hybrids in corn production. Unpublished Ph. D. Thesis. Ames, Iowa. Iowa State College Library. 1954.

7. Fehrenbacher, J. B. and Rust, R. H. Corn root penetration in soils derived from various textures of Wisconsin-age glacial till. Soil Sci. 82:369-378. 1956.

8. _____ and Snider, H. J. Corn root penetration in Muscatine, Elliott and Cisne soils. Soil Sci. 77:281-291. 1954.

9. Hanks, R. J. and Tanner, C. B. Water consumption of plants as influenced by soil fertility. Agron. Jour. 44:98-100. 1952.

10. Hinkle, D. A. Corn fertilizer and spacing tests, 1948 to 1950. Ark. Agr. Exp. Sta. Report Series 24. 1951.

11. Hunter, A. S. and Yungen, J. A. The influence of variations in fertility levels upon the yield and protein content of field corn in eastern Oregon. Soil Sci. Soc. Amer. Proc. 19:214-218. 1955.

12. Jordan, H. V. Fertilizer and production practices for corn in the hill sections of Mississippi. Mississippi Agr. Exp. Sta. Bul. 486. 1951.

13. _____, Laird, K. D. and Ferguson, D. D. Growth rates and nutrient uptake by corn in a fertilizer-spacing experiment. Agron. Jour. 42:261-268. 1950.

14. Kelly, O. J. Requirements and availability of soil water. Adv. in Agron. 7:61-92. 1954.

15. Kiesselbach, T. A. Progressive development and seasonal variations of the corn crop. Nebraska Agr. Exp. Sta. Res. Bul. 166. 1950.

16. Krantz, B. A. and Chandler, W. V. Lodging, leaf composition, and yield of corn as influenced by heavy applications of nitrogen and potash. Agron. Jour. 43:547-552. 1951.

17. _____. Fertilize corn for higher yields. N. C. Agr. Exp. Sta. Bul. 366. 1954.

18. Long, O. H. Nitrogen and spacing experiments with corn. Tennessee Agr. Exp. Sta. Bul. 232. 1953.

19. MacGregor, John M. Soil moisture and balanced fertility factors in corn production. Minnesota Farm and Home Sci. 13:7-8; 20. 1956.

20. Montgomery, E. G., Kiesselbach, T. A. Studies in water requirements of corn. Nebraska Agr. Exp. Sta. Bul. 128. 1912.

21. Muhr, G. R. and Rost, C. O. The effect of population and fertility on yields of sweet corn and field corn. Agron. Jour. 43:315-319. 1951.

22. Nelson, C. E. Lodging of field corn as affected by cultivation, plant population, nitrogen fertilizer and irrigation treatment. Prod. Res. Ser. Report. USDA. No. 16. 1958.

23. Odell, R. T. The effects of physical properties of soils on productivity. J. Am. Soc. Farm Managers and Rural Appraisers, 12:42-47. 1948.

24. _____. How productive are the soils of central Illinois? Univ. of Ill., Urbana. Agr. Exp. Sta. Bul. 522. 1957.

25. _____, and Smith, Guy D. A study of crop yield records by soil types. Soil Sci. Soc. Amer. Proc., 5:316-322. 1940.

26. Osgood, O. T. Order in yields from fertilizer and spacing in corn production. Miss. Agr. Exp. Sta. Bul. 216. 1954.

27. Pesek, J. T. Evaluation of residual nitrogen in soils. Agron. Jour. 50(5): 255-259. 1958.

28. _____, and Dumenil, L. How much fertilizer carry over? What's New in Crops and Soils. 7(8):24-25. June/July. 1955.

29. Smith, G. D. and Smith, R. S. A study of crop yield records by soil types and soil ratings. Soil Sci. Soc. Amer. Proc. 4:375-378. 1939.

30. Smith, G. E. Fertility and corn production. Missouri Agr. Exp. Sta. Bul. 583. 1952.

31. Snedecor, George W. Statistical Methods. 5th ed. Ames, Iowa. Iowa State College Press. 1956.

32. Weaver, John E. Root Development of Field Crops. McGraw Hill Book Company, Inc., New York.

33. Wiersum, L. K. The relationship of the size and structural rigidity of pores to their penetration by roots. Plant and Soil IX, No. 1: 75-85. 1958.

34. Winters, E. and Simonson, R. W. The subsoil. Adv. in Agron. Vol. III. 1951.

APPENDICES

APPENDIX A

DESCRIPTION OF HUNTINGTON SILT LOAM

Huntington silt loam (0 to 2 per cent slopes) (Hu).--This well-drained soil on bottom lands is deep and naturally fertile.

Soil profile:

A_p	0 to 12 inches, dark-brown (10YR 4/3) silt loam; weak fine, granular structure; very friable; slightly acid.
C_1	12 to 26 inches, dark-brown (10YR 4/3 to 3/3)fine silt loam; weak, fine, granular structure; friable; slightly acid to medium acid.
C_2	26 to 40 inches, dark-brown (10YR 3/3 to dark yellowish-brown (10YR 3/4) silt loam; weak, fine, granular structure; friable; slightly acid.

Huntington silt loam is slightly acid to medium acid throughout the profile. It is high in natural fertility and in organic matter. The soil is easy to work and to keep in good tilth. The deep, permeable root zone is well aerated and supplies a large amount of water to plants throughout the year.

APPENDIX B

DESCRIPTION OF WAYNESBORO SILT LOAM

Waynesboro silt loam, 2 to 5 per cent slopes (WaB).--This well-drained soil is on gently sloping parts of stream terraces.

Soil profile:

A_p 0 to 8 inches, brown (10YR 4/3) to dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; very friable; strongly acid.

B_1 8 to 13 inches, reddish-brown (5YR 4/4) fine silt loam; moderate, medium subangular blocky structure; friable; strongly acid.

B_{21} 13 to 21 inches, yellowish-red (5YR 4/8) silty clay loam or clay loam; weak, medium subangular blocky structure; friable; few 3 to 10 millimeter quartz pebbles; strongly acid.

B_{22} 21 to 27 inches, dark reddish-brown (2.5YR 3/4) to dark-red (2.5YR 3/6) silty clay loam or clay loam; moderate, fine, subangular blocky structure; friable; few 3 to 10 millimeter quartz pebbles; strongly acid.

B_{23} 27 to 37 inches, dark-red (10R 3/6) clay or silty clay; strong, fine, angular blocky structure; friable to firm; few 3 to 10 millimeter quartz pebbles.

C 37 to 50 inches +, dark-red (10R 3/6) clay or silty clay, mottled yellowish red and strong brown; strong, fine and medium, angular blocky structure; common quartz pebbles 3 to 10 millimeters in size.

APPENDIX C

DESCRIPTION OF DICKSON SILT LOAM

Dickson silt loam (2 to 5 per cent slopes) (Dk).--This is a moderately well drained to well drained soil that has a fragipan at a depth of about 2 feet.

Soil profile:

A_1 0 to 1 inch, dark grayish-brown (10YR 4/2) silt loam; weak, medium, granular structure; very friable; strongly acid.

A_2 1 to 6 inches, yellowish-brown (10YR 5/4) or pale-brown (10YR 6/3) silt loam; weak, fine, granular structure; very friable; very strongly acid.

B_1 6 to 10 inches, yellowish-brown (10YR 5/4 - 5/6) silt loam; weak, fine, subangular blocky structure; friable; very strongly acid.

B_2 10 to 23 inches, yellowish-brown, (10YR 5/6) coarse silty clay loam or silt loam; moderate, medium, subangular blocky structure; friable, very strongly acid.

B_3m 23 to 38 inches, brownish-yellow (10YR 6/6) silt loam; common medium, distinct mottles of light brownish gray (10YR 6/2) and light gray (10YR 7/2); massive (structureless); friable when moist, hard and brittle when dry; very strongly acid.

APPENDIX C (continued)

C 38 inches +, mottled yellowish-red, yellowish-brown, and gray silty clay loam; mottles are many, medium, and distinct; moderate, medium, angular blocky structure; firm; chert fragments.

APPENDIX D

FARM OWNERS, SITE NUMBER AND SOIL SERIES USED IN THE 1961 CORN STUDY IN PUTNAM COUNTY

Site Number	Farm Owner	Soil
1.	Jones and Chaffin	Dickson
2.	C. B. Palk	"
3.	E. L. Stone	"
4.	Jeff Burton	Waynesboro
5.	Harlan Mullins	"
6.	Ples Deering	"
7.	Vance Bartlett	Huntington
8.	Horace Henry	"
9.	Arnold Hunter	"

APPENDIX E

SOIL TEST VALUES (pH, AVAILABLE P AND EXCHANGEABLE K) ON DICKSON, WAYNESBORO AND HUNTINGTON SOILS IN PUTNAM COUNTY, 1961

Site Number	Sample Number*	pH	Available P lbs./A.	Exchangeable K lbs./A.
1	1	6.2	35.2+H	230H
	2	5.9	35.2+H	127L
	3	5.6	21.8M	109L
	4	6.1	35.2+H	226H
	5	6.0	19.9M	86L
2	1	5.8	35.2+H	214H
	2	5.9	35.2+H	166M
	3	6.0	35.2+H	214H
	4	6.1	35.2+H	184H
	5	6.0	17.8M	82VL
3	1	6.2	35.2+H	358H
	2	5.8	35.2+H	174M
	3	6.0	35.2+H	130L
	4	6.2	35.2+H	308H
	5	5.7	35.2+H	153M
4	1	6.3	35.2+H	339H
	2	6.2	35.2+H	335H
	3	7.2	35.2+H	308H
	4	6.8	35.2+H	317H
	5	6.4	35.2+H	230H

APPENDIX E (Continued)

Site Number	Sample Number*	pH	Available P lbs./A.	Exchangeable K lbs./A.
5	1	6.2	25.3H	313H
	2	6.3	30.4M	238H
	3	5.5	17.8M	203H
	4	6.0	23.1M	270H
	5	6.5	26.1H	150M
6	1	6.4	35.2+H	400+H
	2	6.4	35.2+H	380+H
	3	6.4	35.2+H	400+H
	4	6.0	35.2+H	400+H
	5	6.5	35.2+H	230H
7	1	5.9	35.2+H	274H
	2	6.2	35.2+H	313H
	3	6.3	35.2+H	255H
	4	5.6	35.2+H	286H
	5	6.6	25.3H	218H
8	1	6.4	19.9M	177M
	2	5.9	15.8L	196H
	3	5.6	25.3H	169M
	4	6.2	35.2+H	214H
	5	6.0	15.0L	138M
9	1	5.8	35.2+H	226H
	2	6.1	35.2+H	203H

APPENDIX E (Continued)

Site Number	Sample Number*	pH	Available P lbs./A.	Exchangeable K lbs./A.
	3	5.9	35.2H	226H
	4	5.8	35.2+H	226H
	5	6.2	17.8M	153M

* Refers to area from which sample was taken. Sample numbers 1, 2, 3 and 4 refer to the area used for the residual study and the number corresponds to the treatment number. Sample number 5 refers to the area used in the nitrogen-population study.

APPENDIX F

AN EXAMPLE OF THE CALCULATION OF THE YIELD IN BUSHELS PER ACRE FROM A HARVEST SAMPLE

1. Calculation of acre factor for a harvest area consisting of two rows, 25 feet in length and 3 feet apart.

$$\frac{43,560\ ft^2/A}{(2 \times 25\ ft. \times 3\ ft.)} = 290.4$$

2. Acre factor $= \frac{290.4}{70\ lbs./bu.} = 4.1485$

3. Total field weight of the harvest sample = 33 pounds.

4. Weight of harvest sample converted to bushels per acre

   4.1485 X 33 = 136.901 bu./A.

5. Moisture by Steinlite moisture meter = 20.33 per cent
   Moisture factor to convert to 15.5 per cent moisture = .943.

6. To adjust yield in bushels per acre at 20.33 per cent to 15.5 per cent moisture, the following calculation was made:

   136.901 x .943 = 129.10 bushels per acre.

APPENDIX G

INCHES OF RAINFALL AT THE DIFFERENT SITES FROM MAY 8 THROUGH AUGUST 31, 1961, IN PUTNAM COUNTY

Site Number	Months				Total
	May	June	July	August	
1	3.1	6.8	3.5	4.4	17.8
2	3.1	6.8	3.5	4.4	17.8
3	2.9	6.1	4.6	4.5	18.1
4	3.3	6.7	2.7	4.5	17.2
5	3.0	6.5	2.8	4.5	16.8
6	3.0	6.3	2.6	5.2	17.1
7	2.8	6.1	2.9	4.5	16.3
8	3.2	6.3	2.7	4.3	16.5
9	3.0	5.0	2.8	4.6	15.4

APPENDIX H

ROOTING DEPTH AT SELECTED LEVELS OF N, P AND K ON DICKSON, WAYNESBORO AND HUNTINGTON SOILS IN PUTNAM COUNTY, 1961

Treatments (lbs./A.)	Rooting Depths (Inches)					
	Dickson		Waynesboro		Huntington	
	95%	All	95%	All	95%	All
1. 1960: N=220, P=96 and K=183 1961: N=0, P=0 and K=0	20	23	22	30	30	36
2. 1960: N=420, P=183 and K=349 1961: N=0, P=0 and K=0	22	26	24	36	33	40
3. 1960: N=18, P=16 and K=30 1961: N=0, P=0 and K=0	20	23	23	31	28	32
4. 1960: N=220, P=96 and K=183 1961: N=100, P=87 and K=166	22	24	28	34	30	36
5. 1960: N=18, P=16 and K=30 1961: N=120, P=96 and K=183	12	20	19	29	22	30

APPENDIX I

EARS PER PLANT AT A POPULATION OF EIGHT, TWELVE, SIXTEEN, TWENTY AND TWENTY-FOUR THOUSAND PLANTS PER ACRE USING 120, 220 AND 320 POUNDS OF NITROGEN PER ACRE FOR DICKSON, WAYNESBORO AND HUNTINGTON SOILS

Plants Per Acre	Nitrogen lbs./A.	Means of four replications and three sites		
		Dickson	Waynesboro	Huntington
8,000	120	1.43	1.83	____
12,000	"	1.23	1.39	1.46
16,000	"	1.09	1.16	1.23
20,000	"	____	1.03	1.00
24,000	"	____	____	.92
8,000	220	1.63	1.92	____
12,000	"	1.30	1.46	1.43
16,000	"	1.21	1.23	1.13
20,000	"	____	1.13	.93
24,000	"	____	____	.89
8,000	320	____	____	____
12,000	"	____	____	1.31
16,000	"	____	____	1.10
20,000	"	____	____	.93
24,000	"	____	____	.83

APPENDIX J

PER CENT BARREN PLANTS AT A POPULATION OF EIGHT, TWELVE, SIXTEEN, TWENTY AND TWENTY-FOUR THOUSAND PLANTS PER ACRE USING 120, 220 AND 320 POUNDS OF NITROGEN PER ACRE FOR DICKSON, WAYNESBORO AND HUNTINGTON SOILS

Plants Per Acre	Nitrogen lbs./A.	Means of four replications and three sites		
		Dickson	Waynesboro	Huntington
8,000	120	1.70	.29	____
12,000	"	1.57	0	0
16,000	"	3.91	0	.48
20,000	"	____	2.86	5.58
24,000	"	____	____	10.10
8,000	220	1.37	0	____
12,000	"	.69	0	0
16,000	"	1.53	1.10	2.55
20,000	"	____	0	3.83
24,000	"	____	____	11.60
8,000	320	____	____	____
12,000	"	____	____	.40
16,000	"	____	____	4.63
20,000	"	____	____	10.90
24,000	"	____	____	17.01

APPENDIX K

PER CENT LODGED PLANTS AT A POPULATION OF EIGHT, TWELVE, SIXTEEN, TWENTY AND TWENTY-FOUR THOUSAND PLANTS PER ACRE USING 120, 220 AND 320 POUNDS OF NITROGEN PER ACRE FOR DICKSON, WAYNESBORO AND HUNTINGTON SOILS

Plants Per Acre	Nitrogen lbs./A.	Means of four replications and three sites		
		Dickson	Waynesboro	Huntington
8,000	120	8.97	8.69	____
12,000	"	8.59	9.01	8.18
16,000	"	10.84	9.10	11.08
20,000	"	____	16.00	11.69
24,000	"	____	____	9.69
8,000	220	9.63	7.48	____
12,000	"	8.30	12.61	9.27
16,000	"	12.07	11.83	11.91
20,000	"	____	11.74	12.56
24,000	"	____	____	13.13
8,000	320	____	____	____
12,000	"	____	____	9.39
16,000	"	____	____	12.07
20,000	"	____	____	12.79
24,000	"	____	____	12.38

APPENDIX L

CORN YIELDS OBTAINED AT THREE PLANT POPULATIONS AND FIVE 1960 FERTILIZER TREATMENTS WITH NO ADDITIONAL FERTILIZER IN 1961

Plants Per Acre	Treatment	Means of three replications and two sites		
		Dickson	Waynesboro	Huntington
		Yield (Bu./A.)		
8,000	1	56.9	98.6	57.2
12,000	1	47.1	106.2	65.7
16,000	1	49.4	104.9	60.9
8,000	2	38.4	96.8	69.8
12,000	2	39.5	102.9	62.3
16,000	2	27.2	110.1	71.7
8,000	3	38.4	97.4	74.9
12,000	3	36.5	103.3	78.7
16,000	3	39.0	105.0	77.1
8,000	4	50.1	103.7	76.6
12,000	4	57.0	98.2	73.9
16,000	4	40.9	97.6	70.5
8,000	5	25.2	78.9	65.2
12,000	5	21.0	75.1	67.0
16,000	5	20.8	82.2	54.3