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# The effect of population on whole-plant production of corn harvested for silage

Ichanda M. Uthappa

To the Graduate Council:

I am submitting herewith a thesis written by Ichanda M. Uthappa entitled "The effect of population on whole-plant production of corn harvested for silage." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

Henry A. Fribourg, Major Professor

We have read this thesis and recommend its acceptance:

Robert S. Dotson, O. G. Hall

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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

December 11, 1961

To the Graduate Council:

I am submitting herewith a thesis written by Ichanda M. Uthappa entitled "The Effect of Population on Whole-Plant Production of Corn Harvested for Silage." 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.

Henry H. Fribourg
Major Professor

We have read this thesis and recommend its acceptance:

Robert S. Dotson

O. Glen Hall

Accepted for the Council:

Hilton A. Smith
Dean of the Graduate School

# THE EFFECT OF POPULATION ON WHOLE-PLANT PRODUCTION OF CORN HARVESTED FOR SILAGE

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

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

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by
Ichanda M. Uthappa
March 1962

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# CHAPTER I

## INTRODUCTION

Corn (*Zea mays* L.) is one of the most important livestock feeds in the United States. This crop is of great interest since it produces more dry matter per acre than most other crops grown in temperate climates. It is one of the crops best suited for mechanised agriculture and thereby becomes a potentially promising choice to allocate to agricultural land of high productive potential. "All corn roughage" programs and "high moisture corn feeding" programs are becoming increasingly popular. Consequently, any research finding which can increase knowledge about corn production should be of considerable importance to the livestock industry.

The hybridization of corn has produced hundreds of hybrids of different growth, production and plant characteristics. A choice has to be made from among these many varieties to suit the individual farming conditions for producing optimum yields from an economic point of view. The full-season varieties may produce higher yields than the mid-season ones; but those maturing in a shorter season may allow the planting of winter crops in the fall. Such considerations make it necessary to know the actual dry matter yields of different hybrids grown for harvest at the silage stage of growth. On these points, adequate information applicable to Tennessee conditions is lacking.

Much work has been done on the suitability of different plant populations for corn grain production. When corn is grown for silage, however, both the total dry matter production and the grain production must receive due consideration. Plant population becomes a factor of particular importance when considered in conjunction with other factors such as varying levels of soil fertility and moisture supply. The same rate of plant population may not be applicable to every location, and may have to vary from year to year in order that maximum economic benefit may accrue the grower. Much of the information available on this subject is extrapolated from conclusions drawn from corn grain production experiments. While some workers (15, 73, 75) have concluded that a population of about 24,000 to 35,000 plants per acre was suitable for silage production, some others (53, 65) have felt that high populations of up to 200,000 or 300,000 plants per acre were more suitable or promising ones for forage production. Thus, at the time of the study research verified informations are not available to serve as a basis for making management recommendations to farmers producing corn for silage.

When corn is to be used for silage, the content of grain, which is an important source of carbohydrates, and that of leaves, which is the major source of protein in the total yield, are of primary importance. Furthermore, the plant population can possibly influence the proportion of grain, leaves and stems in the plant. If any of these were appreciably affected, the quality of corn silage also could be affected. Thus, the choice of the variety and of the plant population, as affecting the quality and quantity of corn plant yields, are additional questions that need to be answered.

The three experiments reported here were designed to determine the effects of population on the growth and productivity of two corn hybrids harvested at the silage stage of growth. One of the varieties was a full-season hybrid (Dixie 33) and the other a mid-season hybrid (Tennessee 501). The components of production of the whole above-ground parts of the plants were determined separately in an effort to investigate the effects of population, genotype and environment on the potential quality for silage of these hybrids.

# CHAPTER II

# REVIEW OF LITERATURE

## A. CORN PLANT POPULATION AND GRAIN YIELD

### Effect of Different Row Spacings and Plant Populations

Schaller and Larson (67) studied the effects of two row-spacings, 40 inches and 80 inches, on corn yield. The study was conducted for three years successively at several locations in Iowa. The plant populations were varied from 11,000 to 16,000 corn plants per acre. On the average, only 75% of the acre yield produced by the 40-inch row-spacing was produced by the 80-inch row-spacing. Similarly, Mederski and Hoff (52) in Ohio used 20,000 plants per acre in 1958 in two different spacings: (1) 42 inches between the rows when the plants in the rows were 7 to 8 inches apart and (2) an equidistant spacing where the plants were, on the average, 17.75 inches apart. The latter method yielded 6 to 10 bushels more of corn per acre than did the 42-inch row-spacing.

The experiments of Bryan et al. (11) involved a study of two different spacings (42 and 21 inches) between rows and four different spacings (10.5 inches to 42 inches) between plants in each row. These spacings were studied for seven double crosses and four open-pollinated varieties during four successive years. The results showed that none of these spacings was consistently superior to 42-inch x 42-inch spacing, for grain yield. The closer spacings had consistently more lodging than the wider spacing.

### Effect of Different Populations on Uniform Row Spacing

In Georgia, Boswell et al. (10) studied the effects of different levels of irrigation, nitrogen fertilization, and plant populations

(10,000, 15,000 and 20,000 plants per acre) on corn yield. Population did not affect the grain production significantly; the number of ears increased with the plant population, regardless of level of irrigation. Parks and Overton (64) in Tennessee studied three populations (8,000, 10,000 and 12,000 plants per acre) for four years with Dixie 29, a prolific hybrid. In two of the four years the yields increased significantly with increases in plant population; but the average yields for the four years were not significantly different between the populations.

Lana (44) in Iowa, conducted a study for three years on sweet corn grain production, using three hybrid varieties and five different plant populations (7,841, 11,762, 15,683, 19,603 and 20,524 plants per acre). The maximum yield was obtained with 19,603 plants per acre. The number and weight of the ears increased with increases in plant population.

In New York State, Vittum et al. (77) studied for five years the effects of irrigation, fertilization, and plant populations varying from 10,000 to 17,700 per acre, on sweet corn. Increase in plant population resulted in an increase in total sweet corn yield and in a decrease in total marketable ears.

In experiments with corn population in Nebraska, Murphrey and Dreier (54) found that the corn grain yield increased from 134 bushels per acre to 148 bushels per acre when the plant population was increased from 14,500 to 24,200 in 1955. In 1956, however, the yield did not increase with populations of more than 19,500 plants per acre.

Hoff and Mederski (31) increased corn plant populations from 8,000 to 16,000 by equidistant spacing, as well as by increasing the number of plants in the rows. In either case, the grain yield rose sharply from 90 bushels to 140 bushels with increase in population. The increase obtained in equidistant spacing was greater than the increase obtained from plants in rows. An increase of 4,000 more plants increased the yield by 20 bushels. Increase in plant population decreased the ear weight and increased the percent nubbins.

In Tennessee, Long (48) studied the effect of plant population and nitrogen on corn grain production. The study was conducted at several locations in 1945 with seven varieties and at populations of 5,400, 6,600 and 7,800 plants per acre; and with two hybrids and 8,000, 12,000 and 16,000 plants per acre from 1949 to 1951. Under Long's experimental conditions a plant population not exceeding 12,000 plants per acre was found to be the best for grain yield; and 100 plants for every bushel of yield expected was found to be a fairly practical rule-of-thumb for determining desired plant population.

Discussing the plant population for corn grain production in Minnesota, Caldwell (15) indicated that the ideal stand should vary from 12,000 plants per acre on sandy and drouthy soils to 20,000 plants per acre on heavy soils with good water-holding capacity. For the same reasons, Termunde et al. (73) recommended a range of 8,000 to 24,000 plants per acre for South Dakota, Iowa, Ohio, North Carolina, Mississippi and the Western States. Stringfield (71) stressed the point that an ideal stand is one that gives maximum yield and minimum stalk breakage. He also indicated that the late-maturing varieties produced maximum grain yield at a plant population of 14,000 plants per acre, the medium-maturing ones produced maximum grain yield when the plant population was slightly more than 14,000 plants per acre and the early maturing ones approached maximum yields at plant populations exceeding

20,000 plants per acre. Jordan et al. (35) recommended lower stands for southern hybrids than for Corn Belt varieties since most of the former are prolific. Termunde et al. (73) found, from studies conducted in South Dakota, that the maximum grain yield was obtained at the population where the forage yield was also maximum and that it decreased with further increases in population until the yield was zero at 24,000 to 32,000 plants per acre. Under irrigation the best population for grain was 20,000 to 24,000 plants per acre. Ear size decreased as the population increased.

Lang (45) recommended 4,000 plants per acre for every 25 bushels of yield expected if a top yield is anticipated in Illinois. According to him this rate has been shown to be in the least risk zone of greatest potential; i.e., at this rate there is minimum risk on drouth, barrenness, and damage due to lodging, while highest yield can be expected under favorable conditions.

## B. PLANT POPULATION AND TOTAL DRY MATTER PRODUCTION

King (38) in Michigan, with a stand of 19,280 and 20,520 plants per acre, obtained dry matter yields of 14.0 and 14.7 tons, respectively. These plant populations, however, appear to be too close to each other to give any significant difference in yield.

In an experiment conducted in Georgia (26) corn plants were grown 6, 12 and 18 inches apart, in rows 3.5-feet apart (6,223 to 18,669 plants per acre). The dry matter yields produced by these populations were not significantly different. The 18-inch spacing was preferable to the others since there was the advantage of better grain quality.

Carlson (16) studied the effects of nitrogen fertilization (0, 60 and 120 pounds per acre), different levels of irrigation, and different plant densities (14,000 and 23,000 plants per acre in 1956, and 10,000 and 20,000 plants per acre in 1957) on total dry matter production in corn. On non-irrigated plots the total dry matter yield was not affected by plant population. Under irrigation, the yield increased significantly with increase in plant population at all levels of nitrogen in 1957, and at 60 and 120 pounds per acre in 1956. Higher plant population under irrigation also increased the grain yield per square foot. Similarly, in Mississippi, Jordan et al. (35) investigated the effects of 60 and 120 pounds per acre of nitrogen as compared to no nitrogen, and of 4,000 and 12,000 plants per acre, repeating the experiment on the same site for 10 years. At 4,000 plants per acre,increasing the nitrogen fertilizer rate did not increase yield of total dry matter. When the plant population was increased to 12,000 plants per acre, the yield increased by one bushel for every 1.8 pounds of nitrogen used. Similarly the dry weight of the stover residues also increased with increase of plant population at each level of nitrogen. In the eleventh year the experiment was repeated with no nitrogen fertilization. The results showed no evidence of cummulative depletion of soil fertility by any of the previous treatments.

Parks et al. (64) in Tennessee used Dixie 29, a prolific hybrid corn, in their plant population experiments. They obtained yields of 14.2, 16.7 and 17.8 tons of 67% moisture-corrected silage at populations of 8,000, 10,000 and 12,000 plants per acre, respectively. The experiments were conducted in 1955 and 1957, years when the moisture supplies were adequate. Fribourg[1],

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1/ Fribourg, H. A. Department of Agronomy, University of Tennessee. Effect of high population on corn silage production. Personal communication of data, 1960.

working with corn in Tennessee, studied the effects of populations of 16,100, 28,000, 36,000 and 67,200 plants per acre planted in rows 36, 21, 14 and 7 inches apart, respectively. The total dry matter yields were 5.44, 5.92, 6.10 and 7.92 tons, respectively. The number of ears per acre and percent nubbins increased and the total grain yields and percent grain in total dry matter yields decreased as the plant population increased.

Reid (65) in Illinois, broadcasted 3.5 to 4.0 bushels of seed corn per acre on June 8, a rate which is about 20 times the normal seed rate. This gave a stand of about 300,000 plants per acre. Cuttings were made on July 16, July 24, and August 5. The green yields obtained were 16.2, 29.8 and 30.3 tons, respectively. After this last harvest, the crop lodged severely due to storms and no further cutting was made. Stray cases of nitrogen deficiency were noted in the stand as the end of the experimental period.

Also at Illinois, Mishra and Pendleton (53) compared the dry matter yields of "high population" corn (both one-crop and two-crop systems) with that of normally-grown corn in 40-inch rows. In the first week of April the seeds were planted in 40-inch rows and a "high population" stand of approximately 200,000 plants per acre was drilled in. In the two-crop high population treatment, the first crop was cut in the second week of July and the second crop seeded immediately thereafter. The two-crop high population treatment "outyielded" the other two cropping systems, in dry matter. The one-crop high population outyielded the regular 40-inch row cropping at two out of three locations. Among the three treatments, the protein and moisture contents were highest in the two-crop high population corn and lowest in the regular 40-inch row corn.

At Oxford, Bunting and Willey (13) studied the effects of plant population on maturity, chemical composition and total dry matter production for several varieties of corn. The row-spacing was 24 to 27 inches and the plant density varied from 19,000 to 77,000 plants per acre. Plant density had little effect on time of maturity, plant height or chemical composition. Dry matter yields varied directly, and the percent contribution of the ears to the total dry matter yields varied inversely, with the plant population.

In Sweden, Larsson (46) studied the effect of population on corn plant production. He found that the dry matter yields increased when the seed rate was increased from 70 to 100 and 125 kg/ha. For maximum production, an early yielding variety needed rows 25 cms apart, while the two late varieties needed at least 45 cms between rows.

In West Germany, Jungehülsing (36) did similar studies with corn and concluded that a plant population of about 14,000 to 18,000 plants per acre was preferable for producing high silage yield with optimum grain percentage. Late dough stage was recommended for harvesting.

Lacroix (43) conducted similar experiments in Belgium and found that the green weight increased directly with plant populations of 16,200, 24,300 and 32,400 plants per acre and inversely with distances — 50, 75 and 100 cms., between rows. A plant population of 70,000 plants per hectare (29,100/A) gave the best results for corn. The crop was harvested at the milk stage. The percent dry matter of the plant was little affected by plant population. The percent contributed by the grain to total dry matter decreased when the plant population increased.

Gutknecht and Gysel (29) in Germany studied for three years the effects of plant population on two German corn varieties and five Corn Belt hybrids. The distance between rows was constant at 67 cms. The plant populations were 12,300, 24,300 and 36,800 plants per acre. The climatic conditions in the three different years were markedly different. In this experiment higher plant populations gave higher total dry matter yields; but the percent grain in the dry matter was less.

Discussing the ideal corn stands, Viets (75) recommended 18,000 to 20,000 plants per acre for grain production and 30,000 to 35,000 plants per acre for silage production, According to him higher plant rates reduce the ear size and increase the chances of lodging by wind. Caldwell (15) in Minnesota stated that about the same plant population could be used for grain and silage because in the latter case up to 70% of the feeding value was in the ears. Termunde *et al.* (73) discussing a recent study conducted in South Dakota, stated that the forage yield increased with the increase in plant population until a maximum was reached and thereafter it remained constant or decreased. The maximum yield depended upon the season and location. Under irrigation the best group of population was found to be between 24,000 to 32,000 plants per acre.

## Effect of Row Spacing on Forage Yield

Stickler and Laude (69) used two populations of corn, 15,680 and 10,450 plants per acre, in rows 40 and 20 inches wide. Grain sorghum was planted in rows 10, 16, 20 and 40 inches apart with populations of 78,400 per acre and 52,300 plants per acre. Forage sorghum was planted in rows 20 inches and 40 inches apart with populations of 25,000 and 50,000 plants per acre. They found that the treatment had no effect on grain or stover yields in corn. Grain sorghum gave significantly higher dry matter at 78,000 plants per acre than at 52,000 plants per acre. In this crop significant interaction between row spacing and plant population was encountered.

In spacing trials conducted in the "Belgian Congo" (34) with corn, the best spacing arrangement from the view of mechanized harvesting, was reported to be twin rows 30 cms. apart with 75 cms. space between each pair of rows.

Mederski (52) grew 20,000 plants per acre (a) 7 to 8 inches apart in 42-inch rows and also (b) in equidistant spacings of 17.75 inches. In the latter method of planting, the total dry matter yield per acre and number of ears were larger than with the former method.

In Texas, Bockholt (8) planted four Texas corn hybrids in rows 12, 18 and 24 inches apart, for three years and found that the 12-inch row-spacing produced more silage than either the 18-inch or the 24-inch row-spacing. The 12-inch and 18-inch spacings gave higher grain yields than 24-inch rows. The average silage yield was 9.0 tons per acre.

## C. EFFECT OF CORN VARIETIES ON DRY MATTER PRODUCTION

Choosing a variety of corn for forage production is one of the most important steps since it can influence various factors affecting production such as plant maturity at harvest, time of harvest, total dry matter yield, the percent grain in total dry matter leaf/stem ratio, cost and rate of drying, resistance to diseases and lodging and level of fertilization needed for optimum production.

Many workers (29, 36, 56, 57, 76) have recommended hybrids in preference to open-pollinated varieties for forage production, for many reasons. Hybrids generally produce higher yields than open-pollinated varieties; they are more resistant to disease, lodging and drouth. Several workers (1, 58, 59, 65, 75) have preferred tall, late-maturing hybrids over others because these plants yielded more dry matter per acre than medium and short season hybrids. The harvest time of these hybrids fell well within the growing season, since silage corn is harvested before the ears are well dried. For localities where the growing season is short, early maturing varieties have been recommended (14, 36). For use as hay, rapidly ripening corn has been found to be useful (25), although its use for such purpose is open to question due to the curing problems that could be encountered.

In Australia, corn varieties with high grain yielding capacity "have been found to be the best silage crop" (3). The yield expected was 12 to 15 tons per acre under favorable conditions.

## D. EFFECT OF PLANT POPULATION AND VARIETY ON LODGING

Some of the studies on the effect of population on lodging have been mentioned above. Plant population appears to be an important factor in lodging of corn. Other important factors affecting lodging, according to several workers are, the variety, irrigation and fertilization. Most of the workers who studied corn plant population in relation to lodging have observed a direct relationship between the two.

Experimenting with plant populations of 14,000 to 24,000 corn plants per acre, Murphrey and Dreier (54) found higher percentages of lodged and broken plants in thicker stands. Their explanation was that thicker stands produced taller plants with smaller stem diameters and that the plants were more susceptible to lodging and stem breakage. Nelson (56) found a high incidence of stem breakage (60% in some cases) on irrigated soils in Washington. He compared the stem breakage in corn plots irrigated up to August 30 with those of the plots irrigated up to October 30. The stem breakage in the former was more than in the latter. He found rate of nitrogen fertilization and plant population also as important factors. These caused taller plant growth and heavier ears on stalks. While nitrogen increased the diameter of the stalks and helped to overcome the breakage to some extent, the heavy ears produced by it more than offset the strength of the thicker stalks. He found that stalk breakage increased until the grain yield was maximum.

Bryan et al. (11) experimented for four years with several corn hybrids and open-pollinated varieties at eight different spacing arrangements with populations ranging from 10,160 to 20,320 plants per acre; they consistently found higher percentages of lodging at higher plant populations. Discussing ideal corn stands, Viets (75) and Stringfield et al. (71) favored a stand varying from 8,000 to 24,000 plants per acre for grain production under varying soil conditions and irrigation levels and stated that higher plant populations increased chances of lodging.

Stringfield found practically no increase in lodging when corn populations were between 8,000 and 12,000 plants per acre; but when population was increased from 12,000 to 20,000 there was an increase of 20% to 38% in lodging.

In Texas, Bockholt (8) planted four corn hybrids at 12, 18 and 24 inches of distance between plants in rows which were 40 inches wide and found 48.9%, 37.8% and 35.0% lodging, respectively.

Varying the corn plant population from 19,360 to 77,440, Bunting and Willey (14) found that lodging occured at the higher populations. Early hybrids were less susceptible to lodging than others. Reid (65) in Illinois obtained a population of about 300,000 plants per acre in which the plants grew up to the tasseling stage in 50 days and gave a green weight of 30.3 tons per acre; but at this stage the crop lodged completely and no further harvest was possible.

Long (48) in Tennessee studied the lodging percentages at 60, 90 and 120 pound levels of nitrogen fertilization and at six different plant populations varying from 5,400 to 16,000. In this study, increase in both factors increased lodging, but plant population was the more important factor. Lodging was more severe with Dixie 17, a full-season prolific hybrid, than with Kentucky 103, an early-maturing hybrid. These findings are in agreement with those of Bunting and Willey (14).

Krantz and Chandler (42) found that while increase in plant population and nitrogen increased lodging, 80 pounds of $K_2O$ per acre decreased lodging of corn on soils low in K. Very heavy applications of K had little influence on lodging.

In conclusion, it is fairly evident from the literature that most research to date has been concerned with corn plant populations at relatively low ranges—between 4,000 and 35,000 plants per acre. Many of these experiments were done primarily for investigating the relationship between plant population and grain yield. As various environmental factors, such as soil fertility level and moisture supply varied, the grain yield generally increased with increases in plant population up to about 19,000 plants per acre; after this limit, the grain yield usually decreased gradually.

On the other hand, plant population did not have such a limiting effect on yield when corn was grown for forage production. Limited experiments conducted in Iowa (53), Illinois (65), Great Britain (13) and Tennessee indicate that even at populations exceeding 50,000 plants per acre increases in plant population have resulted in additional increases in forage yield.

Among the small number of corn varieties used for plant population experiments, the full-season hybrids have produced more grain and forage; but these have been generally more susceptible to lodging than hybrids requiring a shorter season to reach maturity.

Thus, it is apparent that there is little information available currently on which to base management decisions as regards the effects of population and variety on the whole-plant production of corn when harvested at the best stage of growth for ensiling.

# CHAPTER III

## MATERIALS AND METHODS

### Location and Soils

The study was conducted during the 1961 growing period at three locations in Tennessee: at the Main Experiment Station, Koella Farm, Blount County, at the Middle Tennessee Experiment Station (M. T. E. S.), Spring Hill, and at the Highland Rim Experiment Station (H. R. E. S.), Springfield[1]. The experiments were grown on Huntington and Sequatchie silt loams at the Koella Farm, on Maury silt loam at Spring Hill and on Huntington silt loam at Springfield.

### Climate

The total precipitation during the fall and winter preceding the experimental period was 23.02, 26.21 and 22.74 inches respectively at the Koella Farm, the M. T. E. S. and the H. R. E. S. The daily precipitations during the experimental period are presented in Appendix A. Except at the M. T. E. S. during June, the precipitation was well distributed over the growing period at all stations.

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1/ Since the names of the Experiment Stations are rather lengthy and since these Experiment Stations have to be frequently referred to, the abbreviations "Koella Farm" for the Main Experiment Station, "M. T. E. S." for the Middle Tennessee Experiment Station and "H. R. E. S." for the Highland Rim Experiment Station will be used in this report.

Treatments

Two varieties of corn were studied: (a) Dixie 33, a full-season, tall-growing, white, prolific hybrid with grains of fair to medium quality; and (b) Tennessee 501, a medium-season, white, semi-prolific hybrid (28). Each variety was grown at different populations ranging from 12,000 to 72,000 plants per acre (PPA)[2]. At the Koella Farm additional populations of 8,000, 48,000 and 100,000 PPA were included also. The populations of 8,000 to 36,000 PPA were planted in rows three feet apart. The 36,000 plant population was planted also in 1-foot rows. All populations with 48,000 or more PPA were planted in 1-foot rows. A detailed list of all plant populations studied is presented in table 1.

Each experimental unit consisted of a plot 30 feet x 12 feet. The rows in the plots were 30 feet long and either 3 feet or 1 foot apart. Thus, each plot contained either 4 or 12 rows, out of which the center 2 or 6 rows were used as harvest rows, the remaining ones being considered guard rows.

The experimental design chosen for the study was a split-plot factorial design with the varieties as main plots and the populations as split-plots. The main treatments were replicated four times at all stations.

Field preparation, fertilizer applications and chemical weed control spraying were done with farm machinery. The planting, thinning and harvesting operations were done by hand.

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2/ Since the term "Plants per acre" has to be used frequently in this thesis, the abbreviation "PPA" will be used to denote this term.

Table 1. -- Row width, rows per plot and space between plants at different desired plant populations for each of the corn varieties studied.

| Thousand plants per acre | Row width in inches | Rows per plot | Space between plants inches |
|---|---|---|---|
| 8 | 36 | 4 | 21.2 |
| 12 | 36 | 4 | 14.5 |
| 16 | 36 | 4 | 10.9 |
| 20 | 36 | 4 | 8.7 |
| 24 | 36 | 4 | 7.3 |
| 36 | 36 | 4 | 4.8 |
| 36 | 12 | 12 | 14.5 |
| 48 | 12 | 12 | 7.3 |
| 72 | 12 | 12 | 10.9 |
| 100 | 12 | 12 | 5.1 |

## Field Preparation and Fertilizer Applications

The fertilization rates and carriers used, and the methods and dates of application at each of the stations are presented in table 2. In accordance with the policy newly adopted by the American Society of Agronomy, the amounts of phosphorus and potash used were calculated in terms of P and K, and not as $P_2O_5$ and $K_2O$. The fertilizers used prior to planting were broadcast and worked into the soil with a heavy disc harrow.

## Planting

The 1-foot rows and 3-foot rows were marked on the plots which were allotted for each treatment. The location of seeds to be planted were marked in each row by using appropriately marked tapes, and seeds were planted with hand-operated corn planters. Planting was done at a rate double that of the final desired stand. The dates of planting at each of the stations are presented in table 3 along with those of thinning and harvesting.

## Weed Control and Thinning

Pre-emergence weedicides were used for weed control: Simazine at the Koella Farm and Atrazine at the other two experiment stations. They were sprayed at the rate of 2 lbs. per acre of active ingredient on the day following planting.

Thinning was done about five weeks from the date of planting, at which time the corn plants were approximately 12 to 15 inches tall.

## Harvesting

At the Koella Farm, the plants had grown to full size by the second week of July; Dixie 33 was at the mid-tassel stage and

Table 2.--Fertilization of corn varieties.-kind, rate and carriers of fertilizers used, and methods and dates of application of fertilizers for two varieties of corn grown for silage at three locations, 1961.

| Station | Fertilizer used | | Carrier | Application | |
|---|---|---|---|---|---|
| | Kind* | Lbs./A | used | Method | Date |
| Koella Farm | N | 100 | Ammonium nitrate | Side-dressed | June 21 |
| | P | 19.2 | 0-20-20 | Broadcast | April |
| | K | 35.58 | 0-20-20 | Broadcast | 21 |
| M.T.E.S. | N | 133.3 | Ammonium nitrate | Broadcast | Before plant- |
| | P | - | - | - | ing |
| | K | 62.23 | Muriate of Potash | Broadcast | Before planting |
| H.R.E.S. | N | 133.3 | Ammonium nitrate | Broadcast | April 28 |
| | N | 67.5 | 15-15-15 | Broadcast | April |
| | P | 29.47 | 15-15-15 | Broadcast | 28 |
| | K | 56.00 | 15-15-15 | Broadcast | " |

* 1 lb. of P = 2.03 lbs. of $P_2O_5$

1 lb. of K = 1.27 lbs. of $K_2O$

Table 3.--Dates of planting, thinning and harvesting of two varieties of corn grown for silage at three locations

| Station | Variety | Sowing | Thinning | Harvesting |
|---|---|---|---|---|
| M.E.S. | Dixie 33 | April 24, 25 | May 29 | July 13, 14, |
| | Tenn. 501 | April 24, 25 | May 29 | 17, 18, 21, 24 |
| M.T.E.S. | Dixie 33 | May 5 | June 8, 9 | August 28 |
| | Tenn. 501 | May 5 | June 8, 9 | August 14, 15 |
| H.R.E.S. | Dixie 33 | April 28 | May 31 and June 1 | August 29, 30 |
| | Tenn. 501 | April 28 | May 31 and June 1 | August 16 |

Tennessee 501 was at late tassel. As a result of storms and rains the crop lodged severely. Lodging was first noticed on July 10 among plots of high population. Since lodging was observed in thinner populations subsequently, and since the weather continued to be adverse, the experiment was harvested completely, priority being given to plots showing a high degree of lodging. Due to adverse weather the harvest time extended from July 14 to 24.

At the M. T. E. S. and at the H. R. E. S., Tennessee 501 was in early dent stage and Dixie 33 was well dented at their respective times of harvest. At both locations, Tennessee 501 was cut on August 14, 15 and 16; Dixie 33 was cut two weeks later, on August 28, 29 and 30. In all cases, plants were cut by hand a few inches above ground level.

Data Collected

The average height of plants in each plot was measured before the plants were cut. If the plants had lodged, the height was measured after cutting. The number of dead and lodged plants, and the total number of plants in each plot were recorded before harvest.

The ears and nubbins were hand-picked and their number and weights recorded. Samples of about 10 lbs. of ears were collected for shelling percentage and moisture content measurements.

The stover was weighed for each row separately. The leaf blades and the stalks of 12 randomly selected plants in each plot were separated and weighed.

The stalk, leaf blade and ear samples were oven-dried at 70$^{o}$C, cooled and weighed. The ears were shelled and the weights of grain and cobs recorded. The moisture content of the dried grain was measured with a Steinlite Electric Moisture Tester.

## Presentation of Data

Data are presented in tabular and graphical forms, considering corn varieties and plant populations separately wherever possible. In the graphs, plant population is plotted on the abcissa and the characteristics under study on the ordinates.

The actual plant populations are rounded off to the nearest ten plants per acre. The number of lodged and dead plants are presented as percentages of the stand remaining at harvest. The nubbins produced are shown as a percentage of the sum of all ears produced, including nubbins; and the number of ears is presented both as ears per acre and average number of ears per plant.

The green and dry weight yields were calculated in tons per acre for stalks, leaves and ears and for the whole plant. The dry weights of ears are expressed also for grains and cobs separately. The shelling percentage was calculated. The contribution that stalks and leaves made to the whole stover weights was calculated as a percentage, for both green and dry weights. The contribution of grain to the total green and dry yields is also presented on a percentage basis. In the case of green weights, the green ear weight was used; but in the case of dry weights, the dry shelled-corn grain weight was utilized.

## Statistical Procedures

The design of the experiment was a split-plot factorial with varieties as main plots and plant populations as split-plots. The amount of data on hand made it necessary to use a high-speed computer. The statistical analysis of the data was done as for a randomized complete block design, taking into consideration the population treatments only. This procedure was resorted to since the IBM 1620 computer available was a newly acquired machine, and a program for analysis of variance of a split-plot factorial design was not available at this time. No statistical comparison between the varieties was made. Thus, statistical probability can be attached to the statements made with respect to the plant population variable, but not with regard to different populations of different varieties.

Analyses of variance were computed for a number of the data collected. When the values of treatment means showed obvious differences, such as in the case of number of dead plants, statistical comparison of the means was deemed to be unnecessary. In a few relevant cases, the means were compared by Duncan's multiple range method, and the results of this test are presented in the appropriate tables of means. In the discussion of results, the expressions, significant and high significant, will be made when referring to statements made at probabilities of .05 and .01, respectively.

CHAPTER IV

# RESULTS AND DISCUSSIONS

## A. EFFECT OF PLANT POPULATION ON CORN WHOLE-PLANT PRODUCTION

### Effect of Population on Plant Characteristics

The actual stand of plants obtained in comparison with the desired plant population, the number of dead plants, the indicence of lodging, the plant height, the number of ears produced and the percentage of nubbins, are presented for each plant population treatment in tables 4, 5 and 6. These factors with the exception of plant population and plant height, are also presented graphically for the data obtained at M.T.E.S. and H.R.E.S. in figures 1, 2, 3 and 4.

Plant population obtained. The actual stand obtained for these treatments with up to 16,000 PPA generally exceeded the desired stand. In the case of higher plant population treatments, the actual stands were less than the desired stands and this difference increased with increasing populations. Since stands were thinned to the exact desired population, it must be assumed that differences between the desired and the actual populations arose between the time of thinning and the time of harvest. Furthermore, since corn stalks appearing to be dead at harvest were recorded separately, discrepancies between desired and actual populations must have been due either to possible inacurracies in recording the stand or to early death of the small corn plants. This writer is confident that the latter possibility is the more likely. The cause of

Table 4.--Height and lodging percent of each of two varieties of corn grown for silage at different plant populations.- Koella Farm, M.E.S., 1961.

| Desired population plants per acre | Row width feet | Actual population plants per acre | Plant height feet | Lodging percent |
|---|---|---|---|---|
| | | Dixie 33 | | |
| 8,000 | 3 | 9,380 | 10.7 | 9.4 |
| 12,000 | 3 | 13,010 | 10.9 | 14.9 |
| 16,000 | 3 | 16,270 | 10.0 | 12.1 |
| 20,000 | 3 | 18,990 | 10.8 | 23.0 |
| 24,000 | 3 | 23,110 | 10.4 | 18.3 |
| 36,000 | 3 | 30,070 | 9.5 | 30.2 |
| 36,000 | 1 | 37,390 | 8.9 | 61.4 |
| 48,000 | 1 | 48,340 | 9.2 | 80.1 |
| 72,000 | 1 | 67,760 | 9.3 | 47.9 |
| 100,000 | 1 | 82,890 | 8.9 | 54.9 |
| s | | 2,094 | 0.804 | |
| $s_{\bar{x}}$ | | 1,047 | 0.402 | |
| C. V. | | 6 | 8.6 | |
| | | Tennessee 501 | | |
| 8,000 | 3 | 9,320 | 8.7 | 5.8 |
| 12,000 | 3 | 10,890 | 9.2 | 19.0 |
| 16,000 | 3 | 16,430 | 9.8 | 20.1 |
| 20,000 | 3 | 19,060 | 8.5 | 21.0 |
| 24,000 | 3 | 22,690 | 8.6 | 24.2 |
| 36,000 | 3 | 30,980 | 9.5 | 42.5 |
| 36,000 | 1 | 37,630 | 8.7 | 73.4 |
| 48,000 | 1 | 46,530 | 8.8 | 83.2 |
| 72,000 | 1 | 61,890 | 8.8 | 44.5 |
| 100,000 | 1 | 80,770 | 8.6 | 72.9 |
| s | | 2,447 | 0.605 | |
| $s_{\bar{x}}$ | | 1,223 | 0.302 | |
| C. V. | | 7 | 6.8 | |

Table 5.--Height, dead plants, percent and per acre, lodging percent, number of ears per plant and per acre and percent nubbins for each of two varieties of corn grown at different populations.-M. T. E. S., 1961. *

| Plant population per acre: Desired | Plant population per acre: Actual | Row width feet | Plant height feet | Dead plants: per-cent | Dead plants: per acre | Lodging percent | Average number of ears: per plant | Average number of ears: per acre | Nubbins percent |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Dixie 33 | | | | | |
| 12,000 | 13,450 | 3 | 9.8 | 0.0 | 0 | 1.8 | 1.48 | 19,420a | 9.2 |
| 16,000 | 17,000 | 3 | 10.0 | 0.0 | 0 | 3.9 | 1.37 | 23,290ad | 13.5 |
| 20,000 | 19,940 | 3 | 10.2 | 0.0 | 0 | 3.9 | 1.19 | 23,780ad | 12.7 |
| 24,000 | 23,350 | 3 | 10.1 | 0.0 | 0 | 7.4 | 1.05 | 24,560 d | 10.8 |
| 36,000 | 33,880 | 3 | 10.0 | 0.0 | 0 | 12.3 | 0.89 | 30,250cb | 12.5 |
| 36,000 | 34,890 | 1 | 9.2 | 0.4 | 121 | 11.7 | 0.93 | 32,820 b | 11.6 |
| 72,000 | 61,350 | 1 | 8.5 | 4.2 | 260 | 67.7 | 0.44 | 26,980cd | 43.4 |
| [illegible] | [illegible] | 1 | [illegible] | 4.4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| s | 1,684 | | 0.319 | | 133 | 3.39 | | 1,679 | 6.07 |
| $s_{\bar{x}}$ | 842 | | 0.159 | | 66 | 1.70 | | 839 | 3.04 |
| C. V. | 6 | | 4.0 | | 32 | 19.7 | | 6 | 37.5 |

* Values having the same symbols are not significantly different at P = .05

Table 6.--Height, dead plants percent and per acre, lodging percent, number of ears per plant and per acre and percent nubbins for each of two varieties of corn grown at different populations.-H. R. E. S., 1961.*

| Plant population per acre | | Row width | Plant height | Dead plants | | Lodging | Average number of ears | | Nubbins |
|---|---|---|---|---|---|---|---|---|---|
| Desired | Actual | feet | feet | per-cent | per acre | percent | per plant | per acre | percent |
| | | | | | Dixie 33 | | | | |
| 12,000 | 13,920 | 3 | 9.4 | 3.5 | 480 | 3.3 | 1.73 | 24,140a | 11.7 |
| 16,000 | 18,090 | 3 | 9.5 | 3.7 | 670 | 5.8 | 1.49 | 27,040ab | 17.1 |
| 20,000 | 18,940 | 3 | 9.8 | 3.8 | 730 | 6.5 | 1.58 | 28,680ab | 13.3 |
| 24,000 | 23,600 | 3 | 9.4 | 6.7 | 1570 | 7.8 | 1.27 | 30,070 b | 14.0 |
| 36,000 | 33,880 | 3 | 9.7 | 9.3 | 3150 | 14.3 | 1.06 | 35,640c | 13.3 |
| 36,000 | 36,120 | 1 | 9.8 | 7.7 | 2780 | 10.2 | 1.00 | 36,240c | 14.6 |
| 72,000 | 64,800 | 1 | 9.8 | 16.5 | 10710 | 31.7 | 0.67 | 42,710 | 29.3 |
| $s_{\bar{x}}$ | 549 | | 0.155 | | 252 | 2.35 | | 1,195 | 2.08 |
| C. V. | 6 | | 3.7 | | 73 | 73.0 | | 8 | 31.7 |

* Values having the same symbols are not significantly different at P = .05

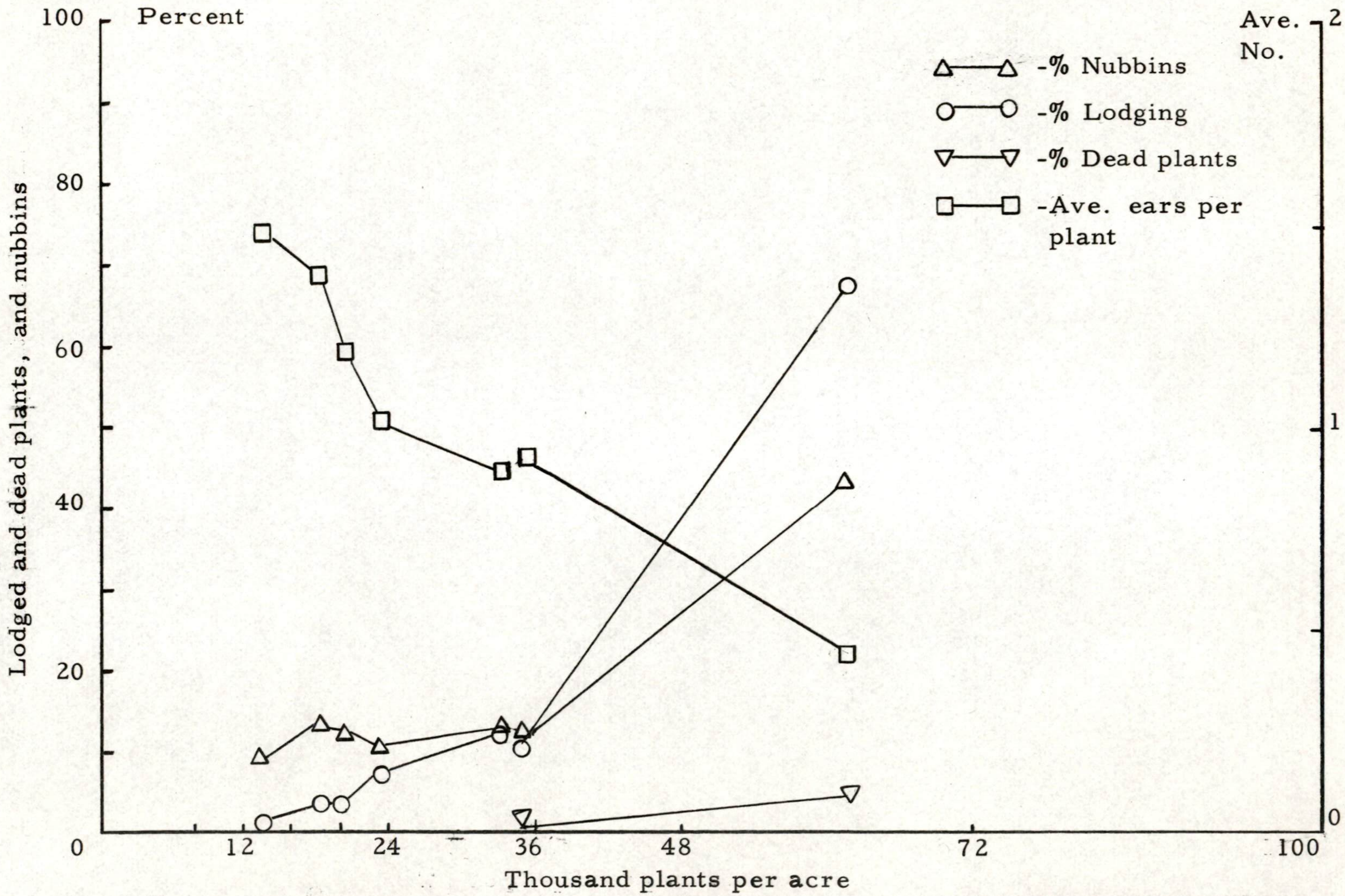


Figure 1.--Average number of ears per plant, and percentages of lodged plants, dead plants and nubbins.-Dixie 33 corn grown at different populations.-M. T. E. S., 1961.

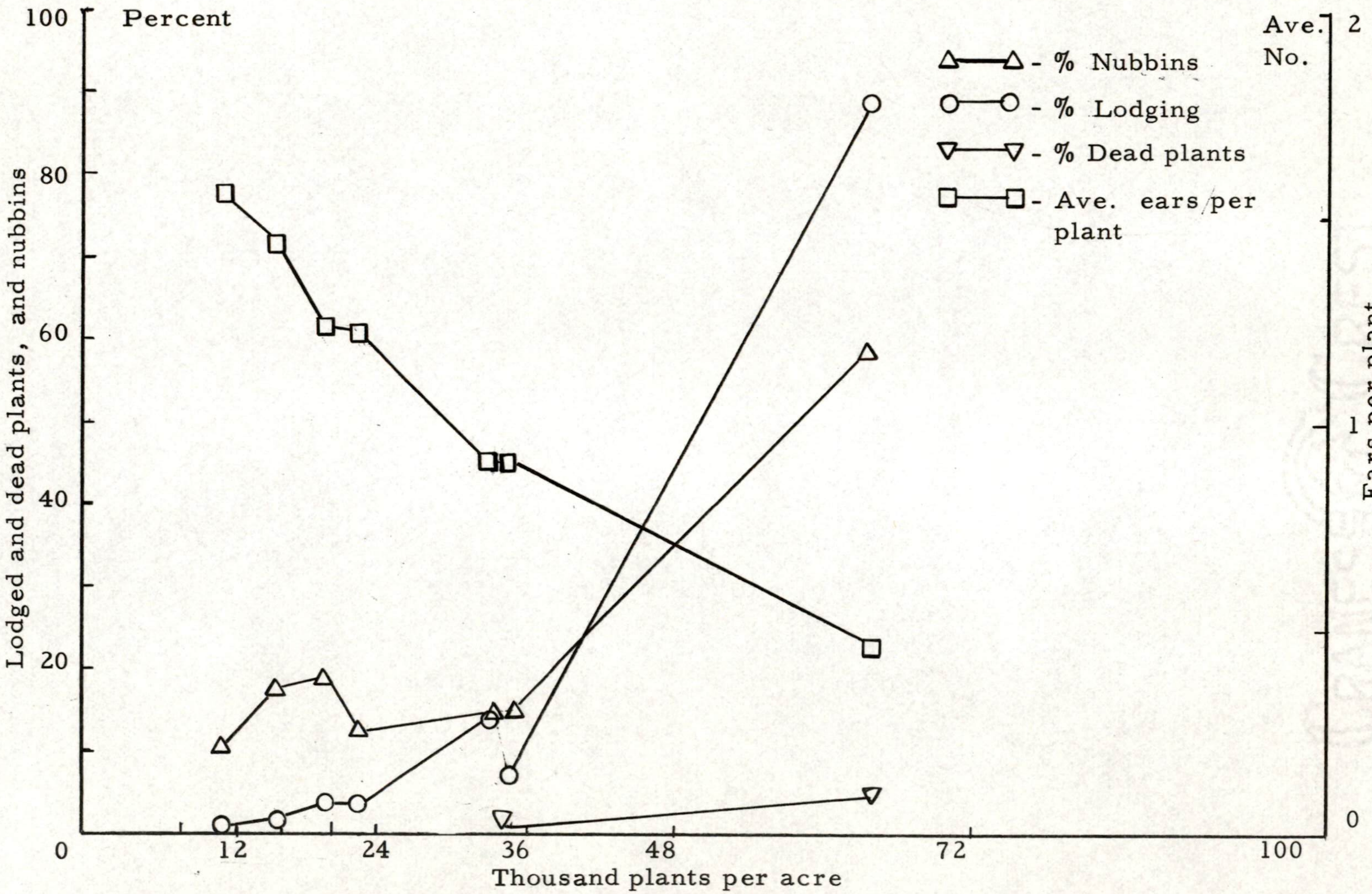


Figure 2. --Average number of ears per plant, and percentages of lodged plants, dead plants and nubbins. -Tennessee 501 corn grown at different populations. -M. T. E. S., 1961.

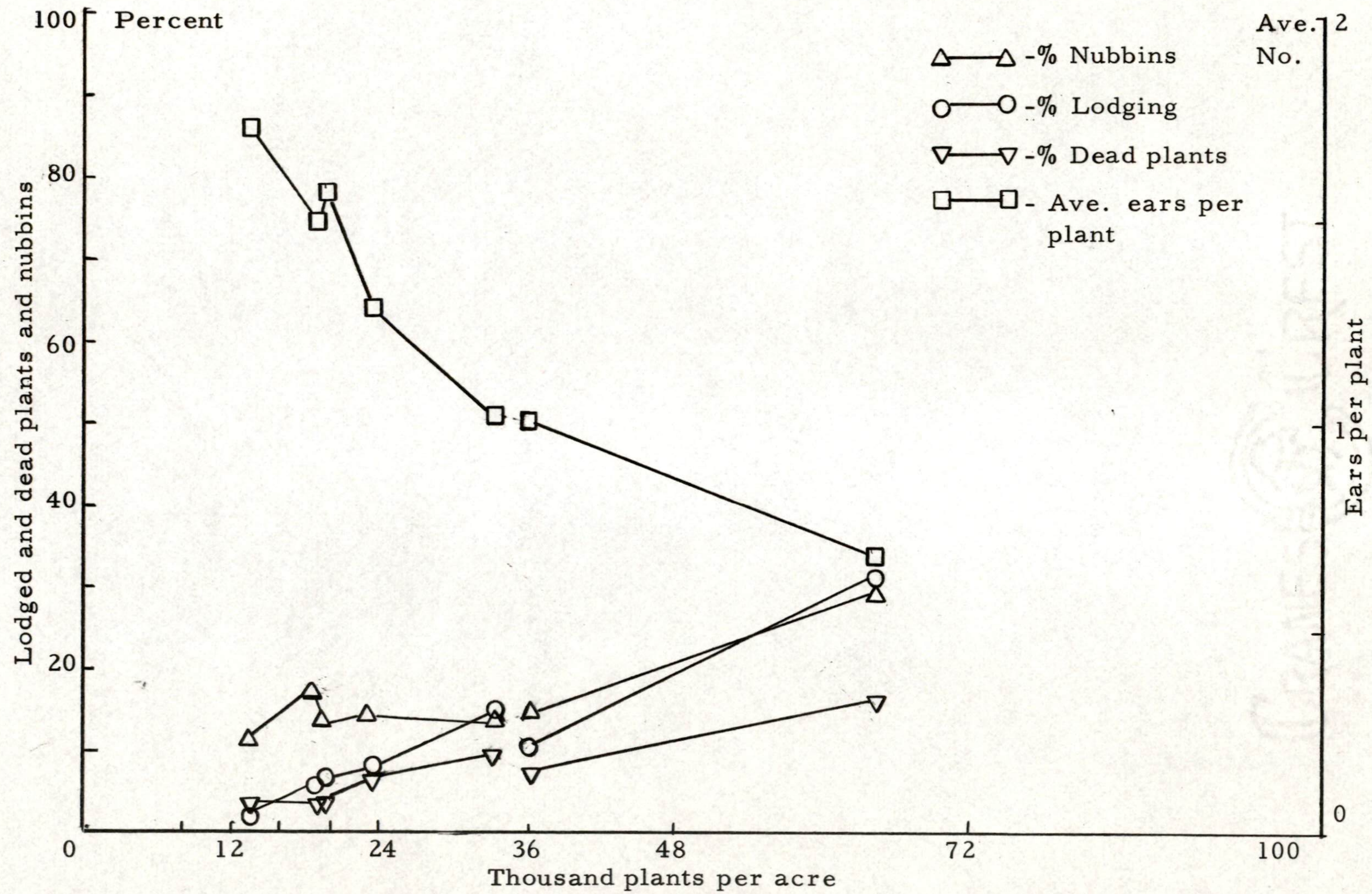


Figure 3.--Average number of ears per plant and percentages of lodged plants, dead plants and nubbins.-Dixie 33 corn grown at different populations.-H.R.E.S., 1961.

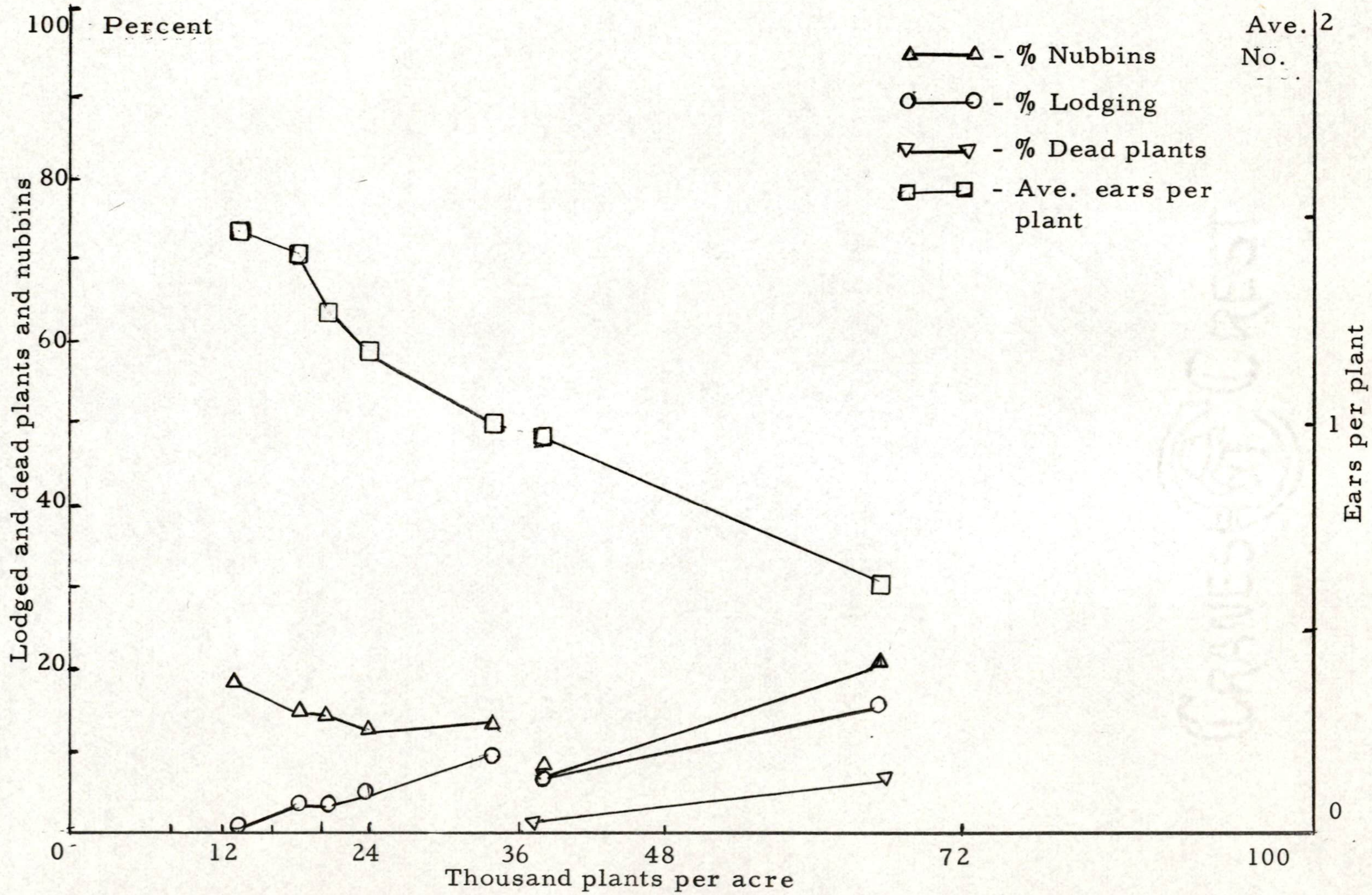


Figure 4. --Average number of ears per plant, and percentages of lodged plants, dead plants and nubbins. -Tennessee 501 corn grown at different populations. -H. R. E. S., 1961.

occurence of dead plants seems to be the intraspecific competition of plants for nutrients discussed by Donald (20) in relation to density of plants.

Dead plants. Dead plants were present only at the two highest plant populations of Tennessee 501 at M. T. E. S. and H. R. E. S., and for the same treatments of Dixie 33 at M. T. E. S. The percentage of dead plants was much higher across all populations of Dixie 33 at H. R. E. S. The percentage as well as the number of dead plants per acre increased with increases in plant population. The range of dead plants was from 0 to 16%, the maximum occurring with the 72,000 PPA treatments. At Koella Farm, the numbers of dead plants were not recorded.

Lodging. At M. T. E. S. and H. R. E. S., lodging percentages increased as plant populations increased. Lodging was considerable at populations of 72,000 PPA. The range observed was from 0.8% at 12,000 PPA treatment to 89% at 72,000 PPA treatment.

At the Koella Farm, the plants lodged mainly due to wind and rain storms. Lodging was noticed first in high population treatments. A record of lodging percentages was made when the plants were harvested. Since priority of harvesting was given to plots already lodged, and since harvesting extended from July 13 to July 24, during which time additional numbers of unharvested plants lodged, a comparison of lodging with treatment was not made. Such a comparison would have been biased.

Plant height. The plant population had a very slight effect on the plant height. Plant heights were significantly different only for Dixie 33 at Koella Farm and at M. T. E. S. At these stations, the plants tended to be taller at populations varying from 12,000 to 24,000 PPA and shorter at the highest PPA treatment. In other cases, no definite trend was observed. The range in plant height was between 8.5 and 10.9 feet for Dixie 33 and between 8.6 feet and 9.8 feet for Tennessee 501.

Ear production. In general, the number of ears per acre increased with increases in plant population. At M.T.E.S., however, the number of ears per acre decreased slightly at the 72,000 PPA treatment. The effect of plant population on ear production was highly significant in all cases. Separation of treatment means by Duncan's multiple range test is indicated in tables 4, 5 and 6 for total number of ears produced. The differences between the treatment means for the number of ears per acre were generally wider at the highest populations. At M.T.E.S. the highest number of ears were produced at 36,000 PPA. The increase in the number of ears with the increase in plant population was gradual and was less than 9,000 ears per acre. On the other hand, at H.R.E.S., the rate of increase of number of ears increased with increases in population until a maximum was reached at the highest population. The range of ear production was much wider here (19,720 to 42,710) than at M.T.E.S.

The average number of ears per plant decreased as the plant population increased. This decrease, for Dixie 33 was from 1.48 to 0.44 ears per plant at M.T.E.S., and from 1.73 to 0.67 ears per plant at H.R.E.S.; for Tennessee 501, it was 1.56 to 0.45 ears per plant at M.T.E.S., and 1.46 to 0.61 at H.R.E.S. Until the increasing plant population reached the 24,000 PPA treatment, the average number of ears per plant remained more than one in all cases. At the two 36,000 PPA treatments of Dixie 33 at H.R.E.S., there was an average of more than one ear per plant; but Tennessee 501 at H. R. E. S. and both varieties at M. T. E. S. had slightly less than one ear per plant at that same population. At the 72,000 PPA treatment, the average was less than 0.5 ear per plant at M. T. E. S. and slightly more than 0.5 ear per plant at H. R. E. S.

Percentage occurence of nubbins. The percent nubbins was considered important in the study because the nubbins are rudimentary ears which fail to develop and their presence indicates that some factor limited full development of the plant. Percentages of nubbins for both varieties at plant populations up to 36,000 PPA at M. T. E. S. and H. R. E. S. varied between 7.0 and 18.1. There appeared to be a slight trend for these percentages to increase when plant population increased from 12,000 to 16,000 PPA, and to decrease slightly when plant population increased to 36,000 plants per acre. At the 72,000 PPA treatments, a very sharp increase in percent nubbins occurred. In the case of Tennessee 501 at H. R. E. S., a high and not readily explainable percentage of nubbins occurred at the 12,000 PPA treatment. The percent nubbins in each of the replications making up this treatment were 11.1, 16.2, 20.0 and 25.4, which indicates not only the fact that there was a wide variability between replications but also that the third and fourth replications contributed most to the high mean percentage value. No particular reason could be found to explain such a marked difference between replications.

Effect of Population on Yields

Green yield. Green yields of leaves, stalks, and grain are presented in tables 7, 8 and 9 and in figures 5 through 10. In tables 10, 11 and 12, the percentages that each of these plant parts

Table 7. --Green yields of stalks, and leaves of two corn varieties grown for silage at different populations. -Koella Farm, M. E. S., 1961. *

| Desired population plants per acre | Row width feet | Actual population plants per acre | Green yield- tons per acre Stalks | Leaves | Total |
|---|---|---|---|---|---|
| | | Dixie 33 | | | |
| 8,000 | 3 | 3,980 | 12.0 | 3.0 | 15.0a |
| 12,000 | 3 | 13,010 | 14.0 | 3.9 | 17.9ab |
| 16,000 | 3 | 16,270 | 14.9 | 4.6 | 19.5 b |
| 20,000 | 3 | 18,990 | 17.2 | 5.5 | 22.7c |
| 24,000 | 3 | 23,110 | 16.3 | 6.4 | 22.7c |
| 36,000 | 3 | 30,070 | 17.7 | 6.0 | 23.7c |
| 36,000 | 1 | 37,390 | 20.3 | 7.5 | 27.8d |
| 48,000 | 1 | 48,340 | 21.2 | 9.0 | 30.2df |
| 72,000 | 1 | 67,760 | 21.3 | 9.6 | 30.9 f |
| 100,000 | 1 | 82,890 | 21.8 | 9.9 | 31.7 f |
| s | | | | | 1.98 |
| $s_{\bar{x}}$ | | | | | 0.992 |
| C. V. | | | | | 8.2 |
| | | Tennessee 501 | | | |
| 8,000 | 3 | 9,320 | 12.5 | 2.6 | 15.1t |
| 12,000 | 3 | 10,890 | 14.1 | 3.1 | 17.2tv |
| 16,000 | 3 | 16,430 | 15.0 | 3.9 | 18.9wv |
| 20,000 | 3 | 19,060 | 16.5 | 4.4 | 20.9wx |
| 24,000 | 3 | 22,690 | 16.8 | 4.6 | 21.4wx |
| 36,000 | 3 | 30,980 | 17.3 | 5.4 | 22.7yx |
| 36,000 | 1 | 37,630 | 18.3 | 6.8 | 25.1y |
| 48,000 | 1 | 46,530 | 21.5 | 8.3 | 29.8z |
| 72,000 | 1 | 61,890 | 19.9 | 8.4 | 28.3z |
| 100,000 | 1 | 80,770 | 20.0 | 8.8 | 28.8z |
| s | | | | | 2.05 |
| $s_{\bar{x}}$ | | | | | 1.03 |
| C. V. | | | | | 9.0 |

* Values having the same symbols are not significantly different at P = .05

Table 8.--Green yields of stalks, leaves and ears and shelling percent for two corn varieties grown for silage at different populations.-M. T. E. S., 1961. *

| Desired population plants per acre | Row width feet | Actual population plants per acre | Green yield - tons per acre | | | | Shelling percent |
|---|---|---|---|---|---|---|---|
| | | | Stalks | Leaves | Ears | Total | |
| | | | Dixie 33 | | | | |
| 12,000 | 3 | 13,250 | 9.0 | 2.6 | 5.7 | 17.3 | 83.9 |
| 16,000 | 3 | 17,000 | 9.9 | 3.2 | 6.3 | 19.4a | 83.4 |
| 20,000 | 3 | 19,940 | 9.5 | 2.9 | 6.5 | 18.9a | 83.9 |
| 24,000 | 3 | 23,350 | 10.2 | 3.1 | 6.3 | 19.6a | 84.6 |
| 36,000 | 3 | 33,880 | 11.5 | 3.8 | 6.2 | 21.5b | 84.4 |
| 36,000 | 1 | 34,890 | 12.1 | 3.4 | 6.1 | 21.6b | 83.3 |
| 72,000 | 1 | 61,350 | 18.4 | 5.9 | 3.5 | 27.8 | 74.5 |
| s | | | | | | 0.928 | |
| $s_{\bar{x}}$ | | | | | | 0.464 | |
| C. V. | | | | | | 4.5 | |
| | | | Tennessee 501 | | | | |
| 12,000 | 3 | 12,240 | 9.9 | 3.2 | 5.4 | 18.5 w | 70.0 |
| 16,000 | 3 | 15,730 | 10.1 | 4.0 | 5.6 | 19.7yw | 71.2 |
| 20,000 | 3 | 19,480 | 11.4 | 4.1 | 5.8 | 21.3yx | 71.9 |
| 24,000 | 3 | 22,810 | 11.7 | 4.6 | 6.1 | 22.4zx | 72.4 |
| 36,000 | 3 | 33,640 | 12.3 | 5.1 | 5.8 | 23.2z | 73.8 |
| 36,000 | 1 | 34,120 | 12.8 | 5.0 | 5.5 | 23.3z | 72.9 |
| 72,000 | 1 | 63,340 | 15.0 | 5.7 | 3.0 | 23.7z | 73.4 |
| s | | | | | | 1.18 | |
| $s_{\bar{x}}$ | | | | | | 0.59 | |
| C. V. | | | | | | 5.4 | |

* Values having the same symbols are not significantly different at P = .05

Table 9.--Green yields of stalks, leaves and ears, and shelling percent for two corn varieties grown for silage at different populations.-H.R.E.S., 1961. *

| Desired population plants per acre | Row width feet | Actual population plants per acre | Green yield - tons per acre | | | | Shelling percent |
|---|---|---|---|---|---|---|---|
| | | | Stalks | Leaves | Ears | Total | |
| | | | Dixie 33 | | | | |
| 12,000 | 3 | 13,920 | 14.0 | 4.2 | 7.2 | 25.4a | 81.8 |
| 16,000 | 3 | 18,090 | 14.4 | 4.5 | 7.6 | 26.5ab | 81.9 |
| 20,000 | 3 | 18,940 | 15.1 | 4.7 | 8.1 | 27.9ab | 82.3 |
| 24,000 | 3 | 23,600 | 15.5 | 5.1 | 7.9 | 28.5abc | 81.0 |
| 36,000 | 3 | 33,880 | 17.4 | 5.8 | 8.2 | 31.4dc | 82.8 |
| 36,000 | 1 | 36,120 | 17.3 | 4.9 | 7.9 | 30.1dc | 81.5 |
| 72,000 | 1 | 64,800 | 20.3 | 5.9 | 6.8 | 33.0d | 82.2 |
| s | | | | | | 2.39 | |
| $s_{\bar{x}}$ | | | | | | 1.20 | |
| C.V. | | | | | | 8.3 | |
| | | | Tennessee 501 | | | | |
| 12,000 | 3 | 13,670 | 12.9 | 3.5 | 6.0 | 22.4t | 70.5 |
| 16,000 | 3 | 17,360 | 14.5 | 4.1 | 6.5 | 25.1tv | 72.0 |
| 20,000 | 3 | 20,630 | 15.6 | 4.7 | 7.0 | 27.3wv | 72.0 |
| 24,000 | 3 | 24,140 | 16.8 | 5.5 | 7.1 | 29.4wx | 71.4 |
| 36,000 | 3 | 34,120 | 18.9 | 6.0 | 7.3 | 32.2yx | 72.1 |
| 36,000 | 1 | 37,120 | 20.4 | 6.6 | 7.5 | 34.5yz | 72.0 |
| 72,000 | 1 | 65,890 | 22.7 | 7.8 | 6.6 | 37.1z | 73.2 |
| s | | | | | | 2.0 | |
| $s_{\bar{x}}$ | | | | | | 0.999 | |
| C.V. | | | | | | 6.7 | |

* Values having the same symbols are not significantly different at P = .05


Figure 5.--Tons per acre of green stems and leaves.-Dixie 33 corn grown for silage at different populations.-Koella Farm, M.E.S., 1961.

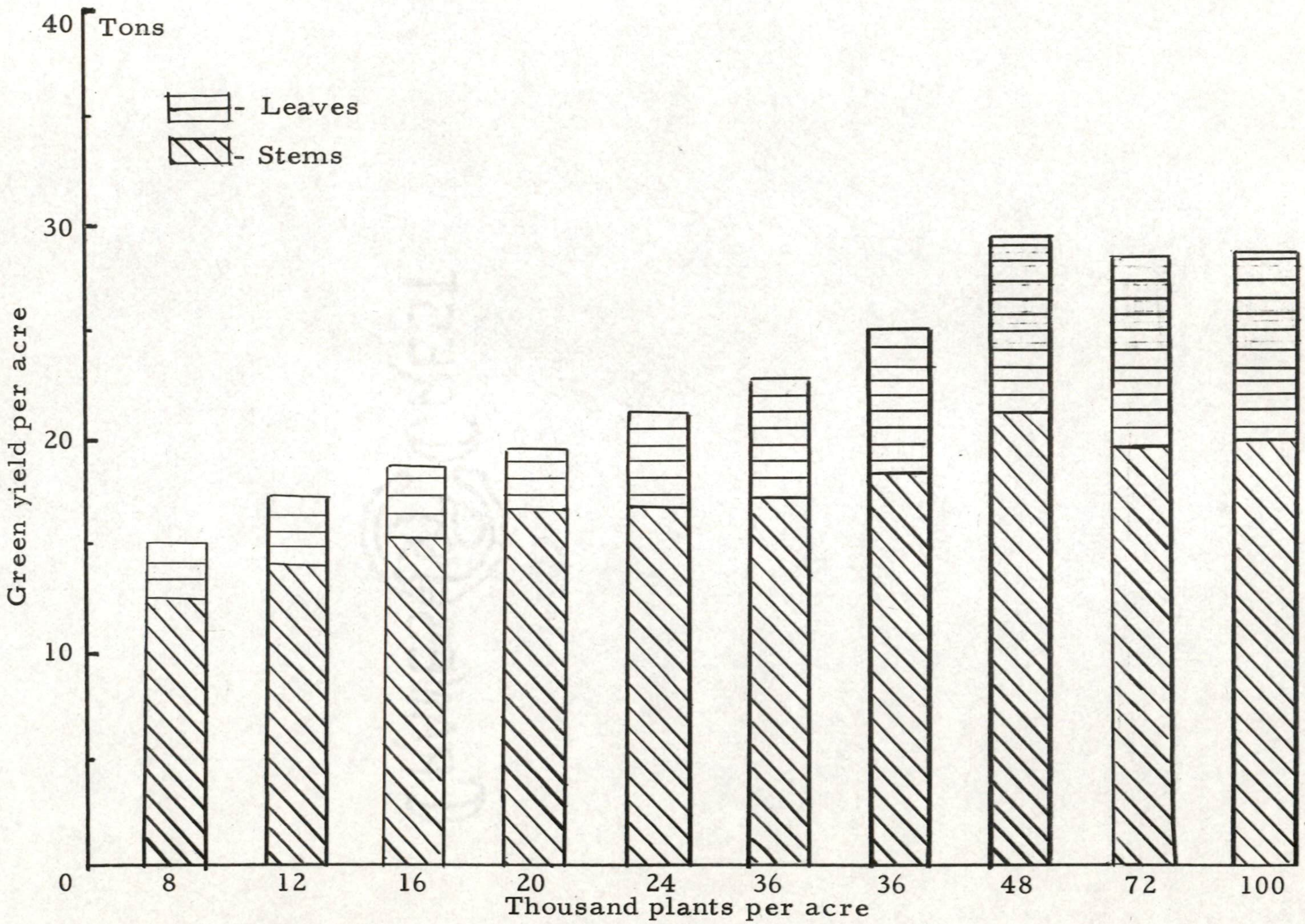


Figure 6.--Tons per acre of green stems and leaves.-Tennessee 501 corn grown for silage at different populations.-Koella Farm, M.E.S., 1961.

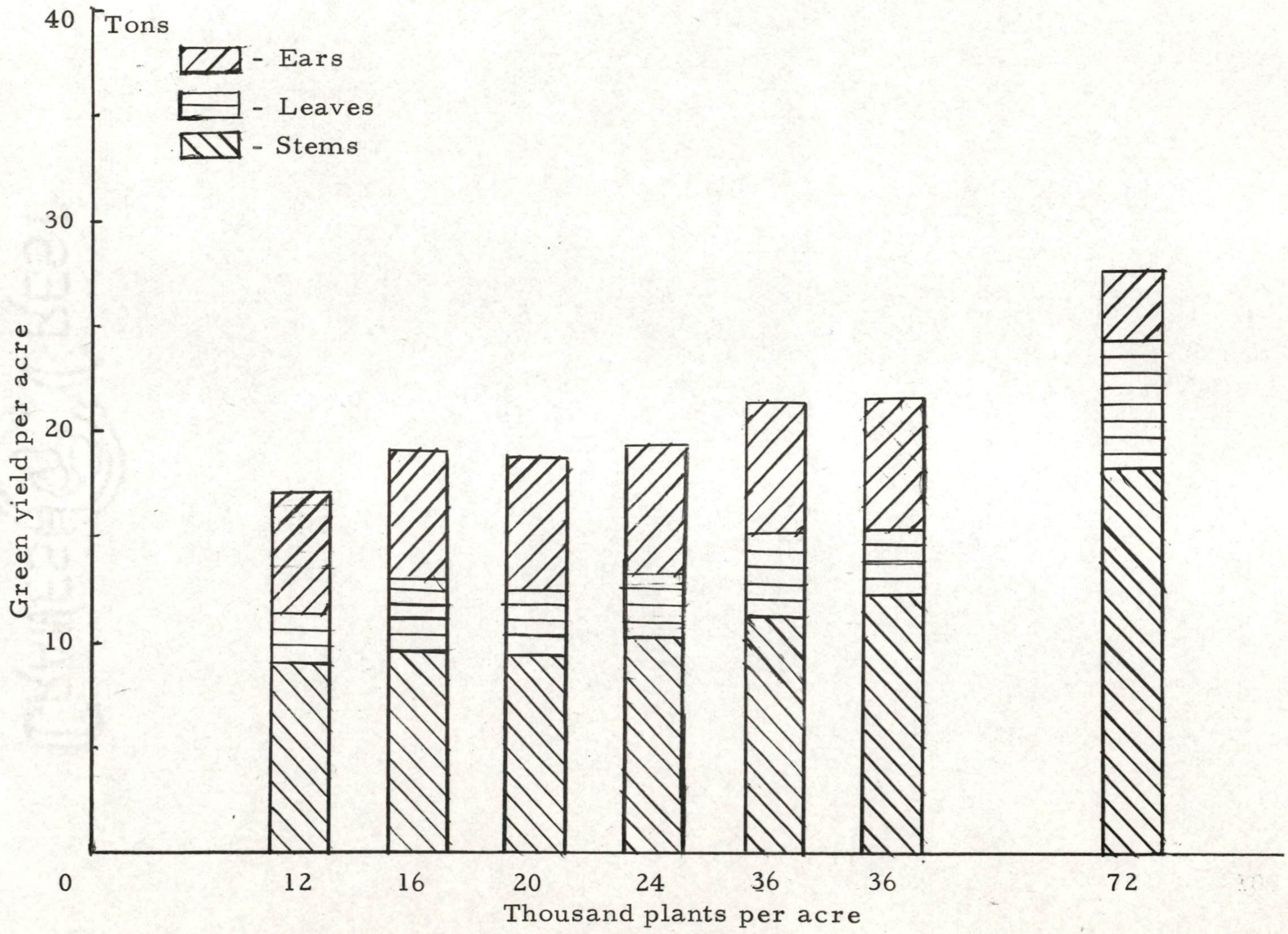


Figure 7.--Tons per acre of green stems, leaves and ears.-Dixie 33 corn grown for silage at different populations.-M. T. E. S., 1961.

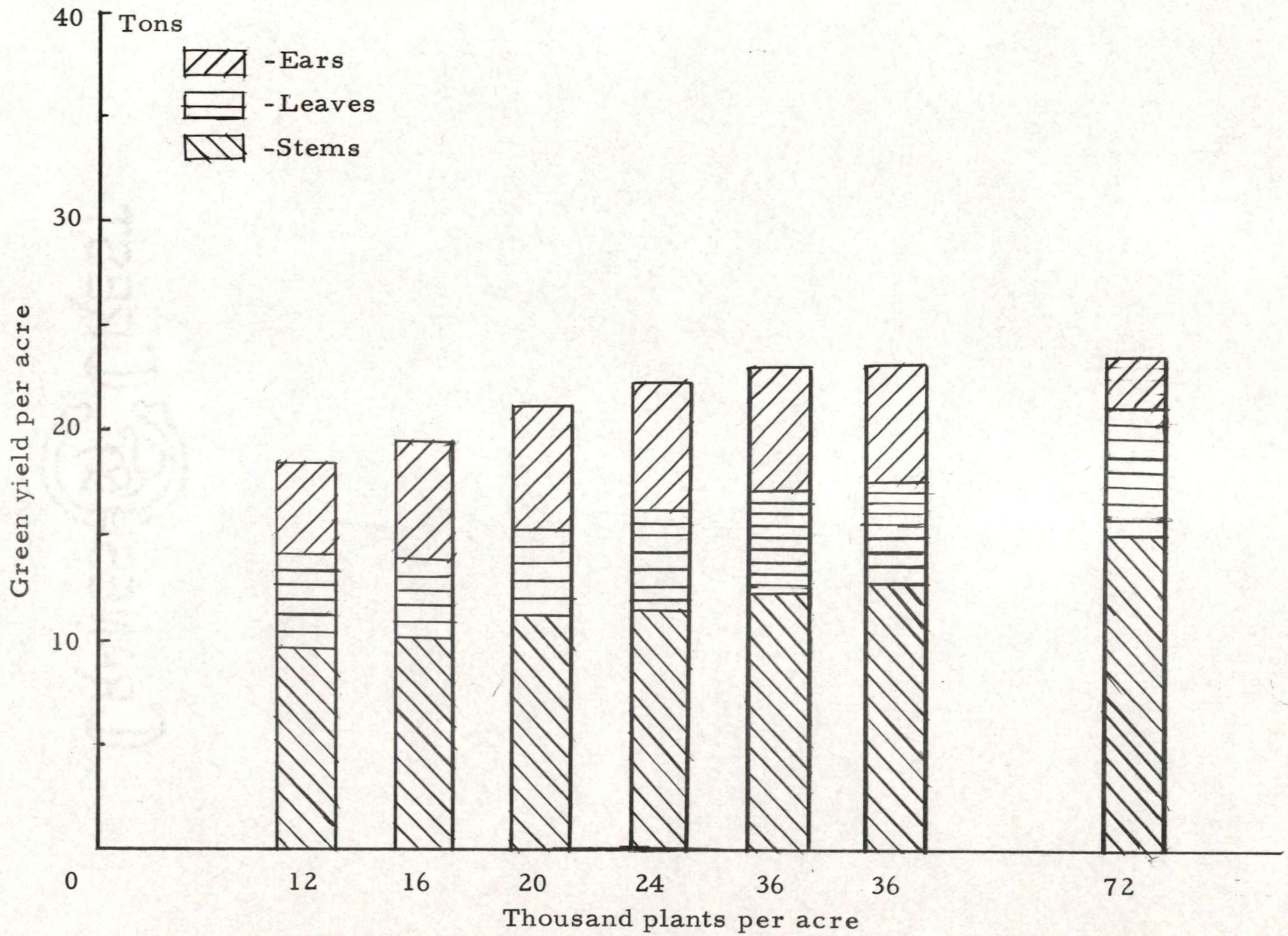


Figure 8.--Tons per acre of green stems, leaves and ears.-Tennessee 501 corn grown for silage at different populations.-M. T. E. S., 1961.

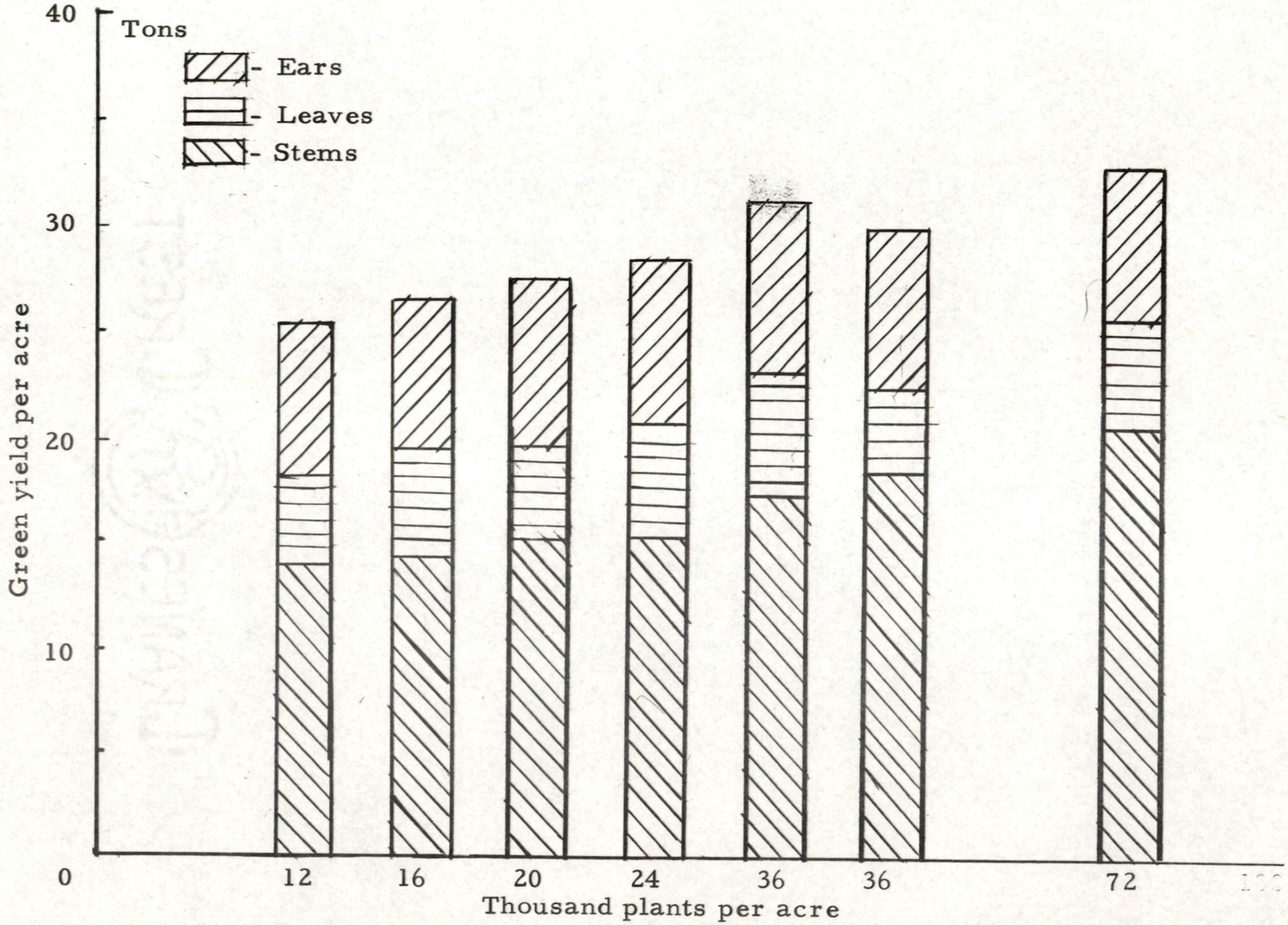


Figure 9.--Tons per acre of green stems, leaves and ears.-Dixie 33 grown for silage at different populations.-H.R.E.S., 1961.


Figure 10.--Tons per acre of green stems, leaves and ears.-Tennessee 501 corn grown for silage at different populations.-H. R. E. S., 1961.

Table 10.--Percentage distribution of total green yield between stalks and leaves for each of two corn varieties grown for silage at different populations.-Koella Farm, M.E.S., 1961.

| Desired population plants per acre | Row width feet | Actual population plants per acre | % green weight of stover | |
|---|---|---|---|---|
| | | | Stalks | Leaves |
| | | Dixie 33 | | |
| 8,000 | 3 | 9,380 | 79.7 | 20.3 |
| 12,000 | 3 | 13,010 | 78.1 | 21.9 |
| 16,000 | 3 | 16,270 | 76.5 | 23.5 |
| 20,000 | 3 | 18,990 | 75.8 | 24.2 |
| 24,000 | 3 | 23,110 | 71.8 | 28.2 |
| 36,000 | 3 | 30,070 | 74.6 | 25.4 |
| 36,000 | 1 | 37,390 | 73.0 | 27.0 |
| 48,000 | 1 | 48,340 | 70.2 | 29.8 |
| 72,000 | 1 | 67,760 | 68.8 | 31.2 |
| 100,000 | 1 | 82,890 | 68.7 | 31.3 |
| | | Tennessee 501 | | |
| 8,000 | 3 | 9,320 | 82.9 | 17.1 |
| 12,000 | 3 | 10,890 | 81.7 | 18.3 |
| 16,000 | 3 | 16,430 | 79.5 | 20.5 |
| 20,000 | 3 | 19,060 | 78.7 | 21.3 |
| 24,000 | 3 | 22,690 | 78.4 | 21.6 |
| 36,000 | 3 | 30,980 | 74.5 | 24.5 |
| 36,000 | 1 | 37,630 | 72.8 | 27.2 |
| 48,000 | 1 | 46,530 | 72.3 | 27.7 |
| 72,000 | 1 | 61,890 | 70.0 | 30.0 |
| 100,000 | 1 | 80,770 | 69.6 | 30.4 |

Table 11. --Percentage distribution green weight of stover between stalks and leaves and grain in total green yield for each of two varieties of corn grown for silage at different populations. -M. T. E. S., 1961.

| Desired population plants per acre | Row width feet | Actual population plants per acre | Percent green weight of stover | | % grain in total green yield |
|---|---|---|---|---|---|
| | | | Stalks | Leaves | |
| | | Dixie 33 | | | |
| 12,000 | 3 | 13,250 | 77.6 | 22.4 | 33.1 |
| 16,000 | 3 | 17,000 | 75.8 | 24.2 | 32.7 |
| 20,000 | 3 | 19,940 | 77.4 | 22.6 | 33.3 |
| 24,000 | 3 | 23,350 | 76.4 | 23.6 | 31.9 |
| 36,000 | 3 | 33,880 | 75.1 | 24.9 | 29.0 |
| 36,000 | 1 | 34,890 | 77.8 | 22.2 | 28.0 |
| 72,000 | 1 | 61,350 | 75.9 | 24.1 | 12.5 |
| | | Tennessee 501 | | | |
| 12,000 | 3 | 12,240 | 75.3 | 24.7 | 28.9 |
| 16,000 | 3 | 15,730 | 71.7 | 28.3 | 28.2 |
| 20,000 | 3 | 19,480 | 73.7 | 26.3 | 27.4 |
| 24,000 | 3 | 22,810 | 71.9 | 28.1 | 27.2 |
| 36,000 | 3 | 33,640 | 70.4 | 29.6 | 25.1 |
| 36,000 | 1 | 34,120 | 72.0 | 28.0 | 23.6 |
| 72,000 | 1 | 63,340 | 71.8 | 28.2 | 10.0 |

Table 12.--Percentage distribution of green weight of stover between stalks and leaves and percent grain in total green yield for each of two varieties of corn grown for silage at different populations.-H.R.E.S., 1961.

| Desired population plants per acre | Row width feet | Actual population plants per acre | Percent green weight of stover | | % grain in total green yield |
|---|---|---|---|---|---|
| | | | Stalks | Leaves | |
| | | Dixie 33 | | | |
| 12,000 | 3 | 13,920 | 77.0 | 23.0 | 28.6 |
| 16,000 | 3 | 18,090 | 76.1 | 23.9 | 28.9 |
| 20,000 | 3 | 18,940 | 76.3 | 23.7 | 28.5 |
| 24,000 | 3 | 23,600 | 75.0 | 25.0 | 27.7 |
| 36,000 | 3 | 33,880 | 75.1 | 24.9 | 26.2 |
| 36,000 | 1 | 36,120 | 78.1 | 21.9 | 26.3 |
| 72,000 | 1 | 64,800 | 77.5 | 22.5 | 20.5 |
| | | Tennessee 501 | | | |
| 12,000 | 3 | 13,670 | 78.9 | 21.1 | 26.8 |
| 16,000 | 3 | 17,360 | 77.9 | 22.1 | 26.1 |
| 20,000 | [illegible] | [illegible] | [illegible] | 23.2 | 25.8 |
| 24,000 | [illegible] | [illegible] | [illegible] | 24.5 | 24.4 |
| 36,000 | [illegible] | [illegible] | [illegible] | 24.2 | 22.7 |
| 36,000 | [illegible] | [illegible] | [illegible] | 24.5 | 21.6 |
| 72,000 | [illegible] | [illegible] | [illegible] | 25.8 | 17.8 |

contributed to the total green weight production are tabulated.

Green yields increased with increases in plant population. However the rate of increase of yield decreased considerably when the PPA was superior to 20,000 plants of Dixie 33 and to 24,000 plants of Tennessee 501. Even so, the green yield at the 100,000 PPA treatment was not inferior to that of treatments with fewer plants. This observation agrees with the findings of Reid (65) who obtained about 30.3 tons of green corn forage from a population of 300,000 PPA.

The effects of the treatments were highly significant at all three locations. Total green yields for Dixie 33 ranged between 15.0 and 31.7, 17.3 and 27.8 and 25.4 and 33.3 tons per acre at the Koella Farm, M.T.E.S., and H.R.E.S., respectively; and between 15.1 and 28.8, 18.5 and 23.7 and 22.8 and 37.1 tons per acre at the same stations for Tennessee 501. Mean separations by Duncan's multiple range tests are presented in tables 7, 8 and 9. The ear productions of the three highest populations (48,000, 72,000 and 100,000 PPA) were not significantly different from one another. The 36,000 PPA treatment of Dixie 33 produced, in 1-foot rows, a green weight not significantly different from that of the 48,000 PPA treatment. On the other hand, the yield of Tennessee 501 in 1-foot rows was not significantly different from that of the 3-foot rows of same population (36,000 PPA) but it was significantly lower than the yield of the 48.000 PPA. At M.T.E.S., the yields of Dixie 33 for the 16,000, 20,000 and 24,000 PPA treatments were not significantly different from each other. The two 36,000 PPA treatments also behaved similarly. Yields of Tennessee 501 in populations ranging from 24,000 to 72,000 were not significantly different. At the H.R.E.S., the yield of Dixie 33 from 12,000 PPA to 24,000 PPA were not significantly different from one another and neither were the yields from the two 36,000 PPA and the 72,000 PPA treatments. However, the yields of the lower population group were significantly different from those of the higher population groups, with the exception that the yield of the 24,000 PPA treatment was not significantly different from that of the 36,000 PPA treatments.

Yields of green whole-plants were markedly different from location to location. Dixie 33 at M.T.E.S. yielded from 17.3 to 27.8 tons per acre, but from 25.4 to 33.0 tons per acre at H.R.E.S. Similarly, Tennessee 501 at M.T.E.S. yielded from 18.5 to 23.7 tons per acre, whereas it yielded 22.4 to 37.1 tons per acre at H.R.E.S. The lowest yield at the H.R.E.S. (which occurred at the lowest population) was approximately equal to the highest yield (at the highest population) at the M.T.E.S. At the Koella Farm, the range of green yields was so wide that the lowest yield was as low as that of the lowest at M.T.E.S., but the highest was in the range of yields obtained at H.R.E.S. If the crop had been able to stand until the silage stage of harvest the yields might have been at least as high as at H.R.E.S.

These differences in yields between stations were not unexpected. At M.T.E.S. the experiment was grown on a Maury silt loam, an upland soil, while at H.R.E.S. it was grown on a Huntington silt loam which usually has a better soil moisture supply during the season and is higher in organic matter content. At M.T.E.S., only 133 lbs. per acre of nitrogen were applied while at H.R.E.S. 208 lbs. per acre were applied. At Koella Farm, the soil also was a Huntington silt loam in addition to some

Sequatchie silt loam. Here plots were adequately fertilized (100 lbs. per acre of N) and had been well fertilized in previous years. However, the fact that total green yields at this location exceeded those at H.R.E.S. was surprising, since the experiment was harvested at the tasseling stage.

At M.T.E.S. the green weights of the whole plant, stems and leaves of 72,000 PPA treatment of Dixie 33 were much higher than those of other treatments. The primary reason for this difference appears to be the fact that this treatment was cut two weeks earlier than the others of that variety (along with the harvest of Tennessee 501 plots). At that time, Dixie 33 was in the early dough stage and possibly contained a higher proportion of its total dry matter in the stems and leaves. In the plots of this variety harvested later, translocation of accumulates to the ear had probably taken place by the time of harvest, two weeks later. Such a possibility is supported by the fact that this treatment, which was cut at the same time as Tennessee 501, had markedly higher dry matter in its leaves and stems, particularly in the 72,000 PPA treatment, than in the other treatments. On the other hand the dry matter content of ears was markedly less than that of other treatments. Another possibility is that the higher weight resulted from a higher moisture content at this earlier date. This also appears to be possible since, though the total green weight in this treatment was markedly higher than that in other treatments, the total dry weight was not markedly different. Indeed there was a higher moisture content in the stems, leaves and especially the ears (75.4% vs. 50.0% in the case of the 36,000 PPA treatment).

Green yields of both stalks and leaves increased as population increased at all locations. The grain yield, however, increased until the plant population reached 36,000 PPA treatment, and then decreased when the plant population was increased to 72,000 PPA. The grain yield of the 72,000 PPA treatment was lower than that of the 16,000 PPA treatment at M.T.E.S., but above that of the 16,000 PPA treatment at H.R.E.S. This difference is due to the fact that higher corn production was obtained at H.R.E.S. than at M.T.E.S.

Generally, the percent grain in the total green yield decreased with increases in plant population. In the case of Dixie 33 at the M.T.E.S., the percentage grain in total green yield was highest at 20,000 PPA, but this was not markedly higher than the percentages of grain in the 12,000 and 16,000 PPA treatments.

The ranges of percent grain for Dixie 33 were 12.1 to 33.1 and 20.5 to 28.6 at M.T.E.S. and H.R.E.S., respectively; and 10.0 to 28.9, and 17.8 to 26.8, respectively, for Tennessee 501 at the same locations. Thus in either variety these ranges at M.T.E.S. were wider than at H.R.E.S. The leaf/stem ratio of the stover was rather constant at all population treatments at M.T.E.S. and H.R.E.S. At the Koella Farm the leaf content increased from 20.3 to 31.3 in Dixie 33 and from 17.1 to 30.4 in Tennessee 501 with the increase in plant population. The percentage of stem, which obviously is the part of the stover remaining, varied inversely with the leaf percentage. This difference between the findings at Koella Farm and those at the other two stations is attributable to the difference in the degree of maturity of plants at harvest.

Dry matter yield. The dry matter yields of stems, leaves, cobs, and grain are presented in tables 13, 14 and 15 and in figures 11 through 16. The percentages of dry matter contained

Table 13. --Dry matter yields of stalks and leaves for two varieties of corn grown for silage at different populations. -Koella Farm, M. E. S., 1961. *

| Desired population plants per acre | Row width feet | Actual population plants per acre | Dry matter yield tons per acre | | |
|---|---|---|---|---|---|
| | | | Stalks | Leaves | Total |
| | | Dixie 33 | | | |
| 8,000 | 3 | 9,380 | 1.6 | 1.0 | 2.6a |
| 12,000 | 3 | 13,010 | 2.1 | 1.3 | 3.4a |
| 16,000 | 3 | 16,270 | 2.1 | 1.4 | 3.5a |
| 20,000 | 3 | 18,990 | 2.2 | 2.1 | 4.3a |
| 24,000 | 3 | 23,110 | 2.4 | 1.6 | 4.0a |
| 36,000 | 3 | 30,070 | 2.6 | 1.8 | 4.4a |
| 36,000 | 1 | 37,390 | 8.8 | 1.6 | 10.4b |
| 48,000 | 1 | 48,340 | 9.9 | 1.6 | 11.5b |
| 72,000 | 1 | 67.760 | 5.4 | 1.8 | 8.2c |
| 100,000 | 1 | 82,890 | 4.6 | 2.1 | 6.7c |
| s | | | 1.14 | 0.656 | 1.16 |
| $s_{\bar{x}}$ | | | 0.571 | 0.328 | 0.581 |
| C. V. | | | 27.4 | 37.3 | 20.0 |
| | | Tennessee 501 | | | |
| 8,000 | 3 | 9,320 | 1.7 | 0.9 | 2.6x |
| 12,000 | 3 | 10,890 | 2.0 | 1.1 | 3.1x |
| 16,000 | 3 | 16,430 | 2.3 | 1.3 | 3.6x |
| 20,000 | 3 | 19,060 | 2.4 | 1.6 | 4.0x |
| 24,000 | 3 | 22,690 | 2.4 | 1.6 | 4.0x |
| 36,000 | 3 | 30,980 | 2.6 | 1.7 | 4.3x |
| 36,000 | 1 | 37,630 | 9.1 | 1.4 | 10.5 |
| 48,000 | 1 | 46,530 | 11.0 | 1.3 | 12.3 |
| 72,000 | 1 | 61,890 | 4.9 | 1.8 | 6.7z |
| 100,000 | 1 | 80,770 | 4.3 | 2.1 | 6.4z |
| s | | | 1.18 | 0.381 | 1.18 |
| $s_{\bar{x}}$ | | | 0.592 | 0.191 | 0.889 |
| C. V. | | | 27.6 | 25.8 | 20.5 |

* Values having the same symbols are not significantly different at P = .05

Table 14. --Dry matter yields of stalks, leaves, cobs and grain and bushels of grain yield for two varieties of corn grown for silage at different populations. -M. T. E. S., 1961.*

| Desired population plants per acre | Row width feet | Actual population plants per acre | Dry matter yield tons per acre | | | | | Grain yield bushels per acre |
|---|---|---|---|---|---|---|---|---|
| | | | Stalks | Leaves | Cobs | Grains | Total | |
| | | | Dixie 33 | | | | | |
| 12,000 | 3 | 13,450 | 2.4 | 1.3 | 0.4 | 2.7 | 6.8 | 96.7 |
| 16,000 | 3 | 17,000 | 2.8 | 1.7 | 0.5 | 3.1 | 8.1ab | 110.0a |
| 20,000 | 3 | 19,940 | 2.5 | 1.8 | 0.4 | 3.0 | 7.7 b | 107.3a |
| 24,000 | 3 | 23,350 | 2.7 | 1.9 | 0.4 | 3.1 | 8.1ab | 112.2a |
| 36,000 | 3 | 33,880 | 2.9 | 2.3 | 0.4 | 3.1 | 8.7a | 109.4a |
| 36,000 | 1 | 34,890 | 2.9 | 2.3 | 0.5 | 3.0 | 8.7a | 106.2a |
| 72,000 | 1 | 61,350 | 4.5 | 2.8 | 0.3 | 1.0 | 8.6a | 37.6 |
| s | | | 0.430 | 0.298 | 0.106 | | 0.559 | 5.57 |
| $s_{\bar{x}}$ | | | 0.215 | 0.149 | 5.32 | | 0.280 | 2.79 |
| C. V. | | | 14.5 | 14.9 | 25.5 | | 6.9 | 5.7 |
| | | | Tennessee 501 | | | | | |
| 12,000 | 3 | 12,240 | 3.2 | 0.8 | 0.6 | 1.7 | 6.3a | 60.6z |
| 16,000 | 3 | 15,730 | 3.0 | 1.1 | 0.6 | 1.7 | 6.4a | 62.2zy |
| 20,000 | 3 | 19,480 | 3.2 | 1.2 | 0.6 | 1.7 | 6.7ab | 65.5zy |
| 24,000 | 3 | 22,810 | 3.2 | 1.4 | 0.6 | 2.0 | 7.2ab | 70.1 y |
| 36,000 | 3 | 33,640 | 3.1 | 1.8 | 0.5 | 2.0 | 7.4ab | 68.1 y |
| 36,000 | 1 | 34,120 | 3.4 | 2.0 | 0.5 | 1.8 | 7.7 b | 63.0zy |
| 72,000 | 1 | 63,340 | 3.5 | 2.6 | 0.2 | 0.8 | 7.1ab | 28.4 |
| s | | | 0.747 | 0.284 | 6.25 | | 0.700 | 5.70 |
| $s_{\bar{x}}$ | | | 0.373 | 0.142 | 3.12 | | 0.350 | 2.85 |
| C. V. | | | 23.3 | 18.2 | 11.7 | | 10.1 | 9.6 |

*Values having the same symbols are not significantly different at P = .05

Table 15.--Dry matter yields of stalks, leaves, cobs and grain and bushels of grain yield for two varieties of corn grown for silage at different populations.-H. R. E. S., 1961.*

| Desired population plants per acre | Row width feet | Actual population plants per acre | Dry matter yield tons per acre | | | | | Grain yield bushels per acre |
|---|---|---|---|---|---|---|---|---|
| | | | Stalks | Leaves | Cobs | Grains | Total | |
| | | | Dixie 33 | | | | | |
| 12,000 | 3 | 13,920 | 3.1 | 1.1 | 0.7 | 3.3 | 8.2a | 117.6a |
| 16,000 | 3 | 18,090 | 3.5 | 1.5 | 0.6 | 3.5 | 9.1ab | 125.5ab |
| 20,000 | 3 | 18,940 | 3.3 | 1.5 | 0.6 | 3.6 | 9.0ab | 129.7ab |
| 24,000 | 3 | 23,600 | 3.2 | 1.7 | 0.7 | 3.5 | 9.1ab | 126.2ab |
| 36,000 | 3 | 33,880 | 3.6 | 1.9 | 0.7 | 3.8 | 10.1cb | 136.4ab |
| 36,000 | 1 | 36,120 | 3.5 | 2.6 | 0.9 | 3.9 | 10.9c | 139.8 b |
| 72,000 | 1 | 64,800 | 4.2 | 2.8 | 0.6 | 3.3 | 10.9c | 118.0a |
| s | | | 0.456 | 0.337 | 0.175 | | .792 | 12.47 |
| $s_{\bar{x}}$ | | | 0.228 | 0.169 | 8.75 | | .396 | 6.23 |
| C. V. | | | 13.1 | 18.1 | 25.6 | | 8.3 | 9.8 |
| | | | Tennessee 501 | | | | | |
| 12,000 | 3 | 13,670 | 2.7 | 1.1 | 0.6 | 1.7 | 6.1 | 61.8 |
| 16,000 | 3 | 17,360 | 3.9 | 1.1 | 0.6 | 2.0 | 7.6z | 72.4z |
| 20,000 | 3 | 20,630 | 3.3 | 1.4 | 0.6 | 2.1 | 7.4z | 75.5z |
| 24,000 | 3 | 24,140 | 3.9 | 1.5 | 0.7 | 2.1 | 8.2z | 74.7z |
| 36,000 | 3 | 34,120 | 4.4 | 1.9 | 0.7 | 2.2 | 9.2y | 78.7zy |
| 36,000 | 1 | 37,120 | 4.5 | 1.9 | 0.7 | 2.6 | 9.7y | 83.4 y |
| 72,000 | 1 | 65,890 | 4.3 | 2.7 | 0.6 | 2.1 | 9.7y | 74.3z |
| s | | | 0.749 | 0.209 | 5.15 | | 0.641 | 5.231 |
| $s_{\bar{x}}$ | | | 0.374 | 0.105 | 2.58 | | 0.320 | 2.01 |
| C. V. | | | 19.3 | 12.7 | 8.1 | | 7.8 | 7.2 |

*Values having the same symbols are not significantly different at P = .05

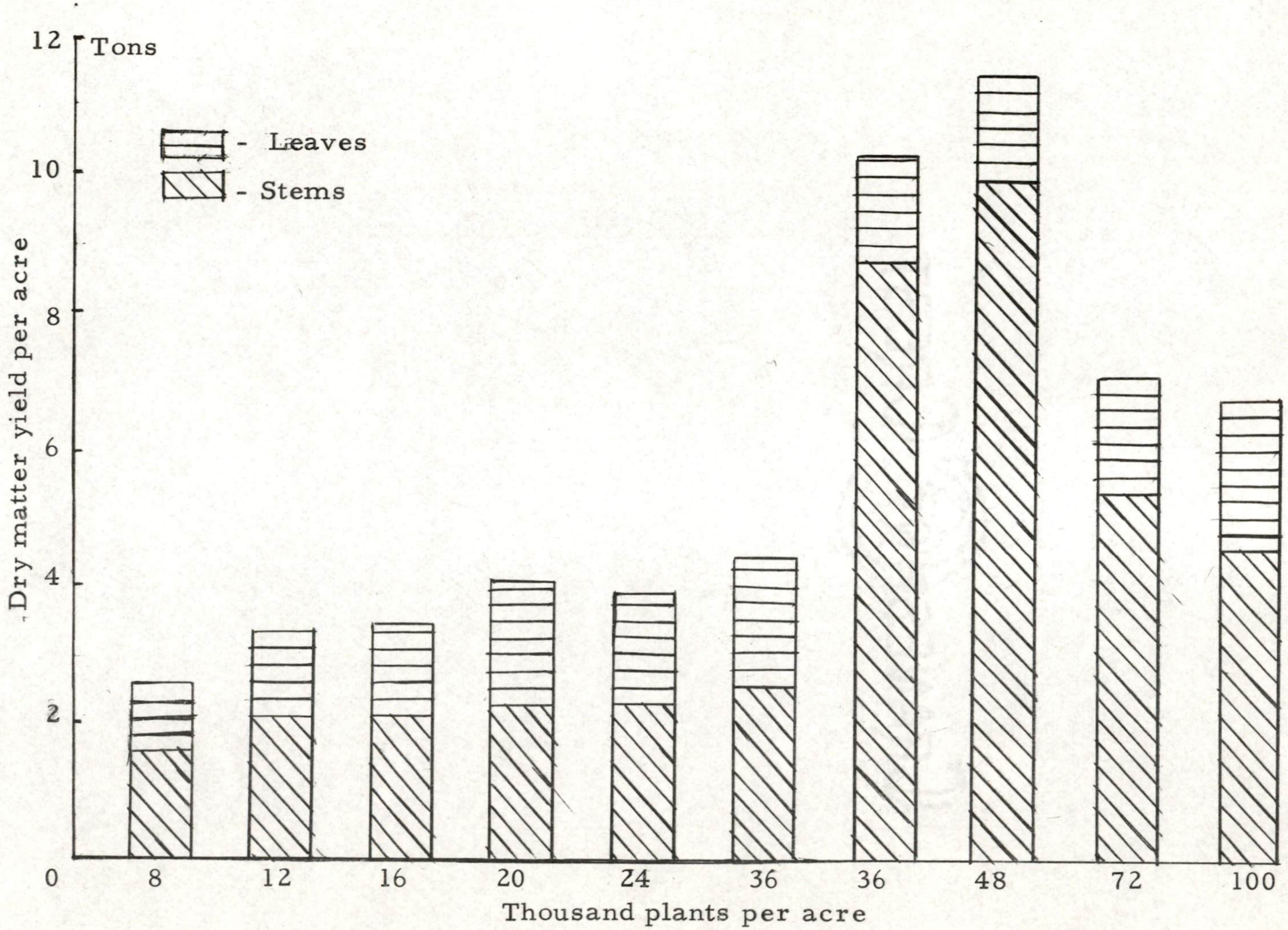


Figure 11. --Dry matter yields of stems and leaves in tons per acre . - Dixie 33 corn grown for silage at different populations. -Koella Farm, M. E. S., 1961.

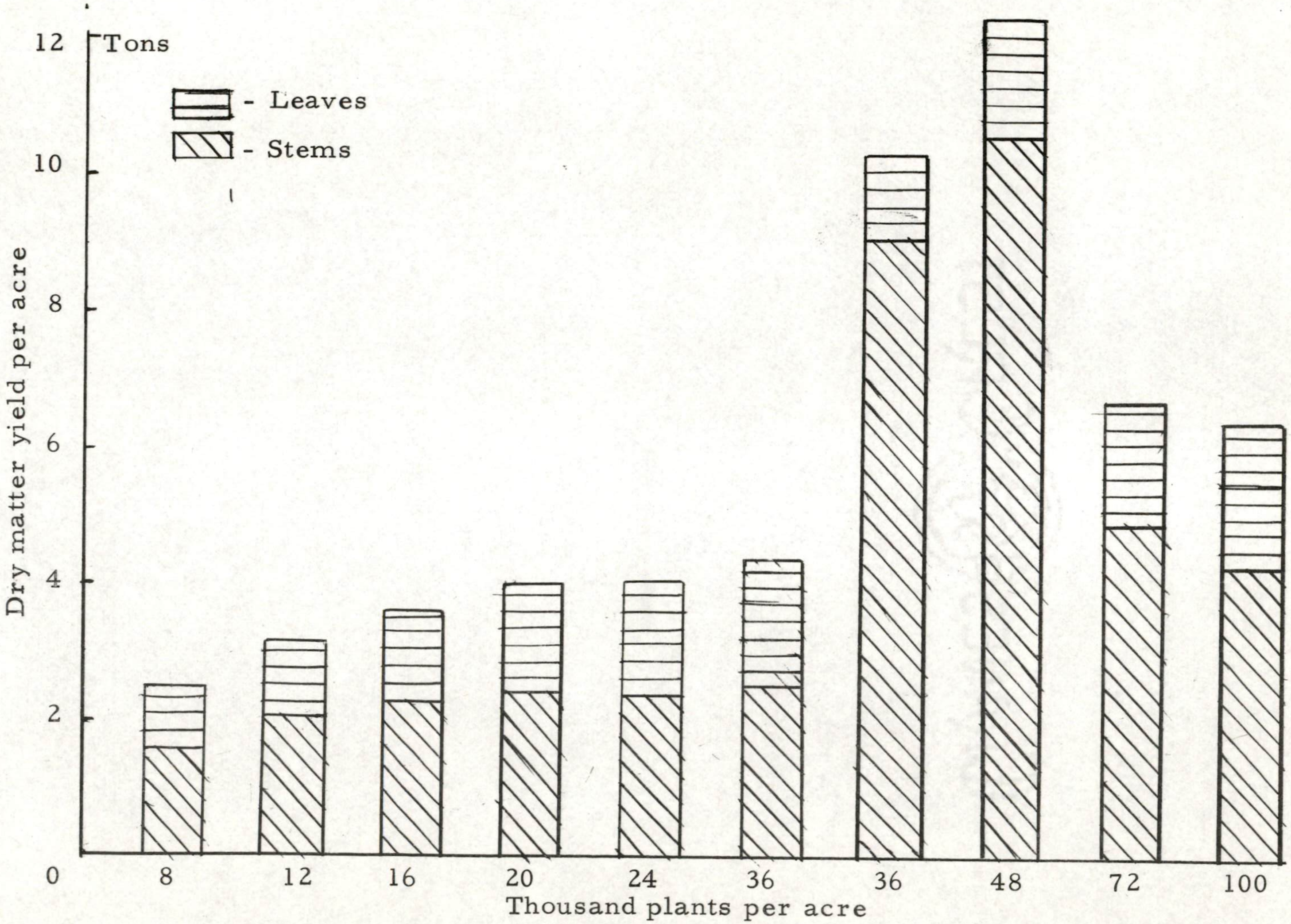


Figure 12. --Dry matter yields of stems and leaves in tons per acre. -Tennessee 501 corn grown for silage at different populations. -Koella Farm, M. E. S., 1961.

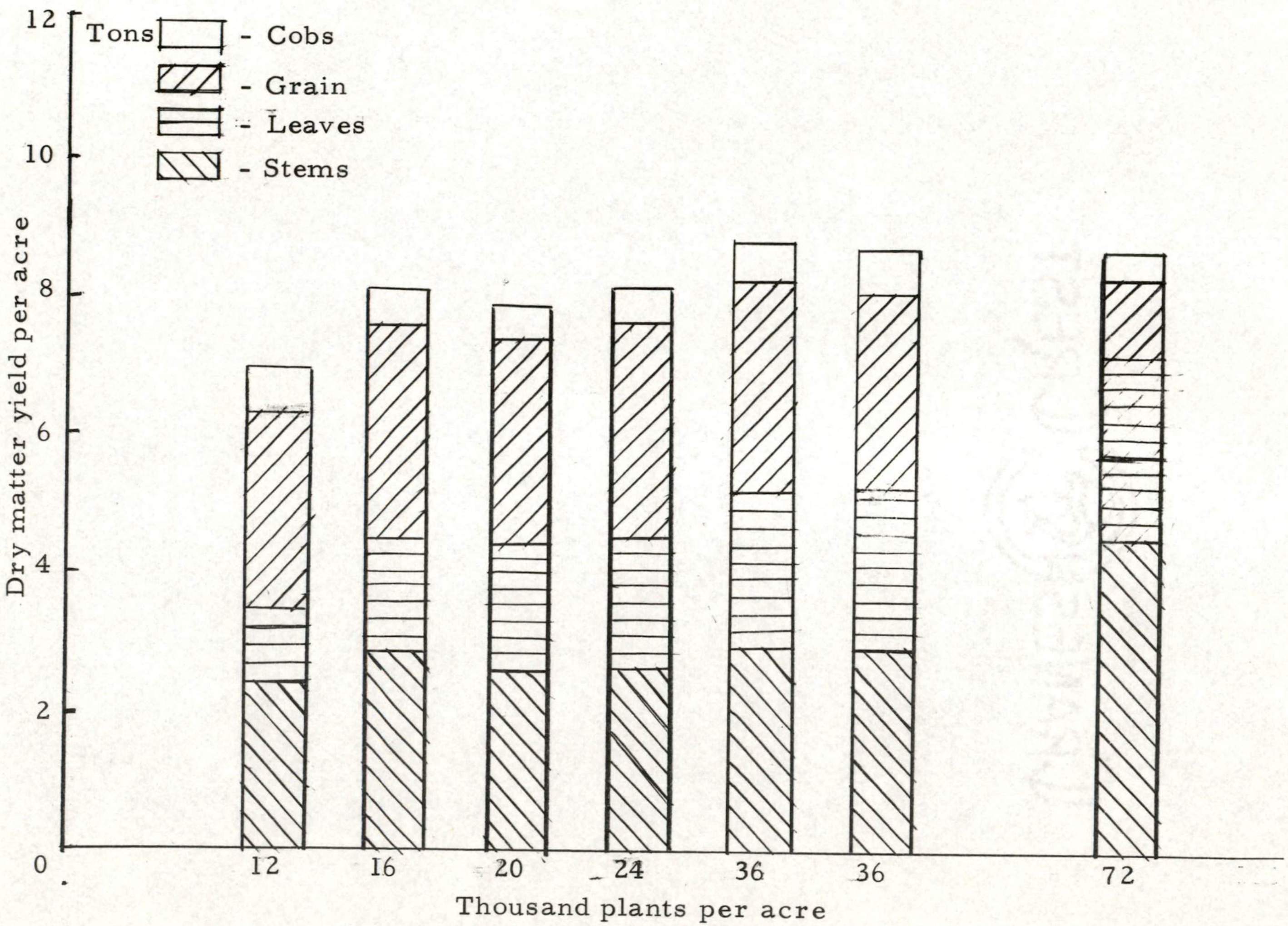


Figure 13. --Dry matter yields of stems, leaves, cobs and grain in tons per acre. -Dixie 33 corn grown for silage at different populations. -M. T. E. S., 1961.

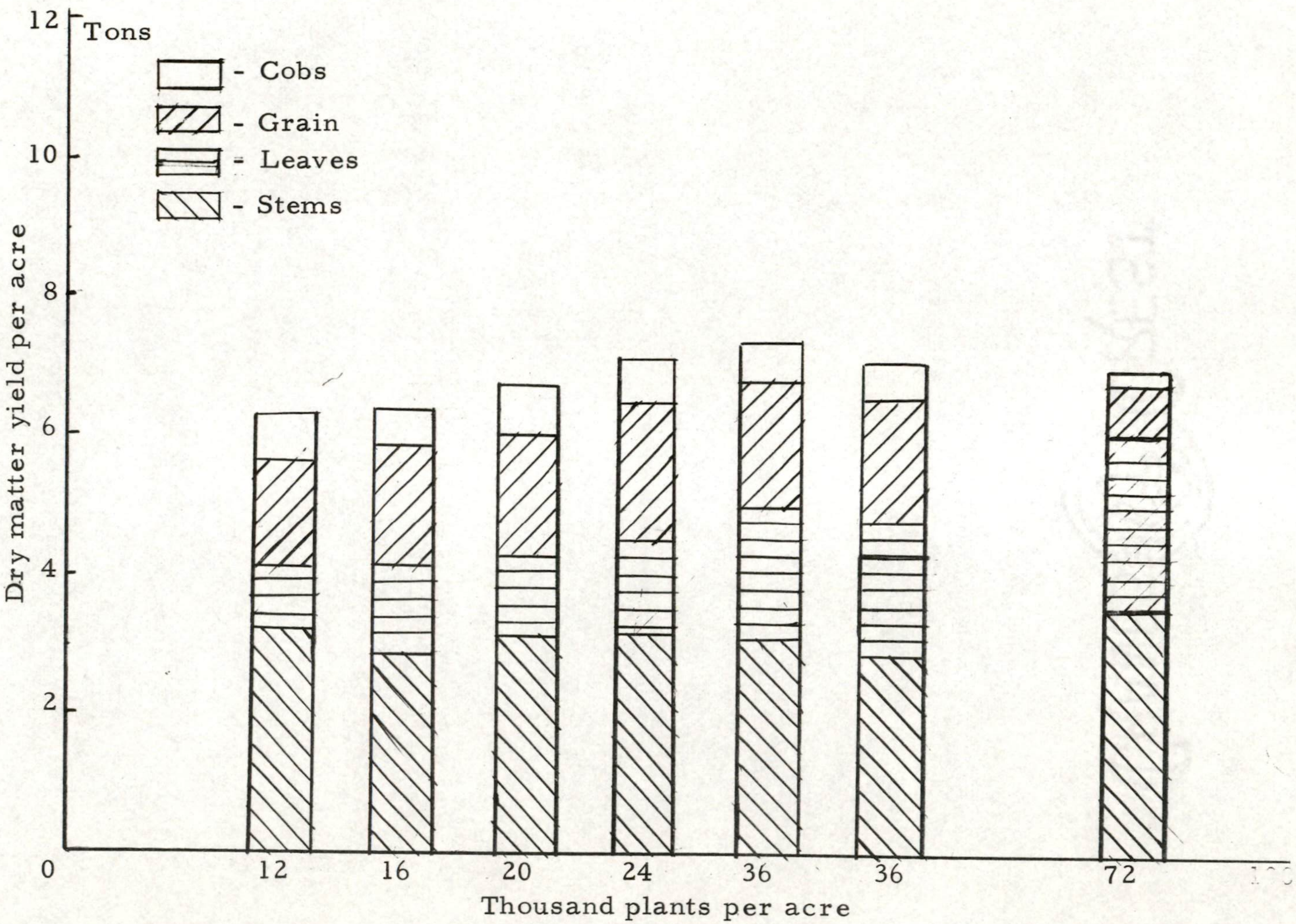


Figure 14.--Dry matter yields of stems, leaves, cobs and grain, in tons per acre.-Tennessee 501 corn grown for silage at different populations.- M. T. E. S., 1961.

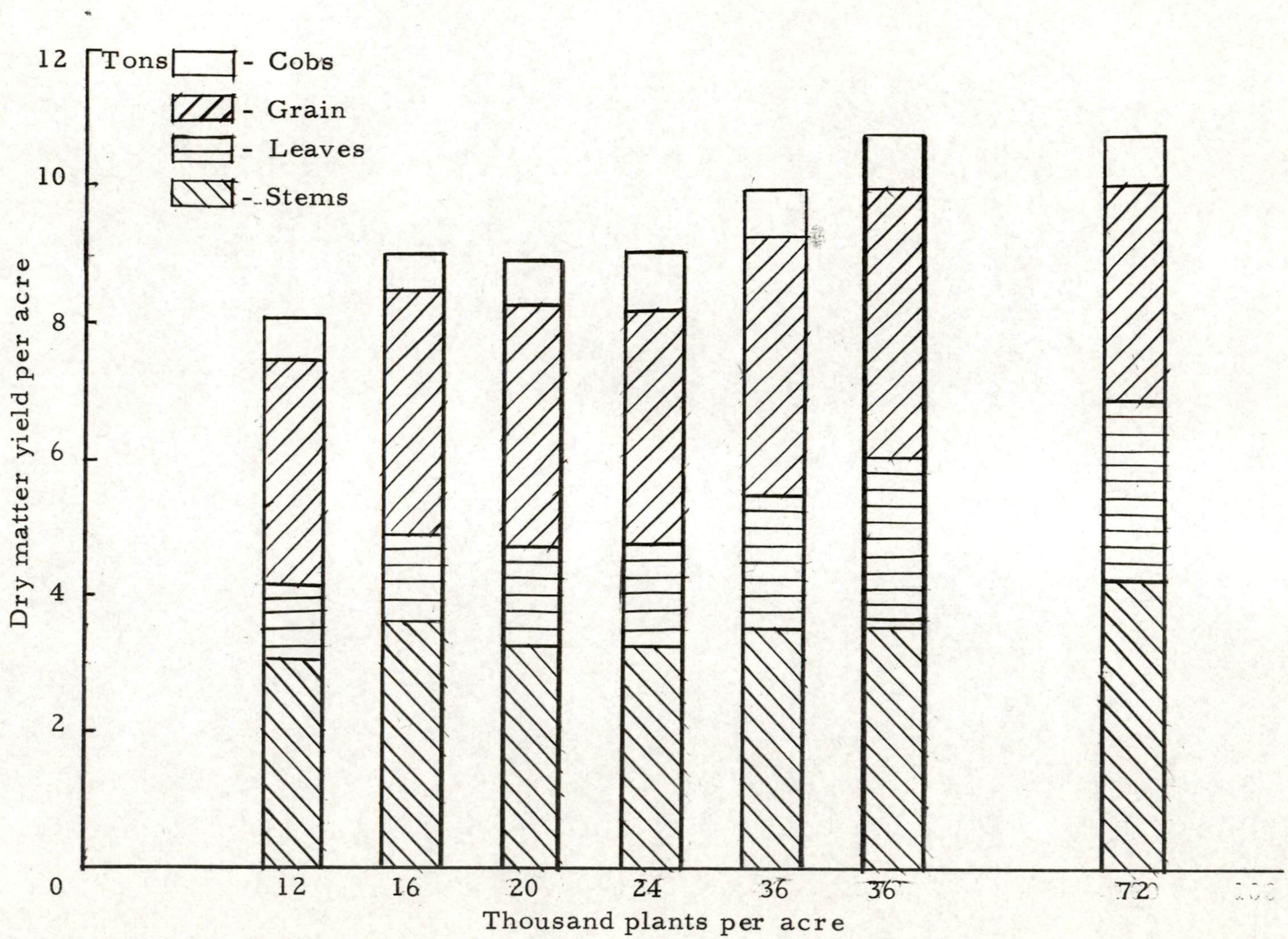


Figure 15. --Dry matter yields of stems, leaves, cobs and grain in tons per acre. -Dixie 33 corn grown for silage at different populations. -H. R. E. S., 1961.

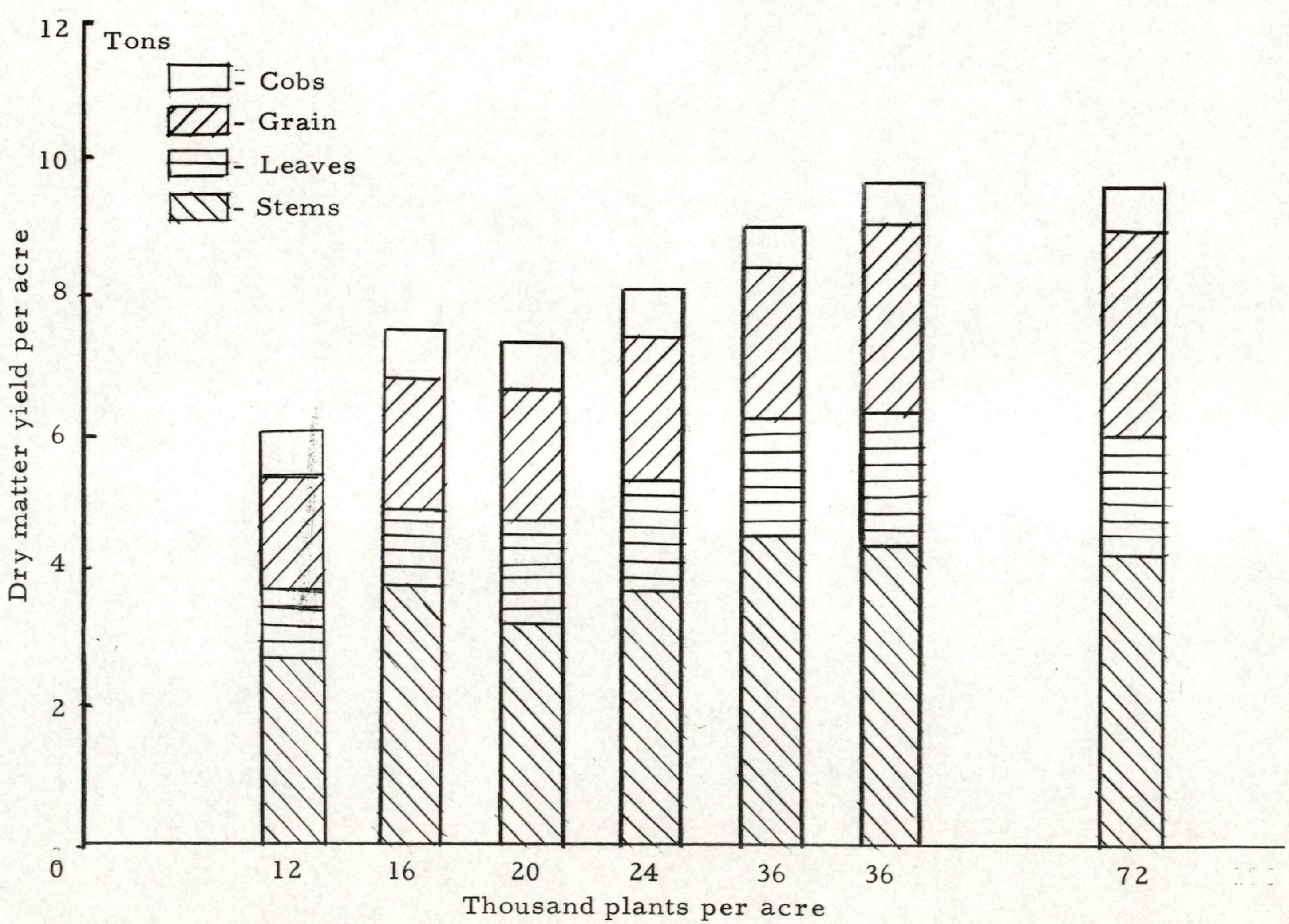


Figure 16.--Dry matter yields of stems, leaves, cobs and grain in tons per acre.-Tennessee 501 corn grown for silage at different populations.-H.R.E.S., 1961.

in leaves and stems making up the stover weight and the percentages of dry grain in total dry matter are presented in tables 16, 17 and 18.

The results show different trends at the several locations as to the influence of population on dry matter production. At the Koella Farm, where the crop was cut at the mid-tasseling stage, the total dry matter increased with population up to 48,000 PPA. Dry matter yields at 36,000 PPA in 1-foot rows and at 48,000 PPA were more than double the yields obtained from 36,000 PPA in 3-foot rows and from lower populations. The high total dry matter yields were attributed to stem yields. This is in contrast to the green yields obtained at these populations, which were not among the highest measured. The next highest yields were in the 72,000 and 100,000 PPA treatments which produced amounts of dry matter intermediate between the two extremes mentioned above, and which were not significantly different. The yields of the treatments of 8,000 to 24,000 PPA were not significantly different from each other and formed the lowest yielding group. These trends were observed for both Dixie 33 and Tennessee 501.

At M.T.E.S., the total dry matter yields of Dixie 33 at populations of 16,000 PPA, 24,000 PPA or more were not significantly different, but were higher than those from other populations. The yield at 12,000 PPA was significantly lower than those at other populations. The dry matter yield at 20,000 PPA was higher than that at 12,000 PPA, but not significantly different from those of the 16,000 and 24,000 PPA treatments. At this location, the dry matter yields of Tennessee 501 were affected by population in a manner similar to the effects on

Table 16.--Percentage distribution of stover dry matter yields between stalks and leaves for each of two varieties of corn grown for silage at different populations.-M.E.S., 1961.

| Desired population plants per acre | Row width feet | Actual population plants per acre | % dry matter yields of stover | |
|---|---|---|---|---|
| | | | Stems | Leaves |
| | | Dixie 33 | | |
| 8,000 | 3 | 9,380 | 70.8 | 29.2 |
| 12,000 | 3 | 13,010 | 71.1 | 28.9 |
| 16,000 | 3 | 16,270 | 69.0 | 31.0 |
| 20,000 | 3 | 18,990 | 64.6 | 35.4 |
| 24,000 | 3 | 23,110 | 65.9 | 34.1 |
| 36,000 | 3 | 30,070 | 66.8 | 33.2 |
| 36,000 | 1 | 37,390 | 79.4 | 20.6 |
| 48,000 | 1 | 48,340 | 79.1 | 20.9 |
| 72,000 | 1 | 67,760 | 71.6 | 28.4 |
| 100,000 | 1 | 82,890 | 68.4 | 31.6 |
| | | Tennessee 501 | | |
| 8,000 | 3 | 9,320 | 75.1 | 24.9 |
| 12,000 | 3 | 10,890 | 74.0 | 26.0 |
| 16,000 | 3 | 16,430 | 72.3 | 27.7 |
| 20,000 | 3 | 19,060 | 70.4 | 29.6 |
| 24,000 | 3 | 22,690 | 70.0 | 30.0 |
| 36,000 | 3 | 30,980 | 68.3 | 31.7 |
| 36,000 | 1 | 37,630 | 81.0 | 19.0 |
| 48,000 | 1 | 46,530 | 82.3 | 17.7 |
| 72,000 | 1 | 61,890 | 70.6 | 29.4 |
| 100,000 | 1 | 80,770 | 68.4 | 31.6 |

Table 17.--Percentage distribution of stover dry matter yields between stalks and leaves and percent grain in total dry matter yields for each of two varieties of corn grown for silage at different populations. - M.T.E.S., 1961. *

| Desired population plants per acre | Row width feet | Actual population plants per acre | % dry matter yields of stover | | % grain in total dry yield |
|---|---|---|---|---|---|
| | | | Stalk | Leaves | |
| | | Dixie 33 | | | |
| 12,000 | 3 | 13,250 | 71.5 | 28.5 | 39.7a |
| 16,000 | 3 | 17,000 | 69.7 | 30.3 | 38.5a |
| 20,000 | 3 | 19,940 | 68.5 | 31.5 | 38.4a |
| 24,000 | 3 | 23,350 | 68.2 | 31.8 | 38.5a |
| 36,000 | 3 | 33,880 | 65.5 | 34.5 | 35.8a |
| 36,000 | 1 | 34,890 | 68.0 | 32.0 | 38.5a |
| 72,000 | 1 | 61,350 | 69.3 | 30.7 | 12.1 |
| s | | | | | 4.52 |
| $s_{\bar{x}}$ | | | | | 2.26 |
| C.V. | | | | | 13.1 |
| | | Tennessee 501 | | | |
| 12,000 | 3 | 12,240 | 76.7 | 23.3 | 26.5y |
| 16,000 | 3 | 15,730 | 71.4 | 28.6 | 27.4y |
| 20,000 | 3 | 19,480 | 72.9 | 27.1 | 27.0y |
| 24,000 | 3 | 22,810 | 70.5 | 29.5 | 27.6y |
| 36,000 | 3 | 33,640 | 66.9 | 33.1 | 25.9yz |
| 36,000 | 1 | 34,120 | 67.3 | 32.7 | 23.1z |
| 72,000 | 1 | 63,340 | 65.1 | 34.9 | 11.2 |
| s | | | | | 1.93 |
| $s_{\bar{x}}$ | | | | | 0.965 |
| C.V. | | | | | 8.0 |

* Values having the same symbols are not significantly different at P = .05

Table 18.--Percentage distribution of stover dry matter yields between stalks and leaves and percent grains in total dry matter yields for each of two varieties of corn grown for silage at different populations.-H.R.E.S., 1961.*

| Desired population plants per acre | Row width feet | Actual population plants per acre | % dry matter yields of stover | | % grain in total dry matter |
|---|---|---|---|---|---|
| | | | Stalks | Leaves | |
| | | Dixie 33 | | | |
| 12,000 | 3 | 13,920 | 75.7 | 24.3 | 40.5a |
| 16,000 | 3 | 18,090 | 72.0 | 28.0 | 40.8a |
| 20,000 | 3 | 18,940 | 72.4 | 27.6 | 40.5a |
| 24,000 | 3 | 23,600 | 69.9 | 30.1 | 39.4ab |
| 36,000 | 3 | 33,880 | 69.9 | 30.1 | 38.6ab |
| 36,000 | 1 | 36,120 | 69.9 | 30.1 | 36.8 b |
| 72,000 | 1 | 64,800 | 69.7 | 30.3 | 30.3 |
| s | | | | | 2.16 |
| $s_{\bar{x}}$ | | | | | 1.08 |
| C.V. | | | | | 5.7 |
| | | Tennessee 501 | | | |
| 12,000 | 3 | 13,670 | 75.5 | 24.5 | 28.6y |
| 16,000 | 3 | 17,360 | 77.8 | 22.2 | 26.9yz |
| 20,000 | 3 | 20,630 | 73.7 | 26.3 | 28.6y |
| 24,000 | 3 | 24,140 | 73.4 | 26.6 | 25.9 z |
| 36,000 | 3 | 34,120 | 73.0 | 27.0 | 24.2 z |
| 36,000 | 1 | 37,120 | 72.7 | 27.3 | 24.2 z |
| 72,000 | 1 | 65,890 | 67.9 | 32.1 | 21.4 |
| s | | | | | 1.81 |
| $s_{\bar{x}}$ | | | | | 0.905 |
| C.V. | | | | | 7.0 |

* Values having the same symbols are not significantly different at P = .05

Dixie 33 production. The yields at the 36,000 PPA treatment were the highest, but were not significantly different from those of all treatments from 20,000 PPA to 72,000 PPA. The range of total dry matter was so narrow that, except for the 36,000 PPA treatment in 1-foot rows, the yields of all other treatments were not significantly different.

At H.R.E.S., dry matter yields increased with increases in plant population up to the 36,000 PPA in 1-foot rows treatment and remained constant thereafter. There was no significant difference between the yields of either row-spacing at 36,000 PPA or between the yields obtained from 36,000 and 72,000 PPA. This occurred with both varieties. The yields at populations of 16,000 to 24,000 PPA were significantly lower than the yields obtained at higher populations and were not significantly different from one another.

In general, within the limits of these experiments, the dry matter yield increased with plant population up to 36,000 to 48,000 plants per acre when cut at the silage stage of growth. At higher populations, no significant increase or decrease in dry matter yield were observed. There was appreciable difference between the yields of the same variety at the three locations. As was the case for total green yields, the minimum yield (at the lowest population) from each variety at H.R.E.S. was not too different from the maximum yield obtained at M.T.E.S.

It should be noted that the range of dry matter production at different populations when the crop was cut at the early to mid-tasseling stage was very wide as compared to those cut at dent stage. The minimum dry matter produced at Koella Farm was 2.6 tons per acre; and this was much less than the minima harvested at either H.R.E.S. or M.T.E.S. (6.3 and 6.1 tons per acre, respectively). The dry matter yields at Koella Farm increased with plant population till they reached a maximum of 12.3 tons per acre at 48,000 plants per acre. This maximum value is in excess of the highest yield produced at either of the other two locations.

Some workers (21, 32, 33, 58, 60) have had the opinion that the optimum stage to cut corn for silage is when the grains are well-formed, for the reason that the total dry matter yield was higher at this stage than at earlier stages. Most investigators have studied the stage of cutting of silage corn at comparatively low plant populations, below 35,000 PPA. The data obtained in this experiment show that the dry matter yields of corn harvested at tasseling stage was low as compared to the dry matter yields of corn cut at dent stage, if the plant population was low. On the other hand, when the PPA was 36,000 or 48,000 in 1-foot rows, the dry matter yield of corn cut at tasseling stage exceeded the dry matter yields of those cut at dent stage. No ready explanations could be offered for this phenomenon. However most of the workers compared the stages of cutting only at plant populations lower than 35,000 PPA, and therefore this situation was not observed. Much of this high yield of dry matter obtained at Koella Farm at 36,000 PPA and 48,000 PPA was contributed by the stems; the contribution by leaves was not appreciable.

The yield of leaves also increased as the PPA increased in both varieties. The increase was gradual, and at Koella Farm the increase was not regular.

There was no apparent relationship between the yield of dry matter of stems and plant population at M.T.E.S. and H.R.E.S.

At the Koella Farm, there was a gradual increase in the stem dry weight yields with increase in population, until a maximum was reached at the 48,000 PPA treatment; thereafter there was a slight reduction in stem dry weight.

The percent leaf in the stover generally increased as the PPA treatment increased at M.T.E.S. and H.R.E.S. The increase was rather small and gradual. At the Koella Farm no definite relationship of percentage of leaves to the plant population was established— except for the fact that at 48,000 PPA and at the 36,000 PPA 1-foot row treatments the percentages of leaves were comparatively low. The percent stem in the stover varied inversely to the percent leaf, since the stover weight was made up of the total of leaf and stem weights.

Grain yields. The corn grain obtained from the field in this experiment was dried and the remaining moisture measured. The total dry weight of grain is tabulated as 15.5% moisture bushels per acre. Therefore, though the crop was harvested at the silage stage, the dry weights of corn grain reported here are on a basis comparable to that used normally for reporting yields harvested at maturity.

Within the limits of the population treatments, the yield of grain first increased with the increase in PPA and then decreased. At M.T.E.S. the highest yield was at 24,000 PPA treatment and the lowest at 72,000 PPA treatment for both varieties. The yield of grain was not significantly affected when the PPA treatment was varied from 16,000 to 36,000 in both varieties; but it was significantly different from those of 12,000 and 72,000 PPA. The highest yields at this station were 112.2 bushels per acre for Dixie 33 and 70.1 bushels per acre for Tennessee 501.

At the H.R.E.S. the highest grain yields for Dixie 33 and Tennessee 501 were 139.8 bushels per acre and 83.4 bushels per acre, respectively; the latter were obtained in 1-foot rows of the 36,000 PPA treatment. At this location also there was no significant difference in grain yields when the plant population was varied between 16,000 and 36,000 PPA. However, there were significant differences between the grain yields of these populations and those of the remaining populations—12,000 and 72,000 PPA. In Tennessee 501, the two 36,000 PPA treatments stood out as the two yielding the highest amount of grain and were significantly different in this respect from other population treatments. The 3-foot row treatment of 36,000 PPA was significantly different from the 72,000 and 16,000 PPA treatments only.

In both varieties the lowest grain yield at M.T.E.S. was 72,000 PPA treatment, while at H.R.E.S. the lowest was at 16,000 PPA treatment. In the latter case there was no significant difference between the yields of 16,000 PPA and 72,000 PPA for Dixie 33. There was marked difference between locations and between varieties with regard to the grain yield. The explanations that can be offered for these differences are the same as those offered for similar differences in total grain yields.

<u>Percent grain in total dry matter yield.</u> When corn is grown for silage, the grain content of the total dry matter production has to receive particular attention for, as stated by Huffman and Duncan (33) corn silage is not just a roughage but a mixture of roughage and grain. Several workers (21, 32, 33, 38, 57, 58, 60, 62) have stressed the role of corn silage as an outstanding roughage in dairy production and in calf feeding (19). These roles of corn silage are largely dependent upon the fact that corn silage contains a considerable

percentage of grain. Furthermore, Nevens et al. (60) after studying the dry matter yields of the leaf, stalk and ear portions of corn forage for several years, found a correlation of 0.964 between the dry ear content and the total dry matter content in corn forage.

In this experiment, at M. T. E. S. the highest grain percentages were produced at the 12,000 PPA treatment for Dixie 33 and at the 24,000 PPA treatment for Tennessee 501. However, in either variety the percent grain at these two populations were not significantly different from those of plant population treatments varying from 12,000 PPA to 36,000 PPA. The range of percent grain in total dry matter was from 12.1 to 39.7 for Dixie 33 and from 11.2 to 27.6 for Tennessee 501. When the plant population was increased to 72,000 PPA treatment the grain content decreased sharply to 12.1% and 11.2% in Dixie 33 and Tennessee 501, respectively.

At the H. R. E. S. the percent grain in total dry matter varied similarly to the way in which it did at the M. T. E. S. The highest grain contents were 40.8% and 28.6% at the 16,000 PPA treatment of Dixie 33 and 20,000 PPA treatment of Tennessee 501, respectively. With Dixie 33, the highest content was not significantly different from that at 12,000 PPA to 36,000 PPA, and with Tennessee 501 the highest grain content was not significantly different from that at the 12,000 and 20,000 PPA treatments. The lowest percentages of grains were 30.3% and 21.4% in the two varieties Dixie 33 and Tennessee 501; these were produced at 72,000 PPA treatments. At the 36,000 PPA treatments, Tennessee 501 produced significantly lower grain percentages than those at lower populations, a situation quite different from that encountered with Dixie 33.

Thus, considering both varieties together the grain content in total dry yield varied from 11.2% to 39.7% at M.T.E.S. and from 21.4% to 40.5% at H.R.E.S. Within the limits of the experiment there was less reduction in percent grain at the H.R.E.S. as the plant population increased. This is probably attributable to the higher level of nitrogen fertilization and moisture supply capacity at the grain maturation period of the Huntington silt loam soil at H.R.E.S. than that of the Maury silt loam at M.T.E.S. These percentages of grain are well above those indicated by Huffman and Duncan (33) but do not agree with the very high grain percentages (up to 70% of the feeding value) indicated by Caldwell (15).

The relationships among the total green yields, total dry matter yields and the percentages of grain in total dry matter yields at different plant populations are presented graphically in figures 17 through 22.

The green yield increased gradually when the PPA treatment increased from the lowest to the highest population. On the other hand, the dry matter yields increased with the increases in population up to 36,000 PPA and thereafter behaved differently at different locations. At the Koella Farm, the dry matter yield increased rather sharply when the plant population was increased from 36,000 (3-foot rows) PPA to 48,000 PPA and decreased considerably with further increases in plant population. This writer does not find any ready explanation under his experimental conditions for such marked increases and decreases which occured in both varieties. At the M.T.E.S., when the plant population increased above 36,000 PPA, the dry matter yield decreased slightly; but at the H.R.E.S. it increased slightly. This difference between M.T.E.S. and H.R.E.S. with respect to

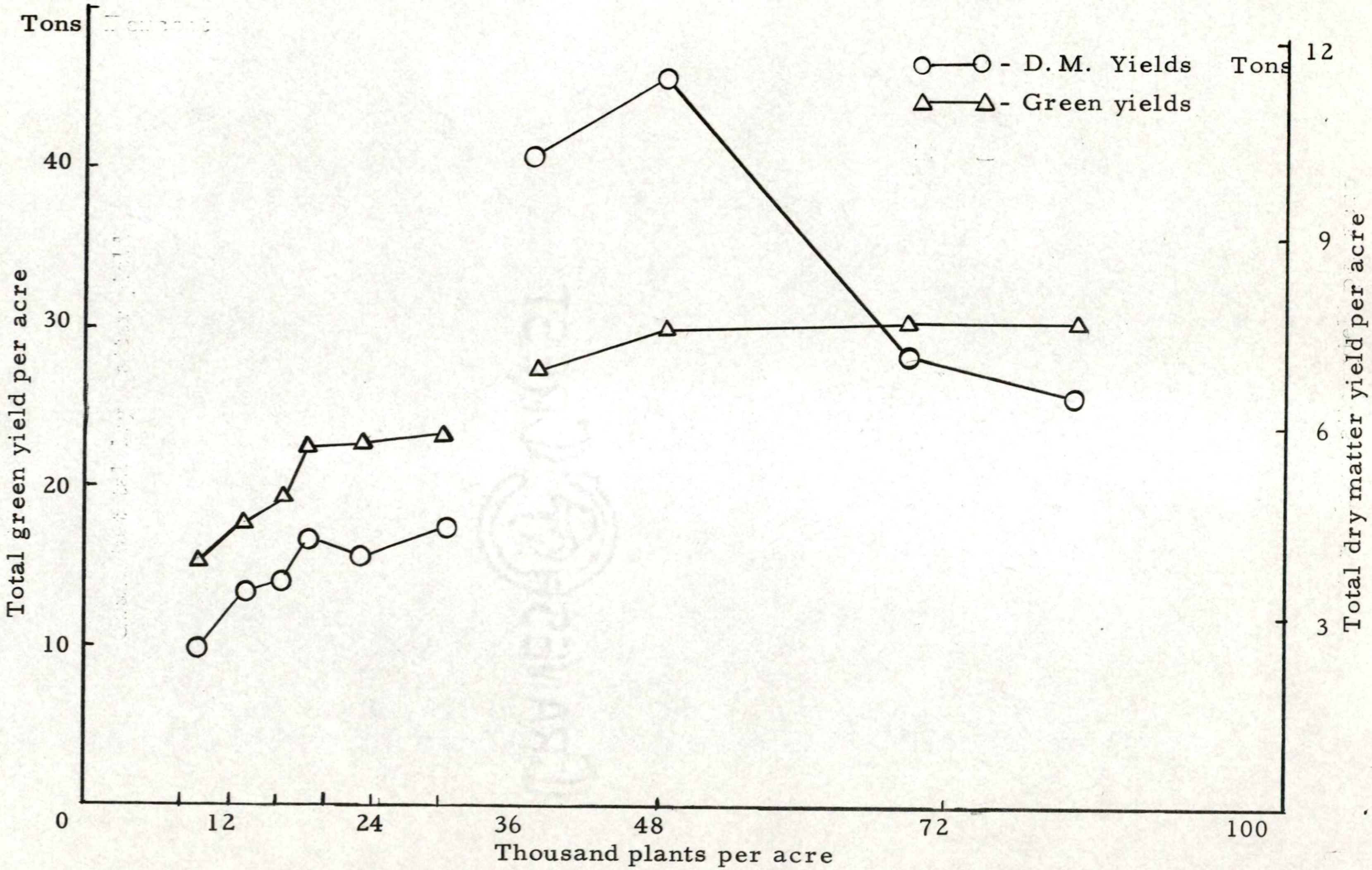


Figure 17.--Total yields of green and dry matter in tons per acre.-Dixie 33 corn grown for silage at different populations.-M. T. E. S., 1961.

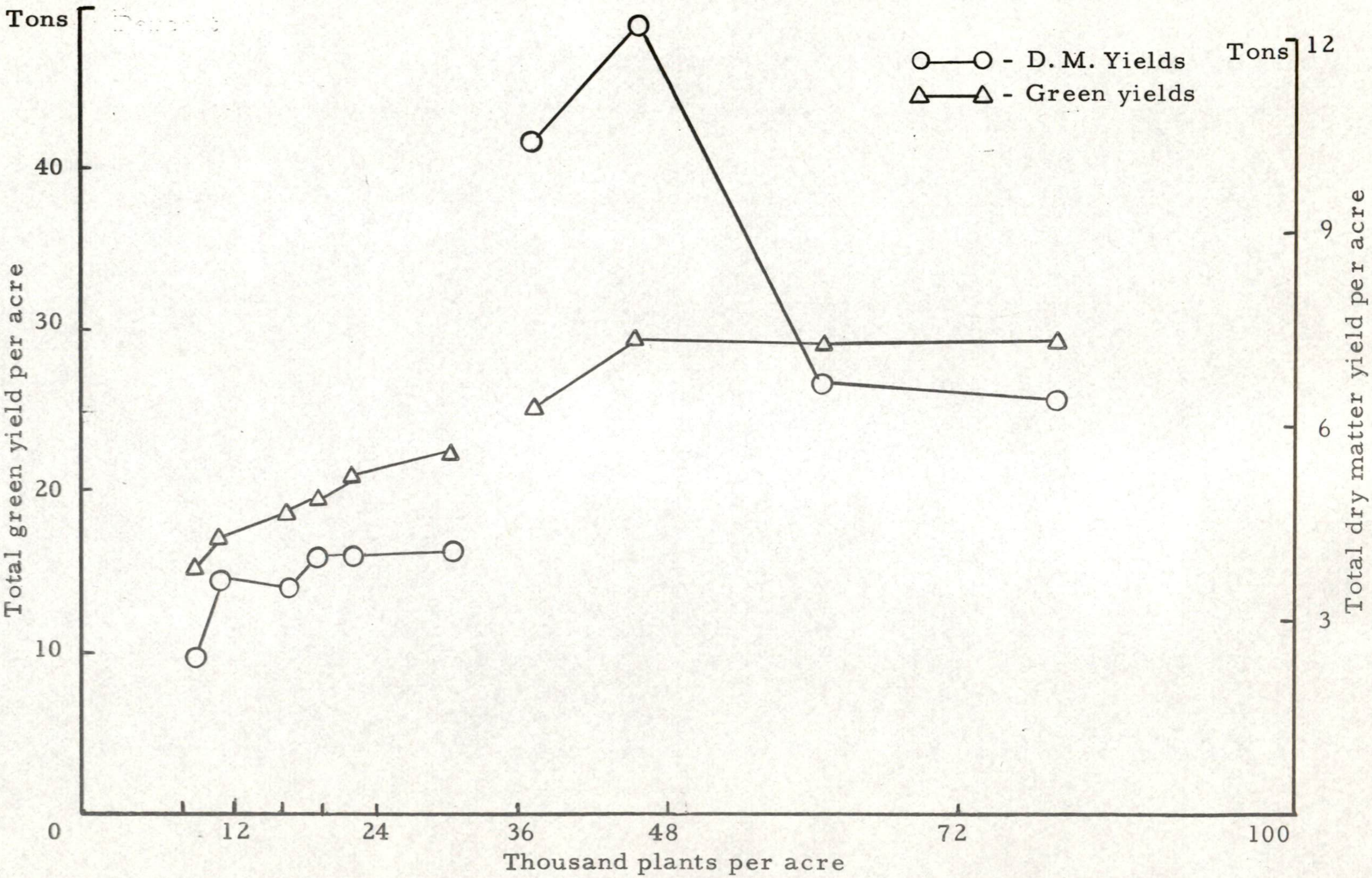


Figure 18. --Total yields of green and dry matter in tons per acre. -Tennessee 501 corn grown for silage at different populations. -Koella Farm, M. E. S., 1961.

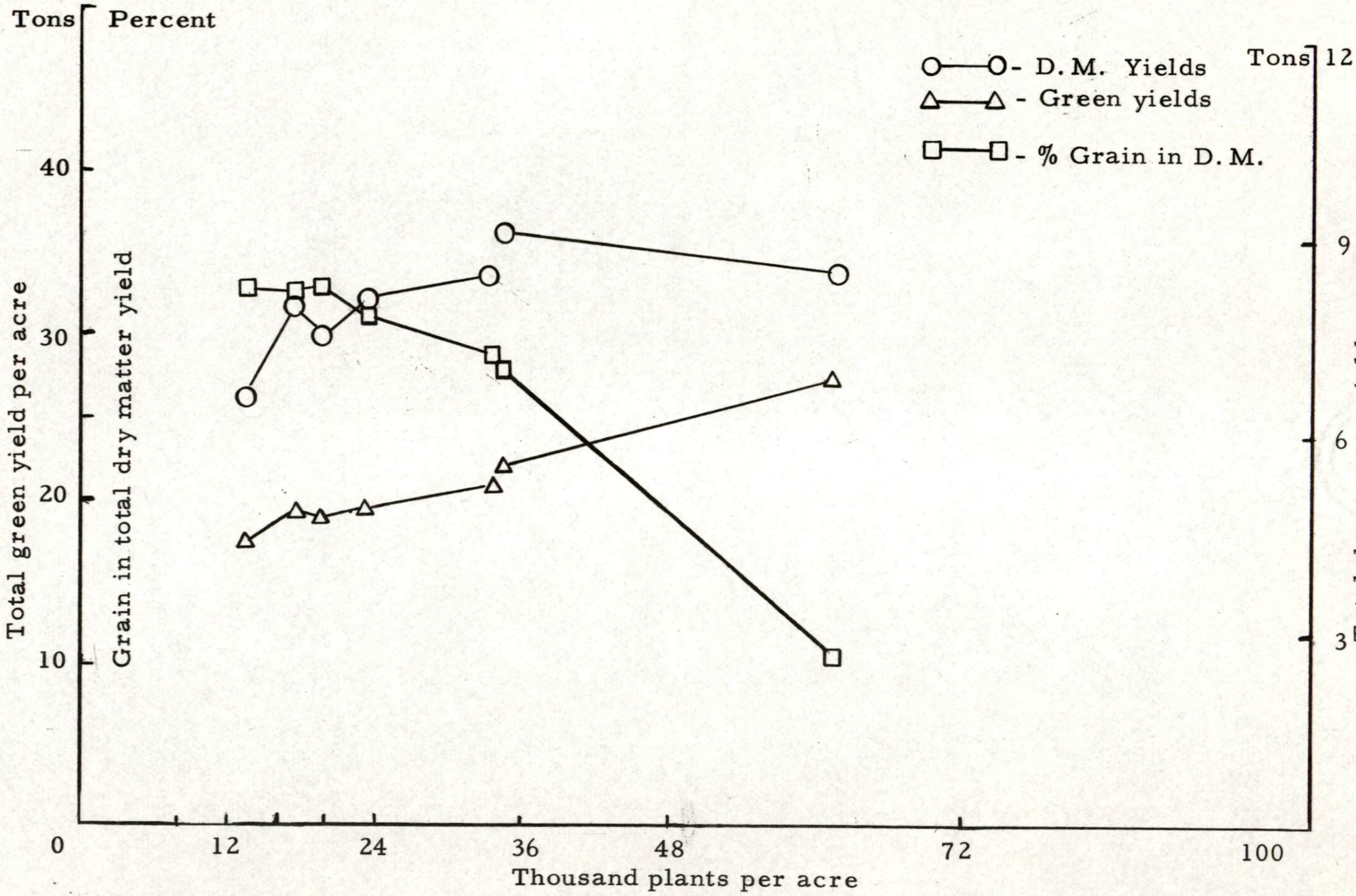


Figure 19. --Total yields of green and dry matter in tons per acre and percent grain in total dry matter yields. -Dixie 33 corn grown for silage at different populations. -M. T. E. S., 1961.

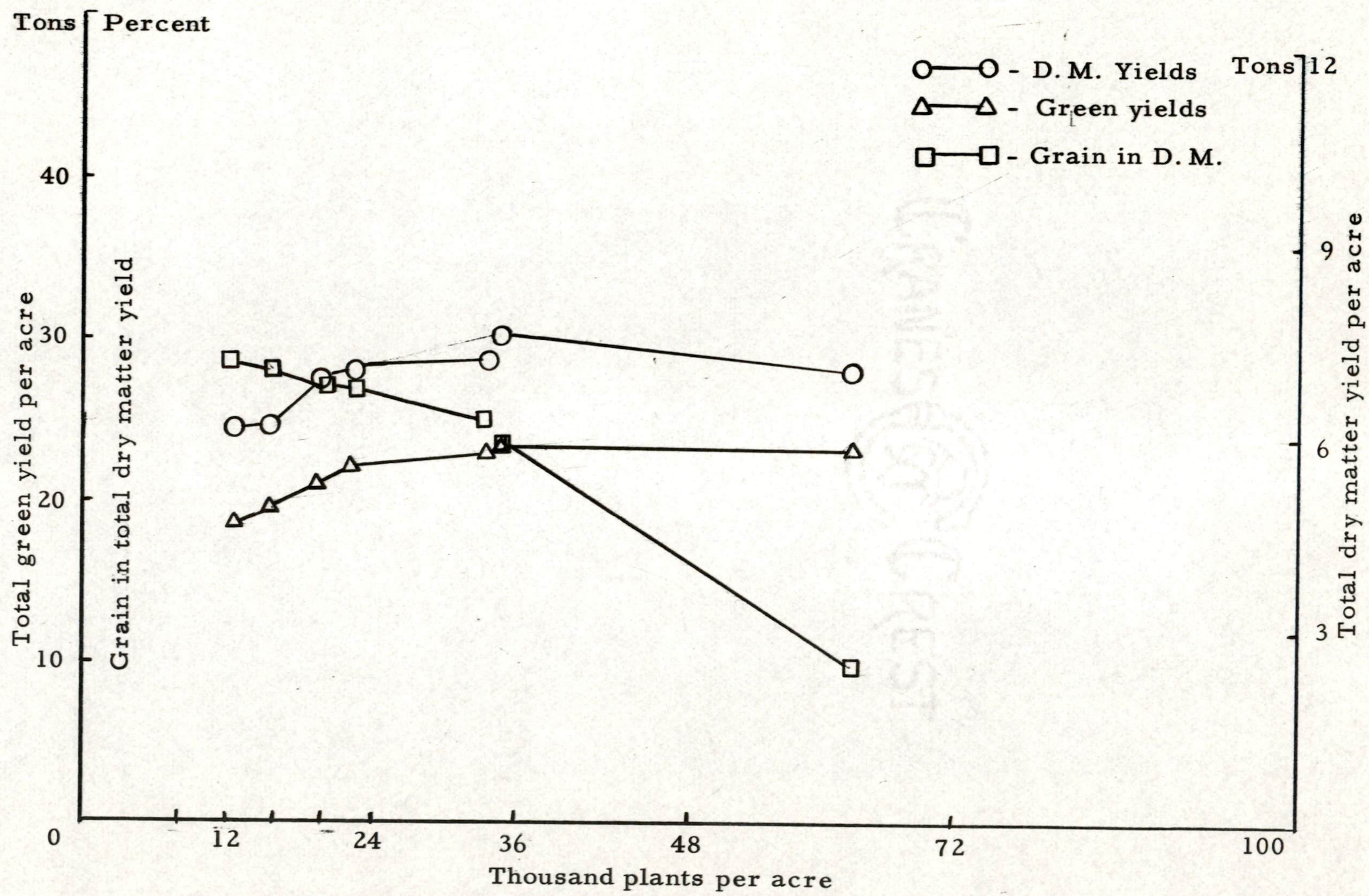


Figure 20.--Total yields of green and dry matter in tons per acre and percent grain in total dry matter yields.-Tennessee 501 corn grown for silage at different populations.-M. T. E. S., 1961.

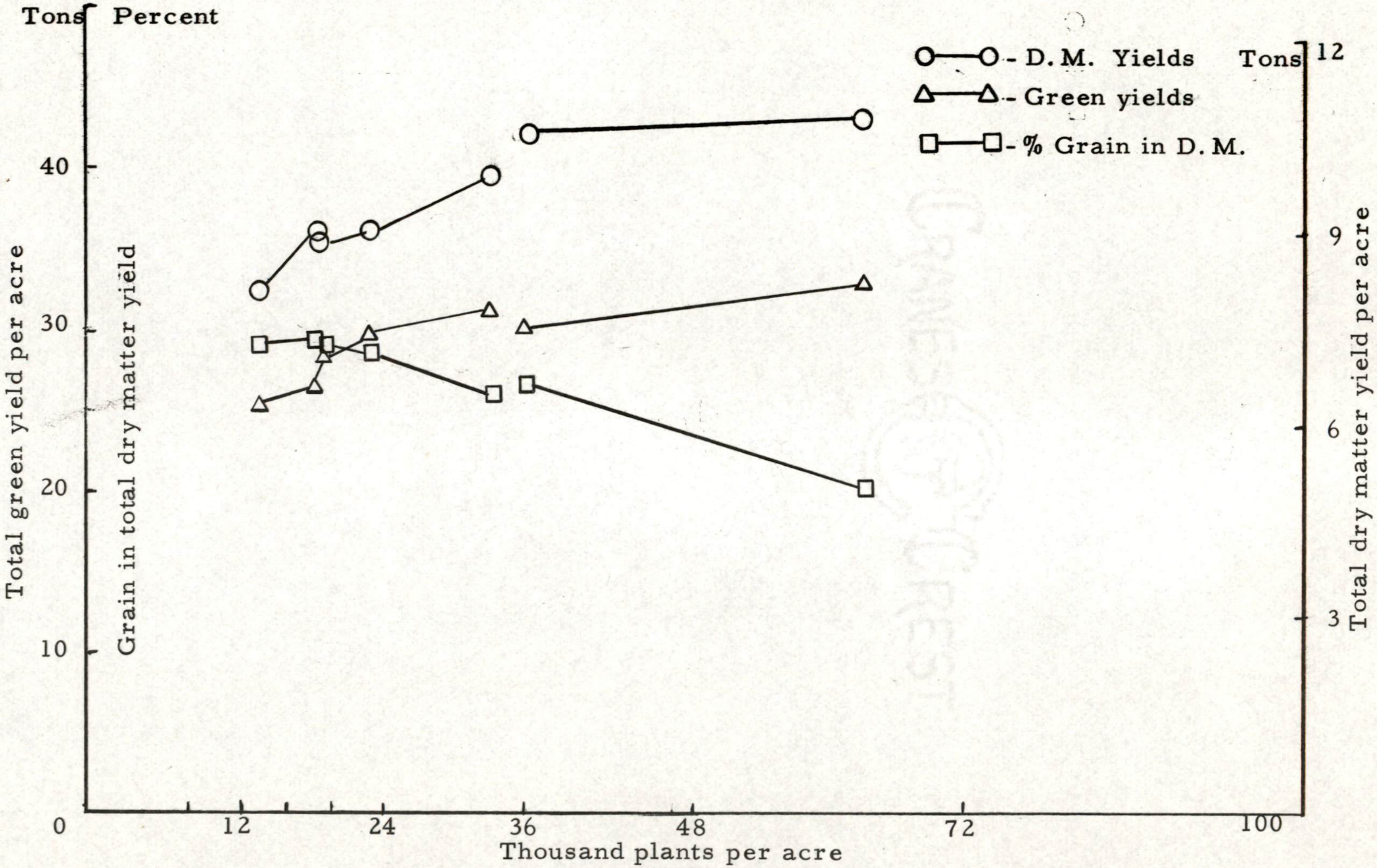


Figure 21. --Total yields of green and dry matter in tons per acre and percent grain in total dry matter yields. -Dixie 33 corn grown for silage at different populations. -H. R. E. S., 1961.

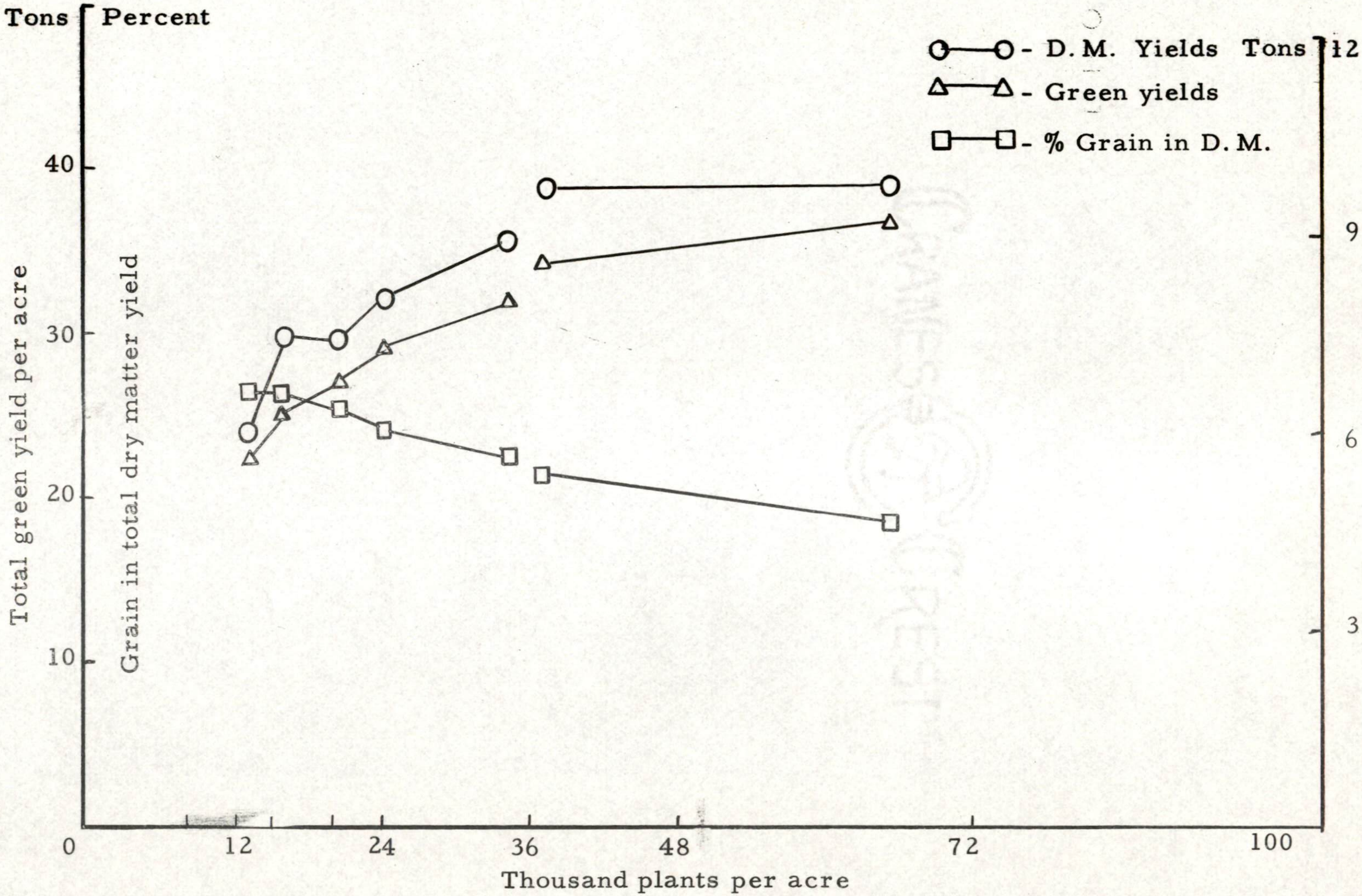


Figure 22. --Total yields of green and dry matter in tons per acre and percent grain in total dry yields.-Tennessee 501 corn grown for silage at different populations.-H. R. E. S., 1961.

dry matter yields at high populations is attributable to the differences in total available nutrients and moisture supply capacity of the two soils on which they were grown. In this connection it should be remembered that at M. T. E. S. the crop was grown on a Maury silt loam with 133 pounds of N per acre and at H. R. E. S. it was grown on a Huntington silt loam with 210 pounds of N per acre. Huntington is generally considered to be a soil with greater moisture supplying capacity and a higher organic matter content than Maury.

The percentages of grain in total dry matter decreased as the plant population per acre increased. Thus the variation of percent grain in total dry matter with respect to increase in plant population was inverse to that of total green and dry matter yields.

## B. EFFECT OF CORN VARIETIES

### Effect of Variety on Total Green and Dry Matter Yields

At the Koella Farm Dixie 33 gave a moderately higher total green yield than did Tennessee 501, in all the different plant populations. At the M. T. E. S. Dixie 33 yielded more than Tennessee 501 at 72,000 PPA. In all other populations, Tennessee 501 produced higher yields. The data at H. R. E. S. showed a different trend: Dixie 33 yielded more until the plant population reached 24,000, but beyond this plant population Tennessee 501 gave consistently higher green yields than Dixie 33.

Taking into consideration all populations, the two varieties did not show much difference in dry matter yield at the Koella Farm. The yield in both varieties ranged from about 2.5 to 12.5 tons per acre. At the M. T. E. S. and the H. R. E. S., Dixie 33 produced a higher dry matter yield than Tennessee 501. The higher yield of Dixie 33 was consistent over all the populations studied. Even though the two soils on which they were grown were different, the two varieties reacted rather similarly, except in the amount of yield. The fact that the crop was cut at a more immature stage at the Koella Farm probably caused the results from this station to be different from those at M. T. E. S. and H. R. E. S.

A comparison of the green and dry weights at the three locations indicate that these two show different trends across the population treatments at different stations. What is important from the production and nutrition points of view is the yield of dry matter. In this study Dixie 33 produced higher dry matter yields, at silage stage of growth, than Tennessee 501 did.

Effect of Variety on Grain Production and Leaf/Stem Ratio

The tons per acre of ears produced by the two varieties at M. T. E. S. were almost equal at all population levels. At H. R. E. S., however, Dixie 33 yielded a higher tonnage of ears than did Tennessee 501. The difference was less marked at high populations. The ranges of yields were 6.7 to 8.2 tons per acre for Dixie 33, and 6.0 to 7.5 tons per acre for Tennessee 501.

In dry grain yields Dixie 33 was consistently superior to Tennessee 501 at all populations at both stations. Considering both locations and different plant populations, the range was 37.6 to 139.8 bushels per acre for Dixie 33 and 28.4 to 83.4 bushels per acre for Tennessee 501.

As such, not only the tonnage of grains and total plant dry matter are important but also the percent grain in total dry matter. The percentages of grain in both green and dry weight yields at both locations were higher in the case of Dixie 33 than for Tennessee 501. Taking both varieties into consideration, the range of percent grain in the total green yield was from 12.5% to 33% for Dixie 33, and 10.0% to 28.9% for Tennessee 501. The range of percentage of grain in the total dry matter yield was 11.2% to 28.6% for Tennessee 501 and 12.1% to 40.8% for Dixie 33. Thus, Dixie 33 maintained a clear-cut superiority in percent grain yield over Tennessee 501 at all populations, except at the 72,000 PPA treatment at M.T.E.S., where the difference was small.

At Koella Farm, Dixie 33 had a slightly higher leaf content than Tennessee 501. The ranges of leaf percentage were 20.6 to 35.4 and 17.7 to 31.7, respectively, for Dixie 33 and Tennessee 501. However at both M.T.E.S. and H.R.E.S. no appreciable difference was found between the two varieties. The difference between the results at M.T.E.S. and H.R.E.S. and those at Koella Farm appears to have been due to the earlier cutting of the forage at Koella Farm.

## C. EFFECT OF ROW SPACING

The 36,000 PPA treatment planted at two different row spacings of 3-foot and 1-foot showed considerable differences with respect to various plant characteristics and production possibilities. In general, the height of plants grown in 1-foot rows was slightly less than that of plants grown in 3-foot rows. In the 1-foot rows, a higher final plant population was obtained than in 3-foot rows, although the same number of plants had been left at thinning time. There was no difference in number of ears between the two spacings, but slightly less lodging was found in 1-foot rows. With respect to percentage of nubbins, number of dead plants and number of ears per plant, the difference between the two row spacings was negligible.

At Koella Farm, where the crop was cut at tasseling stage, the 1-foot rows produced higher yields of stems, leaves and total green matter; but at M. T. E. S. and H. R. E. S. the 1-foot row spacing did not produce a yield appreciably higher than that of 3-foot rows.

With regard to total dry matter yields at the Koella Farm, the 1-foot row-spacing was far superior to the 3-foot row-spacing in both varieties. This difference can be accounted for by the higher contribution of dry matter by the stems, the leaf yield remaining the same in both spacings. At M. T. E. S. and H. R. E. S. there was no significant difference in dry matter production between the two row-spacings. In total grain yields, the 1-foot row-spacing was superior to the 3-foot row-spacing for the two varieties in both locations; for Dixie 33 at M. T. E. S., this difference was not significant.

These observations tend to be in agreement with the results of other workers who found that equidistant spacing of corn was superior to increased plant populations in the rows. In this experiment the 1-foot row-spacing had an average distance of 14.5 inches between plants in the same row, while the corresponding distance in 3-foot row-spacing was 4.8 inches.

## CHAPTER V

## SUMMARY AND CONCLUSIONS

Studies were conducted during the 1961 growing season on the effect of population on the production of all above-ground parts of corn harvested for silage at Koella Farm, Main Experiment Station, Blount County, on Huntington and Sequatchie silt loams; at the Middle Tennessee Experiment Station, Spring Hill, on Maury silt loam; and at the Highland Rim Experiment Station, Springfield, on Huntington silt loam. Two varieties, Dixie 33, a full-season prolific hybrid and Tennessee 501, a mid-season semi-prolific hybrid, were grown at seven different populations ranging from 12,000 to 72,000 plants per acre. At the Koella Farm, three additional populations, namely 8,000, 48,000 and 100,000 plants per acre also were studied. High levels of fertilization were used.

Plant population treatments of 8,000 to 24,000 plants per acre were planted at 3-foot row spacings, those of 36,000 plants per acre were planted both at 3-foot and 1-foot row spacings, and plant populations of 48,000 or more per acre were planted at 1-foot row spacings. Four replications were used at each location; each plot was 1/121 acre.

At the Koella Farm, the experiment was harvested at the tasseling stage because severe lodging due to rain and windstorms affected all treatments. At the Middle Tennessee Experiment Station and at the Highland Rim Experiment Station, harvesting was done at the early dent stage of growth.

From these experiments, the following general conclusions may be drawn:

1. The actual stand generally exceeded the desired stand when the plant population treatment was 16,000 or less plants per acre; and the actual stand was less than the desired stand when the treatment was 16,000 or more plants per acre. This difference was more marked at higher populations than at lower populations.
2. The percentage of plants apparently dead at harvest increased as the plant population increased; it was more marked in Dixie 33 at locations where total plant production per acre was also high.
3. The percentage of lodging increased with increase in plant population; it was slightly higher for Dixie 33 than for Tennessee 501.
4. Plant height tended to be highest at populations of 16,000 to 20,000 plants per acre and lowest at the greatest populations.
5. The number of ears produced per acre increased with increases in plant population when environmental factors did not limit production. When such limiting factors apparently did occur, the total number of ears per acre increased with increases in plant population up to 36,000 plants per acre and decreased with further increases in plant population.
6. The average number of ears per plant decreased with increases in plant population; it was generally more than one ear per plant at populations of 24,000 or less, it was about one ear per plant at 36,000 plants per acre, and it was distinctly less than one per plant at higher populations.
7. The percentage of nubbins among all ears harvested increased with increases in plant population; the increase

was rather sharp when the population was greater than 36,000 plants per acre.

8. The total green yields increased with increases in plant population up to about 36,000 plants per acre. Further increases in plant population did not increase markedly the total green yield. Total green yields per acre ranged from a low of 15.0 tons to a high of 37.1 tons.
9. The green yields of stems and leaves increased also with increases in plant population. The yield of green ears increased slightly with increases in plant population up to 36,000 plants per acre, and over this population it decreased to a small extent.
10. The total dry matter yields increased with increases in population up to 36,000 plants per acre when harvested at early dent; increases in population over 36,000 plants per acre produced a slight increase in yield when plant growth situations were favorable or a slight decrease when plant growth situations were not adequately favorable. The total dry matter yields per acre ranged from 2.6 tons to 12.3 tons.
11. When harvested at the tasseling stage, increases in plant population resulted in increased total dry matter yield. Dry matter yields at populations of 36,000 and 48,000 plants per acre grown in 1-foot rows were almost double those obtained from other population treatments. Increasing the population to 100,000 plants per acre resulted in a decrease in total dry matter yield.
12. When the total green yield increased with increases in plant population, the dry matter yields did not follow

always the same trend at plant populations over 48,000. In a number of cases, particularly when the crop was cut at tasseling, the dry matter yields decreased with increases in population.

13. The total grain yield increased with increases in plant population up to 36,000 plants per acre; beyond this population, it decreased. The total dry leaf yields and total dry stem yields generally increased also with increases in plant population.
14. The percentage of grain in the total dry matter yields as well as in the total green yields, decreased with increases in plant population. Thus the variation in percent grain with increases in plant population was inverse to that of total dry matter or green yields.
15. Plant population had little effect on the leaf/stem ratio.
16. The shelling percentage of grain was not affected by plant population.
17. Among the two hybrids studied, Dixie 33 and Tennessee 501, the former produced a higher stand of plants, a greater number of ears per plant and per acre, a slightly higher percentage of dead plants, a higher total dry matter, and higher grain yields and shelling percentages. The dry matter yields were not markedly different between the varieties when they were cut at tasseling stage. The percentages of nubbins, lodged plants and the leaf/stem ratio apparently were not affected by the two varieties.
18. A row spacing of 1-foot at a population of 36,000 plants per acre resulted in a higher stand, less lodging and

fewer nubbins than 3-foot row spacing. It also produced, generally, a higher green and dry matter yield of stems, leaves and total plant. There was little noticeable difference in total grain production and percentage of grain between the two spacings.

19. Locations affected markedly most yield components and plant characteristics measured.

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APPENDIX

# APPENDIX A

## CLIMATOLOGICAL DATA: DAILY PRECIPITATION RECORDED AT THE U. S. WEATHER BUREAU, AIRPORT STATION KNOXVILLE. - 1961

| Day | April 1961 | May 1961 | June 1961 | July 1961 | August 1961 | Sept. 1961 |
|---|---|---|---|---|---|---|
| 1 | T | .83 | | | | .07 |
| 2 | | | | | T | |
| 3 | .28 | | | .22 | | |
| 4 | | | | | | |
| 5 | .01 | | .31 | | T | .01 |
| 6 | T | | .21 | T | .11 | T |
| 7 | | | | .35 | T | T |
| 8 | | T | .05 | | | .92 |
| 9 | .71 | 1.44 | .15 | | | .37 |
| 10 | 0.01 | T | .01 | | | |
| 11 | | .30 | | .02 | | |
| 12 | .67 | .13 | .50 | .31 | .21 | T |
| 13 | .01 | | .05 | T | | |
| 14 | | | .40 | .84 | | .11 |
| 15 | .46 | .48 | 1.24 | .37 | | T |
| 16 | .01 | | T | .68 | | |
| 17 | | | T | .02 | | |
| 18 | | .46 | | | .01 | |
| 19 | | | | .45 | | |
| 20 | | | .90 | | T | |
| 21 | .06 | | .56 | | | |
| 22 | T | .11 | | .07 | .12 | |
| 23 | T | | .02 | .02 | .32 | |
| 24 | T | | | .01 | .06 | |
| 25 | T | .24 | | | .81 | .28 |
| 26 | .05 | .19 | .14 | .03 | .01 | |
| 27 | .18 | | | | | |
| 28 | | | | | .04 | |
| 29 | T | | | | | |
| 30 | .05 | | | .10 | | |
| 31 | | | | | .06 | |
| Total | 2.5 | 4.18 | 4.54 | 3.49 | 3.04 | .50 |

APPENDIX A (Continued)

CLIMATOLOGICAL DATA: DAILY PRECIPITATION RECORDED AT THE CLIMATOLOGICAL STATION, MAIN EXPERIMENT STATION, KNOXVILLE.

| Day | April 1961 | May 1961 | June 1961 | July 1961 |
|---|---|---|---|---|
| 1 | .09 | | | |
| 2 | .06 | | | |
| 3 | .12 | | | |
| 4 | | | | |
| 5 | .36 | | | |
| 6 | .25 | | .30 | |
| 7 | .03 | | .10 | .05 |
| 8 | | | .09 | .79 |
| 9 | .08 | .99 | .80 | |
| 10 | | .18 | .40 | |
| 11 | | .15 | | |
| 12 | .98 | .75 | | .20 |
| 13 | .12 | .10 | .95 | .36 |
| 14 | | | .48 | |
| 15 | | | .22 | .70 |
| 16 | .50 | .46 | .70 | .43 |
| 17 | | | | .71 |
| 18 | | .10 | | .41 |
| 19 | | .47 | | |
| 20 | | | | 1.40 |
| 21 | .21 | | .48 | |
| 22 | | | .14 | |
| 23 | | .12 | | |
| 24 | | | | .08 |
| 25 | .21 | | | .25 |
| 26 | | .38 | .09 | |
| 27 | | .11 | .08 | .08 |
| 28 | | | | |
| 29 | | | | |
| 30 | | | | |
| 31 | | | | |
| Total | 3.01 | 3.81 | 4.83 | 5.46 |

APPENDIX A (Continued)

CLIMATOLOGICAL DATA: DAILY PRECIPITATION RECORDED AT THE CLIMATOLOGICAL STATION, NEAPOLIS (M. T. E. S.), SPRING HILL.

| Day | April 1961 | May 1961 | June 1961 | July 1961 | August 1961 | Sept. 1961 |
|---|---|---|---|---|---|---|
| 1 | .25 | .10 | | | | .20 |
| 2 | | .90 | | | | |
| 3 | .09 | | | | 0.07 | .19 |
| 4 | | | | .39 | | |
| 5 | | | | | | .15 |
| 6 | | | | | | |
| 7 | | .15 | | .48 | .15 | .20 |
| 8 | | | | | | |
| 9 | .25 | .57 | | | | |
| 10 | .46 | | 2.40 | | | .12 |
| 11 | | | | | | |
| 12 | 1.30 | | | .37 | | |
| 13 | .25 | | | .52 | .11 | |
| 14 | | | | | | .12 |
| 15 | .20 | 1.80 | 1.30 | .43 | | |
| 16 | 1.45 | | .08 | .25 | | |
| 17 | | | | .25 | | |
| 18 | | .36 | | | | |
| 19 | | .15 | | | | |
| 20 | | | | | | |
| 21 | | .30 | .89 | 1.35 | | |
| 22 | | | | 1.37 | | |
| 23 | | .60 | | | | |
| 24 | | | | .37 | .22 | |
| 25 | | .03 | | | .03 | |
| 26 | .27 | .07 | | .21 | .48 | .10 |
| 27 | | | | | | |
| 28 | | | | | | |
| 29 | | | | .06 | | |
| 30 | | | | | | |
| 31 | | | | | | |
| Total | 4.52 | 4.76 | 4.67 | 6.05 | 1.06 | 1.08 |

APPENDIX A (Continued)

CLIMATOLOGICAL DATA: DAILY PRECIPITATION RECORDED AT THE CLIMATOLOGICAL STATION, SPRINGFIELD EXPERIMENT STATION, SPRINGFIELD.-1961.

| Day | April 1961 | May 1961 | June 1961 | July 1961 | August 1961 | Sept. 1961 |
|---|---|---|---|---|---|---|
| 1 | .21 | .36 | | | | .86 |
| 2 | | .54 | | | | .07 |
| 3 | .07 | | | .21 | .45 | |
| 4 | | | | | | .08 |
| 5 | | | | | | .02 |
| 6 | .10 | | | | | |
| 7 | | .10 | .72 | | | |
| 8 | | .39 | .20 | .51 | | .01 |
| 9 | .34 | .60 | 1.88 | | | |
| 10 | .46 | T | .16 | | .12 | |
| 11 | | | .12 | | .01 | |
| 12 | 1.01 | | .03 | .25 | | |
| 13 | .24 | | .10 | .33 | .02 | .56 |
| 14 | | | .11 | .10 | | .14 |
| 15 | .19 | .47 | .88 | .09 | | .04 |
| 16 | .64 | | .21 | .34 | | |
| 17 | | | | .05 | | |
| 18 | | 1.22 | | | | |
| 19 | | T | | .23 | | |
| 20 | | | | .03 | | |
| 21 | | | .21 | .50 | T | |
| 22 | .23 | | | .14 | 0.01 | |
| 23 | .04 | .35 | | | | |
| 24 | | | | .39 | .37 | |
| 25 | | | | .03 | .38 | |
| 26 | .48 | .02 | | .09 | | |
| 27 | | | | | | |
| 28 | | | | | .03 | |
| 29 | | | | .17 | | |
| 30 | .02 | | | | | |
| 31 | | | | | | |
| Total | 4.03 | 4.05 | 4.62 | 3.46 | 1.39 | 1.78 |