FIELD PLOT TECHNIQUE STUDY OF FIVE SUDAN GRASS VARIETIES

By

DONNIE L. NORTHCUTT

Bachelor of Science

Oklahoma Agricultural and Mechanical College

Stillwater, Oklahoma

1955

Submitted to the Faculty of the Graduate School of
the Oklahoma Agricultural and Mechanical College
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1956

FIELD PLOT TECHNIQUE STUDY OF FIVE

SUDAN GRASS VARIETIES

Thesis Approved:

Wayne W. Huffine
Thesis Adviser

Merlowe D. Thorne

Dean of the Graduate School

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation to Dr. W. W. Huffine of the Agronomy Department for his assistance in the planning and execution of this study and in the preparation of this thesis.

He also wishes to acknowledge Dr. M. D. Thorne, Dr. W. W. Hansen, Dr. J. Q. Lynd, and Mr. W. C. Elder for their constructive criticism and assistance in writing this thesis. Further, the author wishes to recognize Dr. F. A. Graybill and Mr. C. E. Denman for their assistance in the statistical analysis of this thesis.

Gratitude is expressed to Donnie Nell, wife of the writer, for meticulous care given to the typing of the manuscript, and for her patience and encouragement throughout the entire course of this study.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The problem of optimum plot size for reliable evaluation of plant production has long attracted much attention from the agronomic research workers. Leonard and Clark (25)[/1] stated that the size of plot was considered in testing the general quality of varieties of crops at the Virginia Experiment Station as early as 1890. Since this date, numerous experiments have been conducted on different crops to determine the most efficient size of plot from which reliable results can be obtained.

The need for more efficient field plot techniques for the evaluation of forage crops assumes greater importance each year. This has been realized by the agronomic research workers testing the existing varieties of forage crops and also new varieties as they become available, without a proportional increase in experimental land.

Due to the need for adequate testing of the many forage varieties now available in all major soil and vegetative areas of Oklahoma, this experiment was conducted to determine whether or not plot size can be reduced and still obtain consistent reliable results.

In this study, sudan grass forage yields from plots 5 feet in length were compared with plots 10, 15, and 20 feet long, all being the same width.

/1 Figures in parentheses refer to "Literature Cited", page 18.

REVIEW OF LITERATURE

There has been much work done with various crops and trees, to determine the most efficient size of plot for experimental purposes. No previous work has been done on the optimum size of plot for use in experimental work with sudan grass.

According to Kiesselbach, (20) the object of most field plot experiments is to compare the performance of various crops in such a manner that the results will be applicable to farm practice. Federer (10) stated that whenever experimental work is started on a new crop it is desirable to determine sample size necessary to obtain reliable results. Leonard and Clark (25) concluded that there are several factors to consider in determining the optimum size of plot for experimental use. Some of these are: kind of crop, number of varieties or treatments, kind of machinery, amount of land, labor, and funds available. Koch and Rigney (23) found that variability of the soil is an important factor in determining plot size for experimental use.

There is and has been a large variation in size between the field plots and nursery plots with various crops. According to Taylor (50) in 1908 the plot size used in experimental work in the United States varied from 2 acres to 1/40 acre in size. The average plot size was 1/10 acre. In 1908 Taylor (50) also found that the variation in size among the 150 plots used at the Rothamstead Experiment Station, England, varied from 1/11 to 1/2 acre in size with the average size being about 1/5 acre.

In 1918 Leonard and Clark (25) found that the plot sizes used in the United States by agronomists varied in size from 1 acre to 1/200 acre and at the present time field plot and nursery plots vary from 1/1000 to 1/10 of an acre in size depending on the crop under investigation. Hays and Immer (15) found that at the present time the field plots usually range from about 1/100 to 1/10 of an acre in size.

Odland and Garber (37) stated that for the sake of economy in land and labor, it is desirable to have the plots as small as possible and replicated a minimum number of times, however it is of greater importance that the plots be large enough and sufficiently often replicated to make the results reliable. Kempthorne (19) concluded that when the size of plot decreases, the proportion of the experimental area that has to be devoted to guard rows becomes very large, and this together with the cost of agricultural operations, tends to produce a medium-sized plot.

Barber (3) found that there are proportionately more plants along the border in small plots than in large ones, and since the plants on the outside of the plots are more productive than those within the plot, the error from this source is greater in small plots than in larger ones.

According to Gardenhire (12) Lyon concluded that when the yield from a number of plants is used as a measure of differences in plots there may be an error caused by a greater or lesser growth in certain plants not due to the treatment, but to the inherent property of certain individuals.

Smith (43) stated that variability can be decreased with increasing plot size. Day (8) found that increasing the size of the plot to at least 1/20 of an acre, and probably much beyond, reduces variation.

Summerby (48) concluded that an increase in the length of plot has greater influence on decreasing the error than has an increase in width. Day (8) stated that the most effective replicated block from the viewpoint of shape is one that is long and narrow and has its greatest dimension in the direction of greatest soil variation. Christidis (7) found that long narrow plots would control soil heterogenity better than plots more nearly square, occupying the same area of land.

Hays and Garber (17) concluded that increasing plot size is a less valuable method of overcoming soil heterogenity than replication. Leonard and Clark (25) also found this to be true.

Hays, Immer, and Smith (16) found generally that increasing replications would decrease the standard error more rapidly than increasing the size of plots. Leonard and Clark (25) stated that Mercer and Hall while working at the Rothamstead Experimental Station in 1910 concluded that the trend of plot size was toward smaller plots and increased replications.

In studying rod-row trials Hays and Garber (17) found that size of plots is less important than replications as a means of controlling variability. Hays and Garber (17) also concluded that the number of replications required to secure a given degree of accuracy is somewhat dependent on the area of the plot.

Vagholkar and others (51) working in India with sugar cane found that when the plot size is greater than 1/90 acre, in general the longer plots show less variations than shorter plots.

When the yield of crops is made the criterion, Lyon (29) concluded that little can be gained in accuracy by using plots larger than 1/5 acre in size. Lyon (29) also stated for obtaining accuracy in sampling soil, the smaller the plot the better.

Working in South Dakota, Salmon (41) concluded that greater accuracy in variety tests can be secured by dividing the 1/10 acre plots into 5 plots 1/50 acre size and replicating each variety 5 times. By this method the same area of ground was required for a given number of varieties.

Mortensen (36) stated that better results have been obtained from small plots repeated often than from larger plots. Mortensen believed that about 1/82 acre is the proper size of plot to use. Wood and Stratton (52) concluded that the probable error is independent of the size of the plot employed provided that this is 1/8 of an acre or larger in size.

Ma and Harrington (31) reported that after 39 systematical tests were run using triple rod-row plots and 1/40 acre plots, the average standard error for the rod-row tests was 12.9% and for the 1/40 acre plots, 7.3%. Studying the methods of eliminating experimental error in comparative crops test, Kiesselbach (21) found that the results from 20 systematically distributed quadrats may be safely substituted for the yields of the entire plot.

While working with wheat, Montgomery (34) concluded that to increase the size of the block up to a certain limit rapidly decreases variability, but error cannot be indefinitely decreased by continuing to increase the size of the plot. When row length is increased four times, the deviation decreases about one-half. Hall (13) found while working with wheat that there is but little advantage in reducing the probable error by the use of larger than 1/5 acre plot size.

Working with wheat at the Cornell Agricultural Experiment Station, Lyon (30) concluded while using a 1/10 acre area that the mean deviation from the normal yield decreased as the replication was increased and the plot size decreased. Day (8) found that increasing the size of plot to at least 1/12 of an acre and probably much beyond, reduces variation. Working with wheat and oats in Quebec, Summerby (48) concluded that large plots have been more accurate than small plots. The mean per cent error ranged from 2.31 with wheat plots 32/1000 acre in size to 7.86 with oats plots 16/10,000 acre in size.

Studying determination of yield on experimental plots by the square yard method Michels and Schwenderman (33) found that difference between plot and square yard yields of wheat, barley, and oats range from 0.2 of a bushel to 3.1 bushels. For all practical purposes from 12 to 18 square yards should be taken before they may be considered comparable to yields computed on an entire plot. Working with a good stand of wheat, Arny and Steinmetz (2) concluded that 4 to 5 systematically distributed square yard area samples would be sufficient to represent a 1/10 acre plot size. Garber, Mcilvan, and Hoover (11) while working with wheat found a high correlation coefficient between the yield from 5 rod-rows and the entire net area of the same plot which was 1/51 of an acre. Working with wheat, oats, and barley in Minnesota, Hays (14) found that the most desirable plot size was a 3 row plot 16 feet in length with the central row harvested for yield test. Montgomery (35) stated that plots 5.5 by 16 feet is a convenient size in working with wheat.

Working with oats, Summerby (47) compared accuracy between plots 1 foot by 15 feet thru 32 feet by 15 feet. Within the limits of sizes used, the small plots were more accurate than large plots. Fairchild (9) found that 3 row plots 1 rod long seemed to be as correct a measure of variability as any number up to ten.

When the amount of land is considered, Love and Craig (28) found while working with oats that 15 foot rows are more desirable than 30 foot rows. In fertilizer tests in Minnesota with cereals, Arny and

Steinmetz (2) concluded that yields from 4 or 5 systematically distributed square yard areas removed from plots 1/10 acre in size or less, from a relatively uniform crop, may be substituted for the yields from the entire field. Arny and Garber (1) found that nine rod-rows from 1/10 acre plot gave practically as accurate indications of value of fertilizer treatment as did harvesting the product of the entire plots.

While working in Texas with cotton, Reyonlds, Killough, and Vantine (39) found that the plot sizes varied with the amount of land available. The larger amount of land, the larger the plots and with smaller areas the plots were smaller and replicated more. Hutchinson and Panse (18) working with cotton in India found that the standard error per cent per plot decreased steadily with increasing plot length and size. Plots of 1/25 of an acre in size were adequate size. Siao (42) working with cotton in China, found that wide plots are more desirable than long narrow plots. The coefficient of variability decreased from 14.05% to 9.86% when the plots were increased from 1 to 8 rows. Ligon (27) found in field tests with cotton that the rows need not be larger than 100 feet in length for determining yield. The plots were three rows in which the central row only was harvested for field data. Rows of greater length resulted in a reduction in error but not in proportion to the amount of land used. The probable error for a single row 100 feet long was 6.05% for 1 replication. When both accuracy in results and economy of land and labor are taken into consideration, Odland and Garber (37) concluded that the most efficient size of plot for soybean testing is a plot 16 feet in length replicated three times.

Working with castor plant Gardenhire (12) concluded that reliable results can be obtained by using 1, 2, or 4 rows 12 hills long.

Field testing with guayule, Federer (10) found that little increase in precision in the experiment could be gained by harvesting more than 12 plants per sample.

Working with mangolds, Mercer and Hall (32) concluded that the error diminishes with the increase in size of plot, but the reduction is small when the plot is increased in size above 1/40 acre. The optimum size of plot is somewhere around 1/40 of an acre.

Krantz (24) working with potatoes in Minnesota concluded that a row 3 rods long was more desirable than a single rod-row and was about as valuable as a six rod-row.

Comparing open pollinated varieties of corn with inbred lines, Bryan (5) found that the open pollinated varieties required twice as much land as did the inbred line for the same degree of precision. He concluded that 16 hill plots approached the small practical size.

For varietal testing corn, Piper and Stevenson (38) found that minimum standard plot size was 5 rows each of 25 hills or 5 rods long. The Nebraska Station, according to Leonard and Clark (25) used 4 rod plots, 12 hills long with the 2 center rows being harvested for yield. At the Oklahoma Agricultural Experiment Station, Brooks and Chessmore (4) stated that single rows 20 hills long are being used. According to Smith (44) the Illinois Agricultural Experiment Station used for varietal testing, plots 5 rows wide and harvested the 3 inside rows for yield tests.

Working with sorghum in Oklahoma, Klages (22) concluded that single row plots replicated frequently enough will give reliable results as will plots with a larger number of rows replicated less frequently. He also stated that in the utilization of single row plots, care must be exercised in the selection of varieties to grow next to each other. Extreme differences in growing habits must be avoided.

Stephens (46) found while working with sorghums in Texas that sufficient reliable experimental results can be obtained in using 1/40 to 1/80 of an acre plot size and replicating 3 or 4 times. The error of a single plot 1/800 of an acre was 10.67% of the mean. As the plot size was increased from 1/800 to 1/20 acre in size, the error was reduced from 10.67% to 3.27% of the mean. This was a reduction in error of 60%.

Swanson (49) found that the most satisfactory length of plot for testing sorghum is 8 rods long and 13 feet wide. Increasing the plots from 1/400 of an acre to 1/25 of an acre reduced the probable error 60.9%. This reduction is not sufficient to justify the use of plots as large as 1/10 acre in variety tests of sorghums.

In field tests with millet, Li, Meng, and Liv (26) concluded that plots 2 rows wide and 15 feet in length proved most efficient. Maintaining the same width plot but increasing the length to 30 feet where area is not a limiting factor seems to be very satisfactory. Increasing the width of plots from 2 to 5 rows results in some reduction in standard error and a further increase to 10 rows also results in a reduced standard error but not in proportion to the area of land used.

Working with forage grasses in Oklahoma, Chessmore (6) found that plots containing 3 or 4 rows gave almost as much information as plots containing 5 rows. Three rows, planted either two or three feet apart are recommended for testing different varieties or spacings that are harvested for seed yields. Three rows, planted one foot apart, are recommended for testing varieties or spacings harvested for forage production.

Various methods have been used in estimating the accuracy of plots of different size. Robinson, Rigney, and Harvey (40) suggested the use of the coefficient of variability to determine the optimum size from uniform data. They found that widening the plot was not as effective in reducing the error as increasing the plot length.

The optimum sample size within plots of different sizes was studied by Snedecor (45). The rows or hills of the corn plots were harvested separately and the efficiency of the plot measured by analysis of variance. He found that an increase in the precision of the experiment could be obtained by increasing the number of sampling units per subplot. The reduction of sampling error in relation to the cost of the additional labor involved was used as a guide in selecting the proper size of plot for future experiments. He emphasized that the equipment used in planting, harvesting, and threshing the plots were additional factors to be considered in studies concerning optimum sample sizes.

Chessmore (6) working with forage grasses, used the relationship between the experimental error for plots and the sampling error within the plots to measure the relative efficiency of each plot size.

According to Leonard and Clark (25) Smith compared the coefficient of variability of different crops for a standard 1/40 acre plot. The crops fell approximately into 3 groups: (1) wheat, sugar beets, soybeans, and forage sorghums were less variable; (2) corn, potatoes, and cotton were in intermediate; and (3) fruit trees were the most variable.

The results of different investigators of field plot techniques are not in agreement regarding the optimum size of plot to use.

The agronomic researcher must remember that the optimum size of plot is largely a matter of convenience and local conditions. Each experimenter at each station must determine this for himself, keeping in mind that it is dependent, first, upon the area of land available; second upon the uniformity of the soil, and third upon the number of plots necessary for a given crop or soil experiment.

MATERIALS AND METHODS

The experiment was conducted under field conditions in 1955 on a Norge fine sandy loam soil on the Oklahoma Agricultural Experimental Station farm, located near Perkins, Oklahoma. There was no fertilizer used in this study, however, the land had been in alfalfa for three previous years.

In this study, 372 Synthetic, Piper, Greenleaf, Wheeler, and Lahoma sudan grasses (Sorghum sudanense (Piper) Stapf.) were used.

All of these grasses were planted in plots 5 rows wide and 20 feet long with rows twelve inches apart. Each plot was planted at the same rate per acre with a Planet Jr. planter and was treated alike throughout the experiment.

A randomized block design was used with four replications. The 5 varieties of sudan grass were randomized as main plots. For each variety yields were obtained from one replication each 5, 10, 15, and 20 feet in length. All of these yields per variety, replications and plot size are presented in table 4 of the appendix.

The plots were harvested on June 24, 1955 and July 16, 1955 with a 3-foot Jari mower. The mower was equipped with a wheel on each side of the cycle bar to permit a uniform six-inch height of cut. Each designated size block was mowed and weighed separately. An approximate 500 gram sample of green forage was obtained from each plot for moisture determination. The yields taken in the field were recorded as pounds of green forage per plot and later adjusted to pounds of dry matter per plot.

The inside three rows of each designated sized plot was harvested separately. The total yield of these rows was used for statistical analyses. The forage yield data was analyzed by an analysis of variance for a randomized block design.

In analysis of variance, one replication was chosen at random to represent one size plot for one specific variety of sudan grass. The replication number used and yields are indicated in table 1. All of the yields were converted to a comparable basis (20 foot length) for statistical analysis as indicated by table 2.

RESULTS AND DISCUSSION

The total yields of 5, 10, 15, and 20 foot plot sizes of each variety is presented in table 1. These yields were converted to a comparable 20 foot length plot size as indicated by table 2 for statistical analysis.

The analysis of variance for the test of significance for plot sizes in this study is presented in table 3. An F value of 3.2019 was obtained in plot size comparison in this study. An F value of 3.24 or larger is required to obtain significance at the 5% level, therefore, there are no significant differences at the 5% level between the four plot sizes used in this comparison. It should be noted, however, that the F value is approaching significance. The results of this study indicate that in sudan grass varietal testing, plot sizes 5, 10, 15, and 20 feet in length, three rows wide may be used with equally reliable results.

Table 1.--Forage yields of 5 sudan varieties from different length plots in pounds of oven dry forage.

	Length of Plots							
	5 foot		10 foot		15 foot		20 foot	
Variety	Rep.	Yield	Rep.	Yield	Rep.	Yield	Rep.	Yield
Synthetic 372	1	1.0331	3	2.3377	4	2.8732	2	4.4555
Greenleaf	3	1.1831	2	1.8834	4	2.6171	1	4.6269
Wheeler	1	1.5683	3	2.2627	4	3.1375	2	4.4492
Lahoma	1	1.0923	4	1.4182	2	3.2096	3	3.9647
Piper	1	1.4982	4	2.2763	2	2.8713	3	4.2111

Table 2.--Forage yields converted to a comparable basis (20 foot length plot) of 5 sudan varieties from different length plots in pounds of oven dry forage.

Variety	5 foot		10 foot		15 foot		20 foot	
	Rep.	Yield	Rep.	Yield	Rep.	Yield	Rep.	Yield
Synthetic 372	1	4.1324	3	4.6754	4	3.8308	2	4.4555
Greenleaf	3	4.7324	2	3.7668	4	3.4892	1	4.6269
Wheeler	1	6.2732	3	4.5254	4	4.1832	2	4.4492
Lahoma	1	4.3692	4	2.8364	2	4.2792	3	3.9647
Piper	1	5.9928	4	4.5526	2	3.8280	3	4.2111

Column group heading: Length of Plots

Table 3. Analysis of variance of the forage yield data from 4 different sized plots of 5 varieties of sudan grass grown at Perkins, Oklahoma in 1955.

Source of variations	Degrees freedom	Sum of squares	Mean square	F
Total	19	10.9800		
Plot size	3	4.1152	1.3717	3.2019
Error	16	6.8648	.4290	

SUMMARY AND CONCLUSIONS

Size of plot studies for sudan grass was conducted under field conditions at the Oklahoma Agricultural Experiment Station farm, located near Perkins, Oklahoma.

In this study, 372 Synthetic, Piper, Greenleaf, Wheeler, and Lahoma sudan grass varieties were used. They were replicated 4 times in a randomized block design. For each variety, yields were obtained from one replication 5 rows wide spaced 12 inches apart, either 5, 10, 15, or 20 feet in length. Only the 3 inside rows were harvested from each plot.

No significant difference was obtained between forage yields of plot sizes 5, 10, 15, and 20 feet in length. This indicates that 5, 10, 15 or 20 foot plots may be used for experimental work with sudan grass with comparable results.

LITERATURE CITED

1. Arny, A. C., and Garber, R. J. Field Techniques in Determining of Plots of Small Grain by Rod-row Method. Jour.Amer.Soc. Agron. 11:33-47. 1919.

2. __________ and Steinmetz, F. H. Field Techniques in Determining Yields of Experimental Plots by the Square Yard Method. Jour. Amer. Soc. Agron. 11:81-106. 1919.

3. Barber, Clarence W. Note on the Influence of Shape and Size of Plot in Tests of Varieties of Grain. Maine Agr. Expt. Sta. Bul. 226:76-84. 1914.

4. Brooks, J. S. and Chessmore, R. A. Performance Test of Corn. Okla. Agr. Expt. Sta. Bul. B.317.

5. Bryan, A. A. A Statistical Study of the Relation of Size and Shape of Plot and Number of Replications to Precision in Yield Comparisons With Corn. Ia. Agr. Expt. Sta. Rpt. for 1930-31. 1931.

6. Chessmore, R. A. Thesis Entitled An Evaluation of Some Field Plot Techniques for Testing Forage Grasses. Univ. of Nebr. 1952.

7. Christidis, B. G. Importance of the Shape of Plots in Field Experimentations. Bibliog. J. Ag. Sci. 21:14-37. 1931.

8. Day, J. W. The Relation of Size, Shape, and Number of Replications of Plots to Probable Error in Field Experimentations. Jour. Amer. Soc. Agron. 12:100-106. 1920.

9. Fairchild, J. A. The Comparative Value of Systems of Replications and Size and Shape of Plots in Oats Nursery Trials. Thesis, Okla. Agr. and Mech. Coll. Stillwater, Okla. 1928.

10. Federer, W. T. Studies on Sample Size and Number of Replicates for Guayule Investigations. Bibliog. tabs. Am. Soc. Agron. 37:469-78. 1945.

11. Garber, R. J., Mcilvain, T. C., and Hoover, M. M. A Method of Laying Out Experiment Plots. Jour. Amer. Soc. Agron. 23:286-298. 1931.

12. Gardenhire, James H. Thesis, Field Plot Technique and Plant Characteristic Studies with Varieties of Castor Plants, Ricimus communis Linn. Okla. Agr. and Mech. Coll., Stillwater, Okla. 1949.

13. Hall, A. D. and Russell, E. J. Field Trials and Their Interpretations. Jour. Bd. Agr. (London), Supplement:p. 5-14, Nov.1911.

14. Hays, H. K. Controlling Experimental Error in Nursery Trials. Jour. Am. Soc. Agron. 15:177-192. 1923.

15. _________ and Immer, F. R. Field Plot Technique. Methods of Plant Breeding, First Edition. McGraw-Hill Book Co. Inc. of New York and London. 1942.

16. _________, and Smith, C. D. Method of Plant Breeding. Second Edition. McGraw-Hill Book Co. Inc. New York 55:459-473. 1955.

17. _________ and Garber, R. J. Breeding Crop Plants. McGraw-Hill Book Co. Inc. New York:73-75. 1927.

18. Hutchinson, J. B. and Panse, V. G. Studies in the Technique of Field Experiments. Bibliog. Tabs. Ind. J. Ag. Sci. 5:523-38. 1935.

19. Kempthorne, Oscar. The Design and Analysis of Experiments. John Wiley and Sons Inc. New York: 206-216. 1952.

20. Kiesselbach, T. A. The Mechanical Procedure of Field Experimentation. Jour. Amer. Soc. Agron. 20:433-442. 1928.

21. _________. Studies Concerning the Elimination of Experimental Error in Comparative Crop Tests. Nebr. Agr. Exp. Sta. Res. Bul. 13. 1918.

22. Klages, K. H. Yield of Adjacent Rows of Sorghums in Variety and Spacing Tests. Jour. Amer. Soc. Agron. 20:582-599. 1928.

23. Koch, E. J. and Rigney, J. A. Method of Estimating Optimum Plot Size From Experimental Data. Tabs. Agron. J. 43:17-21. 1951.

24. Krantz, F. A. A Preliminary Study of Field Plot Technique in Potato Yield Test. Rept. Potato Assoc. Am. 42-44. 1922.

25. Leonard, W. H. and Clark, A. G. Size, Shape, and Nature of Plots. Field Plot Technique. Burgess Publishing Co. Minneapolis, Minn. 141-153. 1946.

26. Li, H. W., Meng, C. J., and Liv, T. N. Field Results in a Millet Breeding Experiment. Jour. Amer. Soc. Agron. 28:1-15. 1936.

27. Ligon, L. L. Size of Plot and Number of Replications in Field Experiments With Cotton. Jour. Amer. Soc. Agron. 22:689-699. 1930.

28. Love, H. H. and Craig, W. T. Investigations in Plot Techniques With Small Grains. Cornell Ag. Exp. Memior 214:1-26. 1938.

29. Lyon, T. L. Some Experiments to Estimate Errors in Field Plot Experiments. Proc. Amer. Soc. Agron. 3:89-114. 1911.

30. __________. A Comparison of the Error in Yield of Wheat From Plots and From Single Rows in Multiple Series. Proc. Amer. Soc. Agron. 2:38-39. 1911.

31. Ma, R. M. and Harrington, J. G. Standard Error of Different Designs of Field Experiments at the University of Saskatchewan. Bibliog. Tabs. Sci. Ag. 28:461-74. 1948.

32. Mercer, W. B. and Hall, A. D. The Experimental Error of Field Trials. Jour. Agri. Sci. 4:107-132. 1911.

33. Michels, C. A. and Schwendermon, John. Determining Yields on Experimental Plots by the Square Yard Method. Jour. Amer. Soc. Agron. 26:993-1001. 1934.

34. Montgomery, E. G. Experiments in Wheat Breeding. U. S. Dept. Agr. Bur. Plant Indus. Bul. 269. 1913.

35. __________. Variation in Yield and Methods of Arranging Plots to Secure Comparative Results. 25th Ann. Rpt. Nebr. Expt. Sta. 164-180. 1911.

36. Mortensen, M. L. The Technique of Field Experiments. Johresber. Ver. Angew. Bot. 9:177-187. 1911. Abs. in Expt. Sta. Record 29:734-735. 1913.

37. Odland, T. E. and Garber, R. J. Size of Plot and Number of Replications in Field Experiments with Soybeans. Jour. Amer. Soc. Agron. 20:93-108. 1930.

38. Piper, C. V. and Stevenson, W. H. Standardization of Field Experimental Methods in Agronomy. Proc. Amer. Soc. Agron. 2:70-76. 1910.

39. Reynolds, E. B., Killough, D. T. and Vantine, J. T. Size, Shape and Replication of Plots for Field Experiments with Cotton. Jour. Amer. Soc. Agron. 26:725-34. 1934.

40. Robinson, H. F., Rigney, J. A. and Harvey, P. H. Investigations in Plot Technique with Peanuts. North Car. Agr. Exp. Sta. Tech. Bul. 86. 1948.

41. Salmon, C. A Practical Method of Reducing Experimental Error in Varietal Tests. Jour. Amer. Soc. Agron. 5:182-184. 1913.

42. Siao, Fu. Uniformity Trials With Cotton. Jour. Am. Soc. Agron. 15:225-229. 1923.

43. Smith, Fairfield H. An Empirical Law Describing Heterogenity in the Yields of Agricultural Crops. Jour. Agr. Sci. 28:1-29. 1938.

44. Smith, L. H. Plot Arrangement for Variety Experiments with Corn. Proc. Amer. Soc. Agron. 1:84-89. 1910.

45. Snedecor, G. W. Statistical Methods, Fourth Edition. Ames, Iowa. The Iowa State College Press. 466-473. 1946.

46. Stephens, J. C. Experimental Methods and the Probable Error in Field Experiments with Sorghum. Jour. Agr. Res. 37:629-646. 1928.

47. Summerby, R. Replication in Relation to Accuracy in Comparative Crop Tests. Jour. Amer. Soc. Agron. 15:192-199. 1923.

48. __________. A Study of Sizes of Plots, Number of Replications, and the Frequency and Methods of Using Check Plots in Relation to Accuracy in Field Experiments. Jour. Amer. Soc. Agron. 17: 140-149. 1925.

49. Swanson, A. F. Variability of Grain Sorghum Yields as Influenced by Size, Shape, and Number of Plots. Jour. Amer. Soc. Agron. 22:833-837. 1930.

50. Taylor, J. W. The Size of Experiment Plots for Field Crops. Proc. Amer. Soc. Agron. 1:56-58. 1907-09.

51. Vagholkar, B. P. and Others. Study on Size and Shape Technique for Field Experiments on Sugar Cane. Tabs. Diag. Ind. J. Ag. Sci. 10:388-405. 1940.

52. Wood, T. B. and Stratton, F.J.M. The Interpretation of Experimental Results. Jour. Agr. Sci. 3:417-440. 1910.

A P P E N D I X

Table 4.--Total yield of forage per replication from 5, 10, 15, and 20 foot plots in pounds of oven dry material for each of the 5 sudan grass varieties.

Size of Plot	Variety	Replication I	II	III	IV
5-foot	Synthetic 372	1.3333	1.0632	1.4388	1.1178
	Greenleaf	1.3902	.9111	1.1831	1.0530
	Wheeler	1.5683	1.3363	1.5729	1.2095
	Lahoma	1.1961	1.1990	1.1507	1.0610
	Piper	1.4982	1.1000	.9396	1.1742
10-foot	Synthetic 372	2.5120	2.5399	2.3377	1.7554
	Greenleaf	2.2953	1.8834	2.0350	1.8665
	Wheeler	2.6838	1.9436	2.2627	2.1419
	Lahoma	2.7396	2.0106	1.8021	1.4182
	Piper	2.8269	2.0083	2.1665	2.2763
15-foot	Synthetic 372	3.5451	3.3923	3.6321	2.3794
	Greenleaf	3.2367	2.7081	2.9902	2.6171
	Wheeler	3.9380	3.1129	3.2703	3.1375
	Lahoma	3.8319	2.8806	2.8140	2.1058
	Piper	4.0447	2.8712	3.2715	3.4951
20-foot	Synthetic 372	4.8784	4.4555	5.0709	3.4972
	Greenleaf	4.6269	3.6192	4.1733	3.6701
	Wheeler	5.5063	4.4492	4.8432	4.3470
	Lahoma	5.0280	4.0796	3.9647	3.1668
	Piper	5.5429	3.9712	4.2111	4.6693

VITA

Donnie Lavon Northcutt

Candidate for the Degree of

Master of Science

Thesis: FIELD PLOT TECHNIQUE STUDY OF FIVE SUDAN GRASS VARIETIES

Major Field: Agronomy (Field Crops)

Biographical:

Personal Data: Born near Lexington, Oklahoma, May 23, 1930, the son of W. C. and Jessie Mae Northcutt.

Education: Attended grade school at Alamo Rural School, Cleveland County, Oklahoma, graduated from Noble High School, Noble, Oklahoma in 1948; attended Oklahoma City University from January to April, 1951 at which time he was inducted in the United States Air Force; entered Oklahoma Agricultural and Mechanical College in 1953 and received his Bachelor of Science degree in Agriculture in 1955 with a major in Animal Husbandry and a minor in Agronomy (Field Crops); entered graduate school at Oklahoma Agricultural and Mechanical College in June, 1955 and will receive Master of Science degree in Agriculture in May, 1956, with a major in Agronomy (Field Crops).

Experiences: Born and reared on the farm; butchered for a large meat market from 1948 to 1949; employed with the Oklahoma Military Department from 1949 to 1951; served in the United States Air Force as an Air Operations Supervisor in 1951 and 1952; employed part time by Oklahoma Agricultural and Mechanical College Agronomy Department in 1955 and 1956.

Member of: FarmHouse Fraternity, Phi Kappa Phi, Alpha Zeta, Agronomy Club, Block and Bridle Club, Oklahoma Crop Improvement Association, Masonic Club, and the Order of the Red Red Rose.

Date of Final Examination: March, 1956

THESIS TITLE: FIELD PLOT TECHNIQUE STUDY OF FIVE SUDAN GRASS VARIETIES

AUTHOR: Donnie L. Northcutt

THESIS ADVISER: Dr. Wayne W. Huffine

The content and form have been checked and approved by the author and thesis adviser. The Graduate School Office assumes no responsibility for errors either in form or content. The copies are sent to the bindery just as they are approved by the author and faculty adviser.

TYPIST: Donnie Nell Northcutt