INTERROW COMPETITION IN GRAIN SORGHUM HYBRIDS AS INFLUENCED BY MATURITY DATES

By

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INTRODUCTION

Grain sorghums are grown in test plots at eight locations in the state of Oklahoma and must meet a specified yield requirement before they may be sold in the state, according to Oklahoma State Seed Law, Regulation number 18.

The amount of land, time, and financial assistance which can be devoted to a testing program of this type is limited. The number of entries tested was not large when the testing program was first begun. With rapid development of hybrid grain sorghums, and because of the general adaptability of the crop to Oklahoma, the number of entries soon became large enough that it was necessary to reduce the plot size from three rows to a single row.

These hybrids exhibit a wide variation in yield, height, maturity, and several other agronomic characters. Considerable variation in soil types and environmental conditions occurs among locations. With such a wide variation among agronomic characters and locations, it follows that any given hybrid may exert a competitive influence on the hybrid in the adjacent row.

It is possible that competition in single row plots could allow an inferior hybrid to produce high enough to qualify for sale and could prevent a superior hybrid from qualifying. Since date of maturity is the agronomic factor which will most likely exert a competitive influence, this experiment was designed to measure the effect of competition due to differences in dates of maturity.

The purpose of this study was to assemble preliminary information and determine if competition between adjacent rows does exist among hybrids of the same general agronomic characters but differing greatly in time of maturity.

REVIEW OF LITERATURE

Competition among rows or among plots has long been recognized as a possible source of error in field experiments (1,24,36)[1]. The Committee for the Standardization of Field Experiments of the American Scoiety of Agronomy (36) stated that when varieties are planted adjacent to each other certain ones may affect others adversely and that all varieties are not influenced alike. To obviate these difficulties, they recommended that one row from either side of each plot in intertilled crops be either removed before harvest or left unharvested.

Kiesselbach (24) stated that any crop being tested should be surrounded by a crop of its own kind in order to avoid the effect of competition for moisture, nutrients, and possibly light. The degree of error resulting from such competition will depend primarily upon the extent to which the crops being tested differ in their vegetative characteristics and this competition will vary in different seasons. This competition, for all practical purposes, may be eliminated by using three or more row plots and discarding the outer rows which are subject to competition with adjoining plots.

Arny (1) stated that border effect on various soil types approximating each other in productivity, varies according to climatic conditions and effects of previous cropping.

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[1] Figure in parenthesis refers to literature cited

It would be desirable to remove as many factors affecting competition among rows and among plots as possible in experiment with any crop. This is impossible to do, in most cases, because of the amount of land, labor, time, and expense necessary. Usually the experimenter will find that he cannot justify the expense involved in removing all sources of plant competition. The alternative is to remove as much error as possible from field experiments due to interrow or interplot competition with the least amount of expense.

Clements (3) stated the following in "Plant Physiology and Ecology."

> "Competition is purely a physical process and .....arises from the reaction of one plant upon the physical factors about it and the effect of these modified factors upon its competitors. In the exact sense, two plants, no matter how close, do not compete with each other as long as the water-content, the nutrient material, the light and heat are in excess of the needs of both. When the immediate supply of a single necessary factor falls below the combined demands of the plants, competition begins."

SORGHUM

Klages, (25) using five row plots, compared the yield of the two outside rows with the three inside rows of both grain and forage type sorghums at four dates of planting. If the yields of the outside rows were statistically different from the inside rows he concluded that active competition from adjoining plots was present. Relatively higher variations in yields were present when the varieties were planted at a time removed from their optimum dates. He found that the outside rows of the plots were influenced either in the same manner as the inside rows, or not at all by the adjacent plots. He concluded that single row plots replicated frequently enough will give as reliable results as will plots with a large number of rows replicated less frequently if uniform stands are employed.

Ross (29) compared the yield of unbordered two row plots with the yield of two row plots bordered on each side with single rows. Four varieties were used which covered a wide range of maturity dates, and the experiment was conducted over a period of five years which included both favorable and unfavorable seasons. No differences in yield or in behavior of the varieties were found under either method and he concluded that sorghums having similar growth habits may be tested in two row plots without border rows.

Conrad, (4) using four-row plots of Honey sorgo in forty-two inch rows interspersed with thirty foot fallow strips, measured the distribution of residual soil moisture and nitrates. The yields of the two border rows of Honey sorgo were statistically different from the yields of the two inner rows, which is indicative of border effect. Honey sorgo showed a definite use of soil moisture six feet away laterally and definite use of nitrates four feet away laterally. Absorption of moisture from a depth of twelve feet and of nitrates from a depth of ten feet also occurred.

Drapala and Johnson (11) studied the effect of interrow competition on Greenleaf sudangrass and Gahi millet in two separate experiments. Each individual plot consisted of fourteen rows, six inches apart. The plots were alternately fertilized at the rate of zero and one-hundred pounds of nitrogen per acre. Yields were taken from each individual row and they found that no border effect between plots was present at distances greater than fifteen inches, or three rows inside the plots. They contend that the border effect is due to growth of the roots toward the fertilizer and that lateral movement of nitrogen is negligible.

CORN

Genter (13) compared the yields of early and late hybrids when bordered by early maturing, late maturing, and combinations of the two hybrids, in both single and double row plots for two years in Virginia. Competition from adjacent plots had no significant effect on the yield of either hybrid planted in single or double row plots in either year. He found that yields tended to be higher in plots bordered on each side by the early hybrid than in those bordered on both sides by the late hybrid. The early hybrid yielded less when grown between the late hybrid than when bordered by itself, and the late hybrid yielded more when grown between the early hybrid than when bordered by itself. Significant differences due to border competition for each hybrid were found when the data were combined for both years and plot sizes. He advised that hybrids of similar maturities should be grouped together, but there was no advantage for two-row plots over one-row plots with regard to competition effects.

Kiesselbach (23) using three-row plots, compared the yields of center rows with that of the border rows and found competition to be present. The degree of competition between adjacent rows was found to vary with the intensity of the limiting factors for growth and the degree of difference between the varieties compared. He suggests grouping of similar varieties, using multiple-row plots and discarding the outside rows, and obtaining uniform stands. He further stated that varieties which differ markedly in vegetative development may have different optimum planting rates, and that several rates of planting may be necessary to obtain a reliable variety test.

Kurtz, Melsted, and Bray (26) grew two single-cross hybrids, WF9 x Hy and K_4 x L317, in alternate rows with different treatments of fertilizer and water in Illinois and found differences in their ability to compete. K_4 x L317 normally outyields the WF9 x Hy hybrid but on the unwatered plots, yields of WF9 x HY were significantly higher (0.01 level). When all plots, regardless of treatment, were compared, the difference in grain yield between the two hybrids was not significant. K_4 x L317 responded more to water than WF9 x Hy and had a higher nitrogen content present in the stover. Significant differences in the nitrogen content of the grain were not found.

Jugenheimer (21) stated that competition between strains differing in maturity or size can be controlled by planting multiple-row plots and discarding the border rows before harvesting.

SOYBEANS

Hartwig, et al. (18) compared the effect of different type borders on two varieties of soybeans at four locations in Mississippi. They reported that the different strains used for borders did not influence yields in the same manner at each location and that unequal competition may influence the chemical composition of the seed. Their conclusions were that variety comparisons in one-row plots will give accurate performance estimates and that multiple-row plots with the border rows discarded should give greater accuracy than single-row plots.

The results obtained by Garber and Odland (12) at the West Virginia Experiment Station are contradictory to those of Hartwig, et al. Three row plots were used and the center-row was compared with the border rows which were adjacent to another variety. They obtained no differences in yield or height and concluded that border rows were not necessary with the conditions found in West Virginia.

Hanson, et al. (16) have developed a statistical model to describe the competing system in soybeans. The competing system tends to follow a simple additive model in which interacting effects can be ignored. The results of the experiment indicate that for quantitative genetic material two-row plots bordered with a common variety should minimize competition effects. In areas where competition is not a major factor, or in tests involving similar genetic material, two-row nonbordered plots should be adequate. They found that percent oil and percent protein were not markedly affected by competition effects.

COTTON

Green (14) measured competition in cotton varieties using the four varieties; Paymaster 54, Parrott, Dortch, and Lankart 57 which vary in maturity from early to late. Lankart 57 and Parrott were planted in yield rows, which were the center rows of three-row plots, bordered with rows of each of the four varieties. He was able to rank the four varieties according to their competitive ability but was unable to find any relationship between yield or earliness and the ability to compete. Border varieties showed an effect in approximately half of the treatments and he suggested that variety tests be planted in four-row plots with the two center rows being harvested for yield.

Christidis (2) of the Greek Cotton Institute, found competitive effects which varied from zero to six percent in a yield test with nine varieties of cotton. The best yielder was not always the best competitor and the plant height data did not show any indication of competition.

The competitive value of a variety was shown to be dependent upon the varieties with which it is grown in competition. He concludes that competition may cause a definite bias in comparing yields of cotton varieties and advises that field trials be arranged so that competition between different varieties will be eliminated.

Hancock (15) reported results from competition between the two varieties California Acala and Delfos 6102, obtained in Tennessee. These two varieties differ materially in maturity, height, vigor, boll size, leaf size, and prolificness. Each variety received three possible border effects; bordered on each side by the same variety, bordered on one side by the same variety and on the other side by the other variety, and bordered on both sides by the other variety. For one season no significant differences were observed among the Delfos combinations, but in most instances the Acala combinations differed significantly. Competition was shown to be an additive factor and it was suggested that two-row plots be used for cotton variety tests on medium fertile soils.

Richmond (28) reported competition effects to be present in cotton variety tests grown in the Brazos River Valley of Texas when early varieties were bordered with late ones and vice versa. Competition effects were not considered significant enough to require border rows in variety tests, however. He concluded that single-row plots would be more practical since border rows would increase the land area required considerably and would assumedly increase the experimental error.

Quinby, Kellogg, and Stevens (27) are in disagreement with the previously discussed literature and in particular the work of Christidis. They reanalyzed the data obtained by Christidis and stated, "Thus the data of Christidis......instead of conflicting with our own, point to the same conclusion, namely that competition is not an important factor in cotton variety tests and that single-row plots can safely be used."

SUGAR BEET

Deming and Brewbaker (10) found the yield of the border rows to be significantly different from the center rows of three-row and eight-row plots in Colorado. They advised providing enough rows per plot so that the two outer rows on each side could be discarded.

Immer (20) studied competition effects in Minnesota using two standard varieties which differed in growing habits. He concluded that the minimum number of rows per plot in variety tests was three, and that the two outside rows must not be included in yield information.

SMALL GRAINS

Hayes and Arny (19) presented evidence which shows that in some cases there is considerable competition between rod rows of spring and winter wheat, oats, and barley grown one foot apart in separate nurseries under Minnesota conditions. In nearly all tests the border rows proved to be more variable in yield than the center rows.

The results obtained by Stringfield (34) in Ohio indicate that competition causes only occasional indications of yield disturbances. The work of Kiesselbach and also that of Stadler is cited by Stringfield (34) and he points out that his results disagree with theirs as well as those obtained by Hayes and Arny (19). The explanation offered is that climatological factors form a basis for the apparently more severe competition in the Middle West.

MATERIALS AND METHODS

The material used in this study was five grain sorghum hybrids of which four were experiment station releases, and one was a commercial release. The experiment station releases were SD 441, NB 504, RS 610, and OK 632. The commercial hybrid was Lindsey 788. All of these hybrids are similar in height, and differ primarily in their dates of maturity. SD 441 (9) is very early maturing, NB 504 (9,35) early, RS 610 (6,7,8) medium, OK 632 (5,6,7) late, and Lindsey 788 (6,7,8) very late maturing.

The medium maturing hybrid, RS 610, was bordered by itself and the other four hybrids to give fifteen different treatment combinations which are shown in Appendix A. The material was grown at the following four locations in a randomized complete block design with four replications.

<u>Perkins Research Farm, Perkins, Oklahoma</u>.

The Perkins test, conducted under dryland conditions in rows forty inches wide, was planted June 18, 1962, on a Vanoss loam (31) under excellent conditions of soil moisture. The rotation on these plots had been sorghum following castorbeans for several years with no fertilizer applied to the sorghum. The test was in good condition just prior to harvesting when some weathering of the seed occurred. A few plants contracted the charcoal rot disease and lodged but the damage was slight. Populations of corn earworm (<u>Heliothis zea</u> (Boddie), Southwestern corn borer (<u>Zeadiatraea grandiosella</u> (Dyar), and the Sorghum midge (<u>Contarinia sorghicola</u> (Coq.) were present during the growing season but the damage resulting from their presence was only slight. Large populations of birds were present, however they were controlled with poisoned grain in feeders and carbide guns to the extent that little damage occurred. The test was harvested on September 29, 1962.

Oklahoma Peanut Research Station, Stratford, Oklahoma.

The Stratford test, conducted under dryland conditions in rows forty inches wide, was planted May 31, 1962, on a Vanoss loam (33). Soil moisture conditions at planting time were favorable. The rotation on these plots had been continuous sorghum for several years with sixty pounds per acre of nitrogen applied to the shredded stalks of the previous year's crop plowed down in the Spring. Populations of insects (Sorghum midge, corn earworm, and Southwestern corn borer) were controlled with two applications of the insecticidal spray "Sevin" at the rate of three pounds per acre. Bird damage was quite severe in the first replication, but damage in the other three replications was negligible. The first replication was discarded and the remaining three harvested on September 22, 1962.

U. S. Southern Great Plains Field Station, Woodward, Oklahoma.

The Woodward test, conducted under dryland conditions in rows forty-two inches wide, was planted June 28, 1962, on a Pratt fine sandy loam (30) under good conditions of soil moisture. The rotation on these plots was continuous sorghum for several years with no fertilizer applied. A large population of the Fall army worm (Laphygma frugiperda (J. E. Smith) was present early in the growing season but caused very little damage. Bird damage was very slight. The fourth replication was discarded because of uneven growth and emergence of plants in this area. The remaining three replications were harvested on November 8 and 9, 1962.

Panhandle Agriculture Experiment Station, Goodwell, Oklahoma.

The Goodwell test, conducted under irrigation in rows twenty-eight inches wide, was planted July 3, 1962, on a Richfield clay loam (32). This is a late planting date for the area but planting activities were delayed due to the excessive amount of precipitation which occurred just prior to the normal planting date and continued through late June. Although the planting date was quite late, the material matured in time to harvest. Besides a pre-planting irrigation, the plots were irrigated four times on the following dates: July 25-26, August 10-11, August 23-24, and August 30-31. Approximately three surface inches of water were applied at each irrigation. The rotation on these plots has been continuous sorghum with eighty pounds per acre of nitrogen applied approximately one month prior to planting. Slight damage by birds occurred, but they were controlled to a great extent by the use of carbide guns. The plots were harvested on November 9, 1962.

At all locations, the rate of planting was excessive in order to insure proper stands. The excess plants were removed approximately one to two weeks after emergence. The plant spacing at Perkins and Stratford was approximately one plant every seven and one-half inches (approximately 21,000 plants per acre). The spacing at Woodward was one plant every six inches (approximately 25,000 plants per acre), and at Goodwell one plant every three and one-half inches (approximately 64,000 plants per acre). The plots received sufficient cultivations to insure good control of weeds. The rows at Perkins, Stratford, and Goodwell were planted in an east-west direction, while those at Woodward were in a north-south direction.

The area harvested at all locations was 1/500 of an acre. The plots were harvested when RS 610 was in the combine-ripe stage. The heads were cut one-half inch below the head base with a pair of hand pruning shears to insure uniform threshing percents. The harvested heads were stored in burlap bags and all threshed on the same day with an "Almaco" portable nursery thresher. Rainfall data for each location are presented in Appendix B.

The following measurements were made on all plots:

1. Days to average bloom

Days to average bloom is an index of maturity and was computed by the following formula;

$$\text{Days to Ave. Blm.} = (\text{date planted to date of first bloom}) + \frac{(\text{date all blm.} - \text{date first bloom})}{2}$$

Date of first bloom was considered the date when three heads in the row started shedding pollen. Date of all bloom was considered the day when the last heads in the row started shedding pollen.

The next five measurements; plant height, flagleaf height, head length, exsertion, and culm diameter, were taken from five preselected plants in the row. At Goodwell measurements were made on plant numbers twenty, forty, sixty, eighty, and one-hundred. At the three remaining locations, measurements were taken on plant numbers fifteen, twenty-five, thirty-five, forty-five, and fifty-five.

2. Plant height

Plant height was measured from the ground level to the top of the head to the nearest inch.

3. Flagleaf height

The height of the flagleaf was measured from the ground level to the flagleaf to the nearest inch.

4. Head length

Head length was measured from the top of the head to the base of the head to the nearest inch.

5. Head exsertion

Head exsertion was the distance from the flagleaf to the base of the head. This distance was calculated by the following formula.

Head Exsertion = Plant height - (Flagleaf height + head length).

Under favorable growing conditions RS 610 normally has a positive exsertion. However, several of the plants had a negative exsertion at Stratford due to the fact that they did not completely emerge out of the sheath.

6. Culm diameter

Culm diameter was measured at the point of "minimum diameter" which is approximately one and one-half inches below the bottom branch of the head according to Kinzer (22). This point of "minimum diameter" was measured with a pair of Craftsman vernier calipers to the nearest 1/1000 of an inch.

7. Total heads including tillers

Total heads including tillers was the number of heads harvested from the plot (1/500 acre).

8. Number of tillers

A tiller was considered to be a secondary growth from the base of the culm which produced a seed head. The number of tillers in the row were counted and recorded at the three dryland locations. An accurate tiller count was impossible at the Goodwell station because of the large plant populations and narrow spacings between and within rows.

9. Percent nitrogen

The percent nitrogen in the seed was determined by the Kjeldahl Method (17).

10. Percent water

The percent water in the seed was determined from one-hundred gram samples oven dried at 100^{o} Centigrade for twenty-four hours. Percent moisture was calculated by the following formula:

% Water = Wet wt. - Dry wt., where the wet weight was 100 grams.

11. Test weight

The test weight of all samples was taken when the material was threshed, with a "Burrows" hand type test weight apparatus of the one quart size.

12. Weight of one thousand seed in grams

One thousand seeds from each sample were counted out of a random sample and weighed on a "Mettler" electronic balance accurate to 1/100 of a gram.

13. Threshing percent

Threshing percentages were calculated by the following formula:

Threshing Percent = (Threshed grain weight ÷ Head weight) x 100.

14. Lodging percent

The lodging percents were determined by the following formula:

% Lodge = (Number lodged in the row ÷ Total number in the row) x 100

The number of lodged plants was counted just prior to harvest. Any plant which was down to the extent that a combine would not pick it up under normal conditions was considered lodged and these plants were not harvested.

15. Percent stand

The stand percentages were calculated by the following formula:

$$\% \text{ Stand} = (\text{Number of plants in row} \div \text{Optimum number of plants}) \times 100$$

The optimum number of plants was the number of plants in the row which were left after thinning for the desired spacings at each location. There were eighty plants per row at Perkins and Stratford, sixty-nine at Woodward, and 160 at Goodwell.

16. Threshed grain per acre

The yield of grain in pounds per acre was calculated from the following formula;

$$\text{Threshed Grain per Acre} = (\text{Pounds of grain per row})\ (500).$$

The factor, 500, was used since the harvest area was 1/500 of an acre.

17. Pounds of heads per acre

The pounds of heads per acre was computed from the following formula:

$$\text{Pounds Heads per Acre} = (\text{Head weight per row})\ (500).$$

This measurement was calculated for a check on the threshing percentages.

18. Grams of seed per head

The grams of seed per head is a computed figure which shows the average weight in grams of the seed on a single head in the row. It was calculated with the following equation:

$$\text{Grams seed per head} = \frac{(\text{Pounds grain per row})\ (\text{Grams per pound})}{\text{Number of heads per row}}$$

Grams per pound is a constant value, 453.6.

19. Number of seeds per head

The number of seed per head is calculated using the grams of seed per head, which gives the number of seed on an average head in the row. This measurement was based upon the heads from the main stalks and also the heads from the tillers. The number of seeds per head was calculated by the following equation:

$$\text{Number of seeds per head} = \frac{(\text{Grams of seed per head})\ (1000)}{\text{Weight of 1000 seed}}$$

The data were analyzed in the Statistical Laboratory and Computing Center of the Oklahoma State University Department of Mathematics and Statistics using the IBM 650 computor. Analyses of variances were computed for each variable at each location. If a significant F value was obtained, treatment differences were measured with Tukey's "w" procedure, or as it is more commonly known the HSD (Honestly Significant Difference) test at the .05 level of probability.

DISCUSSION OF RESULTS

Analyses of variances and means for the results of this experiment are presented in Appendices E, F, and G, respectively. The analyses of variance and treatment means occupy a considerable amount of space, and since they are unnecessary for the reading of this discussion it has been convenient to place them separately from the discussion.

Plant height, number of tillers, percent nitrogen, percent water, test weight, days to average bloom, and threshing percent were not significantly influenced by the fifteen treatments at any location. The remaining variables which were affected by treatments were not the same from location to location. Each location is discussed separately because of this inconsistency.

GOODWELL

Flagleaf height, culm diameter, total heads including tillers, weight of 1000 seed in grams, threshed grain per acre, pounds of heads per acre, and grams of seed per head were significantly different among treatments. It should be noted that flagleaf height and culm diameter were only slightly significant ($F = 1.98$ and 1.95 respectively, when compared to the tabulated $F_{.05}$ of 1.94). Tukey's HSD test failed to detect any difference among treatments for these two variables. It, therefore, appears doubtful that any important differences exist. The remaining five variables were significantly different at the .01 level of probability.

The results of Tukey's HSD test at Goodwell are presented below.

Total No. of Heads Including Tillers		Grams Wt. of 1000 Seed		Pounds Threshed Grain per Acre		Pounds of Heads per Acre		Grams Seed per Head	
Treat. No.	Yield	Treat. No.	Yield	Treat. No.	Yield	Treat. No.	Yield	Treat. No.	Yield
10	160.5	1	28.45	1	6975	1	9575	7	43.8
9	158.8	6	28.27	7	6938	6	9288	1	43.0
3	154.3	4	27.68	9	6863	7	9213	8	42.3
5	149.3	3	27.43	6	6775	9	9188	6	42.0
1	148.0	5	27.43	3	6688	3	8925	11	41.3
6	146.8	7	27.23	5	6575	4	8725	4	40.6
4	146.3	2	27.18	4	6513	8	8675	5	40.2
7	144.3	8	27.14	10	6450	10	8638	3	39.5
14	143.0	9	27.08	8	6425	5	8450	12	39.5
13	141.3	11	26.90	11	6263	11	8425	2	39.4
12	140.3	12	26.71	12	6088	12	8150	9	39.3
15	140.0	10	26.58	2	5863	2	8050	10	36.5
11	138.5	14	24.71	14	5500	15	7963	15	35.5
8	138.0	13	24.24	15	5438	14	7663	14	35.0
2	135.0	15	24.24	13	5338	13	7513	13	34.6

Note: Any two means connected by the same line are not significantly different

The means for total heads including tillers fall into two groups when the HSD test is used. All treatments, except treatment number two (Ee M E), or treatment number ten (M M M), could be grouped together.

The HSD test shows treatments thirteen (L M L), fourteen (Ll M L), and fifteen (Ll M Ll) to be significantly different from all other treatments for weight of 1000 seed in grams. This indicates that bordering of RS 610 with later maturing hybrids will decrease the weight of seed, which may in turn decrease the yield of grain per acre under irrigated conditions.

These same treatments (thirteen, fourteen, and fifteen) were the three lowest treatments for threshed grain per acre. The treatment means fall into three groups with considerable overlapping.

Treatments thirteen, fourteen, and fifteen are also the lowest for pounds of heads per acre. The treatment means are arranged into three groups with slightly more overlapping than was present in threshed grain per acre.

Grams of seed per head were also less when RS 610 was bordered with later maturing hybrids. Treatments thirteen, fourteen, and fifteen had fewer grams of seed per head than the other twelve treatments. The treatment means are arranged into three groups with considerable overlapping when Tukey's HSD test is used.

PERKINS

Head length, number of seed per head, and percent stand responses were significant at the .05 level by the F test. It should be noted that percent stand was only slightly significant ($F = 1.97$ as compared to tablulated $F_{.05}$ of 1.94). This difference could possibly be due to a hard, washing rain just after the plants had emerged, rather than being caused by treatment effects. The stand was, in general, excellent, but slight variations in plant distribution occurred in a few plots which might be attributed to this rain. Tukey's HSD test failed to detect any stand difference among treatments.

Head length was significant by the F test but the HSD test did not show a difference among treatments. It is plausible that important differences were not present since head length is one of the components of grain yield, and yield of threshed grain was not significant. The same rain mentioned in connection with percent stand could have been responsible for this significance since slight variations in stands were observed. The plants in treatments where this variation occurred would have a slightly larger area of space and this could conceivably result in an increase in head length.

Tukey's HSD test for number of seed per head is given below.

Treatment Number	Yield
1	2766
14	2626
6	2595
4	2567
15	2532
8	2527
11	2503
2	2490
9	2483
13	2479
10	2436
5	2433
7	2412
12	2212
3	2103

All of the treatment means can be grouped together with the exception of treatment number one (Ee M Ee), or all of the treatment means except treatment number three (Ee M M) and treatment number twelve (M M L1) can be grouped together. Competition due to differences in maturity cannot be directly shown for number of seeds per head since treatment one produced the highest number of seed per head and treatment three (Ee M M) the fewest. This difference could be attributed to causes other than treatment effects.

STRATFORD

The only variable showing significant differences among treatments was percent lodging. RS 610 is susceptible to lodging by the charcoal rot disease and the Southwestern corn borer. Both of these were in evidence at Stratford. The damage caused by borers is of doubtful significance since they would presumably infest the plots in a more or less random manner and show no treatment preference. The lodging resulting from the charcoal rot disease could possibly have been due to treatment effects but no pattern due to maturity competition was noticed.

Since the HSD test failed to detect any differences among treatments, and the grain yields were not significantly different, it is doubtful that the lodging percentage found in this location is of any major importance.

WOODWARD

Exsertion was the only variable which showed differences among the treatments. Treatment differences detected by the HSD test are shown below:

Treat.:	1	7	10	3	14	13	6	12	11	2	5	4	9	15	8
Yield:	8.2	8.0	7.7	7.6	7.5	7.5	7.5	7.3	7.3	7.2	6.6	6.6	6.5	5.6	4.6

All of the means can be grouped together with the exception of treatment eight (E M L) which showed the least exertion, and all of the treatment means except treatment number one (Ee M Ee) and treatment number seven (E M M) can be grouped together. Visual inspection of the means does not show any definite trend in so far as earliness or lateness of the border rows is concerned. Treatment one (Ee M Ee) was exerted only 0.7 inch more than treatments thirteen (L M L) and fourteen (L M Ll). This differences could possibly have been due to rounding error in measurements. Late hybrids, when compared with early hybrids as border rows, do not appear to increase or decrease the exsertion of RS 610.

ANALYSES OF VARIANCES WITH LOCATIONS COMBINED

The combined analyses of variances in Appendix E show that responses due to locations were highly significant for all nineteen variables. Treatment by location interactions, significant at the .01 level were found for the following variables: Total heads including tillers, weight of 1000 seed in grams, days to average bloom, threshed grain per acre, pounds of heads per acre, and number of seeds per head. This is to be expected of these six variables since planting dates, soil types, and environmental conditions varied greatly from location to location.

The coefficients of variability were similar to those found in this type of experiment. The extremely high coefficients of variability obtained for lodging percent and number of tillers may possibly be due to the fact that the means for lodging percent and number of tillers are quite small.

SUMMARY AND CONCLUSIONS

Interrow competition in grain sorghum hybrids was studied at four locations in Oklahoma; Perkins, Stratford, Woodward and Goodwell. The test at Goodwell was irrigated and the three remaining locations were under dryland conditions. Five hybrids, varying in maturity from very early to very late, were used to border a medium maturing hybrid, RS 610, to give fifteen treatments. The treatments were planted in a randomized block design with four replications at each location.

The nineteen variables studied were: (1) plant height, (2) flag-leaf height, (3) head length, (4) exsertion, (5) culm diameter. (6) total heads including tillers, (7) number of tillers, (8) percent nitrogen, (9) percent water, (10) percent lodge, (11) percent stand, (12) threshing percent, (13) test weight, (14) days to average bloom, (15) pounds of heads per acre, (16) threshed grain per acre, (17) weight of 1000 seed in grams, (18) grams of seed per head, and (19) number of seed per head. Analyses of variance for each location were computed with a IBM 650 computor. When a significant F value was found, Tukey's HSD test was made to study possible differences among treatments for each variable at each location.

Plant height, number of tillers, percent nitrogen, percent water, test weight, days to average bloom, and threshing percent responses were not significantly different at any of the locations.

Differences were shown to exist for total heads including tillers, weight of 1000 seed in grams, threshed grain per acre, pounds of heads per acre, and grams of seed per head at Goodwell. These differences provide evidence that interrow competition may be present. Since this experiment was run only one year, it can not be determined that interrow competition would be present every year. The planting date at Goodwell was approximately one month later than normal. This alone could account for the fact that competition occurred (25). It is also possible that interrow competition may be expected to occur more readily in irrigated tests since narrow spacings, both within and between rows are necessary for the production of high yields.

The data obtained from Perkins, Stratford, and Woodward indicate that interrow competition does not occur under dryland conditions with the material used in this study. Although climatological conditions for growth of grain sorghums varied from location to location, the results obtained at each of the dryland locations were essentially of the same pattern in that there were very few significant differences among the treatment responses.

Seven variables showed differences among treatments at Goodwell, three variables showed differences among treatments at Perkins, one variable showed differences among treatments at Stratford, and one variable showed differences among treatments at Woodward. Any variable which was significantly different at one location was not significantly different at any other location.

With the material used in this study and under the climatic conditions present in Oklahoma in 1962, interrow competition under dryland conditions appears to be negligible. The results of this study indicated that interrow competition was present under irrigated conditions at Goodwell. More data is needed to substantiate this since the planting date at Goodwell was approximately one month removed from the optimum.

LITERATURE CITED

1. Arny, A. C. Border effect and ways of avoiding it. J. Am. Soc. Agron. 14: 266-278. 1922.

2. Christidis, B. G. Intervarietal competition in yield trials with cotton. J. Agri. Sci. 25: 231-237. 1935.

3. Clements, Frederic E. Plant Physiology and Ecology. New York: Henry Holt and Company, p. 252, 1907.

4. Conrad, J. P. Distribution of residual soil moisture and nitrates in relation to the border effect of corn and sorgo. J. Am. Soc. Agron. 29: 367-378. 1937.

5. Cunningham, Thomas S. Three new grain sorghum hybrids for Oklahoma. Okla. State U. Ext. Circ. L-73.

6. Davies, F. F. Performance tests of sorghum in Oklahoma 1961. Okla. Agri. Exp Sta. Misc. Pub. MP-66. March, 1962.

7. ___________. Performance tests of sorghum varieties and hybrids 1960. Okla. Agri. Exp. Sta. Misc. Pub. MP-63. March, 1961.

8. ___________. Performance tests of sorghum varieties and hybrids 1959. Okla. Agri. Exp. Sta. Misc. Pub. MP-60. March, 1960.

9. ___________. Summary of Oklahoma Regional Yield Nurseries 1960, 1961. Unpublished material. Agron. Dept. Okla. State U. Stillwater, Okla.

10. Deming, G. W. and H. E. Brewbaker. Border effect in Sugar Beets. J. Am. Soc. Agron. 26: 615-620. 1934.

11. Drapala, W. J. and C. M. Johnson. Border and competition effects in Millet and Sudangrass plots characterized by different levels of nitrogen fertilization. Agron. J. 53: 17-19. 1961.

12. Garber, R. J. and R. E. Odland. Influence of adjacent rows of Soybeans to one another. J. Am. Soc. Agron. 18: 605-607. 1926.

13. Genter, C. F. Plot competition between corn hybrids. Agron. J. 50: 205-206. 1958.

14. Green, J. M. Border effects in Cotton Variety Tests. Agron. J. 48: 116-118. 1956.

15. Hancock, N. I. Row competition and its relation to cotton varieties of unlike plant growth. J. Am. Soc. Agron. 28: 948-957. 1936.

16. Hanson, W. D., D. A. Brim and K. Hinson. Design and analysis of competition studies with an application to field plot competition in the Soybean. Crop Sci. 1: 255-258. 1961.

17. Harper, H. J. Methods for analysis for soil and plant material. Soil Laboratory Mimeo. O.A.M.C. Stillwater, Okla. 1948.

18. Hartwig, E. E., H. W. Johnson and R. B. Carr. Border effects in Soybean Test Plots. Agron. J. 43: 443-445. 1951.

19. Hayes, H. K. and A. C. Arny. Experiments in field technic in rod row tests. J. Agri. Res. 11: 399-419. 1917.

20. Immer, F. R. Varietal competition as a factor in yield trials with Sugar Beets. J. Am. Soc. Agron. 26: 259-261. 1934.

21. Jugenheimer, Robert W. Hybrid maize breeding and seed production FAO (Food and Agriculture Organization of the United States) Agriculture Development Paper No. 62. Chapter 18, Field Plot Technique. 1958.

22. Kinzer, H. G. The effects of insect populations on seed production of Sorghum vulgare (pers.). Ph.D. Thesis, Oklahoma State University Library, 1962.

23. Kiesselbach, T. A. Competition as a source of error in comparative corn yields. J. Am. Soc. Agron. 15: 199-215. 1923.

24. ______________. Plot competition as a source of error in crop tests. J. Am. Soc. Agron. 11: 242-247. 1919.

25. Klages, K. H. Yields of adjacent rows of sorghums in variety and spacing tests. J. Am. Soc. Agron. 20: 582-598. 1920.

26. Kurtz, T., S. W. Melsted and R. H. Bray. Yield and nitrogen composition of Two Single-Cross Corn Hybrids when grows in alternate rows. Agron J. 41: 474-476. 1949.

27. Quinby, J. R., D. T. Kellough and R. H. Stansel. Competition between cotton varieties and adjacent rows. J. Am. Soc. Agron. 29: 269-279. 1937.

28. Richmond, T. R. Competition in cotton variety treats. J. Am. Soc. Agron. 35: 606-612. 1943.

29. Ross, W. M. A comparison of grain sorghum varieties in plots with and without border rows. Agron. J. 50: 344-345. 1958.

30. Smith, Roy M. Unpublished Soil Survey of Southern Great Plains Field Station, Woodward, Oklahoma. Agron. Dept., Oklahoma State University, Stillwater, Okla.

31. Soil Survey Staff, Okla. State U. Agronomy Dept. Detailed Soil Survey of Perkins Farm, Perkins, Okla. Okla. Agri. Exp. Sta. Processed Series P-315A. February, 1959.

32. Soil Survey Staff, Okla. State U. Agronomy Dept. Detailed Soil Survey of Panhandle A & M Farms, Goodwell, Okla. Okla. Agri. Exp. Sta. Processed Series P-347. April, 1960.

33. Soil Survey Staff, Okla. State U. Agronomy Dept. Detailed Soil Survey of Oklahoma Peanut Research Station, Stratford, Okla. Okla. Agri. Exp. Sta. Processed Series P352. June, 1960.

34. Stringfield, G. H. Intervarietal competition among small grains. J. Am. Soc. Agron. 19: 971-983. 1927.

35. Webster, O. J. Summary of Regional Yield Grain Sorghum Nurseries in Nebraska for 1959-1961. Unpublished material. Agron. Dept. U. of Nebraska, Lincoln, Nebraska.

36. Wianco, A. T., et al. Report of committee on standization of field experiments. J. Am. Soc. Agron. 16: 1-16. 1924.

APPENDICES

APPENDIX A

List of Treatments and Their Designations

Treatment Number	Letter Designation*	Hybrids in Rows			Numbers		
1	Ee M Ee	SD 441	RS 610	SD 441	1	3	1
2	Ee M E	SD 441	RS 610	NB 504	1	3	2
3	Ee M M	SD 441	RS 610	RS 610	1	3	3
4	Ee M L	SD 441	RS 610	OK 632	1	3	4
5	Ee M Ll	SD 441	RS 610	Lind 788	1	3	5
6	E M E	NB 504	RS 610	NB 504	2	3	2
7	E M M	NB 504	RS 610	RS 610	2	3	3
8	E M L	NB 504	RS 610	OK 632	2	3	4
9	E M Ll	NB 504	RS 610	Lind 788	2	3	5
10	M M M	RS 610	RS 610	RS 610	3	3	3
11	M M L	RS 610	RS 610	OK 632	3	3	4
12	M M Ll	RS 610	RS 610	Lind 788	3	3	5
13	L M L	OK 632	RS 610	OK 632	4	3	4
14	L M Ll	OK 632	RS 610	Lind 788	4	3	5
15	Ll M Ll	Lind 788	RS 610	Lind 788	5	3	5

* Ee denotes very early, E denotes early, M denotes medium, L denotes late, and Ll denotes very late maturing.

APPENDIX B

1962 DAILY PRECIPITATION AT

PERKINS, STRATFORD, WOODWARD, AND GOODWELL

1962 Daily Precipitation - Agronomy Research Farm, Perkins, Oklahoma

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1						1.15		.52					
2						1.45				.15		.94	
3							.02		1.85				
4				.05					.04				
5	.22			.21						.51			
6				.04						.01	.18		
7						.15			.45				
8				.21		.30			.11				
9						3.28							
10				.72		.03	2.90						
11	.02			.06									
12										.06			
13													
14	T												
15		.25							2.49				
16							1.60						
17									.01		.24		
18	.19					.03				.03			
19	.02									.55		.04	
20		.05	.56	.02					.50	.83		.04	
21													
22				.13		.81							
23						.53							
24			.46			T	.54	.22	.14			.14	
25			.15		.43								
26	.09	.02			.05						.83		
27		.20		.37			.18						
28				.06	2.25		.18			.49	.03		
29						.15						.02	
30							.24		12				
31							.32	.06					
Total	.54	.52	1.17	1.87	2.73	7.88	5.98	.80	5.71	2.63	1.28	1.18	32.29

1962 Daily Precipitation - Peanut Research Station, Stratford, Oklahoma

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1						1.75							
2						.50							
3													
4				.75									
5				.35		.40				.27			
6						.53			.30				
7									1.09				
8	.11					.33			.41				
9						.45							
10			.11			.30				2.35			
11													
12													
13										.20			
14													
15		.12					.10		1.65				
16													
17											.28		
18						.30							
19		.08										1.57	
20			1.30				.73		.82				
21	.20												
22				.50	.25	.16							
23		.30		.41	.07								
24				.10	.62		.20	.43				.13	
25	.11				.33		.58		.49				
26					.48						1.75		
27				.79		.07				5.30			
28		.68			.68		.20			.15	.05		
29													
30			.29			.05			.34				
31								2.15					
Total	0.42	1.18	1.70	2.90	2.43	4.84	1.81	2.58	5.10	8.27	2.08	1.70	35.01

1962 Daily Precipitation - U.S. Southern Great Plains Field Station, Woodward, Oklahoma

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1												.16	
2						1.71			T	T		.57	
3						.65						T	
4	.18			.46						T			
5				.27						.24			
6				.02		.27			T				
7	.04			.02					.06				
8	.33					.53			T	T			
9			.11	.10		.29							
10			T	T		.14							
11							T						
12					T			.12					
13		T											
14	T	.10				T			1.44		T		
15		T					.02	.06	T		T		
16					.65				1.34				
17	.01					.32				.04	.31		
18	.02					.10			.06		T	T	
19							T		.63			T	
20					.05	.03			T				
21	T					.38							
22						.32			T				
23			.01				.88		.23			.05	
24	T		.32				.15		.16				
25	.40	T									.28	.13	
26				1.47		T					.07		
27					.02		.01					T	
28					.26					.42			
29													
30							1.02	1.12			.03		
31					1.46		.40						
Total	.98	.10	.44	2.34	2.44	4.74	2.48	1.30	3.92	.70	.69	.91	21.04

1962 Daily Precipitation - Panhandle Agriculture Experiment Station, Goodwell, Oklahoma

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1						1.83		.91				T	
2						.38			.35			.13	
3						T						T	
4				.13			.36		T				
5				.08					T	.14			
6				.15			T						
7									T				
8	T			T		T			.94				
9	.03					.49	.12		T				
10				.29		.79							
11			T	.02		.09	.45						
12				T									
13					T			2.28					
14		.16				.07			.41				
15								T	.06		T		
16					.46		.02		.26	T	.35		
17										.02	.14	.01	
18	.01				.46	.23				T	T		
19	T				T		.22		T	.07	T		
20	.02						.08		.07	T			
21	T							T	T				
22				T		.34			T				
23						.99			.17				
24		T	.65			T	.18		.16				
25	.09		T			T						.27	
26	.04	T		T		3.51					.02		
27		T			T		.09						
28		T		T			.18						
29							.43						
30			T				.13	T					
31							.42	.12					
Total	.19	.16	.65	.67	.92	8.72	2.68	3.31	2.32	.23	.51	.41	20.77

APPENDIX C

DESCRIPTIONS OF SOIL TYPES AT PERKINS, STRATFORD, WOODWARD, AND GOODWELL

Vanoss Loam

Type Location: 550 ft. north and 1250 ft. east of the SW corner of section 36, T18N; R2E, Agronomy Research Station, Perkins, Oklahoma.

Profile:

A_{1p}	0-8"	Brown (7.5YR 5.3; 3.5/2, moist) loam or coarse silt loam; weak medium granular; friable; soft and crumbly; permeable; pH 6.0; rests with a shear face on the layer below.
A_1	8-16"	Brown (7.5YR 4.5/3; 3.5/2, moist) loam or silt loam; moderate medium granular; friable; pH 6.2; grades to layer below.
A_3	16-22"	Brown (7.5YR 4/3; 3/2, moist) heavy loam or light clay loam; moderate medium granular; friable; permeable; pH 6.0; grades to layer below.
B_{2-1}	22-32"	Brown (7.5YR 5/3; 4/3, moist) clay loam; compound moderate medium granular and weak fine subangular blocky; firm; hard when dry; porous and permeable; pH 6.0; grades to the layer below.
B_{2-2}	32-40"	Brown (7.5YR 5/4; 4/4 moist) sandy clay loam; same as the layer above; pH 6.5; becomes more coarse with depth and grades to the layer below.
B_3	40-50"	Strong brown (7.5YR 5.5/6; 5/6 moist) sandy clay loam; weak medium subangular blocky; friable to firm; porous and permeable; pH 6.5; grades to the layer below.
C_1	50-60"	Same as the layer above but contains a few, medium distinct yellowish-red (5YR 5/6) mottles; pH 6.5; grades to the layer below.

The lower three horizons, which were not included in this profile description, appear to be stratified old alluvium. The upper four horizons are composed of less sandy materials which might comprise a loess cap overlying the older alluvium.

In areas where wind erosion has removed some of the finer materials, surface textures are fine sandy loams. A horizons range from 14 to 22 inches deep and B_1 horizons vary from 0-6 inches thick. A_3 and B_1 horizons are often difficult to distinguish.

Vanoss loam, clayey substrata, 1-2% slopes

Type Location: 900 ft. north and 800 ft. west of the east quarter-corner, section 10, Oklahoma Peanut Research Station, Stratford, Oklahoma.

Profile:

A_1	0-12"	Grayish-brown (10YR 5/2; 3.5/2, moist) loam; weak to moderate medium granular; friable; porous and permeable; pH 6.0; grades to the horizon below.
B_1	12-20"	Grayish-brown (10YR 5/2; 4/2, moist) clay loam with common, medium and fine, distinct yellowish-red (5YR 5/6) mottles; weak fine subangular blocky; firm; hard when dry; porous and permeable; pH 6.0; grades to the horizon below.
B_{2-1}	20-30"	Brown (10YR 5/3; 4/3, moist) fine sandy loam with common, medium to coarse, distinct yellowish-red (5YR 5/6) mottles; weak medium subangular blocky; very firm, slowly permeable; pH 6.0; grades to layer below.
B_{2-2}	30-42"	Gray (10YR 5/1; 4/1, moist) sandy clay coarsely mottled with brownish-yellow (1oYR 5/6) and strong-brown (7.5YR 5/6); weak medium blocky; very firm; very slowly permeable; pH 6.5; grades through a broad transition to the C layer.
C	42-52"	Coarsely mottled brownish-yellow (10YR 6/6; 5/6, moist), yellow (10YR 8/6; 7/6, moist), and light-brownish-gray (10YR 6/2; 5/2 when moist) sandy clay loam; weak medium blocky; firm; permeable; pH 6.5; becomes more sandy in lower part.

The thickness of A_1 and B_1 layers above clay varies from 18 to 32 inches and averages about 22 inches. Locally the B_{2-1} is a light sandy clay of yellowish-brown color. B_{2-2} layers range from gray, mottled with brownish-yellow to brown, mottled with light gray and brownish-yellow. C horizons are coarsely mottled light gray, brown and reddish-yellow corase sandy clays usually weakly stratified with clay loams.

Pratt fine sandy loam, 1-3% slopes

Type Location: 825 ft. east and 575 ft. south of west quarter corner of section 36, Woodward Research Station, Woodward, Oklahoma.

Profile:

A_1	0-12"	Dark brown (10YR 3/3; 4/3, dry) sandy loam; moderate fine and medium granular structure; friable moist; pH 6.5; gradual boundary.
B_2	12-24"	Dark brown (7.5YR 3/3; 4/3, dry) sandy loam; slightly higher in both sandy and clay than the above horizon; weak, coarse ill-defined prisms separating easily to weak medium granules; friable moist, hard dry; pH 6.5; gradual boundary.
B_3	24-40"	Dark brown (7.5YR 3/4; 4/4 dry) sandy loam; structure similar to above; friable moist; slightly hard dry; pH 7.0: non-calcareous; gradual boundary.
C	40-60"	Brown (7.5YR 4/4; 5/4 dry) loamy fine sand; single grain structure; loose dry, moderately coherent moist; pH 7.2; non-calcareous.

The surface varies from 8 to 17 inches deep and from sandy loam to fine sandy loam in texture. B horizons are generally of the same textural class as the A horizon but slightly higher in clay content.

Richfield clay loam, 0-1% slopes

Type Location: 1,050 ft. west and 140 ft. south of the east quarter corner along the east-west field road in the NW NE SE section 36, T2N; R13E. Panhandle A & M College Farm, Goodwell, Oklahoma

Profile:

$A1_p$	0-7"	Dark grayish-brown (10YR 4/2; 3/2, moist) clay loam; broadly weak prismatic but crushes easily in moist state to medium granules; firm; hard when dry; pH 7.2; rests with less than an inch transition on the layer below.
B_{2-1}	7-18"	Dark grayish-brown (10YR 4/2; 3/2 moist) clay; compound weak prismatic and weak medium blocky; very firm; very hard when dry; sides of peds coated with clay films; pH 7.5; upper 3 to 4 inches slightly darker; 3 inch transition to layer below.
B_{2-2}	18-24"	Pale brown (10YR 6/3; 5/3, moist) calcareous heavy silty clay loam; weak blocky; crushes with moderate pressure when moist to medium granules; contains a modicum of thin streaks and spots of $CaCO_3$; occasional $CaCO_3$ concretions in the lower part which grades to the layer below.
C_{ca}	24-38"	Pale brown (9YR 6/3; 5/3 moist) strongly calcareous silty clay loam; very weak granular to porous massive; friable; contains from 15 to 20% $CaCO_3$ in the form of very pale brown soft concretions and streaks 1/4 to 3/8-inch in thickness; grades slowly to the layer below.
C	38-58"	Reddish-yellow (7.5YR 6/5; 5/5 moist) calcareous silty clay loam much like the layer above but contains much less $CaCO_3$ and this is mostly in the form of hard concretions and spots; grades to layer below.

Thickness of A horizons vary from 5 to 10 inches but average about 7 inches. Where the deeper A horizons prevail, transitions to subsoils are less abrupt and the upper subsoils are less compact than normal.

APPENDIX D

PARENTAGE AND CHARACTERISTICS OF THE FIVE HYBRIDS: SD 441, NB 504, RS 610, OK 632, AND LINDSEY 788

SD 441, a hybrid from Reliance 4192 x SD 102, was released by the South Dakota Experiment Station. Under Oklahoma conditions it will reach a height of approximately forty-nine inches, with a mid-bloom date of fifty-one days from planting (9).

NB 504, a hybrid from Combine Kafir-60 x Day-Atlas 3494, will reach the mid-bloom period about five days earlier than RS 610 (35) in Nebraska where it was developed. Under Oklahoma conditions NB 504 grows to an approximate height of forty-five inches and will reach the mid-bloom period in about fifty-four days (9).

RS 610 is a regional hybrid from Combine Kafir-60 x Combine 7078. In Oklahoma it attains an approximate height of forty-six inches and reaches the mid-bloom period in about fifty-eight days (6,7,8).

OK 632, a hybrid from Redlan x OK RY8, is a hetero-yellow endosperm type released by Oklahoma. It will reach an approximate height of forty-eight inches with a mid-bloom date of sixty-two days (5,6,7).

Lindsey 788 is a hybrid developed by the Lindsey Seed Company of Lubbock, Texas. The parentage of this hybrid is not known since commerical companies maintain a closed pedigree system. In Oklahoma Lindsey 788 attains an approximate height of forty-seven inches and reaches the mid-bloom period in about sixty-five days (6,7,8).

APPENDIX E

ANALYSES OF VARIANCES FOR NINETEEN VARIABLES COMBINED OVER LOCATIONS

Plant Height Source	df	MS	F	Tabulated F .05	.01
Total	209				
Location	3	1573.18	602.82**	2.64	3.86
Rep in Loc	10	4.42	1.73		
Treat	14	2.33	0.91		
Treat x Loc	42	1.94	0.76		
R x T in Loc	140	2.55			CV = 3.61%
Flag Leaf Height					
Total	209				
Location	3	988.46	606.42**		
Rep in Loc	10	2.71	1.66		
Treat	14	2.11	1.29		
Treat x Loc	42	2.32	1.42		
R x T in Loc	140	1.63			CV = 4.20%
Head Length					
Total	209				
Location	3	25.39	169.27**		
Rep in Loc	10	1.10	7.33		
Treat	14	.29	1.93*		
Treat x Loc	42	.15	1.00		
R x T in Loc	140	.15			CV = 4.31%
Culm Diameter					
Total	209				
Location	3	.1230638	269.76**		
Rep in Loc	10	.0016645	3.65		
Treat	14	.0006000	1.31		
Treat x Loc	42	.0004678	1.02		
R x T Loc	140	.0004562			CV = 5.27%
Total Heads Including Tillers					
Total	209				
Location	3	146217.41	3923.19**		
Rep in Loc	10	59.47	1.60		
Treat	14	30.91	.83		
Treat x Loc	42	79.28	2.13**		
R x T in Loc	140	37.27			CV = 8.31%
Number of Tillers					
Total	149				
Location	2	355.07	54.37**		
Rep in Loc	7	3.21	.49		
Treat	14	2.91	.45		
Treat x Loc	28	7.10	1.09		
R x T in Loc	98	6.53			CV = 132.64%

* = Significant at .05 level
** = Significant at .01 level

Percent Nitrogen	df	MS	F	
Total	209			
Location	3	6.320429	276.80**	
Rep in Loc	10	.138629	6.07	
Treat	14	.022399	.98	
Treat x Loc	42	.031554	1.38	
R x T in Loc	140	.022834		CV = 8.08%
Percent Water				
Total	209			
Location	3	5.1131	40.48**	
Rep in Loc	10	.0548	.43	
Treat	14	.0614	.49	
Treat x Loc	42	.0746	.59	
R x T in Loc	140	.1263		CV = 3.62%
Test Weight				
Total	209			
Location	3	535.6729	821.84**	
Rep in Loc	10	4.8068	7.37	
Treat	14	.8384	1.29	
Treat x Loc	42	.7774	1.19	
R x T in Loc	140	.6518		CV = 1.4%
Weight of 1000 Seed in Grams				
Total	209			
Location	3	864.9975	422.71**	
Rep in Loc	10	12.5623	6.14	
Treat	14	6.3771	3.12**	
Treat x Loc	42	4.3649	2.13**	
R x T in Loc	140	2.0463		CV = 6.18%
Days to Average Bloom				
Total	209			
Location	3	485.0376	664.98**	
Rep in Loc	10	1.7878	2.45	
Treat	14	.0084	.01	
Treat x Loc	42	1.3784	1.89**	
R x T in Loc	140	.7294		CV = 1.49%
Threshing Percent				
Total	209			
Location	3	1661.8030	90.73**	
Rep in Loc	10	81.3526	4.44	
Treat	14	14.1098	.77	
Treat x Loc	42	18.4251	1.01	
R x T in Loc	140	18.3162		CV = 6.41%

Exsertion	df	MS	F	
Total	209			
Location	3	652.20	521.76**	
Rep in Lic	10	2.47	1.98	
Treat	14	1.79	1.43	
Treat x Loc	42	1.31	1.05	
R x T in Loc	140	1.25		CV = 23.78%
Percent Lodge				
Total	209			
Location	3	486.96	14.23**	
Rep in Loc	10	65.91	1.93	
Treat	14	29.74	.87	
Treat x Loc	42	24.37	.71	
R x T in Loc	140	34.22		CV = 143.38%
Percent Stand				
Total	209			
Location	3	68.63	7.87**	
Rep in Loc	10	6.97	.80	
Treat	14	10.91	1.25	
Treat x Loc	42	9.07	1.04	
R x T in Loc	140	8.72		CV = 2.99%
Pounds Threshed Grain Per Acre				
Total	209			
Location	3	248263005	1452.48**	
Rep in Loc	10	993814	5.81	
Treat	14	576211	3.37**	
Treat x Loc	42	422596	2.47**	
R x T in Loc	140	170924		CV = 12.3%
Pounds Head Weight Per Acre				
Total	209			
Location	3	394440232.00	1458.39**	
Rep in Loc	10	1294303.10	4.78	
Treat	14	777938.79	2.88**	
Treat x Loc	42	513991.31	1.90**	
R x T in Loc	140	270463.54		CV = 10.61%
Grams of Seed Per Head				
Total	209			
Location	3	2358.81	54.34**	
Rep in Loc	10	366.14	8.43	
Treat	14	85.43	1.97*	
Treat x Loc	42	53.45	1.23	
R x T in Loc	140	43.41		CV = 15.17%
Number of Seed Per Head				
Total	209			
Location	3	10686726.59	200.68**	
Rep in Loc	10	421944.75	7.92	
Treat	14	96564.24	1.81*	
Treat x Loc	42	69528.16	1.31**	
R x T in Loc	140	53252.47		CV = 12.04

APPENDIX F

ANALYSES OF VARIANCES FOR

NINETEEN VARIABLES AT

PERKINS, STRATFORD, WOODWARD AND GOODWELL

		LOCATION							
		PERKINS		STRATFORD		WOODWARD		GOODWELL	
VARIABLE	SOURCE	df	MS	df	MS	df	MS	df	MS
Plant Height	REPS	3	8.8897	2	3.6515	2	2.7902	3	1.5420
	TREAT	14	2.1640	14	1.1894	14	2.5098	14	2.2826
	ERROR	42	3.7083	28	1.8610	28	1.9292	42	2.2739
Flagleaf Height	REPS	3	2.5431	2	6.2942	2	3.0302	3	.2833
	TREAT	14	2.3755	14	1.5826	14	2.3669	14	2.7542*
	ERROR	42	1.7597	28	2.1589	28	1.2749	42	1.3923
Head Length	REPS	3	.7342	2	2.2649	2	2.0586	3	.0664
	TREAT	14	.1671*	14	.1917	14	.1965	14	.1735
	ERROR	42	.0823	28	.1077	28	.2500	42	.1783
Culm Diameter	REPS	3	.00025	2	.00586	2	.00163	3	.00028
	TREAT	14	.00017	14	.00052	14	.00096	14	.00034*
	ERROR	42	.00044	28	.00048	28	.00085	42	.00017
Total Heads Including Tillers	REPS	3	8.7776	2	12.1555	2	30.2000	3	161.2443
	TREAT	14	24.3142	14	11.7555	14	4.5238	14	228.1714**
	ERROR	42	17.6349	28	12.4412	28	14.8666	42	88.3873

* Significant at .05 level
** Significant at .01 level

VARIABLE	SOURCE	PERKINS df	PERKINS MS	STRATFORD df	STRATFORD MS	WOODWARD df	WOODWARD MS	GOODWELL df	GOODWELL MS
Number of Tillers	REPS	3	4.3111	2	.9555	2	3.8000	3	.0000
	TREAT	14	10.5642	14	5.5079	14	1.0380	14	.0000
	ERROR	42	10.5134	28	6.1222	28	.9666	42	.0000
Percent Nitrogen	REPS	3	.2279	2	.2235	2	.0876	3	.0267
	TREAT	14	.0158	14	.0102	14	.0822	14	.0087
	ERROR	42	.0145	28	.0097	28	.0721	42	.0070
Percent Water	REPS	3	.0537	2	.0202	2	.0682	3	.0699
	TREAT	14	.1267	14	.0346	14	.0502	14	.0735
	ERROR	42	.1927	28	.0209	28	.0846	42	.1579
Test Weight	REPS	3	3.3708	2	17.8388	2	.8222	3	.2111
	TREAT	14	.7946	14	.8531	14	1.1865	14	.3363
	ERROR	42	.4422	28	1.1305	28	1.1436	42	.2140
Weight of 1000 Seed in Grams	REPS	3	11.8965	2	35.8977	2	2.9763	3	4.0618
	TREAT	14	6.1186	14	2.3665	14	3.9685	14	6.9881**
	ERROR	42	3.6792	28	1.6714	28	2.0108	42	.6869

* Significant at .05 level
** Significant at .01 level

		LOCATION							
		PERKINS		STRATFORD		WOODWARD		GOODWELL	
VARIABLE	SOURCE	df	MS	df	MS	df	MS	df	MS
Days to Average Bloom	REPS	3	.8611	2	3.2666	2	1.6222	3	1.8389
	TREAT	14	.6738	14	1.8952	14	1.4031	14	.1714
	ERROR	42	.3849	28	1.8619	28	.9317	42	.1841
Threshing Percent	REPS	3	154.6653	2	159.4320	2	12.6949	3	1.7586
	TREAT	14	22.1842	14	13.1157	14	16.2537	14	17.8312
	ERROR	42	15.6874	28	28.0715	28	20.8339	42	12.7629
Exsertion	REPS	3	1.1484	2	5.8995	2	2.6346	3	1.3820
	TREAT	14	.7225	14	1.8397	14	2.6918*	14	.4806
	ERROR	42	2.0793	28	1.0167	28	1.1584	42	.6448
Percent Lodge	REPS	3	116.8166	2	100.4429	2	.1306	3	35.8308
	TREAT	14	84.6047	14	17.8479*	14	.1120	14	.3000
	ERROR	42	109.3255	28	6.5036	28	.1306	42	.3171
Percent Stand	REPS	3	.1655	2	5.4166	2	17.4470	3	7.8348
	TREAT	14	.6120*	14	6.8348	14	22.2316	14	8.4653
	ERROR	42	.3099	28	4.2309	28	26.3406	42	8.3836

* Significant at .05 level
** Significant at .01 level

		LOCATION							
		PERKINS		STRATFORD		WOODWARD		GOODWELL	
VARIABLE	SOURCE	df	MS	df	MS	df	MS	df	MS
Grams of Seed per Head	REPS	3	604.0606	2	720.3620	2	179.1380	3	16.7293
	TREAT	14	78.1020	14	19.8825	14	113.5367	14	34.2628**
	ERROR	42	44.3434	28	35.4096	28	100.9398	42	9.4643
Threshed Grain per Acre	REPS	3	1977376	2	1647722	2	164055	3	127486
	TREAT	14	235773	14	33198	14	358150	14	1216875**
	ERROR	42	146035	28	67960	28	216734	42	233914
Pounds of Heads per Acre	REPS	3	2070486	2	2573555	2	376165	3	277376
	TREAT	14	263630	14	41246	14	507357	14	1507678**
	ERROR	42	193670	28	96591	28	257416	42	471869
Number of Seed per Head	REPS	3	742046	2	755885	2	176600	3	42779
	TREAT	14	100616*	14	95605	14	95087	14	13838
	ERROR	42	46601	28	69591	28	109104	42	11775

* Significant at .05 level
** Significant at .01 level

APPENDIX G

TREATMENT MEANS AT

PERKINS, STRATFORD, WOODWARD, AND GOODWELL

FOR NINETEEN VARIABLES

T NO.	PLANT HEIGHT	HEAD LENGTH	FLAGLEAF HEIGHT	CULM DIAMETER	TOTAL HEADS	NO. OF TILLERS	PERCENT NITROGEN	PERCENT WATER	TEST WEIGHT	WEIGHT OF 1000 SEED IN GRAMS
					PERKINS					
1	44.1	9.8	33.4	.4062	44.5	2.0	2.06	10.0	53.3	21.5
2	44.3	9.6	34.2	.4112	48.5	3.7	2.08	10.1	53.6	21.3
3	45.4	9.2	34.9	.4000	44.0	2.5	2.00	10.1	53.3	22.5
4	45.5	9.6	35.3	.3900	47.5	6.2	2.09	10.2	53.5	20.3
5	45.2	9.4	34.5	.3987	45.7	3.0	2.16	10.0	53.0	19.3
6	44.9	9.5	34.7	.4000	49.0	7.0	2.07	10.0	53.8	21.4
7	46.2	9.8	35.3	.4050	48.0	5.7	2.12	9.8	53.6	20.0
8	45.0	9.7	35.1	.4062	48.2	6.0	2.12	10.5	52.8	20.1
9	44.3	9.8	33.0	.4062	42.0	2.0	1.97	10.2	53.7	21.8
10	45.9	9.4	35.7	.4000	43.7	5.0	2.10	9.8	52.5	18.5
11	46.6	9.7	35.7	.4025	49.7	4.2	2.06	9.8	52.7	19.0
12	46.0	9.2	35.0	.3875	49.7	5.7	2.10	10.2	53.6	20.7
13	45.9	9.8	35.1	.3937	49.2	4.5	2.00	10.0	53.1	19.0
14	45.1	9.6	35.0	.4050	48.7	6.0	1.98	10.1	53.5	20.0
15	45.2	9.6	34.9	.3950	47.7	5.2	1.94	10.0	54.1	22.2
					STRATFORD					
1	38.3	8.2	26.6	.3866	43.3	3.6	2.32	9.7	52.6	18.7
2	37.4	7.7	25.6	.3750	42.0	3.0	2.33	9.5	51.8	18.5
3	37.0	7.9	26.2	.4016	38.6	0.3	2.39	9.7	52.3	18.3
4	37.9	7.9	26.7	.3916	40.3	1.6	2.32	9.6	53.1	18.0
5	38.0	7.4	25.0	.3550	43.3	3.0	2.28	9.7	53.5	20.5
6	39.0	8.0	26.4	.4033	40.0	1.3	2.30	9.7	52.6	19.2
7	38.4	8.1	27.2	.3950	39.0	3.3	2.29	9.8	52.3	17.6
8	38.7	8.2	27.0	.3933	41.0	1.0	2.22	9.9	53.6	18.6
9	38.6	7.6	26.1	.3783	43.3	3.0	2.18	9.8	53.1	18.9
10	37.0	7.7	25.8	.3983	36.6	1.0	2.25	9.6	52.6	18.4
11	38.2	7.8	25.8	.3866	42.3	4.6	2.37	9.7	52.6	17.6
12	38.4	8.0	26.9	.3816	38.6	0.0	2.27	9.8	52.3	17.9
13	37.8	7.9	25.4	.3850	41.0	1.3	2.33	9.8	52.3	19.5
14	38.6	8.1	27.5	.4050	39.6	1.3	2.33	9.6	52.1	16.8
15	39.0	8.4	27.0	.4000	41.3	3.0	2.21	9.8	53.3	18.8
					WOODWARD					
1	40.1	9.1	24.8	.3066	44.0	0.3	1.45	10.0	58.1	26.0
2	39.1	8.8	25.1	.3216	44.6	1.0	1.47	10.0	58.0	26.0
3	40.0	9.2	25.2	.3216	45.6	0.3	1.64	10.1	57.5	24.7
4	40.2	9.3	26.3	.3583	48.3	1.0	1.71	10.1	57.0	27.9
5	40.4	9.4	26.3	.3500	46.0	2.6	1.79	9.8	58.6	27.0
6	41.7	9.3	26.9	.3283	44.3	0.0	1.40	10.0	58.8	26.5
7	40.6	9.1	25.5	.3133	44.0	1.0	1.57	10.0	58.3	26.6
8	39.8	9.8	27.3	.3733	46.3	0.6	1.92	9.6	59.3	28.9
9	41.6	9.4	27.6	.3516	43.6	0.6	1.50	10.0	58.1	26.7
10	40.6	9.2	25.6	.3316	44.3	0.6	1.51	10.0	58.8	25.8
11	40.2	9.3	25.6	.3300	44.6	0.6	1.49	10.0	59.1	26.6
12	42.0	9.4	27.2	.3266	45.0	0.6	1.50	10.0	58.0	26.1
13	40.6	9.2	25.8	.3300	45.0	1.0	1.30	10.1	57.8	26.0
14	42.1	9.4	27.1	.3416	45.3	0.6	1.48	10.0	57.8	25.7
15	39.4	9.7	26.0	.3466	43.6	0.6	1.76	10.0	58.5	24.0
					GOODWELL					
1	50.6	9.1	32.4	.2900	148.0		1.67	9.4	58.7	28.4
2	49.7	8.8	31.6	.2900	135.0	N	1.61	9.3	59.0	27.1
3	51.3	8.8	34.0	.2912	154.2	O	1.50	9.4	58.8	27.4
4	50.1	9.2	32.3	.3150	146.2		1.62	9.4	58.8	27.6
5	52.1	8.9	33.7	.2900	149.2	C	1.54	9.2	58.7	27.4
6	50.7	9.0	32.8	.3000	146.7	O	1.67	9.3	59.0	28.2
7	51.5	8.8	33.7	.2912	144.2	U	1.56	9.8	58.8	27.2
8	50.2	9.0	32.5	.3150	138.0	N	1.58	9.4	59.1	27.1
9	51.3	9.5	33.5	.2987	158.7	T	1.62	9.3	59.1	27.0
10	49.8	9.3	31.9	.3062	160.5		1.58	9.4	58.8	26.5
11	50.2	9.0	32.0	.3125	138.5	T	1.63	9.4	59.2	26.9
12	49.5	9.2	31.2	.2987	140.2	A	1.59	9.4	58.8	26.7
13	49.9	9.1	32.0	.3087	141.2	K	1.56	9.2	58.3	24.2
14	50.7	9.1	32.2	.3050	143.0	E	1.59	9.5	58.1	24.7
15	50.4	9.4	32.3	.3012	140.0	N	1.55	9.5	58.6	24.2

T NO.	DAYS TO BLOOM	% THRESH	EXSERTION	% LODGE	% STAND	POUNDS GRAIN	POUNDS HEADS	GRAMS SEED/HEAD	NUMBER SEED/HEAD
					PERKINS				
1	55.0	65.7	2.9	2.87	99.7	2937	4425	60.1	2766
2	55.5	65.6	2.4	2.82	100.0	2850	4325	53.4	2490
3	55.5	61.9	3.3	19.70	100.0	2362	3725	47.3	2103
4	54.5	64.9	2.6	6.30	99.4	2737	4212	52.3	2566
5	55.5	60.3	3.3	6.30	99.0	2375	3925	47.3	2432
6	55.0	66.8	2.7	4.70	100.0	2987	4462	55.4	2595
7	55.0	63.1	3.0	6.60	100.0	2562	4012	48.9	2412
8	54.0	64.6	2.1	11.27	100.0	2712	4175	51.1	2526
9	56.0	64.3	3.5	3.15	100.0	2487	3862	54.2	2483
10	55.0	59.8	2.7	12.27	99.4	2187	3625	45.2	2435
11	55.5	62.1	3.1	5.97	100.0	2625	4212	47.8	2502
12	55.5	63.1	3.7	6.90	100.0	2500	3937	45.4	2211
13	55.5	62.9	3.0	4.72	99.7	2562	4075	47.3	2479
14	55.5	67.7	2.5	5.67	98.7	2812	4150	52.9	2626
15	55.5	66.6	2.7	1.90	99.7	2987	4437	56.4	2532
					STRATFORD				
1	62.3	60.2	5.4	5.46	98.7	1683	2766	35.6	1880
2	62.3	58.4	6.0	5.43	100.0	1533	2566	32.3	1709
3	62.3	62.4	4.8	6.43	96.2	1600	2550	37.3	2015
4	62.6	62.7	5.2	5.06	99.1	1716	2716	38.5	2105
5	61.0	60.1	7.5	3.76	100.0	1533	2516	31.9	1537
6	61.6	61.5	6.6	5.86	100.0	1633	2650	37.0	1943
7	62.0	59.1	5.0	7.66	98.3	1483	2500	36.2	2033
8	62.6	61.6	5.4	3.36	100.0	1800	2900	39.6	2126
9	62.0	63.3	6.8	3.40	98.3	1766	2783	37.2	1965
10	62.3	61.3	5.5	10.53	99.6	1633	2650	40.4	2181
11	62.6	58.9	6.5	10.06	99.6	1533	2583	32.9	1853
12	63.6	56.2	5.4	5.86	100.0	1433	2533	33.8	1875
13	61.0	61.7	6.4	3.36	100.0	1550	2500	34.6	1739
14	63.3	59.8	4.9	9.10	95.0	1616	2650	36.7	2136
15	61.0	64.2	5.6	8.76	100.0	1700	2650	37.4	1979
					WOODWARD				
1	56.3	65.3	8.2	0.00	97.1	1866	2850	38.5	1479
2	57.3	63.6	7.2	0.00	94.2	1866	2933	38.4	1479
3	56.0	69.3	7.6	0.00	96.6	2216	3200	44.2	1794
4	55.0	69.8	6.6	0.46	100.0	2783	3966	52.4	1866
5	55.3	66.8	6.6	0.00	99.5	2383	3533	47.3	1731
6	55.6	66.9	7.4	0.00	92.3	2266	3366	46.9	1767
7	55.6	68.5	8.0	0.00	94.7	2300	3333	49.1	1820
8	54.3	71.2	4.6	0.46	99.5	3166	4433	62.0	2143
9	55.3	69.4	6.5	0.46	100.0	2400	3450	49.8	1868
10	55.6	68.1	7.7	0.00	99.0	2116	3083	43.7	1683
11	56.0	65.4	7.2	0.00	95.6	2233	3350	45.1	1677
12	55.0	67.2	7.3	0.00	99.5	2266	3366	46.2	1766
13	55.3	62.7	7.5	0.00	99.0	1866	2950	37.7	1445
14	55.3	66.1	7.5	0.00	93.7	2116	3200	43.3	1682
15	55.3	67.5	5.6	0.00	93.7	2083	3083	43.3	1806
					GOODWELL				
1	57.0	73.2	11.0	2.97	94.8	6975	9575	43.0	1512
2	57.5	72.6	11.3	3.00	100.0	5862	8050	39.3	1450
3	57.5	74.9	10.5	3.00	99.5	6687	8925	39.4	1442
4	57.0	74.6	10.6	2.82	100.0	6512	8725	40.6	1468
5	57.5	78.0	11.4	3.10	96.7	6575	8450	40.2	1469
6	57.0	72.9	10.9	2.82	99.7	6775	9287	42.0	1486
7	57.0	75.2	11.0	2.67	99.5	6937	9212	43.7	1607
8	57.0	74.1	10.6	2.05	99.5	6425	8675	42.3	1559
9	57.5	74.7	10.3	2.50	99.5	6862	9187	39.3	1453
10	57.0	74.6	10.5	2.65	100.0	6450	8637	36.5	1374
11	57.5	74.2	11.1	2.82	100.0	6262	8425	41.2	1535
12	57.5	74.7	11.0	2.65	100.0	6087	8150	39.4	1480
13	57.5	71.1	10.8	3.15	99.5	5337	7512	34.5	1424
14	57.0	71.7	11.4	2.72	98.4	5500	7662	34.9	1414
15	57.0	68.9	10.7	2.67	99.4	5437	7962	35.4	1461

VITA

Jerry Pat Crill

Candidate for the Degree of

Master of Science

Thesis: INTERROW COMPETITION IN GRAIN SORGHUM HYBRIDS AS INFLUENCED BY MATURITY DATES

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Biographical:

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Date of Final Examination: May, 1963