USE OF BLACK LAYER TO STUDY
DRY MATTER ACCUMULATION
IN GRAIN SORGHUMS

By

MITHLESH KUMAR

Bachelor of Science in Agriculture

Andhra Pradesh Agricultural University

Hyderabad, India

1965

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1975

USE OF BLACK LAYER TO STUDY

DRY MATTER ACCUMULATION

IN GRAIN SORGHUMS

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGMENTS

The author is grateful to his major advisor, Dr. D. E. Weibel for his understanding, encouragement, and valuable guidance throughout the course of this research and graduate study. He is also grateful to Dr. R. D. Morrison for constant guidance during the statistical analyses of the data. Gratitude is extended to Dr. L. W. Reed and Dr. L. I. Croy and Professor C. E. Denman who made valuable suggestions as members of the advisory committee. The author is grateful to Professor C. E. Denman for furnishing data in the study.

The author also expresses appreciation to the Department of Agronomy for the financial help through part-time work and to Rick Duncan who was very helpful throughout the study.

The author is extremely grateful to his late father, Dr. D. Tulsidass who was a pillar of strength throughout his study and without whose moral and financial help this study would not have been possible.

The author is also grateful to his mother Sita Bai, his uncle, D. Devi Pershad, and his brothers and sisters who constantly helped and encouraged him during the entire study.

He wishes to thank Mrs. Snavely for the co-operation and careful manner in which she typed this work.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Sorghum is one of the most widely cultivated cereal crops and ranks after rice, wheat, and maize in the total world acreage. All the cultivated sorghums as well as a group of semi-wild weedy sorghums are included in the complex species (Sorghum bicolor (L.) Moench).

One of the most important aspects of current sorghum research is yield, since sorghum is one of the most important staple foods in parts of Asia and Africa. Sorghum is also a very important feed grain in other parts of the world. Any efforts to improved yield would benefit many people. One factor involved in grain yield concerns the amount of grain, or dry matter, produced per day for the life of the plant. Studies to determine the relative rate of dry matter accumulation per day could result in the use or development of improved types. Ultimately these improved types would benefit farmers.

The purpose of the research reported herein was to study the rate of dry matter accumulation per day among early, medium, and late maturity groups of sorghum hybrids at selected locations. The factors for which the dry matter accumulation per day was determined were planting to black layer, planting to mid-bloom, and mid-bloom to black layer.

CHAPTER II

LITERATURE REVIEW

Studies Relating to Dry Matter Accumulation

Percentage of dry matter in corn (Zea mays, L.) has received much attention as a measure of maturity. Yield losses resulting from premature harvesting have been pointed out by Schweitzer (31). Hopper (17) found 68.7%, 98.9%, and 100% of maximum dry weight in grain of corn in dough, glazed, and ripe stages. Lambert (24) calculated that corn at 75% moisture had produced 15% of its maximum grain yield, at 55% moisture 74%, and at 45% moisture 91% of its miximum yield.

Until recently workers used moisture in the grain for measuring relative maturities in corn. However Aldrich calculated the percentage of dry matter (1) because he thought that a curve rising towards maturity seemed preferable to one decreasing and that it could readily be graphed with kernel weights. He studied 10 varieties planted on two different dates and did not find any differences among the strains in the rates of dry matter increases. He concluded that percentages of the dry matter in the grain at harvest time may confidently be used to measure relative maturities among strains.

The data obtained by Aldrich (1) indicated that the yield of a plot of corn continues to increase until the dry matter in the grain averages 65%, or the moisture falls to 35%. Dessureaux, Neal and Brink (12) concluded that strains of corn that flower early tend to mature more rapidly than those that flower late. However, the rate of kernel maturation may be slow in some early strains, and relatively rapid in some late ones. The quick maturing strains of each maturity class, early and late respectively, were characterized by a slower rate of dry matter increase in the later phase of kernel development.

There is no agreement on the amount of translocation of materials into the grain after the plants have been cut. However Kedzie (21), Briggs (3), Teller (34), and Harlan and Pope (16) found increases in kernel weights of cereal crops when harvested prematurely and dried on culms. Nicholson (26) in Scotland cut oats at 6 stages. The first stage when milkyness was evident in the grain, and the last stage at full maturity. The position of dry matter peak yields in terms of stage of maturity was 7, 8, and 14 days prior to ripening during 3 consecutive years of trial. There was an average decline of 5% subsequent to the peak.

Physiologic Maturity and Black Layer in Corn

The term maturity in recent years has been defined as the point at which maximum grain development is first attained (1). The definition of maturity was later termed as "physiologic maturity" by Shaw and Loomis (32). They showed that moisture percentage as a basis for prediction of maturity was found to be unreliable. They reported that large differences in moisture percentage at the time of physiologic maturity existed among hybrids in any one year and for any one hybrid in different years.

Dry matter measurements have been used as a method of finding the date of physiologic maturity. Hanway (15) defined this as stage 10 in the development of corn plants. Shaw and Thom (33) found physiologic maturity dates by measuring dry matter accumulation in the grain. Their work showed large variations between sample weights, which made determination of maximum dry matter accumulation difficult. Dry matter accumulation curves tend to approach a maximum value asymptotically, making the determination of a precise end point difficult. Shaw and Thom (33) avoided this difficulty by using 95% of the maximum dry weight as determined by harvests taken well after physiologic maturity, as their end point.

Neal (25) in his heat unit calculations has classified corn as mature when it contains approximately 30% moisture. Shaw and Thom (33) found moisture levels at physiologic maturity to average 30%, 37%, and 42% for three widely different maturing varieties. Hallauer and Russell (14) also found a wide range of moisture percentages at maturity.

According to Kiesselbach and Walker (23) the development of tissue that will eventually turn into the black layer or the closing layer starts soon after fertilization of kernels. This tissue grows completely across the placento-chalazal region of the kernel by approximately 20 days after pollination and remains active until about 2 weeks before maturity, when visual black layer development begins. This black closing layer develops in a region of cells several layers thick which are formed between the basal endosperm of the kernel and the vascular area of the pedicel early in speed development. As physiologic maturity is approached, these cells shrink and become compressed into a dense layer which appears black to the naked eye. At approximately the same time, the basal conducting cells of the endosperm get disorganized and are crushed tangentially ceasing the translocation functions.

At the time of maturity the black closing layer connects with the testa and the pericarp to form a suberized barrier around the seed.

Daynard and Duncan (8) discussed black layer development as a suitable means of determining physiologic maturity of corn. They found that initial visual occurrence of black layer development was highly correlated with predicted dates of maximum kernel dry weight and that definite end points for grain filling could be determined. This indicated that more precise physiologic maturity dates could be determined by using this method than by using kernel dry matter or moisture content. Daynard (7) found that kernels forming black layers had moisture levels of 28 to 42%.

The visual pattern of black layer development takes place in five phases reported by Rench and Shaw (30). At phase 1 the milkline has almost reached the tip of the kernel. The milkline is a band which forms at about 40 days after fertilization across the kernel and separates the maturing starchy area from the lower milky region where food storage deposit continues: dry matter is increasing with a corresponding loss of moisture (2). When split open, the kernel is no longer milky but does have a brown area opposite the embryo. From phase 1 to phase 2, the moist brown area dries and narrows into a brown layer. In phase 3 a thin brown layer develops from the side opposite the embryo to halfway across the funiculus, indicating that the visual black layer development has begun. Phase 4 is identified by a brown line going completely across the base of the kernel. Phase 5 shows the complete black layer development. The brown layer has darkened to black.

In a study made by Rench and Shaw (30) to determine the relationship between visual kernel black layer development and dry matter accumulation, kernels were taken from the same plant at intervals of 3 days and rated as to their phase of black layer development from plants approaching maturity. They dried the remaining kernels from the same sample and evaluated for dry matter and moisture content. They found that peak dry matter accumulation coincided with initial occurrence of visual black layer formation. Weight lost by kernels from initial visual black layer development to completed black layer formation was significant. Kernel moisture declined significantly during black layer development.

All varieties tested by Rench and Shaw (30) had the same dry matter accumulation and loss rate when regressed against the phases of black layer development. They found that the amount of dry matter accumulation in grain varied according to planting dates and varieties, and they found a similar rate of kernel filling from one phase of black layer formation to another for all varieties. It was further concluded that all varieties at all dates of planting exhibited maximum kernel dry weight at phase 3 of black layer development. The conclusion was drawn from the dry matter data that black layer formation can be used to determine physiologic maturity in corn. The cause and mechanisms of black layer formation are unknown. However it is speculated by Daynard and Duncan (8) that such development is related to assimilate movement into the developing floret.

The description of Johan (19) and Kiesselbach and Walker (23) suggested that the formation of this black layer could serve as a reliable indicator of physiologic maturity in corn. They cautioned, however, that in order for the black layer to be a satisfactory indicator of physiologic maturity (1) its presence or absence must easily be detectable, (2) it must develop rapidly with a relatively precise end point,

(3) this end point must correlate with the attainment of maximum kernel dry matter, and (4) it must be present in a wide variety of genotypes. They found a close correlation among hybrids between the date the black layer was first visible and the predicted date of the achievement of maximum kernel dry weight. This correlation was not significant within each hybrid, because of the presence of high variability in the date of maximum kernel dry weight.

Daynard and Duncan (8) concluded that in corn the first appearance of black layer would be a reliable sign that maximum kernel dry weight has been achieved. The simplicity of this method is in marked contrast to harvesting, drying, and weighing techniques. The prime value of this method would be of using it in a breeding program which is directed towards an expansion of the grain filling period.

Previous studies in corn did not encourage selection programs which were based on yield components (4), but recent reports by Daynard, Tanner, and Duncan (9) and Johnson and Tanner (20) indicated that corn yields may be positively correlated with rate of dry matter accumulation and duration of grain filling period.

Black Layer and Physiologic Maturity in Grain Sorghum

The appearance of a black closing layer in the placental region near the sorghum [*Sorghum bicolor* (L.) Moench] kernel attachment point coincides with the cut off of translocation to the kernel (13). This layer helps in identifying physiologic maturity or date of maximum dry weight accumulation. This is important because one can characterize genotypes in terms of grain filling period by noting the blooming dates and dark layer formation. Yields and days to physiologic maturity can be used to study rate of dry matter accumulation.

Sorghum research workers usually use days from planting to bloom to indicate the relative maturity of hybrids. Relative dates when percent of grain moisture will allow harvest or safe storage is the measure of maturity. Moisture content at harvest reflects the plant response to environment for a full growing season, where as days to bloom measures the plant response for only the early part of the season (11).

Warnes (11) studied the relation of days to one-half bloom versus moisture content of grain and headstem during the maturation period of certain grain sorghum hybrids. The 33 entries in the study were placed into 5 maturity groups to facilitate comparison. The grouping was done on the basis of days from planting to one-half bloom. He concluded that average days from planting to one-half bloom and grain moisture content were highly correlated, but correlations were lower at successive sampling dates as the crop approached combine maturity. Correlations between grain moisture and days from planting to bloom, within a single maturity group, were much lower than when all 33 entries were compared, suggesting that hybrids of a single maturity group had similar drying and filling rates. Some of the change in relative maturity took place before the study began and in one continued throughout the sampling period. Days from planting to one-half bloom give a general indication of relative maturity of sorghum hybrids.

The determination of physiologic maturity in sorghum has been done largely (as in corn) on the basis of maximum dry weight date determined by repeated sampling and drying. Pauli, Stickler, and Lawless (27), Collier (5), Wilkner and Atkins (35), and Kresting, Stickler, and Pauli (22) also used this method. In practice bloom dates have been taken as indications to physiologic maturity (6).

In a study of the grain filling period in relation to seed size of 148 sorghum varieties at ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Hyderabad, 1974, it was found that the grain filling period (days from flowering to black layer) played an important role in determining seed size, seed weight per thousand, seed volume, weight of seed per head, and seed per head. Varieties with longer grain filling periods exceeded in all the above variables (18).

Quinby (28) first considered the use of dark layer formation in sorghum as an indication of its physiologic maturity. Eastin, Hultquist, and Sullivan (13) conducted a study to correlate external appearance of black layer with the cut off of translocation to the kernel using 14C labelled assimilate as marker. They found that the dark layer appearance coincided with cessation of assimilate transport to kernels. In their study the lack of significance for genotypes or treatments by genotypes in the analysis of variance suggested that dark layer formation was consistent among the three genotypes and probably can be safely used as an indicator of physiologic maturity and the realization of maximum dry weight.

Quinby (29) in a study to determine the length of grain filling period found that all entries under study reached maximum kernel weight between 30 and 40 days after flowering. He did not find any significant differences in duration of dry weight accumulation between parents and hybrids. He concluded that hybrid vigor did not tend to lengthen the period of dry weight accumulation in the endosperm.

CHAPTER III

MATERIALS AND METHODS

Grain sorghum hybrid performance tests of commercial hybrids are conducted annually by the Oklahoma Agricultural Experiment Station in order to provide yield data and agronomic information to help the producer in selecting a hybrid for production on his farm. These performance tests are conducted at 10 locations in the state. They usually consist of approximately 100 entries grouped into early, medium, and late maturing hybrids. The tests are arranged in a randomized complete block design with three replications (Figure 1). Early, medium, and late maturity hybrids are grouped together to reduce interplot competition. Four of these tests were selected for study. Some of the conditions for the four tests are shown in Table I.

All plots of sorghum received nitrogen, phosphorous, and potassium as indicated by soil tests. In 1974, in most instances, rainfall during the summer was below normal and its distribution was such that the season was dry during the periods when the crop was in heavy water use stage. Such a condition resulted in yield reductions in certain cases. There were insect problems, particularly greenbugs, at the research stations near Goodwell and near Perkins. In each instance, the required spray program was carried out.

The varieties used in the study can be found in the appendix as well as in the research report of "Performance Tests of Hybrid

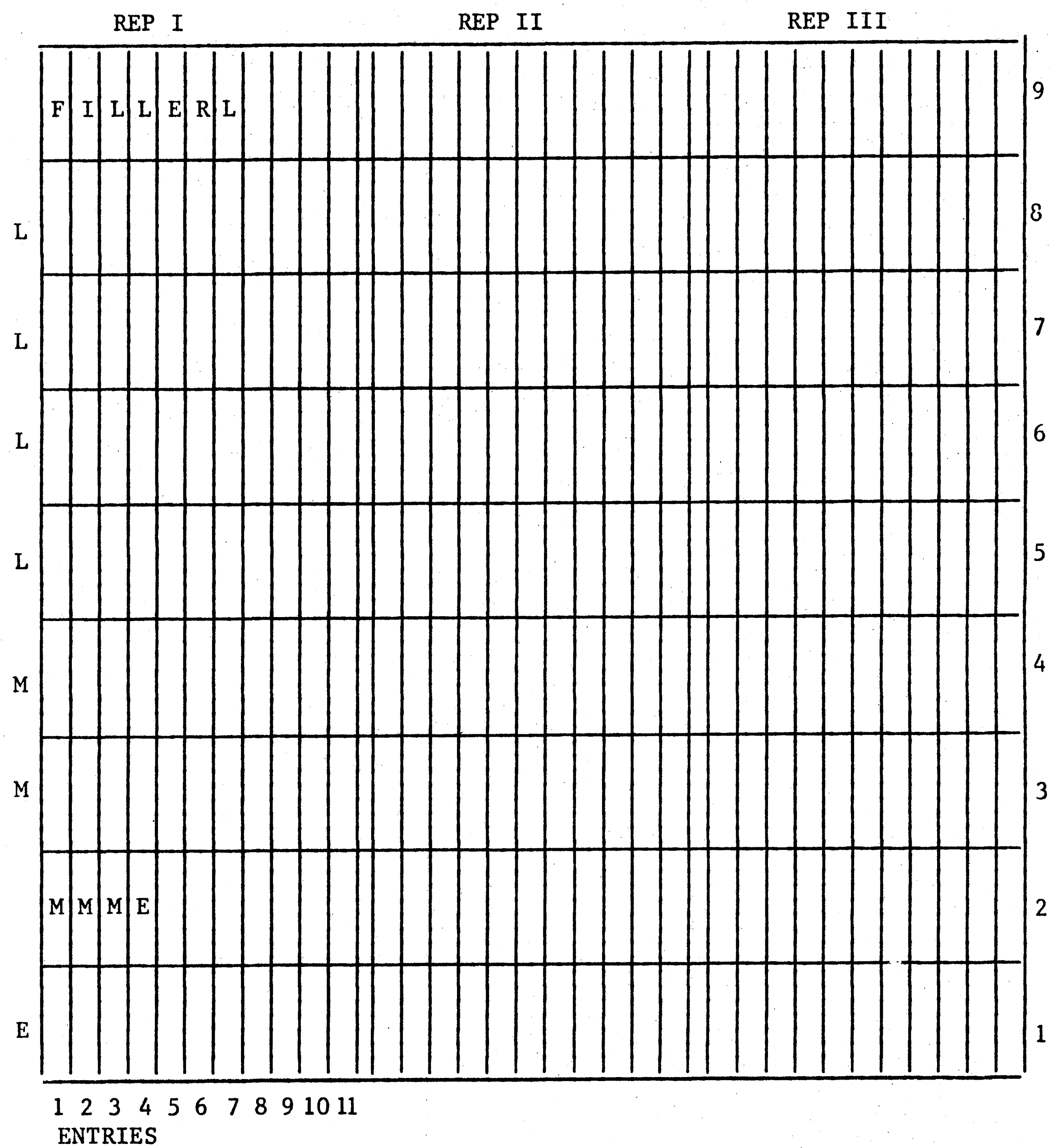

Figure 1. Diagram of the Field Showing Positions of the early, medium, late in Replications

TABLE I

TEST LOCATIONS AND CONDITIONS

Location	Row Width	Plants per Acre	Moisture	Elevation	Planting Date	Fertilizer	Insecticide and Fungicide	Irrigation	74 Date of Harvest
OC Perkins	32	49,000	Dryland	900	06-13-74	N 265/A 45:0:0 P None K 170/A 0:0:60	Parathion and Toxaphene	-	9/15 to 11/14
03 Perkins	40	39,000	Dryland	900	06-13-74	N 265/A 45:0:0 P None K 170/A 0:0:60	Parathion and Toxaphene	-	9/15 to 11/14
08 Lahoma	40	26,000	Dryland	1200	06-20-74	82-68-0	-	-	11/18 and 11/19
09 Goodwell	28	65,000	Irrigated	3200	06-17-74	244#	Parathion	6	11/17 to 11/21

Sorghums and Corn in Oklahoma (10).

Data pertaining to the black layer formation were obtained by visiting the fields twice weekly and examining the formation of black layer in the grain. The procedure adopted was to remove grains from the central parts of the panicle and to look for the black layer in the placental area near the kernel attachment point. Four to six panicles were selected for examination at random from each entry in each replication and in each maturity group. For each entry which showed the formation of black layer, the date was noted. One entry in the late maturing group did not mature at Goodwell in all three replications. This particular variety was removed from all the other locations under study to keep the analysis in proportion.

Analysis of variance were conducted on the combined data for the four locations, the combined data from dryland locations, and for each location separately for yield in pounds per acre, yield per day from planting to mid-bloom, yield per day from planting to black layer, yield per day from mid-bloom to black layer, days from planting to mid-bloom, days from planting to black layer, and days from mid-bloom to black layer. A cross-product analysis of variance was conducted also to study the relationships among the variables.

The objectives of the study were:

1. To study the dry matter accumulation per day from planting to black layer.

2. To study the dry matter accumulation per day from mid-bloom to black layer and,

3. To study the difference in the rate of dry matter production among and within early, medium, and late maturing hybrids.

CHAPTER IV

RESULTS AND DISCUSSION

Table II shows means and ranges of dry matter accumulation for the variables grain yield in pounds per acre, yield per day from planting to black layer, days to black layer, yield per day from planting to mid-bloom, days to mid-bloom, yield per day from mid-bloom to black layer, and days from mid-bloom to black layer for early, medium, and late maturity groups for the Perkins location with a row spacing of 32 inches. Mean yields per acre increased from early to medium to late maturity groups as did the means for all the other variables except for days from mid-bloom to black layer from medium to late maturity groups. In this case the increased yield per acre of the late over the medium maturity group was accounted for by the increased yield per day from mid-bloom to black layer. The ranges for each variable showed that there was considerable variation present for entries. The analysis of variance showed a significant difference among entries within groups for the variables.

Table III shows means and ranges for the same variables at the Perkins location with a row spacing of 40 inches. The level of grain yield was lower in this test than in the previous one with narrower rows. The mean yields in pounds per acre showed again a significant increase from early to medium to late maturing hybrids. There were increases from the early to medium to late maturity groups for all the

TABLE II

DRY MATTER ACCUMULATION AND OTHER DATA FOR GRAIN SORGHUM AT OC PERKINS (32-INCH ROWS)

Maturity Group	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to Bl	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb-BL	Days From Mb-BL
Early	Mean	2409	29.7	80.8	47.0	51.3	82.2	29.5
	Low	1280	16.4	75.3	24.5	48.3	44.6	26.3
	High	3213	36.3	92.0	56.9	59.7	100.4	37.7
Medium	Mean	2887	31.3	92.2	49.4	58.7	86.7	33.6
	Low	2178	25.4	77.7	32.8	51.0	69.2	26.3
	High	3648	39.6	106.0	60.8	69.0	115.8	38.3
Late	Mean	3492	36.3	96.2	55.9	62.6	104.9	33.5
	Low	2477	26.0	89.7	40.1	53.3	69.7	26.3
	High	4601	45.0	106.0	68.5	70.7	139.4	38.0

TABLE III

DRY MATTER ACCUMULATION AND OTHER DATA FOR GRAIN SORGHUM AT 03 PERKINS (40-INCH ROWS)

Maturity Group	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to Bl	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days From Mb to BL
Early	Mean	2047	25.3	81.1	40.1	51.2	70.0	29.9
	Low	1220	17.4	70.0	27.1	32.0	32.2	25.7
	High	2461	31.2	96.3	47.4	59.3	94.6	38.0
Medium	Mean	2465	26.9	91.7	42.8	57.8	73.1	34.0
	Low	1525	18.1	76.0	28.1	51.0	53.4	30.0
	High	3441	37.4	105.7	58.9	69.3	109.0	38.7
Late	Mean	3010	31.5	95.7	48.9	61.6	89.1	34.1
	Low	2178	24.4	84.3	41.9	52.0	58.4	28.3
	High	4073	40.9	105.7	65.4	72.0	117.2	38.7

other variables also. Again the ranges showed wide variation for the variables, and the analysis revealed significant differences among and within maturity groups.

Table IV presents means and ranges for dry matter accumulation for the same variables at Lahoma. There was an increase in yield in pounds per acre as the maturity period increased. There was a general increase in the means of the other variables from early to medium to late maturing types except yield per day from mid-bloom to black layer between medium to late types. In this case the increased days from mid-bloom to black layer may account for the modest increase in grain yield per acre. Highly significant differences were found among maturities for the variables pounds per acre, days to black layer, and days to mid-bloom, and significant differences were found for other variables under study. Significant differences were also found for the above variables for entries within maturities for the three maturity groups.

Table V gives the data for the Goodwell location where the test was grown under irrigated conditions. There was a 2-fold increase in the means for grain yield per acre in the three maturity groups compared to the other locations. Grain yields increased with the later maturing groups. Days to black layer increased with the later maturity groups also, but the dry matter accumulated per day from planting to black layer was similar for the three maturity groups. Days from planting to mid-bloom and also the dry matter accumulated per day for that period showed an increasing trend. A reverse situation appeared in the case of the dry matter accumulated per day from mid-bloom to black layer even though the days from mid-bloom to black layer increased from early to medium to late. This reverse situation might be the result of the crop maturing during cooler days, and especially

TABLE IV

DRY MATTER ACCUMULATION AND OTHER DATA FOR
GRAIN SORGHUM AT 08 LAHOMA

Maturity Group	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
Early	Mean	2517	31.3	80.4	50.1	50.3	84.3	30.1
	Low	1459	19.8	73.7	35.3	41.3	45.3	26.3
	High	3115	40.2	95.0	64.9	57.0	108.1	38.0
Medium	Mean	3042	33.8	90.1	53.4	56.7	92.5	33.5
	Low	1764	21.9	76.0	33.0	49.3	58.3	25.0
	High	5619	57.7	105.0	87.0	64.7	172.0	43.0
Late	Mean	3267	34.3	95.2	55.0	59.3	91.7	35.9
	Low	1655	17.7	84.0	28.9	52.7	46.1	30.0
	High	5009	49.7	106.0	79.1	66.3	134.2	42.0

TABLE V

DRY MATTER ACCUMULATION AND OTHER DATA FOR
GRAIN SORGHUM AT 09 GOODWELL

Maturity Group	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to Bl	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
Early	Mean	5543	48.2	115.0	95.7	57.8	97.8	57.1
	Low	3202	22.2	89.3	41.9	54.7	47.3	39.0
	High	7053	56.8	136.0	111.8	65.7	126.1	70.3
Medium	Mean	6370	49.0	130.2	110.8	63.2	95.7	67.0
	Low	5160	40.9	114.0	83.0	57.3	80.9	56.3
	High	7895	58.5	139.0	124.8	67.3	111.2	73.7
Late	Mean	6745	48.7	138.8	102.4	65.9	93.2	72.6
	Low	3643	25.7	131.3	56.9	61.3	46.9	64.3
	High	7636	62.0	147.7	132.0	70.7	117.2	82.7

nights, at the higher elevation in the fall of the year. Highly significant differences were found for maturities for variables pounds per acre, days to black layer, yield from planting to mid-bloom, days to mid-bloom and days from mid-bloom to black layer. However, no significant difference was found for the variable yield per day from planting to black layer. Significant differences were found for entries within maturity groups for all the variables under study.

Table VI shows a comparison of the performance of early maturity groups and Table VII shows a comparison of the performance of the medium maturity groups from the four locations from the previous tables for the variables under study. At Perkins there was a reduction in yield in pounds per acre from 32-inch rows to the 40-inch rows. The 32-inch rows had more plants per acre and apparently utilized available moisture and nutrients to better advantage. The yield per day was greater for all three measurements in 32-inch rows than in 40-inch rows. There was little difference in days to black layer, days to mid-bloom, and days from mid-bloom to black layer for the three dryland locations. The difference in dryland and irrigated conditions can be illustrated by observing the early maturing group at Goodwell which required 115 days from planting to black layer compared to 80 days for the other locations. The early group at Goodwell also accumulated more dry matter per day than at the other locations for the three variables. The medium maturity group at Goodwell had a period of 130 days from planting to black layer when compared to 90 for dryland locations. The medium group at Goodwell also accumulated more dry matter per day than at the other three locations.

Table VIII shows a comparison of the performance of the late maturity groups for the variables under study. The number of days in

TABLE VI

DRY MATTER ACCUMULATION IN EARLY MATURITY GROUPS AT ALL LOCATIONS

Location	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
OC Perkins 32-inch	Mean	2409	29.7	80.8	47.0	51.3	82.3	29.5
	Low	1280	16.4	75.3	24.5	48.3	44.6	26.3
	High	3213	36.3	92.0	56.9	59.7	100.4	37.7
03 Perkins 40-inch	Mean	2047	25.3	81.1	40.1	51.2	70.0	29.9
	Low	1220	17.4	70.0	27.1	32.0	32.2	25.7
	High	2461	31.2	96.3	47.4	59.3	94.6	38.0
08 Lahoma	Mean	2517	31.3	80.4	50.1	50.3	84.3	30.1
	Low	1459	19.8	73.7	35.3	41.3	45.3	26.3
	High	3115	40.2	95.0	64.9	57.0	108.1	38.0
09 Goodwell	Mean	5543	48.2	114.9	95.7	57.8	97.8	57.1
	Low	3202	22.2	89.3	41.9	54.7	47.3	39.0
	High	7053	56.8	136.0	111.8	65.7	126.1	70.3

TABLE VII

DRY MATTER ACCUMULATION IN MEDIUM MATURITY GROUPS AT ALL LOCATIONS

Maturity	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
0C Perkins 32-inch	Mean	2887	31.3	92.2	49.4	58.7	86.7	33.6
	Low	2178	25.4	77.7	32.8	51.0	69.2	26.3
	High	3648	39.6	106.0	60.8	69.0	115.8	38.3
03 Perkins 40-inch	Mean	2465	26.9	91.7	42.8	57.8	73.1	34.0
	Low	1525	18.1	76.0	28.1	51.0	53.4	30.0
	High	3441	37.4	105.7	58.9	69.3	109.0	38.7
08 Lahoma	Mean	3042	33.8	90.1	53.4	56.7	92.5	33.5
	Low	1764	21.8	76.0	33.0	49.3	58.3	25.0
	High	5619	57.7	105.0	87.0	64.7	172.0	43.0
09 Goodwell	Mean	6370	49.0	130.2	100.8	63.2	95.7	67.0
	Low	5160	40.9	114.0	83.0	57.3	80.9	56.3
	High	7895	58.5	138.0	124.8	67.3	111.2	73.7

the three variables, days to black layer, days to mid-bloom, and days from mid-bloom to black layer were similar for the three dryland locations. Yield per day from mid-bloom to black layer was higher for Perkins with a row spacing of 32-inches than for Lahoma even though the days from mid-bloom to black layer were not different. The late maturity group at Goodwell required a period of 138 days from planting to black layer when compared to 95 days at the other three locations. The rate of dry matter accumulation per day was also higher for the three variables when compared to the other three locations.

Table IX presents a comparison of the performance of the early, medium, and late maturity groups by combining data from the three dryland locations, Perkins (32-inch), Perkins (40-inch), and Lahoma. Since the data from the individual locations showed similar trends and even similar magnitudes, it was deemed feasible to combine them for comparison. In the lower half of the table data shown previously for Goodwell has been included to facilitate the comparison. From this table it is evident that for the combined data from the dryland locations there was an overall increase from early to medium to late for all the variables for rate of dry matter accumulation per day as well as for the corresponding days. Highly significant differences were found for all the variables for the maturities. The three maturity groups at Goodwell also showed an increasing trend for the pounds per acre from early to late. Highly significant differences were found for maturities for this variable but no significant difference was found for maturities for the variable yield per day from planting to black layer. Highly significant differences were found for maturities at the three dryland locations as well as at the irrigated location at Goodwell for the variable days to black layer. An increasing trend was found for

TABLE VIII

DRY MATTER ACCUMULATION IN LATE MATURITY GROUPS
AT ALL LOCATIONS

Location	Mean and Range	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
OC Perkins 32-inch	Mean	3492	46.4	96.2	55.9	62.6	104.9	33.5
	Low	2477	26.0	89.7	40.1	53.3	69.7	26.3
	High	2601	45.0	106.0	68.5	70.7	139.4	38.0
03 Perkins 40-inch	Mean	3010	31.5	95.7	48.9	61.6	89.1	34.1
	Low	2178	24.4	84.3	41.9	52.0	58.4	28.3
	High	4073	40.9	105.7	65.4	72.0	117.2	38.7
08 Lahoma	Mean	3267	34.3	95.2	55.0	59.3	91.7	35.9
	Low	1655	17.7	84.0	28.0	52.7	46.1	30.0
	High	5009	49.7	106.0	79.1	66.3	134.2	42.0
09 Goodwell	Mean	6746	48.7	138.8	102.4	65.9	93.2	72.9
	Low	3643	25.7	131.3	56.9	61.3	46.9	64.3
	High	7636	62.0	147.7	132.0	70.7	117.21	82.7

TABLE IX

DRY MATTER ACCUMULATION FOR EARLY, MEDIUM, LATE, MATURITY GROUPS

Maturity Groups	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
			0C Perkins (32-inch), 03 Perkins (40-inch), and 08 Lahoma combined				
Early	2324	28.8	80.8	45.7	50.9	78.8	29.9
Medium	2798	30.7	91.4	48.5	57.7	84.1	33.7
Late	3256	34.0	95.7	53.3	61.1	95.3	34.5
			09 Goodwell				
Early	5543	48.2	114.9	95.7	57.8	97.8	57.1
Medium	6370	49.0	130.2	100.8	63.2	95.7	67.0
Late	6745	48.7	138.8	102.4	65.9	93.2	72.9

the variables yield per day from planting to mid-bloom and days to mid-bloom for the dryland as well as irrigated locations. Highly significant differences among maturities were found for the two variables at dry and irrigated locations, but a reverse situation appeared for the variable yield per day from mid-bloom to black layer at the irrigated location at Goodwell from early to medium to late. The dry matter accumulation per day was higher for the early maturity group and lower for the later maturity groups even though the days from mid-bloom to black layer increased. This might be the result of the crop maturing in cooler periods at the higher elevation at Goodwell.

Table X presents correlation coefficients between grain yeild in pounds per acre and other variables under study at the locations in column one. The significance was tested at .05 and .01 levels. From the table it is evident that correlations were highly significant and the trend was positive for the variables yield per day from planting to black layer, yield per day from planting to mid-bloom, and yield per day from mid-bloom to black layer. This implies that as grain yield increases, the other variables mentioned above also increase, and there is a linear relationship. No general trend was evident between grain yield in pounds per acre and the variables days from planting to black layer, days from planting to mid-bloom, and days from mid-bloom to black layer. There is a slight negative correlation between grain yield in pounds per acre and days to mid-bloom at various locations.

The lack of substantial correlation between grain yield in pounds per acre and any of the three periods of days seemed to indicate independent distribution of grain yields and time periods within maturity groups. It should be possible, therefore, to select for grain yield

TABLE X

ESTIMATED CORRELATION COEFFICIENTS BETWEEN GRAIN YIELD AND OTHER VARIABLES (1)

Locations	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL	Degrees of Freedom
OC, 03, 08, 09 Maturities Comb.	0.95**	-0.01	0.98**	-0.17**	0.82**	0.05	728
OC, 03, 08 Maturities Comb.	0.98**	-0.12**	0.98**	-0.19**	0.90**	-0.006	546
OC Maturities Comb.	0.98**	-0.03	0.97**	-0.21**	0.89**	0.13	182
03 Maturities Comb.	0.97**	-0.10	0.97**	-0.22**	0.87**	0.04	182
08 Maturities Comb.	0.98**	-0.20**	0.98**	-0.17*	0.92**	-0.13	182
09 Maturities Comb.	0.91**	0.08	0.98**	-0.16*	0.72**	0.11	182
OC, 03, 08 Early	0.98**	-0.04	0.98**	-0.16	0.89**	-0.03	108
OC, 03, 08 Medium	0.98**	-0.30**	0.98**	-0.24**	0.92**	-0.13	144
OC, 03, 08 Late	0.98**	-0.07	0.98**	-0.17**	0.90**	0.04	282
OC Early	0.97**	0.09	0.97**	-0.18	0.83**	0.16	36

TABLE X (CONTINUED)

0C Medium	0.98**	-0.30*	0.98**	-0.36**	0.93**	0.02	48
0C Late	0.98**	0.04	0.97**	-0.17	0.90**	0.22*	94
03 Early	0.97**	0.03	0.97**	-0.04	0.87**	0.05	36
03 Medium	0.98**	-0.02	0.98**	-0.22	0.92**	0.12	48
03 Late	0.97**	-0.14	0.97**	-0.27**	0.84**	0.04	94
08 Early	0.99**	-0.24	0.99**	-0.25	0.93**	-0.08	36
08 Medium	0.98**	-0.46**	-0.99**	0.14**	0.92**	0.41**	48
08 Late	0.98**	-0.10	0.96**	-0.14	0.92**	-0.04	94
09 Early	0.93**	0.02	0.97**	-0.04	0.76**	0.03	36
09 Medium	0.92**	-0.28*	0.97**	-0.09	0.79**	-0.26	48
09 Late	0.91**	0.22*	0.98**	-0.33**	0.68**	0.27**	94

[1]The values in the table are obtained from the pool sum of squares and cross products of Rep * Mat (Loc) + Rep * Entry (Loc Mat).

*Significant at .05 level

**Significant at .01 level

+0C Perkins 32-inch rows; 03 Perkins 40-inch rows; 08 Lahoma; 09 Goodwell

‡Degrees of freedom with respective tabulated corelation values at .05 and .01 probability levels are 728-.075 and .098; 546-.088 and .115; 182-.138 and .181; 108-.195 and .254; 144-.159 and .208; 282-.113, and .148; 36-.325 and .418; 48-.273 and .354; 94-.205 and .276

at least within a maturity group, without concern for the length of time periods studied.

CHAPTER V

SUMMARY AND CONCLUSIONS

A field trial was utilized to study dry matter accumulation in grain sorghum. For this purpose grain sorghum hybrids in the Oklahoma Grain Sorghum Performance Test provided the experimental material. The tests were conducted at four locations in the state, Perkins (32-inch rows), Perkins (40-inch rows) (dryland), Lahoma (dryland), and Goodwell (irrigated). The formation of black layer on the kernel at the point of attachment was taken as the indicator of physiologic maturity of the grain. Thus the rate of dry matter accumulation per day was studied for the variables planting to black layer, planting to mid-bloom and mid-bloom to black layer for the three maturity groups early, medium, and late.

Yield per day or the rate of dry matter production per day for the periods from planting to black layer, planting to mid-bloom, and mid-bloom to black layer on an average showed an increasing trend for the three dryland locations from early to medium to late maturity groups. It can be concluded that on an average the dry matter accumulation increases as the maturity period increases. But looking at the individual entry means in appendix, it can be seen that in some cases entries in early and medium groups produced more than the late maturity groups, however, in this study the maturities were studied for their means. At the irrigated location at Goodwell an increasing trend was found for the variables pounds per acre, days to black layer, yield per day from planting to mid-bloom, days to mid-bloom, and days from mid-bloom to black layer, but the dry matter accumulated per day from planting to black layer was similar for the three maturity groups. A reverse situation appeared in the case of dry matter accumulated per day from mid-bloom to black layer. This could be the result of the crop maturing during cooler days and especially nights at the higher elevation in the fall of the year.

In the correlation studies for grain yield in pounds per acre with the other variables under study, it was found that there was significant positive relationship between the variable grain yield in pounds per acre and yield per day from planting to black layer, yield per day from planting to mid-bloom, and yield per day for mid-bloom to black layer. No general trend of relationship was found for the other variables. This could be interpreted to mean that selection for increased yield could be accomplished independently from these variables.

Conclusions:

1. Significant differences were found in dry matter accumulation from planting to black layer among maturities as well as locations (dryland), but not for the irrigated location.
2. Yield per day from planting to mid-bloom as well as days to mid-bloom increased from early to medium to late for the three dryland locations as well as for the irrigated location.
3. Yield per day from mid-bloom to black layer increased significantly from early to medium to late maturity groups at dryland locations and decreased at the irrigated location.
4. Strong positive correlation was found for variables grain

yield in pounds per acre with the variables yield per day from planting to black layer, yield per day from planting to mid-bloom, and yield per day from mid-bloom to black layer.

LITERATURE CITED

1. Aldrich, S. R. 1943. Maturity measurements in corn and an indication that grain development continues after premature cutting. J. Am. Soc. Agron. 35: 667-680.

2. Aldrich, S. R. and E. R. Leng. 1972. Modern corn production. F. and W. Publishing Corporation. Cincinnati, Ohio.

3. Briggs, L. J. 1895. Harvesting wheat at successive stages of ripeness. Michigan Agr. Exp. Sta. Bul. 125: 34-35.

4. Carter, M. W. and C. G. Poneleit. Black layer maturity and filling period variation among inbred lines of corn (Zea mays L.) Crop Sci. 13: 436-439.

5. Collier, J. W. 1963. Caryopsis development in several grain sorghum varieties and hybrids. Crop Sci. 3: 419-422.

6. Dalton, L. G. 1967. A positive regression of yield on maturity in sorghum. Crop Sci. 7: 271.

7. Daynard, T. B. 1972. Relationships among black layer formation, grain moisture percentage and heat unit accumulation in corn. Agron. J. 64: 716-719.

8. Daynard, T. B. and W. G. Duncan. 1969. The black layer and grain maturity in corn. Crop Sci. 9: 473-476.

9. Daynard, T. B., J. W. Tanner, and W. G. Duncan. 1971. Duration of the grain filling period and its relation to grain yield in corn, Zea mays L. Crop Sci. 11: 45-48.

10. Denman, C. E., R. D. Morrison, and R. A. Peck. 1975. Performance tests of hybrid sorghums and corn in Oklahoma -1974. Okla. Agr. Exp. Sta. Res. Rpt. P-711.

11. Dennis, D. W. 1963. Comparison of methods of evaluating relative maturity in grain sorghum hybrids. Agron. J. 55: 545-549.

12. Dessureaux, L., N. P. Neal, and R. A. Brink. 1948. Maturation in corn. J. Am. Soc. Agron. 40: 733-744.

13. Easton, J. D., J. H. Hultquist, and C. Y. Sullivan. 1973. Physiologic maturity in grain sorghum. Crop Sci. 13: 175-178.

14. Hallauer, A. R. and W. A. Russell. 1962. Estimates of maturity and its inheritance in maize. Crop Sci. 2: 289-294.

15. Hanway, J. J. 1963. Growth stages of corn (Zea mays, L.) Agron. J. 55: 487-492.

16. Harlan, H. V. and M. N. Pope. 1926. Development in immature barley kernels removed from the plant. Jour. Agr. Res. 32: 669-678.

17. Hopper, T. H. 1925. Composition and maturity of corn. N. Dak. Agr. Exp. Sta. Bul. 192.

18. ICRISAT. Annual report. 1973-1974. International Crops Research Institute for the Semi-Arid Tropics.

19. Johan, H. 1935. Histology of the caryopsis of yellow dent corn with reference to resistance and susceptibility of kernel rots. J. Agr. Res. 51: 855-883.

20. Johnson, D. R. and J. W. Tanner. 1972. Comparison of corn (Zea mays L.) inbreds and hybrids grown at equal leaf area index, light penetration, and population. Crop Sci. 12: 482-485.

21. Kedzie, R. C. 1893. The composition of wheat at various periods of ripening. Mich. Agr. Exp. Sta. Bul 101: 3-5.

22. Kersting, J. F., F. C. Stickler, and A. W. Pauli. 1961. Grain sorghum caryopsis development. I. Changes in dry weight, moisture percentage, and viability. Agron. J. 53: 36-38.

23. Kiesselbach, T. A. and E. R. Walker. 1952. Structure of certain specialized tissues in the kernel of corn. Am. J. Bot. 39: 561-569.

24. Lambert, W. L. 1939. Indications of maturity in corn. B. S. Thesis. Purdue University, Lafayette, Indiana.

25. Neal, N. 1968. Maturity rating systems for corn hybrids. Proceedings of the Twenty-Third Annual Corn and Sorghum Research Conference. American Seed Trade Association, Washington D. C. 23: 45-53.

26. Nicholson, I. A. 1957. The effect of stage of maturity on the yield and chemical combination of oats for hay making. Agr. Sci. 49: 129-139.

27. Pauli, A. W., F. E. Stickler, and J. R. Lawless. 1964. Developmental phases of grain sorghum (Sorghum vulgare, Pers) as influenced by variety, location, and planting date. Crop Sci. 4: 10-13.

28. Quinby, J. R. 1971. Time of physiologic maturity of sorghum parents and hybrids. Sorghum Newsletter 14: 98. Iowa State University.

29. Quinby, J. R. 1972. Grain filling period of sorghum parents and hybrids. Crop Sci. 12: 690-691.

30. Rench, W. E. and R. H. Shaw. 1971. Black layer development in corn. Agron. J. 63: 303-305.

31. Schweitzer, P. L. 1889. Study of life history of corn at its different periods of growth. Mo. Agr. Exp. Sta. Bul. 9: 3-28.

32. Shaw, R. H. and W. E. Loomis. 1950. Basis for the prediction of corn yields. Plant Physio. 25: 225-244.

33. Shaw, R. H. and H. C. S. Thom. 1951. On the phenology of field corn, silking to maturity. Agron. J. 43: 541-546.

34. Teller, G. L. 1898. A report of progress of investigations in the chemistry of wheat. Ark. Agr. Exp. Sta. Bul. 53.

35. Wilkner, I. and R. E. Atkins. 1960. Drying and maturity of grain sorghum as affected by water loss from plant parts. Iowa State J. Sci. 35: 25-40.

APPENDIX

TABLE XI

MEAN SQUARES FOR ENTRIES

Locations and Maturities	Grain Yield in Lbs/Acre ‡(1000's)	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
OC, 03, 08, 09 + All Maturities	2212	144**	346**	394**	163	1399**	89**
OC, 03, 08 All Maturities	1243**	108*	290**	221**	162	1477*	73**
OC All Maturities	596**	57**	96**	144*	68	658**	29**
03 All Maturities	409*	41*	99**	91*	64	531*	31**
08 All Maturities	1164*	117*	117**	264*	39	1113	35**
OC, 03, 08 Early	1189**	125*	281**	238*	212	1428*	67**
OC, 03, 08 Medium	1289*	111*	452**	217*	208	1616*	109**
OC, 03, 08 Late	1241*	101*	210*	216*	119*	1368*	56*
OC Early	637*	61*	85*	154*	95**	636*	23*
OC Medium	4509*	40*	144**	104*	84**	469*	38**

TABLE XI (CONTINUED)

OC Late	654*	63*	75**	159*	50**	763*	27**
03 Early	359*	54*	113**	94*	92**	721*	37**
03 Medium	562*	56*	145**	151*	82**	536*	37**
03 Late	350*	29*	70**	59*	44**	456*	25*
08 Early	647*	85*	104**	208*	43**	708*	25*
08 Medium	1734*	175*	187**	375*	50**	1822*	62**
08 Late	1071*	100*	86**	230*	32**	907*	24*
09 Early	3949**	244*	321**	1012*	36**	912*	163*
09 Medium	1602*	58*	135*	277*	22**	233*	66*
09 Late	2016*	1128	46*	451*	7*	481*	47*

* Significant
** Highly Significant
\+ OC=Perkins 32-inch row; 03=Perkins 40-inch rows; 08=Lahoma; 09=Goodwell

‡ The mean squares for grain yield in pounds per acre must be multiplied by 1000.

TABLE XII

MEAN SQUARES FOR MATURITIES

Locations	Grain Yield in Lbs/Acre (1000's)	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
OC, 03, 08, 09 All Maturities	84175***	1545**	24078**	4760**	7748***	12456**	4520***
OC, 03, 08 All Maturities	56247***	1991**	13639***	4023**	6485***	19949**	1343***
OC	26362**	1168**	4800***	2043**	2642***	14324**	363***
03	20944***	995**	4366***	1936**	2245***	10509**	386**
08	11465**	184*	4504***	496*	1664***	1345*	704**
09	29576**	10	11727***	911**	1337**	470*	5147**

TABLE XIII

NAMES OF COMMERICAL HYBRIDS IN THE STUDY

Entry	Entry Designation	Entry	Entry Designation	Entry	Entry Designation
	Early		Medium		Late
1	ACCO R 1014	13	NK SAVANNA 4	19	G-820
2	(COOP) SG-10	14	NK 262	20	G-840 Y
3	DEKALB BR-35R	15	NK 266A	21	GROWERS ML-134
4	EARLY ORO	16	NK EXP 3101	22	GROWERS L-141
5	EXCEL 202-C	17	NK EXP 3150	23	MCNAIR 895
6	EXCEL 433	18	ORO-Y	24	NC+ 66X
7	FUNK G-393	19	P-A-G 525	25	NC+ 70X
8	FUNK G-399	20	PIONEER BRAND X1029	26	NK 270A
9	MCNAIR 521	21	PIONEER BRAND 8600	27	NK 277
10	MCNAIR 550	22	PIONEER BRAND 8674	28	NK 278
11	MINI MILO 52	23	SG-800	29	NK 279
12	NK 121	24	T-E GRAINMASTER-R	30	NK 285
13	NK 180A	25	Y-200	31	NK SAVANNA 2
14	NK 233!			32	P.E. 62Y
15	PE 401		Late	33	P.E. 65Y
16	SGY-680	1	ACCO R 109A	34	P.E. 500
17	T-E CHAMP	2	CHALLENGER	35	P.E. 550
18	WGF	3	(COOP) SG-22	36	P.E. 710
19	YELLOW MARTIN	4	(COOP) SG-36	37	PIONEER BRAND 8311
		5	DEKALB BR-54	38	PIONEER BRAND 8313
	Medium	6	DEKALB BR-63	39	PIONEER BRAND 8442
1	(COOP) SG-21	7	DEKALB C-42C	40	SGY-844
2	C.Q. 68	8	DEKALB C-43Y	41	SGY-850
3	DEKALB C-42D	9	DEKALB F-66R	42	STURDY 6100
4	FUNK G-577	10	NK 277	43	T-E 77A
5	FUNK HW3525	11	EXCELL 811-A	44	T-E 88A
6	GOLDEN 685	12	EX 8049	45	T-E EXP 7019
7	GROWERS M-120A	13	FRONTIER 412 A	46	T-E EXP 7404
8	H-500	14	FRONTIER 4122	47	T-E TOPS
9	MCNAIR 650	15	FUNK G-522	48	T-E TOTAL
10	MCNAIR 656 BR	16	FUNK G-634	49	775 W
11	NC+ 54X	17	GB-500		
12	NK SAVANNA 3	18	G-814BR		

TABLE XIV

ENTRY MEANS FOR THE VARIABLES UNDER STUDY
PERKINS (32-INCH ROWS) LOC OC

Entry	Replications	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
Early								
1	3	2640	31.18	84.66	48.57	54.33	87.14	30.33
2	3	2423	13.75	76.33	50.11	48.33	86.78	28.00
3	3	2450	31.42	78.00	49.22	49.66	87.97	28.33
4	3	3212	35.62	90.33	56.61	57.00	96.18	33.33
5	3	1987	24.87	80.00	38.76	51.33	69.71	28.66
6	3	2640	30.91	85.66	47.51	55.66	88.51	30.00
7	3	2395	28.75	83.33	46.07	52.00	76.54	31.33
8	3	2450	29.48	83.00	44.24	55.33	88.44	27.66
9	3	2940	36.26	81.00	56.88	51.66	100.42	29.33
10	3	3130	34.02	92.00	52.40	59.66	97.20	32.33
11	3	1687	24.15	69.66	52.74	32.00	44.56	37.66
12	3	2613	33.85	77.00	52.72	49.66	95.70	27.33
13	3	2096	27.82	75.33	42.78	49.00	79.65	26.33
14	3	2232	28.40	78.66	45.86	48.66	75.06	30.00
15	3	2259	29.58	76.33	46.11	49.00	82.53	27.33
16	3	2232	27.71	81.00	42.70	52.33	79.69	28.66
17	3	2668	31.65	84.33	48.51	55.00	91.09	29.33
18	3	1279	16.44	78.00	24.50	52.33	50.99	25.66
19	3	2423	29.99	81.33	46.89	51.66	84.05	29.66
Late								
1	3	3648	36.97	98.66	59.47	61.33	97.87	37.33
2	3	3620	37.81	95.66	58.40	62.00	107.27	33.66
3	3	3076	34.18	90.00	54.01	57.00	93.56	33.00
4	3	2804	26.45	106.00	40.49	69.33	76.29	36.66
5	3	2885	27.39	105.33	41.82	69.00	79.40	36.33
6	3	3539	38.75	91.33	54.50	65.00	134.47	26.33

TABLE XIV (CONTINUED)

7	3	3430	36.79	93.33	56.68	60.66	105.23	32.66
8	3	2477	26.00	95.33	41.56	60.00	69.65	35.33
10	3	3593	35.82	100.33	56.71	63.33	97.45	37.00
11	3	4029	40.70	99.00	63.30	63.66	114.01	35.33
12	3	3757	38.44	97.66	61.21	61.33	103.47	36.33
13	3	4029	40.27	100.00	62.57	64.33	113.53	35.66
14	3	4601	44.98	102.66	67.36	69.00	136.02	33.66
15	3	3512	35.85	98.00	58.66	60.00	92.29	38.00
16	3	3729	37.19	100.33	58.19	64.33	103.42	36.00
17	3	2885	31.30	92.33	47.70	60.66	91.33	31.66
18	3	2994	36.03	83.00	56.01	53.33	101.34	29.66
19	3	3784	39.22	96.33	62.44	60.66	105.92	35.66
20	3	2831	26.79	105.66	40.14	70.66	80.69	35.00
21	3	3430	37.56	91.33	55.04	62.33	118.28	29.00
22	3	3701	39.91	92.66	59.03	62.66	123.27	30.00
23	3	3784	38.75	97.66	59.43	63.66	111.56	34.00
24	3	3185	35.00	91.00	54.32	58.66	98.54	32.33
25	3	3375	33.77	100.00	54.45	62.00	88.97	38.00
26	3	2695	29.85	90.33	50.11	54.00	74.15	36.33
27	3	3947	41.19	95.66	68.03	58.00	104.64	37.66
28	3	3512	35.01	100.33	52.99	66.33	103.28	34.00
29	3	2967	31.92	93.00	48.45	61.33	93.90	31.66
30	3	3021	30.76	98.00	47.34	63.66	87.91	34.33
31	3	4192	40.90	102.66	59.85	70.00	130.05	32.66
32	3	3348	34.64	96.66	54.27	61.66	96.21	35.00
33	3	3566	38.29	93.00	60.67	58.66	104.02	34.33
34	3	3403	37.81	90.00	60.73	56.00	100.26	34.00
35	3	3185	35.00	91.00	51.90	61.33	107.65	29.66
36	3	3321	34.84	95.33	50.37	66.00	113.17	29.33
37	3	4301	42.27	102.00	65.87	65.33	118.23	36.66
38	3	3375	37.09	91.00	54.45	62.00	116.41	29.00
39	3	3865	38.55	100.33	57.87	67.00	115.77	33.33
40	3	4110	42.97	95.66	68.51	60.00	115.29	35.66
41	3	4110	43.82	94.00	67.94	60.66	123.50	33.33
42	3	2749	30.66	89.66	48.55	56.66	83.34	33.00
43	3	3893	42.16	92.33	60.54	64.33	139.38	28.00

TABLE XIV (CONTINUED)

44	3	3702	40.68	91.00	61.87	60.00	119.30	31.00
45	3	3348	36.79	91.00	54.01	62.00	115.47	29.00
46	3	3130	30.53	102.33	44.21	70.66	98.83	31.66
47	3	3321	34.70	95.66	49.57	67.00	115.73	28.66
48	3	3893	38.67	100.66	60.51	64.33	107.28	36.33
49	3	3920	38.95	100.66	60.66	64.66	108.90	36.00
Medium								
1	3	2749	30.54	90.00	50.90	54.00	76.48	36.00
2	3	3049	33.98	89.66	55.44	55.00	87.85	34.66
3	3	3130	33.98	92.33	52.98	59.33	94.87	33.00
4	3	3267	35.90	91.00	52.69	62.00	112.65	29.00
5	3	2804	30.94	90.66	45.22	62.00	98.01	28.66
6	3	2695	25.42	106.00	40.31	67.66	69.19	38.33
7	3	2695	30.07	89.66	49.00	55.00	77.87	34.66
8	3	3294	33.89	97.33	54.36	60.66	90.03	36.66
9	3	3648	38.29	95.33	60.80	60.00	103.47	35.33
10	3	3076	30.57	100.66	47.90	64.33	84.57	36.33
11	3	2477	29.98	82.66	47.93	51.66	80.11	31.00
12	3	3620	39.64	91.33	60.43	60.00	115.75	31.33
13	3	3294	35.17	93.66	53.13	62.00	104.37	31.66
14	3	2913	32.36	90.00	52.96	55.00	83.23	35.00
15	3	2640	29.14	90.66	48.27	54.66	73.62	36.00
16	3	2232	23.25	96.00	32.84	68.33	80.64	27.66
17	3	2450	31.02	79.33	46.17	53.00	94.91	26.33
18	3	3403	32.10	106.00	49.32	69.00	91.97	37.00
19	3	2913	28.12	103.66	44.55	65.33	76.30	38.33
20	3	2178	28.29	77.66	42.80	51.00	83.67	26.66
21	3	2668	29.31	91.00	48.51	55.00	74.11	36.00
22	3	2613	29.15	89.66	47.52	55.00	75.47	34.66
23	3	2858	31.52	90.66	51.07	56.00	82.71	34.66
24	3	2831	31.24	90.66	51.48	55.00	79.47	35.66
25	3	2668	29.56	90.33	48.28	55.33	76.23	35.00

TABLE XV

ENTRY MEANS FOR THE VARIABLES UNDER STUDY
PERKINS (40-INCH ROWS) LOC 03

Entry	Repli-cations	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
Early								
1	3	2352	27.77	84.66	43.27	54.33	77.78	30.33
2	3	1873	24.52	76.33	38.73	48.33	66.94	28.00
3	3	1851	22.40	82.66	36.83	51.66	59.84	31.00
4	3	2461	26.48	92.66	42.94	57.33	69.23	35.33
5	3	1764	21.82	81.00	35.53	49.66	56.89	31.33
6	3	2352	27.65	85.00	42.49	55.33	79.32	29.66
7	3	2439	31.18	78.33	46.85	52.00	94.63	26.33
8	3	2178	25.92	84.00	39.35	55.33	76.04	18.66
9	3	2003	23.96	82.66	38.40	52.33	63.82	31.33
10	3	1698	17.61	96.33	28.75	59.33	45.53	37.00
11	3	1219	17.44	70.00	38.11	32.00	32.18	38.00
12	3	2330	29.71	79.00	46.40	50.66	82.64	28.33
13	3	2221	29.31	75.66	44.27	50.00	87.30	25.66
14	3	2221	28.31	78.66	45.33	49.00	75.84	29.66
15	3	2286	30.09	76.00	47.36	48.33	82.53	27.66
16	3	2047	26.71	76.66	41.20	49.66	76.07	27.00
17	3	2047	24.47	83.66	37.97	54.00	68.99	29.66
18	3	1372	17.72	77.33	27.06	50.66	51.45	26.66
19	3	2178	27.63	79.00	41.84	52.00	82.40	27.00
Late								
1	3	2918	30.35	96.33	48.16	60.66	82.08	35.66
2	3	2831	28.41	99.66	45.92	61.66	76.54	38.00
3	3	2700	30.02	90.00	47.67	56.66	81.10	33.33
4	3	2918	28.59	102.33	43.35	67.66	84.16	34.66
5	3	3506	34.83	100.66	54.78	64.00	95.81	36.66
6	3	3397	37.21	91.33	54.56	62.33	117.19	29.00
7	3	2983	32.03	93.66	49.12	61.00	92.64	32.66
8	3	2570	27.04	95.00	43.82	58.66	70.86	36.33

TABLE XV (CONTINUED)

10	3	3027.	30.37	99.66	48.58	62.33	81.10	37.33
11	3	2983	29.74	100.33	46.18	64.66	83.92	35.66
12	3	3049	32.71	93.66	50.33	60.66	93.69	33.00
13	3	4072	40.87	99.66	65.37	62.33	109.08	37.33
14	3	3332	32.99	101.00	49.53	67.33	98.90	33.66
15	3	2896	30.85	94.00	48.29	60.00	85.49	34.00
16	3	3637	36.37	100.00	57.17	63.66	100.00	36.33
17	3	2657	28.77	92.66	44.31	60.00	82.33	32.66
18	3	2374	28.14	84.33	45.65	52.00	73.38	32.33
19	3	2983	31.12	96.66	50.19	60.00	81.93	36.66
20	3	2962	28.02	105.66	43.56	68.00	78.56	37.66
21	3	2722	30.14	90.33	45.40	60.00	89.92	30.33
22	3	3158	34.58	91.33	50.66	62.33	109.08	29.00
23	3	3310	33.10	100.00	52.56	63.00	89.50	37.00
24	3	2613	28.82	90.66	44.22	59.00	83.29	31.66
25	3	2918	30.23	96.66	47.85	61.00	82.64	35.66
26	3	2178	24.38	89.33	41.88	52.00	58.36	37.33
27	3	3223	34.34	94.00	55.66	58.00	90.60	36.00
28	3	3005	29.96	100.33	46.78	64.33	83.41	36.00
29	3	2657	29.19	91.00	44.54	59.66	85.17	31.33
30	3	2831	28.89	98.00	45.18	62.66	80.18	35.33
31	3	2983	29.14	102.33	43.36	69.00	89.50	33.33
32	3	3136	32.52	96.66	52.10	60.33	86.56	36.33
33	3	2809	28.26	99.33	46.25	60.66	72.67	38.66
34	3	2635	29.39	89.66	46.00	57.33	81.59	32.33
35	3	2853	31.47	90.66	47.84	59.66	92.33	31.00
36	3	3114	33.55	93.00	48.96	63.66	107.46	29.33
37	3	3506	35.98	97.66	54.07	65.00	108.41	32.66
38	3	3027	33.26	91.00	50.55	60.00	97.61	31.00
39	3	3245	32.44	100.00	48.43	67.00	98.29	33.00
40	3	2700	28.04	96.66	45.80	59.00	72.76	37.66
41	3	2896	29.07	99.66	47.22	61.33	75.70	38.33
42	3	2657	29.62	89.66	47.28	56.33	79.51	33.33
43	3	3136	34.46	91.00	50.04	62.66	110.87	28.33
44	3	3267	35.90	91.00	55.49	59.00	101.97	32.00

TABLE XV (CONTINUED)

45	3	2896	31.94	90.66	48.29	60.00	94.63	30.66
46	3	3419	32.76	104.33	47.72	72.00	105.38	32.33
47	3	3027	32.90	92.00	48.82	62.00	100.91	30.00
48	3	3245	32.54	99.66	52.34	62.00	86.03	37.66
49	3	3506	34.83	100.66	54.79	64.00	95.67	36.66
Medium								
1	3	2003	22.38	89.66	38.60	52.33	53.42	37.33
2	3	2439	27.28	89.33	43.81	55.66	72.32	33.66
3	3	2831	31.22	90.66	49.67	57.00	84.35	33.66
4	3	2570	28.35	90.66	43.12	59.66	82.87	31.00
5	3	2286	24.94	91.66	38.13	60.00	72.28	31.66
6	3	2482	23.50	105.66	36.72	67.66	65.34	38.00
7	3	2482	27.68	89.66	46.52	53.33	68.67	36.33
8	3	3441	35.51	96.66	58.93	58.33	89.71	38.33
9	3	3114	32.44	96.00	52.48	59.33	85.05	36.66
10	3	2766	27.26	101.66	43.99	63.00	71.70	38.66
11	3	2308	27.81	83.00	45.26	51.00	72.16	32.00
12	3	3245	37.35	87.00	56.95	57.00	109.03	30.00
13	3	2591	27.84	93.33	42.26	61.33	81.99	32.00
14	3	2265	24.97	90.66	39.71	57.00	67.35	33.66
15	3	2308	25.78	89.66	42.75	54.33	65.22	35.33
16	3	2657	26.48	100.33	38.34	69.33	85.70	31.00
17	3	2178	28.75	76.00	41.72	52.33	91.91	23.66
18	3	2330	22.79	102.33	34.42	67.66	67.66	34.66
19	3	2700	26.47	102.00	42.23	64.00	71.39	38.00
20	3	1873	22.94	81.66	36.72	51.00	61.21	30.66
21	3	2199	24.23	90.66	39.99	55.00	61.50	35.66
22	3	1524	18.08	84.33	28.14	54.33	50.81	30.00
23	3	1851	20.57	90.00	33.32	55.66	53.77	34.33
24	3	2482	27.51	90.33	45.89	54.33	68.99	36.00
25	3	2700	29.77	90.66	49.94	54.00	73.84	36.66

TABLE XVI

ENTRY MEANS FOR THE VARIABLES UNDER STUDY
LAHOMA LOC 08

Entry	Repli- cations	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
Early								
1	3	2722	31.60	86.33	51.36	53.00	82.28	33.33
2	3	2156	28.11	76.66	44.57	48.33	76.73	28.33
3	3	2526	33.55	75.33	53.02	47.66	91.38	27.66
4	3	2831	32.12	88.66	51.63	55.00	85.06	33.66
5	3	1981	25.87	76.66	39.41	50.33	75.47	26.33
6	3	2962	33.58	77.99	53.23	55.55	82.29	32.33
7	3	2657	31.92	83.33	50.87	52.33	85.71	31.00
8	3	1894	22.55	84.00	35.75	53.00	61.12	31.00
9	3	2853	35.03	81.66	55.65	51.66	95.85	30.00
10	3	2983	31.51	95.00	52.29	57.00	79.92	38.00
11	3	1459	19.83	73.66	35.27	41.33	45.32	32.33
12	3	2983	39.96	74.66	64.85	46.00	104.23	28.66
13	3	3027	40.18	75.33	63.95	47.33	108.12	28.00
14	3	2090	27.42	76.33	43.75	48.00	73.54	28.33
15	3	2286	30.09	76.00	48.10	47.66	80.60	28.33
16	3	2548	32.29	79.66	49.36	51.66	94.12	28.00
17	3	3114	37.85	82.66	61.40	51.00	98.96	31.66
18	3	2090	27.55	76.00	44.64	47.00	72.13	29.00
19	3	2657	34.20	77.66	52.12	51.00	99.56	26.66
Late								
1	3	3441	36.19	94.66	60.34	57.00	90.74	37.66
2	3	3637	39.31	92.33	63.74	57.00	102.66	35.33
3	3	2809	33.17	84.66	51.37	54.66	93.65	30.00
4	3	3506	33.39	105.00	54.51	64.33	86.21	40.66
5	3	3855	39.19	98.33	63.12	61.00	103.44	37.33
6	3	4225	44.49	95.00	67.08	63.00	132.43	32.00
7	3	2526	27.42	92.00	43.28	58.33	74.87	33.66
8	3	1655	17.72	93.00	28.86	57.33	46.05	35.66

TABLE XVI (CONTINUED)

10	3	3332	34.48	96.66	54.62	61.00	93.49	35.66
11	3	3419	35.25	97.00	56.47	60.66	93.82	36.33
12	3	2548	27.62	92.33	46.07	55.33	69.06	37.00
13	3	3746	38.03	98.66	61.41	61.00	100.14	37.66
14	3	5009	49.71	101.00	79.11	63.33	134.18	37.66
15	3	2700	38.07	96.33	46.57	58.33	70.73	38.00
16	3	3746	36.15	103.66	60.82	61.66	89.20	42.00
17	3	3245	34.92	92.66	55.21	58.66	95.09	34.00
18	3	3528	42.00	84.00	66.12	53.33	115.19	30.66
19	3	3223	33.40	96.66	54.80	59.00	85.60	37.66
20	3	3354	32.15	104.33	52.23	64.33	83.76	40.00
21	3	3876	42.89	90.33	67.57	57.33	117.48	33.00
22	3	3702	38.45	97.33	61.41	60.66	103.02	36.66
23	3	3615	37.57	96.33	59.84	60.33	100.96	36.00
24	3	3637	39.34	92.33	63.11	57.66	104.83	34.66
25	3	2439	25.21	96.66	42.79	57.00	61.38	39.66
26	3	2787	33.02	84.33	52.94	52.66	87.84	31.66
27	3	3005	32.10	94.33	52.89	57.00	81.84	37.33
28	3	4595	45.72	100.33	72.03	64.00	126.28	36.33
29	3	2657	29.38	90.33	46.50	57.00	79.86	33.33
30	3	3179	32.03	100.00	51.41	62.00	85.13	38.00
31	3	4116	39.20	105.00	63.08	65.33	103.66	39.66
32	3	3179	33.61	95.00	54.88	58.00	86.83	37.00
33	3	2526	26.95	94.66	44.92	56.33	67.51	38.33
34	3	2962	34.54	86.00	66.00	54.00	92.85	32.00
35	3	2787	30.85	90.33	48.34	57.66	85.30	32.66
36	3	3332	34.35	97.00	54.03	61.66	94.41	35.33
37	3	3702	38.14	97.00	59.28	62.33	106.99	34.66
38	3	3724	40.92	91.00	64.19	58.33	113.41	32.66
39	3	3441	34.75	99.66	53.77	64.00	98.50	35.66
40	3	2482	26.33	94.66	43.56	57.00	66.92	37.66
41	3	2526	27.04	94.00	44.65	56.66	68.72	37.33
42	3	2918	33.92	86.33	53.00	55.00	94.67	31.33
43	3	3092	32.86	94.66	51.03	60.66	92.68	34.00
44	3	3201	35.57	90.66	57.60	55.66	93.47	35.00

TABLE XVI (CONTINUED)

45	3	2896	31.40	92.33	48.84	59.33	89.01	33.00
46	3	3267	30.82	106.00	49.25	66.33	82.58	39.66
47	3	3092	31.88	97.00	50.08	61.66	87.83	35.33
48	3	3136	32.46	96.66	52.38	59.66	85.49	37.00
49	3	3397	33.29	102.00	55.44	61.33	83.46	40.66
Medium								
1	3	2374	26.37	90.00	43.18	55.00	67.84	35.00
2	3	2766	32.68	84.66	50.90	54.33	92.33	30.33
3	3	3267	36.07	90.66	58.33	56.00	94.55	34.66
4	3	2700	29.80	90.66	46.25	58.33	83.88	32.33
5	3	3484	35.87	97.33	57.37	60.66	95.88	36.66
6	3	3267	32.40	101.33	51.04	64.00	89.69	37.33
7	3	3092	35.67	86.66	57.74	53.66	92.91	33.00
8	3	2273	23.67	96.33	39.87	57.33	58.28	39.00
9	3	2744	29.85	92.66	48.59	56.33	78.02	36.33
10	3	3593	36.93	97.33	59.27	60.66	97.99	36.66
11	3	1981	25.74	77.00	38.08	52.00	79.43	25.00
12	3	3855	42.69	90.33	66.12	58.33	120.47	32.00
13	3	3637	39.81	91.33	61.61	59.00	113.09	32.33
14	3	2678	30.46	88.33	47.33	56.66	85.64	31.66
15	3	2766	32.70	84.66	52.78	52.33	86.14	32.33
16	3	5619	57.74	97.33	86.96	64.66	171.95	32.66
17	3	3484	45.85	76.00	68.32	51.00	139.39	25.00
18	3	3245	30.90	105.00	50.98	63.66	78.49	41.33
19	3	3267	31.55	103.66	54.10	60.66	76.86	43.00
20	3	2526	33.14	76.33	93.57	49.33	51.32	27.00
21	3	3005	32.42	93.00	79.56	55.00	54.76	38.00
22	3	1764	21.87	81.66	65.52	53.66	32.95	28.00
23	3	3267	36.96	88.33	102.13	56.33	58.03	32.00
24	3	3179	38.30	83.33	106.41	53.0	60.22	30.33
25	3	2199	24.53	89.66	63.74	55.33	39.94	34.33

TABLE XVII

ENTRY MEANS FOR THE VARIABLES UNDER STUDY
GOODWELL LOC 09

Entry	Replications	Grain Yield in Lbs/Acre	Yld/day from Pl to BL	Days to Black Layer	Yld/day from Pl to Mb	Days to Mid-bloom	Yld/day from Mb to BL	Days from Mb to BL
Early								
1	3	6572	52.30	125.66	99.00	59.33	110.92	66.33
2	3	5911	54.00	109.66	110.66	56.00	105.56	53.66
3	3	5859	53.99	108.66	108.59	54.66	107.48	54.00
4	3	7052	55.14	127.66	108.84	63.00	111.77	64.66
5	3	5146	46.28	111.33	92.83	55.66	92.44	55.66
6	3	5509	46.65	118.33	92.36	58.33	94.47	60.00
7	3	6235	53.41	117.00	104.90	57.33	108.88	59.66
8	3	5445	45.62	119.33	90.61	59.33	91.91	60.00
9	3	6300	50.80	124.66	98.02	59.33	106.20	65.33
10	3	4887	35.93	136.00	69.23	65.66	74.74	70.33
11	3	3202	35.88	89.33	82.68	50.33	63.60	39.00
12	3	4835	46.41	104.00	101.71	56.00	86.35	48.00
13	3	5030	47.20	106.33	97.16	54.66	92.31	51.66
14	3	5872	52.16	113.00	106.15	57.00	102.81	56.00
15	3	5833	52.06	112.33	102.14	54.66	106.70	57.66
16	3	6028	56.19	107.66	126.13	58.33	103.42	49.33
17	3	6909	56.77	122.00	117.46	62.66	110.27	59.33
18	3	2463	22.21	111.00	47.33	58.66	41.94	52.33
19	3	6209	52.25	119.00	102.82	58.00	107.13	61.00
Late								
1	3	7143	50.47	141.66	94.19	65.66	108.80	76.00
2	3	6961	51.14	136.00	98.46	65.33	106.72	70.66
3	3	6404	45.79	140.66	84.93	64.33	99.64	76.33
4	3	6534	47.90	136.33	93.14	66.00	98.90	70.33
5	3	6728	45.67	147.66	81.80	65.00	103.51	82.66
6	3	6534	48.09	136.00	97.37	67.66	96.65	68.33
7	3	6534	47.95	136.33	92.25	65.33	100.00	71.00

TABLE XVII (CONTINUED)

8	3	5600	40.05	139.66	75.20	65.00	86.16	74.66
10	3	6352	48.24	131.66	97.77	66.66	95.33	65.00
11	3	7350	54.04	136.00	104.47	65.66	112.02	70.33
12	3	6624	45.60	145.33	82.51	64.66	102.44	80.66
13	3	8841	61.97	143.00	117.15	67.00	131.96	76.00
14	3	6106	42.78	142.66	80.82	67.00	91.13	76.66
15	3	7156	52.51	136.33	100.61	65.00	110.09	71.33
16	3	6871	49.11	139.66	94.44	67.00	102.55	72.66
17	3	7195	51.17	140.66	96.46	66.00	109.04	74.66
18	3	6572	48.67	135.00	89.25	61.33	107.18	73.66
19	3	7610	56.76	134.00	111.39	65.66	115.87	68.33
20	3	7234	51.24	140.66	98.86	67.66	106.96	73.00
21	3	7623	56.85	134.00	113.16	66.66	114.27	67.33
22	3	6624	46.05	144.33	86.33	67.00	98.87	77.33
23	3	7337	53.95	136.00	103.34	65.00	112.88	71.00
24	3	6132	43.46	140.66	81.65	65.66	93.46	75.00
25	3	7597	55.03	138.33	104.46	65.33	116.34	73.00
26	3	6093	44.84	136.00	82.32	62.00	98.58	74.00
27	3	3642	25.69	143.00	46.92	64.33	56.86	78.66
28	3	8167	58.12	140.33	110.78	66.66	122.60	73.66
29	3	5846	42.12	138.66	80.38	65.66	89.20	73.00
30	3	5419	39.57	137.00	76.21	65.66	82.39	71.33
31	3	8102	57.96	139.66	120.39	67.33	112.12	72.33
32	3	7247	51.22	141.66	111.49	65.00	95.19	76.66
33	3	6819	47.33	144.33	103.83	65.66	87.35	78.66
34	3	6106	44.12	138.33	93.52	65.33	83.66	73.00
35	3	7635	54.82	139.33	114.71	66.66	105.27	72.66
36	3	6209	42.58	146.33	92.68	67.00	78.97	79.33
37	3	6598	50.17	131.33	98.48	67.00	102.40	64.33
38	3	6715	48.35	138.33	104.98	64.33	90.18	74.00
39	3	6793	48.78	139.33	100.42	67.66	94.99	71.66
40	3	6806	48.89	139.33	105.24	64.66	91.43	74.66
41	3	7402	54.11	137.00	113.34	65.33	103.63	71.66
42	3	5808	43.35	134.00	87.16	66.66	86.32	67.33
43	3	6158	45.27	136.00	90.92	68.00	90.28	68.00

TABLE XVII (CONTINUED)

44	3	6469	46.80	138.33	98.55	65.66	89.15	72.66
45	3	6352	45.27	140.66	95.77	66.33	86.37	74.33
46	3	6715	46.26	145.33	95.19	70.66	90.39	74.66
47	3	6417	46.04	139.66	94.63	68.33	91.64	71.33
48	3	7285	54.78	133.00	112.09	65.00	107.14	68.00
49	3	7298	55.64	131.33	111.71	65.33	111.41	66.00
Medium								
1	3	5820	43.76	133.00	94.54	61.66	81.59	71.33
2	3	5691	44.00	130.00	90.29	63.00	86.25	67.00
3	3	6598	47.78	138.00	102.47	64.33	89.53	73.66
4	3	6158	46.30	133.00	93.81	65.66	91.46	67.33
5	3	7441	55.15	135.00	113.27	65.66	107.63	69.33
6	3	6832	50.23	136.00	101.53	67.33	99.72	68.66
7	3	6054	50.55	120.33	99.31	61.00	103.31	59.33
8	3	7169	53.57	134.00	110.29	65.00	104.21	69.00
9	3	6909	51.23	135.00	106.84	64.66	98.57	70.33
10	3	7895	58.49	135.00	124.77	63.33	110.20	71.66
11	3	5808	47.96	121.66	98.45	59.00	93.90	62.66
12	3	6897	51.47	134.00	107.20	64.33	99.04	69.66
13	3	6222	46.46	134.00	95.74	65.00	90.30	69.00
14	3	5808	45.35	129.33	90.58	64.00	91.51	65.33
15	3	6456	50.70	128.33	104.08	62.33	99.48	66.00
16	3	5561	40.91	136.33	83.01	67.00	80.85	69.33
17	3	5704	50.05	114.00	98.75	57.66	101.84	56.33
18	3	7558	56.00	135.00	115.69	65.33	108.57	69.66
19	3	7104	54.41	130.66	107.12	66.33	111.18	64.33
20	3	5159	44.89	115.00	90.10	57.33	90.14	57.66
21	3	6378	48.52	131.66	101.93	62.66	93.29	69.00
22	3	5172	43.17	120.66	85.24	60.66	88.49	60.00
23	3	6754	50.06	135.00	105.57	64.00	95.37	71.00
24	3	5989	45.03	133.00	99.29	60.33	82.41	72.66
25	3	6106	48.01	127.33	99.04	61.66	93.25	65.66

VITA

Mithlesh Kumar

Candidate for the Degree of

Master of Science

Thesis: USE OF BLACK LAYER TO STUDY DRY MATTER ACCUMULATION IN GRAIN SORGHUMS

Major Field: Agronomy

Biographical:

Personal Data: Born in Hyderabad, India, June 11, 1946, the son of Dr. D. Tulsidas (Late).

Education: Attended Andhra Pradesh Agricultural University, Hyderabad, India, and graduated with the Bachelors degree in Agriculture in September, 1965. Attended Oklahoma State University majoring in Agronomy; fulfilling the requirements for Master of Science degree at Oklahoma State University in December, 1975.

Professional Experiences: Worked for the State Department of Agriculture in Andhra Pradesh from 1966 to 1969 as an Agriculture Extension Officer. Worked on the farm for three years from 1969 to 1972. Employed by the Oklahoma State University Department of Agronomy as a graduate assistant during 1975.