THE REACTION OF GRAIN SORGHUM HYBRIDS TO GREENBUG INFESTATIONS UNDER DIFFERENT CULTURAL PRACTICES

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THE REACTION OF GRAIN SORGHUM HYBRIDS TO GREENBUG INFESTATIONS UNDER DIFFERENT CULTURAL PRACTICES

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Grain sorghum, Sorghum bicolor (L.) Moench, is one of the major cereal crops in the world. In 1968 the greenbug, Schizaphis graminum (Rondani) evolved a strain, Biotype C, which became a pest of grain sorghum in the United States, (Harvey and Hackerott 1969). In the spring of 1974, the greenbug demonstrated a resistance to the organophosphate chemicals which had been used effectively in the control of the insect. Plant resistance in sorghum cultivars have been reported and utilized in the production of greenbug resistant hybrids.

The increasing cost and problems with the organophosphate chemicals and the development of resistant hybrids have greatly enhanced the capability of grain sorghum production. Cultural practices also are important in the production of grain sorghum. A better understanding of such practices with the influence of greenbugs is important in grain sorghum production. The purpose of this study was to measure the effects of greenbug populations on grain sorghum production as influenced by certain sorghum cultural practices.

CHAPTER II

LITERATURE REVIEW

Grain sorghum, *Sorghum bicolor* (L.) Moench, is one of the major cereal crops in the world. In the past decade, grain sorghum has been subjected to greenbug infestations which have become a pest of sorghum in all areas where the crop is grown.

The greenbug, *Schizaphis graminum* (Rondani), was first described by Rondani in Italy in 1852. It was first reported on grain sorghum in 1863 by Passerini in Italy (Webster and Phillips 1912). Greenbugs have also been reported on sorghums in Africa (Matthee 1962) and in Europe (Barbulescu 1964). It was first discovered in the United States on oats in Virginia ca. 1882 (Webster and Phillips 1912). It was not until 1968 that greenbugs were reported on grain sorghum (Harvey and Hackerott 1969). Prior to 1968 the greenbug was considered a damaging pest only on small grains. The sorghum greenbug was recognized as biotype C and could be separated from biotypes A and B by morphological and ecological differences (Harvey and Hackerott 1969). Biotype A and B could be separated from biotype C on the basis of reaction to host plants. Biotype B caused little or no damage to Piper sudangrass whereas the C biotype greenbug survived and caused severe damage to the host plant (Harvey and Hackerott 1969). Wood (1961) reported the differences of the biotypes A and B in the greenbugs using selection Dickinson 28A. Biotype A showed a distinct nonpreference to the wheat selection whereas biotype

B showed a high preference. Starting about 1951 successful control of the greenbug was achieved with emulsions of ethyl parathion (Dahms 1951). In 1974 efforts to control the greenbug were not completely successful. The organophosphate resistant greenbugs were designated as biotype D and separated from biotype C which is susceptible to insecticides (Teetes et al. 1975).

Insect resistant genotypes are very useful in reducing insect damage. Harvey and Hackerott (1974) found that when seedlings of a susceptible grain sorghum were infested with greenbugs, reduced grain and forage yields resulted, but greenbugs did not reduce yields of a resistant type. They also reported that the influence of greenbug feeding caused reduced tillering, plant height, and delayed maturity more in a susceptible sorghum than a resistant sorghum.

Sorghum cultivars and progenies were rated for resistance to the greenbug (Weibel et al. 1972). The utilization of F_1's of the resistant varieties "Shallu grain", "PI 264453", and "IS 809" had an intermediate score between resistant and the susceptible parents. The score was closer to the resistant parent and indicated that one parent could give considerable resistance to greenbugs. Data from the F_2 populations indicated that the inheritance of resistance probably was controlled by a single incompletely dominant factor. Johnson et al. (1974) also indicated that hybrids with one resistant parent had enough resistance to control greenbug populations.

Teetes et al. (1974) reported that sorghum lines "IS 809", "KS 30", and "SA 7536-1" showed significantly less greenbugs than susceptible lines "TX 2536" and "TX 7000". Sorghums "KS 30" and "IS 809" had less leaf damage caused by greenbugs than the susceptible "TX 2536" and "TX

7000". Fewer offspring per day were reared on the resistant "IS 809" line than those reared on the other sorghum lines. Tolerance appeared to be the primary mechanism of resistance.

Hackerott and Harvey (1971) reported that grain yields are reduced by greenbugs destroying the leaves on the susceptible grain sorghum lines. The loss of yield was caused by both reduced seed size and numbers of seeds per head.

Smith et al. (1969) mechanically simulated greenbug damage by removing all leaves except the upper three throughout the vegetative stage of the sorghum plant and achieved a 30% yield loss.

Starks and Wood (1974) reported that greenbug damage to sorghum can be present in various stages of plant growth and is more complex than mechanical damage.

White (1977), by using various sorghum cultural practices, found that early maturing hybrids maintained the highest greenbug populations as compared to medium and late hybrids. Wider row spacings always contained more greenbugs than narrow row spacings. Planting dates did not influence the rate of infestation. The third planting produced the highest counts in 1976, whereas the first planting produced more greenbugs in 1977.

The use of insecticides on grain sorghum has been important in controlling insect pests. Harvey and Hackerott (1970) reported the effect of greenbugs during the preboot, milk, and soft dough stages of plant growth. Stages left untreated with an insecticide significantly reduced grain yields.

Johnson et al. (1974) showed by use of disulfoton, a greenbug controlling insecticide, that in treated plots the mean number of greenbugs per plant was lower and leaf injury from greenbug feeding was less. The evolution of greenbugs resistant to the organophosphate chemical in 1974 brought new problems in controlling the pest. This resistance in the greenbug was possibly influenced by the genetic, biological, and ecological factors that vary with species populations and location (Georghiou and Taylor 1976). Proper cultural practices are needed to aid in controlling insect pests.

Altering planting dates have been used in controlling insect pests. Early planting dates were of greater value than hybrid corn variety in reducing the damage of the southwestern corn borer, Zeadiatrea grandiosella (Dyar), (Henderson and Douglas 1967). Chiang and Hodson (1963) reported that the European corn borer, Ostrinia nubilalis (Hubn), damaged corn less when planted at an early date. The planting date is also effective in the control of damage done by the sorghum midge, Contarinia sorghicola (Coqiullett), as found by Wiseman and McMillian (1969) and Newman (1962).

The altering of planting dates has also had an influence on yield (Newman 1960). Grain sorghum was planted on four dates from April 28th to June 25th. The April 28th planting produced a significantly higher average yield than any of the May and June plantings. Maturity was also a factor. The late maturing hybrids produced more than the early and medium maturity groups when planted in mid-April. Genter and Jones (1970) reported that corn yield was related to planting date X year interactions. The amount and distribution of rainfall during the silking period and planting dates were the dominant factors in corn yield.

Changing plant population and row spacing has an influence on the canopy and insect populations of agronomic crops. These changes influenced the number and size of the individual leaves in the crop and is expressed in sorghum as the leaf-area index (Goldsworthy 1970). Siegliner (1936) was first to determine the number of leaves per stalk and found the number of leaves and length of the vegetative period to be highly correlated. He also reported that the presence of an additional leaf delayed heading by about three days.

Peck and Weibel (1971) reported that the number of leaves and the total leaf area varied with maturity. Results were obtained by working with early, medium, and late maturing sorghum hybrids. The late maturing hybrid produced a greater number of leaves and leaf area than the earlier maturing hybrids.

Pimental (1961) working with Brassica oleracea (L.) and Davis (1966) working with Radar-2 oats, Avena sativa (L.) both found that the largest number of insect pests were related to plant densities. More insects were found in the high plant populations with a more dense canopy.

Cultural practices in changing the plant populations and row spacings influence differences in total yield production. Mann (1965) reported that seeding rates in excess of 4 pounds per acre reduced grain sorghum yields under dryland conditions. Grain yields were not significantly different when planted at 21 and 42 inch row spacings at the same rate of seed per acre. The trend showed that plant populations have more effect on yield than do row spacings. Karchi and Rudich (1966) revealed that the yield superiority of narrow rows was mainly associated with more heads per unit area and seeds per head. Robinson et al. (1964) stated that yield increased as rows narrowed from 40 to 10 inches, but plant population had little effect on yield. Panicles per acre and seeds per panicle increased with narrow row spacings. Brown and Shrader (1959) working with grain sorghums under drouth conditions reported that low plant populations and wide row spacings produced lower forage yields but greater grain yields.

Martin and Sieglinger (1929) showed that the days from planting to maturity decreased as sorghum was planted later in the growing season. The height of the plants increased as the growing season progressed. The test weight in pounds per bushel showed no difference at the various dates of planting.

CHAPTER III

METHODS AND MATERIALS

This study was conducted on the Agronomy Research Station at Perkins, Oklahoma. The research period extended from April 27, 1976 to October 15, 1977. Two major problems occurred during the study. A light infestation of greenbugs each year and a lack of available moisture during the 1976 growing season. The drought conditions made it difficult to measure the reduction of yield due to greenbug populations. Therefore, the yield data from the 1976 growing season is not reported in this study. The reduction of yield can also be noted in sorghum experimental plots as shown by Denman et al. (1977). The seasonal rainfall, April through August, for two years was 30.01 and 47.27 centimeters respectively (Table VII). Most of the rainfall was obtained in the months of April and May. Six sorghum hybrids were evaluated under cultural practices to determine the yield potentials influenced by greenbug populations.

The experiment was arranged in a split-plot design with the main plots being sorghum hybrids and the subplots being insecticide treatments. There were 3 planting dates, 2 row spacings, 4 replications, and 6 sorghum hybrids. The overall dimensions of the test were 211 X 18 m. One and one-half meter alleys were cut between the 4 replications leaving 6.1 m of row. Each plot was 6.1 m long by 6 rows wide and was further subdivided to give two 3-row subplots. The soil type was a

Teller loam with less than a two percent slope. The study site was fertilized with 120 kg/ha of nitrogen and 77 kg/ha of potassium. The herbicide milogard was applied at a rate of 1.72 kg ai/ha for weed control.

The six sorghum hybrids were obtained from DeKalb Ag Research, Inc. with two near isogenic lines for each of the maturity classes. The resistant lines were early C-42a^{+}, medium E-59^{+}, and late F-67^{+}. The susceptible lines were early C-42a, medium E-59, and late F-67. The medium hybrid was classified as a medium-late type. The experiment was planted on April 27, May 15, and June 9 for the 1977 growing season.

Two different row spacings and plant populations were employed. Row spacings were 91.4 and 76.2 cm with plants in the rows thinned to 12.7 cm and 7.6 cm, respectively. This gave a total plant population for the 91.4 cm rows of 86,000 plants/ha and for the 76.2 cm rows of 172,000 plants/ha. An insecticide of 15% granular disulfoton was applied at the rate of 1.13 kg ai/ha to the 3-row subplots of each 6 row plot. Hence, a plot of 6 rows contained 3 rows of treated plants and 3 rows of untreated plants. The insecticide was applied to the whorl of the sorghum seedlings after a considerable build-up of greenbugs.

Throughout the growing season measurements and observations were made by sampling 10 consecutive plants from the center of each subplot. Bloom notes were taken to calculate mid-bloom days for each treatment.

At the time of grain maturity, notes were taken for plant height and lodging. The subplots were harvested by taking the heads from 3 m of the middle row from each subplot. The heads were threshed to obtain plot grain weight and test weight.

In the statistical analyses, the least significant difference tests at the 0.05 probability level were used to test the means if the F tests were significant. However, difference between planting dates and row spacings could not be included in the statistical analysis because they were treated as individual experiments.

CHAPTER IV

RESULTS AND DISCUSSION

In this experiment, certain sorghum cultural practices were studied to determine the effects on greenbug infestations in the field. As stated earlier, from the complications of the design of the test, planting dates and row spacings could not be included in the statistical analysis. Therefore, each planting date at each row spacing was analyzed separately to give six different analysis of variance tests. By these six separate tests, different interactions among the means of the main and subplot units were derived. At each planting date and row spacing, the F-tests were used to determine if the main, subplot units, or interactions were significant. The highest level was the three-way interaction and it was used if significant by the F-test. The next level was the two-way interaction down to the main (hybrids) and subplot units (resistance or treatment).

The mean yield among different interactions for planting date 1 and row spacings 76.2 and 91.4 cm are given in Table I. The hybrid x resistance x treatment interaction was shown to be significant at the 76.2 cm row spacing.

The analysis shows four different groups of treatment combinations. The first group consists of two combinations, (MRU and LSU), the yields of which range from 3125 to 3171 kg/h. These two combinations were not significantly different when compared to each other. The two combina-

TABLE I

MEAN YIELD AMONG DIFFERENT INTERACTIONS, PLANTING DATE 1[1] ROW SPACINGS 76.2 AND 91.4 CM

Entry[2]	Row Spacing 76.2 cm	Entry	Row Spacing 91.4 cm
ERT	2881 b	E - T	4007 a
ERU	2929 b	E - U	3377 c
EST	2636 c	M - T	3885 a
ESU	2538 cd	M - U	3641 b
MRT	2783 b	L - T	3214 c
MRU	3125 a	L - U	3967 a
MST	2538 cd		
MSU	2441 d	- R -	3838 a
LRT	2881 b	- S -	3526 b
LRU	2929 b		
LST	2490 cd		
LSU	3271 a		

[1]Planting was made April 27, 1977.

[2]Entry, E = early, M = medium, L = late sorghum hybrids; R = resistant, S = susceptible plants; T = treated, U = untreated plants with insecticide.

All means of a given interaction followed by the same letter are not significantly different at the 0.05 probability level.

tions show that treatment with an insecticide is not important in yield. However, maturity is important when selecting resistance. The second group consists of five combinations, (ERT, ERU, MRT, LRT, and LRU), the yields of which range from 2783 to 2929 kg/h. The yields of the second group are significantly different from the first combinations of treatments. The five combinations are not significantly different when compared to each other. The five combinations show that resistance is important given any maturity group or treatment. The third group consists of only one combination, (EST), the yield of which is 2636 kg/h. The fourth group consists of four combinations (ESU, MST, MSU, and LST), the yields of which range from 2441 to 2538 kg/h.

The interactions of significance for the 91.4 cm row spacing at planting date 1 were the hybrid x treatment and the entry of resistance versus susceptibility. The analysis shows three different groups of treatment combinations. The first group of the hybrid x treatment interaction consists of three combinations (E-T, M-T, L-U), the yields of which range from 3885 to 4007 kg/h. The analysis shows that when an early or medium maturity group is selected, insecticide treatment is important. When a late maturing group is selected, insecticide treatment is not important. The second group, which is significantly different from the first, consists of one combination, (M-U), the yield of which is 3641 kg/h. The third group consists of two combinations, (E-U and L-T), the yields of which range from 3214 to 3377 kg/h. The interaction of resistance versus susceptibility showed that resistant hybrids averaged over hybrids and treatments were shown to be significantly higher in yield than the susceptible hybrids.

In planting date 1 at both row spacings, it became apparent that hybrids at any combination of treatment or resistance were not important. Resistance seemed to be the most important factor at the 76.2

cm row spacing at any combination of hybrid or treatment. Resistance was also important at the 91.4 cm row spacing excluding hybrids or treatment. It indicated that plant resistance to the sorghum greenbug plays an important role in obtaining higher yield when compared to susceptible plants.

The mean yield among different interactions for planting date 2 and row spacing 76.2 and 91.4 cm are given in Table II. In the 76.2 cm row spacing the analysis of variance test showed no significance for any interactions or hybrid, resistance, or treatment tested separately at the 0.05 probability level. The hybrids were shown to be significantly different at the 91.4 cm row spacing, excluding resistance or treatment. The highest yield was obtained from the early hybrids followed by the medium and late hybrids. The lack of significant differences for interactions at the 76.2 cm row spacing and the higher yield of the early hybrids probably can be attributed to the lack of moisture instead of the influence of greenbugs. The lack of moisture could have neutralized the effects of the greenbugs on the different variables of the test. As shown in Figure 1, the test weight of the grain was much lower as compared to the other two planting dates and there were no significant differences among hybrids. This is evident by the lack of moisture during the time of anthesis. Table VII in the appendix shows that during the month of July, 8.00 centimeters of precipitation fell. However, from July 11 to July 30, during anthesis of the hybrids, only 1.39 cm of precipitation was available. The yields of the early hybrids were significantly greater than the yields of the medium and late hybrids. This, too, was probably due to the lack of moisture.

TABLE II

MEAN YIELD AMONG DIFFERENT INTERACTIONS, PLANTING DATE 2[1] ROW SPACINGS 76.2 AND 91.4 CM

Entry[2]	Row Spacing[3] 76.2 cm	Entry	Row Spacing 91.4 cm
ERT	2392 a	E - -	2563 a
ERU	2392 a	M - -	2329 b
EST	2343 a	L - -	2197 c
ESU	2294 a		
MRT	1952 a		
MRU	2294 a		
MST	2001 a		
MSU	2392 a		
LRT	2099 a		
LRU	2343 a		
LST	2490 a		
LSU	2392 a		

[1]Planting was made May 15, 1977.

[2]Entry, E = early, M = medium, L = late sorghum hybrids; R = resistant, S = susceptible plants; T = treated, U = untreated plants with insecticide.

[3]No significance of a given interaction shown by the F-test at the 0.05 probability level for the 76.2 cm row spacing.

All means of a given interaction followed by the same letter are not significantly different at the 0.05 probability level.

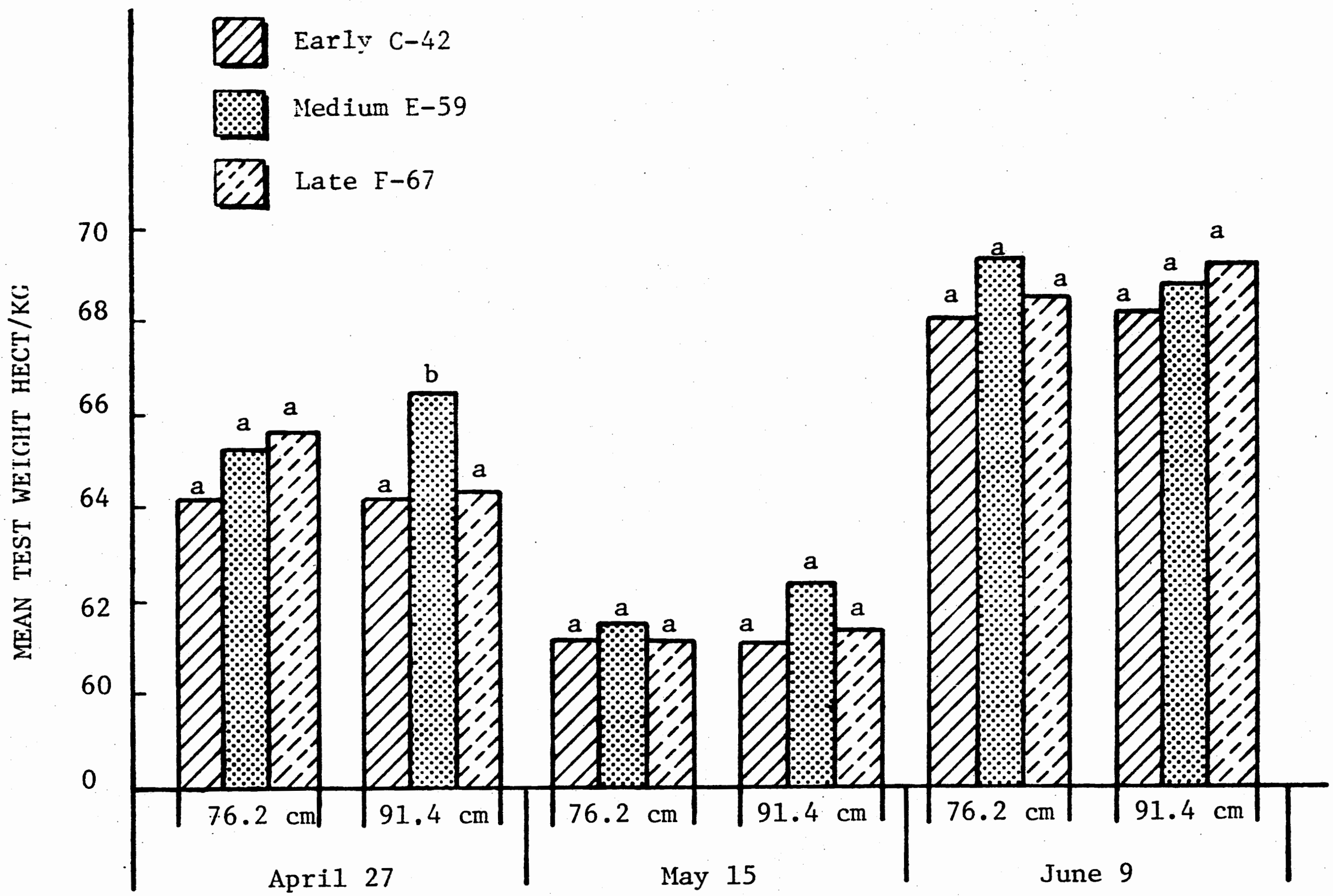

Figure 1. The comparison of test weight among three sorghum hybrids. A hybrid within a row spacing having the same letter is not significantly different at the 0.05 probability level.

The early hybrids being smaller plants with less leaf area and leaves were probably less affected than the larger medium and late maturing hybrids.

The mean yield among different interactions for planting date 3 and row spacings 76.2 and 91.4 cm are given in Table III. The three-way interaction of hybrid x resistance x treatment was shown to be significant at the 76.2 cm row spacing. The analysis shows five different groups of treatment combinations. These five groups are significantly different among each group. The first group consists of one combination, (EST), the yield of which is 4345 kg/h. This indicates that treatment is important in yield when using a susceptible, early maturing type. The second group consists of three combinations, (ESU, MRT, and LRT), the yields of which range from 3857 to 3955 kg/h. Treatment is important using the medium and late maturing groups. The analysis indicates that treatment is important in three of the four interactions. The third group consists of five combinations (ERU, MRU, MSU, LST, and LSU), the yields of which range from 3418 to 3711 kg/h. The fourth group consists of two combinations (ERT and LRU), the yields of which range from 2978 to 3125 kg/h. The fifth group consists of one combination (MST), the yield of which is 2637. In the 91.4 cm row spacing, the entry of medium maturity was significantly higher in yield when compared to the early and late hybrids. The analysis shows that from the 76.2 cm row spacing, the medium hybrid, resistant plant, and treated combination were second highest in yield. The medium hybrids were significantly higher in yield when compared to the early and late hybrids in the 91.4 cm row spacing. The analysis indicate that the combination of the medium hybrid, resistant plant, and treated would be

TABLE III

MEAN YIELD AMONG DIFFERENT INTERACTIONS, PLANTING DATE3[1] ROW SPACINGS 76.2 AND 91.4 CM

Entry[2]	Row Spacing 76.2 cm	Entry	Row Spacing 91.4 cm
ERT	3125 d	E - -	3825 b
ERU	3711 c	M - -	4476 a
EST	4345 a	L - -	4008 b
ESU	3857 b		
MRT	4101 b		
MRU	3515 c		
MST	2637 e		
MSU	3613 c		
LRT	3955 b		
LRU	2978 d		
LST	3418 c		
LSU	3564 c		

[1]Planting was made June 9, 1977.

[2]Entry, E = early, M = medium, L = late sorghum hybrids; R = resistant, S = susceptible plants; T = treated, U = untreated plants with insecticide.

All means of a given interaction followed by the same letter are not significantly different at the 0.05 probability level.

the best practice to use later in the growing season when greenbug populations are generally higher.

The comparison of mean yields from planting date, row spacing, and resistance on three sorghum hybrids are given in Table IV. In comparing overall means for hybrids at both row spacings on the first planting date, resistant hybrids were shown to be significantly higher than the susceptible hybrids. At the next two planting dates and row spacings, resistance was not significantly different from susceptibility. The analysis indicates that resistance seems to have played an important role against greenbugs for increased yield at the first planting date.

The comparison of mean yield from planting date, row spacing, and treatment on three sorghum hybrids are given in Table V. In comparing overall means for hybrids at each planting date and row spacing, it becomes apparent that yield was not significantly affected by treatment to control greenbugs. Although not significantly different, there was a slight increase in yield due to treatment at the last planting date at both row spacings.

The comparison of mean yield from row spacing and planting date on three sorghum hybrids are given in Table VI. Although no statistical comparisons can be made between row spacings and planting dates, observations can be made. The yield from the 91.4 cm row spacing at each planting date was somewhat greater as compared to the 76.2 cm row spacing. This was probably related to the lack of moisture during certain times in the growing season and to the competition for moisture from the more dense plant populations in the 76.2 cm row spacing. The last planting date contained the highest yield.

The comparison of days to midbloom among three sorghum hybrids is given in Figure 2. The lack of moisture or greenbugs did not seem to

TABLE IV

COMPARISON OF MEAN YIELDS FROM PLANTING DATE, ROW SPACING, AND RESISTANCE OF THREE SORGHUM HYBRIDS

Planting Date	Row Spacing	Resistance[2]	C-42	Sorghum Hybrids[1] E-59	F-67	Overall Mean
April 27	76.2 cm	R	2905	2953	2905	2921 a
		S	2587	2490	2880	2652 b
	91.4 cm	R	3682	4048	3783	3837 a
		S	3702	3478	3397	3525 b
May 15	76.2 cm	R	2392	2123	2221	2245 a
		S	2319	2197	2441	2319 a
	91.4 cm	R	2665	2278	2156	2366 a
		S	2461	2380	2237	2359 a
June 9	76.2 cm	R	3417	3808	3466	3563 a
		S	4101	3124	3490	3571 a
	91.4 cm	R	3560	4495	3905	3986 a
		S	4089	4455	4109	4217 a

[1]Hybrids = early, medium, and late maturity groups

[2]Resistance = R = resistance, S = susceptible plants

All means followed by the same letter are not significantly different at the 0.05 probability level.

influence the midbloom of the sorghum hybrids. The factors affecting the midbloom of the hybrids were the different maturity groups of the sorghum hybrids and planting dates. The early maturing hybrids at each

TABLE V

COMPARISON OF MEAN YIELDS FROM PLANTING DATE, ROW SPACING, AND TREATMENT ON THREE SORGHUM HYBRIDS

Planting Date	Row Spacing	Treatment[2]	C-42	Sorghum Hybrids[1] E-59	F-67	Overall Mean
April 27	76.2 cm	T	2758	2660	2685	2701 a
		U	2734	2783	3100	2872 a
	91.4 cm	T	4007	3885	3214	3702 a
		U	3377	3641	3967	3662 a
May 15	76.2 cm	T	2367	1977	2294	2212 a
		U	2343	2343	2367	2351 a
	91.4 cm	T	2461	2278	2258	2332 a
		U	2665	2380	2136	2393 a
June 9	76.2 cm	T	3735	3368	3686	3596 a
		U	3783	3564	3271	3539 a
	91.4 cm	T	3946	4455	4028	4143 a
		U	3702	4495	3987	4061 a

[1]Hybrids = early, medium, and late maturity groups.

[2]Treatment = T = treated, U = untreated plants with insecticide.

All means followed by the same letter are not significantly different at the 0.05 probability level.

row spacing and planting date required significantly less days to midbloom as compared to the medium and late hybrids. The late maturing hybrids in most instances, required significantly more days to midbloom

TABLE VI

COMPARISON OF MEAN YIELDS FROM ROW SPACING AND PLANTING DATE ON THREE SORGHUM HYBRIDS

Planting Date	Row Spacing	C-42	Sorghum Hybrids[1] E-59	F-67	Mean
April 27	76.2 cm	2746	2721	2892	2786
	91.4 cm	3692	3763	3590	3682
May 15	76.2 cm	2355	2160	2331	2282
	91.4 cm	2563	2329	2197	2363
June 9	76.2 cm	3759	3466	3478	3568
	91.4 cm	3824	4475	4007	4102

[1]Hybrids = early, medium, and late maturity groups.

as compared to the medium hybrids with the exception of the last planting date. The sorghum hybrids planted earlier in the growing season were delayed in anthesis due to low soil and air temperatures. This is also apparent in Figure 2.

The comparison of height among three sorghum hybrids are given in Figure 3. The influence of height on the sorghum hybrids was probably related to different maturity classes as well as available moisture and row spacing. The late maturing hybrids, although not always significantly different, were greater in height as compared to the early and medium hybrids. The sorghum hybrids at the 91.4 cm row spacings at each planting date were somewhat taller as compared to the 76.2 cm row spacing.

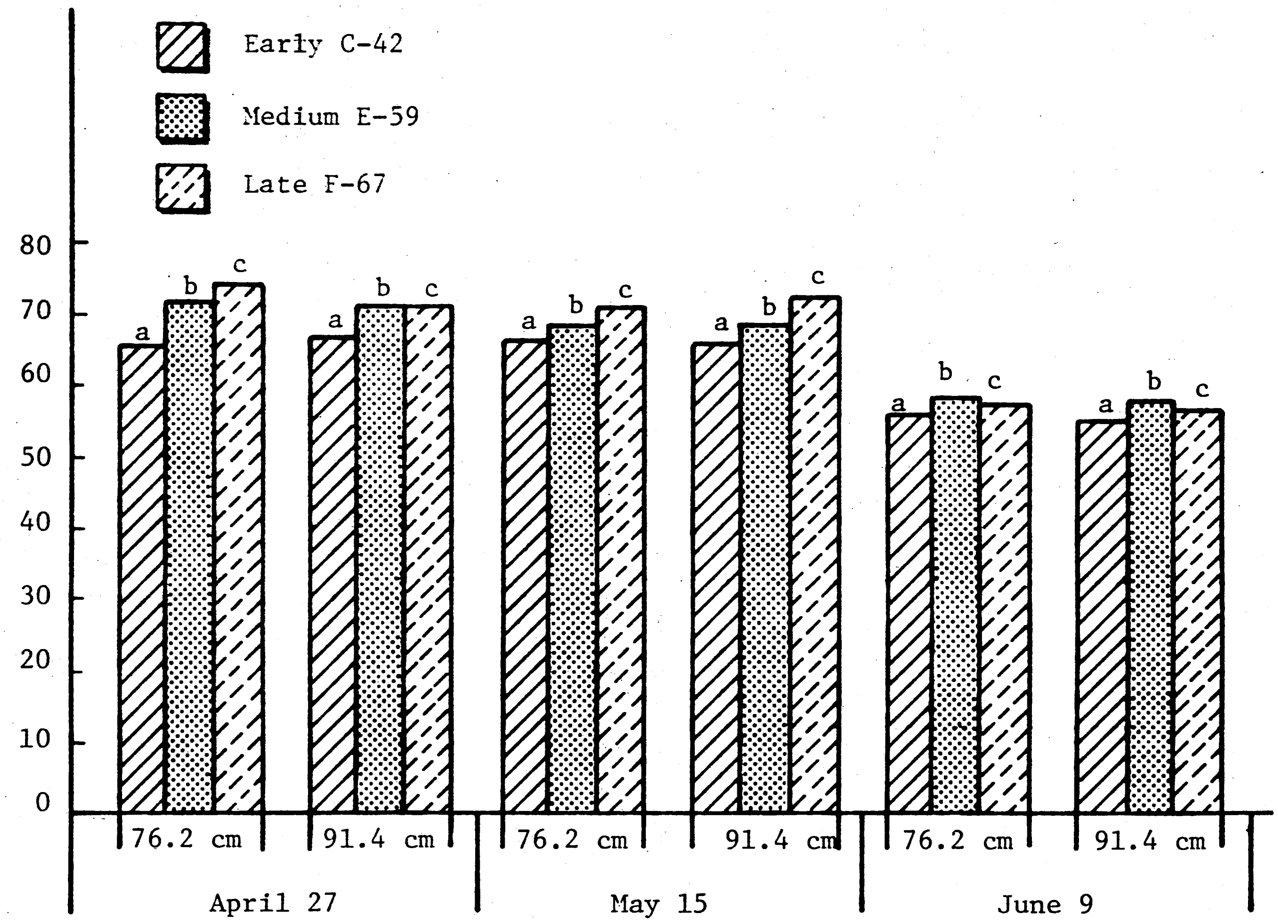

Figure 2. The comparison of midbloom among three sorghum hybrids. A hybrid within a row spacing having the same letter is not significantly different at the 0.05 probability level.

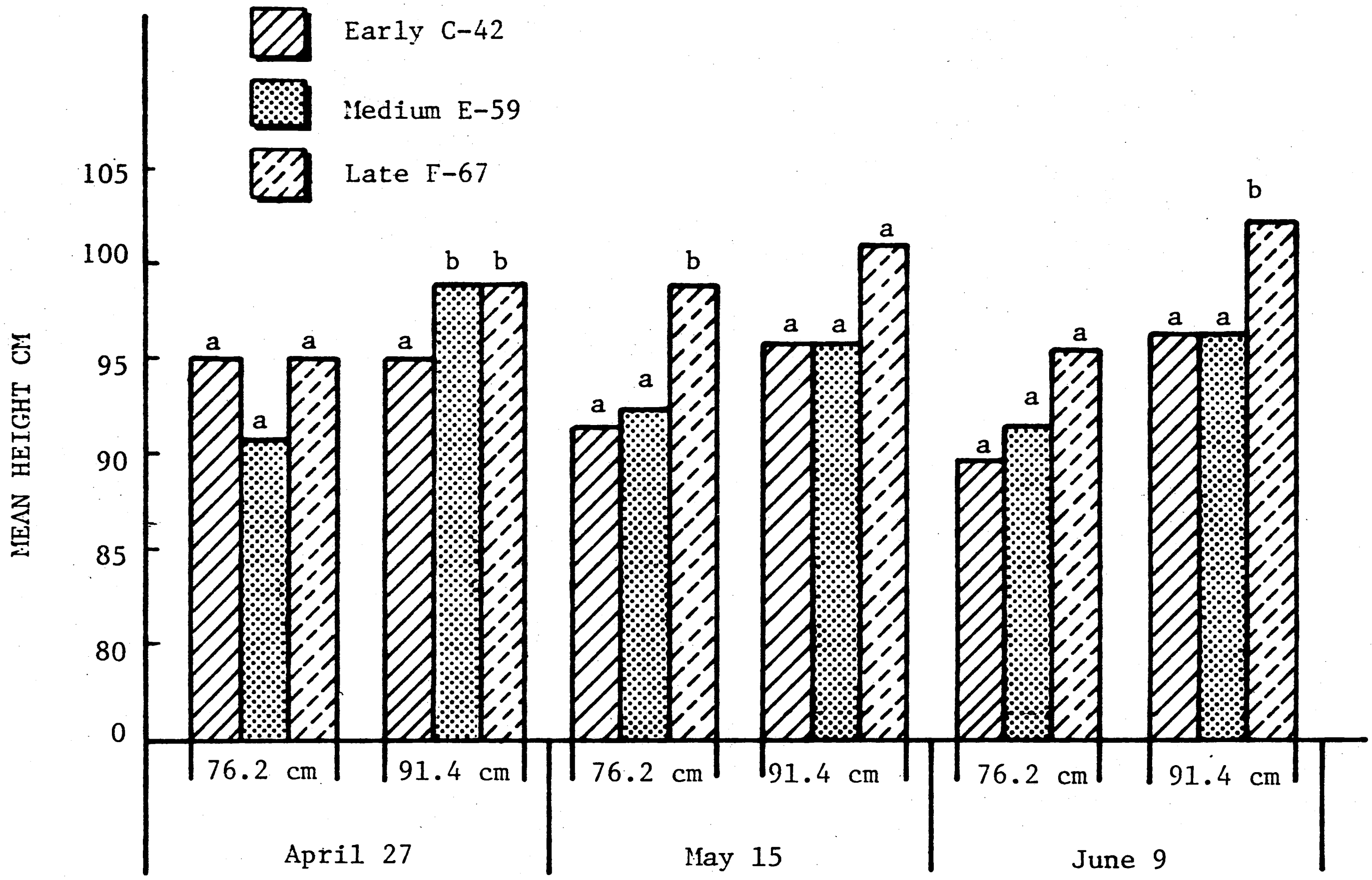

Figure 3. The comparison of height among three sorghum hybrids. A hybrid within a row spacing having the same letter is not significantly different at the 0.05 probability level.

The comparison of lodging among three sorghum hybrids are given in Figure 4. The lodging of the early maturing sorghum hybrids was less in the first planting date at 91.4 cm, but lodging of the early hybrids was significantly more when compared to the medium and late hybrids at the second and third planting dates at both row spacings. This is probably related to the maturity classes of the hybrids and moisture stress.

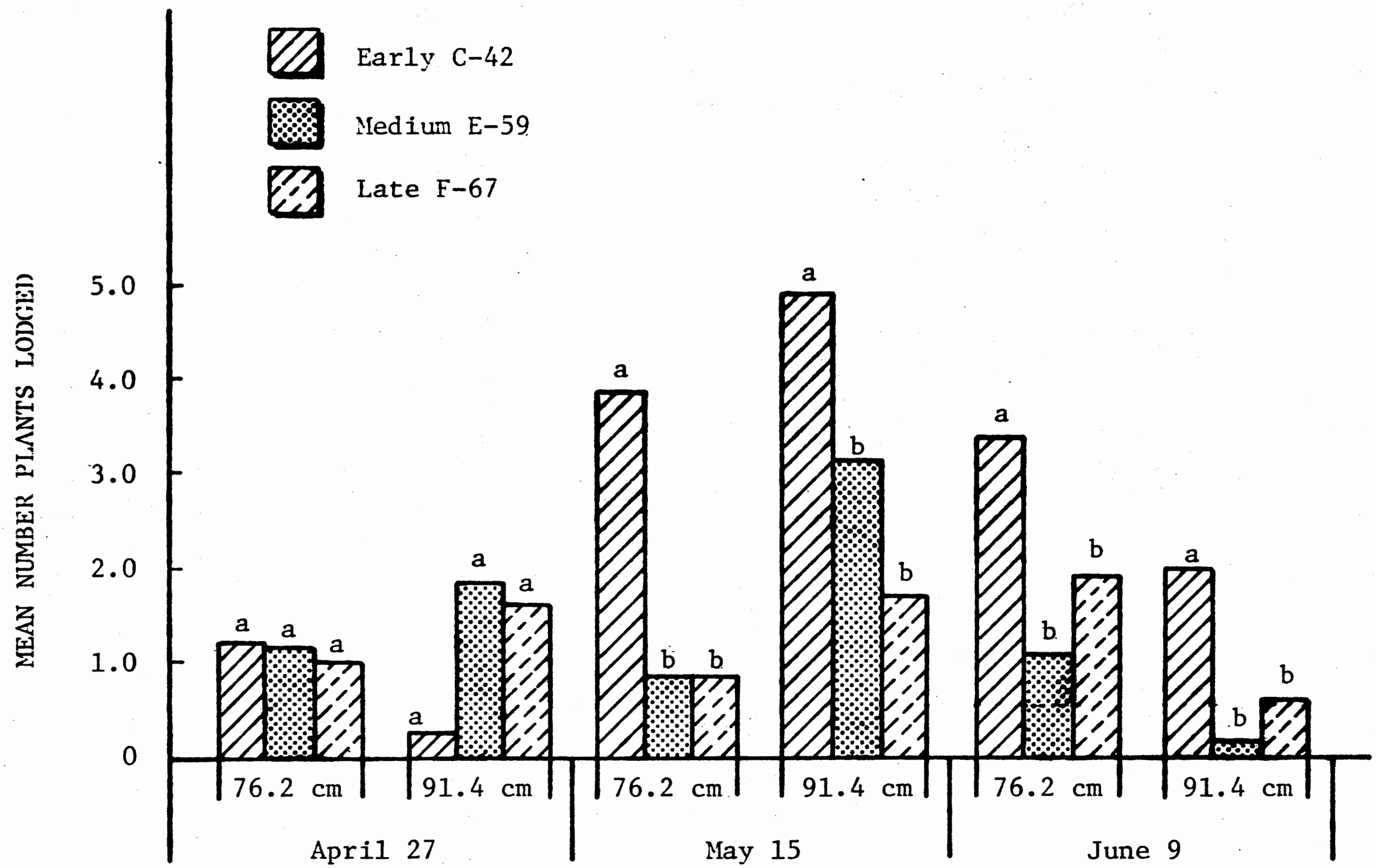

Figure 4. The comparison of lodging among three sorghum hybrids. A hybrid within a row spacing having the same letter is not significantly different at the 0.05 probability level.

CHAPTER V

SUMMARY AND CONCLUSIONS

Three near isogenic pairs of sorghum hybrids were evaluated under certain sorghum cultural practices while exposed to greenbug populations. The experimental design was a split plot design with main plots arranged as randomized complete blocks. The main plots were hybrids and the subplots were insecticide treated versus untreated. There were 3 planting dates, 2 row spacings, 4 replications, and 6 sorghum hybrids.

In the study from one summer of data, it appeared that resistance tended to increase yield as opposed to susceptibility in plants. The use of resistant cultivars significantly increased yield within the first planting date. The first planting date also produced the highest counts of greenbugs during the 1977 growing season.

The lack of moisture during the critical time of anthesis during the second planting date confounded the various interactions. Therefore, no given interaction was found to be significant at the second planting date. Hybrids proved to be the only entry of significance at the 91.4 cm row spacing. The early hybrid was significant over the medium and late hybrids in yield.

The interaction of a medium hybrid, resistant plant, and treated was the second highest in yield on the third planting date at row spacing 76.2 cm. At the 91.4 cm row spacing, the medium hybrid was significantly different as compared to the early and late hybrids.

Treatment, although not significantly different, did help to increase yield over both row spacings. From these indications it would seem that a medium hybrid with resistance and treatment would prove to be useful in increasing yield when greenbug infestations are present.

Altering of planting dates did seem to help in increasing yield. The highest greenbug counts were made on the first planting date whereas the highest grain yields were obtained from the third planting date. More greenbugs were found on the early maturing hybrids and at the wider row spacings. Yield was more dependent on plant maturity than greenbug infestations. Greater yields were obtained from medium and late maturing hybrids. Higher yield was found on the wider row spacings as compared to narrow row spacings. Although more greenbugs were found on the wider row spacings, the increase in yield from the wider row spacing was probably attributed to the less dense plant population of the wider rows and less competition for moisture among plants.

In the course of the study, three important factors led to problems. One of the problems involved was the experimental design in the field. The design of the experiment made it impossible to replicate and randomize planting dates and row spacings in the field of study. Such an attempt made it impossible to prepare proper seedbeds throughout the growing season.

The second problem was the weather. The lack of moisture during the 1976 growing season made it difficult to measure the loss of yield due to the greenbug.

The third problem that occurred was a light infestation of greenbugs during both growing seasons. These problems made it difficult to measure the influence of greenbugs to the economic loss of grain yield. Therefore, from this study, conclusions may only be indications of certain trends.

It would be important for future researchers to randomize all treatments in the experimental design. Research should also be conducted in areas where greenbug populations are normally high. A source of water for irrigation would be useful over periods of limited precipitation.

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TABLE VII

PRECIPITATION[1] FOR EACH MONTH, YEAR, AND LONG TERM AVERAGE, PERKINS, OKLAHOMA

Month	1976	1977	Long Term Average
January	0.00	0.56	3.89
February	1.29	2.95	3.71
March	4.62	6.35	5.59
April	13.06	5.66	8.03
May	7.49	21.49	12.93
June	1.27	4.83	11.63
July	3.91	8.00	8.76
August	4.29	7.32	8.10
September	4.24	4.50	8.08
October	4.62	3.20	8.15
November	0.56	3.94	4.83
December	0.53	0.97	3.61
Total	45.88	69.77	87.31

[1]Measured in centimeters

VITA ∂

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