A STUDY OF GREENBUG RESISTANCE IN SORGHUM PI220248

BY

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A STUDY OF GREENBUG RESISTANCE

IN SORGHUM PI220248

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CHAPTER I

INTRODUCTION

Grain sorghum, Sorghum bicolor (L.) Monech, is an important feed grain of the world and is the staple food source in some countries. The greenbug, Schizaphis graminum (Rondani) has been a destructive insect pest of sorghum since 1968 when a new biotype appeared which could survive on sorghum. It has been estimated that direct damage and indirect control expenses have cost grain sorghum producers in the United States about $12 million per year from 1968 to 1976. The greenbug is also regarded as the most important insect pest of wheat. It is also a pest of oats, barley, and rye and has been reported on more than 60 members of the Gramineae.

Insecticides can be used on sorghum for greenbug control, however, greenbugs have been known to develop resistance to repeated use of insecticides. The safest, most practical, and the most economical type of control is host plant resistance. Through the use of plant resistance the added expense of applying pesticides could be avoided and also the risk of possible toxicity to the crop and the applicator. Also insecticidal control of greenbugs may not be economically feasible in some areas. The use of resistant sorghums could also increase the effectiveness of parasites and predators in controlling greenbug populations. The usage of plant resistance could significantly lower production costs.

The purpose of this study was to determine the nature of inheritance of greenbug resistance in PI220248 to facilitate breeding procedures in developing resistant parents for hybrid production.

CHAPTER II

LITERATURE REVIEW

The Greenbugs

The greenbug, Schizaphis graminum, (Rondani) was first described by Rondani (1852) in Italy. The greenbug was reported on sorghum, Sorghum bicolor (L.) Monech, as 1863 (Webster and Phillips, 1912), but it could not survive beyond one generation. This posed the question whether sorghum could be considered a host plant (Kelly, 1917). This question was resolved in the summer of 1968 when grain sorghum was seriously damaged by the greenbug over extensive areas of the United States. Outbreaks were reported from Arizona, Colorado, Kansas, Nebraska, Oklahoma, South Dakota, and Texas (USDA, 1969). Evidence that a new strain or biotype had developed that could damage sorghum was based primarily on populations being adapted to higher termperatures (Harvey and Hackerott, 1969). Previous outbreaks on small grains had occured during cool months,and when the temperature increased the greenbug populations decreased (Harvey and Hackerott, 1969). This development of a new biotype enabled the greenbug to attack maturing sorghum during July and August and then move to small grains in the fall of the year.

The greenbug is light green in color with a darker mid-dorsal abdominal stripe. Alate and apterous forms may be present in the same colony. The greenbug has piercing-sucking mouth parts and injects a

toxin during feeding (Saxena and Chada, 1971). Because of the presence of this toxin only a very few insects are required to produce plant damage. Females produce living young parthenogenetically (Mayo and Starks, 1972). Greenbugs in culture cages in the greenhouse lay eggs during some periods, but none of the eggs have been observed to hatch (Starks and Burton, 1977). Populations have been reported up to 40,000/plant on sorghum, and it has been estimated that an acre of grain sorghum can harbor several million greenbugs (Starks and Burton, 1977). Due to the greenbugs high parthenogenetic reproductive rate, the chance for genetic variation is very high.

Biotypes

The only reliable method for distinguishing between biotypes of the greenbug is by differential host plant reaction. At present greenbugs can be separated into five biotypes (A,B,C,D, and E).

Biotype A - Biotype A greenbugs were those prevalent in the area before 1958 and for a few years thereafter. The wheat (Dickinson Sel. 28A) (a hexaploid selection from a durum cultivar) was resistant to biotype A (Wood, 1961).

Biotype B - A new biotype appeared in 1958 and Dickinson Sel. 28A was susceptible to it (Wood, 1961). Wood (1961) labeled it biotype B. Biotype B had replaced biotype A in wheat fields in Oklahoma by 1966 (Starks and Burton, 1977). Biotype B was not morphologically or reproductively different from biotype A, however, biotype B differed in its feeding habits (Wood, 1971). Biotype A feeds intercellularly in the phloem tissues of the vascular bundles and biotype B feeds both intra- and intercellularly and prefers the mesophyll parenchyma of the leaf (Saxena and Chada, 1971).

Biotype C - During the summer of 1968 the greenbug attacked several million acres of grain and forage sorghum in all stages of growth in practically all sorghum growing areas of the western United States (USDA, 1969). This was the first wide spread attack on sorghum and it came during the hot summer months. Prior to 1968 the greenbug usually attacked during the cooler months and then disappeared when temperatures increased (Harvey and Hackerott, 1969). The new strain of aphids attacking sorghum was designated biotype C and it was determined to be distinct from biotypes A and B (Harvey and Hackerott,1969). Harvey and Hackerott (1969) separated biotypes B and C by using seedling 'Piper' sudangrass which is resistant to biotype B but susceptible to biotype C. Biotype C feeds in the vascular bundle as does biotype A. The body of biotype C is a much paler green and the cornicles are not so conspicuously black tipped as A or B biotypes (Wood, 1971). Also, biotype C thrives at a higher temperature than does biotype B (Mayo and Starks, 1974).

Biotype D - During the fall of 1973 there were reports from the Texas High Plains of poor control of greenbugs in wheat by disulfoton, an organophosphorus insecticide. Teetes et al. (1975) found that a change had occured in the greenbug of such economic significance that populations sampled indicated a new biotype. They designated the organophosphorus resistant greenbug biotype D. Biotype D has the same host plants as biotype C and would be seperated from biotypes A and B on the basis of host plant reaction as described by Harvey and Hackerott (1969).

Biotype E - In January of 1980 wheat lines resistant to biotype C failed to survive laboratory infestations of a culture of greenbugs collected in November 1979 by N.E. Daniels from a wheat field near

Bushland, Texas. Porter et al. (1982) found that wheats with 'Amigo' and 'Gaucho' resistance, and the octoploid triticale (Tricosecale Wittmark) having the 'Insave' rye genome were all susceptible to this culture. Their studies indicated Insave rye, 'Will' barley and oats which were resistant to biotype C were resistant to the new biotype. 'Largo', an amphiploid of Triticum turgidum and T. tauschii was resistant to the new biotype. Sorghum lines having resistance to biotype C from tunis grass, PI38108, were susceptible, but the sorghums PI220248 and 'Capbam' were resistant. Seedling evaluations of F1 hybrids indicated that the resistance of PI220248 and Capbam was dominant (Johnson et al., 1981a). Porter et al. (1982) concluded in their study that Largo was a useable source of resistance in wheat and that PI220248 and Capbam were useful sources of resistance in sorghum to biotype E greenbugs. Daniels and Chedestar (1981) conducted a biological experiment on reproduction, longevity, and temperature tolerance of biotypes C and E. They found that at higher temperatures, biotype E greenbugs began reproduction at a lower instar age than biotype C. High temperatures did not affect biotype C reproduction. The life span of biotype E was shortened compaired to biotype C under the same temperature conditions. No morphological differences were found to exist.

Sources of Resistance and Inheritance

After the greenbug attacked sorghum in damaging proportions in the summer of 1968 collections of sorghums were screened to find resistance to this new sorghum pest. Wood et al. (1969) found one line (SA 7536-1, a S. virgatum derivative) to have a high degree of tolerance to the greenbug biotype C.

Harvey and Hackerott (1969) screened 648 cultivars and breeding

lines. Greenhouse seedling survival trials indicated two Sorghum virgatum sources (PI38108 and T.S.1636), some of their derivatives, and Sudan-grain (a derivative of Sorghum virgatum) as being resistant to biotype C greenbugs. They studied the inheritance of resistance of a cross of a resistant Sorghum virgatum derivative (H3411), and a susceptible cultivar (KS8A), in F1 and F2 progenies, and the F2 progenies of a cross of two resistant lines (H3411 and Sudan grain). In the F1 and F2 generations of the resistant x susceptible cross they found the F1 and the resistant parent survived 100% while the susceptible parent was killed. Their F2 generations did not deviate significantly from a ratio of 9 resistant to 7 susceptible plants. The F2 generations of a cross of two resistant lines did not segregate. They concluded from their F2 segregation ratios that resistance was controlled by dominant genes at more than one locus. All sources of resistance traced to Sorghum virgatum.

Weibel et al. (1972) conducted a study to determine the inheritance of biotype C greenbug resistance from resistant varieties Shallu Grain (SA 7536-1), PI264453, and IS809. F1 and F2 populations were planted in short rows in flats in the greenhouse. They indicated that the inheritance of resistance probably was controlled by a single incompletely dominant factor. F1 plants gave an intermediate score between resistant and susceptible parents but indicated that one resistant parent in a hybrid could give considerable resistance, and that breeders should have little difficulty transferring this resistance to adapted lines.

Buajarern (1972) studied biotype C greenbug resistance with nine parental lines, three resistant and six susceptible, 21 F1's, 12 F2's, and 18 backcrosses. He found that resistance appeared to be conferred

by an allelic series at the same locus. He found gene actions to be additive, partially, or completely dominant depending on the parents and crosses involved.

In November, 1979 a new biotype (biotype E) was discovered near Bushland, Texas. Porter et al. (1982) evaluated lines for seedling resistance to biotype E. They found that sorghum lines possessing biotype C resistance from tunis grass (Sorghum virgatum) were susceptible, but Sorghum PI220248 and Capbam were resistant to biotype E.

Johnson et al. (1981a) evaluated lines for seedling resistance to biotype E in the greenhouse in 1980. They found three lines, PI220248, PI264453 and Capbam were resistant to biotype E.

Johnson et al. (1981b) evaluated sorghum cultivars subjected to large, natural populations of greenbugs at Halfway, Texas in August, 1980. Two cultivars, PI220248 and Capbam exhibited high levels of resistance to the aphid in the boot stage. Later, seedling evaluations indicated that PI220248, Capbam, PI264453, and TAM Bk 42, a derivative of PI264453, possessed seedling resistance to the aphid. Nonpreference studies, conducted on seedlings in the greenhouse indicated that PI220248, Capbam, and Tx2737 were less preferred than Tx430. Seedling evaluations of F1 hybrids indicated that the resistance of PI220248 and Capbam was dominant.

Starks et al. (1983) preformed greenhouse screening tests with biotype E on previously biotype C resistant lines. They found PI220248, PI264453, and Capban to have a commercially useable level of resistance to biotype E. Other entries were significantly different from their susceptible entry (BOK8), but the level of resistance was too low to allow the selection of plants from a segregating population.

Boozaya-Angoon (1983) studied inheritance of resistance to greenbug

biotype E. She used two resistant lines, PI220248 and PI264453 crossed to susceptible parents. Parental lines, F1's, F2's, and backcross generations were used in the study. She found that resistance to greenbug biotype E was dominant in both parents. Sorghum PI220248 exhibited a higher level of resistance to biotype E than sorghum PI264453. In F2 populations of susceptible x resistant parents resistance appeared to be controlled by a single dominant gene. Both resistant varieties expressed almost the same level of resistance in their F2 populations. Backcross data substantiated the previous conclusion that resistance to greenbug biotype E of PI220248 and PI264453 is controlled by a dominant gene at one locus.

Adult Plant Resistance

DePew and Witt (1979) studied the effects of biotype C greenbug on 13 greenbug-resistant and three susceptible sorghum hybrids during 1976-77. Split-plot experiments consisted of control vs no control of greenbugs. They found that under greenbug attack greenbug-resistant sorghum hybrids out yielded susceptible hybrids. Control of greenbug substantially increased yields of both resistant and susceptible sorghum hybrids over no control.

Hackerott and Harvey (1971) studied the effects of greenbugs on resistant KS30 and susceptible CK-60 sorghum. A split-plot design was used with insects controlled and not controlled. Their data indicated that insecticides would probably not be required to prevent greenbug damage to plants possessing resistance genes from KS30.

Kofoid et al. (1976) studied the relationship of greenbug resistance to various agronomic traits. One hundred greenbug resistant and one hundred susceptible S2 progenies were used. Data collected in the absence

of greenbug infestation indicated that no difference existed between the two populations for any of the traits they studied. The same entries tested in the presence of a greenbug infestation showed the mean of the resistant population to be significantly greater for height, grain yield, grain wt/plant, grain wt/head, and live leaves/plant; and significantly less for greenbug mummies/plant, dead leaves/plant, and damaged leaves/plant. Therefore they concluded greenbug resistance had no deleterious effects upon any of the agronomic traits they studied, but greenbug resistance increased yields of the resistant S2 progenies over the susceptible S2 progenies in the event of greenbug infestations.

CHAPTER III

MATERIALS AND METHODS

The inheritance of resistance of PI220248 was studied by using it as the pollen parent on the following emasculated parents susceptible to biotype E: Shallu Grain, KS30, IS809, BOK8, OKGP14 and OKGP21 (two bloomless lines), OKGP17 (sparse-bloom line),and biotype E resistant PI264453. Parental lines are listed in Table I. The parental lines were planted in five pots each in the sorghum greenhouse in December 1980. In early 1981 plants were hand emasculated and pollen transfered from PI220248. Five different plants of PI220248 were used as a pollen source. F1 seed was harvested from the greenhouse and the F1 generation was grown at the Agronomy Research Station near Perkins, Oklahoma. The parents of each cross were grown on each side of their F1 progeny to verify the integrity of the parents and F1 plants. Panicles were bagged to ensure self fertilization of the F1 plants. Two F1 panicles were selected randomly from each F1 row. The F1's selected were harvested and threshed seperately. The F2 generation was grown in the winter nursery in Puerto Rico. The cross PI220248 x PI264453 was determined to be from selfed seed. The cross was attempted again at the winter nursery. All panicles were bagged in the winter nursery to ensure self fertilization of the F2 plants. Panicles were harvested and threshed seperately. Seed from each F2 plant was stored in paper packets. F3 seed from these packets was used to screen to biotype E greenbugs. The crosses studied are shown in TABLE II.

TABLE I

SORGHUM PARENTS USED

Entry	Parent	Source	Seedling Reaction To Biotype E
1	PI220248	Plant Introduction Station Experiment Georgia	Resistant
2	PI264453	Plant Introduction Station Experiment Georgia	Resistant
3	IS809	Sorghum Improvement Station New Delhi, India	Susceptible
4	KS30	Kansas Agricultural Experiment Station	Susceptible
5	Shallu Grain	Texas Agricultural Experiment Station	Susceptible
6	BOK8	Oklahoma Agricultural Experiment Station	Susceptible
7	OKGP14 (bloomless Redlan)	Oklahoma Agricultural Experiment Station	Susceptible
8	OKGP21 (bloomless ROKY34)	Oklahoma Agricultural Experiment Station	Susceptible
9	OKGP17 (sparse-bloom ROKY47)	Okalhoma Agricultural Experiment Station	Susceptible

TABLE II

CROSSES MADE TO SCREEN TO BIOTYPE E GREENBUG

Entry	Identification	Generation Screened	Designation
1	PI220248-4 x PI264453	F3	Resistant x Resistant
2	IS809 x PI220248-8	F3	Susceptible x Resistant
3	KS30 x PI220248-1	F3	Susceptible x Resistant
4	Shallu Grain x PI220248-6	F3	Susceptible x Resistant
5	BOK8 x PI220248-4	F3	Susceptible x Resistant
6	OKGP14 x PI220248-1	F3	Susceptible x Resistant
7	OKGP21 x PI220248-8	F3	Susceptible x Resistant
8	OKGP17 x PI220248-10	F3	Susceptible x Resistant

Techniques for screening were simular to those described by Starks and Burton (1977). F3 progeny rows were planted in metal flats 35.5 x 50.8 x 9.5 cm filled with a soil, sand, and peat mixture. Ten equally spaced rows 5 cm apart and 2.5 cm deep were made by pressing a planting board on top of the soil mixture. About 25 seeds of each F3 progeny were planted in each row and covered with the soil mixture. Seeds were treated with the fungicide vitavax before planting. In each flat a resistant and suceptible check was planted randomly. Flats were uniformly watered after planting and whenever necessary. The first watering contained a water soluable fertilizer. Tests were conducted in the greenhouse at the USDA-Agricultural Research Service Plant Science Research Laboratory. The greenbugs were cultured in the greenhouse by the USDA-Agricultural Research entomology personnel. Greenbug cultures were maintained on susceptible sorghum planted in 20.32 cm plastic pots with cylindrical plastic cages to prevent contamination from other insects and to confine the greenbugs. When the sorghum plants reached the two-leaf stage, they were infested with all ages of biotype E greenbugs. Flats were checked and were reinfested if needed to produce a uniform infestation. Most of the greenbugs were apterous viviparites. Flats were evaluated when the susceptible check had died. A visual rating of 1 to 6 was used for each plant as follows:

1. no injury
2. chlorosis on one leaf
3. one leaf dying or dead, other leaves showing slight chlorosis
4. half of leaves dying or dead
5. all leaves wilted or dying or dead, growing point still green
6. dead plant

The F3 progeny rows were determined to be resistant, segretating, or susceptible. The expected segregation of F3 progeny rows of a resistant x susceptible cross with one dominant gene for resistance would be 0.25 resistant, 0.5 segregating, and 0.25 susceptible. The chi-square analysis for goodness of fit was used with the assumption that resistance was controlled by a single major gene.

The average damage classes were calculated by multiplying the number of plants by their respective damage scores and dividing the summation of these numbers by the total number of plants. These numbers were calculated separately for the resistant, segregating and susceptible progeny rows for each cross.

CHAPTER IV

RESULTS AND DISCUSSION

There were five different plants of PI220248 used as a pollen source in the crosses. It was later determined that these plants were not all homozygous for resistance. Reminant seed of PI220248-1 was not available for testing, however, it was probably segregating for resistance. The reaction and damage scores of the other four parental plants are shown in Table III. PI220248-4 was determined to be completely susceptible to biotype E greenbugs. PI220248-6 was homozygous for resistance, and PI220248-10 had only three susceptible plants out of 41 tested. PI220248-8 segregated 36 resistant to six susceptible. Due to the nonpurity of the pollen parents an F1 resulting from a cross with a heterozygous parent may or may not have received a gene for resistance.

Frequency distributions of F2 genotypes as determined by the reaction of the F3 progeny rows are shown in Table IV. Within each cross the progeny of each F1 was tested separately. The observed frequencies of the F3 progeny rows of the three crosses IS809 x PI220248-8, Shallu Grain x PI220248-6, and OKGP17 x PI220248-10 were not significantly different from the expected frequencies with one gene segregation. The frequency distributions of the two F3 progenies of the cross OKGP14 x PI220248-1 were not the same. One F3 progeny was completely susceptible while the other fit the expected ratio of one gene segregation. Therefore one of the F1's received a resistant gene but the other did not. Since the

TABLE III

REACTION OF PI220248 AND THE AVERAGE DAMAGE CLASS WHEN TESTED IN THE SEEDLING STAGE TO BIOTYPE E GREENBUG

Entry	Parent	Res.	Sus.	Av. Damage Class[a]
1	PI220248-4	—	15	6.00
2	PI220246-6	32	—	2.32
3	PI220248-8	36	6	2.95
4	PI220248-10	38	3	2.24

[a] 1 = no injury, 6 = dead plant

TABLE IV

FREQUENCY DISTRIBUTION OF F2 GENOTYPES OF SORGHUM
AS DETERMINED BY REACTION OF F3 PROGENY ROWS
TESTED IN THE SEEDLING STAGE
TO BIOTYPE E GREENBUG

Entry	Identification	From F1 Plant	Res.	Seg.	Susc.	P Value[a]
1	PI220248-4 x PI264453	a. Obs.	1	20	30	0.005
		Exp.	12.75	25.50	12.75	
		b. Obs.	5	21	35	0.005
		Exp.	15.25	30.50	15.25	
2	IS809 x PI220248-8	a. Obs.	15	38	28	0.25-0.1
		Exp.	20.25	40.50	20.25	
		b. Obs.	17	22	17	0.5-0.25
		Exp.	14	28	14	
3	KS30 x PI220248-1	a. Obs.	5	32	13	0.05-0.025
		Exp.	12.50	25	12.50	
		b. Obs.	28	23	4	0.005
		Exp.	13.75	27.50	13.75	
4	Sh. Gr. x PI220248-6	a. Obs.	15	39	16	0.75-0.5
		Exp.	17.50	35	17.50	
		b. Obs.	5	23	16	0.1-0.05
		Exp.	11	22	11	

TABLE IV (Continued)

Entry	Identification	From F1 Plant	Res.	Seg.	Susc.	P Value[a]
5	BOK8 x PI220248-4	a. Obs.	0	8	72	0.005
		Exp.	20	40	20	
		b. Obs.	0	10	69	0.005
		Exp.	19.75	39.50	19.75	
6	OKGP14 x PI220248-1	a. Obs.	0	0	100	0.005
		Exp.	25	50	25	
		b. Obs.	20	41	29	0.5-0.25
		Exp.	22.50	45	22.50	
7	OKGP21 x PI220248-8	a. Obs.	0	26	60	0.005
		Exp.	21.50	43	21.50	
		b. Obs.	6	40	44	0.005
		Exp.	22.50	45	22.50	
8	OKGP17 x PI220248-10	a. Obs.	13	37	12	0.5-0.25
		Exp.	15.50	31	15.50	
		b. Obs.	11	34	24	0.1-0.05
		Exp.	17.25	34.50	17.25	

[a] Calculated by chi-square on the basis that the parents are differentiated by one major gene.

PI220248-4 pollen parent did not contain a resistant gene then the cross BOK8 x PI220248-4 was largely susceptible. The cross OKGP21 x PI220248-8 did not fit the expected ratio, and it had a predominance of susceptible plants. This could be due to PI220248-8 segregating for resistance. The KS30 x PI220248-1 cross had a predominance of resistant plants in one F3 progeny. This type of deviation can occur by chance when screening to greenbugs. At different temperatures the host-pest relationship can be different. The PI220248-4 x PI264453 cross was expected to be all resistant in the F3, since both parents were reported to be resistant to biotype E. However, the PI220248-4 male plant was susceptible (Table III) and the source of PI264453 was almost completely susceptible. (See Table V for reaction of female parents.) Therefore the PI220248-4 x PI264453 cross had a predominance of susceptible plants.

An average damage score was calculated from the scores for all the F3 rows classified as resistant for cross PI220248-4 x PI264453 a and b. A similar calculation was done for those rows classified as segregating and for susceptible. These same calculations were done for all other crosses (Table VI). Of the resistant progeny rows the cross OKGP17 x PI220248-10 had the lowest damage score and OKGP21 x PI220248-8 had the highest. The PI220248-10 resistant parent also had the lowest damage score (Table III). The overall average damage score of the resistant progeny rows was 2.90 and the overall damage score of the susceptible rows was 5.50. The overall damage score of the segregating rows fell in between these two as expected.

TABLE V

REACTION OF EMASCULATED PARENTS AND THE AVERAGE DAMAGE CLASS WHEN TESTED IN THE SEEDLING STAGE TO BIOTYPE E GREENBUG

Entry	Parent	Res.	Sus.	Av. Damage Class[a]
1	PI264453	11	128	5.78
2	IS809	—	91	5.84
3	KS30	—	89	5.56
4	Shallu Grain	—	98	5.04
5	BOK8	—	90	5.77
6	OKGP14 (bm bm)	—	89	5.76
7	OKGP21 (bm bm)	—	93	5.25
8	OKGP17 (h h)	—	78	5.80

[a] 1 = no injury, 6 = dead plant

TABLE VI

AVERAGE DAMAGE SCORES OF THE F3 PROGENY ROWS CLASSIFIED AS RESISTANT, SEGREGATING, AND SUSCEPTIBLE TESTED IN THE SEEDLING STAGE TO BIOTYPE E GREENBUG

Entry	Identification	Gen.	From F1 Plant	Res. [a]	Seg. [a]	Susc. [a]
1	PI220248-4 x PI264453	F3	a.	2.95(1)[b]	4.03(20)[b]	5.76(30)[b]
			b.	3.09(5)	3.92(21)	5.49(35)
2	IS809 x PI220248-8	F3	a.	2.78(15)	3.80(38)	5.40(28)
			b.	2.49(17)	3.64(22)	5.39(17)
3	KS30 x PI220248-1	F3	a.	3.00(5)	4.03(32)	5.43(13)
			b.	3.00(28)	3.66(23)	5.38(4)
4	Sh. Gr. x PI220248-6	F3	a.	2.85(15)	3.69(39)	4.95(16)
			b.	2.90(5)	3.74(23)	4.69(16)
5	BOK8 x PI220248-4	F3	a.	----(0)	4.09(8)	5.86(72)
			b.	----(0)	4.38(10)	5.76(69)
6	OKGP14 x PI220248-1	F3	a.	----(0)	----(0)	5.79(100)
			b.	2.57(20)	3.84(41)	5.74(29)
7	OKGP21 x PI220248-8	F3	a.	----(0)	4.38(26)	5.78(60)
			b.	3.37(6)	4.29(40)	5.67(44)
8	OKGP17 x PI220248-10	F3	a.	2.35(13)	3.78(37)	5.49(12)
			b.	3.00(11)	4.04(34)	5.51(24)
			$\overline{X}$	2.90	3.95	5.50

[a] 1 = no injury, 6 = dead plant

[b] Number of rows scored in parentheses

CHAPTER V

SUMMARY AND CONCLUSIONS

A study was initiated to determine the inheritance of resistance of PI220248 to biotype E of the greenbug. PI220248 was crossed on to one resistant and seven susceptible lines. F3 progeny rows were used to determine the F2 genotypes. F3 progeny rows were infested with greenbugs at the two-leaf stage and damage ratings were taken when a susceptible check had died. Plants were scored on a scale of one to six with one equal to no damage and six to a dead plant.

Results from F3 progeny rows indicated resistance to biotype E in PI220248 was probably controlled by a single dominant gene. The susceptibility among some F3 progeny rows and the resistant x resistant cross was thought to be caused by impurity of some of the resistant lines used. When resistant plants can be identified there should be little difficulty in developing sorghum varieties resistant to biotype E.

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