STUDY OF THREE BACTERIAL DISEASES OF SORGHUM

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OF SORGHUM

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CHAPTER I

INTRODUCTION

The sorghums are members of the grass family, Gramineae, which has been further divided into two sub-families (12). The sub-family, Panicoideae, includes the tribe Andropogoneae in which the sorghums are grouped, and the sub-family, Festucoidae, in which many of the common cereals such as wheat, barley and oats are classified (37).

Cultivated sorghums probably originated in east central Africa, in or near Ethiopia or Sudan, because of the great diversity of types growing in that region (3,36). Most of the evidence today points to Abyssinia as the place of origin of sorghums as a cultivated crop. From Africa, it was probably transported to Arabia, then to India and later to China (3). Sorghum was first brought into the United States and grown along the Atlantic coast about the middle of the last century. From there, sorghum was carried westward to drier regions and before 1900 it was well established in the southern Great Plains and in California. Grain sorghums in the United States are grown extensively in areas too hot and too dry for corn. In humid areas the grass and sweet sorghums are grown for forage and syrup (25).

Production of sorghum is a large scale operation all over the world, and sorghum cultivation is a very important step in solving the problems of hunger in the developing countries. In the United

States most of the production is concentrated in the southwest and the bulk of the crop is used for livestock feed. In 1977, Oklahoma ranked fourth in the United States in production of sorghum grain with 21,470 million bushels on 565,000 acres, the crop ranked fourth among Oklahoma crops with a value of $25,749,000. The price of sorghum has decreased substantially since 1974 when sorghum grain reached the highest price in the last 10 years.

There are many diseases that impose a threat to the stability of production of the sorghum crop. Among the wide variety of diseases which attack the sorghums, the bacterial diseases are probably the least known. Even though the bacterial diseases are rarely reported to cause heavy losses (4,5,6,14) they still may be economically important. Heavy losses are rare but the fact that they can occur means the disease could reach epidemic proportions. Bacterial diseases have been found in varying amounts in almost every field since grain sorghum were first planted, and are equally prevalent in the forage sorghums.

Symptoms of streak and stripe are similar, but stripe usually has the longer lesions. Spots also occur and are very distinctive symptoms; small spots later may unite to form a stripe. The sheath and blade of a leaf may be heavily invaded with any one of the bacterial diseases considered in this study, and may spread rapidly by rain. The bacteria are often carried on the seed.

In most cases it is difficult to measure an effect on yield. Yield losses probably are not generally significant but heavy losses sometimes occur (30).

CHAPTER II

LITERATURE REVIEW

Species of sorghum have been shown to be susceptible to a number of bacterial diseases, but this study is concerned only with the most common of these: bacterial leaf spot caused by Pseudomonas syringae Van Hall, bacterial leaf stripe caused by Pseudomonas andropogonis (E. F. Sm.) Stapp., and bacterial leaf streak caused by Xanthomonas holcicola (Elliott) Starr and Burkholder. Pseudomonas andropogonis is probably most wide spread and severe in the United States of America (37). All three of these pathogens have more or less world-wide distribution having been reported from many countries of the world (United States of America, South and Central America, Australia, Nigeria, South Africa, Formosa, China and others) (6,7,8,13,15,16,17,18,30), and attack sorghum, sudangrass, Johnsongrass, and broom corn (23,24,26,28,34,35).

There are several Pseudomonas and Xanthomonas species which are able to attack sorghum. Many of them produce similar disease symptoms in artificially inoculated sorghum as well as in the field (2,11). Numerous studies have been made to try to differentiate these pathogens (9,10,11,32). One of these studies in 1972 reported,

> Eighteen cultures of six Pseudomonas species which produce similar symptoms in artificially inoculated sorghum were differentiated on morphological, cultural, and biochemical characters. Two cultures received as P. andropogonis and P. alboprecipitans were identified as P. rubrisubalbicans and P. rubrilineas respectively (11, p. 448).

Another study in 1962 reported,

> A comparative study has been made of 209 phytopathogenic Xanthomonas cultures comprising 57 recognized species, using the so-called standard methods in an attempt to clarify the identification of the species by laboratory procedures. The various species that have been proposed could not be differentiated by any of all of the 30 different tests used. They form a remarkably uniform group which could easily be distinguished from some other yellow pigment producing organisms that were included for comparative purposes. It is suggested that the many Xanthomonas species could well be regarded as special forms of one species adapted to particular host (2, p. 393).

Based on this information it is the opinion of the author that in many cases some of these pathogens are mis-identified due to the similarities of the symptoms and the problems involved in identification.

Bacterial stripe attacks the leaves and leaf sheaths and may spread to the stalks. When young the lesions are narrow, pigmented intervenial stripes only a few mm in width but which may reach 50 centimeters or more in length.

Lesions caused by bacterial streak are generally not as long or liniar as those of stripe. Also, early stages of streak lesions show water soaking, whereas those of stripe do not. A pigmented, crusty exudate is usually found on lesions of bacterial stripe and a cream colored exudate is usually associated with lesions of bacterial streak, but exudate is not found associated with bacterial spot (28).

In color, these symptoms vary considerably according to cultivar of host plant. Shades from light brown to dark purplish-red may occur. However, in any given cultivar the color is fairly constant. The pathogen of bacterial spot, Pseudomonas syringae, causes a variety of

symptoms in its numerous host plants. It usually attacks leaf, stem, flowers and buds. This pathogen attacks: sorghum, wheat, pears, citrus, avocado, legumes, stone fruit, peaches, hibicus, and many others (13,20,21,29).

On susceptible grass host, P. syringae, causes leaf spotting. The leaf lesions are at first dark green and water-soaked in appearance, soon becoming reddish, and finally dry and light-colored in the center with narrow reddish borders. Lesions of bacterial spot are elliptical, rarely exceeding 10 mm in diameter. Leaf spotting begins on the lower leaves and under suitable climatic conditions spreads to upper leaves as the plant approaches maturity (32).

CHAPTER III

MATERIALS AND METHODS

Isolation of Pathogens

Bacteria were isolated from lesions on sorghum and Johnson grass leaves collected in several locations in Oklahoma (Stillwater, Perkins, and Enid), New Mexico (Clovis), Texas (College Station and Corpus Christi). The isolate, K-1, of the bacterial leaf streak pathogen obtained from Dr. Joe Martin, Kansas State University, Hays, Kansas, also was used.

Three isolates were made from material collected in Oklahoma, bacterial leaf spot and bacterial leaf streak from sorghum leaves, and bacterial leaf stripe from Johnson grass leaves. All had typical symptoms. From New Mexico, one isolate of bacterial leaf stripe was made from typical symptoms on leaves collected from a commercial field of sorghum. From Texas, two isolates of bacterial leaf spot were made. One was from College Station and the other from Corpus Christi. Both were from leaves collected in commercial fields of sorghum (1).

All isolates were tested for pathogenicity on sorghum cultivars (Sumac, Red Amber, White Kafir, Sunrise) reported in the literature as susceptible and only Wonder Club reported in the literature as resistant.

All seed were planted in pots, 15 cm. in diameter, 5 seeds per/ pot. The experiments were made in growth chambers where the temperature was controlled by thermostat at $\pm$ 1°C. The relative humidity was controlled by putting different amounts of water inside of a humidifier, according to the level of humidity desired. When the water had all evaporated from the humidifier the relative humidity would remain constant at a given level so long as the chamber remained closed. After several trails the relative humidity could be maintained at the desired levels within $\pm$ 5%.

Methods of Inoculation

In order to determine the most efficient method of inoculation, experiments were made using various methods as follows:

1. Spraying the leaves with the suspension of bacteria in distilled water by means of an atomizer after which the leaves were injured with a needle. The bacteria were grown on nutrient agar 24-48 hours. Then the cultures on agar were washed with 5 ml of steril distilled water and this solution used to inoculate 10-days old plants planted in 15 cm. pots, with 3 pots for each treatment.
2. Dusting the leaves with carborundum (600 mesh), followed by spraying the leaves with the bacterial suspension, and then the leaves were rubbed gently with the fingers.
3. Water-soaking the leaves with a suspension of bacteria in distilled water by using a syringe. No further injury to the leaves was made.

4. Spraying the leaves with a 24-hour old culture of bacteria in nutrient broth. No injuries were made to the leaves.

Testing of Cultivars

The isolate, K-1, of bacterial leaf streak obtained from Dr. Joe Martin was highly pathogenic, and was used to test cultivars and selections of sorghum for diseases reaction. Three hundred eighty-five cultivars and lines of sorghum were tested (38). These cultivars and selections were planted in flats 31 x 8 x 25 cms. with 30 entries of 10 seeds per flat. These flats were placed in a growth chamber at 80^{o}F and with a day length of 14 hours. Relative humidity was controlled at 95% or higher as described previously. The seedlings were inoculated 10 days after planting with a 24-hour old culture of the bacteria in nutrient broth and which numbered approximately 1×10^{8} bacteria/ml. The nutrient broth was sprayed on uninjured leaves with an atomizer.

CHAPTER IV

RESULTS AND DISCUSSION

All Oklahoma isolates of bacterial leaf spot (Pseudomonas syringae) and bacterial stripe (Pseudomonas andropogonis) proved highly pathogenic and produced distinctive symptoms in susceptible sorghum seedlings. The bacterial leaf streak pathogen (Xanthomonas holcicola) did not produce any sumptoms even though it was isolated from a very distinctive symptom on sorghum leaves. The isolate of bacterial leaf stripe from New Mexico was highly pathogenic on the varieties tested. Of the two isolates of bacterial leaf spot from Texas, only the Corpus Christi isolate was pathogenic.

Effect of Temperature and Humidity on Infection

In order to determine the best condition of humidity and temperature for the bacteria to produce infection the following experiment was made. Five cultivars of sorghum were used: Red Amber, White Kafir, Sunrise, Sumac, and Wonder Club. All seeds were planted in clay pots 15 cm in diameter, five seeds per/pot, three pots for each treatment, two replications and one check. The temperatures used were $13^{o}C$, $16^{o}C$, $27^{o}C$, $32^{o}C$, and $35^{o}C$, the levels of humidity used were

55%, 60%, 80%, 90% and 95%. Temperature and humditiy were maintained at the desired levels as described previously.

In all cases, plants were kept in a chamber no longer than five days after inoculation except for those at 13°C in which case the plants were kept for nine days.

Results are given in Table I. Good infection was obtained within a range of temperature from 16°C through 32°C, but only when the relative humidity was 95% or more.

In this study it was found that the temperature was not a critical factor, but that humidity had to be above 95% or no infection was produced. When the temperature was above 90°F and the humidity near 100%, leaves developed tip and marginal burn.

Below 60°F, the plants grew very slowly and infection did not occur. The best interaction of host parasite was at 80°F and above 95% humidity. All isolates were tested in the same manner and the results were the same in each case.

Methods of Inoculation

The four methods of inoculation tested produced approximately the same results. Symptoms generally appeared on most cultivars in approximately 2-4 days after inoculation when the temperature was maintained at 80°F and the relative humidity near 100% for a period no shorter than 24 hours after inoculation. The response time varied somewhat with the cultivar, and in some cases did not appear until eight days after inoculation. The easiest and most efficient method was to simply spray with a nutrient broth culture.

TABLE I

INFECTION OF SORGHUM WITH THE BACTERIAL LEAF STRIPE PATHOGEN AT VARIOUS LEVELS OF TEMPERATURE AND HUMIDITY

Varieties	Humidity	13°C	16°C	27°C	32°C	35°C
Sumac	55%	-[1]	-	-	-	-
Red Ambar	55%	-	-	-	-	-
Wonder Club	55%	-	-	-	-	-
Sunrise	55%	-	-	-	-	-
White Kafir	55%	-	-	-	-	-
Sumac	60%	-	-	-	-	-
Red Ambar	60%	-	-	-	-	-
Wonder Club	60%	-	-	-	-	-
Sunrise	60%	-	-	-	-	-
White Kafir	60%	-	-	-	-	-
Sumac	80%	-	-	-	-	-
Red Ambar	80%	-	-	-	-	-
Wonder Club	80%	-	-	-	-	-
Sunrise	80%	-	-	-	-	-
White Kafir	80%	-	-	-	-	-
Sumac	90%	-	-	-	-	-
Red Ambar	90%	-	-	-	-	-
Wonder Club	90%	-	-	-	-	-
Sunrise	90%	-	-	-	-	-
White Kafir	90%	-	-	-	-	-
Sumac	95%	-	+	+	+	-
Red Ambar	95%	-	+	+	+	-
Wonder Club	95%	-	-	-	-	-
Sunrise	95%	-	+	+	+	-
White Kafir	95%	-	+	+	+	-

[1] - = no symptoms; + = symptoms.

With any of these methods of inoculation the shape of lesions varied with the cultivar in the early stages of infection, but in all cases typical symptoms (of spot, streak and stripe) developed in later stages of disease development.

Testing of Cultivars

Once an efficient method of inoculation had been found, and the environmental conditions necessary for infection were established, a large scale test of disease reaction to bacterial streak was made. The results of this test of 385 cultivar and selections are given in Table II. The plants were examined each day and the first appearance of symptoms after inoculation was recorded.

Ten days after inoculation the severity of the symptom expression was noted. Each entry was classified on a scale from 1 to 4, where 1 = highly resistant (HR), 2 = moderately resistant (MR), 3 = moderately susceptible (MS), and 4 = highly susceptible (HS).

TABLE II

RESULTS OF VARIETIES TESTED

Entry Number	Cultivar or Selection	Days to First Symptom[1]	Disease Rating[2]
1	DwF. Milo CI332	4	2
2	Dwf. Milo R-332	3	3
3	D.D.R.-332	4	3
4	Texas Milo T.S. 338	4	3
5	Std. Yel. Milo #234	3	2
6	D.D. Yel. Milo #868	3	3
7	D.D. Yel. Milo	3	3
8	Ea. Wh. Milo #480	3	3
9	Std. Wh. Milo #352	2	3
10	Dwf. Wh. Milo #627	2	4
11	D.D. Wh. Milo	2	3
12	Sooner Milo #917	2	3
13	Sooner Milo	3	3
14	Sooner Milo GC 241	3	3
15	D.D. White Sooner	3	2
16	D.D. Yel. Sooner	3	2
17	Day Milo CI 959	4	3
18	Bonar X-Day-4	5	2
19	480x332-51(Ea.Wh.Milo x D.Milo)	5	2
20	Colby Milo CI 1118	4	3
21	Resistant Colby	5	1
22	Ryer Milo #15	4	4
23	Resistant Pygmy	5	3
24	Manko Milo	6	2
25	Fargo #809	3	3
26	Sweet Milo	4	3

TABLE II (Continued)

Entry Number	Cultivar or Selection	Days to First Symptom[1]	Disease Rating[2]
27	Atlands Milo	5	1
28	Beaver Milo CI 871	4	3
29	Rest Beaver GC 38276	3	3
30	Beaver Sel #225-3-1	3	2
31	KxM-82-6 #1090	3	3
32	Kafir x Milo	3	3
33	KxM-8-2-26 (off type)	3	3
34	Smiths MxK C.I. 808	3	4
35	Wheatland CI 918	2	4
36	Dalhart Wheatland	4	3
37	Wheatland GC 38288	3	3
38	White Wheatland	2	3
39	Martin	3	4
40	White Martin	2	4
41	Westland GC 38296	4	3
42	Midland	2	4
43	Plainsman	3	4
44	Caprock	2	4
45	Redbine 60	2	4
46	Redbine 66	2	4
47	Comb 7078	5	1
48	Chinch bug rest comb.	3	3
49	696 x 332 (Pig Nose Durra D.Y.M.	3	3
50	Club Day 16 x 338-4	3	3
51	Club x Day 16	-	-
52	Ea. Kalo CI 1009	2	4
53	Kalo CI 902	4	2
54	Reliance	2	4

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom [1]	Disease Rating [2]
55	Std. Blackhull Kafir CI 71	2	4
56	Blackhull Kafir CI 204	2	4
57	Lowe Blackhull Kafir	2	3
58	Sol, Kafir	2	4
59	Pink Kafir CI 432	2	4
60	White Kafir	2	4
61	Western Blackhull Kafir CI 906	2	4
62	Texas Blackhull Kafir CI 865	2	4
63	Sharon Kafir	2	4
64	Sante Fe Kafir	2	4
65	Reed Kafir CI 628	2	4
66	Bishop Kafir CI 814	2	4
67	Dwf. Bishop	2	4
68	Hydro Kafir CI 1023 (Okla. Blackhull)	2	4
69	Pearl Kafir	2	4
70	Rice Kafir	3	4
71	Corneous Kafir	3	2
72	Pierce Kafir	2	4
73	Wonder Kafir CI 872	3	3
74	Club Kafir CI 901	2	3
75	Wonder Club	-	1
76	Cody Kafir	-	1
77	71 x Leoti-2-7	4	3
78	Dawn Kafir CI 340	2	4
79	White African Kafir CI 633 II	2	4
80	Sunrise Kafir CI 472	-	-
81	Bird Proof Kafir #662	2	4
82	Witch Weed Rest Kafir	3	3

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom[1]	Disease Rating[2]
83	Buckskin Kafir	4	3
84	Marum Kafir CI 556	4	3
85	Greely Kafir CI 972	2	3
86	Weskan Kafir CI 1117	4	2
87	Tricker Kafir	6	1
88	Cheyenne Sweet Kafir	2	3
89	Highland Kafir	4	2
90	Improved Coes	-	2
91	Coes	-	1
92	Dwf. Freed CI 971	-	1
93	Freed Sorgo CI 350	2	4
94	Sedan Red Kafir CI 1103	2	4
95	Ea. Red Kafir CI 866	2	4
96	Red Kafir	2	4
97	Red Kafir CI34	2	4
98	Red Kafir 4-B	2	4
99	Tall Red Kafir #7	2	4
100	Dwf. Mutant Red Kafir	2	3
101	Tall Mutant White Kafir	2	3
102	Texioca 54	-	1
103	Texica 63	-	1
104	Miloca	-	1
105	Schrock-Ellis Ks 51M432	-	1
106	Westland x Cody	-	1
107	Midland x Waxy Kafir SA 5874-6-1-3-4	-	1
108	Waxy x Dwarf	-	1
109	#1 Parent	6	1
110	Custer	4	2

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom[1]	Disease Rating[2]
111	Dwf. Ea. Red Kafir 8-2	2	3
112	Dwf. Red Kafir 4-1-4	3	3
113	Redlan	2	3
114	Dwf. Kafir 44-14 CI 340	4	2
115	Dwf. Kafir 24-43	5	2
116	Comb Kafir-60	4	2
117	Edwards (white combine)	-	1
118	Comb Kafir 54T	-	1
119	Red Comb (tan) SA 5874-33-3-1	-	1
120	Red Comb SA 5507-31-3-5-1	-	1
121	Milo x Hegari 10-1	-	1
122	Migari 11-2	-	1
123	Migari	-	1
124	Darso #615	-	1
125	Darso OK #1	-	1
126	White Darso	4	2
127	Darset	5	2
128	Yellow Darso	6	2
129	Feterita CI 182	3	4
130	Feterita CI 693	2	4
131	Feterita CI 745	2	4
132	Dwf. Feterita	2	4
133	Dwf. Feterita	2	4
134	Dwf. Feterita	2	4
135	D.D. Feterita	2	4
136	Spur Feterita CI 623	2	4
137	Cacha Feterita	2	4
138	Red Feterita CI 693-R	2	4
139	White Feterita CI 755	4	3

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First[1] Symptom	Disease[2] Rating
140	Dwf. White Feterita	3	3
141	Kaferita CI 811	2	4
142	Kaferita CI 812	2	4
143	Dwf. Brown Kaferita	2	4
144	Chiltex CI 874	2	4
145	Prema CI 873	2	4
146	Bonita	5	3
147	Ajax CI 968	3	3
148	Gurno	5	3
149	Cody x Dwh. Fet-1 (RWD1)	5	1
150	White Durra CI 81	6	2
151	Calif. Wh. Durra	6	2
152	Dwf. Wh. Durra CI 977	7	1
153	Bonar Durra	7	2
154	Red Durra	6	3
155	Corneous Durra CI 695	?	3
156	Pig Nose Durra CI 696	2	4
157	Chicken Maize	6	2
158	Kashakashi	4	4
159	Hegari CI 750	2	4
160	Ea. Hegari SA 281	2	4
161	Ea. Hegari T.S. 25240	2	4
162	D.D. Ea. Hegari	2	4
163	Ladore	2	3
164	Norkan HC 381	3	2
165	Atlas CI 899	3	2
166	Ellis	5	1
167	Dwf. Ellis	-	1
168	Leoti x Atlas H.C. 34358	-	1

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom[1]	Disease Rating[2]
169	Jap Dwf. Kaoliang CI 1332	-	2
170	Shantung Kaoliang CI 293	7	1
171	Blackhull Kaoliang CI 310	3	3
172	Early Kaoliang CI 791	7	1
173	White Kaoliang #46676	-	1
174	Tall White Kaoliang CI 792	3	2
175	White Kaoliang 603	4	2
176	Tull Kaoliang	-	1
177	Manchu Kaoliang CI 171	-	1
178	Valley Kaoliang CI 309	7	1
179	Brown Kaoliang FPI 46677	5	2
180	Broom Kaoliang CI 799	-	1
181	Blk Jap Kaoliang	4	2
182	Brown Kaoliang x Sudan-1	4	2
183	Wild Amber	2	3
184	Early Amber	2	3
185	Black Amber	2	3
186	Red Amber FCI 9092	2	3
187	Dalhart Ea. Sumac	2	3
188	Kansas Ea. Sumac	3	4
189	Sumac FPI 35038 (6550)	3	3
190	Sumac FCI 1712	3	3
191	Sumac FPI 63715	3	3
192	Yellow Sumac WD 97-14	2	3
193	Rox Orange	3	3
194	Cron's Orange	-	1
195	Kansas Orange	4	3
196	Early Orange	2	3
197	African Millet Sorgo	2	3

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom[1]	Disease Rating[2]
198	Sourless Sorgo FCI 9111	3	2
199	Wh. Suan. Col. x Leoti	4	2
200	Leoti Sorgo FCI 6610	-	1
201	Sorgo CI 660	-	1
202	Freemont	5	2
203	Red X	2	4
204	White African	5	2
205	Red X	4	3
206	Tracy	3	3
207	Iceberg	3	4
208	Williams	4	4
209	Blue Ribbon	3	4
210	Collier Sorgo	2	4
211	Tan Sugar Drip	-	1
212	Sugar Drip	4	3
213	Honey Drip	4	3
214	Bug-Rest-Honey	-	1
215	Collier	6	2
216	85 X 813-14	-	1
217	Red Amber x Feterita	2	4
218	Leoti x Feterita HC 3429	-	1
219	K.O. x D.Y. Mito KS 24136	4	3
220	Dawn x (K.O.X. Milo)	4	3
221	Shallo CI 85	8	1
222	Grohoma CI 920	5	2
223	Tall White Sorghum	3	3
224	Corneous Sorghum	3	4
225	D.O. Schrock SA 6638-31-1-2	3	4
226	Schreek #616	2	4
227	Combin Sargrain	3	4

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom	Disease Rating
228	Sagrain	4	4
229	Sedan grain SA 6552-7-5-2	-	1
230	Tunis grain SA 6223-2-4-4-5	-	1
231	Rancher	6	2
232	Grain-O-the Plains	-	1
233	Early Juicy	-	1
234	Norghum	6	2
235	Winner	7	1
236	D.D.Ea. Shallo SA 6399-3	8	1
237	Shallu grain SA 7536-1	2	4
238	Cim. Co. Grain	-	-
239	Darso (Jesse Sel-Dawnee)	8	1
240	Brawley	-	1
241	Wiley	-	1
242	White Collier	-	1
243	Darso x #1	4	2
244	Dwarf Darso	3	2
245	Highland x Dwf. Darso - 5-1-1	4	2
246	Bonar-Day x Darso - 2-2-1-1	5	2
247	Darset	3	3
248	Y. Darso x Darset	8	1
249	Ea. D.K. (918 x 71-27-2)	5	2
250	Waxy D.K. x 1023-1	4	2
251	Waxy D.K. x 1023-12-1	6	1
252	Waxy Sweet x Highland-1-1-1	6	1
253	Waxy Sweet x Highland-1-2-1	5	2
254	Dwf. Hydro x Brittle G1-1-2-1	-	1
255	Dwf. Red x Dwf. Hydro-Rice	3	2
256	Til K x 44 xy Peric-2	3	2
257	Tan Redland	8	1

TABLE II (Continued)

Entry Number	Cultivar or Selections	Days to First Symptom[1]	Disease Rating[2]
258	Dwf. Redland	5	2
259	White Tan Redland	7	1
260	811 - Redland - 3	6	2
261	White Redland	5	2
262	51 x 811-4-1-2	5	2
263	M52 x 920-3-1	6	2
264	811 x 750-1-2	-	1
265	#1 x Kashkashi x 10-4	-	1
266	695 x Dwf.-1-1-1	-	-
267	Waxy x Dwf.-2-1	8	1
268	Do #1	0	1
269	ddRK Mutant	2	4
270	Tenuous Kafir	5	3
271	Tenuous Kafir	5	3
272	Tenuous Kafir	4	3
273	Tenuous Kafir	3	3
274	IS 809 (3 dwf.)	7	1
275	IS 809 (4 dwf.)	8	1
276	Shallu Grain SA 7536-1	4	3
277	PI 264453	-	1
278	bm-1, (RWD3xWeskan-4-3-1-1-2-2	-	1
279	bm-2, (R-Redland derix)	-	1
280	B Redland	5	2
281	B Dwf. Redland	-	-
282	B Wheatland	7	1
283	B Wheatland 04	5	2
284	B Wheatland DY 54	7	1
285	B Oky 54	4	2
286	B Oky 55	8	1
287	Bok 8	4	3

TABLE II (Continued)

Entry Number	Cultivar or Selections		Days to First Sympton[1]	Disease Rating[2]
288	Bok 24		6	2
289	Bok 11		5	2
290	Bok 12		8	1
291	TX 428		6	2
292	TX 430		-	1
293	TX 622		3	3
294	TX 623		5	2
295	TX 624		6	2
296	TAM 2566		5	2
297	IS 2816 C		-	-
298	IS 2801 C		2	4
299	IS 530 C	75-1001	7	1
300	IS 1047 C	75-1003	6	2
301	IS 1121 C	75-1005	-	1
302	IS 1133 C	75-1006	6	2
303	IS 1134 C	75-1008	5	2
304	IS 1139 C	75-1010	6	2
305	IS 1140 C	75-1012	-	1
306	IS 1141 C	75-1014	-	1
307	IS 1143 C	75-1016	-	1
308	IS 1151 C	75-1018	8	1
309	IS 1159 C	75-1020	6	2
310	IS 1166 C	75-1022	7	1
311	IS 1207 C	75-1024	2	3
312	IS 1309 C	75-1026	3	3
313	IS 1335 C	75-1028	6	2
314	IS 1526 C	75-1031	8	1
315	IS 2169 C	75-1033	6	2
316	IS 2177 C	75-1035	-	1
317	IS 2198 C	75-1037	-	1

TABLE II (Continued)

Entry Number	Cultivar or Selections		Days to First Symptom[1]	Disease Rating[2]
318	IS 2246 C	75-1039	-	1
319	IS 2477 C	75-1041	-	1
320	IS 2478 C	75-1043	6	2
321	IS 2501 C	75-1045	5	2
322	IS 2508 C	75-1047	6	2
323	IS 2662 C	75-1049	2	4
324	IS 2757 C	75-1051	4	3
325	IS 3071 C	75-1053	2	4
326	IS 3464 C	75-1055	5	3
327	IS 3477 C	75-1057	3	4
328	IS 3574 C	75-1059	-	-
329	IS 3612 C	75-1062	5	3
330	IS 3620 C	75-1064	-	-
331	IS 3625 C	75-1065	7	2
332	IS 3627 C	75-1067	4	2
333	IS 3814 C	75-1069	-	1
334	IS 3911 C	75-1071	-	1
335	IS 3955 C	75-1073	-	1
336	IS 3956 C	75-1075	6	2
337	IS 4839 C	75-1077	8	1
338	IS 4884 C	75-1079	7	1
339	IS 5394 C	75-1080	6	1
340	IS 5530 C	75-1082	8	1
341	IS 5554 C	75-1084	-	1
342	IS 5747 C	75-1086	-	1
343	IS 5769 C	75-1088	-	1
344	IS 5887 C	75-1090	6	2
345	IS 5892 C	75-1092	8	1
346	IS 6271 C	75-1094	-	1
347	IS 6389 C	75-1096	-	1

TABLE II (Continued)

Entry Number	Cultivar or Selections		Days to First Symptom[1]	Disease Rating[2]
348	IS 6418 C	75-1098	-	1
349	IS 6439 C	75-1100	6	2
350	IS 6440 C	75-1102	8	1
351	IS 6456 C	75-1104	5	2
352	IS 6710 C	75-1106	-	1
353	IS 6845 C	75-1108	6	2
354	IS 6882 C	75-1110	7	2
355	IS 6895 C	75-1112	8	1
356	IS 6906 C	75-1113	-	-
357	IS 6964 C	75-1115	5	2
358	IS 7044 C	75-1117	-	1
359	IS 7094 C	75-1119	-	1
360	IS 7173 C	75-1122	-	1
361	IS 7242 C	75-1124	5	2
362	IS 7254 C	75-1126	8	1
363	IS 7340 C	75-1128	-	1
364	IS 7367 C	75-1130	-	1
365	IS 7379 C	75-1132	-	1
366	IS 7470 C	75-1134	8	1
367	IS 7444 C	75-1136	7	1
368	IS 7447 C	75-1138	-	1
369	IS 7452 C	75-1139	-	1
370	IS 7518 C	75-1141	4	3
371	IS 7524 C	75-1142	5	3
372	IS 7535 C	75-1144	-	1
373	IS 7537 C	75-1146	6	2
374	IS 7541 C	75-1148	5	2
375	IS 7542 C	75-1149	3	4
376	IS 7543 C	75-1152	8	1
377	IS 7596 C	75-1154	8	1

TABLE II (Continued)

Entry Number	Cultivar or Selections		Days to First Symptom[1]	Disease Rating[2]
378	IS 7612 C	75-1156	7	1
379	IS 7617 C	75-1158	7	1
380	IS 7735 C	75-1160	7	1
381	IS 7738 C	75-1162	8	1
382	IS 7762 C	75-1164	6	1
383	IS 7769 C	75-1165	8	1
384	IS 7776 C	75-1168	4	3
385	IS 7778 C	75-1170	-	1

[1]Days after inoculation on which the first symptoms appeared.

[2]Severity of the symptoms 10 days after inoculation where 1 = highly resistant, 2 = moterately resistant, 3 = moderately susceptible, and 4 = highly susceptible.

CHAPTER V

SUMMARY

1. Several isolates of three bacterial pathogens of sorghum (X. holcicola, P. syringae, P. andropogonis) were made from diseased specimens collected in Oklahoma, Texas and New Mexico, and an isolate of X. holcicola was obtained from Dr. Joe Martin from Kansas.

2. The most suitable conditions of humidity and temperature for these bacteria to produce infection on sorghum were investigated. It was found that the temperature range from 60°F to 90°F with a relative humidity near 100% was the most satisfactory.

3. Testing of pathogenicity showed that all the isolates of bacterial leaf spot (P. syringae) and bacterial leaf stripe (P. andropogonis) were highly pathogenic and produced very distinctive symptoms on susceptible varieties. The isolate of X. holcicola from Kansas also was pathogenic.

4. Various methods of inoculation were tested and the best method for testing large host populations consisted of spraying the leaves with a culture of bacteria in nutrient broth. No injury to the leaf was required.

5. Three hundred eighty-five cultivars and selections were tested for reaction to bacterial leaf streak and some of them like Cody, Tull Kaoliang, and Leoti, were highly resistant. It was found that the

Feteritas as a group were highly susceptible while some resistant was found in the Kafirs.

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