AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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BATCH #18

1. SUBJECT CLASSIFICATION

A. PRIMARY
Agriculture — AH20-0170-G214

B. SECONDARY
Plant diseases--Cereals--Sorghum--Nigeria

2. TITLE AND SUBTITLE
New sources of resistance to the downy mildew disease of sorghum

3. AUTHOR(S)
Futrell,M.C.; Webster O.J.

4. DOCUMENT DATE
1966

5. NUMBER OF PAGES
4p.

6. ARC NUMBER
ARC NI633.174.F996a

7. REFERENCE ORGANIZATION NAME AND ADDRESS
USDA/ARS

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*
(In Plant disease reporter,v.50,no.9,p.641-644)

9. ABSTRACT

10. CONTROL NUMBER
PN-RAB-084

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Downy mildew?
Fungus diseases
Nigeria
Sorghum
Varietal resistance

13. PROJECT NUMBER

14. CONTRACT NUMBER
PASA RA-4-00 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Copy 2 of 2
4/R16
N:
633.174
F996a
PASA RA-4-60

NEW SOURCES OF RESISTANCE TO THE DOWNY MILDEW DISEASE OF SORGHUM

Maurice C. Futrell and Orrin J. Webster[1]

Summary

Part of the world collection and the Nigerian collection of grain sorghums was screened for resistance to downy mildew in 1964 and 1965 in natural epiphytotics at Samaru, Nigeria. Twenty-two lines in the Nigerian collection were free of mildew in both years. Fourteen percent of the entries in the world collection were resistant in 1965. The highest percentage (47%) of resistant entries was found in the Caffrorum race. Most of the resistant entries were collected in southern Africa, which is probably the geographic point of origin for sorghums resistant to downy mildew. Most of the resistant lines in the Nigerian collection were collected in the Adamawa Province, which is located in the eastern part of northern Nigeria. Sorghums collected in the southern and western parts of northern Nigeria were susceptible. Twenty-eight resistant lines, mostly from races other than Caffrorum, were crossed with the sterile A line of Combine-Kafir-60 to combine genes for resistance to downy mildew from two sources in progeny plants variable in plant height and maturity. Selections from these crosses will be made to produce a wide range of adaptation.

INTRODUCTION

Downy mildew, Sclerospora sorghi Weston & Uppal, is almost worldwide in distribution. Tarr (6) summarizes the distribution of the disease in Africa and Asia, and the C.M.I. Distribution Map of Plant Diseases No. 179 lists it in China and Italy. In 1964 Reyes, et al. (3,4) reported its occurrence in Mexico and the United States. According to Safeeulla and Thirumalachar (5), the disease has become increasingly severe in India in recent years. The spread of the disease in the United States has been rapid, especially on sorghums of the Sudanense type grown for forage (2,3).

The need for new varieties, inbred lines and hybrids with resistance to downy mildew has been pointed out by a number of workers (1,2,3,6). The first screening for resistance was done by Safeeulla and Thirumalachar (5) in India. These workers reported that the varieties C.O. 6, Honnur Bile, Kasturi Bile, and Bonita did not develop the disease when inoculated artificially. Miller (2) reported that Kafir was the most resistant race in material tested in Texas. Part of the world sorghum collection assembled in India was evaluated for response to the disease at Samaru, Nigeria in 1965 (1).

The purpose of this paper is to report sources of resistance to this disease found in the world and Nigerian sorghum collections screened at Samaru, Nigeria in 1964 and 1965. Progress in combining sources of resistance in hybrid crosses is also reported.

EXPERIMENTAL

The Nigerian collection was evaluated for downy mildew reaction during the wet season (June to September) of 1964 and 1965. The world collection was evaluated in 1965 only. Each sorghum entry was seeded in a 30-foot row in soils known to contain a large number of oospores of the downy mildew fungus. There were 25 to 30 sorghum plants per row. The plants were classified for downy mildew twice during the growing season. The reaction to the downy leaf symptoms caused by the sporangiophore-sporangiospore stage of the fungus was recorded during the first 2 weeks of July, and the systemic symptoms caused by the sexual stage of the fungus were recorded during September. Rows with plants infected with downy mildew were classified as susceptible. If no plants were susceptible, the row was classified as resistant. Resistant sorghum entries have been arranged according to the geographic areas where they were collected (Tables 1 and 2) and races (Table 3).

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Research supported in part by funds provided by the U.S. Agency for International Development.

Table 1. Response to downy mildew of sorghums in the Nigerian collection grown at Samaru in 1964 and 1965, arranged by province of origin

Province	No. lines tested 1964	No. lines tested 1965	No. lines resistant in both years
Adamawa	31	31	8
Kano	44	11	5
Katsina	35	10	4
Bornu	53	30	2
Sokoto	74	61	1
Niger	24	88	1
Bauchi	36	20	1
Kabba	12	12	0
Benue	24	27	0
Plateau	18	33	0
Ilorin	11	61	0
Zaria	37	77	0
Not designated	0	92	0
Total	397	553	22

Table 2. Response to downy mildew of sorghums in the world collection grown at Samaru, Nigeria in 1965, arranged by countries of origin.

Country of origin	No. entries tested	% Entries resistant
India	855	6
USA	599	20
Nigeria	530	6
Sudan	194	19
Volta	75	15
Japan	60	13
Uganda	53	23
Mali	47	13
Ethiopia	46	30
South Africa	42	67
Rhodesia	26	35
Mexico	21	33
Other countries	145	14
Total	2693	14

Table 3. Response to downy mildew of sorghums in the world collection grown at Samaru, Nigeria in 1965, arranged by races.

Race	No. entries tested	% Entries resistant
Conspicuum	544	3
Durra	510	3
Caudatum	381	20
Roxburghii	169	5
Dochna	142	9
Caffrorum	97	47
Nigricans	69	35
Caffrorum-Durra	68	47
Sudanense	68	0
Nigricans-Feteritas	56	29
Caffrorum-Birdproof	50	28
Subglabrescens	48	34
Bicolor	47	28
Subglabrescens-Milo	42	33
All others[a]	402	14
Total	2693	14

[a]This composite includes all other races tested with less than 40 entries each. They are: Roxburghii-Shallu, Guineense, Margaritiferum, Membranaceum, Nervosum-Broomcorn, Nervosum, Nervosum-Kaoliang, Dochna-Leoti, Dochna-Amber, Dochna-Collier, Dochna-Roxburghii, Dochna-Nigricans, Dochna-Durra, Caffrorum-Darso, Caffrorum-Feteritas, Nigricans-Bicolor, Sumac, Caudatum-Guineense, Caudatum-Bicolor, Caudatum-Dochna, Durra-Roxburghii, Durra-Membranaceum, Nandyal, Durra-Nigricans, Durra-Kaura and Cernuum.

Most of the resistant lines selected were very tall and none was suitable for mechanical harvesting. Twenty-eight were crossed with the sterile A line of Combine-Kafir-60. These hybrids have been grown through the F_1 generation and a number of the F_1 progenies have been backcrossed to Combine-Kafir-60. The F_1 progenies that were fertile were backcrossed to the A line of Combine-Kafir-60. The objectives of the crosses and backcrosses were as follows: To provide materials for studying the inheritance of downy mildew, to determine which of the male parents will restore fertility of the F_{1s}, and to determine which male parents may be potential B lines as indicated by sterility of the F_{1s}.

RESULTS

Twenty-two lines in the Nigerian collection were resistant to downy mildew in both years (Table 1). Eight of the 22 came from the Adamawa Province, at the eastern border of northern Nigeria. Lines collected in the western and southern provinces were all susceptible.

Table 4. Fertility of F_1 progenies of sorghum lines resistant to downy mildew when crossed with the A line of Combine-Kafir-60.

I.S. no.	Country of origin	Race	Response of F_1 flowers
189	USA	Caffrorum	Sterile
676	USA	Bicolor	Sterile
949	Africa	Bicolor	Sterile
959	USA	Bicolor-Kafir	Sterile
2824	Rhodesia	Caudatum	Sterile
3147	South Africa	Dochna-Feterita	Sterile
3479	Sudan	Caudatum	Fertile
3547	Sudan	Caudatum	Fertile
4974	India	Durra	Sterile
5694	India	Roxburghii	Fertile
6738	Volta	Conspicuum	Sterile
6776	Cameroon	Durra	Fertile
6825	Volta	Conspicuum	Sterile
6832	Volta	Conspicuum	Sterile
7056	Central African Republic	Caudatum	Fertile
7088	Central African Republic	Nigricans-Feteritae	Fertile
7[illegible]	Central African Republic	Caudatum	Fertile
7[illegible]	Nigeria	Caudatum	Fertile
7284	Nigeria	Caudatum	Fertile
7291	Nigeria	Caudatum	Fertile
7300	Nigeria	Caudatum	Fertile
7338	Nigeria	Caudatum	Fertile
7492	Nigeria	Caudatum	Fertile
7519	Nigeria	Caudatum	Fertile
7528	Nigeria	Caudatum	Fertile
7610	Nigeria	Caudatum	Fertile
8056	Japan	Subglabrescens	Fertile
8083	Japan	Caudatum	Sterile

Fourteen percent of the entries in the world collection were resistant to downy mildew (Tables 2 and 3). The highest percentage of resistant entries was found in sorghums collected in southern Africa (Table 2). Sixty-seven percent of the collections made in South Africa were resistant. Thirty-five percent of those from Rhodesia were resistant. The percentage of downy mildew resistant entries in each race is given in Table 3. The Caffrorum and the Caffrorum-Durra races have the highest number of resistant entries. These two races originated in the southern part of Africa. Resistant lines were found in all countries and in all races studied.

The asexual stage of the fungus appeared on many more plants than did the oospore stage.

Twenty-eight resistant lines were crossed with the sterile A line of Combine-Kafir-60 (Table 4). Nine of the 28 lines were from the Nigerian collection and were resistant in 1964 and 1965 tests. Eleven gave sterile F_1 plants, which indicated that they were probably carrying one or more non-restorer genes. The sterility was not complete in all eleven lines. Flowers of the F_1 progenies of I.S. 189, 2824, and 4974 were sterile from the time the flowers first appeared in mid-February until the secondary tillers ceased flowering in the latter part of April. The F_1 progenies of I.S. 676, 949, 959, 3147, 6738, 6825 and 6832 had sterile flowers on the primary culms that emerged in February, but the secondary tillers which bloomed in mid-April set from 5 to 10% seed under selfing bags. Flowers on the primary culms of the F_1 progenies of I.S. 8083 were sterile in early March, but by mid-April the flowers on the secondary tillers were fertile. Seventeen of the twenty-eight lines produced fertile F_1 progenies and these were backcrossed to the A line of Combine-Kafir-60.

DISCUSSION

The highest percentage of lines resistant to downy mildew was found in the Caffrorum class originating from South Africa. Miller (2) also found the Kafirs to be the most resistant to downy mildew. This indicates that the geographic point of origin of sorghums with resistance to downy mildew is the southern part of Africa. The disease has probably been in that area for a long time and the natural selection for resistance has occurred over a number of years. The resistant lines may have spread north through central Africa and into the eastern part of northern Nigeria. No resistant lines were found in material collected in the northern and western part of northern Nigeria.

The fact that some resistant lines were collected from all parts of the world suggests that there are probably different genes for resistance, and that physiologic races of the pathogen may occur. More study is needed on these points.

The growing of plants in infested soil can be used for gross screening of large numbers of lines, but more refined techniques are needed to identify physiologic races and to study the mode of inheritance of resistance. The method described by Safeeulla and Thirumalachar (5) offers promise.

The production of sterile flowers from F_1 plants during February, followed by the production of fertile, or partly fertile flowers by April presents an interesting biological problem. The shift in fertility may be caused by environmental changes that occurred over this period of time. Some of these were: Increase in temperature, increase in humidity, change in day-length and light quality. As the daylength increased there were more direct rays from the sun and a change in the red-light/blue-light ratio. There were also marked changes in the internode elongation in these lines; the primary culms averaged 4 feet in height in February, and the secondary tillers on the same plants ranged from 6 to 8 feet in height in April. Both the change in fertility of the flowers and the change in height of the plants were probably the results of hormone or auxin change in the plant. Gibberellic acid is known to affect internode length.

The variation in the degree of fertility of the F_1 plants from crosses between resistant lines and sterile Combine-Kafir-60 suggests that there are different genetic mechanisms operating for restoration in the male parents. Further investigation on this problem would be worthwhile.

Literature Cited

1. FUTRELL, MAURICE C. 1965. Downy mildew reaction of grain sorghums in world collection. Mimeographed Report (in French and English) of the First Meeting of Joint Project 26, Scientific, Technical and Research Commission, Organization for African Unity, Samaru, Nigeria, October 3-8, 1965.
2. MILLER, FREDERICK R. 1965. Sorghum breeding in Texas. Sorghum Newsletter 8: 60.
3. REYES, LUCAS, D. T. ROSENOW, R. W. BERRY, and M. C. FUTRELL. 1964. Downy mildew and head smut diseases of sorghum in Texas. Plant Disease Reptr. 48: 249-253.
4. REYES, L., D. T. ROSENOW, and M. C. FUTRELL. 1964. Downy mildew of grain sorghum in Texas. (Abst.) Phytopathology 54: 626.
5. SAFEEULLA, K. M., and M. J. THIRUMALACHAR. 1955. Resistance to infection by Sclerospora sorghi of sorghum and maize varieties in Mysore, India. Phytopathology 45: 128-131.
6. TARR, S. A. J. 1962. Diseases of sorghum, sudan grass and broom corn. Commonwealth Mycol. Inst., Kew, Surrey.

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