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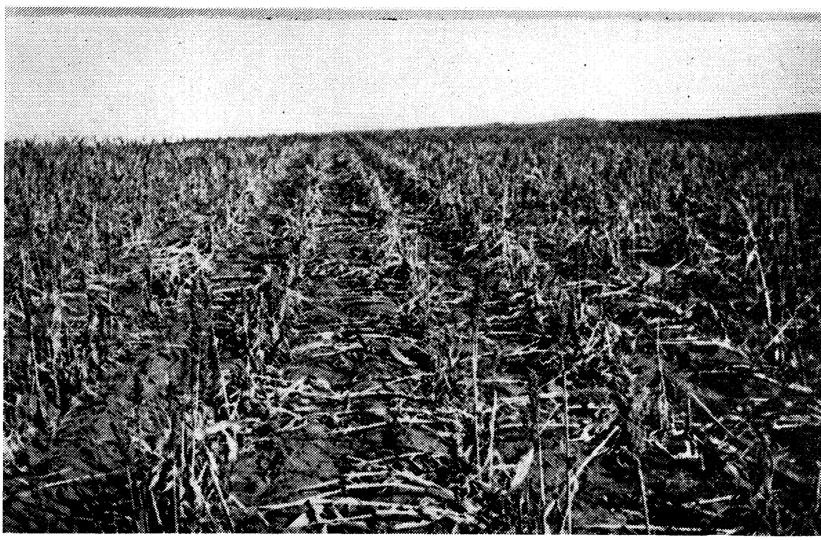

Sorghum damaged by charcoal rot frequently lodges. Sometimes lodging is severe, as shown in the above picture of an affected sorghum field.

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CHARCOAL ROT OF SORGHUM

By DALLAS F. WADSWORTH and JOHN B. SIEGLINGER*

In August of 1938 a new disease of sorghum causing lodging was reported in Texas. In September of the same year similar severe lodging of sorghum was found at the Oklahoma Agricultural Experiment Station's farm at Perkins, Oklahoma.

This disease occurs as a root and internal stalk rot. Diseased stalks often take on a gray, ashy appearance of charcoal, which suggests the common name, "charcoal rot."

When charcoal rot was first reported, it was thought to be rather generally distributed in the western part of Texas and in two counties of Oklahoma. Since that time, it has been found in all of the sorghum-growing areas of the State. It now occurs in at least 27 states in the warmer climates of the United States. It appears to be most prevalent in the drier regions of the southern Great Plains, but has been found in Illinois and Indiana, and has even been recorded as far north as Douglas County, Oregon.

Under conditions favorable to the causal organism, the stand loss may range from severe to virtually complete. Such losses pose a serious problem to growers who devote over 10,000,000 acres annually to the production of sorghum.

This publication is concerned with charcoal rot of sorghums. However, this disease also occurs on numerous commercially important crops such as corn, cotton, cowpeas, alfalfa, soybeans, field beans, potatoes, sugar beets, peanuts, sunflowers, watermelons, peppers, gourds, chrysanthemums, strawberries, cedar, catalpa, sudan grass, mung beans, broom corn, and probably many others.

Research aimed at reducing the loss due to charcoal rot of sorghums was started by the Oklahoma Agricultural Experiment Station shortly after the disease was first recognized. The chief aim has been to find strains which resist the disease, so these strains can be used as parent material in breeding resistant varieties. Forage sorghums, for some reason as yet unknown, have more natural resistance than do the grain types. **Three forage varieties now commonly grown—Atlas, African Millet, and Sumac 1712—were found highly resistant.** Breeding for resistance in combine-type grain sorghums is under way.

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*Respectively: Assistant Plant Pathologist, Department of Plant Pathology; and Agronomist, Sorghums (Cooperative U. S. Department of Agriculture), Department of Agronomy. Charcoal rot disease readings prior to 1948 were made by D. E. Hoffmaster, formerly Assistant Plant Pathologist, and D. A. Preston, formerly Assistant Plant Pathologist. Photographs used are by courtesy of the Nebraska Agricultural Experiment Station.

The Causal Organism

In many cases, diseased sorghum plants contain a complex of fungi. However, the fungus **Sclerotium bataticola** Taub. is frequently found to be the most prevalent. Recent observation indicates that the disease is caused by several fungi that attack in some orderly fashion or sequence, with **Sclerotium bataticola** being the last and most conspicuous of the sequence.

The causal agent is now more correctly named **Macrophomina phaseoli** (Maubl.) Ashby, which is a different stage of the same fungus.

How to Recognize the Disease

The most conspicuous symptoms and signs of charcoal rot appear as the crop approaches maturity. At this stage of development, temperatures may be rather high and soil moisture conditions poor; both of these conditions aid the causal agents. The severely damaged plants lodge badly, particularly in areas of moderate winds.

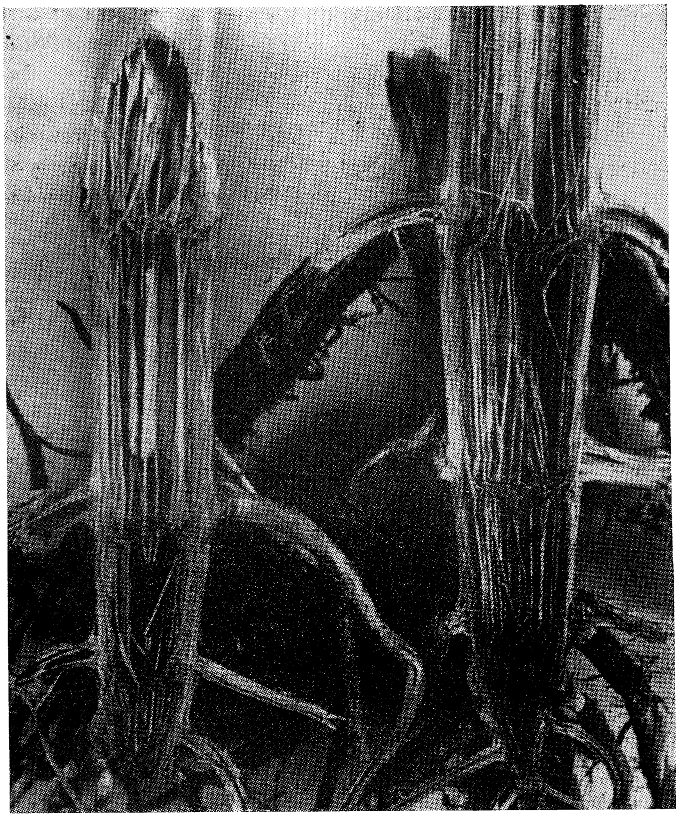
If badly lodged stalks are split and examined closely, the pith or inside of the stalk will be in various stages of disintegration. The rot may extend for some distance up the stalk, as well as down into the root system. A typical diseased stalk is but a hollow stem, with the stringy remains of the food-conducting system loosely attached within the stalk. Inside the hollow stem and upon the remaining strands of the food-conducting stems are numerous small, black fruiting bodies. These fruiting bodies of the fungus, called "sclerotia" give the affected area its charcoal coloration. Sclerotia are very resistant to adverse environmental conditions, being able to survive in the soil or in plant tissue for many years. This ability to live over in the soil means that the soil is usually infested with the charcoal rot casual agent.

At maturity the heads of diseased plants are not developed normally, giving a poor yield of shrunken grain.

There are reports that this disease may attack in the seedling stage and near mid-season also, but it occurs more commonly after heading.

Varietal Tests For Resistance

Determinations of the occurrence of charcoal disease have been made in the Woodward sorghum variety nurseries since 1940, and at Perkins since 1942. In both nurseries each variety has two rates of spacing.



Charcoal rot destroys the pith in the stalks of affected plants. The picture shows corn stalks injured by the disease. Similar damage is done in sorghum stalks.

Half of each row is thick (plants 6-8 inches apart) and the other half is thin (plants 3 feet apart).

At both Stations each variety is examined for charcoal rot in November shortly after the first frost. Ten stalks of the thick spacing and ten stalks of the thin spacing of each variety are examined by making a long diagonal cut through the stem approximately 4 to 6 inches above the soil line. The stalks are then scored in the field as diseased when either standing or lodged plants have a discolored, stringy, disintegrated pith or hollow stem. Some stalks may show pith damage from termites, borers, and physical effects, but these are readily distinguished from those with charcoal rot.

For these determinations, both

nurseries are planted with the same varieties where possible. The majority of varieties are carried over from year to year, but an occasional strain or variety may be added or dropped from the planting plan at either nursery.

The two nurseries differ chiefly in these respects: the Perkins nursery is planted in May, and the Woodward nursery in June; and the Woodward nursery includes milos, whereas they are not grown at Perkins because of chinch bug damage.

Results and Discussion

At Perkins, ten varieties have shown no charcoal rot. These varieties are: Rice Kafir, Tall Red Kafir no. 7, Atlas Sorgo 899, Wild Amber Sorgo*, Kansas Orange, African Millet, Sumac 35038, Sumac 1712, Tall White Sorghum 787, and Corneous Sorghum 6166.

Seven of the above varieties have also remained disease free at the Woodward Station. Tall White Sorghum no. 787 and Wild Amber Sorgo each showed one diseased plant in 1940, and Rice Kafir showed one diseased stalk in 1947.

Table 1 shows that there has been more charcoal rot at Perkins than at the Woodward Station, as an average of the eight-year period. It is believed that the higher percentage of charcoal rot at Perkins was largely due to the longer growing season at that location, rather than possible varietal differences. The level of charcoal rot was the lowest in 1945 at Perkins and in 1942 and 1949 at Woodward. During these years there was average or slightly above average rainfall, with average or slightly below average temperatures, according to the U. S. Weather Bureau and Experiment Station records. This suggests that the fungus was controlled to some extent by ample moisture and mild temperatures, which is in line with evidence obtained by Livingston in Nebraska.**

Table 1 also shows that more charcoal rot occurs in the thick spacing, where competition for soil moisture is an influencing factor. Thus, environment and cropping practices play important parts in the level or intensity of this disease during each growing season.

Summary

Sorghum varietal nurseries have been examined for susceptibility to the charcoal rot fungus each year since 1940 at the Woodward Experiment Station, and since 1942 at the Perkins Experiment Station.

* Wild Amber was omitted from the Perkins nursery in 1949.

** Livingston, J. E., *Charcoal Rot of Corn and Sorghum*. Nebr. Agri. Exp. Sta. Research Bul. 136 (April, 1945).

TABLE 1.—Percent of Charcoal Rot in Sorghum Nurseries at Perkins and Woodward, Oklahoma.

Year	Perkins Thick spacing	Perkins Thin spacing	Woodward Thick spacing	Woodward Thin spacing
1942	13.46	12.67	0.64	1.35
1943	7.04	4.44	5.87	2.82
1944	15.77	11.62	3.13	1.31
1945	2.83	3.12	14.77	6.70
1946	23.40	19.79	5.57	3.62
1947	9.01	7.75	8.64	0.97
1948	5.04	12.37	6.31	3.07
1949	12.30	18.16	0.34	0.23
8 yr. total	11.11	11.24	5.66	2.51

Ten plants at the thick spacing and ten plants of the thin spacing for each variety were examined in both nurseries. The percentages listed are based on the total number of diseased plants as compared to the total number of healthy ones in each nursery. The Perkins nursery averages about 145 varieties per year. The Woodward nursery averages about 176 varieties per year.

During this period the seven varieties Tall Red Kafir no. 7, Atlas Sorgo no. 899, Kansas Orange, African Millet, Sumac no. 35038, Sumac no. 1712, and Corneous Sorghum have shown no charcoal rot. Three other varieties Wild Amber Sorgo, Tall White Sorghum no. 787, and Rice Kafir have shown a high degree of resistance.

Data from these nurseries show that the fungus was more serious at thick rates of planting, and also indicate that ample moisture and mild temperatures tend to inhibit the fungus.

At the present time, three forage sorghums—Atlas, African Millet, and Sumac 1712—are widely grown in Oklahoma because of resistance to the charcoal rot organisms.