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Black Chaff of Wheat and Barley

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Before the late 1970s, black chaff disease was seldom a problem among wheat producers in southern Idaho. Glumes would occasionally become blackened because of infection by the pathogen, but yields were seldom affected. In 1979, several sprinkler-irrigated wheat fields in the Burley area were observed in which the top (flag) leaves of many plants were partially or totally killed. Isolations proved that the causal agent was the black chaff pathogen. A survey the following year revealed that many fields in the Cassia and Minidoka county area had severe black chaff. Many fields had plants with flag leaves and heads that had died prematurely resulting in shriveled grain and reduced yields. Such epidemics have occurred in subsequent years in several fields in southcentral and eastern Idaho. However, the disease is not known to be a problem in northern or southwestern Idaho.

Yield losses estimated to be as high as 40 percent have occurred in the most severely diseased fields, although losses in most cases are approximately 10 percent or less. Barley, rye and triticale are other hosts of the black chaff pathogen, and severe epidemics have also occurred in barley.

Disease Cycle

Black chaff is caused by the bacterium *Xanthomonas campestris* pv. *translucens*. The pathogen survives on and in wheat and barley seed and may also survive on plant debris and weed hosts. It is spread over short distances by splashing water, plant contact and "spike-visiting" insects and over long distances by contaminated seed.

Fig. 1. Black chaff-infected wheat seedling showing water-soaked spots on leaves.

Contaminated seed is the principle source of inoculum in southern Idaho, but research is ongoing to determine the importance of other inoculum sources. Infected seedlings provide point sources (i.e., disease foci) for spread of the pathogen within the field (Fig. 1). Disease development generally progresses slowly during early and mid season. Symptoms are not easily found on immature plants, and growers frequently do not realize they have a problem until the crop heads out, at which time the flag leaf may exhibit areas of water soaked and dead tissue.

The pathogen grows best when leaves are wet (from dews, precipitation or sprinkler irrigation) and when temperatures are above 80°F. Black chaff is usually most severe in sprinkler irrigated fields but may occasionally be severe in rill-irrigated ones. It is rarely a problem in dryland fields. At harvest, the pathogen is returned to the soil with plant debris and is also found on the harvested grain.

Fig. 2. Black chaff symptoms in wheat heads include: (A — left) dark interveinal streaks and blotches on the glumes and (B — right) severe infection with no kernels formed.

Symptoms and Signs

The name black chaff describes the characteristic symptoms on the head — dark interveinal streaks and blotches on the glumes (i.e., chaff) (Fig. 2A). However, these symptoms are similar to a non-infectious condition known as brown necrosis or melanism. Hence, diagnosis must be done carefully. The entire head may become infected (Fig. 2B) when epidemics develop early in very susceptible varieties. In such heads, kernels are not formed, and they often have a chlorotic appearance and feel sticky and spongy when squeezed.

Fig. 3. Black chaff symptoms and signs in wheat necks include: (A — left) dark purple lesions with light yellow centers and (B — right) yellow crystalline bacterial exudate.

Infected awns (''beards'') have a characteristic ''barber pole'' appearance because of alternating bands of healthy and diseased tissue. This symptom is diagnostic. Symptoms on the stem (neck) between the head and flag leaf appear as dark purple lesions up to 1 inch long which may contain a diffuse, light yellow center (Fig. 3A).

The most frequently observed symptom of black chaff in southern Idaho is leaf streaking and spotting (Figs. 4A and 4B). Streaking is more pronounced in barley and, as such, the name of the disease in barley is commonly referred to as bacterial leaf streak. Lesions begin as translucent water soaked streaks and spots which turn brown after a few days. In wheat, lesions may occasionally be surrounded by a diffuse lime-green halo.

Under moist conditions, viscous, light yellow droplets or slime layers composed of millions of bacterial cells may be seen on the infected tissue. As weather conditions turn dry, those droplets appear as tiny yellow sugar crystals (Fig. 3B) or as layers of dried cells called ''shellac.'' A water droplet which lands on the dried cells quickly resuspends and disperses the cells to surrounding plants.

Control

Bacterial diseases are usually difficult to control in the field, and black

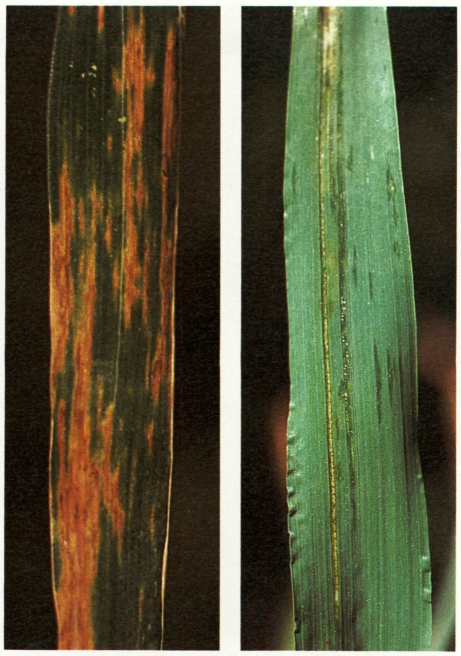

Fig. 4. Leaf streaking and spotting are the most common black chaff symptoms in Idaho. Black chaff symptoms in wheat are shown at left (A), and the symptoms in barley are at right (B).

chaff is no exception. No chemicals are available to treat infected plants or prevent spread from plant to plant. Since the pathogen is seedborne, the most logical approach for control is through the use of clean seed.

Black chaff is presently not covered under the certification standards of the Idaho Crop Improvement Association. However, the University of Idaho offers a seed assay service for black chaff which determines the level of seed contamination by the black chaff bacteria and provides an estimate of the probability of a black chaff epidemic. If a grower has a choice of two seedlots to plant, he should plant the one with the lower contamination level. Seedsmen and growers who would like to use this service should contact the Seed Pathology Lab, Plant, Soil and Entomological Sciences Dept., University of Idaho, Moscow, Idaho 83843-4196 for more details.

No effective seed treatments are currently registered for black chaff control. Laboratory and field studies have demonstrated the effectiveness of a seed soak technique which can ultimately be used to treat breeder's seed to eradicate the pathogen. However, in a seed increase and certification program, plants produced from clean seed may become reinfected and, therefore, must be produced away from other potential sources of inoculum such as commercial wheat or barley fields or infected stubble. A distance of ¼ mile from potential inoculum sources is advised to protect the seed crop from recontamination.

The role of various environmental conditions in black chaff development is not fully understood, but it is important to realize that the environment does strongly affect the disease. Therefore, disease severity varies from year to year and among locations in the state.

Even though a seed field may not show any black chaff symptoms, it is possible for the pathogen to increase on the leaf and head surfaces, resulting in contaminated seed. When that seed is planted the next year, better weather conditions may be present which would lead to an epidemic. Therefore, seed production under dryland conditions would be ideal to minimize potential disease spread. Rill irrigation should also work well.

Sprinkler irrigation should not be used for seed production. This precaution applies only to wheat and barley raised for seed. It does not apply to commercial production.

Varietal resistance may offer some degree of control in the future, but present data are insufficient to recommend one variety over another.

No cost effective protectant foliar sprays are known for the control of black chaff. Once the disease has developed in the field, the only recommended disease control practice is to reduce the frequency of sprinkler irrigation. Care should be taken to avoid unduly stressing the crop for moisture, especially during the kernel filling stage.

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