Karnal Bunt

Robert L. Forster and Blair J. Goates

Karnal bunt, or partial bunt, is a fungal disease of wheat, durum wheat, rye, and triticale (a hybrid of wheat and rye). It was detected for the first time in the United States in March 1996 in durum wheat seed by the Arizona Department of Agriculture. On March 25, 1996, the Animal and Plant Health Inspection Service (APHIS) issued a federal Karnal bunt quarantine for the state of Arizona and six adjacent counties in Texas and New Mexico. On April 19 the quarantine was extended to include Imperial County and the eastern part of Riverside County in southern California.

Twenty-one countries currently list Karnal bunt (KB) as a quarantine pest. With the detection of KB in the United States, we are no longer considered free of this disease. APHIS imposed the quarantine in an attempt to contain and eradicate KB and has developed a plan to test wheat from across the United States for KB spore contamination to satisfy our foreign customers that our wheat exports are free of KB. Fortunately, almost all of our trading partners have agreed to accept exports as long as the wheat is certified as originating in areas where KB is not known to occur. In that light, an extensive preliminary KB survey project coordinated by the Kansas Department of Agriculture between 1993 and 1995 found no contaminating KB spores in wheat from North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, or Texas.

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The latest information on KB is available on the internet at the USDA's karnal bunt page: http://www.aphis.usda.gov/oa/bunt/kbhome.html.

history

Karnal bunt is so named because it was discovered on wheat grown near Karnal, India, in 1931. Since then it has been found in all major wheat-growing states of India, as well as in Pakistan, Iraq, Mexico, and Afghanistan. The disease has been present in Mexico since 1970 and has been well established in some areas of northwestern Mexico since 1982.

impact

Yield losses resulting from KB are generally light. Surveys in India during years of heavy disease revealed a total yield loss of about 0.5 percent, but in a few fields, as much as 89 percent of the kernels were infected, with yield losses ranging from 20-40 percent in highly susceptible varieties. The disease does not present a risk to human health, but does reduce flour quality. Generally, wheat containing more than 3 percent bunted kernels is considered unfit for human consumption. Odor and palatability of whole meal and finished products are adversely affected by the chemical trimethylamine produced by the fungus. Pasta products made with flour contaminated with KB spores can have an unacceptable color.

By far, the greatest impact of the disease in the United States could be on grain exports. The United States is the world's leading wheat exporter, accounting for one-third of total world wheat exports. United States wheat exports in 1995 were valued at $4.9 billion.

crops affected

As noted, KB affects wheat, durum wheat, and triticale. Rye has been shown to be susceptible with artificial inoculation. Barley and oats are not susceptible. Durum wheats and triticale are less susceptible than hard red and soft white wheats.

symptoms and detection

Karnal bunt is difficult to identify in the field. Developing wheat kernels are randomly infected and usually only partially converted to the fungus, which is why KB is sometimes called partial bunt. Infection typically occurs in only a few seeds per head, and not all heads on a single plant are infected. Infected grain shows no symptoms until near maturity. Even then the disease is difficult to detect in the field; the grain must be threshed and examined.

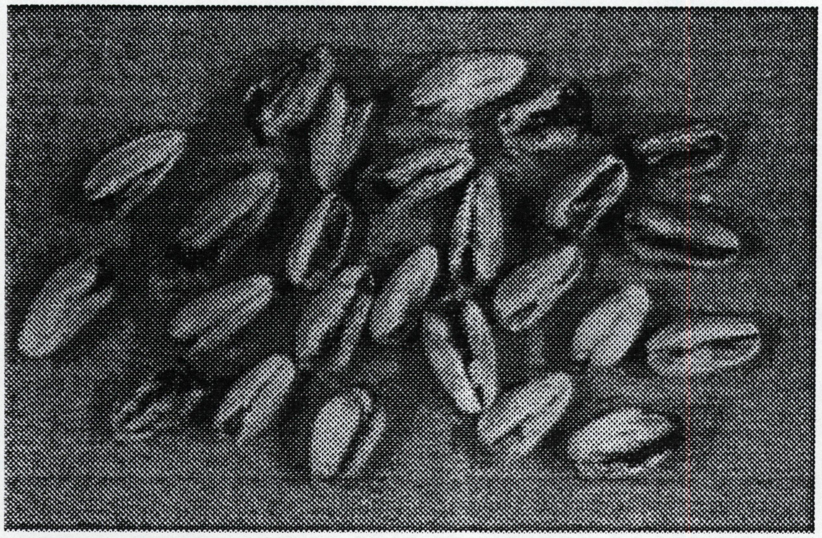

Fig. 1. Karnal bunt infected wheat seeds showing different severities of infection. (Photo by B. J. Goates)

The diseased portion of kernels is dark in color (fig. 1) and fishy smelling. The kernel usually remains whole, with only a part of the germ end converted into a black powdery spore mass, usually along the kernel groove. Only in extreme cases is the entire kernel converted into spores. Diagnosis must be done carefully, since three other diseases can be mistaken for KB: black point, common bunt, and dwarf bunt. However, the large, dark teliospores of the KB fungus are diagnostic.

infection and disease cycle

Karnal bunt is caused by the fungus Tilletia indica (also known as Neovossia indica) and is spread by spores (teliospores and sporidia). Teliospores can be carried in soil and on a variety of surfaces, including seed and other plant parts, farm equipment, tools, and even vehicles. They can also be windborne. KB spores are uplifted during the burning of wheat fields, and areas downwind may become contaminated if the spores remain viable.

Infection occurs after heading when sporidia produced from teliospores at the soil surface are dispersed to the glumes of the wheat spike (fig. 2). Fungus threads (hyphae) from sporidia penetrate stomata and grow intercellularly to the base of the developing kernel. The ideal conditions for infection are cool temperatures (59°-72°F) and rainfall, overhead irrigation, or high humidity. These conditions must occur during heading and for a few weeks afterward for KB to develop.

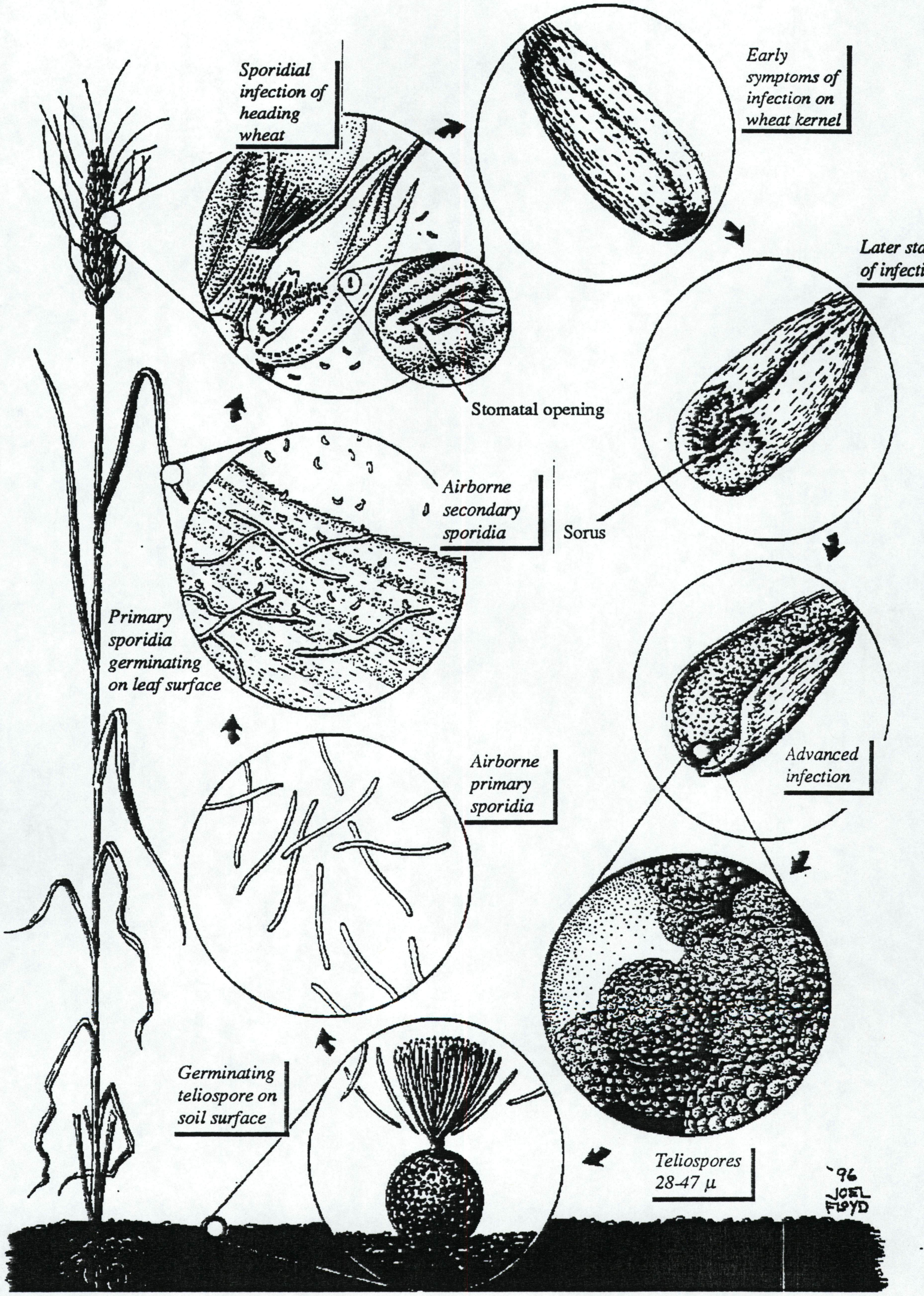

Fig. 2. Life cycle of the Karnal bunt fungus Tilletia indica. (Illustration courtesy of J. Floyd, APHIS)

Teliospores can survive in soil for several years. Moderate temperatures and dry soil during fallow periods, such as those that occur in the southwestern states, favor spore survival. Even though temperate climates do not appear to favor spore survival or disease establishment, the introduction of contaminated seed may lead to minor outbreaks during subsequent years. Thus, it is necessary to be vigilant regarding seed sources. Each diseased kernel can produce thousands to millions of spores that can contaminate machinery and facilities. Grain that is not diseased can become contaminated by passing through contaminated equipment. Spores can be easily isolated from grain that is very slightly contaminated with spores.

control

Compared to the fungi that cause common bunt (stinking smut), dwarf bunt (TCK smut), and loose smut of wheat, the KB fungus is unique and very difficult to control. Chemical seed treatments used to control other bunt and smut diseases of wheat are not effective for control of KB because there is insufficient chemical in the plant at heading when infection occurs. Also, the inoculum does not infect the developing seedling as in other bunt diseases nor is it internal to the seed as in smuts. KB teliospores must make their way to the soil surface or be deposited there during planting for sporidia to develop and be moved by air currents to infect the flowers.

Fungicide seed treatments have been used to reduce the spread of inoculum via seed; however, there are only a few fungicides currently registered for use against bunts in the US, and none is known to kill KB spores on the seed surface. A number of chemical companies are seeking to register fungicides such as PCNB and carboxin + thiram (Vitavax 200 or RTU-Vitavax-Thiram) for use against KB since they are reported to inhibit the germination of seedborne KB spores in Mexico. The problem with all the current fungicides is that KB spores will germinate once the chemical is washed off the spore. For small samples, spores on seed surfaces may be eliminated by disinfesting seeds in a 1.75 percent solution of sodium hypochlorite (i.e., one part of household bleach to two parts of water) plus Tween 20 with agitation for 10 minutes followed by rinsing. Germination of seed treated in this manner is reduced slightly. All seed coming from KB infested areas such as Arizona is being assayed for KB spores and must possess export/import permits for movement within the United States.

Currently, resistance in wheat varieties adapted to Idaho is unknown. There are some good sources of resistant germplasm in the collection of the International Center for the Improvement of Maize and Wheat in Mexico and elsewhere which could be exploited in future breeding efforts.

Acknowledgments Some of the information herein comes from the USDA/APHIS Karnal bunt page on the World Wide Web and several state extension newsletters. Special thanks to Joel Floyd of APHIS for permission to use the drawing of the life cycle of Telletia indica.

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