UNIVERSITY OF ILLINOIS EXTENSION
College of Agricultural, Consumer and Environmental Sciences

report on
PLANT
DISEASE

RPD No. 205
November 1991

DEPARTMENT OF CROP SCIENCES
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

CORN EAR AND KERNEL ROTS

Corn is susceptible to a number of ear- and kernel-rotting fungi that reduce the yield, quality, and feeding value of the grain. In Illinois, ear rots occur in most fields every season. Losses vary greatly between years and from one locality to another during the same year.

After examining ears from two varieties over an 18-year period in Illinois, it was estimated that the total damage caused by ear-rotting fungi varied from 1.75 to almost 15% (average, 7.1%). During another 12-year period, he determined the prevalence of ear rots on four or more hybrids by isolating fungi from rotted or discolored kernels in shelled corn. Rot-damaged kernels varied from less than 1% to over 8.5% (average, 3.5%). Over a 25-year period,. N. E. Stevens, plant pathologist from the University of Illinois, reported that the number of carloads of corn received during the month of June at a number of Illinois terminals graded with damage of more than 5% varied from about 1% to over 90% (average, 36.5%).

Figure 1. Corn earworm injuries followed by fungus attack.

The large variations in the prevalence of ear rots during different years was highly correlated with the amount of rainfall during July, August, and September. The greatest losses occurred when the rainfall was above normal from silking to harvest. Other factors that lead to increased ear rot losses are damage by corn earworms (Figure 1), European corn borers, birds, and by the lodging of the stalks where the ears touch the soil. Hybrids that have the most ear rot in standing corn usually have the most in lodged corn as well.

1. **Fusarium kernel or ear rot**, caused by the fungi *Fusarium moniliforme* and *F. subglutinans* (teleomorphs *Gibberella fujikuroi* and *G. subglutinans*), is the most widespread disease attacking corn ears in Illinois. The occurrence of these fungi increases when harvest is delayed beyond physiological maturity. The first symptom is a salmon pink-to-reddish brown discoloration of the caps of individual kernels or groups of kernels scattered over the ear. Rot seldom involves the whole ear. As the disease progresses, infected kernels become covered with a powdery or cottony-pink mold growth composed of large numbers of microscopic spores (Figure 2). Kernels infected late in the season develop whitish streaks on the pericarp (Figure 3). The same fungi are commonly found in stalks and seeds that appear normal.

For further information, contact Dean K. Malvick, Extension Specialist and Field Crops Pathologist, Department of Crop Sciences, University of Illinois, Urbana-Champaign.

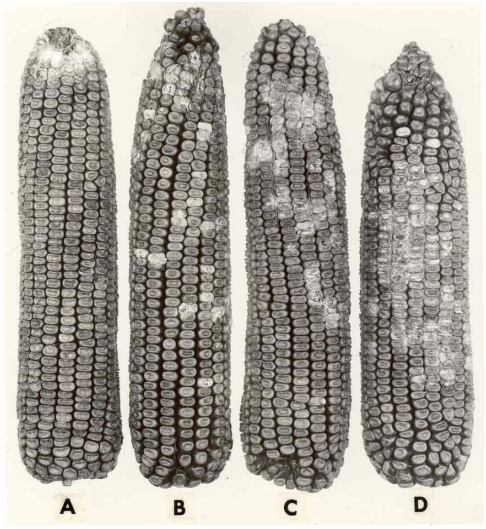

Figure 2. Fusarium ear rot: (A) ot at tip of ear following damage by earworms or birds; (B) scattered rot, largely preceded by growth cracks; (C) extensive rot following earworm injury; (D) severe rot after soaking by rain.

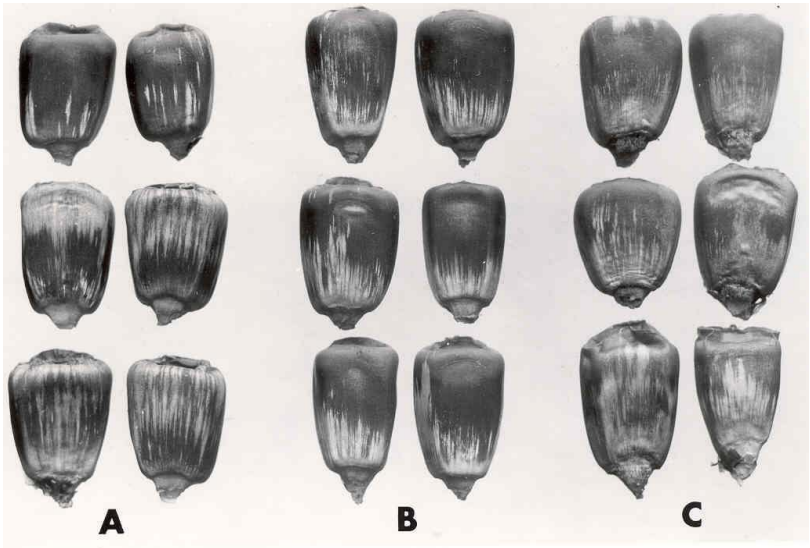

Figure 3. Corn kernels with white streaks caused by infection with Fusarium Cephalosporium, and Nigrospora. White streaking is a sure sign the kernels are infected with fungi.

Infection commonly follows some form of injury. Bird feeding encourages infection at the tip of the ear. Kernels damaged by growth cracks, other pericarp injuries, or the feeding of European corn borers or corn earworms usually rot. Disease development and spread are favored by dry, warm weather.

2. **Gibberella ear rot or red ear rot**, caused by the fungus *Gibberella zeae* (anamorph *Fusarium graminearum*, synonym *F. Roseum* f. sp. *cerealis* (Graminearum), is common in Illinois in some years. This fungus, however, is much more important as a major cause of stalk rot. A reddish mold, usually starting at the tip of the ear, is characteristic of Gibberella ear rot. All kernels become reddish as the fungus colonizes the entire ear. The husks may adhere tightly to the ear and a pinkish to reddish mold often grows between them (Figure 4). Superficial, speck-sized, bluish black perithecia occasionally develop on the husks and ear shanks. The corn ears are generally susceptible only when they are very young, and cool, wet weather within 3 weeks of silking favors disease development. Ears infected early in the season may rot completely, although complete rotting is rare in Illinois. Ears with loose, open husks are often more susceptible than those with good husk coverage. Sap beetles are capable of transmitting conidia and ascospores of the fungus, both within and between corn ears, thus increasing the amount of ear rot. Inbreds and hybrids differ in susceptibility. Corn infected with Gibberella ear rot is particularly toxic to hogs, dogs, and other animals with similar digestive systems, causing vomiting, dizziness, loss of weight,

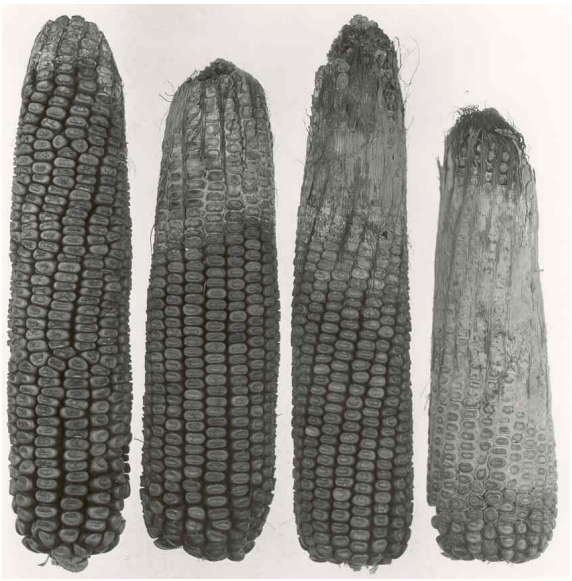

Figure 4. Gibberella ear rot, uniform rather than scattered infection ranging from a small amount on the tip of the ear (left) to complete rotting (right).

or even death in severe cases. Hogs refuse infected corn on the ear when 5 to 10 percent or less of the kernels are rotted. When such corn is ground, hogs must eat it or starve. Infected corn is also toxic to humans.

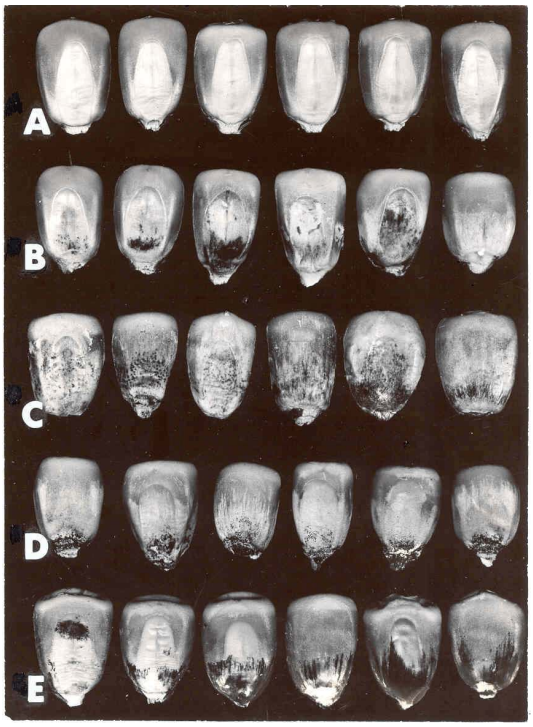

Figure 5. Corn kernels: (A) sound; (B) damaged by Diplodia zeae; (C) damaged by Physalospora zeae; (D) damaged by Nigrospora oryzae; (E) damaged by Cladosporium herbarum.

3. **Nigrospora ear rot or cob rot** is caused by the fungus *Nigrospora sphaerica*, synonym *N. oryzae*, teleomorph *Khuskia oryzae*. The disease is widely distributed, but its prevalence varies greatly from year to year. Affected ears, which are not conspicuous until harvest, are chaffy, weigh less than healthy ears, and have kernels which are loose on the cob. Shanks, bases, and cobs of badly infected ears are often shredded, particularly when the ears are picked mechanically or later when the ears are shelled. In shelling, the cobs break into small pieces. Many diseased ears are knocked to the ground by mechanical pickers. Infected ears show large numbers of speck-sized, jet-black spore masses scattered in the shredded pith of the cob and on the tip ends of the kernels (Figure 5D). Affected kernels are slightly bleached, often with whitish streaks starting at the tips and extending toward the crowns, and may show a gray mycelial growth (Figure 6). Pound for pound, Nigrospora-rotted corn has almost the same nutritive value as healthy corn. Infection usually starts at the butt end of the ear although sometimes at the tip. Damage is most severe when normal plant growth is arrested or plants are killed prematurely by frost, drought, hail, stalk or root rots, leaf blights, insect damage, root injury, or infertile soil.

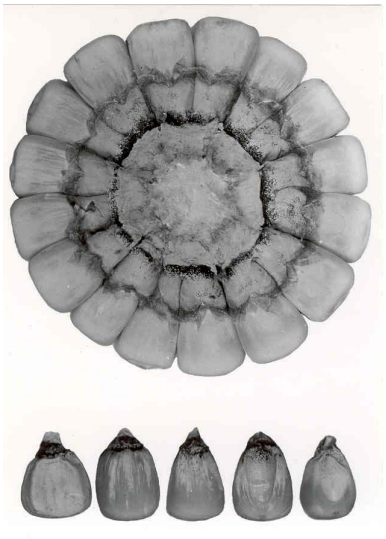

Figure 6 Nigrospora ear rot. Note black dots at ends of kernels and in cross section of the ear. Whitish streaks on kernels are due to air channels in the pericarp. Similar streaking occurs in kernels infected with Fusarium moniliforme and Cephalosporium acremonium.

4. **Diplodia ear rot or dry rot**, caused by the fungus *Diplodia maydis*, synonym *D. zeae*, was formerly a serious ear rot in Illinois, but is uncommon now. The same fungus is commonly associated with stalk rot and may cause a seed rot-seedling blight. The husks of ears which are infected early appear bleached or straw-colored, in contrast to green healthy ears. Infections occurring within 2 weeks after silking cause the entire ear to be gray-brown, shrunken, very lightweight, and completely rotted (Figure 7). Lightweight ears stand upright, with the inner husks stuck tightly together and to the ear by white mycelial growth. Ears infected later in the season usually show no external evidence of disease. When the husks are opened a white mold is seen growing

Figure 7. Diplodia ear rot. Lightweight mummified ear at right resulted from an early infection. The other ears were infected later.

between the kernels. All or part of an ear may be rotted. In still later infections, the white mold may or may not be visible between the rows of kernels. Ears sometimes appear healthy until after shelling, when the brown germs and dead kernels become evident. Infection usually begins either at the base of the ear progressing toward the tip or at an exposed ear tip, but can also advance from the stalk through the shank and into the ear.

Speck-sized, black fruiting bodies (pycnidia) of the *Diplodia* fungus are often found scattered on the husks and sides of the kernels (Figures 8 and 5B) as well as the floral bracts and cob tissues. The pycnidia are filled with thousands of microscopic spores that may be carried considerable distances by the wind to initiate new infections. Rotted ears have both reduced nutritive value and reduced palatability to hogs. Dry weather early in the season followed by abnormally wet weather just before and after silking favors ear infection. Ears are most susceptible from silking to about three weeks later. Hybrids with poor husk coverage or thin pericarps are often very susceptible. Some isolates of *Diplodia maydis* may induce vivipary (premature germination of kernels on the ear).

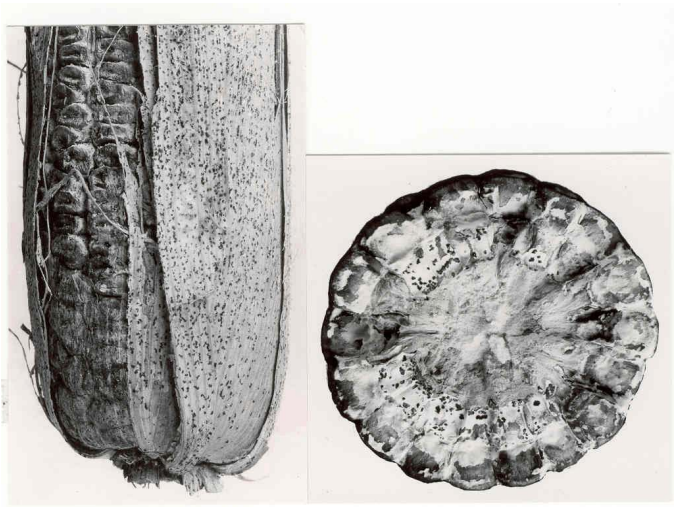

Figure 8. Diplodia pycnidia in the husks (left) or in the broken cross section (right) of completely rotted ears. The black pycnidia are large in the broken ear.

5. **Gray ear rot**, caused by the fungus *Botryosphaeria zeae*, synonym *Physalospora zeae*, anamorph *Macrophoma zeae*, is rare in Illinois and occurs only in restricted areas. Early infections may produce symptoms similar to those of diplodia ear rot: (1) a grayish white mold develops on and between the kernels, usually starting at the base of the ear; (2) in early infections the husks are bleached and adhere tightly to the ear; (3) the ears are lighweight, stand upright, and at harvest are slate gray instead of grayish brown, as in Diplodia ear rot; and (4) when the shank and butt are rotted, the ear breaks off. In later stages, gray ear rot may be distinguished from Diplodia by the presence of numerous, small, black specks (sclerotia) scattered throughout the interior of the cob, on the husks, and under the seed oat of the kernels (Figure 5C). Kernels may develop a uniform slate gray to black streaking. The fungus growth on the surface of the ear and between the kernels is also a darker gray than on Diplodia-rotted ears. Early infection usually causes the ears to be shriveled, black, and mummified (Figure 9). Disease development is favored by extended periods of warm-to-hot weather for several weeks after silking.

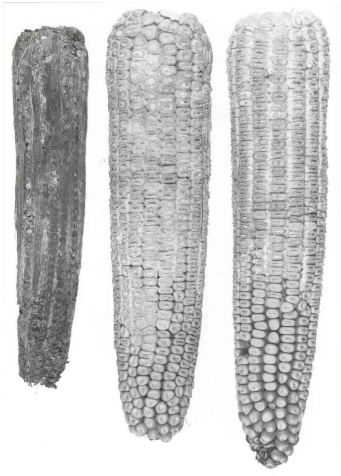

Figure 9. Gray ear rot. Early infection (right) causes ears to be shriveled and black; late infection (left) may resemble Diplodia ear rot. Sclerotia, rather than pycnidia, are produced.

6. **Penicillium rot** (*Penicillium* spp) is found occasionally, particularly on ears injured mechanically or by corn earworms and European corn borers. The typical powdery, blue-green or green mold grows on and between the kernels (Figure 10), which are frequently bleached and streaked. Damage usually occurs at the tip of the ear, but may be found on other parts.

The same fungi cause seedling blight and "blue-eye" storage rot of shelled corn with a high moisture content.

Figure 10. Penicillium rot. Note the powdery mold growing on and between the kernels.

7. **Aspergillus ear rot** (*Aspergillus* spp) is ordinarily of little importance before harvest. However, Aspergillus infections often follow drought stress and damage done by corn earworms and European corn borers and other insects. The causal fungi bring about serious losses in stored corn, on the ear or shelled. A tan, sooty-black, greenish, or greenish yellow mold grows on and between the kernels (Figure 11). Damage is most common at or near the tip of the ear. Silk infection is favored by high day and night temperatures.

Certain *Aspergillus* fungi (*A. flavus* and *A. parasiticus*) that cause ear and kernel rots also produce aflatoxins. Aflatoxins are potent carcinogens that can cause serious feeding problems in a wide range of animals. Fortunately, aflatoxins are rarely found in the field in Illinois because temperatures at or near harvest rarely exceed 80°F (27°C), the temperature at which these fungi begin to produce significant quantities of aflatoxins. In Illinois, aflatoxins are usually the result of the activities of *A. flavus* and *A. parasiticus* invading growth cracks and injuries of shelled corn in storage. Corn planted and harvested late and grown under nitrogen stress more commonly contain aflatoxins prior to harvest than corn grown under good management practices and supplied with adequate nitrogen.

Figure 11. Aspergillus ear rot (Aspergillus glaucus group) (courtesy J. Tuite).

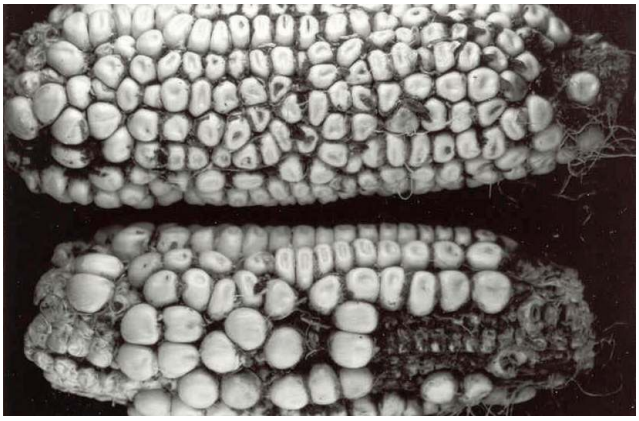

Figure 12. Trichoderma ear rot.

8. **Trichoderma ear rot** (*Trichoderma viride*) is evident as a green, fuzzy mold growing on and between the husks and kernels (Figure 12). *Trichoderma* is usually secondary to insect or mechanical damage to the ear.

9. **Cladosporium kernel or ear rot** (*Cladosporium herbarum*, synonym *Hormodendrum cladosporioides*) occasionally has been found in Illinois, especially following an early frost. Symptoms include the development of dark, greenish black, blotched or streaked kernels scattered over the ear (Figure 5E). The black discoloration shows first near the tips of the kernels and develops toward the crown in more or less irregular streaks. The fungus may also invade crowns damaged by growth cracks. Further rotting may occur during storage. When completely colonized, the ears are dark and lightweight.

10. **Black ear rot** (*Biplorais zeicola,* synonym *Helminthosporium carbonum,* Races 1 or 2*; Bipolaris maydis,* synonym *Helminthosporium maydis,* Race T; and *Exserohilum rostratum* (synonym *Helminthosporium rostratum),* is occasionally found, mostly on certain inbred lines. The same fungi also cause stalk rots, leaf blights, and seedling blights. Damaged ears have a black, "felty" or velvet-like mold growth over and between the kernels (Figure 13). Such ears appear to have been charred by fire.

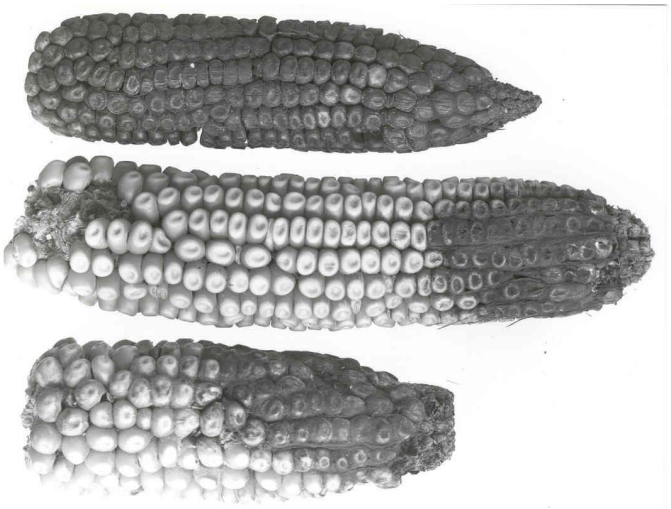

Figure 13. Corn ears from an inbred attacked by Helminthosporium carbonum, Race 1.

11. **Rhizopus ear rot** (*Rhizopus* spp) is characterized by a coarse white mold over the ear in which numerous black sporangia appear as black specks (Figure 14). Rhizopus rot is usually found only on ears injured by insects or hail a few weeks after silking during or following hot, very humid weather.

12. **Physalospora ear rot** (*Botryosphaeria festucae*, synonym *Physalospora zeicola*, anamorph *Diplodia frumentii*) is rare in Illinois. The disease develops as a dark brown-to-black, "felty" mold growth on all parts of the ear (Figure 15). Mildly infected ears may have a few blackened kernels near the base of the ear. Warm, humid weather favors infection.

13. **Rhizoctonia ear rot** (*Rhizoctonia zeae*), rare in Illinois, is recognized in its early stages by a salmon-pink mold growth on the ear. Infected ears later become dull gray. Numerous white to salmon-colored sclerotia develop on the outer husks with the sclerotia later turning dark brown to black. Warm-to-hot, very humid weather is favorable for infection.

Figure 14. Rhizopus ear rot.

DISEASE CYCLE

The fungi that cause ear and kernel rots of corn overseason in crop residues, in or on the soil surface, or in stored grain. The fungi tend to increase in numbers if corn is grown in the same field year after year. However, these fungi are so common and widespread in the Corn Belt that crop rotation and a clean plowdown of crop residues would make little difference in the total inoculum levels unless essentially all the corn growers in a county followed those practices.

The fungi, except *Rhizoctonia* and *Botryosphaeria festucae*, produce large numbers of microscopic spores that are disseminated by air currents, rain, birds, insects, mites, and humans. The spores germinate at favorable temperatures in the presence of moisture. The resulting hyphae penetrate the husks, kernels,

cob, or shank. Several ear- and kernel-rotting fungi also cause stalk rot, seed rot-seedling blight, and leaf blight.

Figure 15. Physalospora ear rot.

CONTROL

1. **Grow resistant varieties.** Inbred lines differ in their resistance to the various ear- and kernel-rotting fungi and transmit their reaction to their hybrid combinations. No inbred line or hybrid, however, is completely resistant to all ear-rotting fungi. Corn breeders usually discard the most susceptible inbreds and do not use them in hybrid combinations. Hybrids with poor husk coverage or weak seed coats, in which kernels tend to "pop" or "silk cut", are often more susceptible to infection by certain ear- and kernel-rotting fungi.

2. **Grow full-season, adapted hybrids that are resistant to stalk rots and leaf blights.**

3. **Practice balanced soil fertility, based on the results of a soil test**. Where possible, irrigate during extended droughts.

4. **Control corn earworms and European corn borers**, where practical, by timely applications of insecticides, as recommended by University of Illinois Extension Entomologists.

5. **Harvest the corn as soon as moisture levels permit**. To avoid unnecessary injuries to the kernels, the combine should be properly adjusted and run at the recommended speed.

6. **Store ear corn and shelled grain at the recommended levels of moisture content**: below 18% for ears and 13 to 15% for shelled corn. Where possible, aerate the grain to maintain a uniform temperature of 40°to 50° (4° to 10°C) throughout the bulk.

7. **Store only properly cleaned grain in a bin that has first been thoroughly cleaned of debris**. This practice will limit the development of ear and kernel rot as well s storage rot fungi.

Thorough plowing-under of crop refuse and rotation with nonsusceptible crops (such as soybeans, small grains, forage legumes, and grasses) are of **doubtful value** in controlling ear and kernel rots in Illinois.