Controlling Rootrots of Cereals and Grasses

By Roderick Sprague

There are a number of kinds of molds causing decay of the underground parts of cereals and grasses in North Dakota. Most of the damage is done by four species as follows: (1) The root browning fungus, (2) the common rootrot fungus, (3) the damping-off fungus and (4) the scab fungus. The latter is largely confined to the eastern part of the state. If scabby seed is planted, seedling injury will result.

The root browning fungus is the main cause of the May-June blight of April-seeded grasses. It also causes the widespread root browning of spring-sown small grains, of mature grass stands, and is the cause of a disease of sorghum. Its continued attack upon the roots of older grass plants speeds the “going out” of established stands in the western part of the state.

The common rootrot fungus causes seedling death in cereals and grasses and also causes the common root decay, leaf spot blotch and head mold of cereals and of some grasses. It is more serious on cereals than the root browning fungus but on grasses the latter is more important because of the losses due to May-June blight in the seedling stage.

The damping-off fungus is one of the chief causes of seed rot or preemergence rot in grasses in early season and causes a root necrosis or decay in roots of corn, oats, millets, and sorghum.

The scab fungus causes a serious disease of wheat, corn, and barley east of that part of the Great Plains lying west of the Red River Valley but is seldom important in the true Plains country.

Some of the rootrots are seasonal. Root browning and seedling blight develop during May through June. Mild secondary infection occurs in the fall or even during the summer on growing crops but injury usually is not important after June. The damping-off fungus develops earlier in the spring than the blight fungus. It and other molds and bacteria cause the death of seedlings at sprouting time in cold, wet soil. At least twenty-five percent of all grass seed planted in the spring fails to emerge because of the damping-

1Cooperative investigations between the Divisions of Cereal Crops and Diseases, Forage Crops and Diseases, Soils, Fertilizers and Irrigation, Bureau of Plant Industry, Soils and Agricultural Engineering; Agricultural Research Administration; Nursery Division, Soil Conservation Service, U. S. Department of Agriculture; and the North Dakota Agricultural Experiment Station. This article is a progress report based on seven years of study, in North Dakota and adjacent states.
2Pathologist, Division of Cereal Crops and Diseases and Collaborator, Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering.
3Pythium arrhenomanes (See also P. graminicolum)
4Helminthosporium sativum.
5Pythium debaryanum (Also P. irregularare and P. ultimum)
6Fusarium graminearum (Also F. culmorum)
off fungus and associated forms. The common rootrot fungus and the scab fungus also cause serious seedling injury when they are seed-borne. The common root-rot fungus continues to prey on the roots until maturity of the crop.

**CONTROL OF THE ROOTROTS**

The suggestions on control of the rootrots are as follows:

**Seed Treatment**

The molds that cause injury or death to the roots and crowns of cereals and grasses in North Dakota are present in most soils in the region. Some of these molds, such as the common rootrot fungus, and the scab fungus, also are carried on the seed. These seed-borne molds can be readily killed by treating the seed with New Improved Ceresan, one-half ounce per bushel for cereals and three-fourths to one ounce per bushel for grasses. While dryland grown seed of crested wheatgrass may be relatively free from molds, it has been found that grass seed grown on the eastern edge of the Northern Great Plains is frequently moldy and requires treatment.

In addition to killing molds on the seed, seed treatments are somewhat effective in checking seed rot in cold wet soil. However seed treatment has slight effect in controlling damping-off in grasses and none in controlling soil-borne blight.

**Rotation Practices**

By use of practical rotation practices, it is possible to alter growing conditions so as to favor the crop plant over the compet-
ever, because it is wide-spaced, permitting aeration of the soil surface and because the plant debris which is left does not afford much food for the non-parasitic increase of the common rootrot fungus. If grass weeds, such as pigeon grass, are allowed to grow, however, root browning and common rootrot fungi increase to a point where serious injury is likely to occur in the following grain or grass crop, particularly if the next crop is stubbled in. At Mandan, millets, sorghums and sudan grass are not always desirable crops to precede grass, particularly millets, which are carriers of a number of species of rootrot fungi.

A rotation of wheat-corn-oats is helpful in keeping rootrot losses at a minimum. Another rotation that has given some promise is wheat-oats-fallow, where fallow and oats are practical. Oats preceding grass is a satisfactory crop. While oats are moderately susceptible to the damping-off fungus, they do not seem to increase the root-browning fungus to any extent.

In fallow, as fungi-suppressing bacteria decrease in numbers, through starvation, the damping-off fungi become more aggressive for a time. Therefore, alfalfa, and to some extent small seeded grasses, are likely to suffer heavy losses from seed rot when seeded on fallow under unfavorable climatic conditions. Oats may show some increase in loss from root necrosis on fallow but since wheat is resistant to most strains of the damping-off fungus, it is not damaged. Crested wheatgrass is also somewhat resistant to the damping-off fungus and can be seeded on fallow. Root browning is not appreciably increased by fallow in this region.

It is difficult to starve out some fungi by fallowing. The common rootrot fungus, which depends on humus to survive fallow periods in the soil, can be starved out in time. The root browning fungus and also the damping-off fungus live for several years in continuous fallow. We have found a few soil samples, however, such as from old shelter belts, that were nearly free from parasitic molds. They are the exception.

In using legumes in rotation, in the vicinity of Mandan, alfalfa alone or mixed with adapted grasses, is one of the most desirable crops from the standpoint of rootrot control. While soil from young seedings of alfalfa shows great increase in damping-off fungi during the first season, these molds gradually disappear in later years from the drying out of the soil.

Sweet clover also starves out fungi detrimental to cereals and grasses but in the years following the plowing under of the sweet clover, the parasitic fungi tend to return sooner than following alfalfa.

**Seeding Dates**

Cool season grasses, such as crested wheatgrass, Russian wild-rye, and brome grass, tend to escape seedling blight injury at Mandan if they are seeded so as to permit the seedlings to be older than six weeks by late May or early June. When possible, crested wheatgrass or wild-rye should be seeded in the fall at Mandan or even in very late fall or during the winter if open weather permits. If spring-seeded at Mandan, seedings should be made as early as the ground
can be prepared. Warm season grasses, such as blue grama, sudan grass, and millets, may be sown later.

**VARIETAL AND SPECIES RESISTANCE**

**CEREALS:** No true resistance to rootrots occurs but rootrot tolerant strains of spring wheat show five to six percent loss in North Dakota while varieties susceptible to rootrot average about seven or eight percent loss. Some of the standard varieties of spring wheat such as Pilot, Mida, and Rival are considered tolerant while most of the durums and such older varieties as Ceres are considered susceptible to the whole rootrot complex.

Root decay of oats is important in eastern North Dakota but has been severe only one year (1942) in western and central North Dakota since 1940. Varietal resistance studies have not shown any outstanding varieties.

Barley has suffered heavily from rootrot in recent years, so much so that it is disappearing as a crop in some areas. The variety Flush has been resistant at Dickinson but is not otherwise outstanding there. Breeding for rootrot resistance in barley should be worthwhile.

**GRASSES:** Summarized data on the relative resistance of species of grasses to blight at Mandan are given in Table 1. In addition to the information on the species or kinds of grasses, some information has been obtained on the relative resistance to the fungi of strains and commercial varieties of these species or kinds of grasses.

Everything else being equal, strains of grass that produce large plump seed are best adapted for surviving seedling blight because such seeds have more reserve food and produce more vigorous seedlings. Thoroughly cleaned seed with high test weight should be used.

Strains of brome grass and of intermediate wheatgrass also resistant to leaf spotting as well

### TABLE 1—SUMMARIZED DATA ON THE RELATIVE RESISTANCE OF CERTAIN GRASSES TO THE COMMON ROOTROT FUNGI AT MANDAN.

<table>
<thead>
<tr>
<th>Name of grass</th>
<th>Seeding Blight Fungus</th>
<th>Common Rootrot Fungus</th>
<th>Damping-Off and Seedrot Fungus</th>
<th>Special notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluegrass, Canby's</td>
<td>MR to S</td>
<td>R</td>
<td>I to VS</td>
<td>Seedrot in eastern N. Dak.</td>
</tr>
<tr>
<td>Bluegrass, Sandberg's</td>
<td>MR to S</td>
<td>R</td>
<td>I to VS</td>
<td>Seedrot in eastern N. Dak.</td>
</tr>
<tr>
<td>Bluegrass, Kentucky</td>
<td>MS</td>
<td>S</td>
<td>S</td>
<td>Use certified strains</td>
</tr>
<tr>
<td>Brome, Smooth</td>
<td>MS to S</td>
<td>S</td>
<td>S</td>
<td>Use Mandan strain</td>
</tr>
<tr>
<td>Bunchgrass, Feather</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>Seed when soil is warm</td>
</tr>
<tr>
<td>Grama, Blue</td>
<td>S</td>
<td>VS</td>
<td>VS</td>
<td>Adapted only to light soils</td>
</tr>
<tr>
<td>Reegrass, Indian</td>
<td>VS</td>
<td>MS</td>
<td>MS</td>
<td>Use improved strains</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>MS</td>
<td>I</td>
<td>S</td>
<td>Do not seed over 1½ inches deep</td>
</tr>
<tr>
<td>Wheatgrass, Crested, Fairway</td>
<td>MS</td>
<td>MS</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Wheatgrass, Crested, Standard</td>
<td>MS</td>
<td>MS</td>
<td>MS</td>
<td>Treat moldy seed</td>
</tr>
<tr>
<td>Wheatgrass, Intermediate</td>
<td>MS</td>
<td>MS</td>
<td>S</td>
<td>Treat moldy seed</td>
</tr>
<tr>
<td>Wheatgrass, Longstemmed S to MS</td>
<td>MS</td>
<td>S</td>
<td>S to MS</td>
<td>Resistance has been variable</td>
</tr>
<tr>
<td>Wheatgrass, Slender</td>
<td>MS</td>
<td>S</td>
<td>MS</td>
<td>Short-lived</td>
</tr>
<tr>
<td>Wheatgrass, Western</td>
<td>MS to S</td>
<td>MS</td>
<td>MS</td>
<td>Treat moldy seed</td>
</tr>
<tr>
<td>Wildrye, Canada</td>
<td>MS</td>
<td>MS</td>
<td>MS</td>
<td>Use rust resistant strain</td>
</tr>
<tr>
<td>Wildrye, Russian</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>Seed in fall if possible</td>
</tr>
</tbody>
</table>

R, resistant; MR, moderately resistant; I, intermediate or variable in reaction, depending on race or strain of Pythium present; S, susceptible; MS, moderately susceptible; VS, very susceptible.
as ones better adapted to combat inroads of seedling blight are being developed. Much of this work is in the experimental stage.

**Tillage Practices**

Stubble mulching places most of the diseased straw and humus near the surface where it is close to the roots of the next crop. In humid regions this might be serious but in North Dakota the devitalizing effect of sunlight and drying on the old diseased plant parts reduces the danger to a minimum. In some cases and probably at intervals it should be advisable to plow under this diseased material.

Burning off the stubble has too superficial effects to be of very much value in destroying diseased material. Sometimes, however, burning reduces losses from the humus-carried common rootrot fungus. The root browning fungus and the damping-off fungi go too deep in the soil to be killed by stubble burning.

Except in 1940, and again in 1946, the date of plowing, either spring or fall, has not influenced the development of rootrot in cereals. In 1940, rootrot loss was much worse in the fall-plowed plots. The same was true in 1946.

Firm, but not hard-packed, seed beds aid to some extent in holding some rootrots in check. Fallow should be kept free from grass weeds, and in areas where wireworms are serious, all weeds should be eliminated from fallow and kept down in seeded fields. Wireworms and rootrots seem to aid each other in some places in northeastern North Dakota.

**Fertilizers**

Where fertilizers are used in potato and wheat rotations in the lighter soils of northeastern North Dakota, rootrot is less serious than in former years. Brief trials in former years and replicated ones in 1945 have indicated that pellet form ammonium phosphate (16-20-0) at the rate of 100 pounds per acre applied after seeding in the spring is advantageous. In 1946, the weather was too dry after seeding to permit the plants to utilize the fertilizer in time to have any effect either on rootrot or on yield.

Where barnyard manure was used in the rotation plots at Mandan and Dickinson, rootrot was reduced during all but the drier years. The judicious use of barnyard manure, therefore, usually is helpful in controlling rootrots in grain.

**Summary**

To reduce losses from rootrots in cereals and grasses, plant clean, plump seed in soil that has an adequate and balanced supply of nutrients, particularly nitrogen and phosphorus. While crop rotation will not eliminate rootrot, it will prevent maximum injury which results from continuous use of one crop.

Corn is the best crop to seed on land that has just had sod or a green manure crop plowed under. After the first year from green manure, or sod, rootrot losses usually are reduced. For this reason grass, or alfalfa or a mixture of grass and alfalfa should be included in long-time rotations. Rotations that include corn, wheat, and oats; or wheat, oats, and fallow, are beneficial in holding rootrot losses at a minimum.
Grass crops should follow oats or some crop that is not too susceptible to root browning. For cool season grasses in western North Dakota, seedings in early fall, late fall or very early spring are recommended. Since the critical time in the growth of seedlings is during the May-June blight period, if it is possible to have the seedlings older than six weeks they have a better chance to outgrow the blight fungi.

Fallow and corn land should be kept free from weeds, particularly free from pigeon grass, which carries a number of root-rot fungi.

Rootrot tolerant strains should be grown, if available. Where improved grass strains are available they should be used because they often are more vigorous than the common strains.

Seed treatment with ethyl mercury phosphate (such as New Improved Ceresan) is good insurance to protect grass and cereals from seed-borne rootrot fungi.

A survey of, "Fertilizer Consumption in the United States for the year ending June 30, 1945," made by A. L. Mehring, H. M. Wallace, and W. Scholl, of the Division of Soils, Fertilizers, and Irrigation, B. P. I., S., and A. E., U. S. Department of Agriculture, furnishes the following statistics in regard to the use of commercial fertilizers in North Dakota:

**Total Consumption of All Fertilizers 6,812 Tons for year July 1, 1944 to June 30, 1945**

<table>
<thead>
<tr>
<th>Constituents (Tons)</th>
<th>In Mixed Fertilizers</th>
<th>In All Fertilizers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>560</td>
<td>1492</td>
</tr>
<tr>
<td>Potash</td>
<td>379</td>
<td>379</td>
</tr>
</tbody>
</table>

The difference between the column "In all fertilizers" and the column "In mixed fertilizers" indicates the amount of unmixed fertilizer bought; it will be noted that a little nitrogen is bought in unmixed goods; a large amount of phosphoric acid, nearly three times as much as is bought in mixed goods, and all of the potash is bought in mixed goods. (Reviewed by H. L. W.)

Observations made by Federal and State Entomologists in Iowa indicates that the State of Iowa suffered a $25,000,000 loss of corn in 1946 due to damage by the European Corn Borer. Their observations indicate that the corn borer population increased 100 percent over 1945 and that there is a steady northern and westward movement of the insect. North Dakota farmers have already been advised that a single case of invasion of the insect was noted in Traill County, North Dakota, this summer.