Controlling Rootrots of Cereals and Grasses[1]

By
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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[3], (2) the common rootrot fungus[4], (3) the damping-off fungus[5] and (4) the scab fungus[6]. 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-

[1]Cooperative 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.

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[3]**Pythium arrhenomanes** (See also **P. graminicolum**)

[4]**Helminthosporium sativum.**

[5]**Pythium debaryanum** (Also **P. irregulare** and **P. ultimum**)

[6]**Fusarium 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 root-rot 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 competing parasitic molds or fungi. In some soils such as in old prairie sod or in balanced rotations, the soil-borne parasitic molds are more likely to be held in check or may be said to be in a state of equilibrium with the non-injurious fungi and bacteria. Some of the parasitic molds live and thrive on humus and half dead plant parts rather than as aggressive parasites. As soon as sod or green manure is plowed under, however, there follows a period when bacteria increase in numbers and there appears to be a shortage of available food, especially nitrogen, for all of the soil inhabitants. During this time, just after sod or green manure is plowed under, root-rots are likely to become more serious because the causal fungi attack the plant roots to obtain food. Corn, or sometimes oats, should be seeded the first year after breaking or after plowing under green manure crops.

After the *first* year from sod, the benefits in control of rootrot are evident from examination of the roots of cereals or of grasses sown on this land. All observations indicate that it is highly desirable to plow under grasses or some legume at intervals to keep the rootrot fungi in check. The secret seems to be in keeping a proper balance between nitrogen and phosphorus.

At Mandan and Dickinson, it has been found that standard rotations with cereal crops show only moderate differences in control or suppression of rootrot fungi during the seven-year period 1940-46. Some cereals such as oats and corn inhibit the common rootrot fungus, but the damping-off and root browning fungi are not depressed by them. Corn is usually beneficial, how-

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 nonparasitic 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 Plush 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.

Name of grass	Relative resistance to: Seedling Blight Fungus	Common Rootrot Fungus	Damping-Off and Seedrot Fungus	Special notes
Bluegrass, Canby's	MR[1] to S	R	I to VS	Seedrot in eastern N. Dak.
Bluegrass, Sandberg's	MR to S	R	I to VS	Seedrot in eastern N. Dak.
Bluegrass, Kentucky	MS	R	I to S	
Brome, Smooth	MS to S	S	MS	Use certified strains
Bunchgrass, Feather	S	S	S	Use Mandan strain
Grama, Blue	S	MS	VS	Seed when soil is warm
Ricegrass, Indian	VS	VS	MS	Adapted only to light soils
Switchgrass	MS	I	S	Use improved strains
Wheatgrass, Crested, Fairway	MS	MS	S	Do not seed over 1½ inches deep
Wheatgrass, Crested, Standard	MS	MS	MS	Treat moldy seed
Wheatgrass, Intermediate	MS	MS	S	Treat moldy seed
Wheatgrass, Longstemmed	S to MS	S	S to MS	Resistance has been variable
Wheatgrass, Slender	MS	S	MS	Short-lived
Wheatgrass, Western	MS to S	MS	MS	Treat moldy seed
Wildrye, Canada	MS	MS	MR	Use rust resistant strain
Wildrye, Russian	S	S	MS	Seed in fall if possible

[1]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 rootrot 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

Consumption of Fertilizer Constituents (Tons)

	In Mixed Fertilizers	In All Fertilizers
Nitrogen	80	88
Phosphoric Acid	560	1492
Potash	379	379

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 un-mixed 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.