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Plant Diseases Common, Destructive, Preventable in South Dakota

W.F. Buckhholtz

PLANT DISEASES

Common, Destructive, Preventable

in

SOUTH DAKOTA

PLANT DISEASE CONTROL

an integral part of

AGRICULTURAL PRODUCTION FOR VICTORY

Agricultural Experiment Station
South Dakota State College
Brookings, South Dakota

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COMMON DESTRUCTIVE PREVENTABLE DISEASES OF FIELD, GARDEN AND FRUIT CROPS IN SOUTH DAKOTA

W. F. Buchholtz*

Plant Diseases and Agricultural Production for Victory

Abundant agricultural production is a victory goal and in South Dakota is based on an abundance of feed, forage and cash field crops and an adequate home vegetable and fruit supply. On the other hand, soil conservation and the maintenance of South Dakota's agricultural productivity depends on a practice of moderate rather than wholesale over-cropping of cultivated land. Shortages of labor and machinery place a definite limit on the amount of really good farming that can be done it South Dakota for the duration of the war. One of the ways to insure maximum crop production from a minimum of planted acres is to prevent useless losses from easily preventable plant diseases.

One striking illustration will suffice to emphasize this point. In 1942, South Dakota farmers will probably plant nearly 2,000,000 acres of sorghum, and will probably harvest nearly 500,000 acres for grain. According to recent experience, 5 to 10 percent of this crop will never reach the bin because of sorghum smut. This means the useless loss of 250,000 to 500,000 bushels of feed grain, not counting the lowered nutritive value and palatability of the fodder from more than a million acres harvested for forage! Treatment of every sorghum seed planted in South Dakota in 1942 with a suitable seed disinfectant would reduce this tremendous loss to practically nil, at an almost insignificant cost.

In order to facilitate prevention of this and other similar entirely unnecessary plant disease losses at a time when they are particularly costly, the following list of preventable diseases, their most distinguishing characteristics and their control has been prepared for those who are engaged directly or indirectly in agricultural production for victory in South Dakota. This is not in any sense a complete list of South Dakota plant diseases and the descriptions are not comprehensive. Only the recognizable, most costly, and in most cases controllable diseases are included. Certain limitations to control are pointed out, with particular reference to some necessarily cumbersome methods and wartime shortages of materials.

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Fungicide Supplies Likely to be Limited During the Emergency

Mercury, copper and formaldehyde are the basic ingredients of many plant disease control materials. All of these are used in armament manufacture and by 1943 supplies for plant disease control may be limited. Sulfur and its derivatives will probably be available. Some substitutes may be available and their usability will be publicly announced when such becomes necessary. Among the materials of which a shortage may be expected are:

Copper carbonate - for treating sorghum and wheat seed for smut.

Copper sprays and dusts.

Organic mercury dusts and sprays. These include:

Merko, Barbak and New Improved Semesan Jr. for treating seed corn.

New Improved Ceresan and Ceresan for treating cereals and sorghum seed for smut and other seed-borne diseases.

Semesan Bel for treating potato seed pieces.

Semesan for treating vegetables, seeds and bulbs.

Mercuric chloride (corrosive sublimate) - for treating potato seed pieces and general disinfection in greenhouses, seedbeds, etc.

Formaldehyde - for treating potato seed pieces and general disinfection in greenhouses, seedbeds, etc.

Serious South Dakota Field Crop Diseases

SORGHUM

1. Smut

Sorghum smut is the black sooty degeneration of all the kernels of the ear. The individual black spore masses are a bit longer than the normal kernel and may be temporarily covered by a white or gray membrane which ruptures finally in harvesting, if not before, so that the tiny black spores are caused to scatter and some to be deposited on the surface of normal kernels. There they remain to germinate with the seed the following spring to infect all parts of the growing plant. Black spore masses displace the kernels of all ears on plants thus infected.

Control: Kill the spores adhering to the seed by treating before planting with copper carbonate, 3 oz. per bushel, well agitated with the seed to assure uniform coverage. Organic mercury dusts such as New Improved Ceresan or New Improved Semesan Jr., will also give control at the rates recommended for small grain or corn, depending on the material selected. Seed treatment also helps insure a uniform stand of healthy, vigorous plants.

2. "Milo" Disease

"Milo" disease constitutes a failure of grain sorghum where amber forage sorghums succeed. Grain sorghum stands which start to "burn" when 12 to 15 inches high and fail to head normally despite thin planting and a fair moisture supply may be afflicted with the "Milo" disease, especially if amber forage varieties on the same field or under similar conditions are normal. This disease is probably not yet common in South Dakota. Knowledge of its presence or absence would be particularly useful at the Agricultural Experiment Station at Brookings.

Control: Over-cropping to sorghum contributes to a "pollution" of the soil with this disease in Kansas. Resistant strains have been selected but seed of such may be hard to buy. Above all, report grain sorghum failures in the vicinity of amber sorghum successes to the county agent or the plant pathologist, South Dakota Agricultural Experiment Station, Brookings. There is reason to believe, but yet no proof, that "Milo" disease occurs in some South Dakota grain sorghum fields. Definite knowledge of its presence or absence in the state is highly desirable, since it is perhaps the most destructive known sorghum disease. It is not brought in on seed and can not be controlled by seed treatment.

3. Sorghum is also afflicted with "weak neck" and "charcoal rot", but their occurrence in South Dakota has not been determined and their control is not known.

CORN

1. Seed rot and seedling blight

Sometimes seed from nearly healthy-appearing ears is inconspicuously infected or covered with fungi (molds) which may rot the seed or the roots of seedlings from such seed. This is especially true of 1942 seed. Such infected seedlings may die, but more often are "blighted" or stunted. Apparent recovery is deceiving, for the life-long capacity of a corn plant is limited by its development during the first six weeks of growth. If cold wet weather prevails after planting, seed rot and seedling blight may result from the infection of disease-free seed by soil-borne fungi.

Control: Treat all seed before planting with New Improved Semesan Jr., Barbak C or Merko, 2 oz. per bushel. Spergon, which contains a new non-metallic toxic ingredient, has recently been offered for sale. It has proven satisfactory in corn-belt states and therefore probably will in South Dakota. Spergon will be tried at Brookings this year.

Corn seed treatment also helps insure a stand from slightly diseased seed or even disease-free seed in cold wet soil. Seed treatment may not increase the stand or yield from disease-free seed which germinates in warm soil, but the stand insurance provided by seed treatment in South Dakota will be well worth the cost. The amount of mercury applied to a bushel of corn seed is small; there is little waste even if the insurance was not needed.

2. Other corn diseases such as smut, stalk rot, ear rot, rust, etc. occur in South Dakota, but no simple reliable control measures are available.

WHEAT

1. Rusts

There is no need to further describe wheat rusts here, or to emphasize that there are two common wheat rusts in South Dakota, stem rust and leaf rust, both of which have first a red stage, later a black stage.

Control: Plant resistant varieties. The following table lists the common varieties of wheat and their susceptibility or resistance to stem rust and leaf rust.

Variety	Resistance or Susceptibility to: Stem Rust	Leaf Rust
Thatcher	Very resistant	Very susceptible
Ceres	Susceptible	Susceptible
Pilot	Resistant	Resistant
Rival	Resistant	Resistant
Reward	Very susceptible	Very susceptible
Marquis	Very susceptible	Very susceptible
Burbank (Quality)	Very susceptible	Very susceptible
Mindum	*Resistant	Resistant
Kubanka	*Resistant	Resistant
Red durum (Pentad)	Very resistant	Very resistant

*Mindum and Kubanka were infected with stem rust at Brookings in 1941. According to the Federal Rust Laboratory at St. Paul, race 17 is now the most common race of stem rust in the wheat belt. Race 17 rusts durum wheats. Dr. E. C. Stakman points out that if we have a serious stem rust out-break, durum wheats may be damaged more than in past years.

Plant early. Every additional week toward maturity lessens rust damage.

Barberry eradication is a constructive enterprise insuring the freedom from local beginnings of stem rust outbreaks and the permanence of rust-resistant varieties developed by the plant breeder. The barberry eradication and wheat and other small-grain breeding programs of the South Dakota Agricultural Experiment Station and the U. S. Department of Agriculture deserve support. Both are stabilizing factors in South Dakota's cereal production capacity.

2. Smuts

a. Bunt, covered or stinking smut of wheat is apparently again becoming common in durum and Reward wheats in the South Dakota spring wheat area. The following communities shipped "smutty" wheat to Minneapolis in 1941: Groton, Britton, Willow Lake, Florence, Kranzberg, Rauville, Watertown, Waverly. This smut is characterized by black sooty degeneration of all the kernels of all the heads of an infected plant. The black spore mass is covered by a gray membrane and remains intact until mechanically broken, usually by harvest operations, when the tiny spores are disseminated and some are deposited on the surface of normal kernels. There they remain to germinate with the seed and inconspicuously infect all parts of the growing plant. Black spore masses displace the kernels of all heads on plants thus infected. The damage to the crop is a reduction in yield and the undesirable smell imparted to the mass of grain, which is discounted by the buyer.

Control: Kill the spores adhering to the seed by treating with a suitable seed disinfectant. An organic mercury dust, New Improved Ceresan, 1/2 oz. per bushel, is the most commonly used and recommended treatment. Copper carbonate, 3 oz. per bushel, well agitated with the seed to assure uniform coverage, is also effective. Covered smut can be disseminated in a thresher.

b. Loose smut is, as the name indicates, not covered in the infected heads and is characterized by a black sooty disintegration of the entire wheat head excluding the rachis. The black spore mass is disseminated principally by wind at about the time the wheat blossoms, leaving only the unadorned rachis of the smutted head. Some of the spores come to rest on developing normal kernels, germinate and grow into them immediately without destroying them. Hence the fungus over-winters inside the seed, which bears no external evidence of infection. When an infected seed germinates, the fungus resumes inconspicuous growth with the plant throughout the season and infects and destroys every head formed.

Control: The loose smut fungus can be killed only one way: by heating the seed which harbors it internally. This is accomplished by immersing and holding the seed in water hot enough to kill the smut fungus but not the seed. Obviously the process is difficult and tedious; in fact it is desirable to treat only enough seed to grow clean seed for the crop two years hence. Fortunately, loose smut is not prevalent on spring wheat in South Dakota. Anyone having it might do well to sell his seed stock and buy seed from a neighbor or Crop Improvement Association member known to have a smut-free seed stock. Should it become necessary to attempt a hot water treatment of wheat seed, consult the county agent or the experiment station plant pathologist.

3. Seed Rot and Seedling Blight

Seed rot and seedling blight may be caused by seed or soil-borne fungi. Sometimes wheat seed rots during germination, or young seedlings may "blight" and die or be stunted. This is particularly true of shrivelled, scabby or "black point" kernels. Scabby or "black point" kernels are infected by fungi (molds) which rot the germinating seed or infect the young seedling, resulting in blighted or stunted plants. The presence of fungi can be detected on seed in a rag doll tester, where they develop on infected kernels into extensive white, pink, black or green cottony or velvety mold growths.

Control: Treat the seed with an organic mercury dust (New Improved Ceresan) 1/2 oz. per bushel, or with copper carbonate, 3 oz. per bushel. These are the treatments recommended for bunt or covered smut. The abundant presence of seed-borne fungi on seed wheat should first be determined in a rag doll germination test. Copper and mercury should be conserved, and the increase in yield from treating plump, disease-free wheat often is negligible. Wheat seed will germinate at a low temperature and tolerate very low temperatures. Disease-free wheat does not need seed treatment for stand insurance in cold wet weather after planting, as does disease-free corn. However, if the seed is not plump and hard, or if there is a likelihood of contamination with covered smut spores or considerable moldy seed in the germination test, the seed should be treated.

4. There are several other common wheat diseases which take a certain toll but for practical purposes they are at present unpreventable and are not ennumerated here.

BARLEY

Barley is the most afflicted of all the small grains with disease; in fact where the climate is favorable for corn, barley diseases are the limiting factors in satisfactory barley production and use. Fortunately the climate north and west of the corn-belt is not so favorable for barley diseases, and in that area diseases ordinarily need not discourage barley production. Of the barley diseases, the smuts can be serious anywhere and can be controlled. They and barley rusts and scab will be briefly discussed here.

1. Covered Smut

Covered smut of barley, like that of wheat is characterized by black sooty degeneration of all the kernels of all the heads of an infected plant. The black spore mass is covered by a membrane and remains intact until mechanically broken, usually by harvest operations, when the tiny spores are disseminated and some are deposited on the surface of normal grain. There they remain to germinate with the seed and inconspicuously infect all parts of the growing plant. Black spore masses displace the kernels of all heads on plants thus infected. The

damage to the crop is in direct proportion to the number of heads destroyed.

Control: Kill the spores adhering to the seed by treating before planting with an organic mercury dust, New Improved Ceresan, 1/2 oz. per bushel as per directions on the carton. Covered smut can be disseminated in a thresher.

2. Loose Smut

Barley loose smut, like that of wheat, is not covered by a membrane so that the black sooty degeneration engulfs the entire head excluding the rachis. The black spore mass is disseminated, principally by wind, at about the time the barley plant blossoms, or a bit later. Some of the spores come to rest on developing normal kernels, germinate, and grow into them before maturity and without visible external effect. When an infected seed germinates, the fungus also resumes growth and finally destroys every head formed on the infected plant.

Control: Since infection by certain strains of the barley loose smut fungus does not extend deeply into the seed, seed treatment as for covered smut sometimes also controls loose smut, namely, an organic mercury dust (New Improved Ceresan), 1/2 oz. per bushel. Other strains, which grow deep into the embryo ("germ") can be controlled only by the hot water treatment, about which the county agent or the experiment station plant pathologist should be consulted. The correct procedure, therefore, if barley has been heavily smutted (a considerable amount in east-central South Dakota has), is to treat the seed with an organic mercury dust; if a noticeable amount of smut still persists in the crop, see your county agent and consult your experiment station plant pathologist about the hot water treatment.

3. Rusts

Barley is parasitized by the same rusts which occur commonly on wheat in South Dakota, stem rust and leaf rust, both of which have first a red stage, later a black stage.

Control: Plant early. Every additional week toward maturity lessens rust damage. All of the barley varieties available for South Dakota are susceptible to both stem rust and leaf rust.

4. Barley Scab or Blight

This is the other disease of barley that should be watched, even if control is not possible, since an excess of 5 percent scabby kernels in barley usually makes it unfit for hog feed and more than 4 percent* disqualifies it for malting purposes. There was considerable scabby barley grown in eastern South Dakota in 1941. Scabby barley is characterized by shrivelled kernels, darker than normal on heads or in the bin with considerable plump, bright kernels. These shrivelled discolored kernels are infected by a fungus whose growth by-products cause swine to vomit and refuse their feed. If planted, such kernels may fail to germinate, or if they do, may produce a blighted, stunted seedling.

*To grade "No. 1 Malting", the "blight" content must be under 2 percent.

Control: Careful screening and fanning may remove some of the shrivelled infected kernels. Dilution of the infected barley with other feeds may enable hogs to utilize scabby barley. Cattle can eat it with safety and it may be safely included as a part of the sheep and poultry ration. Treatment of scabby barley seed with an organic mercury dust (New Improved Ceresan), 1/2 oz. per bushel, will result in a more uniform stand of healthy seedlings than from scabby seed planted without treatment. Seed treatment will not insure freedom of the crop from scab, since the fungus over-winters also on corn and cereal residues outdoors. Seeding barley on other than corn land or plowing under infected over-wintered cornstalks are sometimes recommended, but unplowed corn land, other than for scab control is probably the most suitable place to seed barley. Wheat and oats are not so susceptible to scab as barley.

OATS

Oats are not afflicted with many serious diseases. This relative freedom from disease doubtless accounts for their popularity in the corn-belt and makes them a stable small grain feed choice in that area during the war emergency. Two destructive diseases are sometimes prevalent, crown rust and smut.

1. Crown Rust

Crown rust is the leaf rust of oats. Stem rust is not mentioned because Richland and Miomark are highly resistant and Gopher, though susceptible, is early and may escape severe damage. These varieties are very susceptible to crown rust. The control for crown rust lies in the use of a variety resistant also to it. Such a variety will soon be available, possibly in 1943, from the South Dakota Agricultural Experiment Station, through your County Crop Improvement Association. The buckthorn is the alternate host of crown rust of oats. Extensive hedges of it sometimes are the source of severe early spring outbreaks in adjacent or nearby oat fields.

2. Smut

Smut is common in Richland and Gopher oats in South Dakota. All oats smut is essentially the same and can be controlled by an organic mercury dust (New Improved Ceresan), 1/2 oz. per bushel, applied as per directions on the carton. Miomark is smut-resistant; the prospective new South Dakota variety is smut-resistant. Oats smut can be disseminated in a thresher.

RYE

None of the diseases occurring on rye in South Dakota can be actively controlled by the grower at present. Ergot, however, is worthy of attention. Ergot is characterized by the long hard black mass protruding from the floret from the region where the kernel, which it replaces, should have been. Ergot is toxic when eaten by animals and man and can and should be removed by screening and fanning the grain before feeding. Cleaning the

seed before planting will not entirely control but may reduce the amount of ergot in the crop. Rye ergot contains a valuable drug, ergosterol, of which our foreign supply is no longer available. For information regarding a market write the Pharmacy Department, Agricultural Experiment Station, Brookings, South Dakota.

FLAX

Recommended wilt-resistant varieties of flax (Bison, Redwing) should be grown. If the seed lot is shrivelled and moldy in a germination test and if plantings are made before April 20, seed treatment with an organic mercury dust (New Improved Ceresan), 1/2 oz. per bushel, may serve as stand insurance.

Treatment of disease-free seed of cereals and flax for yield increase

We are faced with the possibility of limited supplies of mercury and copper fungicides. When seed grain and flax is not plump and hard or is from a smutty crop or is badly infected by seed-rotting or seedling pathogens as indicated by initial superficial observation or a germination test, it should by all means be treated. If the crop was smut-free and the seed is disease-free, bright, plump and hard there may be justification for saving valuable fungicidal material by not treating.

Experiments now being planned for all experiment stations in the upper Mississippi valley will determine the possibility of using less than the now recommended amounts per bushel of cereal and flax seed disinfectants. Tests of substitute materials are to be included. The resulting information will be made available for 1943. For the present, the usual recommended amounts should be applied. Heavier applications result in no better control and are a waste of valuable materials needed for defense.

Serious South Dakota Garden Crop Diseases

Garden Crop diseases in South Dakota are the same as in other midwestern states, although the dry summer atmosphere in most cases is not favorable to extremely rapid spread of foliage diseases. The diseases that occur affect quality more than quantity of the product and therefore are of greater concern in the commercial than in the farm or home garden.

SANITATION AND ROTATION

The destruction of plant residues and rotation of crops in the farm or home garden constitute feasible means of insuring yield and a minimum lack of quality because of disease. The roots of beans, beets, cabbage, carrots, celery, eggplant, onions, peas, peppers, potatoes, tomatoes and melons all are susceptible to diseases which may persist in the soil. Asparagus, beans, beets, celery, eggplant, lettuce, onions, peas, peppers, potatoes, tomatoes and vine crops (cucumbers, melons) are susceptible to foliage diseases which may persist in infected plant residues. Destruction or removel of these residues and a change of place for a particular crop are effective plant disease control measures even in a small garden.

SPECIFIC SERIOUS DISEASES IN THE FARM AND HOME GARDEN

While in most instances, plant diseases probably will not make the difference between success and failure of South Dakota garden crops, two such crops are very susceptible to diseases for which control measures must be practiced, namely, potatoes and vine crops (cucumbers, squash). Sweet corn smut is prevalent, particularly on early varieties, but no control is known. Sweet corn smut is not poisonous; uninfected portions of partially smutted ears are as good to eat as smut-free ears.

1. Potatoes

Every potato patch in South Dakota should be planted with certified seed potatoes. The diseases which stunt the development of the potato plant are inherent in the "juice" of what may appear to be sound potatoes. They are spread by the cutting knife, planter, cultivator and certain insects, including grasshoppers, flea beetles and aphids. <u>They can not be controlled by seed piece treatment</u>; only such surface-borne diseases as scab and black scurf can be <u>partially</u> controlled by seed piece treatment. To control the degeneration diseases inherent in the "juice" of the potato requires expert roguing, such as only the experienced certified seed potato grower is able to provide. The gardener should not be encouraged to try it.

The most urgent potato disease control measures for the farm and home garden are: (1) Buy certified seed potatoes at least every other year, preferably every year; (2) Rotate the potato patch to prevent the accumulation of the potato scab fungus in the soil. The spread of disease by insects is not a current detriment to the potato yield, although, of course, insects are very harmful in themselves, particularly leaf hoppers. Leaf hopper burn can be controlled by a Bordeaux mixture spray, applied as per direction on the carton.

2. Vine crops (cucumbers, squash)

These crops are susceptible to the bacterial wilt disease which is just what the name indicates, a wilt of the entire vine of cucumbers and squash particularly, from which no recovery is possible. The causal bacterium is harbored through the winter in the body of and subsequently spread by the common cucumber beetles. These beetles should be so drastically controlled that they do not start feeding on the young plants, for they can feed enough to infect the plant with the wilt bacterium before they have done any noticeable damage of their own. Start dusting as soon as the plants break ground with 7 percent pyrethrum or 3/4 percent retenone dust and repeat often enough to keep the plants well covered.

DISEASES OF VEGETABLES IN FRAME GARDENS

Just what disease problems are likely to occur in the highly publicized frame garden is at present not known. However, moderately high temperatures and abundant soil moisture such as may well prevail in frame gardens may be very conducive to the development of plant diseases. With many crops the conditions most suitable for rapid luxuriant growth are also most suitable for plant disease development.

From the standpoint of disease control in frame gardens, the following suggestions are in order:

(1) Do not overwater. An excess of soil moisture may be as bad as a deficiency, particularly in alkaline central and western South Dakota soils.

(2) Don't allow dew to accumulate and persist under the cover. Dew on leaves is the most common aid to infection by plant disease organisms.

(3) Remove the residue of each crop immediately after harvest.

(4) If disease troubles arise, remove all the soil to a depth of at least six inches and replace with clean field soil before making the next season's plantings. If unusual disease troubles persist, consult your county agent and experiment station plant pathologist.

Serious South Dakota Fruit Crop Diseases

Fruit growing is not an extensive commercial enterprise in South Dakota. With a few noted excpetions, fruit diseases usually are not alarmingly serious in South Dakota; when present they affect the quality rather than the quantity of the crop. Fungicide applications are expensive; some contain metals vital to defense. Efforts at fruit disease control by the home orchardist should aim to accomplish all that is possible by sanitation practices, supplemented where necessary by a minimum of timely, well applied spraying.

APPLES

1. Scab

Apple scab occurs as velvety olive brown to black webby spots on the leaves, flowers and fruits, rarely on twigs. The causal fungus destroys the normal waxy covering. The tissues underneath dry out and subnormal growth of the spot area may result in distortion of the infected fruit or leaf.

The causal fungus over-winters on infected fallen leaves, from which spores are discharged and borne to opening apple buds in the spring, where the unfolding leaves and flowers are subject to infection. The first spots thus formed bear still other spores which may find their way to new unfolding leaves or small fruits.

Control: Since the fungus over-winters primarily on dead leaves, the thorough destruction of fallen infected apple leaves is the basis for control in the farm orchard. In South Dakota, apple scab is not of sufficient importance to warrant a spray schedule just for apple scab control. However, should the grower apply a calyx spray for codling moth, the addition of Bordeaux mixture, as per directions on the carton, to the insecticide mixture would be desirable in eastern South Dakota.

2. Blotch

Apple blotch is manifested as irregular brown spots on the fruit, small yellow to light brown spots on the leaves, or as purple to brown cankers on small twigs. Severely infected fruit may crack and twigs may sometimes be girdled and killed. A large percentage of infected fruit drops prematurely.

The causal fungus over-winters primarily in the twig cankers. In late spring, spores which ooze from infected cankers find their way to fruits, leaves and twigs where they germinate and the resulting fungus growth enters the immediately underlying tissues. Further development and spread depends upon warm damp weather.

Control: Since the fungus over-winters primarily in twig cankers, the removal by pruning of all killed or cankered twigs eliminates a large portion of the over-wintering source of the pathogen. The severity of blotch in South Dakota is not sufficient to warrant spraying for blotch alone. However, if a codling moth spray is applied in June, the addition of Bordeaux mixture as per directions on the carton to the insecticide mixture would be desirable in eastern South Dakota.

3. Rust

Rust occurs on apple leaves and small twigs as yellow to orange swollen spots with black pimples in their centers usually on the upper leaf surface and stellate projections on the lower leaf surface. On the red cedar, which is an alternate host, it occurs as green to reddish brown galls two inches or less in diameter.

In May, rust spore masses ooze from the galls on the red cedar and find their way to apple leaves and small twigs. There they germinate and the resulting fungus growth enters the tissues underneath. The developing spot first forms the ultimately black pimples on the upper leaf surface, later the stellate protrusions on the lower leaf surface. From the centers of these protrusions spores are shed and carried by wind to the red cedar, where they germinate. The resulting fungus growth invades underlying tissues and the formation of galls is under way.

The apple rust fungus persists over winter only in the galls on red cedar. Apple rust occurs freely only where red cedars and apples grow side by side, within 1/4 mile.

Control: Either cedars or apples must be removed from the association. In one case in southeastern South Dakota, both cedars and apples were suffering from this disease. Diligent repeated picking by April 1 of all the cedar galls is a possible but not very feasible means of control. It is useless to spray after the yellow spots are visible on apple leaves; at that time no further spread occurs. If spraying is attempted, all leaves must be kept covered (with Bordeaux mixture) from the time the buds open until at least June 1, preferably until June 15.

4. Fire blight

This disease is prevalent in the Spearfish valley and has recently occurred in northeastern South Dakota. It is not likely to be serious in South Dakota generally. As the name indicates, it is characterized by a general dying of afflicted parts as if from fire. Blossoms, spurs, leaves or twigs may become limp and blackened. Drying later completes the "blight". Leaves remain on blighted twigs throughout the following winter. Sunker cankers remain where the disease has progressed down a twig to the point of origin from a branch.

In the edge of such cankers the causal bacterium lives over until tree growth is resumed. As the sap flows, the sweet ooze from infected cankers is heavily laden with the deadly "germs". Insects and wind and rain can carry such ooze to growing blossoms, spurs, leaves and twigs where the tiny "germs" enter through natural openings or slight wounds and proceed with the decay of invaded tissues.

Control: Anything conducive to excessively rapid growth favors fire blight development. Excessive irrigation, manuring, cultivation, fertilizing with nitrogen, all are favorable to the development of the disease. Close spacing is conducive to spindly susceptible growth and retards air drainage and subsequent elimination of humid atmosphere and dew, all of which are favorable to the disease.

Prevention lies with the removal of all infected holdover twigs and cankers at a point unquestionably below the edge of the infected region. Careful examination and fastidious pruning are essential. A careless superficial job is quite useless. The pruning knife should frequently be dipped in formaldehyde, 1-15, or 50-75 percent alcohol.

STONE FRUITS (plums, cherries, sand cherries)

The stone fruits are likely to be badly diseased almost anywhere in South Dakota. All are afflicted with one or more of the three diseases which are subsequently discussed: brown rot, "pockets" and yellow-leaf.

1. Brown rot.
This disease affects plums and sand cherries, sometimes cherries to a limited extent. It is a chocolate-brown rot of the nearly mature fruits, primarily, but blossoms and twigs may become blighted and small branches may develop brown rot cankers. The latter usually develop on a branch at the base of an infected twig or spur. After several days duration, the centers of diseased areas are covered with ashen gray tufts of spores of the causal fungus, frequently in concentric rings on the fruit.

Infected fruits are eventually entirely rotted, either on or off the tree. They soon shrivel and dry up and often cling for some time to the tree. They may adhere to similar adjacent fruits. Such rotted, dried fruits are called "mummies". In the spring the causal fungus first develops on and spreads by spores from mummies and branch cankers to flowers and growing twigs. The first rotted petals or twigs are a basis for spread to others by means of the tufted spores which are almost invariably formed. Thus when fruit is approaching the mature susceptible state, the disease is already established on twigs. Fruit infections occur through wounds, chiefly those made by the plum curculio.

Control: The removal and destruction of mummies on the tree and on the ground and pruning out of all cankerous branches serve to reduce the bases of early spring spread of the causal fungus. A dormant spray with lime sulfur as applied for "pockets" will help control brown rot. Likewise will another spray with Bordeaux mixture, applied as per directions on the carton about a month before the plum and sand cherry fruits ripen.

It is principally through wounds made by the plum curculio that the brown rot fungus gains entrance, particularly into fruits. The addition of lead arsenate as per directions on the carton to the pre-ripe Bordeaux spray will aid in curculio elimination. The timely harvest of all ripe fruit and immediate destruction of all undesirable fallen fruit will do away with many curculio larvae before they mature.

2. "Pockets"

This is a disease primarily of plums and sand cherries in South Dakota. On the latter it is the cause for more inquiry than any other single South Dakota fruit disease. It is characterized by enlarged, bladder-like elongated fruits and enlarged, reddish-colored and finally decayed leaves and growing twigs. It is caused by a fungus whose spores live over winter on the bud scales and whose mycelicum perhaps persists at the lower edge of the lesions on infected twigs. Infection takes place as the buds swell and begin to grow. There is no further spread during the season.

Control: Control consists in eliminating the spores in the bud scales before the buds swell with a dormant spray, in either the fall or spring. Spray every bud; those missed will probably show the disease. Later sprays are of no avail in controlling "pockets". Use lime sulfur, diluted 1-15 with water; apply with some sort of pressure sprayer to get uniform coverage with a fine mist spray.

3. Leaf blight or yellow-leaf

This is a disease primarily of cherries, but sand cherries and plums are also mildly affected. The striking symptoms are a spotting, yellowing, and final falling of the leaves, usually about the time the fruit matures. The fruit is not affected. Damage results from the weakening of the tree by defoliation while the next season's fruit buds are setting and the tree is "hardening" for winter. The short life of cherry trees is doubtless in part a result of this disease.

The causal fungus over-winters on fallen infected leaves and in the spring spreads from them to the new leaves, from which further spread can occur.

Control: Destruction of the fallen leaves plus protection of the new leaves by a minimum of two sprays with Bordeaux mixture as per directions on the carton should adequately control this disease in South Dakota. The first spray should come after the cherries are well set, the second immediately after the cherry crop has been harvested. The single brown rot spray for plums and sand cherries about a month before the fruit ripens should suffice to also control yellow leaf, since plums and sand cherries are not as susceptible as cherries, particularly sweet cherries.

RASPBERRIES

Anthracnose or "gray bark" and leaf spot (all one disease) may occur in some South Dakota gardens, but is probably not serious except in the southeastern part of the state. It is characterized by first purple, later gray, merging spots, finally with pits at their centers, on the current season's canes. The next season, serious cracking with subsequent excessive water loss reduces the yield from such infected canes.

The fungus spreads by spores formed in the spring on one-year-old (bearing) canes or on over-wintered leaves if they were infected. Spread and infection occurs first at about the time the buds are starting to grow and continues throughout the season during warm, damp weather.

Control: The disease is primarily one of old patches. If new plants are clean when set out the disease usually does not develop for 3 or 4 years. New plants should be bought from a careful, reputable nurseryman whose stock undergoes careful inspection for disease.

Removal of dead leaves and dead canes (previous season's bearers) will help some. If present, however, the disease can be properly controlled only by spraying. Lime sulfur 1-15, applied as the buds are swelling, is the most important spray and should be the only one needed in South Dakota.

STRAWBERRIES

1. Foliage diseases.

Several leaf spots of strawberries are known and may occur to a limited extent in South Dakota. They are probably not serious enough to warrant the use of spray materials at this time. They are primarily diseases of old beds. Setting out vigorous plants in a new bed every 3 or 4 years in a different area in the garden should prevent unusual outbreaks of strawberry leaf diseases in South Dakota

2. "Virus" diseases.

The causes of "yellows" and "crinkle" (severe) are inherent in the "juice" of the strawberry plant and are spread most freely by aphids. The only control is ruthless elimination of diseased plants in old beds and then exclusion from new beds.

Suggested Fruit Disease Control Program for South Dakota

	Apples	Stone Fruits			Raspberries	Strawberries
		Plums	Sand Cherries	Cherries		
Eradication (Sanitation)	Destroy over-wintered leaves infected with scab and blotch. Prune out blotch- and blight-infected twigs and cankers. Remove rust-spreading cedar or pick off all galls on cedars annually.	Prune out "pockets" infected twigs. Prune out all brown rot cankers. Remove and destroy all brown rot mummies from trees and ground underneath. Rake up and burn all over-wintered leaves (for yellow-leaf control).			Set out anthracnose-free plants from reputable nursery. Destroy dead canes, leaves.	Remove yellow, crinkled plants from old bed; omit from new bed. Start new bed every three or four years
Protection	Bordeaux mixture added to codling moth insecticide as calyx spray (for scab) and in June (for blotch; scab if present).	Dormant lime-sulfur spray for "pockets" and brown rot. July Bordeaux spray for yellow-leaf. (This spray controls brown rot on fruits. Add lead arsenate for curculio elimination).		Fruit-set Bordeaux spray for yellow-leaf.	Delayed dormant lime-sulfur spray (for anthracnose).	
Culture	Avoid excessive irrigation cultivation, manuring, fertilizing; provide adequate tree space (for fire blight).					