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THE PREVENTION OF SMUTS

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LOSSES CAUSED BY SMUT

The smuts of grain crops cause an estimated annual loss in Minnesota of at least \$4,000,000. Seed selection and disinfection, combined with proper cultural operations when necessary, can prevent almost all of this loss. In order intelligently to apply these measures for the prevention of smut, it is necessary to recognize the nature and peculiarities of the different smuts.

WHAT SMUT IS

All smuts are caused by parasitic fungi. A hundred years ago many people supposed that they were caused by the weather, by an unkind Providence, or by some strange disordered process within the plants themselves. These notions were disproved long ago.

The smut mass of any smut consists of countless numbers of minute spores, "seeds," of the smut fungus. (See Figure 1.) These spores are from about one five-thousandth inch to one one-thousandth inch in size, the individual spores being invisible unless magnified. In water, they germinate in from 6 to 72 hours, depending on the kind, by sending out mold-like threads which, under suitable conditions, branch and grow until a network of these fungous threads is developed. (See Figure 2.) When a spore germinates on the right kind of grain plant, the smut threads enter the plant, get their food from it, grow in it, and finally produce spores on it, giving the grain the smutted appearance.

KINDS OF SMUT

In Minnesota, smuts occur on wheat, oats, barley, rye, corn, sorghum, timothy, millet, and several grasses. It is important to know that each crop plant is attacked by its own particular kind of smut and that in general the smut from one kind of crop plant will not transfer to another kind. For instance, the wheat smuts attack only wheat; they will not attack barley, rye, or oats. Neither will smuts of barley, oats, and rye attack any other cereals.

More than one kind of smut may occur on the same cereal. Brief descriptions of the smuts of the various crop plants are therefore given.

Smuts of Wheat

There are two smuts of wheat in Minnesota, the stinking smut and the loose smut. It is important to know the difference between the two because they require different treatment.

Stinking smut (See Figure 3 B).—Stinking smut is also called covered smut and bunt. Smutted heads usually are lighter in color. The chaff spreads apart farther than on normal heads, but is not destroyed. The smut occurs inside the chaff in place of the wheat kernels, forming hard masses of spores—the smut balls. The smut balls remain inside the chaff until they are broken in handling the grain during harvesting and threshing. The odor of smut balls, especially when broken, is very unpleasant.

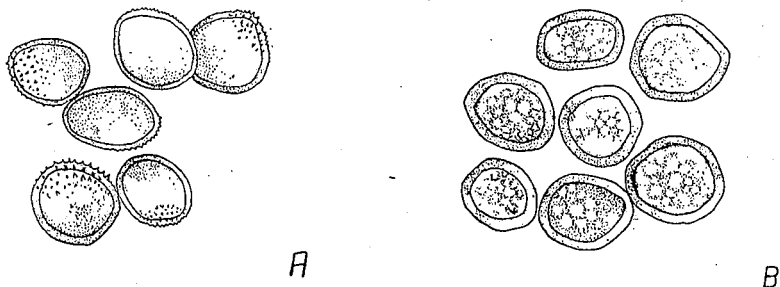


Fig. 1. Spores of Common Smuts, Enlarged 1300 Times
A. Loose smut of wheat. B. Smut of oats.

Treatment: Remove smut balls from seed grain. This may be done by fanning, or by stirring the grain in water or a disinfecting solution. The smut balls will rise to the surface and can be skimmed off. Then use one of the following methods for disinfecting the seed: dipping in formaldehyde solution, page 9; sprinkling with formaldehyde solution, page 10; dipping in bluestone solution, page 11; soaking in hot water, page 11.

Loose smut (See Figure 3 C).—Loose smut is also called naked smut. It can very easily be distinguished from stinking smut because both the chaff and the kernels are destroyed and there are no distinct smut balls. The whole wheat head becomes a mass of smut which is soon blown away by the wind, leaving only the naked stalk on which a little of the smut dust may remain. There is no odor.

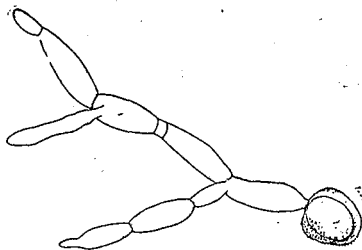


Fig. 2. Spore of Loose Smut of Wheat, Enlarged About 600 Times
This spore has sent out a germ tube which has begun to branch.

Treatment: Select seed from unsmutted fields; establish a seed plot; disinfect seed by the modified hot water treatment, page 13.

Smuts of Barley

There are two smuts of barley, the covered and the loose or naked smut. They must be treated differently and it is therefore important to be able to recognize them.

Covered smut (See Figure 4 C).—In covered smut, balls are produced very much as in stinking smut of wheat, but the chaff is also smutted. The balls are covered by a thin grayish membrane through which the smut mass appears greenish black. The membrane may be broken and some of the smut blown away; usually, however, the smut balls remain in place until broken in handling the grain. This smut usually appears after the barley is headed.

Treatment: Remove smut balls and use one of the following treatments: Dipping in a formaldehyde solution or sprinkling with it, pages 9 and 10; soaking in hot water, page 12.



Fig. 2. Loose and Stinking Smut of Wheat

- A. Normal head of wheat and kernels.
 B. Head of wheat affected by stinking smut, showing smut balls at a.
 C. Loose smut.

Loose smut (See Figure 4 B).—Loose smut of barley looks like the loose smut of wheat. It usually shows as soon as the head comes out from the boot. The spores are soon blown away, leaving only the naked stalk, thus enabling one to distinguish it easily from covered smut. (Compare Figures 4 B and 4 C.)

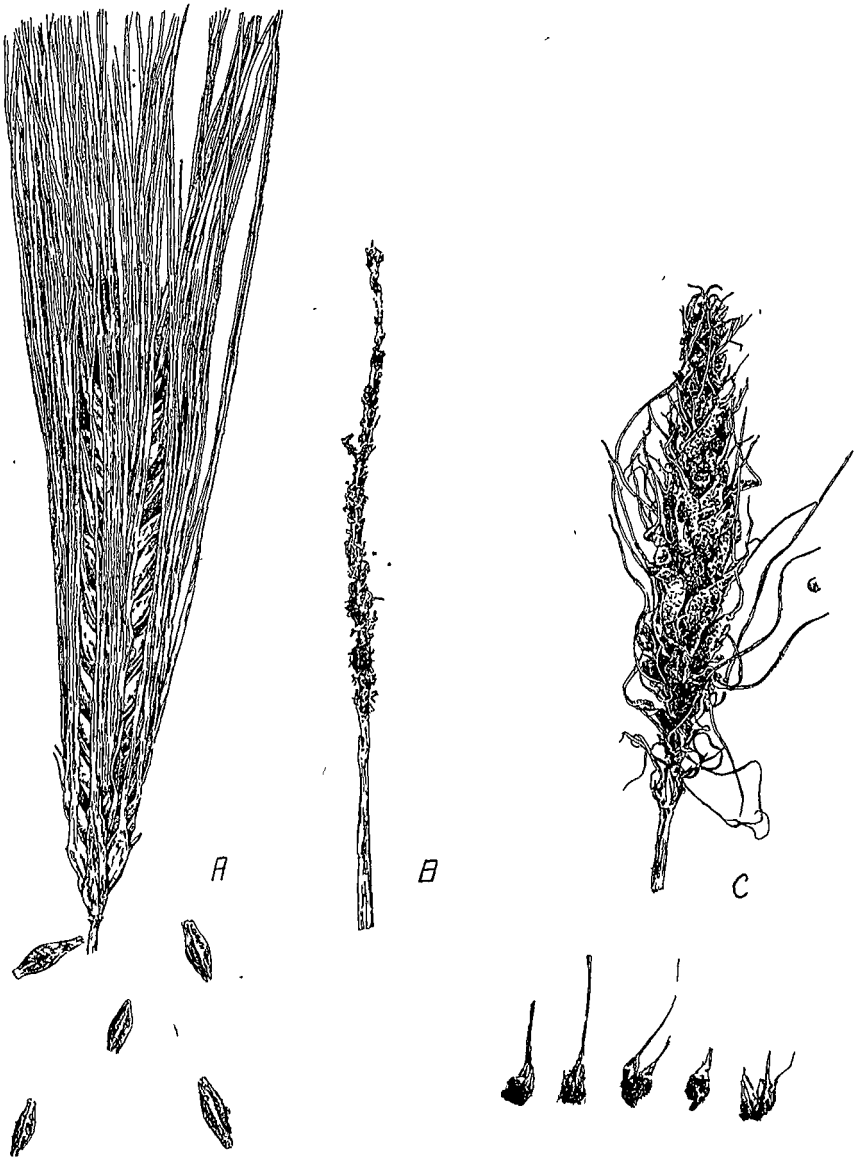


Fig. 4. Loose and Covered Smut of Barley

A. Normal head and kernels.

B. Head deformed by loose smut.

C. Covered smut, showing smut balls below.

Treatment: Select seed from an unsmutted field; maintain a seed plot; disinfect the seed by the modified hot-water method, page 13; possibly soak a long time in formaldehyde, page 13.

Smut of Oats

There are two smuts of oats, the loose and the covered, but, as far as is now known, they can be controlled in the same way, so they are considered together.

The entire head, including the chaff, is usually smutted. (See Figure 5.) The smut-dust may be blown away easily, or it may remain covered by a grayish membrane for a time. The smut may appear as soon as the head comes



Fig. 5. Oat Smut
On left, healthy head of oats; on right, smutted head.

out of the boot and may escape notice because smutted plants are often shorter than healthy ones.

Treatment: Sprinkling with formaldehyde solution or dipping in it, pages 9 and 10; soaking in hot water, page 11.

Smut of Rye

There is only one smut of rye of economic importance in Minnesota. It differs from those already described in that it attacks leaves and stems as well as heads. (See Figure 6.) The smuts of wheat, oats, and barley rarely do this.

The following description of rye smut is taken from Agricultural Experiment Station Bulletin 160, which is now out of print.¹

"Rye smut appears first as long, narrow, parallel, lead-gray stripes. In the earlier stage the black, or brownish black, smut-dust is under the epidermis of the plant; hence the color. Later the epidermis breaks and the dark smut masses are exposed. Smutted plants are usually stunted and misshapen, and seldom produce normal heads. If heads are produced, they are almost always empty, or are destroyed by the smut. As a rule, nearly every stalk of a plant is smutted.

"The disease usually appears about heading-time, altho it can be detected earlier, and is most conspicuous when the grain is ripening. At this time the straw and leaves of affected plants are often split longitudinally, and the plants may break over. Diseased plants often escape notice, even at this time, because of their small size and failure to produce heads."

Treatment: Disinfect seed with formaldehyde, page 9; and practice crop rotation. The seed need not be covered after dipping.

Smut of Corn

Corn smut may occur on any part of the corn plant above ground. It forms large smut balls, covered at first with a white or grayish membrane. These contain enormous numbers of spores which are blown about by the wind as soon as the smut mass becomes dry. (See Figures 7, 8, and 9.)

Treatment: Practice sanitation and rotation, pages 15 and 16.

Smuts of Sorghum

There are two smuts of sorghum, the kernel or grain smut and the head smut. Only the kernel smut is common in this state.

Kernel smut.—Cone-shaped smut balls replace some or all of the kernels in a head. The chaff may or may not be destroyed. Each smut ball is usually covered by a grayish or grayish-brown membrane which is usually broken only when the grain is handled. This smut is similar to stinking smut of wheat and covered smut of barley.

Treatment: Soak in formaldehyde solution, page 10.

Head smut.—All or a part of the head is reduced to a smut mass when attacked by head smut. Smut balls, retaining in general the shape of kernels, as in the kernel smut, do not occur. The general appearance is much like that of corn smut.

Treatment: See page 16.

Smut of Timothy

Timothy smut has not been common in the state. The same smut also occurs on redtop, orchard grass and several other grasses. Like rye smut, it

¹ Stakman, E. C., and Levine, M. N. Rye smut. Minn. Agr. Exp. Sta. Bull. 160. 1916.

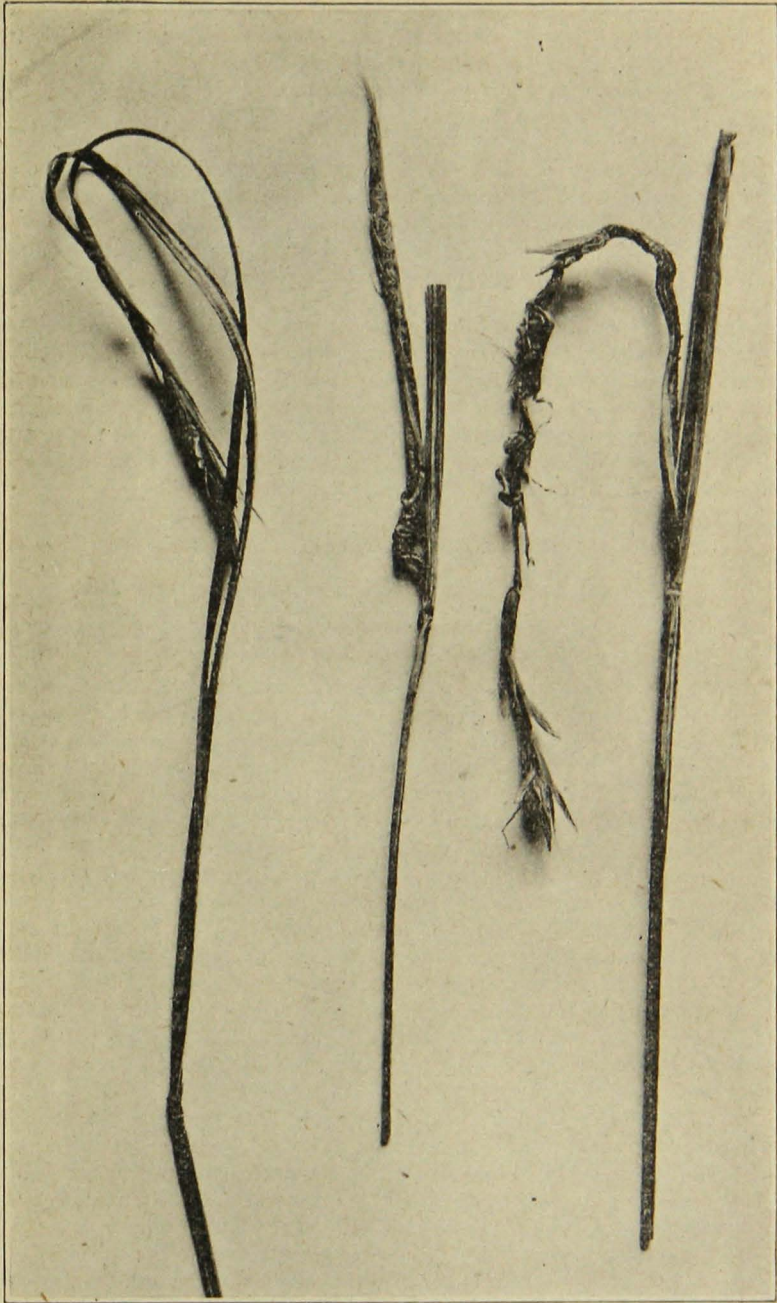


Fig. 6. Rye Smut on Heads and Stems
This shows distortion and splitting of the stems.

affects leaves, stems, and heads. Black, longitudinal stripes are formed; the leaves may split, giving them a ragged appearance; the heads may be destroyed and the whole plant may be stunted.

Treatment: Use modified hot-water treatment, page 13.

Smut of Millet

The kernel smut of millet forms small balls where the seed ought to be. In this respect it resembles stinking smut of wheat and covered smut of barley.

Treatment: Soak in formaldehyde solution, page 10.

HOW SMUTS LIVE AND SPREAD

Smuts are spread by the wind, on seed grain, by threshing machines, smutty grain drills and other implements, and by grain sacks or tanks. But they do not all live over winter in the same way, nor do they all infect plants at the same stage of growth. Some live over winter on the seed, some inside of the seed, and some mainly in the soil and in manure piles. Since the treatment depends on the habits of the smut, a brief explanation of the peculiarities of each group is given before the treatments are described.

HOW TO PREVENT SMUTS

Group I, Smuts That Overwinter Mainly on the Seed

Stinking smut of wheat, covered smut of barley, smut of oats, rye smut, kernel smut of sorghum, millet smut

The habits of these smuts are very similar. Smut balls are formed and usually remain on the plants until harvesting or threshing time when they are broken and the spores smeared on the outside of the kernels. Smut of oats is slightly different, in that the spores may be blown about by the wind while the grain is still standing. The really important fact is that the spores are on the outside of the kernels and may remain there over winter. When the grain is planted, the smut spore germinates and sends out mold-like threads which can infect the plant only in the seedling stage. They grow in it until about heading-time, in most cases, when the smut fungus again produces spores which constitute the smut. Whenever any smut of this group gets on the outside of the seed grain, some smut is likely to appear in the crop. Anything which will kill the spores on the seed will prevent these smuts, if the seed is kept clean.

The treatments for the smuts in Group I are similar, but the details may vary. Some general precautions should be observed.

General precautions.—1. All unbroken smut balls must be removed before the grain is treated.

2. If hot water is used the proper temperature must be maintained for each kind of grain.

3. If formaldehyde is used it must be standard strength (40 per cent).

4. Treated grain must be dried if it is not sown soon after treatment; otherwise it may heat, sprout, or mold, and will not germinate well.

5. Grain must not be allowed to freeze when it is wet.

6. If wet, swollen grain is sown, the seeder or drill must be properly set.

7. Do not put the treated grain on floors, or into sacks, seeders, or anything else which has contained smutty grain, unless the containers have been disinfected. Treated seed is not protected from later infection; it must be kept free from smut. Containers and implements may be disinfected by boiling

in water (sacks) or by being scrubbed with a strong solution of formaldehyde (1 pint in 15 gallons of water).

8. Always make a germination test of treated seed and make allowance in rate of seeding if some has been injured.

Formaldehyde Treatments

Formaldehyde is also sold under the trade name formalin and is widely used in the middle west on account of its cheapness and effectiveness against the smuts of Group I. It can be bought in small quantities from druggists for



Fig. 7. Corn Smut on Tassel

from about twenty-five to sixty cents a pint. In larger quantities it is usually cheaper. It is not poisonous, altho the fumes are unpleasant and it may cause smarting of the skin. It must be of standard strength and should be kept in tightly closed containers. When it is mixed with water, it should be used only on the same day.

Dipping in formaldehyde solution.—For preventing stinking smut of wheat, smut of oats, covered smut of barley, and rye smut.

Materials needed:

Formaldehyde (40 per cent) A large barrel, tank, or smut machine

Water Coarse sacks (disinfected)

A disinfected floor or canvas on which to put the treated seed.

Pour 1 pint (1 pound) of guaranteed² formaldehyde into 40 to 45 gallons of water and stir thoroly. Put about a bushel of grain into a sack and dip it into the formaldehyde solution, lift it out, let it drain for a minute or two, and dip it again. Repeat several times to make sure that every kernel is wet. Then remove the sack, let the solution drain back into the barrel, and keep the grain in the wet sacks from 2 to 12 hours; or dump into a pile and cover with a clean canvas, blanket, or sacking from 2 to 12 hours, if convenient. Then sow at once or spread out to dry. This method is satisfactory if only a small amount of grain is treated and if the smut balls, especially of wheat, have all been removed by fanning or by floating off in water. "See Stinking Smut of Wheat.)

If large quantities of seed are to be treated, a smut machine or an open tank should be used.

If an open tank is used, the formaldehyde solution is put into the tank and the grain is then poured in. It should then be thoroly stirred so as to wet every kernel and allow all smut balls to rise to the surface, when they may be skimmed off and destroyed. The grain may then be shoveled out and handled as in the dipping method.

It may be found convenient to have a raised tank. Bore a hole near the bottom at one end, and fit it with a plug. Fasten wire screen on the inside of the tank over the hole and remove the plug when the treatment is complete, allowing the solution to drain into a tub, then shovel the grain out, and, when all the grain is out, pour the solution back. This will waste less material.

Two large tubs may be used in the following way: Bore a hole fitted with a removable plug near the bottom of both tubs and fasten a piece of wire screen over the hole inside the tub. Put one tub on a platform above the other in such a position that the solution can be drained into the lower one. Put the solution to be used in the upper tub and treat as in the open tank. Then pull out the plug and allow the solution to drain into the lower tub and treat in the same way while the grain is being dumped out of the upper tub. Then the positions of the two tubs can be reversed and the process continued until all the grain has been treated. Forty gallons of solution will treat from 40 to 50 bushels of grain.

Soaking in formaldehyde solution.—For kernel smut of sorghum and millet smut.

For kernel smut of sorghum put one pint of full-strength formaldehyde into 30 gallons of water and stir thoroly. Soak the seed for one hour, stirring occasionally, then remove and dry enough that it can be sown.

For millet smut, put one pint of formaldehyde into 45 gallons of water and soak the seed for two hours, then spread out to dry.

Sprinkling with formaldehyde solution.—For stinking smut of wheat, covered smut of barley, smut of oats, and rye smut.

The grain to be treated must be free from smut balls or the treatment may not be effective. Select a convenient place on which to spread out the grain. A granary floor, a wagon-box, or something of like nature is satisfactory. Disinfect the floor or wagon-box by scrubbing with a solution of 1 pint of formaldehyde to 15 gallons of water. Then spread the grain to be treated in a layer a few inches deep on the floor and, while one person sprinkles or sprays the grain with a solution of 1 pint of formaldehyde to 40 gallons of water, another must shovel it over in such a way as to wet the outside of all the grain.

² If not sure of the quality of the formaldehyde, send a small sample to the Chemist, University Farm, St. Paul, for analysis.

Then the grain is shoveled into a pile and covered with clean sacking or canvas for from 2 to 12 hours, when it may be sown or spread out to dry. Forty gallons of the solution will treat from 40 to 50 bushels of grain.

Bluestone treatment—For stinking smut of wheat only.

Bluestone has been used extensively for stinking smut of wheat only, because it has been supposed to injure the seed of barley and oats and has not been tried much for other grains. At the Washington State Experiment Station,³ it has recently been shown that it protects seed against reinfection better than formaldehyde does. The method recommended is to dip the seed, free of smut balls, for 10 minutes in a solution of 1 pound of bluestone, 1 pound of common salt, and 5 gallons of water. The seed is then removed and soaked for 10 minutes in milk of lime made by slaking 1 pound of quick lime in a little water and then adding enough water to make 10 gallons. The seed is not covered after treating.



Fig. 8. Young Smut Balls on Corn Stalk and Leaves

Hot-water treatment.—For stinking smut of wheat, smut of oats, and covered smut of barley.

This treatment is cheap and effective but must be very carefully used. For stinking smut of wheat and smut of oats the seed is soaked from 10 to 15 minutes in water at a temperature of 132 or 133 degrees, F. The temperature

³ Heald, Frederick, and Woolman, H. M. Bunt or stinking smut of wheat. Wash. Agr. Exp. Sta. Bull. 126. Nov. 1915.

must not go lower than 130 degrees, or higher than 135 degrees, F. For covered smut of barley, it must not go lower than 126 degrees or higher than 129 degrees, F.

Materials needed:

- Three large tubs, barrels, or other containers
- Several ordinary pails
- Coarse sacks or, better, fine-mesh wire-bottomed baskets
- A paddle for stirring the water
- Clean space on which to dump soaked seed
- A large vessel for heating water
- A standardized thermometer.⁴



Fig. 9. Older Smut Ball, Causing Corn Stalk to Break

For Wheat and Oats

Mark the barrels 1, 2, and 3. Put hot water into barrels 1 and 2 and cold water into 3. Keep the temperature of the water in No. 1 at from 115 to 120

⁴ The thermometer used should be only one accompanied by a certificate of the Bureau of Standards, Washington, D. C. It may be purchased through a local dealer or obtained from a manufacturer or large dealer.

degrees F. Keep the temperature of the water in No. 2 between 132 and 133 degrees F. Put the grain, about half a bushel at a time, in the baskets or sacks and dip it into barrel No. 1. Stir and skim off smut balls. When the temperature of the grain is nearly 120 degrees F., remove, drain, and put into barrel No. 2 for from 10 to 15 minutes. Keep the temperature between 132 and 133 degrees F. by adding hot or cold water as necessary, and stirring. Do not pour the hot or cold water directly on the grain. Move the basket around so as to keep all of the grain at the same temperature and stir to make sure that all smut balls have been removed. Be sure not to let the temperature go below 130 or higher than 135 degrees F. At the end of the required time, remove the grain and immediately spread out to dry in a layer 2 or 3 inches deep. Shovel it over now and then to hasten drying. If the grain can not be spread out at once, dip it in cold water to reduce the temperature.

When live steam is available, the process may be simplified by running steam pipes into the water and regulating the supply as necessary. Only one tank or vat is necessary when steam can be used.

The hot water method is not very popular because it seems difficult. In reality, however, it is not hard to maintain the temperature at the desired point if enough water is used in proportion to the bulk of grain being treated.

For Barley

Barley can be treated like oats and wheat except that the temperature of the water must be between 126 and 129 degrees F.

Group II, Smuts Which Overwinter Inside the Seed

Loose smut of wheat, loose smut of barley, and timothy smut

The loose smuts are distributed by the wind when the grain is in flower. The spores fall on the young, partly-formed kernels, germinate there, and send their mold-like threads inside the kernel. The smut threads remain dormant without injuring the kernel or giving any indication of their presence until the grain is planted. They begin growing when the grain sprouts, and get into the growing point of the plant, grow up with it, and finally cause smut, on wheat and barley at heading-out time and on timothy both then and earlier. The process is then repeated. Since the smut is inside of the seed, it is harder to treat than the smuts of Group I.

Timothy smut has not been serious enough in this state to attract attention and no seed disinfection experiments have been made. However, results obtained at Cornell University⁶ indicate that either the temperature recommended for wheat or that recommended for barley is effective.

Loose smut of barley can sometimes be prevented by soaking in formaldehyde solution, 1 pint of formaldehyde to 40 gallons of water, for two hours at a temperature of 68 degrees, F. The treatment, however, is not always effective.

Jensen's modified hot-water treatment.—The following recommendations for treating grain for loose smuts of wheat and barley are given in Bulletin 152, Bureau of Plant Industry, United States Department of Agriculture.⁸

In general, the method to be recommended is the following: The keeping of a seed plat the seed for which has been cleaned of smut by the application of Jensen's modified hot-water treatment and the use

⁶ Osner, George A. Leaf smut of timothy. Cornell Univ. Agr. Exp. Sta. Bull. 381. 1916.

⁸ Freeman, E. M., and Johnson, E. C. The loose smuts of wheat and barley. U. S. Dept. of Agr. Bur. Pl. Ind. Bull. 152. 1909.

of the grain from this plat for seed the succeeding year, when no further treatment is necessary. If the farm is very large it may require several years to get the smut entirely eliminated from the whole farm. This recommendation involves two processes, which will now be described.

Selection of the Seed Plat

A good, clean, well-cultivated piece of land should be selected and set aside for the raising of seed for the succeeding year. For this plat seed should first be carefully cleaned and selected by the best fanning and sifting processes. This seed should then be treated as directed later. The plat ought to be large enough to provide at least twice as much grain as will be necessary for farm seed the following year, in order to allow for loss in cleaning and selecting. This seed plat must not be placed next to fields of smutted crops of the same cereals. The plat ought also to be located so that the prevailing winds at flowering-time will not carry spores to the seed plat from a neighboring field of the same grain. The isolation of this plat from smutted crops of the same cereal is absolutely necessary, not only from crops on the owner's farm, but from neighboring farms as well. A strip of wood, a corn field, a large meadow, or a barley or oat field, intervening between the wheat seed plat and fields of smutted wheat will be useful, and similarly a field of corn, oats, or wheat or a large meadow or strip of wood between the barley seed plat and the smutted field will be a valuable protection. This point can not be too strongly emphasized and the cooperation of neighbors may be necessary to carry it into effect.

Treatment of the Seed for the Seed Plat

After seed for the plat has been properly cleaned it must be treated by the Jensen method to eliminate the smut. This can be done according to the following directions: The clean seed should be soaked for from five to seven hours in water at ordinary room temperature, 17 to 22 degrees C. (63 to 72 degrees F.) It should be placed in small, loose sacks or wire baskets containing not more than one half peck each and drained for a short time. It is of the greatest importance that the seed be treated in small lots in order that all of the grain may be quickly and uniformly brought to the desired temperature. Two tubs or vats of water should be provided. In one tub (No. 2) the exact temperature required should be maintained. The other tub (No. 1) is used for bringing the grain to the temperature of the treatment, so as not to lower the temperature in tub No. 2. Galvanized iron tubs of 20 to 40 gallons capacity, and kerosene or gasoline double-burner stoves are sufficient for treatment. The drained sacks or baskets of seed should be plunged into tub No. 1 for a minute, then transferred to tub No. 2, and kept agitated while immersed at temperatures and for the periods specified below, the temperatures mentioned being maintained as nearly as possible:

For barley, 15 minutes at 52° C. (125.6° F.)

For wheat, 10 minutes at 54° C. (129.2° F.)

In treating barley, if the temperature should rise above 52° C. (125.6° F.) the time of immersion must be reduced to ten minutes at 53° C. (127.4° F.), or five minutes at 54° C. (129.2° F.). Above 54° C. (129.2° F.) there is no safe margin. If the temperature falls

slightly below 52° C. (125.6° F.) the time of treatment should be increased in proportion. A temperature lower than 51° C. (123.8° F.) will not be effective. In treating wheat, if the temperature should rise above 54° C. (129.2° F.) or fall below 52° C. (125.6° F.), the time for immersion must be diminished or increased accordingly. Under no circumstances should a temperature of more than 55° C. (131° F.) be allowed. Temperatures below 51° C. (123.8° F.) are ineffective.¹

Seed treated as indicated may be planted as soon as it is sufficiently dry to run freely through the drills. Allowance must then be made for the swollen seed, and also for injury in treatment. The increase due to swollen seed can be estimated by measuring seed before and after treatment. The seed may be treated several months before seeding-time and then dried quickly and carefully. In many cases the grain germinates as well or better when rested after treatment than if sown immediately. The seed may be dried by spreading it out in thin layers not over 2 inches in depth on a clean granary floor or on canvas and shoveling or raking it from time to time. It must not be allowed to sprout. Care must be taken to prevent the freezing of the grain when it is moist, as this will impair germination.

A good thermometer should be used for all treatments.² The use of an instrument which is not accurate will result in injury to the germinating power of the grain on the one hand or in failure to prevent the smut on the other.

Several weeks before sowing, the seed should be tested for germination. This can be done by placing several small lots of grain of 100 seeds each between damp blotters and keeping them at a living-room temperature for several days. The percentage of sprouted kernels will show the power of germination. If this is low, a corresponding increase in the rate of seeding is necessary.

The seed plat should be maintained from year to year, at least as long as any smut is present on the farm. Seed obtained from the treated seed plat does not have to be treated the following year. All fields that are free from smut must be kept separated, as previously stated, from smutted fields of the same grain. Coöperation with neighbors may be necessary to bring this about.

¹ Two men working together can easily treat one bushel of grain an hour, or enough seed in one day to sow a seed plat from 6 to 10 acres in size.

² Thermometers may be submitted to the Bureau of Standards, Washington, D. C., for test. A charge of about 50 cents will be made for testing at the two points necessary. They should be graduated in single or half degrees—Centigrade—directly upon the stem or upon a scale contained within the stem, and should preferably read from 0° to 100°. The bulbs, at least, should be made of a suitable glass, such as Jena "Normal" thermometer glass or Corning Medium thermometer glass, in order that the readings may not change with time, and the general construction of the thermometer should be good. However, thermometers with the Bureau of Standards' certificates can be purchased directly from manufacturers or large dealers, and this is generally a much more convenient way to secure them because it avoids the risk and expense of shipping them to and from Washington.

Group III, Smuts Overwintering in the Soil

Corn smut, head smut of sorghum

Smuts over-wintering in the soil can infect growing parts of plants at any age, thus differing from the smuts in Groups I and II. The spores are blown about by the wind, may remain in the soil or in manure piles over winter, and, under favorable conditions, infect other plants. The fact that these two smuts are not carried mainly either on or in the seed and can infect plants at any age makes them difficult to control.

Little is really known about the control of the sorghum head smut, but what applies to corn smut may also apply to the sorghum smut. Seed treatment for these smuts is of little real value, if any, unless seed is being taken into a new territory. Fresh manure should not be put on corn ground and a rotation should be practiced. It may be profitable to collect and burn the smut balls. It has been found recently that most of the corn smut spores are killed in the silo.⁷ The general use of silos, together with good cultural methods, may therefore somewhat reduce the losses from corn smut.

If you do not know which smut you have, write or send a sample to the Plant Pathologist, University Farm, St. Paul. If further information is desired write and ask for it.

⁷ Piemeisel, F. J. Some facts of the life history of *Ustilago zeae* (Beckm.) Unger. *Phytopathology* 4:411. 1914.