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TREATMENT OF CEREAL SEED

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TREATMENT OF CEREAL SEED

J. E. Machacek, R. C. Russell, and L. E. Tyner[1]

High quality seed of a suitable variety is the foundation of good cereal crops. The variety chosen should be well adapted to the particular district in which it is to be grown. Equally important is the quality of the seed. It should be pure as to type, plump, free from injury and disease, and of good germinability. The best seed available to the farmer is Registered or Certified seed. Ordinary seed, however, can be greatly improved by proper cleaning and treating.

While much of the cereal seed sown in Canada is of comparatively good quality, some of it possesses defects of varying importance. It may be shrunken, cracked in threshing, damaged by frost, mouldy, infected with seedling-blight fungi, or, as is very often the case, contaminated or infected by smut. These defects, resulting in reduced germination, leaf-spotting, head-blighting, or smuttiness, lower farm income by several million dollars annually. In addition to any reduction in yield, the market value of the crop may be reduced, as grain that is discoloured or smutty is de-graded. Occasionally, also, a further loss may result from the poisoning of livestock fed with scabby or ergotty grain.

The smuts are probably the most important seedborne diseases of cereals in Canada. About three out of every 1000 carloads of wheat passing through Winnipeg during the past several years have been graded "smutty" on account of bunt (stinking smut). Smut in barley and oats is also common and heavy losses from smut occur in these crops in some districts. On account of their importance, the smuts are given special consideration in this publication.

[1] Plant Pathologist and Associate Plant Pathologists, respectively.

TABLE 1.—SEED-TESTING LABORATORIES IN CANADA

Address of laboratory	Area served	Kind of test made
Associated Laboratory Services, Canada Building, Saskatoon, Sask.	Prairie Provinces	Disease
Line Elevators Farm Service, 765 Grain Exchange Building, Winnipeg, Man.	Prairie Provinces	Germination, purity, and disease
Plant Products Division, Sackville, N.B.	Maritime Provinces	Germination and purity
Plant Products Division, 1254 Bishop Street, Montreal, Que.	Quebec	
Plant Products Division, Production Service, Ottawa, Ont.	Eastern Ontario	
Plant Products Division, 86 Collier Street, Toronto, Ont.	Western Ontario	
Plant Products Division, Dominion Public Building, Winnipeg, Man.	Manitoba	
Plant Products Division, 523 Federal Building, Saskatoon, Sask.	Saskatchewan	
Plant Products Division, Immigration Building, Calgary, Alta.	Alberta	
Plant Products Division, Postal Station C, Vancouver, B.C.	British Columbia	

Farmers who intend to use their own grain for seed purposes are advised to send representative samples (one pound each) to their nearest seed-testing laboratory for a test. Most of these laboratories (Table 1) test the seed for germination and purity only, but some test it for seed-borne diseases, as well. None, thus far, test the seed for loose smut infection.

Unless seed has been examined at a seed-testing laboratory and found to be sound and free from smut spores and certain other important disease organisms, it should be treated with a good disinfectant. The treatment now generally recommended, except for loose smut of wheat and of barley, is an organic mercury dust or liquid applied to the seed after it has been thoroughly cleaned. Wheat should be treated at least 24 hours before seeding. It is advisable to treat oats and barley at least a week in advance of seeding, as the smut infection sometimes present under the hulls of coarse grains requires for its control a much longer exposure to the action of the fungicide than is necessary in the case of wheat, where the contamination occurs as spores on the surface of the seed.

A safe rule to follow is to treat seed even if only a trace of smut is detected in the crop. The need for treatment, however, will depend on the variety as well as on the amount of smut present on it. Smut increases very quickly in a susceptible variety, and slowly or not at all in a resistant one (Table 2). If

TABLE 2.—SMUT-RESISTANCE OF VARIETIES OF WHEAT, OATS, AND BARLEY

Degree of Resistance	Smuts controlled by chemicals			Smuts controlled only by hot water	
	Wheat (Bunt)	Oats (Covered and Loose Smut)	Barley (Covered and False (Loose Smut)	Wheat (Loose Smut)	Barley (Loose Smut)
Resistant	Canus Renown	Brighton Erban Fortune Garry Valor	Titan Wisconsin 38	Thatcher Renown	
Semi-resistant	Apex Redman Regent Yogo	Alaska Beaver Exeter	Barboff Byng Charlottetown 80 Compana Galore Mensury Ott. 60 Montcalm Newal O.A.C. 21 Olli Rex Velvon II Warrior	Apex Pelissier Redman Regent	Compana Olli Titan Trebi Warrior Wisconsin 38
Susceptible	Carleton Coronation II Dawson's Golden Chaff Garnet Kharkov MC 22 Jones' Fife Marquis Mindum Pelissier Red Bobs Reliance Rescue Ridit Stewart Thatcher	Ajax Banner Beacon Cartier Eagle Larain Legacy Roxton Vanguard Victory	Colsess Garton's Hannchen Plush Prospect Regal Sanalta Trebi Vantage	Canus Coronation II Garnet Marquis Mindum Red Bobs Reliance Rescue Stewart	Barboff Byng Charlottetown 80 Colsess Galore Garton's Hannchen Mensury Ott. 60 Montcalm Newal O.A.C. 21 Plush Prospect Regal Rex Sanalta Vantage Velvon II

seed is heavily contaminated with smut, it may be advisable to discard it and purchase Registered or Certified seed, or any other stock that is free or relatively free from smut. Before changing to a new variety, even a resistant one, it is important to ascertain if the new variety is one of those recommended for the particular district in which it is to be grown. A susceptible variety, when treated may in some districts, outyield a resistant one and, as the cost of treatment is low, there would be no advantage in making the change. Furthermore, a variety that is resistant to the races of smut now prevalent may at some future time prove to be susceptible to new races that may appear.

Seed treatment, aside from a slight additional cost in materials and labour, has but few limitations. No harm is done to the seed if it is treated with modern seed disinfectants according to directions supplied by the manufacturer. An overdose of a disinfectant, or improper mixing of seed and disinfectant may, however, reduce seed germination. An incidental hazard is that, if the disinfectant is poisonous, carelessness on the part of the operator in applying it may result in personal discomfort or illness. While treating seed the operator should wear a dust mask, with goggles to protect the eyes. If the treating is done in a building, good ventilation should be provided, or the machine should be placed where a breeze or draft will carry flying dust away. A dry, detached building is the best place to treat grain.

As organic mercury seed disinfectants are poisonous, treated seed should be clearly labelled and kept in a place inaccessible to livestock. Surplus treated seed should not be held over to the next season but, if possible, should be sold as seed or sown for green feed.

Kinds of Seed Treatment

Passing seed grain through a fanning mill is an effective way of removing many of the disease-producing organisms that may be present in it, in addition to getting rid of coarse matter, chaff, and weed seeds. Thus, many smut balls and ergot bodies are screened off and light kernels, which are likely to be diseased, are blown away. Moreover, thoroughly cleaned seed can be treated with a disinfectant more effectively than uncleaned seed. For these reasons thorough cleaning should be considered as a prerequisite to treatment.

Chemical Treatment

The term "Seed Treatment" usually refers to the application of a chemical disinfectant to the seed. The disinfectant may be applied as a dust, slurry (a thin paste formed by the addition of a little water to the dust), or liquid. Disinfectants that are sold for use as a dust or slurry contain, in addition to the active chemical, a considerable proportion of some inert substance such as talc. Most of the chemical fungicides sold at present in Canada contain mercury in some form. Ceresan, Ceresan M, Half-ounce Leytosan, and Lunasan are commercial fungicides that are applied as dusts to the seed. Ceresan M may also be used as a slurry. Panogen is applied in liquid form. The two latter treatments, if properly applied, dampen the seed but do not wet it. The treated seed will run easily through the drill and may be stored without risk of sprouting or becoming mouldy. Users of any seed disinfectant should adhere strictly to the manufacturer's directions to obtain the best results.

Some chemicals, such as formaldehyde, are commonly applied to small grains as "steeps" or "sprinkles". The dust fungicides mentioned in the preceding paragraph may also be used in the same way, in which case the solutions are made up by dissolving two ounces of the dust in 10 gallons of water. The steep treatment is carried out by soaking the grain for five minutes in the solution. The sprinkle treatment involves sprinkling the solution over a pile of seed and then shovelling the pile over until all of the kernels are moistened. One gallon

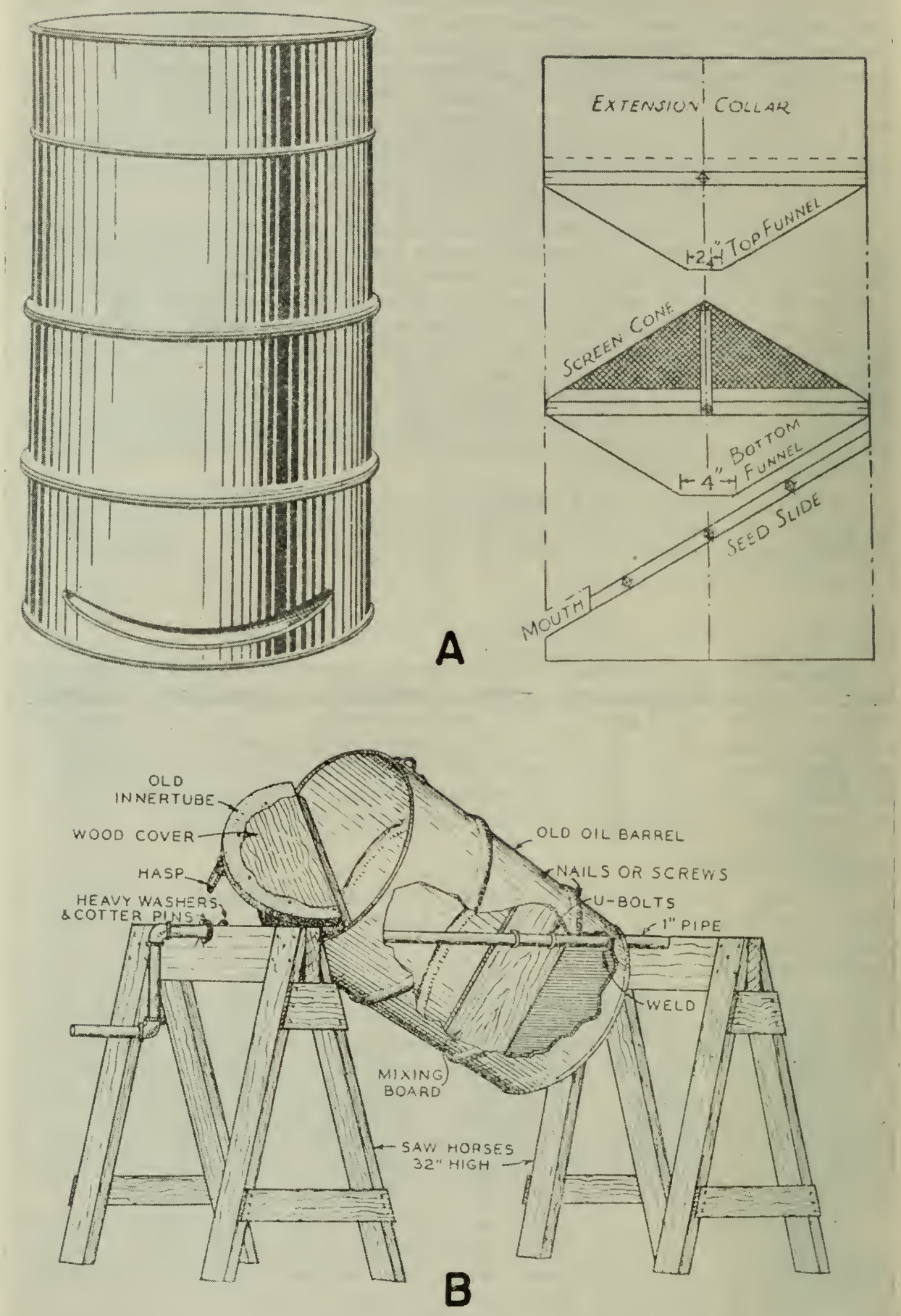

Figure 1—Home-made seed treaters made from oil-drums. A. Stationary, upright treater. B. Rotating treater.

of solution will treat about one bushel of seed. After treatment by either of the two methods, the grain should be spread out to dry. It is advisable to sow the treated seed as soon as it will run through the drill. If through the absorption of the solution the seed becomes swollen, the rate of seeding must be increased.

In general, the practice of steeping or sprinkling is not recommended on account of the extra time and labour involved and also because of the fact that over-treatment may occur and cause harm to the seed. Treatment with formaldehyde may impair germination and consequently is not recommended, although it does reduce the amount of smut. Liquid organic mercury treatments, when properly applied, generally increase germination and are as effective as dusts in controlling most seed-borne diseases.

Hot-water Treatment

Certain diseases of small grains, the causal agents of which are deep-seated in the seed, may be controlled by soaking the seed in hot water. This treatment is particularly effective in controlling the loose smuts of wheat and barley. The seed is first soaked in cool water for four hours, then warmed in water at 125°F. for two minutes, and finally soaked for 10 minutes in hot water (128°F. for barley, and 129°F. for wheat). After immersion in the hot-water bath, the seed should be plunged into cold water and then spread out to dry. The times of immersion and the temperatures must be carefully watched as too long an immersion or too high a temperature will injure the seed, while too short an immersion or too low a temperature will fail to control loose smuts.

Unless special equipment is available, it is impractical on the ordinary farm to treat large quantities of seed by the hot-water method, and only small quantities of seed should be treated at a time. The treated seed may be sown to produce a supply of smut-free seed. It may be advisable to buy seed that has been treated at an experimental station or creamery, or Registered or Certified seed that has very little or no loose smut in it.

Seed Treating Equipment

Probably the least efficient method of treating seed with a dust is to scatter the dust over a pile of seed and then mix grain and dust with a shovel. For small quantities of seed it is advisable to use one of the home-made dusters shown in Figure 1. Of the two devices shown, the rotating-drum type is the more satisfactory. Where a large amount of seed is to be treated, a factory-made machine is a necessity. The Kemp Rocker Seed Treater (Fig. 2,A) is designed to apply dust disinfectants; the Gustafson Slurry Machine (Fig. 2,C) is used for slurry treatments; and a special machine (Fig. 2,B) has been devised to apply Panogen. Farmers who prefer the formaldehyde treatment may use the Bulldog Immersion Smut Machine (not illustrated). Whichever means of application is employed, it is important that every seed be thoroughly and adequately covered with the disinfectant.

In the United States there has been, in recent years, a decided increase in custom cleaning and treating of seed by stationary or mobile units (Fig. 2,D). The advantages of this practice are obvious. In the first place, the cleaning and treating operations are performed uniformly and expertly. Secondly, the farmer is saved the time and labour involved in seed treatment and is not exposed to flying dust or fumes. Finally, the cost of cleaning and treating seed in this way is not great.

In anticipation of increased custom treating of seed in Canada, several large-capacity cleaning and treating units have been placed on the market. So far, the Gustafson Slurry Machine and a large Panogen machine (U.S. 48) are the only machines of large capacity that have come into prominence in this country. Other types as well may soon come into use.

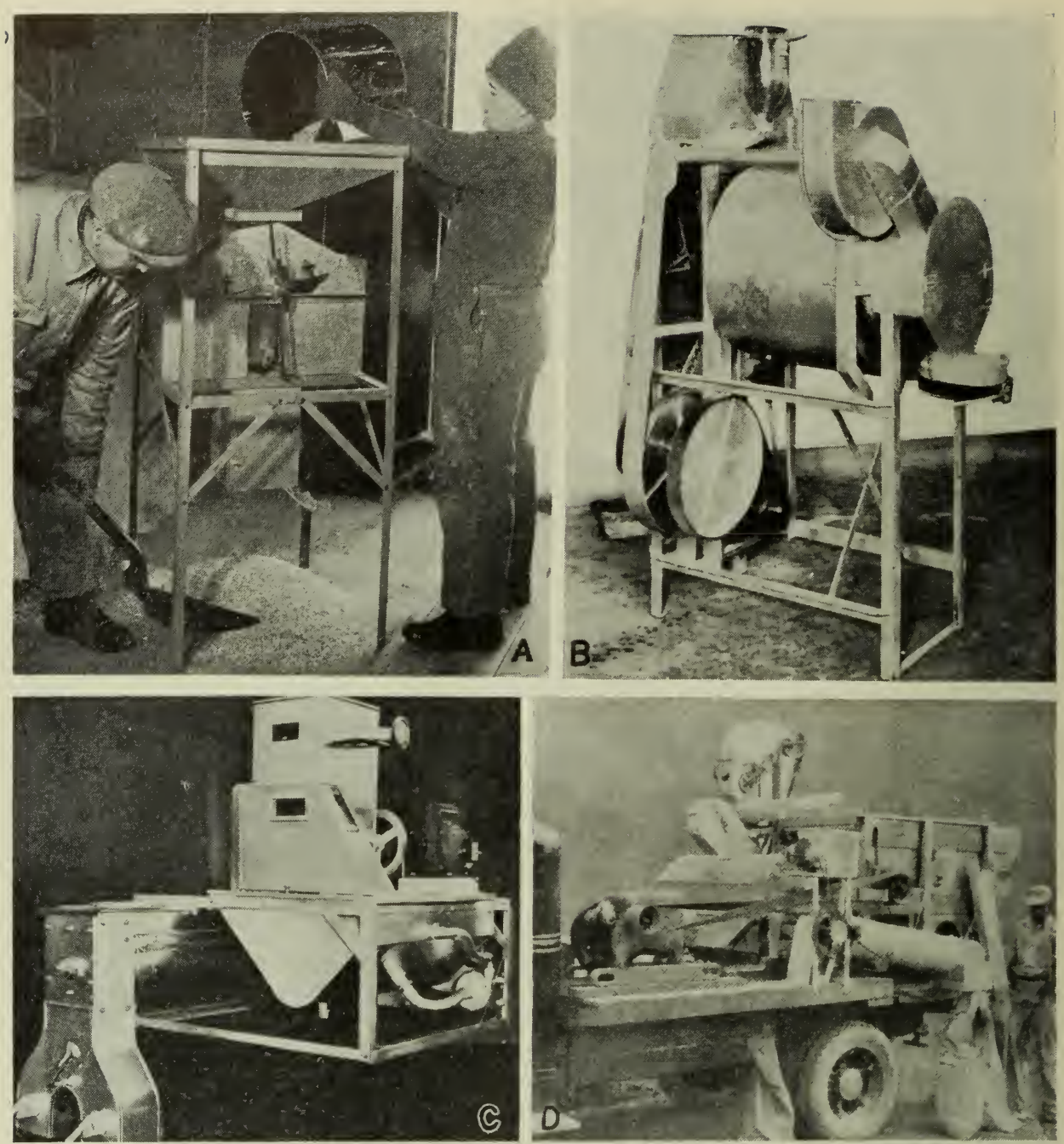

Figure 2—Types of factory-made seed treaters. A. Kemp Rocker Seed Treater. B. Panogen machine. C. Gustafson Slurry Treater. D. Combination Clipper Cleaner and Afco Seed Treater on truck for mobility.

The Smuts Commonly Attacking Cereals in Canada

The smut diseases of cereals are caused by parasitic fungi. There are many kinds, or species, of smut fungi but in Canada only eight cause serious damage to cereal crops. Three species occur on wheat, two on oats, and three on barley. A crop may be affected by more than one species of smut, but the species occurring on one crop do not affect crops of another kind. Each smut species may be composed of a number of parasitic races which differ in their ability to attack particular varieties of the crop concerned. Two races of the same species of smut may hydridize, thereby producing a new race. This process complicates the problem of breeding smut-resistant varieties of cereals.

The common cereal smuts may be divided into two groups, depending on the manner in which they live over from one season to another. In one group (bunt of wheat, covered smut and loose smut of oats, and covered smut and

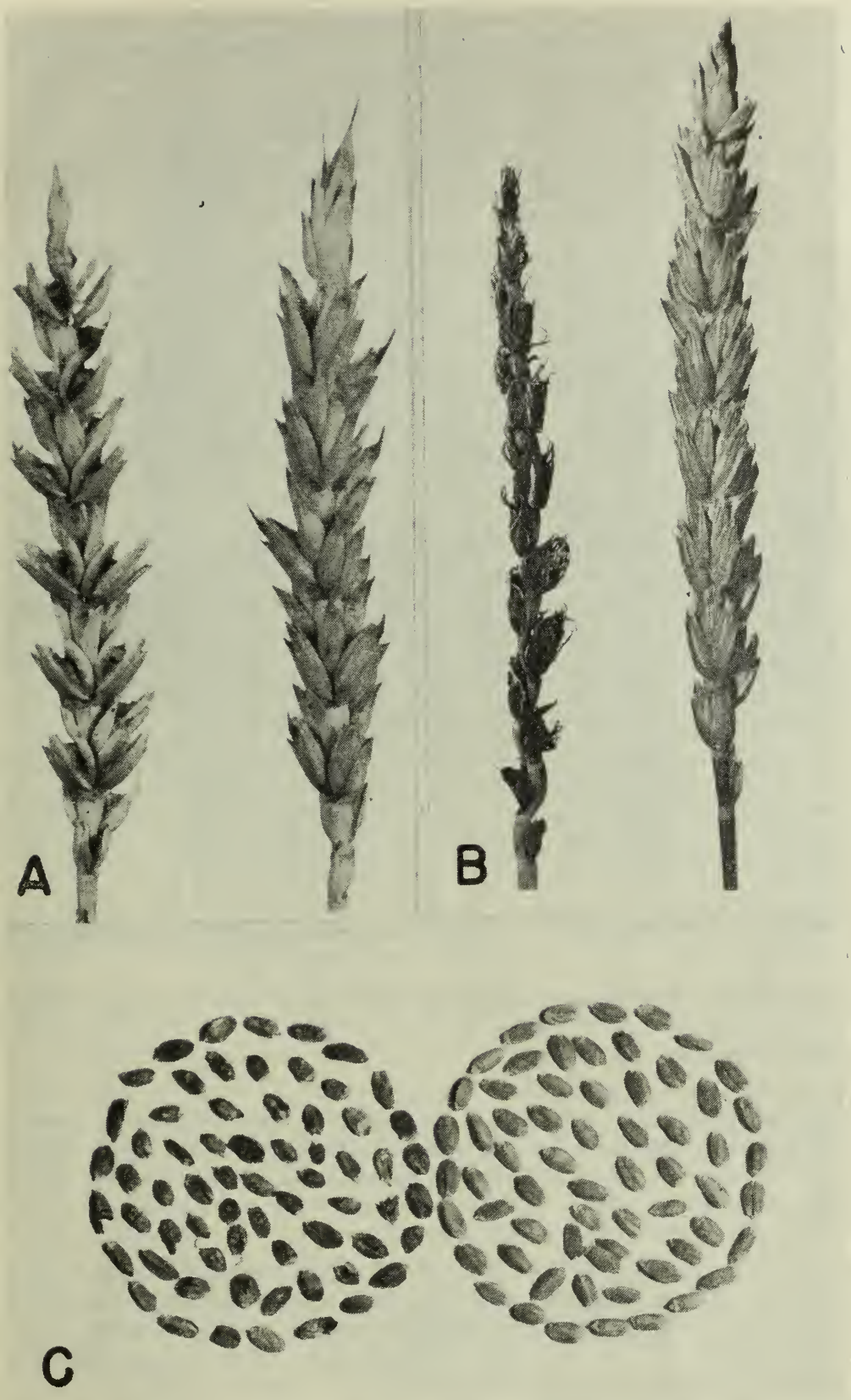

Figure 3—Smuts of wheat. A. Bunt. B. Loose Smut. In each instance diseased head is on left and healthy head on right. C. Bunt balls left, healthy kernels right.

false loose smut of barley), the smut fungus overwinters on the seed surface or just under the hull. After the seed is sown, the fungus begins or resumes growth and infects the seedling below the soil surface. It then grows within the plant until it reaches the developing head. As a result, the head is partially or completely destroyed and the affected parts are transformed into masses of dark-brown spores which are set free during the ripening period and in threshing. The spores contaminate healthy seed, but, as they are present on the outside of the seed only, surface disinfection will control these smuts.

In the second group of smuts (loose smut of wheat and loose smut of barley), the fungus becomes established within the seed and resumes growth after the seed is sown. It eventually enters the head and transforms all but the central stalk into a loose mass of dark-brown spores. These spores are blown to open flowers in the heads of nearby healthy plants at flowering time. There the spores germinate and the fungus enters the young seed embryo, where it becomes dormant as the seed ripens. As the fungus is located deep in the seed, it cannot be destroyed by surface disinfection, so treatment with hot water is required.

Bunt (Stinking Smut) of Wheat

A wheat head attacked by this smut is illustrated in Figure 3,A. All parts of the head are intact except the kernels, which have been transformed into greyish-brown bodies (Fig. 3,C) containing a black mass of spores. The spores may give off a fishy odour. If the smutted heads are soaked in water for a time, the smut bodies swell and can be seen more easily than when dry. When immature, the affected heads are frequently of a deeper green colour than healthy heads and their stems may be slightly shorter.

There are two species of smut fungi (*Tilletia caries* and *T. foetida*) that cause bunt. They can be distinguished from one another only with the aid of a microscope. One variety of *T. caries* causes dwarf bunt, which is characterized by an increased tillering in the affected plants and a conspicuous shortening of their stems. The spores of this variety may lie dormant in soil for several years and, when once the ground becomes contaminated, the disease cannot be controlled by seed treatment. Thus far, dwarf bunt has been found only in British Columbia and certain parts of the United States.

Deep seeding in cool soil increases the amount of bunt in a crop.

Loose Smut of Wheat

As wheat heads emerge from their sheaths, it may be seen that some of them have been transformed into a dark-brown, powdery mass of spores (Fig. 3,B). The spores are soon blown away, leaving only the bare central stalk of the head. A close scrutiny of the crop is required to reveal these comparatively inconspicuous stalks. Thus, although a ripe crop may appear to be free from smut, it may actually be seriously affected.

The fungus causing loose smut of wheat is *Ustilago tritici*. It is closely related to the fungus causing loose smut of barley, but the smut from wheat will not infect barley nor will the smut from barley infect wheat.

Covered Smut and Loose Smut of Oats

These two smuts are grouped together because their life histories are similar and they are controlled by the same treatments. Covered smut, caused by the fungus *Ustilago Kolleri*, is very common in oats. It destroys the seed and part of the chaff (Fig. 4,A). Loose smut (*Ustilago avenae*), also very common on oats, destroys the panicle almost completely (Fig. 4,B). It is often difficult to distinguish between the two kinds of oat smuts, as the extent to which the panicle is destroyed varies considerably within each species, and also because the two species may hybridize and give rise to intermediate forms. If the spore

Figure 4—Smuts of oats. A. Covered Smut. B. Loose Smut. In each case a healthy panicle is shown between two diseased ones.

masses are fairly compact, as frequently happens, fragments of them may be found in the threshed grain. Most of these fragments may be removed from the seed by cleaning, but usually the seed remains contaminated with loose spores.

Deep seeding and warm soil favour smut infection in oats. Oats sown late in the spring when the temperature of the soil is relatively high tend to have more smut in them than an early-sown crop.

Covered Smut of Barley

This smut (*Ustilago Hordei*) is comparatively easy to recognize. Most of the infected head is destroyed, but the spore masses replacing the kernels remain enclosed by a greyish-white, papery membrane (Fig. 5,A). During threshing the spore masses are broken up, contaminating the seed with loose spores and fragments of the spore masses. Infection of barley seedlings by this smut, as in the case of the two smuts of oats, is favoured by deep and late seeding.

False Loose Smut of Barley

False loose smut (*Ustilago nigra*) and loose smut are frequently present in the same field of barley, and it is difficult to distinguish one from the other (Compare B and C, Fig. 5). Both transform the chaff and seed into a mass of dark-brown spores, leaving only the central stalk intact. Many spores of false loose smut are blown away soon after the infected heads emerge and may lodge

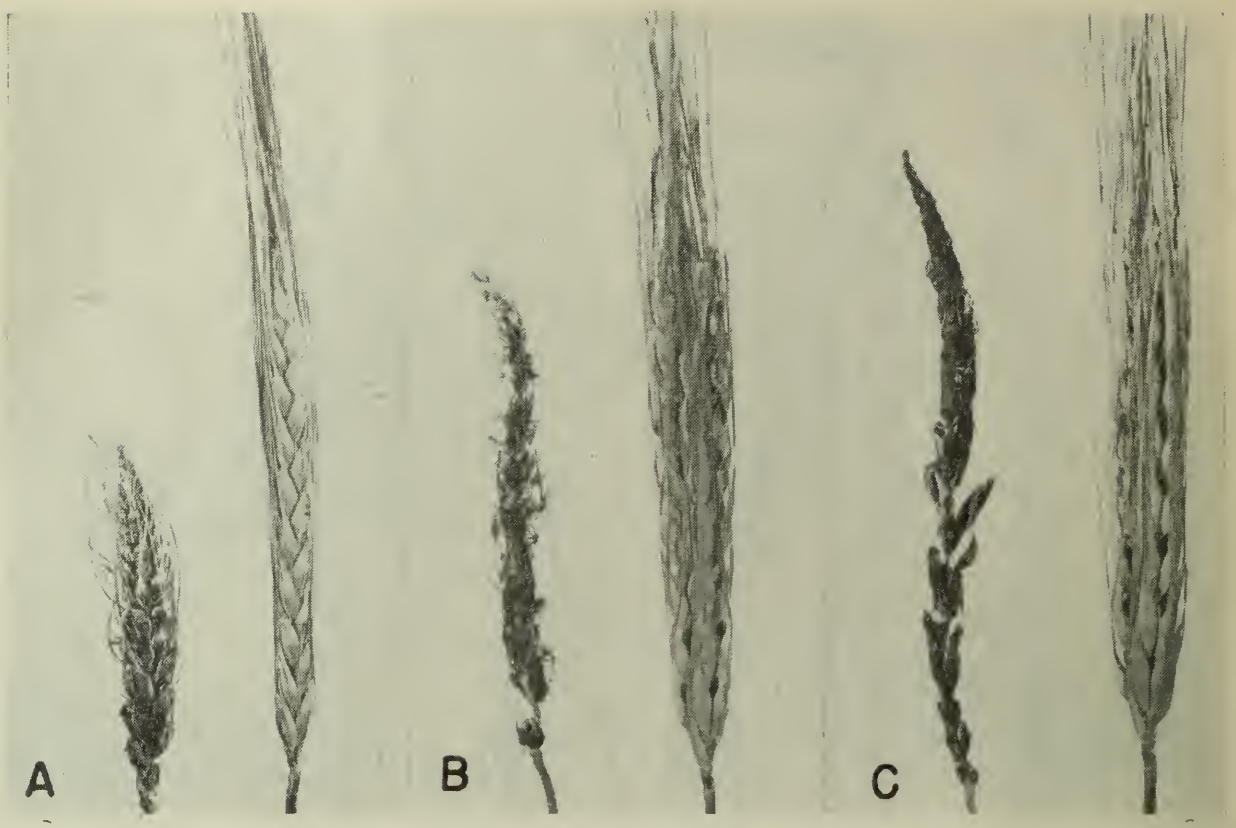

Figure 5—Smuts of barley (diseased heads on left). A. Covered Smut. B. False Loose Smut. C. Loose Smut.

in the florets of healthy heads, where they germinate. Those that remain on the infected heads are set free during threshing and are dusted onto the surface of the grain. The fungus threads produced by spores that germinate in the florets do not penetrate into the embryo of the kernel, as in loose smut, but remain on, or just under, the surface of the hull. Treatment of barley seed with any of the recommended seed treating materials will, therefore, control false loose smut.

Loose Smut of Barley

A head of barley affected by loose smut (*Ustilago nuda*) is shown in Figure 5,C. Spores of loose smut are formed as very loose powdery masses which blow away and leave the central stalk of the head bare. As in loose smut of wheat, the spores alight in the florets of healthy heads, where they infect the young embryo of the kernel. As the kernel matures, the fungus within it becomes dormant and overwinters in this state. Loose smut spores that are present on the surface of barley seed are unable to cause seedling infection, as do those of the covered and false loose smuts.