Seed Treatments for Farm Crops

UNIVERSITY OF ILLINOIS
COLLEGE OF AGRICULTURE : AGRICULTURAL EXPERIMENT STATION
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Many of the recommendations in this circular are based on experiments reported in Bulletin 420 of this Station, “Seed Treatment for the Control of Certain Diseases of Wheat, Oats, and Barley.”

The small gravity treater shown on the front cover is further pictured and described on pages 14-16. It is a new style of treater which has not yet been used widely but which is proving satisfactory for wheat, oats, and barley.

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Seed Treatments for Farm Crops

By Benjamin Koehler, Associate Chief in Crop Pathology

The large losses that occur each year in the grain crops of Illinois and other states as the result of certain disease infections can be prevented or greatly reduced by treating the seed with certain chemical disinfectants. Carefully controlled experiments show that the proper use of the right chemical will kill the fungus spores and bacteria of many important diseases that are carried forward from one year to the next on or in the planted seed.

Many people do not realize the extent of the losses from easily preventable diseases of farm crops. Oat smut alone is estimated to reduce Illinois oat yields an average of 12 million bushels a year. Stinking smut of wheat causes a double loss; not only does it reduce the amount of grain produced, but the smut galls crushed during threshing contain spores which, when liberated, give the sound grain a dark color and foul odor, causing it to be discounted on the market.

Besides controlling certain recognized seed-borne infections seed treatments often control some of the diseases that attack young seedlings that are not seed-borne so far as can be determined. Wheat, oats, barley, and corn have all been benefited in stand, vigor of plants, and yield of grain under these circumstances. Applied to winter wheat, these disinfectants have usually increased the number of plants living thru the winter. Apparently the dust which remains on the seed when it is planted has the power to protect the young seedling from certain soil-borne organisms that are ready to attack when the seed germinates. Of course the seedling diseases that result from infection carried on the seed—scab and blight of wheat and barley and certain diseases of corn—may also be controlled by seed treatment.

Tho highly effective and worth while in controlling some very significant diseases, seed treatments are not a cure-all. None of the rust diseases, for example, nor corn smut, nor corn ear rots can be so controlled, for they reach the plant by other avenues than the seed.

In addition to the diseases specifically mentioned herein as controlled or not controlled by seed treatment, there are a number of so-called minor diseases, some of which may occasionally flare up to importance. It should also be explained that some of the common Illinois crops not mentioned herein are omitted, not because there are no diseases affecting them, but because not enough is known at present about the possibility of controlling them by seed treatment.
RECOMMENDED SEED DISINFECTANTS

For Barley

Seed treatment will control *covered smut* and two kinds of *loose smut* (Fig. 1), *stripe* (Fig. 2), *Gibberella seedling disease* (*scab*; Fig. 3), and *Helminthosporium seedling disease*.

The extent to which most barley varieties are injured by the above diseases would justify treatment regularly every year as a routine matter. Some of the organic mercury compounds have shown outstanding merit for this purpose. New Ceresan (ethyl mercury phosphate), applied as indicated on pages 13 to 16, is recommended when the seed carries these infections.

When Wisconsin Pedigree 38 is used,—a new variety that is increasing rapidly in popularity, is outstanding for high yield, quality of grain, resistance to the stripe disease, and has the desirable smooth awns,—it is still an open question whether seed treatment as a regular practice is worth the trouble and expense. But when the barley seed of this or any other variety is infected with *scab*, *blight*, or *smut*, seed treatment is a paying practice.

Occasionally heavy smut losses will occur in spite of the organic mercury treatment. When this happens, seed should be obtained from someone known to have barley that is free from smut, or the hot-water treatment (page 18) should be applied.

Barley diseases not controlled by seed treatment are: *leaf rust*, *stem rust*, *head scab* and *blight*, *spot blotch*, *mildew*, and *false stripe*.

For Broomcorn

*Covered kernel smut*, the principal disease attacking broomcorn, destroys the seeds in the head or brush and produces, in their place, dark galls full of dusty smut spores. Occasionally a similar but more fragile smut called *loose smut* is found. Both these smuts can be controlled by sifting and fanning the grain to remove as many smut balls as possible and then treating the seed with New Ceresan, page 13.

For Corn

Only the *seedling diseases* of corn are controlled by seed treatment. Some of these are caused by fungi carried in or on the seed, as are *Diplodia zeae* (Fig. 4), *Fusarium moniliforme*, *Gibberella saubinetii*, *Basisporium gallarum*, and others. Others are caused by infections carried in the soil, the nature of which are not yet well understood. The soil-borne infections sometimes cause more injury than the seed-borne infections.
All common barley varieties are susceptible to smut. At b is shown covered smut; at c, one of the two loose smuts. Chemical seed treatment effectively controls the covered smut and one of the loose smuts.

Stripe-infected barley plants seldom produce heads, but are short and weak. The leaves have dark stripes on them and many of them split before the grain ripens. From these leaves the spores spread to healthy heads.
The greatest injury from the above diseases occurs when corn is planted early and germinates slowly. Seed treatment is therefore especially effective in increasing stand, vigor, and yield when corn is planted in the first half of May or earlier, tests at the Illinois Station show. Benefit from such treatment has varied, however, with seed, soil, and weather conditions, but the average increase in yield in the northern two-thirds of Illinois has been about 3 bushels an acre.

![Fig. 3.—Healthy Barley Kernels (A) and Scab-Infected Kernels (B)](image)

As barley kernels are covered with a hull, scab infection is not so easy to detect by mere observation as is scab in wheat. Infected kernels show brown to grayish brown discolorations, and sometimes some of the pink fungous growth can be seen.

One of the best disinfectants for seed corn now on the market is New Improved Semesan Jr., the active ingredient of which is ethyl mercury phosphate. Directions for applying this material are given on page 19.

It should be added, however, that the production of good seed corn ordinarily requires attention to more details than does the production of seed of the small grains, and that seed treatment is only one of several essential steps. For discussion of other aspects of good seed corn production, see Circular 364 of this Station, "Control of Corn Diseases in Illinois."

Some of the other corn-seed disinfectants now on the market fail to carry on their labels a statement of the composition of the active ingredient. Without such information there is no basis on which recommendations concerning them can be made, for a manufacturer may change the nature of a seed-treatment compound at will and still retain the original trade name.
Proper seed treatment applied to Diplodia infected seed makes a striking difference in the growth of the seedlings. The seed used in the above tests had been infected with *Diplodia zeae*, but the infection had not gone far enough to kill the germs. When Diplodia has killed the germs, as it often does, discolorations are likely to show in the shelled grain, and the affected ears can be detected and discarded.
Important corn diseases not controlled by seed treatment, or con­trolled only slightly, are: ear rots, smut, bacterial wilt, stalk rots, root rots, and leaf blight.

For Oats

Smut is the most important disease of oats. The average annual loss to the crop in Illinois, including the loss from plants weakened by latent infection as well as from smutty heads, is estimated at 7 percent. There are two kinds of smut in oats—loose smut and covered smut. Both can be controlled in the same way.

New Ceresan and formaldehyde both control smut of ordinary hulled oats equally well (pages 13 to 18). The New Ceresan dry treatment is more expensive than formaldehyde applied by the spray or sprinkle method, but it is simpler to use and has given better yields of grain. At times New Ceresan has improved the stand and vigor of young plants thru the control of seedling diseases of oats also (Fig. 5). This was not true of formaldehyde.

FIG. 5.—STAND AND VIGOR OF OATS INCREASED BY CERTAIN SEED TREATMENTS

The seed for this field was treated by a farmer and sown with an ordinary grain drill. In the rows to the left of the center, untreated seed was used; to the right, the seed was treated with Ceresan. Rows a' and b' were sown with the same drill shoes as rows a and b respectively and at the same rate of seeding. The differences exhibited here are due to the seed treatment.
For the treatment of *hull-less oats* there seems to be little choice between copper carbonate and New Ceresan (pages 12 and 13). Both have controlled smut perfectly in the hull-less varieties and sometimes have given an increase in plant vigor similar to that shown in Fig. 5. Formaldehyde, however, causes excessive seed injury to hull-less varieties.

All oat seed should be treated when there is any reason to suspect that it may contain smut infection. Even when the crop appears to be free from smut, infection may have blown in from neighboring fields, and it is therefore advisable to treat the seed every second year regardless of appearances.

Important oat diseases not controlled by seed treatment are *leaf rust* and *stem rust*.

**For Sorghum**

*Covered kernel smut* is the most destructive disease of sorghum. Plants affected by this smut, instead of producing seed, produce false kernels filled with smut spores. Some of these spores are carried by the wind or by threshing operations to the good kernels. Occasionally a somewhat similar but more fragile form called *loose smut* is found on sorghum.

Seed contaminated with either of these smuts should be sifted and fanned well to remove smut galls, and then treated with copper carbonate or New Ceresan (pages 12 and 13).

**For Wheat**

The important diseases of wheat that can be controlled by seed treatment are: *stinking smut*, or *bunt*, and *loose smut* (Fig. 6), *Gibberella seedling disease* (scab, Fig. 7), and *Helminthosporium seedling disease*.

*Stinking Smut.* Heavy infections with stinking smut can be detected readily by a dark discoloration of the grain, especially in the brush, and a foul fishy odor. Light infections that cannot be detected readily in the seed may cause considerable loss, so that the appearance of the seed cannot be taken as the sole basis for judging whether the seed should be treated. In a large part of the state wheat is a minor crop grown in a rotation with other crops. Here the farmers usually grow considerable oats or barley or both. When these crops are threshed alternately with wheat, there is no great danger of carrying the infection from one farm to another in threshing machines. Furthermore Turkey wheat, which is somewhat resistant to stinking smut, is the principal variety in a large part of this area. *In this region, there-
FIG. 6.—SMUT-INFECTED WHEAT (RIGHT) AND A HEALTHY HEAD (LEFT)

(a) Sound head of Fulhio wheat, (b) sound kernels, (c) head infected with stinking smut, (d) stinking smut galls formed in place of kernels, (e) loose smut head with smut spores mostly blown away. Different methods of seed disinfection must be used to control these two smuts.
Scab-infected kernels are more or less shriveled, light in weight, bleached, and some kernels usually show some pink color. The infected kernels can be removed, to a large extent, by thorough fanning. Seed treatment with good organic mercury compounds definitely benefits the resulting crop. Therefore, it would seem wise to urge seed treatment only when the grain is known to carry infection.

In certain limited areas of the state wheat is the principal small grain crop. Furthermore soft wheats, which appear to be more susceptible to bunt than Turkey, are grown to a considerable extent in these locations. Intensive cropping favors the spread of infection from one farm to another, and here one seldom finds a field entirely free from stinking smut unless the seed has been properly treated. Intensive cropping also favors the spread of other diseases besides stinking smut, some of which are held in check by seed treatment. In this region, therefore, it seems advisable to recommend treating the seed every year. The odds that seed treatment with copper carbonate or New Ceresan (pages 12 and 13) will pay for itself, even tho the seed appears clean, are very good.

Scab. Any season when weather conditions are right, scab infection may break out anywhere in the corn belt in severe form on wheat. Infected seed can be detected by a certain amount of bleached kernels (Fig. 7). Thorough fanning, followed by treatment with New Ceresan (page 13), appears to be the most effective means of control. This procedure will prevent seedling blight and weak plants that are caused by scab, but will not prevent a recurrence of head infection, as that is caused by wind-borne spores coming in contact with the heads.
Since the wind-borne spores come mostly from old cornstalks left in the field from the previous year, the best way to hold head scab of wheat or barley in check is never to sow these crops on cornstalk land and to plow under thoroly all corn refuse on adjacent fields.

Loose Smut. Only the hot-water method of seed treatment (page 18) is effective against loose smut (Fig. 6). As this treatment is a little difficult to apply and causes some damage to germination, and as loose smut is not usually very serious, treatment is not usually recommended. Trouble with this smut can often be overcome by exchanging grain with a neighbor whose wheat carries less infection. However, the hot-water method has been used with success by farmers the world over, and any careful person can manage it.

DIRECTIONS FOR APPLYING DISINFECTANTS

Copper Carbonate

(For Stinking Smut of Wheat, Kernel Smut of Sorghum, or Smut of Hull-less Oats)

To apply copper carbonate properly to wheat, sorghum or oats, for the above diseases, a machine is needed. One made from an oil drum (Fig. 8) is very satisfactory if the drum is filled one-third full and is revolved thirty or more times. A power cement mixer is good if the opening can be closed tightly. For large amounts of seed a commercial machine thru which the wheat passes in a steady stream saves time. A number of such machines are on the market. One type employs a mixing drum with a power drive, another is equipped with a series of baffle plates over which the grain and dust flow by gravity. Both types, when properly constructed, give good results. A combined cleaning and treating machine is shown in Fig. 9.

A good job of mixing cannot be done with a shovel. Altho shovel-treated grain may look to the naked eye as tho well treated, best smut control is not likely to be obtained by this method. The copper carbonate, to be most effective, must be rubbed into the entire seed coat of every kernel.

Use 2 to 3 ounces of 18- to 20-percent dilute copper carbonate to each bushel of seed, or 2 ounces of the concentrated 50-percent grade. The dilute grade has proved very satisfactory in Illinois.

Grain treated with copper carbonate can be stored from one year to the next in a dry place without harm. It has been said that insects and mice do not attack treated grain so readily as they do untreated grain. The cost of copper carbonate is 2 to 3 cents a bushel of grain.

When working with copper carbonate, use care not to inhale the
dust. Work in the open or in a drafty place or if this is impossible, wear a respirator. *Breathing very much of the dust will cause illness.*

After treated wheat has stood in the drill hoppers over night or longer, make sure the cylinders are loose before using the machine again. This can be done by turning the drive rod back and forth with a wrench. Otherwise, especially if the weather has been damp, the cylinders may stick and injure the drill.

**Fig. 8.—A Seed-Treating Machine Suitable for Applying Dry Disinfectants**

A machine like this can be made from a 30-gallon oil drum. The lid should fit dust-tight. One bushel is treated at a time. This style of machine originated at the Pennsylvania State College. Larger machines can be used if a power drive can be arranged. Power machines with continuous action are being offered on the market.

**Ceresan Treatment**

*(For Stinking Smut of Wheat, Smuts of Oats, Smuts of Barley, Scab or Blight of Wheat and Barley, Stripe Disease of Barley, and Kernel Smuts of Broomcorn and Sorghum)*

Ceresan is a patented commercial compound that is sold widely.

¹The earlier Ceresan product (ethyl mercury chlorid) the author understands is no longer marketed extensively for wheat, oats, and barley, being superseded by the "new improved" Ceresan. All directions for treatment therefore refer to the later product.
Some of the essential features of this machine are: (A) an elevator which raises the grain from a hopper near the ground; (B) a weighing device; (C) fanning mill; (D) disk cleaner; (E) an adjustable positive feed for delivering the disinfectant to the treating drum; (F) a revolving treating drum with baffle plates on the inside. A number of machines of this type are rendering valuable custom service on farms in the soft-wheat belt of Illinois. Very good preparation of seed for planting is done quickly with little labor and at low cost.

The new product, containing 5 percent ethyl mercury phosphate, is used at the rate of only $\frac{1}{2}$ ounce per bushel. This is sufficient for disease control; if more is used, yields are likely to be lowered.

It is best to apply Ceresan with a treating machine such as described for the copper carbonate treatment. If the mixing has been thorough, the seed may be sown at once. For best results, it should be sown within a day or two.

The small gravity treater shown in Fig. 10 and on the front cover works much faster than a barrel treater but it does not do so thoroughly.

1 The design shown in Fig. 10 is adapted from drawings in "Cereal Seed Treating Equipment and Chemicals," a mimeographed publication issued by the Division of Cooperative Extension, U. S. Department of Agriculture, December, 1934.
In operating this treater, one man pours a bushel of grain slowly into the funnel at the top, while another gradually pours in a \( \frac{1}{2} \)-ounce measure of Ceresan directly above the center of the funnel, as shown in the picture on the front cover. Treatment can be applied much more rapidly with this equipment than with the barrel mixer, and with much less effort. Also the sack being tightly connected with the spout, there is less diffusion of dust.

A perforated as well as an unperforated surface and various angles to the cones were tested by the writer. The plan shown here appeared to give the most satisfactory results. The perforations must either be large enough to permit the grain to pass thru easily or be small enough—\( \frac{1}{16} \) inch or less—so that oats will not get caught in them. Wheat gives less trouble than oats. The solid center of the screened cone prevents the dust from falling down thru the center and covers that part of the screen where the oats are most likely to get caught in the perforations.
job of mixing. It does a better job, however, than can be done with a shovel, and is satisfactory for applying Ceresan if the grain is allowed to stand in sacks or a deep wagon box for 24 hours before it is sown. Shovel-mixing, altho the poorest method of applying seed disinfectants, can be used with some measure of success with Ceresan because Ceresan works as a gas as well as by contact. When grain is shovel-treated with Ceresan, 24-hour storage is necessary, as it is when the gravity treater is used.

If it is desired to store the grain for a week or longer, the dosage should be reduced to three-fourths or one-half the amount specified above, that is, \( \frac{3}{8} \) or \( \frac{1}{4} \) ounce per bushel. This will be sufficient for smut control and will tend to avoid damage from storage. When such small amounts are used, it becomes increasingly necessary to do the mixing thoroughly with a good mixing machine.

Do the treating out-of-doors where there is some air movement, or do it in a drafty place under a roof. *Do not inhale this dust, for it is poisonous.*

**Formaldehyde Spray Treatment**

*(For Oat Smuts)*

To treat oats for smut by the formaldehyde spray method a quart-size spray gun (Fig. 11) and ordinary commercial formaldehyde are needed. Both can be purchased cheaply at most drug stores.

*If the oats are to be sown the same day or the next day,* mix 1 pint of formaldehyde with 1 pint of water. This quart of half-strength solution is sufficient for 50 bushels of oats. One man scoops the oats from one pile to another while another man shoots 3 or 4 full strokes on each shovelful as it is picked up. The number of shots depends on the sprayer as well as the size of the shovel. After this has been done, turn the pile at least once more by shoveling it into another pile or into sacks or a wagon box. If the seed is not sacked, cover it with blankets or canvas for 5 hours or overnight before seeding.

If, after this treatment, the oats should have to be stored several days or a week before being planted, no great harm will be done; but the seed will suffer least damage if sown as soon as possible after the treatment is completed. Spreading the grain out thin and airing it will help to prevent damage in storage.

*If to be stored 2 to 5 days before sowing,* use less formaldehyde. Mix 1 part formaldehyde with 2 parts water and apply 1 quart of the mixture to 50 bushels of oats as directed above.

*If to be stored longer than 5 days,* mix 1 part formaldehyde with 3 parts water and apply 1 quart of the mixture to 50 bushels of oats.
SEED TREATMENTS FOR FARM CROPS

FIG. 11.—THE SPRAY METHOD OF TREATING OATS WITH FORMALDEHYDE

The spray method is one of the most practical methods of applying formaldehyde to oats. The work should be done in a ventilated place, otherwise the fumes become obnoxious.

Shovel from one pile to another two or three times, then put into sacks or cover with canvas. These reduced dosages, recommended when oats are to be stored before seeding, are sufficient for smut control if the mixing is done properly. If more formaldehyde is used, there is danger of reducing the yield of the crop.

The approximate cost of the formaldehyde is $\frac{1}{2}$ to $\frac{2}{3}$ cent a bushel. The formaldehyde should be kept tightly corked.

Formaldehyde-treated oats may be fed to animals if the oats are first thoroly aired.

**Formaldehyde Sprinkle Treatment**

*(For Oat Smuts)*

The formaldehyde sprinkle method, as developed at the Illinois Station, calls for 1 pint of formaldehyde to 80 bushels of oats. This
treatment controls the smut well if the solution is thoroughly mixed with the grain and the pile is tightly covered for about three hours. The more usual recommendation is to use 1 pint of formaldehyde to 50 bushels of oats. In the hands of the average user, this greater concentration is surer to control smut but it is also more apt to cause injury to the seed. The treatment should be applied at a temperature of 60° F. or warmer.

Mix 1 pint of formaldehyde with 10 gallons of water for each 80 bushels of seed to be treated. Make up immediately before use, or keep tightly corked.

Sprinkle the solution over the oats with a sprinkling can, using 1 pint to each bushel, and mix thoroughly. Pile the oats up and cover with blankets, canvas, or sacks which have been moistened with the same solution.

After about three hours uncover the oats. If they have been thoroughly mixed they will have absorbed the moisture so well that they will be dry enough to sow at once in a broadcast seeder or drill. If the oats cannot be seeded at once, they should be spread out in a thin layer and stirred occasionally to allow the formaldehyde gas to escape.

**Hot-Water Treatment**

*(For Loose Smuts of Wheat and Barley)*

The hot-water treatment applied for the control of loose smuts of wheat and barley kills other seed infections besides the loose smuts but, as it causes some seed injury and the method is exacting, it is not recommended except for loose smuts that are not controlled by chemical treatments. An accurate thermometer is necessary.

Place the grain in loosely woven sacks, half a bushel to each sack, and tie the sacks at the top so as to leave plenty of room for expansion and for the agitation of the grain.

Soak in cold water for 4 to 5 hours.

Dip for a minute or two in water at about 120° F. to warm the grain so it will not lower unduly the temperature of the final treating solution.

Plunge wheat into water at 129° F., and barley into water at 127° F., and allow to remain 10 minutes. Agitate the grain in the sacks during this time.

Spread out the grain so that it will cool quickly and dry.

Before the next sack is treated, restore the correct temperature by adding boiling water.

Sow the seed as soon as it is dry enough to be run thru a drill.
Allow for the swollen condition of the grain and probable injury to germination. In certain tests involving 33 samples of machine-threshed grain, the average germination before treatment was 87.6 percent, after treatment it was only 52.7 percent.

Because of the tediousness of this process it is commonly used only to obtain smut-free grain for a small plot from which sound healthy seed may be taken for the general seeding the following year. One of the worst difficulties with this method is to get the heat to penetrate quickly and thoroughly into the grain mass within the sacks. Suitably constructed wire baskets are better than sacks. Special revolving wire-covered drums, chain hoists, and live steam for heat control make treatment on a large scale practical.

Semesan Jr. Treatment

*For Seedling Diseases of Corn*

This material, like Ceresan, is a patented commercial compound. The “new improved” product contains ethyl mercury phosphate as the active ingredient.¹

Use at the rate of 1½ to 2 ounces a bushel of seed corn. Mix thoroughly with the seed. The barrel type of mixer (Fig. 8, page 13) or a revolving churn, filled less than half full of seed, is very satisfactory for this purpose.

Another method of mixing is to use an excess of the disinfectant, shake or roll it with the seed in a closed can, and then screen off the excess dust.

Apparently seed corn can be treated with this material a few months before it is planted without risk of being damaged if the treated seed is stored in a dry and heated building.

¹The contents of both Ceresan and Semesan Jr. are clearly indicated on the labels. The significance of this fact is explained in the footnote on page 6.
SEED-BORNE DISEASES cause heavy losses each year to Illinois farmers. Effective seed treatment will prevent or substantially reduce such losses in—

CORN
WHEAT
OATS
BARLEY
SORGHUM
BROOMCORN

This circular gives brief and simple directions for applying such treatments. With inexpensive equipment, any farmer can do this work for himself . . . . . .