DUSTING FOR SMUT
COPPER CARBONATE DRY TREATMENT
FOR BUNT OF WHEAT

BY
H·E·MORRIS and A·J·OGAARD

ISSUED BY
MONTANA STATE COLLEGE, EXTENSION SERVICE
BOZEMAN
This page blank in the original.
Dusting For Smut
COPPER CARBONATE TREATMENT FOR BUNT OF WHEAT
BY
H. E. MORRIS,
Associate Botanist,
Montana Experiment Station
A. J. OGAARD,
Extension Agronomist,
Montana Extension Service

Smut is produced by a small plant, mould-like in appearance, belonging to a group called fungi. Smut lives most of its life within and at the expense of the wheat plant. The smut powder so familiar to all is composed of myriads of spores which corre-
What Is Smut?

Spond to seeds in the higher plants. In the process of harvesting and threshing, these spores are distributed, many of them adhering to the wheat. Conditions favoring the germination and growth of the wheat are favorable to the growth of the fungus and it germinates with the wheat; then if it comes into close contact with a young wheat seedling, it attacks it and from that time forth grows within the wheat plant. At about the time the wheat plant should normally form grain, the fungus becomes very active, starts grow-

Fig. 1—Enlarged wheat kernels. Note the rough surface and the "brush" in which smut spores find lodgement. The copper carbonate dust is held in similar manner and kills the germinating spores with which it comes in contact.
DUSTING FOR SMUT

ing vigorously and produces the black smut powder, thus completing its cycle of life.

Kinds of Smut

Strictly speaking there are three classes of smuts. First, smuts similar to the bunt of wheat, where infection occurs only in the seedling stage, commonly called Covered Smuts. In this class of smut the spores are carried on the outside of the seed; therefore they can be destroyed by treating the seed with a chemical, either as a powder or in a solution which kills the spores but does not injure the grain. The only exception is bunt, which may also infect the wheat plant from the soil under some conditions. This commonly occurs in the winter wheat sections of Eastern Washington and Oregon. In these sections clouds of smut spores or “smut showers” infect the surface of the soil during the fall months. In this state such soil infection is not important except in some seasons in the case of winter wheat planted on summer fallowed land. Smut spores do not generally live over winter in the soil. Infection of spring wheat is therefore a result of smut spores on the outside of the untreated seed when planted.

Second, smuts similar to the loose smuts of barley, where infection occurs only when the plants are in blossom, commonly known as Loose Smuts. In this class of smut the fungus is carried within the seed; therefore, it can only be destroyed by dipping in water just hot enough to kill the smut spore and yet not hot enough to kill the seed itself. (See Note) This method is exacting on account of the slight difference in the degree of heat which will kill the smut spore and that which will kill the germ of the wheat.

Third, smuts similar to corn smut where any young growing plant may become infected, as the silk, tassels, leaves, stems, etc. This class of smut can be controlled only by destroying the diseased plants when they first appear. Seed treatment is of no value.

Bunt or Stinking Smut

Bunt, or stinking smut of wheat, belongs to the first class.

NOTE—Soaking two hours with formaldehyde (1-30 strength) is now recommended for control of loose smut of barley.
That is, infection occurs only in the seedling stage and therefore it cannot and does not spread from plant to plant in the field.

Just as there are different kinds of apples, so are there different kinds of smut, each peculiar to the plant upon which it grows. **Wheat smut will not grow upon oats or barley.** Oat smut will not grow upon wheat and barley and barley smut will not grow upon wheat and oats.

Dr. E. C. Stakman, University of Minnesota, says: “We have continued experimental work with copper carbonate dust and we can only confirm our previous conclusions that copper carbonate dust is the most satisfactory fungicide for the prevention of stinking smut of wheat. It is not as effective as formaldehyde in preventing the covered smuts of oats and barley, consequently we do not recommend it for these two grains.

“It also has been our experience that a copper carbonate dust with a copper content of about 25% is as effective as one with a much higher content of copper. Since the dust with the lower content is cheaper, we recommend it in preference to that with the higher copper content.”

Copper sulphate or bluestone has been a standard remedy for smut for many years. In 1858, Kuehn recommended a dilute solution of copper sulphate as a remedy against smuts. He used one pound of copper sulphate to every five bushels of wheat, and ever since that period it has been extensively used with some modification in the formula.

One pound of copper sulphate dissolved in five gallons of water and the grain soaked for ten minutes was the standard remedy until formaldehyde was recommended in 1897.

The advantages of copper sulphate are: (1) It is one of the most efficient fungicides, and when used properly will give excellent smut control. (2) It affords a certain degree of protection to the seed after it is planted, due to the coating of the seed. (3) Seed thoroughly dried after treatment may be stored before seeding.
Copper Sulphate Method

The disadvantages of the treatment are, (1) Seed may be injured or so affected that the roots and young stem grow abnormally. To prevent this injury the bluestone treated wheat should be soaked in lime water, which means extra cost in labor and time. (2) In drilling, an estimated allowance must be made for the swelling of the seed during treatment.

The copper sulphate treatment was partly supplanted by the formaldehyde treatment recommended in 1897.

Formaldehyde Next Used

The advantages of the formaldehyde treatment are: (1) causes less seed injury than copper sulphate. (2) It is cheaper and more easily handled. (3) It controls smut more effectively except where soil infection is an important factor.

Its disadvantages are: (1) Seed cannot be safely stored after treatment, even when thoroughly dried, for often seed injury results from the continued action of the chemical. (2) When treated seed is sown in soil too dry for immediate germination, considerable injury often results. (3) An estimated allowance must be made when the seed is drilled due to the swelling of the seed during treatment.

Copper Carbonate Method

In order to encourage the grower to practice yearly treatment of his grain, the objections to the use of copper sulphate, copper sulphate and lime, and formaldehyde must be overcome. A new

Prof. W. W. Mackie, University of California says: "Many farmers report that the copper carbonate treated seed germinates so much better than the seed treated with other chemicals, that approximately 25% less seed is needed to secure a good stand. Usually farmers report more vigorous and early germination of copper carbonate dusted seed. This advantage is usually reflected in superior crops. * * * * The absence of germ injury to seed wheat treated with copper carbonate has been conclusively demonstrated by hundreds of control tests. Everywhere farmers have observed the same results. While complaint of seed injury caused by formaldehyde and bluestone treatments have been frequent, none have been received against copper carbonate."
method of seed treatment, the copper carbonate dust method, does away with many of these objections and is effective in controlling smut.

Copper carbonate in the form of a finely divided powder was first tested by Darnell-Smith as a fungicide in New South Wales. In 1917 he reported that this treatment gave better results than either formaldehyde or copper sulphate (bluestone). The copper carbonate dust treatment caused no injury to germination even when the seed was stored for indefinite periods, and gave increased yields with less smut.

Early History of Dust Method

These results soon attracted attention in America. Mackie and Briggs of California were the first to verify them. Other investigators in many parts of the country soon began to test out the dust treatment and in a great majority of cases, favorable results were obtained. It is now generally recommended for the control of bunt in wheat.

The advantages of the dust treatment may be briefly enumerated as follows: (1) It saves time and is more convenient and agreeable. (2) Wheat may be treated during spare time previous to seeding. (3) It is non-injurious to germination and vigor of growth. (4) Less seed per acre is necessary in comparison with the standard formaldehyde or copper sulphate treatment. (5) The seed may be planted in dry ground without danger of loss of vitality, as so often happens following the formaldehyde treatment.

George L. Zundel, Pathologist of Washington State College, writes that in 1922 enough seed to plant 734,000 acres was treated with copper carbonate; in 1923, this acreage was increased to 1,500,000. Prof. W. W. Mackie of California states that in 1920 a few ounces of copper carbonate were used; in 1921 about 12,000 to 15,000 acres were sown with treated seed, but 1922 estimates place the acreage at more than 250,000.

A manager of a large ranch in Montana states that the particular value of dry treatment is the saving in time, as one man with a good machine can keep three drills working, while under the "soak" method about three men were necessary for the same work.
The copper carbonate dust method for treating stinking smut or bunt of wheat is now recommended in several states and has been found satisfactory from the standpoint of germination, smut control and yield. It has not given as good control as the standard liquid treatment on the grains having hulls, that is, oats and barley.

What Is the Dust Treatment? The copper carbonate dry dust treatment for smut consists of mixing a definite amount of copper carbonate with a definite amount of wheat—without becoming mixed up with the powder personally. To be effective it is necessary that the kernel be coated with the fine dust. The fine particles of copper carbonate destroy the smut spores lying on the outside of the wheat kernel.

H. A. Rodenhiser, Plant Pathologist, University Farm, St. Paul, Minnesota, states: “I may say that in the past two years we find the use of copper carbonate for the control of bunt in wheat most satisfactory. This is true from the standpoint of germination, smut control and yield. Copper carbonate dust reduced the amount of smut of hulled oats and covered smut of barley in all trials, but in about half of the tests the amount of reduction was slight. For these smuts it appears that copper carbonate dust is not as effective as formaldehyde.”

Quality and Amounts of Dust Recommended. The standard copper carbonate as recommended for this treatment should be light and fluffy and of a light green color. Heavy, bluish, or coarse powders should be avoided. The standard dust should test about 50% to 54% metallic copper and should be fine enough to permit from 98% to 100% to pass through a 200 mesh screen. The success of the treatment depends on the even distribution of the powder over the surface of the kernel. “Extended” products testing about 20% metallic copper are also being used for this treatment. These are sold under various trade names such as Coppercarb, Smuticide, Wheatcote, etc. From the experimental evidence now available it would appear that these
“extended” products may be substituted for the standard copper carbonate in Montana where smut infection is generally rather light. For Montana conditions, two ounces of the standard dust and possibly three ounces of the extended product should be sufficient. The use of more dust than will adhere to the wheat is mere waste. The cost is slightly higher than for the formaldehyde treatment but the amount of seed saved and other advantages of the dry treatment far overshadows the treatment cost margin.

Copper carbonate supplies may be obtained thru local drug stores, wholesale drug firms, some implement dealers and seed houses. County Agents and Smith-Hughes Agricultural Instructors will supply information regarding available sources. Where such service is not available, persons may write to Montana Extension Service, Bozeman, for such information.

Do Not Feed

The copper carbonate dust is not extremely poisonous but reasonable care should be exercised in handling it. Some reports received indicate that chickens have died from the effects of eating treated grain. Livestock have been physicked by eating treated grain, but are reported to have recovered. In case it becomes necessary to feed treated grain to livestock, the grain should be thoroughly washed, as copper carbonate is practically insoluble in water and therefore is easily removed by this method.

Do Not

Inhale the

Dust

The injurious effects to men while treating the grain are apt to be somewhat serious unless proper precautions are taken. The dust affects the sensitive lining of the nose and throat when inhaled. The immediate effect is usually sneezing, and if exposure to the dust is continued, headache and nausea are apt to result. Mixing devices should be used which are dust-tight. The mixing should be done in a well ventilated room, preferably out of doors. In copper carbonate factories, the workers use masks or special respirators and suffer no inconvenience. Many farmers are also using these respirators which are light and permit breathing and talking without difficulty. Drug stores furnish these respirators at about $2.00 each.
Fig. 2.—Three types of commercial mixing machines.
Prof. H. P. Barrs of the Oregon Agricultural College states: “The standard high quality type of copper carbonate containing 50% copper and having satisfactory fineness is an exceedingly effective means of controlling wheat smut when thoroughly applied to the seed. This is true even with very heavily smutted lots of seed. For instance, we secured perfect control with two ounces of copper carbonate on grain which had one part of stinking smut to 500 parts of wheat, by weight. This is a very heavy degree of smutting but still the copper carbonate did successful work. The same lot of smutted wheat treated with two ounces of low grade copper carbonate, however, showed 25% smut. The untreated grain in this lot gave about 87% of smut. The low grade copper carbonate in the case referred to last was Corona copper carbonate with 21.5% copper present. This indicates that the highest grade copper carbonate gives a much greater margin of safety than the low grade copper carbonate. Although at the lower rate of smutting, that is, one to one thousand, or one to three thousand, we get practically perfect control with either the high grade or the lower grade material.”

Tying a wet handkerchief over the nose and mouth is a common practice. Where proper precautions are taken, no trouble is to be expected. One of the manufactured mixing machines is fitted with a special suction fan which removes excess dust and thus relieves the operator from inhaling any of the copper carbonate.

Manufactured Mixing Machines There are various types of mixing machines on the market which are proving very successful. Most of them are designed to mix the grain continuously as it comes from the fanning mill, delivering the treated grain in bags with a minimum degree of exposure of the operator to the dust. Aside from being convenient, the big advantage of the better of the manufactured machines lies in the fact that mixing is more thoroughly done than is the case with the homemade types in the hands of the average operator. For large farms or where several farmers own and use the same outfit, these manufactured machines will undoubtedly become popular. County agents or the Montana Extension Service at Bozeman will be glad to place farmers in touch with dealers handling such machines.
Fig. 3—Homemade barrel type of mixer.

Homemade Barrel Type

Under present conditions and for smaller farms, homemade mixers will be used to a large extent. One of the common complaints registered against the homemade mixers is the lack of thoroughness of mixing. Too many operators hurry the mixing process and seem to feel that mere mixing of the powder with the wheat is sufficient. It must be pointed out, however, that the seed should be **coated with the dust**, which means continued mixing to rub the powder onto the kernels. Therefore farmers are urged to continue the mixing process for some time after the powder appears to be uniformly distributed. Treat your grain in spare time when you need not hurry. If a little mixing is good, more mixing is better. Some of the types developed for this work are described
below. An ordinary wooden barrel or a steel oil barrel may be fitted up and makes a satisfactory mixing device. A shaft is placed thru the ends of the barrel with the ends of the shaft resting on a suitable frame. This shaft is turned by a crank or pulley. The grain and dust are delivered into and out of the barrel thru a dust-tight door placed on the middle of the barrel. To make the mixing more thorough and rapid, three baffle-boards or irons are fitted lengthwise on the inner walls of the barrel.

A modification of this type of mixer is the fitting of a shaft thru the middle of the barrel so that the barrel is revolved end over end. This type will do good work but the action is jerky and more power is necessary in mixing.

O. S. Fletcher, County Agent, Latah County, Idaho, found in a series of carefully conducted tests that the power type of mixer was more efficient than the barrel churn.

![Fig. 4.—Homemade cubical box. (churn type).](image)

**Cubical Box**

One of the easiest homemade mixers to construct and a very effective machine is a cubical box, operated on the same principle as the regular box type churn. A box two feet each way will mix a sack of wheat at a time. The box should be constructed of good flooring as it is desirable that it be as nearly dust-tight as possible. The shaft should be placed through two diagonally opposite corners. The box is revolved by a crank or pulley. One of the outer corners may be cut off sufficiently to allow a dust-tight lid to be
clamped over the resulting opening by means of an endgate rod screwed into the diagonally opposite corner. This type of mixer does not require baffle boards.

Fig. 5.—Homemade box mixer.

Mixing With Other types of homemade mixers are being used, but the barrel and box machines are as good, if not better than any of the other homemade models. Farmers are cautioned against attempting to properly mix such small amounts of a fine powder with such proportionately large quantities of wheat, by short cut methods such as shoveling on a floor or stirring in the drill box. Satisfactory results cannot be obtained by such methods. Use the right amount and kind of dust and thoroughly mix in a dust-tight machine.
County Agent Fred Bennion, formerly with the Montana Extension Service, now of Pendleton, Oregon, who has been doing considerable work with the dust treatment, says:

"The dry treatment of wheat has come to stay. A check of several thousand acres of both treatments in this county has proven conclusively that the dry treatment will control smut as well as any of the wet treatments.

"The past year was a bad smut year, and regardless of treatment quite a percentage of the heads in the field were smutty. Naturally with an increase of from 2,000 to 75,000 acres in the county, some mistakes were made. Manufacturers of dry treating machines overrated the capacity in many cases. Farmers who tipped up their machines on end in order to make them take care of grain coming from a 60 to 70 bushel per hour cleaner, did not get as good results as farmers who treated at the rate of from 30 to 35 bushels per hour. Too much copper carbonate was used. If the job is done thoroughly and the wheat is not too smutty, two ounces is sufficient. An excess will not hurt the wheat, but it is an unnecessary expense and a disagreeable inconvenience.

"In regard to the rate and time of seeding, do not judge too much by the past season. While most farmers did not have nerve enough to cut down their drills enough, the season was partly responsible for the thick stand, and the rate of seeding should not be cut down too much. However, it is safe to say that from 25% to 30% less seed can be used when the dry treatment is used."