4-1-1960

Seed Treatment and the Seedsman

T. C. Ryker

SEED TREATMENT AND THE SEEDSMAN

T. C. Ryker[1/]

If we review the history of seed treatment, we find not long ago only a few crops were treated. There was little choice in treating material and it was hard work for the farmer. Then, it just wasn't the seedsman's problem. In contrast, today seed treatments are applied to all crop seeds. If the seed is worth planting, it is worth treating. There is a large selection of excellent treating materials, and seed treating is now an integral part of seed processing. Seedsmen now have this responsibility because the farmer wants this service and is willing to pay for it.

To accept this responsibility, a working knowledge of the treating materials and an understanding of the principles and procedures involved in using them are required.

Seed Treating Products

Seed treatments disinfect and protect.

By disinfection, we actually mean disinfestation or ridding the seed surfaces of organisms which are potentially disease producing. Present disinfectants are effective against all but the internal borne organism, such as the loose smuts of barley and wheat. The organic mercurials, because of their extremely high disinfecting efficiency, are the predominant disinfectants today.

A seed protectant is a chemical that, by its presence on the seed, prevents attack by seed-borne or soil-borne organisms to seed after planting. Such organisms cause diseases known as seed rot and seedling blights or damping-off. All crop seeds can benefit from a protectant. But many do not require a disinfectant because of the absence of seed-borne diseases.

1/ Dr. Ryker is Associated with the Industrial and Biochemicals Department, E. I. du Pont de Nemours and Company, Wilmington, Deleware.

In addition, certain insecticides have come into use to protect against storage insects or soil insects, such as the seed corn maggot and wire worm that may attack the seed and germinating seedling.

Seed treating products are formulated for the various types of treaters. It is important that the one selected is designed for the treater that is to be used -- dust, slurry, or direct.

Organic Mercurials:

The organic mercurials serve the dual role of both disinfection and protection. They are used on seed not easily injured where disinfection is necessary or difficult. With volatile mercurials, the fumes serve two important function. They contact all the seed surfaces, including underhull parts, to do a complete job of disinfection; and they are absorbed by the seed surfaces to obtain a complete retentive coating of the seed parts for its protection once it is planted. To obtain the benefits of this volatility or fume action, treated seed must be held at least 24 hours before planting. With longer storage, it is possible to get disinfection with reduced dosage, but some seed protection is sacrificed. The fume action is not so important on wheat because its smooth coat is easily covered. But it is essential for coverage of rough-coated barley, loose-hulled oats, and the linty surface of cotton.

In general, mercurials are recommended for the treatment of small grains, flax, cotton, and safflower. Proper dosage is critical. Over-treatment may result in seed injury, and under-treatment may fail to adequately control disease. Seeds thoroughly cured, dried, and properly treated can be safely stored if a few precautions are taken:

1. Insure good storage conditions. High temperatures and high moisture favor seed deterioration and chemical injury.

2. Particular care should be given to treating. While there is roughly a 100 percent margin of seed safety, injury is still possible from overdosage or from

poor distribution of the chemical on the seed. Over-treatment cannot be removed by washing, due to the absorption of the mercury into the seed coats.

3. Mechanical injury to the seed favors treatment injury, particularly when seed is initially stored under high temperature conditions. This can occur with wheat where attention is not given to proper thrashing (too high cylinder speed), resulting in skin breaks over the germ. Delaying treatment until cool weather permits safe treatment of such seed. Too severe debearding of oats favors treatment injury. Frosted seed are more susceptible to mercury injury than sound seed.

4. Treated seed should not be held in air-tight storage. Open bins, sacks, and paper bags -- the normal methods of handling seed -- are all suitable, safe procedures.

Non-Mercurials:

The non-mercurial "protectants" are based on such chemicals as thiram, captan, and chlorinil. They are generally used for the treatment of crop seeds other than the flax, small grains, and cotton. However, both mercurials and non-mercurials may be used on sorghum, rice, and acid-delinted cotton seeds.

Protectant effectiveness is dependent upon complete seed coverage, and higher dosages are generally required than for the volatile organic mercurials. The protectants have the advantage of an extremely wide margin of seed safety and lower health hazards to users. The treating rates may be adjusted to seeds' needs and to the expected severity of the planting conditions. There are no special storage requirements.

Certain other non-mercurials are used for special purposes on some of the crops normally treated with a mercurial. Copper carbonate controls stinking smut of wheat and kernel smut of sorghum, but has little seed protectant value. Hexachlorobenzene is a specific for stinking smut or bunt of wheat. It is not effective against the smuts of barley and oats and has relatively no seed protectant

value.

Insecticides:

Insecticides are finding increasing use in seed treating. These may be merchandised in combination with the fungicide, or as distinct products for individual use, or combined with the fungicide in the treating process. The uses include: protection against storage insects, particularly various cereal crop seeds; protection against certain soil insects that attack the seed and germinating seedling, particularly sorghum, corn, beans, and vine crop seeds; and, protection of the growing plant through systemic action, such as with certain organic phosphates on cotton. The use of insecticides can require special storage precautions for seed safety.

Justification For Seed Treating

The benefits of seed treatment, so well defined through commercial and public research, are so great that it is hard to justify not treating. Published research names the benefits of seed treatment as improved stands, quality, yields, and return on invested capital through disease and insect control. It has been said that no other agricultural practice returns more for the investment than seed treatment. Yet, a sizable portion of the seed planted today is not treated. So there is need for more widespread understanding of the specific benefits:

1. Controlling seed-borne diseases: Seed disinfection -- proper seed treatment is effective against most of the many seed-borne diseases that are common with small grains and cotton. These diseases, from a treatment standpoint, may be conveniently grouped under three types:

> (a) Systemic diseases that infest the seed during the harvest or storage period resulting in infection of the developing seedling following planting. Treatment is completely effective. Such diseases include bunt or stinking smut of wheat; loose kernel and covered kernel smuts and Helminthosporium stripe of barley; loose and covered smuts of oats; head and kernel smuts of rye; loose

kernel and covered kernel smuts of sorghum, and kernel and head smuts of millet.

(b) Systemic diseases that infect the seed during the flower stage to become established within the seed and from there within the resulting plant. Chemical treatment is not effective. These include the loose smuts of barley and wheat. Hot water or water steep treatment advised for control. Three other smuts, while neither seed-borne nor controlled by treatment, should be mentioned because of frequent confusion with the above smuts. These are dwarf bunt of wheat, head smut of sorghum, and corn smut.

(c) Non-systemic diseases that infest the seed during the harvest or storage period and the fungus, following planting, attacks the seed and seedling to kill it before emergence or produces a blighted plant from which the disease spreads to neighboring plants. Treatment effectively controls the seed-borne phase. These diseases may, to varying degrees, also over-winter on plant debris. They include the many Helminthosporium spots, blotches or blights of barley, oats, rice, rye, sorghum, and wheat; Fusarium scab or blight of barley, oats, rye, sorghum, and wheat; bacterial blights of barley, oats, and sorghum; anthracnose, bacterial and ascochyta blights of cotton; rust of safflower; anthracnose and pasmo disease of flax.

Even for seed known to be resistant, it is still sound economy to treat as a precaution against the introduction or spread of new diseases or new strains of the fungi. This has happened with new races of smut and the scourge of Helminthosporium Victoria blight of oats.

2. Protecting seeds against seed rot and seedling blights: Seed protection -- seed treatment, by its protective coating around the seed, acts as a barrier once the seed is planted to ward off attack by both seed-borne and soil-borne organisms. These organisms affect all crop seeds, and the degree of attack will depend upon a number of factors. This is understandable if we recognize that each individual seed is a source of food once it takes on water, as occurs with germination, to become attractive to many organisms. Of particular importance are the organisms Pythium species and Rhizoctonia that are present in all soils. They may rot the seed before germination gets well started or they may kill the seedling before it emerges, or so affect it that it dies after emergence or survives only as a weakened plant. These effects, depending upon the crop involved, are

variously noted as seed rot, pre-emergence damping-off, damping-off, and seedling blight or soreshin in the case of cotton.

The response to a protective treatment will vary with the kind of crop seed, the vigor of the particular seed, the amount of the seed, mechanical injury to and the adversity of planting conditions. In general, conditions favoring rapid germination minimize disease attack, while disease is favored by the reverse, unfavorable conditions induced by adverse temperature or extremes of moisture. Crop seeds differ in their natural protective mechanism. Beans, sweet corn, sorghum, and peanuts are somewhat more susceptible to attack than many other kinds, and hybrid corns are more susceptible than the former open-pollinated corn. The vigor of the seed, which has been spoken of as "the physiological age," affects response to treatment; the weaker the seed, the greater the need for the protectant. Vigor cannot necessarily be determined by the standard germination test. For example, year-old corn may germinate as well as new corn, but it will not perform as well in the soil without added protectant fungicides. The condition of the seed surface affects susceptibility. With mechanical harvesting and preparation of the seed, it is almost impossible to avoid skin breaks or abrasions. The fungicide compensates by protecting these cracks and abrasions from entrance of fungi. This is particularly important on flax, beans, peas, corn, sorghum, and peanuts.

3. Improving germination: Seed mold control -- while we normally do not think of treatment as affecting germination of seeds, there are important situations in which it does. By germination, we mean the standard germination tests that are used as a measure of seed potentialities, and not plant emergence or performance. Treatments will often improve germination through the control of seed surface molds. Though normally not considered pathogenic, they may infest the seed following moist harvesting or storage conditions. In the germination tests, they may smother the seed before it has a chance to germinate. Treatment may also actually help maintain vitality during storage if mold infestation is severe enough to actually damage

seeds. These benefits are common on vegetable seeds such as spinach and beans, and on field crop seeds such as sorghum and soybeans. Warm, more humid climates accentuate this condition.

4. Protecting against storage insects: The protection of seed from insect damage in storage becomes of increasing importance with the trend toward processing, treating, and unit packaging of the seed at harvest time. Some fungicides, such as mercurials and thiram, have insect repellent properties, but for complete protection it is necessary to add insecticide for the more troublesome seeds. The need varies with the crop seed and the location, and the insect sanitation conditions of storage. More insecticide is needed to protect seed in the South than in the North, in warm storage than in cool storage, where infestations starts in the field rather than from storage, and where poor insect sanitation is practiced.

Several insecticides have proven effective for combining with the seed treating fungicide. These include DDT, methoxychlor, and malathion. Dosage for DDT and methoxychlor is based on one-half ounce per bushel of a three per cent dust for dry application; and two ounces of a 50 percent wettable powder per gallon of slurry, treating approximately 30 bushels. The slurry rate applies approximately 35 ppm for wheat. For Malathion Premium Grade 75 percent Emulsifiable, the recommended rate of use is one pint per 1,000 bushels which applies approximately 10 ppm for wheat. When an insecticide is used with the liquid mercurials agitation is required. It is not advisable to store the mixture. These amounts of insecticide are minimal and adequate for the temperate zones but additional insecticides may be needed in warmer climate areas.

Methoxychlor and DDT are relatively stable and do not break down in storage, whereas malathion loses effectiveness with storage.

In some products, sufficient insecticide has been added to the fungicide for minimum protection against storage insects.

5. Controlling soil insects: Combination treatments -- the term

"combination treatments" has come to mean the addition of an insecticide with the fungicide for the added protection of the seed and seedling against certain soil insects, such as the wire worm and the seed corn maggot. In contrast to storage insect protection, it is a means of giving limited protection to the seed and seedling until it becomes resistant to attack or can survive limited attack. It is not a means of disinfesting the soil. Where insect damage is heavy or confined to the roots and stalks, soil application rather than seed application is recommended.

In two general areas combination treatments have paid big dividends: (1) the northern Great Plains wheat growing area where the wire worms have been most troublesome; (2) wide areas on corn and certain vegetable crops where the seed corn maggot is often a limiting factor in getting satisfactory stands. It is quite probable that country-wide, soil insects account for more seed and seedling damage than is presently recognized.

Interest in seed application of insecticides came with the development of chlorinated hydrocarbon insecticides, such as lindane, aldrin, heptachlor, and dieldrin, that proved highly effective against soil insects. The only complication to use was the occurrence of adverse seed effects causing reduced stands. Apparently the insecticide predisposes the seed to attack by organisms. This adverse effect could be overcome by the adequate use of certain protectant fungicides.

Non-mercurial fungicide combination products, such as thiram-dieldrin and captan-dieldrin, have become standard for beans, lima beans, sweet corn, sorghum, and vine crop seeds. These combination treatments give insect protection and fungus protection comparable to the fungicide alone with no loss in the wide margin of seed safety, even in the absence of insect damage. Dieldrin is preferred over the other insecticides because its longer residual stability permits seeds to be treated well in advance of planting or carried over from one season to the next without appreciable loss of insecticidal effectiveness.

With mercurials, there is something of the same fungicide-insecticide relationship as with the non-mercurials. But there are certain significant differences that limit incorporation of an insecticide with a mercurial fungicide in a single product. The treating rate of the mercurial cannot be increased to get the added seed protection often needed for the insecticide use without risk of phytotoxicity from the mercurial. The practical requirements of a liquid treatment for most areas necessitate use of oil type solvents for the insecticide. These, in turn, increase the potential phytotoxicity over that of a wettable powder formulation. Treatment cost for grains such as wheat is more critical than with the higher priced seed of corn, beans, etc., on which the non-mercurial combination products are used.

In spite of these factors, the addition of an insecticide to mercurial treatment has proven highly profitable in specific areas where wire worms are a problem. The benefits of a good stand of healthy plants from the first planting far outweigh the cost and any adverse seed effects from the treatment. Generally, treatment with the insecticide is made only when the seed is to be planted where wire worms are likely to be a problem, and dual treaters have been developed that permit selective treatment of the seed with the insecticide. Aldrin and heptachlor, for economy reasons, have been the favored insecticides since treatment is usually made close to or at planting time to avoid need of a long residual retention on the seed. In addition, wettable powder or emulsifiable liquid formulations may be added with the fungicide treatment in slurry treaters.

Seed Treatment of Specific Crops

Oats: This crop is unique among small grains in that only a small percentage is treated despite greater benefits from treatment. Oats are a haven for seedborne diseases which include black loose smut, covered smut, Helminthosporium leaf blotch, Helminthosporium (victoriae) blight, Fusarium scab, and bacterial blights. All of these diseases can, to a large degree, be controlled by proper

seed treatment. While the smuts are quite noticeable and often serious, the Helminthosporium blights are particularly damaging in the South. They may completely destroy fields or may result in thin stands of lower vitality plants. Dr. Ivanoff at Mississippi State University has recently published material on these two Helminthosporium diseases and the effectiveness of seed treatment in their control.

The initial infection from the Helminthosporium fungi occurs on the coleoptile as the seed germinates. To prevent this infection, it is necessary to have a volatile mercurial to penetrate the hull. The presence of Helminthosporium on the seed can be readily observed by planting in sand or by peeling back the hull to expose the base of the coleoptile in the germinator.

It is easy to demonstrate yield benefits from treatment of three to five or more bushels per acre. Often, of even greater importance is the increase in forage as reflected in improved grazing. These benefits are derived from cost of three to five cents per bushel for chemicals.

Cotton: The primary purpose in treating cotton seed is to improve germination, emergence, and promote healthier stands through prevention of seed decay. Non-viable seed in an untreated lot or in a poorly treated lot will actually stimulate fungus growth, and thus increase the seedling disease problem. Control of certain seed-borne diseases, such as anthracnose, is not as important today as formerly because of the eradicant action from treating over the years. However, these seed-borne diseases must not be overlooked in the treatment of machine and fuzzy seed since they will always remain a threat. On acid-delinted seed, surface-borne organisms are not a factor due to their elimination in the acid process, but seed protection is doubly important because the acid removes part of the natural protection in the seed coat.

The problem on cotton is not in getting the seed treated. Everyone treats. But seed often is not adequately treated. Too much emphasis has been on cost,

12 to 20 cents per hundred weight, and not on the benefits derived. Even with the best treating job, there is still need for more prolonged protection. Replanting is costly, particularly now with the general use of pre-emergence herbicides. Hence, the interest in soil treatment.

The volatile mercurials have, for the most part, been the preferred treatment for machine delinted and fuzzy seed.

Corn: Treatment of corn is not a problem. All hybrid seed is treated. Seed protection is the need, and the cold test was developed on corn as a quick and easy means of evaluation. This permits adjustment in the treating rate to fit the protection needs. Carry-over corn and corn with skin abrasions need more protectant. Secondary considerations in the selection of treatment include planting effects on the seed and disposal of unused treated seed. Consideration should be given to the addition of an insecticide for protection against soil insects. Combination treatment is beneficial in many areas, although not widely accepted for certain practical reasons. The relatively high price for hybrid corn seed makes the cost of treatment (around 10 cents a bushel for the fungicide) of little importance.

Yield benefits from treatment usually closely follow stand improvements. In some instances, yield benefits have occurred in the absence of stand increases, presumably as a result of treatment producing more vigorous plants.

Sorghum: The advent of hybrid sorghum has brought new consideration in treatment of this crop seed and a wider appreciation of value of seed treatment. With open pollinated varieties and the little premium placed on quality seed, low cost treating and control of the loose and covered kernel smuts were the determinants. For these, the mercurials had the nod, even though sorghum seed is quite sensitive to mercury injury.

The more costly protectant fungicide treatments based on thiram or captan, while recognized as being effective against the smuts, were not previously

considered needed for seed protection. The emphasis has changed with hybrid sorghum. Sorghum seed is extremely susceptible to seed rot which can be much more effectively prevented with the protectant fungicides than with the mercurials. The seed is so susceptible that good evaluation of treatment can be made without resorting to a cold test, as is necessary for corn.

A third consideration is the suppression of seed molds that are serious when moist weather occurs during the maturation and harvesting periods. These molds not only reduce the seed vigor, but may obscure germination evaluation. With infested seed, it is not uncommon to show substantial increases in germination percentages from treatment and the seed benefited by an increase in the amount of the protectant fungicide. An interesting new development followed the evaluation of "Arasan" 42-S thiram seed disinfectant and protectant as a sorghum head spray for bird repellency. While not too successful against the birds, treatment with one-half to one gallon of product per acre inhibited the development of the seed mold sufficiently to increase the quality of the seed.

The fourth consideration in treating sorghum concerns the addition of a soil insecticide. Combination treatments have almost invariably improved stands over that from the fungicide alone. If we should rate the various treatments on stands, we would have a relationship something as follows: untreated seed 50, mercurial treatment 70, protectant fungicide 80, combination 90.

Soybean Seed Treatment

Soybean seeds are more susceptible to deterioration than almost any other crop seed. Therefore, it is important that soybean growers and seed processors understand the critical factors affecting deterioration, and the benefits made possible through treatment with a protectant fungicide. These benefits have often been obscured by the tendency in some areas to recommend treatment only in the event of poor quality seed.

Seed Deterioration Factors:

1. Aging -- the rate and extent of natural deterioration are controlled largely by temperature and moisture conditions. Changes in these conditions occur in the field before harvest, resulting in seed stresses that produce internal injuries. It is not weeks or months that determine the relative age or vigor of the seed, but rather the sum total of moisture and temperature conditions. Treatment helps protect weakened seed, particularly under adverse growing conditions.

2. Diseases -- exposure of soybean seed to adverse weather promotes growth of many common mold fungi, as well as the "purple stain" fungus. At germination time these organisms may completely overgrow the seed before it has a chance to get started. Soybean seed in the East and South is particularly subject to field weathering. Treatment stops the development of the seed molds when present to substantially increase the germination and performance. Treatment also prevents spread of seed-borne "purple stain."

3. Mechanical Injury -- mechanical bruising and fracturing are important factors in seed deterioration. Seeds with low moisture content are most susceptible to mechanical injury. Breakage from harvesting and handling seed with low moisture content is particularly a problem in the Midwest. Cracked seed favors attack by soil-borne organisms. Treatment protects these seed once they are planted.

Recent studies by Dr. Moore of North Carolina, Dr. Walters of Arkansas, and Mr. Wyllie and Mr. Goth of Minnesota reemphasize the benefits gained by treating soybean seed, not only in better stands but also in increased yield. Treatment is low-cost insurance, seven to 10 cents per bushel of seed. In some areas the addition of a soil insecticide is beneficial.

In conclusion I want to reemphasize that seed treatment is no longer the farmer's problem, but should be considered as a part of seed processing. It is one of the steps that the seedsman must take if he is to give the grower the best possible seed performance.