Chapter 2 Seed Treatment

The Pesticide Label

It is essential for an individual to read the entire product label and labeling and totally understand all information before handling any product. By law, chemical containers are required to bear the label registered with the US Environmental Protection Agency. Valuable information is provided on the label about the chemical, learn to use this information.

1. Name of product - Brand Name
2. Ingredient Statement
3. Registration and Establishment Numbers
4. Manufacturer
5. Type of Pesticide
6. Type of Formulation
7. Restricted Use Designation
8. Front Panel Precautionary Statement
9. Statement of Practical First Aid
10. Hazards to Humans and Domestic Animals
11. Environmental Hazards
12. Physical or Chemical Hazards
13. Directions for Use
14. Entry Statement
15. Storage and Disposal

The most important few minutes in pest control is the time you take to read the label.

Seed Treatment

Since the early 1950's, the treatment of planting seeds with chemical pesticides has been a standard practice in agriculture in the US, and is widely accepted by both seedsmen and their customers as a recognized part of seed conditioning for many crop species. Many leading agricultural scientists have recognized seed treatment as one of the most economical and efficient methods of pest control available. Because of the increasing complex nature of seed treatment, and because of EPA interdiction into seed treatment, today it is more important than ever that the seed conditioner know why and how to apply precise amounts of EPA approved pesticides uniformly and safely to their lot.

History of Seed Treatment

Although seed treatment has been a widely accepted practice in the United States for over 30 years, the practice has been recognized as beneficial for hundreds of years.

The earliest reported use of seed treatment dates back to 60 A.D. when Pliney used wine and crushed cypress leaves to protect seed from storage insects. Modern day scientists have given credence to the practice since hydrogen cyanide evolves under this condition.

In the 1600's a reported shipwreck resulted in a load of grain being soaked with seawater. It was later found that the crop produced from these seed contained significantly less bunt (stinking smut) than adjacent fields planted with non-soaked seed. Although this practice was described and recognized as beneficial at that time, it was not until 1750 that the Frenchman Tillet proved scientifically the benefits of salt and lime to control common bunt of wheat.

From this point, seed treatment has evolved into a more complex science. With the advent of the organic mercurial in the 1920's, a new era in seed treatment began that has since resulted in multiple contact and systemic fungicides being available to the conditioner. Although concern for safety has resulted in the mercurial being banned, the new contact and systemic fungicides has provided a more complete arsenal that allows the conditioner to apply seed treatment that meet his specific needs.

Seed Treatment "Basics"

Listed below are the "basics" involved with the selection of, use of, results expected from, and legal and hazard aspects, both of the chemicals and machinery available for treating seed. Each of these "basics" will be discussed in detail in this chapter.

1. Analyze why you need to treat your seed; what are your objectives: specifically what disease(s) and/or insect(s) do you mean to control or condition do you wish to correct?

2. Become familiar with the chemical(s) you are using or anticipate using; know its spectrum of control and its mode of action; know its toxicity classification (LD50); know WPS requirements for handlers, know its antidote or practical statement of treatment (PST); be aware of any physical hazards associated with it such as flammability, corrosiveness, etc.; know about seed safety (phytotoxicity margin).

3. Understand the basic working principle of the seed-treating machine you are using; know how to properly calibrate it, maintain it, and clean it.

4. Know the legal ramifications of seed treatment; know and understand the applicable regulations and laws with regard to the chemical treatment, treating machinery, wastes from the treatment operation, treated seed labeling, disposal of empty containers, etc.

Seed Storage and Seed Treatment

Maintaining the viability of seed in storage is dependent on several factors. Seed moisture content, relative humidity, and temperature are the most important. Moisture content at the time of storage, the physical conditions of the storage area and management determine the relative humidity and temperature in the storage area thus influencing the moisture content of the seed. Seeds are hygroscopic materials that are they change in moisture content in relation to the relative humidity and temperature of the surrounding air. This changing in seed moisture content is not an instantaneous process. Some 15 to 20 days may be required for equilibration if relative humidity is kept constant. The process is fairly rapid at first then slower as the seed nears equilibrium.

Soybeans at 65 percent relative humidity would equilibrate at 11.0 percent seed moisture and at 75 percent relative humidity would equilibrate at 13.1 percent seed moisture at an air temperature of 70 to 75 degrees F. Wheat at 60 percent relative humidity and corresponding temperatures would be 11.9 percent seed moisture and at 75 percent relative humidity would be 14.6 percent seed moisture. The reason for differences between soybeans and wheat is the difference in chemical composition of the seed.

Seed moisture has a greater effect on the life of the seed than does temperature. Sufficiently dry seed can withstand relatively high temperatures while seed at higher moisture will deteriorate at low temperatures. Management of both moisture and temperature are necessary to maintain viability and quality.

Generally we think of seed moisture contents of 11 to 14 percent being ideal for most seed kinds stored in Tennessee. This is not true however for cotton, which ideally should be at a moisture content of 10 percent or less. Cottonseed at 11 to 12 percent seed moisture will store well for a few months (5 to 6) provided seed are adequately cooled by aeration.

Normally if seed are cooled to approximately 60 degrees F this will be adequate for short-term storage.

Storage conditions can have a direct effect on insect and microorganism activity. As a rule seed stored at 12 percent moisture or less are less affected by insects and storage fungi than seed at higher moisture contents. Lower temperatures also retard insect and microorganism activity.

Insecticides applied to seed and in storage areas will aid in insect control. Prior to seed storage, areas should be thoroughly cleaned and sprayed with a recommended insecticide.

The addition of fungicides **does not** extend the life of seed in storage. Fungicides will reduce field losses from disease. Application of fungicides prior to planting will be just as effective as application prior to storage.

Definition of Treated Seed

The term "treated" means given an application of a pesticide or subjected to a process designed to reduce, control or repel disease organisms, insects, or other pests, which attack seeds or seedlings.

Seeds Normally Treated

The kinds of seeds that are normally treated with one or more pesticides are: corn, peanuts, cotton, sorghum, wheat, oats, rice, rye, barley, millet, soybeans (under some conditions), pine tree and most vegetable seeds.

Internally and Externally Infested Seed

Seed normally have microorganisms on the seed surface. In addition several kinds of bacteria and fungi find their way into the interior of seed. The soil in which the seed is planted is also well populated with many kinds of microorganisms, some of which are often times destructive to the seed and some are quite beneficial. Internally and externally infested seed may be means of introducing diseases into a crop even though the soil is free of potential dangerous disease organisms. There is a very long list of diseases which the seed are the principle source of introducing disease organisms. Some examples of such diseases are smuts of small grains, bacterial blight of cotton, certain virus diseases of soybeans and many others. There are many other diseases where the seed are one way, whereby; disease organisms may be transferred to disease free fields. Examples of such diseases of importance in Tennessee are septoria leaf and glum blotch of wheat and loose smut. The primary control of these diseases, which are carried on and/or within the seed, is maintaining seed production fields free of those diseases transmitted by the seed. The presence of certain seed transmitted organisms can be reduced in many cases by proper seed treatment fungicides.

One of the most critical periods in the life of a plant is from the time the seeds are placed in the soil to the establishment of the young plant as an independent organism. During this time the young plant is very tender and succulent and very susceptible to the attack of various disease causing organisms. Diseases that occur on the young seedlings are referred to as seedling diseases.

Disease Development

Seed Rot: This is simply a rotting of the seed before or as it germinates. Planting poor quality seed can encourage seed rot. Mechanically damaged seed may have cuts or cracks in the seed coat through which seed rotting organisms in the soil may enter and result in rotting. Poor quality seed are generally weaker and slower germinating increasing its exposure time to seed rotting organisms. Slower germination also increases the time of exposure to environmental conditions, which favor the development of disease.

Seedling Diseases

Pre-emergent Damping Off: This is the occurrence of seedling disease prior to the emergence of the seedling from the soil.

Post-emergent Damping Off: This phase of seedling disease occurs after the seedling has emerged from the soil. One symptom of this disease on soybeans and cotton is a reddish-brown lesion at or near the soil line. This phase of seedling disease may be evident as wilted plants, which generally die quickly. Plants with only partial girdled stems may survive but are reduced in their vigor by the presence of the stem lesion, which restricts the movement of water and nutrients essential for growth and development.

Root Rot: As the name implies this is simply a rotting of part or all of the root system, resulting in plant death. In cases where only part of the root is affected new roots may develop just below the soil line. These new roots frequently grow in the area of the soil where the herbicides have been placed. Herbicides may cause adverse effects to future plant growth and development. During periods of dry weather such plants are more subject to drought stress due to the shallow root system.

Some of the Disease Causing Organisms Associated with Seedling Disease

Rhizoctonia solani. This fungus is one of the most common disease organisms in the soil. It is primarily a problem during wet, cool weather. The environmental conditions, which favor the growth and development of this fungus, are unfavorable for the growth and development of some plant types such as cotton. The growth and development of the cotton plant is slowed and the plant is weakened, thus more susceptible to the disease. Rhizoctonia is responsible for the disease sore shin, which can cause pre- and post- emergent damping off.

Pythium deBaryanum, P. ultimum, P. aphanidermatum, P. irregulare. These fungi belong to a group called the water molds. During a particular phase in the development of this fungus water is essential for mobility thus making the presence of water necessary for proper development and spread of diseases caused by this fungus. It is frequently involved with root rots of seedlings. The growth and development of Pythium is favored by soil temperatures higher than those favored for the growth and development of Rhizoctonia. Pythium like Rhizoctonia is a common soil inhabitant. Neither of these fungi is ordinarily seed borne. In certain years Pythium is a problem and other years Rhizoctonia may be a problem. This is brought about strictly by the differences in environmental conditions required for the growth and development of each fungus. Pythium and Rhizoctonia are not always the major organisms involved in stand losses. At times environmental conditions favor the growth and development of organisms other than Rhizoctonia and Pythium. Under such conditions these other organisms may be primarily responsible for stand losses.

Fusarium monififorme and other *Fusarium species*. The Fusaria are also common soil inhabitants and are frequently associated with seedling disease but not as frequently as Rhizoctonia and Pythium. Fusarium unlike Pythium and Rhizoctonia is occasionally seed borne.

Other Organisms Associated with Seedling Disease

Macrophomina phaseoli (soil inhabitant), *Sclerotinia* sp. (soil inhabitant), *Heliminthosporium* sp. (soil-borne, air-borne and seed-borne), *Phytophthora* sp. soil inhabitant (water mold).

Insects

Insect problems may be of two types: (1) insect problems in storage and (2) insect problems in the field.

The more common stored grain insects are rice weevil, granary weevil, angoumois grain moth, lesser grain borer, cadelle beetle, saw-toothed grain beetle, confused flour beetle, flat grain beetle and Indian meal moth.

These insects are primarily a problem in grain seed such as wheat, corn and rice but can also be a problem in garden beans, field peas, cottonseed and some vegetable seed.

Insect problems in the field can occur in two groups: (1) soil insects that damage or destroy seed and (2) insects that attack seedlings.

The primary soil insects are wireworms, seed corn maggots, southern corn rootworms and lesser corn stalk borers. The primary insects that attack seedlings that can be controlled with seed treatment insecticides are thrips, aphids and plant bugs.

Seed Treatment Chemicals

There are three ways that seed treatment chemicals are classified: by formulation type, by function or purpose (target), and by chemical structure type or makeup.

Classification by Formulation Type

Seed treatment can be classified into four basic types of formulations:

1. True Liquids: This type of formulation generally consists of emulsions, which are suspensions of one liquid as minute globules in another liquid. If water soluble, these can be diluted to enhance seed coverage through slurry type seed treaters. If low rates of formulated product per hundredweight are recommended and the product cannot be diluted with water, the treatment should be applied through a treater that has a mist or spray applicator to insure proper seed coverage.

2. Flowables: Flowables are colloidal suspensions produced by pre-dispersing insoluble particles in what usually is a pourable medium that may possess binders, dyes, spreading agents, etc. Flowables can be further broken down into two distinct categories:

a. *Concentrated*: Concentrated flowables are designed to be diluted with water before being applied to the seed. A premix tank with adequate agitation is necessary to apply this type of seed treatment.

b. *Ready-To-Use*: These formulations are designed so that with minimum agitation they can be applied directly to the seed without dilution with water. In some cases the conditions may elect to dilute this type of formulation in order to enhance seed coverage. If so, care should be taken to adjust the application rate proportions.

3. Soluble or Wettable Powder: Soluble and wettable powders are designed to be mixed with water before being applied to seed. Soluble powders are capable of forming a true solution in water, whereas wettable powders are insoluble compounds to which wetting agents have been added to facilitate rapid formation of a suspension. Generally speaking, this type of formulation results in more dust being generated in the treating area, than flowables or true liquids because it is more difficult to bind powdered formulations to the seed.

4. Dusts: Dust formulations are powders that are designed to be applied to seed in their dry state. Some types of seeds, i.e., grasses and peanuts, are coated very easily with dust, however, the disadvantage resulting from worker exposure, and expense of dust control systems should be considered by the conditioner before using this type of formulation.

Before selecting any seed treatment, the conditioner should consider the following points regarding the formulation.

1. Seed and Seedling Phytotoxicity: The formulation should not have a deleterious effect on germination within the time period the seed are normally offered for sale.

2. Temperature Stability: Be sure the formulation is stable under the temperature conditions it was stored and used under.

3. Adhesion/Binding Properties: Most formulations use one or more binders or stickers to reduce dusting-off of chemical from treated seeds. This reduces worker exposure to chemical dust in the treating area.

Classification by Function or Purpose (Target)

There are three broad classes of seed treatment chemicals as far as function or purpose in common use in seed treating facilities in the United States -- fungicides, insecticides, and non-pesticidal conditioning aids.

Fungicides

There are seed treatment fungicides that control seed borne (surface and internal), soil borne (pre- and post-emergence) and air or wind-borne fungi.

Of course, some of these fungicides control both seed borne and soil borne organisms. The basic principle however, is that you must, as a seed treater, realize what organism(s) you are trying to control with your fungicide in order to select the proper one with the proper spectrum of activity.

Fungicidal seed treatment may be divided into two categories, depending on the nature and purpose of the treatment. These categories are (1) seed disinfestation and (2) seed protection. Most fungicides are seed protectants.

Seed Disinfestation: is the control of spores and other forms of pathogenic organisms found on the surface of the seed.

Seed Protection: is chemical treatment to protect the seed and young seedling from pathogenic organisms in the soil.

Some fungicides are systemic, that is, as seed germinate and seedlings begin to grow the fungicide is taken into the plant and moves into the growing plant parts.

Insecticides

The most common objective for treating seed with an insecticide is for the control of stored seed (grain) pests.

Fumigation is one method of controlling insects in stored seed. Fumigation requires a category separate from seed treatment. Malathion is not labeled any longer for use in stored grain treatments.

For control of insects in stored grain, see UT Extension Service publication number PB1395 *Insects in Farm Stored Grain.*

Insecticides are also applied directly to seed for control of soil insects that attach seed and seedlings. These may be applied along with fungicides in the treating process in the seed conditioning plant. Insecticides to control insects attacking seedlings are systemic, that is, they are taken into the plant as seed germination and plant development progress. They move throughout the plant giving some insect control for a short period of time.

Some insecticide seed treatments under certain conditions may be slightly phytotoxic. Some seed damage may occur. Certain fungicides have been reported to act as “safeners” when certain systemic insecticides are used. Research has indicated that harmful effects of these insecticides may be reduced by first applying the fungicide then the insecticide.

As with fungicides, where insect pressures are heavy seed treatment alone may not give adequate control. It may be necessary to apply additional insecticide in the soil, at planting or spray seedlings. For insect control recommendations, see Extension Service publications for the crop of your interest.

Non-Pesticidal Compounds

There are only two basic types of chemicals commonly used in the United States that fall in this category: seed applied micronutrients or trace elements (examples are the use of zinc as a rice seed treatment and molybdenum as a soybean seed treatment) and herbicide safening compounds (an example being the use of Concep[R] for protecting sorghum seeds from injury by grass herbicides) and seed applied growth regulators (example being Gibberellic acid to control growth in rice seedlings). There are several other non-pesticidal chemicals being developed for use in the United States for correction of specific conditions. Some examples are seed applied gametocides, seed applied growth regulants and stimulants, and transpiration and respiration regulators.

Classification by Chemical Structure

Please refer to Appendix of this handbook for a complete list of EPA approved chemicals for seed treatment listed by generic name and chemical structure classification. Basically, the fungicides are classified into the following six chemical structure groups:

Seed Treatment Fungicides

1. Inorganic
2. Metallic Organic
3. Antibiotics
4. Carbamate
5. Chlorinated Hydrocarbons
6. Miscellaneous Organics

The insecticides are classified into the following four chemical structure groups:

Seed Treatment Insecticides

1. Naturally Occurring (Mined or botanical)
2. Chlorinated Hydrocarbons
3. Organic Phosphate
4. Carbamates

Seed Coatings and Seed Pelleting

One of the new areas gaining widespread use, throughout the seed industry involves the use of seed coatings and seed pelleting. Both types can be used to apply chemicals to seeds. Technology in application has advanced allowing for products (insecticides, safeners, fungicides, micronutrient, and trace elements) to be applied as a “treatment” to seeds.

Seed coatings are very similar to standard slurry-type seed treatments in application. There is a minimal increase in seed weight and allows for the formulation to be change during the process so multi-layer films can be applied. The coating process aids seed protection by precisely loading the exact amount of chemicals onto seeds. Likewise, coating encapsulates the treatments in a polymer case. This encapsulation has benefits both to the seed being treated and personal handler safety.

Seed pelleting is characterized by its ability to totally obscure the shape of the encased seed. This improves seed plant ability and performance.

Benefits of coating and pelleting seed:

1. Prevent or minimize dust off of chemicals
2. Precision placement of chemicals
3. Accurate delivery of small quantities of chemicals
4. Improved plantability
5. Minimize personal exposure to chemicals
6. Appearance enhancement to product

Seed Treatment Machinery

There are probably as many different ways of classifying seed treatment machinery, as there are authors who have written on the subject. Possibly one of the simplest and most straightforward ways is outlined below:

Wet Type Seed Treaters

All treaters of this type in use in the United States employ the weight of seed to operate the seed dump and chemical measuring system of the treater. The amount of seed is measured by placement of a weight on the weigh pan arm while the amount of chemical applied to each batch of seed is determined by the size of the chemical cup (dipper cups) in the metering tank. The actual principle of application of the chemical onto the seed is then accomplished in one of the three ways described below:

Slurry Principle: This principle simply involves the seed and chemical being conveyed in some way and as they tumble together a physical "brushing" or "rubbing" action which spreads a coating of chemical onto seed. The two most common devices used on slurry treaters are auger type mixers and revolving drum mixers.

Most of the older so called true slurry treaters actually have the chemical metering tank and the premix or slurry tank combined as part of the treater. This tank is filled at various intervals either by pouring by hand, or pumping from an auxiliary tank. Chemical measurement is accomplished by a chain of cups and seed measurement is by a one-pan counterweight system. Each time a batch of seed is dumped, the chemical in one cup on the chain is dumped onto the seed. Blending of the chemical and seed together is accomplished in a auger mixer film-coater unit.

The newer so-called metered slurry treaters generally have a dual seed weigh pan, which operates by the weight of seed falling onto that side of the pan.

The amount of seed measured is controlled by placement of the counterweight while the amount of chemical measured at each trip of the weigh pan is determined by the size of chemical cups used in the metering tank.

Each time the weigh pan trips, seed flows through the measuring unit and into the coating chamber. At the same time, chemical is delivered to the chemical cup receptacle and flows through a tube to the coating chamber (either auger mixer or revolving drum mixer).

As the seed and chemical are conveyed through the coating chamber to the discharge, they tumble together, spreading an even coat of chemical on seed. This mixing action, before final discharge, also allows some of the moisture in the chemical to evaporate from the seed, which facilitates handling after treating.

Mist or Atomization Principle: Treating machines using this principle employees the same counterweighted dual seed weigh pan and metering tank with chemical cups systems designed above. With this principle, each time the weigh pan trips, seed flows to the retarding hopper, where it is gradually released to a dispersion cone. At the same time, chemical is delivered from the chemical cup receptacle and metering tank and flows through a hose to a revolving disc, which atomizes the chemical into a penetrating mist. As seed falls over a dispersion cone and through the treating chamber, it is enveloped by chemical mist that contacts even the hard to reach indentations of the seed. As you might expect, the mist or atomization principle treaters are recommended when small amounts of chemical must be applied to relatively large quantities of seed. Also, the chemicals used in these type treaters are generally true liquids or flowables of low viscosity that lend themselves to being atomized into a mist.

Spray Principle: The commonly used machines that use this principle are essentially the same as the mist or atomization treaters described above except that instead of a mist disc, they employ one ore more non-plugging nozzles to spray the chemical uniformly onto the seed. Some of these nozzles operate from the pressure in the chemical holding receptacle and some have an airline from a compressor or blower. It should be kept in mind that many of the newer mist or atomization and spray principle treaters also employ a coating chamber of some type, to provide additional distribution of chemical over the seed surface.

Dry Type Seed Treaters

The dry or dust type treaters are a specially designed treater for treating peanuts, beans, peas, and grass seed, and other commodities where a dry chemical must be applied or where the seed to be treated are very fragile in nature. With the dry type seed treater, measured amounts of powdered chemical are uniformly and continuously applied to seed by the use of a vibrating feeder from a Syntron Control. Like the wet type treaters, seed measurement is controlled by placement of a counterweight and the use of double weigh pan system. As with the slurry type treaters the blending of the chemical and seed together is accomplished in a coating chamber.

There are both auger type mixer and revolving drum mixer coating chambers available in commercial use on dry type treaters in the United States. If the auger type mixer is used, normally the element inside the chambers is a tampico brush or nylon brush for gently movement of seed to the end of the coater.

Seed Treatment Calibration

To obtain proper calibration of chemical to the seed being treated you must have three known facts:

1. The label rate of the seed treatment chemical.
2. How many pounds of seed are dumped each time the weigh pan arm trips.
3. The size of the chemical cups being used and consequently the amount of chemical discharge each time the weigh pan arm trips.

The following is a procedure, which can be, used as an aid to seed treatment calibration:

STEP NO. 1

Read the label to determine the amount of chemical to apply to either a bushel of seed or 100 lbs. of seed.

Note: It is usually easier to work with 100 lbs. of seed. If the treatment rate is expressed in ounces per bushel or cwt., convert to cc's per cwt. This is done by multiplying ounces by 30 (30cc = 1 oz.)

For example assume a treating rate of 400 cc per 100 lbs. of seed.

STEP NO. 2

Prior to treating, run a minimum of 100 lbs. of seed through the treater and count the times the weigh pan arm trips.

1. Divide the trips into the amount of seed going through the treater. This is pounds of seed per dump.
2. Example: 30 trips with 150 lbs. of seed, thus 150 ÷ 30 = 5 lbs. per dump.

STEP NO. 3

Mathematically determine the proper chemical cup size in cc's.

1. First divide the dump weight obtained in Step. No. 2 into 100 lbs. This gives you the number of dumps per 100 lbs. of seed. i.e.,

$$\frac{100}{5} = 20 \text{ dumps}$$

2. Second divide the number of dumps per 100 lbs. into the chemical treating rate obtained from the label. This gives you the size chemical cup to use.

i.e., 20 dumps (Step 3[1])
400 cc per 100 lbs. (Step No. 1 example)
400 ÷ 20 = 20 cc chemical cups

You have now mathematically calibrated the treater. As per the example to apply 400 cc per cwt. of seed you need a 5-lb. dump with 20 cc chemical cups.

STEP NO. 4

Mathematical calibration is only a starting point. To ensure that the proper amount of chemical is being applied to the seed the following methods should be used as checks.

Method 1: *Catch the chemical* - simply pull the chemical hose from the seed-treating chamber and catch a minimum of 10 trips in a measuring cup. If you had 20 cc cups you should have caught 200 cc of chemical. If not, make the necessary adjustments.

Method 2: *Treated seed comparison* - compare the amount of chemical used to the amount of seed treated. This is the most accurate method, i.e. Assume a use of 5 gallons of chemical, which should treat 70 bushels per gallon. Thus 350 bushels should have been treated, if not make the necessary adjustments.

SPECIAL NOTE: Calibration may be adjusted by: (1) changing or adjusting chemical cups, (2) changing the counterweight position upward or downward and (3) changing the water dilution ratio of calibration.