SEED TREATMENT

A STUDY GUIDE FOR COMMERCIAL APPLICATORS

CATEGORY 2D

This study guide was adapted from
The Ohio State University Bulletins 638-98 Seed Treatment and 639-98 Seed Treatment for Agronomic Crops and 821-12 Seed Treatment Workbook.

1998 – Ohio Department of Agriculture – Pesticide Regulation
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CHAPTER 1

Seed Treatment Laws, Regulations
and Important Information

Learning Objectives
What is seed treatment?
The labeling requirements
Material Standards

Definition of Seed Treatment
"Seed treatment" means the application of pesticides to seed for the control of insects and disease organisms.

907.07 Labeling and inspection fee requirements.
No person shall sell any agricultural, vegetable, or flower seed:

(E) If the seed has been treated with poisonous material, unless the seed and the label on the package of seed comply with sections 907.44 and 907.45 of the Revised Code;

907.41 Coloration of seed or grain definitions.
As used in sections 907.41 to 907.47, inclusive, of the Revised Code:

(A) "Grain" means whole seeds or entire grains or any altered form thereof of wheat, corn, oats, rye, barley, and sorghum or any other large seeded cereal, field peas, field beans, soybeans, or any other large seeded legume.

(B) "Treat" means to apply a substance designed to control or repel plant disease organisms, insects, or other pests of such grain or the seedlings thereof.

(C) "Seed treatment material" means a substance used to control or repel plant disease organisms, insects, or other pests of such grain or the seedlings thereof, provided however that the term does not include substances to the extent that they are used to control pests of stored grain.

(D) "Person" includes any individual, partnership, corporation, company, society, association, receiver, trustee, or any agent thereof engaged in the handling of agricultural or vegetable seeds, or seed treatment material.

(E) "Sell" includes transfer of ownership or custody, or the receiving of, accepting, or holding on consignment for sale.

907.42 Poisonous seed treatment material standards.
No person shall sell, distribute, or have in the person's possession for sale, a poisonous seed treatment material in the state unless the material meets the color standards or specifications that are established by the director of agriculture pursuant to section 907.43 of the Revised Code. Products sold and distributed as seed treatments shall conform to directions for use on labels accepted for registration under Chapter 921 of the Revised Code and the federal "Insecticide, Fungicide and Rodenticide Act," 61 Stat. 163 (1947), 7 U.S.C.A. 135, as amended.

907.43 Coloring and dyeing of grain and seed treatment material.
The director of agriculture, subject to sections 119.01 to 119.13, inclusive, of the Revised Code, shall promulgate rules and
regulations establishing standards or specifications or both for the coloring or dyeing of grain, and seed treatment materials, and adopt and enforce such other rules or regulations as he may deem necessary to carry into effect sections 907.41 to 907.47, inclusive, of the Revised Code.

907.44 Exceptions. No person shall sell, distribute, or have in his possession for sale any seed or grain which has been treated with a poisonous material unless the seed or grain has been colored or dyed a color contrasting with its natural color. Seed or grain to which a material has been applied for the express purpose of killing or mitigating insects, fungi, or other forms of plant or animal life present in the grain, and which bears no residue of a poisonous material for which a tolerance has not been established, or which bears no residue in excess of a tolerance recognized in regulations adopted under authority of sections 907.41 to 907.47, inclusive, of the Revised Code, and in accordance with sections 119.01 to 119.13, inclusive, of the Revised Code, are exempted from the coloring and labeling requirements of sections 907.41 to 907.47, inclusive, of the Revised Code.

907.45 Label information. No person shall sell, offer for sale, barter, or exchange any seed or grain which has been treated with a poisonous material, or which has been admixed with other seed or grain so treated unless:

(A) The container thereof, or invoice in case of bulk shipments, carries a label or statement in not less than eight-point type the words, "warning-poison treated-do not use for food, feed or oil purposes";

(B) It bears the common accepted coined, chemical, or abbreviated chemical (generic) name of the applied substance.

Labeling requirements for treated seed. Seed once treated cannot be used for food feed or any other purposes. Under the federal and state seed laws, the following information is required to be shown on the label: a word or statement in type no smaller than eight points indications that the seeds have been treated; the commonly accepted, chemical (generic) name of the applied substance including the application rate, and a caution statement if the substance used in such a treatment has an amount remaining with the seed that is harmful to humans or other vertebrate animals.

Seed treated with highly-toxic substances shall be labeled in red ink to show a statement such as “Poison Treated.” In addition, the label should show a symbol of a “skull and crossbones”. Seed treated with less toxic substances shall be labeled to show a caution statement in no smaller than eight point type such as “Do not use for food, feed, or oil.”

Coloring seed treated with poisonous substances All treated seed must be colored an unnatural color to distinguish it from untreated grain and prevent unintended use as food for man, feed for animals, or for oil purposes. All treated seed must be colored with a dye, color coat, or color film which should cause no obvious problem with germination, danger to personnel processing or using the seed. Dyes are designed to stain the seed with color. Color coat pigments cover the seed with color, and color films are made from a polymer that creates a colored film around the seed. Seed treatment companies offer a wide variety of color and surface texture options to seed processors.
CHAPTER 2

Common Pests of Seed - Diseases

Learning Objectives
Common Diseases
Disease Organisms
Damage Caused to Crops

Diseases:
(a) Seed rot-rotting of seed before germination.
(b) Damping-off and seedling blight--soft rot of stem tissues near ground level and water soaking of seedling tissues.
(c) Seedling wilt--gray coloration starting at the leaf tips and extending rapidly to the whole leaf, causing complete collapse of seedlings in 24 to 28 hours.
(d) Root rot--water soaking, browning and sloughing of rootless.
(e) Loose and covered smut of small grains.

Disease Organisms:
(a) Pythium species,
(b) Fusarium,
(c) Diplodia,
(d) Penicillium,
(e) Helminthosporium,
(f) Ustilago (smut)
(g) Rhizoctonia.

Seed and Soil-Borne Diseases of Field Crops

Corn Diseases
Damping-off and seed decay. Germinating corn seed can be attacked by several seedborne and/or soil borne fungi. Pre-emergence and post-emergence damping-off caused by fungi is most common in poorly drained, cold soils. Seed rots and seedling blights are commonly caused by Pythium and Fusarium species, and may be caused by Penicillium and Bipolaris species. All of these fungi can rot seed prior to germination. Infected seedlings typically show a marked softening of stem tissue at the soil line.

Kernels with surface cracks caused by mechanical harvesting are especially susceptible to seed rots caused by soil-borne pathogens. Broad spectrum, protectant-type fungicides are highly recommended for both corn and sorghum, especially when early planting in cold, wet soils is attempted. Pythium seedling blight is most significant under these conditions. Most seed corn companies treat their seed prior to bagging. However, planter-box formulations of these materials are available for use by the grower on untreated field, sweet, and popcorn seeds.

Soybean Diseases
Phytophthora damping-off and root rot is caused by the fungus Phytophthora sojae, and is particularly a problem in low, poorly drained, clay soils. However, the disease can be encountered on a variety of soil types if the soil remains wet for several days soon after planting. Phytophthora can attack soybean plants at any stage of development and stands can be reduced by seed rotting and preemergence damping-off. Young plants can be killed soon after emergence. Brown, water-soaked stems and yellow,
wilted leaves are the primary symptoms of post-emergence damping-off.

Phytophthora survives in the soil as thick-walled spore, called oospores. Early in the growing season, when the soil remains wet for several days (temperatures above 60 degrees F), these spores will germinate, producing a second type of spore called a sporangium. The sporangium then germinates to produce a third type of spore called a zoospore in large numbers. Zoospores are attracted to chemicals released by soybean roots and swim through a thin film of water until a root is encountered. The zoospores produce a hyphae (a threadlike structure) and infect the soybean root. The fungus grows in the roots and eventually into the plant stem. As the plant dies, oospores are formed by the fungus.

Phytophthora damping off

Pythium damping-off can be caused by several species of Pythium. Pre-emergence damping-off, seed decays, and root rots of soybean all can be caused by this group of fungi. Pythium rots can occur on soybeans at any stage of plant development but are much more prevalent on seedlings. Diseases caused by Pythium can occur over a wide range of temperatures, but are most common during cold periods (below 55 degrees F) with high soil moisture.

Seedlings infected with Pythium often fail to emerge. Stems of infected seedlings appear water-soaked and translucent above the soil line. Diseased areas later turn brown and appear shrunken; eventually, the stem and smaller roots decay and the seedlings die.

Pythium species survive also as oospores. During periods of high soil moisture, the resting spore germinates and infects seeds or young plants in much the same way as Phytophthora. Germinating soybean seeds release a wide variety nutrients or by-products that can stimulate the growth and attract spores of the fungus. Many different seed treatment materials will effectively prevent losses from Pythium seed rot and seedling blights.

Soybean damage from Pythium

Rhizoctonia seedling blight is caused by the fungus Rhizoctonia solani, and may occur at any time, but a protected cool period of low soil moisture followed by warming soil temperatures with a brief rainy period favors disease development. Seedlings under stress are more susceptible to Rhizoctonia seedling blight. Example of stress are herbicide injury or desiccation during early seedling growth. Seedlings and young plants are most often affected. Infected plant stems and older roots appear reddish brown and have sunken lesions. Stems may be girdled just above the soil line; tissue thus damaged may appear cracked or cankered. In dry windy
weather, severely infected plants wilt and die rapidly.

Rhizoctonia solani survives in the soil as sclerotia. The fungal mycelium body itself may also survive in soil or in association with old plant residue. Growth of the fungus in soil depends on soil nutrient supply, pH, moisture, and temperature. As the fungus grows in soil, it can encounter and infect germinating soybean seeds or young plants. Several seed treatment materials can control the seed rot phase of this disease, however, none are highly effective against the post-emergence or stem rot phase of the disease.

Phomopsis seed rot is a common seed disease in Ohio and is caused by the seed-borne fungi, Phomopsis longicolla, Diaporthe phaseolorum var. sojae, and D. phaseolorum var. caulivora. Infected seeds typically germinate poorly or not at all.

Phomopsis seed rot of soybean

Severely infected seeds appear shriveled, cracked, and elongated, and may be covered with a white moldy growth. However, seeds may be infected and fail to show any symptoms at all. Infection of seeds is most common when warm, wet weather delays harvest. When moldy seeds are planted, seedling death results in poor stands. Generally, higher soil temperatures favors development of seed rot and seedling blight. Seed treatments can increase the germination rate up to 20 percent. Seed lots with less than 80 percent germination should not be used.

Recent research demonstrates that Sclerotinia white mold can be introduced into new fields on infested soybean seed. In addition, this fungus, Sclerotinia sclerotiorum, forms hard, black, small, irregular-shaped sclerotia both inside and outside of infected soybean plants. These sclerotia are harvested with the seed or returned to the soil with plant debris at harvest. Seed should be well cleaned to remove sclerotia and treated with appropriate fungicide seed treatment to eradicate the fungus from infested seed.

**Wheat and Spelt Diseases**

Loose smut caused by the fungus Ustilago tritici has little effect on seed quality. However, it can result in substantial yield losses if left unmanaged. Symptoms are most noticeable between heading and maturity of the crop. Diseased flowering heads are conspicuously darker when compared to healthy, green heads. Also, diseased heads typically emerge earlier. Diseased spikelets may be entirely transformed into dark fungal spore masses. As the head emerges, floral tissue is torn and the spores are released. Eventually only a spike is left where a normally healthy head should be. Spores of the fungus are dispersed by wind to nearby healthy flowers where they initiate new infections during wet weather. Unlike bunt, the loose smut fungus infects the developing kernels without causing noticeable damage.
Ustilago tritici survives in infected wheat seed. The fungus becomes active when the seed germinates and grows into the growing point of the developing wheat plant. Fungal growth closely follows the plants’ growth. When the flowers form, the fungus again sporulates and starts the cycle again. Use a systemic fungicide seed treatment to eliminate this pathogen from infected seed.

**Head scab:** caused by Fusarium spp., is frequently a major cause of poor quality wheat seed in Ohio. Infected seed appear whitish to reddish in color and are nearly always shrunk and light after emerging from the soil. Roots of plants killed by seedling blight appear light to reddish brown in color and may be covered with mold. If they survive, they generally lack vigor and may produce only a few weak tillers. Planting infected seed early when soil temperatures are above 60 degrees F generally increases loss from seedling blight. The best control of the seed-borne phase of scab is to first clean seed lots to remove all lightweight seed, thus increasing test weights; and second, treat with a fungicide that is effective in controlling seedling blights.

Stagonospora glume blotch, caused by the fungus Stagonospora nodorum has increased in the US in recent years probably due to expanded use of nitrogen fertilizers, semidwarf wheat varieties, and reduced tillage. Symptoms can develop throughout the growing season on all above-ground plant parts. Initial symptoms are small chlorotic flecks usually on lower leaves or those in contact with soil. The glumes of the wheat heads become infected in late spring before flowering. Lesions generally begin at the glume tips and are dark brown in color. During favorable weather, the fungus penetrates the glumes and infects the seed causing severe shriveling of the grain.

Stagonospora survives on seed, straw, and/or volunteer wheat. With the onset of moist weather, spores are produced and are spread to healthy wheat plants by splashing rain. Glume blotch is most common in relatively warm weather when the temperature is between 70 degrees F and 80 degrees F.

**Alfalfa Diseases:** Phytophthora damping-off and root rot is caused by the fungus, Phytophthora megasperma f.sp. medicaginis. Standing water, poor drainage, and generally
wet soil conditions favor disease development. This disease can be lethal to seedlings and established plants.

Seedlings may fail to emerge or can be killed after emergence. A conspicuous yellowing of leaves, particularly lower ones, is a characteristic symptom. Infected seedlings often wilt. Seedling tap roots have dark brown to black lesions and may be rotten 2-4 inches below the crown. A yellow discoloration of internal root tissue is often present. Tap roots may appear discolored. The life cycle of Phytophthora on alfalfa is similar to that on soybean, however, the fungi are completely different and do not attack the other plant host. Seed treatments are labeled for control of Phytophthora damping off. However, to protect stands beyond the seedling stage, alfalfa varieties with resistance to the fungus should be used.
CHAPTER 3

Common Pests of Seed – Insects

Learning Objectives
Learn about soil borne insects
Learn about grain insects
Learn what and how they damage seed

Insect pests of seeds in soil
Soil insect pests are generally more of a problem on corn and soybeans than on small grains and forages. Soil-applied insecticides recommended for control of rootworm larvae also may prevent early stand losses due to wireworms, grubs, seed corn maggot, and seed corn beetles. If a soil-applied insecticide is used at planting, then a seed applied insecticide may not be necessary. Refer to the label of the soil-applied insecticide to determine which insects are controlled before purchasing a seed treatment insecticide. Stand losses to these soil insects is generally not significant enough to warrant routine use of soil-applied insecticides in first-year corn. The use of insecticide for first-year corn may change in the future due to a biotype of the western corn rootworm beetle. Benefits from suppression of early-season soil pests may be significant in 1) no-till or reduced-tillage conditions with poor weed control where a high risk exists for a given insect problem such as wireworms and grubs in corn following established sod, and 2) continuous corn where early-season pests may cause unacceptable stand losses.

Seed corn maggot or the bean seed maggot are small, yellowish-white, legless fly larvae found feeding on corn seeds. Extensive feeding by these maggots will cause a reduction in stand. In general, seed corn maggot problems are most likely to occur in situations where; 1) high organic matter or decaying vegetation attracts egg-laying adult flies (i.e. a green cover crop such as rye or alfalfa is plowed or disked under), and 2) cool, damp soil conditions delay seed germination and prolong the period vulnerable to maggot attack. No-till production systems have not been found to increase the likelihood of problems with seed maggots. Several products are formulated for application prior to planting seed on the farm as planter-box or hopper-box treatments.

Seed corn maggot

Partially eaten seeds, loss of germination, or stunted seedlings in the presence of small (1/4 to 1/3 inch long) brown ground beetles indicate a seed corn beetle problem. As with seed corn maggots, damage is most likely to occur under cool, damp conditions where seed germination and seedling development are delayed.

Seed corn beetle
Wireworms are the larval stage of the "click beetles." The term "wireworm" applies to a complex of species with life cycles requiring one or more years per generation. Wireworm populations affecting corn are most severe in fields following sod or fields having a prolonged grassy weed problem. The larvae pass through a number of life stages, or instars. The earliest stages are very small and white; the latter stages have a characteristic hard-shell appearance and are yellow-brown in color. Full-grown larvae range from 1/2 to 1 inch long depending on the species. Wireworms damage corn by feeding on germinating seeds and young seedlings and may bore into stalks at the soil level. Stand loss may be significant in fields with high populations. In fields where a soil-applied insecticide is not used, especially first year corn fields, application of seed treatment insecticide is strongly recommended.

Insect Pests of grain
Angoumois Grain Moth the adult is a dull gray. The larvae bore into the kernel, pass through the pupa stage and emerge through a small round hole cut in the outer layer of the kernel. The moth breeds on the surface of the grain.

Cadelle Beetle this is one of the largest stored grain insects and is black in color. The larvae burrow into the woodwork of bins and can stay there to infest new grain. These larvae are white with black heads and two horny, black points at the end of their bodies.

Confused Flour Beetle the confused flour beetle, saw-toothed grain beetle and flat grain beetle are commonly referred to as "bran bugs." The confused flour beetle is reddish-brown and is one of the most common storage insects both in elevators and mills.
Confused Flour Beetle

Flat Grain Beetle this is one of the smallest stored grain beetles. It is a flattened, oblong, reddish-brown beetle with an antennae about 2/3 as long as the body.

Indian Meal Moth

Lesser Grain Borer this is a small beetle, dark brown to black with its head turned down under the front part of the body. It is a strong flier and can live under much drier conditions than most of the other stored grain insects.

Granary Weevil this insect is very similar to the rice weevil and can only be distinguished from it by microscopic examination. It cannot fly.

Flat Grain Beetle

Indian Meal Moth

Lesser Grain Borer

Saw-Toothed Grain Beetle this is a reddish-brown to black insect that has six saw-toothed projections on each side of the front part of the body, visible under microscope.

Indian Meal Moth

Lesser Grain Borer

Saw-Toothed Grain Beetle
Saw-Toothed Grain Beetle
CHAPTER 4

Product Types for Seed Treatments

Learning Objectives
The different types of seed treatment Products
Pesticide types approved for seed treatment
Different categories of Fungicide Seed Treatments

Selection of Treatment Products
Application of seed applied technologies (SAT) can include fungicides, insecticides, nematicides, plant growth regulators and other biologically active materials to seed. SAT may also include other materials such as colorants, polymers, coating materials, drying agents, water, etc. to provide a suitable appearance, physical properties, process performance and other factors. The selection of individual products and blends should be based on and evaluation of data demonstrating efficacy, seed safety, application characteristics and plant-ability of the seed.

The seed treatment product can be a single product, custom blends, and/or ready-to-use.

- A seed treatment recipe is the combination of all the registered treatment products identified by a manufacturer, seed-company, or other entity for a specific purpose on a crop. The components may be sourced from one or multiple manufacturers. The products may be combined in a slurry, on site prior to application or pumped individually into the treating equipment. Each recipe should be evaluated and verified to be suitable for each crop.

- Custom blends are mixture of independently registered products blended together by manufacturers or distributors for applicators to reduce the number of products that need to be combined on site.

- Ready-to-Use (RTU) products are commercially marketed pre-mixtures of registered seed treatment products designed to properly treat seed typically without the use of additional components other than water.

  - Manufacturers should provide the data to demonstrate the performance of these RTU formulations.
  - If other active components are added to a RTU product, then it becomes a custom seed treatment recipe and need to be fully verified.

Pesticide Labels
Before using any pesticide, read and analyze the information about the product. The label contains detailed information about the product such as active ingredient, inert ingredients, warning statements (including "Danger-Keep Out of Reach of Children" or "Poison" and "Handle with Care), antidotes, type seed and rate per bushel, kind of pests controlled, care in handling and use of treated seed, and disclaimer or warranty clause.

Seed Treatment Pesticides
Fungicides: Fungicidal seed treatment may be divided into three categories, depending on the nature and purpose of the treatment. These categories are seed disinfection, seed disinfestation, and seed protection. Note a given fungicide may serve in one or more of these categories.
Seed disinfection: Disinfection is the elimination of a pathogen that has penetrated into living cells of the seed, infected it and become established.

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

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

Seed treatment materials are usually applied to seed in one of three forms - dust, slurries (a mixture of wettable powder in water) and liquids.

Based on composition, seed treatment fungicides may be organic or inorganic, metallic or non-metallic and until recently, mercurial or non-mercurial. Before the cancellation of the volatile mercurials, fungicides for treating seed were generally classified as volatile and non-volatile. With the elimination of the volatile mercurial, most fungicides now approved for use on seed are classified as nonvolatile. When using this type material, complete coverage of the seed is necessary to obtain effective control.

Some of the systemic pesticides, a class of pesticides, may now be used as seed treatment materials. The desirability of having materials that would move inside the seed or plant and control the pest has long been recognized. Such a material is called a systemic. When used according to the manufacturer's recommendations, a systemic moves through the host plant and controls or retards the growth of certain fungi and insects without affecting the host's metabolic system.

Insecticides: Insecticides are often applied to seed to control or reduce insect damage to the seed during storage and to a lesser degree to prevent damage from such insects as wire worms and seed corn maggots in the soil.

Since some of the pesticides are selective in the control of pests, many times two or more compounds are combined in the treater-tank, or an extra tank may be used, to give the spectrum of activity needed.

The manufacturers of pesticides are now making combinations available to seed processors but should a processor blend two or more pesticides, the compatibility of the materials must be determined, as some combinations of materials may seriously reduce seed germination. When applying two or more pesticides at different times, the sequence of application is also important. Whether a single pesticide or a combination is to be applied to the seed, read the label and follow the manufacturer's directions carefully.
CHAPTER 5

Seed Treatment Equipment

Learning Objectives
Different Types of Equipment
How the Equipment is used
Labeling for the Treated Seed
Calibration
What Precautions
The Hazards

Commercial seed treaters are designed to apply accurately measured quantities of pesticides to a given weight of seed. Basically, there are three types of commercial seed treaters on the market-dust treaters, slurry treater and direct treater. The Panogen and Mist-O-Matic treaters are examples of the direct treaters.

Dust Treater: (Using Gustafson LX Dry Powder Seed Treater as an example):

![Gustafson Seed Treater](image)

**Operation**--Controlling the flow of Seed: The amount of seed that flows into the weigh pan, which is just beneath the feed hopper on top of the treater, is controlled by opening or closing the gates of the seed hopper by means of the hand wheel on the side of the hopper. The scale on the hopper shows how far gates are open in inches. Gates should be open to whatever number of inches it takes to keep the weigh pan filled to the required number of pounds per dump as it tilts in either direction. The number of pounds per dump is adjusted by correctly setting the counterweight up or down on the counterweight arm.

**Powder Application**--To ascertain that the correct amount of power is being applied to the seed flow, a preliminary test must be made in which a given number of pounds of seed (example, 100 pounds) are run through the feeder. During this run, the measuring cup provided with the feeder should be used to catch the powder as it comes off the vibrator. After the given amount of seed has run through, the powder should be weighed so as to determine how much is being applied to that amount of seed. The vibrator speed can then be adjusted accordingly. Then another or more tests should be run until proper setting of the vibrator speed is determined for correct coverage.

### Approximate Setting

<table>
<thead>
<tr>
<th>NO. Dumps</th>
<th>Powder Scale Opening</th>
<th>Syntron Setting</th>
<th>Oz. Produced /100lbs</th>
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<tbody>
<tr>
<td>25</td>
<td>1/2</td>
<td>60</td>
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Number 4 on counterweight arm gives five pounds per dump.

**Slurry Seed Treater:** The slurry treatment principle involves suspension of wettable powder treatment material in water. The treatment material applied as slurry is accurately metered through a sample mechanism composed of a slurry cup and seed dump pan. The cup introduces a given amount of slurry with each dump of seed.
into a mixing chamber where seed are blended.

Slurry Seed Treater

While operation of slurry treater is relatively simple, the various operation procedures must be thoroughly understood.

The metering principle is the same in direct, ready-mix or fully automatic treaters, i.e., the introduction of a fixed amount of slurry to a given weight of seed.

To obtain a given dump weight, slurry treaters are equipped with a seed gate that controls seed flow to the dump pan. With the proper seed gate setting, a constant dump weight for a given seed can be obtained.

The amount of treatment material applied is adjusted by the slurry concentration and the size of the slurry cup or bucket. As the dump pan fills, a point is reached where it over balances the counterweight and dumps into the mixing chamber. This brings the alternate weighing pan in position to receive the inflow of seed and activates a mechanism to add a cup of slurry to the mixing chamber. Thus, one cup of slurry is added with each dump of seed.

The mixing chamber is fitted with an auger type agitator that mixes and moves seed to the bagging end of the chamber. The speed of the auger is important because at slow speeds more uniform distribution is obtained.

Slurry tanks have 15 to 35 gallon capacities, depending on the size of the treater. They are equipped with agitators that mix the slurry in the tank and keep it suspended during operation. It is important that the powder be thoroughly suspended in water before treating. If the treater has been idle for any period of time, sediment in the bottom of the slurry cups must be cleaned out.

The proper size slurry cup must be used. Most machines now have cups with ports and rubber plugs for 15 cc, 23 cc, and 46 cc quantities. Some users prefer to mix the slurry in an auxiliary tank and then transfer to the slurry chamber as needed.

Direct Treaters: Direct treaters are the most recent development and include the Panogen and Mist-O-Matic treaters. These two were initially designed to apply undiluted liquid treatment. Instead of applying 23 cc of material per 10 pounds of wheat, as in slurry treaters, they apply 14 to 21 cc (1/2 to 3/4 ounces) per bushel of wheat. This small quantity of material is suitable only with liquid materials that are somewhat volatile and do not require complete, uniform coverage for effective action.

Later modifications for treaters include dual tanks that permit simultaneous addition of a fungicide and an insecticide, and adaptations for the application of slurries. The metering device in both treaters is similar to that of the slurry treater, since it is attained through synchronization of a treatment cup and seed dump. Otherwise, they differ decidedly from the slurry treater and from each other. Both of these direct treaters have an adjustable dump pan counterweight to adjust the
weight of the seed dump. This is not practical with slurry treaters.

Panogen Seed Treater: The operation of the Panogen treater is relatively simple. A small treatment cup, operating from a rocker arm directly off the seed dump pan and out of a small reservoir, meters one cup of treatment with each dump of the seed pan. Fungicide flows through a tube to the head of the revolving drum seed mixing chamber. It flows in with seed from the dumping pan and is distributed over the seed by the rubbing action of the seed passing through the revolving drum.

The desired treating rate is obtained by the size of the treatment cup and adjusting the seed dump weight. Treatment cup sizes are designated by treating rate in ounces and not by actual size, e.g., the 3/4 ounce cup applies 3/4 ounce (22.5 cc) of treatment per bushel with six dumps per bushel. Actual size of this cup is approximately 3.75 cc.

Mist-O-Matic Seed Treater: The Mist-O-Matic treater applies treatment as a mist directly to the seed. The metering operation of the treatment cups and seed dump is similar to that of the Panogen Treater. Cup sizes are designated by the number of cc's they actually deliver, e.g., 21/2, 5, 10, 20 and 40. The treater is equipped with a large treatment tank, a pump and a return that maintains the level in the small reservoir from which the treatment cups are fed. After metering, the treatment material flows to a rapidly revolving fluted disc mounted under a seed spreading cone. The disc breaks the droplets of the treatment into a fine mist and sprays it outward to coat seed falling over the cone through the treating chamber. Just below the seed dump are two adjustable retarders designed to give a continuous flow of seed over the cone between seed dumps. This is important since there is a continuous misting of material from the revolving disc. The desired treating rate is obtained through selection of treatment cup size and proper adjustment of the seed dump weight.

Calibrating a Slurry or Liquid Seed Treater for the Correct Dosage
Determine how much liquid your treater's metering cup or bucket will dump into the seed each time the weighted seed pan trips. Record for future use.

Run seed slowly into the treater until the weighted seed pan dumps seed into the treater. Shut off the feed to the treater immediately. Weigh the amount of seed dumped into the treater. Record the setting of the weight on the weight balance arm and the weight of the grain dumped for future use.

Determine the number of dumps per bushel by dividing the weight per dump into the bushel weight of your seed. For example, a treater dumps 6 pounds of wheat each time the seed pan trips. Dividing 60 pounds per bushel by 6 gives 10 dumps per bushel.

Determine how much of the liquid or slurry you are applying per bushel of seed. To do this, multiply (1 above) the amount of chemical your metering cup dumps into the seed by (3 above) the number of dumps per bushel. Since most metering cup capacities are measured in cc while the chemical recommendations are in ounces per bushel, divide the result by 29.57 to give the liquid ounces per bushel applied.

Metering cup capacity in cc/29.57 * Number of dumps per bushel = ounces of liquid applied per bushel.

For example: 46 cc * 10 dumps/29.57 = 460/29.57 = 15.6 oz. liquid per bushel
To determine the correct amount of powdered chemical to add to one gallon of water for a slurry mixture, divide 128 by the number of ounces of liquid applied per bushel and multiply the result by the ounces of the chemical you want to apply to one bushel.

\[
\text{128 ounces per gallon} / (\text{oz. liquid applied/bu.}) * \text{Oz. powdered chemical desired per bushel} = \text{Ounces of slurry to add to one gallon of water.}
\]

For example: \(128/15.6 * 1.5 = 12.3\) ounces powdered chemical to add to one gallon of water. Note, for additional information, see the Calibration instruction manual furnished with each machine by the manufacturer.

**Requirements under the Federal and State Seed Laws for Labeling Of Treated Seed**

Information required to be shown on the label: A word or statement in type no smaller than 8 point indicating that the seed have been treated.

The commonly accepted, coined, chemical or abbreviated chemical (generic) name of the applied substance and the rate of application.

A caution statement if the substance used in such treatment in the amount remaining with the seed is harmful to humans or other vertebrate animals.

Seed treatment with a mercurial or similarly toxic substance, shall be labeled to show a statement such as Poison Treated in red. In addition, the label shall show a representation of a skull and crossbones.

Seed treated with less toxic substances, if the amount remaining with the seed is harmful to humans or other vertebrate animals shall be labeled to show a caution statement in type no smaller than 8 point such as Do Not Use for Food, Feed or Oil.

Figures shown are minimum labeling requirements and the label may contain additional information such as Purpose of Treatment, Antidotes, Safety Precautions and Procedure to Follow in Case of an Accident.

**Coloring Grain Seed Treated With Poisonous Substances**

All interstate shipments of the food seed such as wheat, corn, oats, rye, barley and sorghum bearing a poisonous treatment in excess of a recognized tolerance or treatment for which no tolerance or exemption from tolerance is recognized must be denatured by a suitable color to prevent use of such seed as food, feed or oil.

Many of the pesticides now come from the manufacturer with the dye or color added as a convenience to the operator; however, some seed processors prefer to mix the dye with the pesticide at the plant so that the desired color may be obtained. Most all treated seed are now colored, with the dye causing no apparent injury to seed germination or danger to personnel processing or using the seed.

**Pesticide Carriers, Binders and Stickers**

These materials are listed on the label as inert ingredients. There is no requirement that the name of these materials be given. They are selected by the manufacturer and are usually neutral in pH, non-toxic to humans and cause no apparent damage to the germination of the seed.
CHAPTER 6

Safe Handling, Transport and Disposing of Treated Seed

Learning Objectives
Personal Protection Equipment
Transporting
Handling
Equipment Cleaning
Seed Label Example

Personal Protection Equipment (PPE):
Always read and follow the pesticide labeling or seed tag safety language regarding PPE. PPE typically includes long pants, long sleeved shirt/coveralls, chemical resistant gloves, shoes and socks, etc. A reference may be required or suggested for PPE as indicated by an equipment manufacturer for operation of equipment used to handle, transport, and plant treated seed. The additional PPE may include eye, ear, respiratory, foot, and/or head protection.

Transporting Treated Seed:
Read and understand the seed treatment tag language and follow all the requirements that are printed or attached to the treated seed containers or contained in shipping documents for bulk treated seed. Make a note of the manufacturer or seed company phone number for specific product questions. Also note any emergency or medical center contact information. Protect the treated seed from direct sunlight, extreme heat and moisture. Avoid any undue mechanical abrasion and damage to the treated seed and packaging containers to minimize dust and spillage and maintain seed quality. If there is a spill, collect the treated seed immediately using proper PPE.

Then dispose of spillage to minimize exposure to people, livestock, wildlife and the environment.

Handling Treated Seed:
Avoid exposure to dust when opening or emptying packaging or while transferring bulk treated seed. Properly dispose of any spillage according to seed tag or labeling to minimize exposure to people, livestock, wildlife and the environment. Handlers should be aware of all seed treatment safety and stewardship tag and language.

Storage of Treated Seed:
Read the seed treatment tag language to understand the specific treated seed storage requirements. The treated seed should be protected from direct sunlight, extreme heat and moisture. The facility should also be well ventilated. Treated seed should be kept secure from children, livestock, wildlife and unauthorized persons.
CHAPTER 7

Seed Treatment for Agronomic Crops

The following pages of the guide are of a workbook full of questions and answers pertaining to seed treatment. (See Next Page)

Example of a Label for Treated Seed

KILL ALL
SYSTEMIC FUNGICIDE

This seed treat with Captan, PCNB and Thiabendazole at the rate specified by the manufacturer.

DANGER
TREATED SEED, DO NOT USE FOR FOOD,
FEED OR OIL PURPOSES,
KEEP OUT OF REACH OF CHILDREN

Causes irreversible eye damage. Harmful if swallowed or inhaled. May cause allergic skin reactions. Do not get in eyes. Avoid Contact with skin and clothing. Remove and separately launder clothing before reuse. Contains materials which may cause cancer based on laboratory animal data. Risk of cancer depends on deration and level of exposure. Overexposure may cause liver damage.

STATEMENT OF PRACTICAL TREATMENT

IF IN EYES: Flush with plenty of water. Call a physician.
IF SWALLOWED: Drink promptly a large quantity of milk, egg white. Gelatin solutions or if not available drink large amounts of water. Avoid alcohol.
IF INHALED: Remove victim to fresh air. If not breathing, give artificial respiration preferably mouth-to-mouth. Get medical attention.
IF ON SKIN: Wash with plenty of soap and water. Get medical attention if abnormal reaction occurs.
Ohio Pesticide Applicator Training

Seed Treatment Student Workbook
Preface
This workbook was prepared by the Ohio State University Extension for use as a self-study guide or in combination with an educational program. It has been developed to assist pesticide applicators in better preparing themselves for taking the exams required for certification in the seed treatment category. The sample questions presented in this manual will help the reader obtain a general understanding of seed pest problems, approaches to control, and general information needed to apply and use pesticides safely.

How to Use this Workbook
This workbook is designed to serve as a supplementary study guide to the following bulletin published by the Ohio Extension. The publication is available through local county Extension offices.

Bulletin 639
Seed Treatment for Agronomic Crops

Users of this workbook should read the bulletin before attempting the workbook. When using this workbook, use the flap on the back cover to conceal the answers while answering the questions on the left-hand page. Once all the questions are answered, the user should check to see if the responses are correct, mark those incorrect, and read the explanation for each question. If the explanation is confusing or if you disagree with the answer or explanation, refer to the section indicated in the reference.

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SEED TREATMENT FOR AGRONOMIC CROPS

1. The first step in ensuring good crop stands is to use high-quality, disease-free seed.
   A. True
   B. False

2. Which of the following factors, over the last decade, has increased the need for high-quality seed?
   A. Early planting
   B. Narrower rows
   C. No-till
   D. Reduced tillage and reduced seed-bed preparation
   E. All of the above

3. Which of the following factors does not affect the quality of the seed?
   A. Damaged seed coat
   B. Sunlight
   C. Poor seed storage (temperature and humidity)
   D. Insect feeding damage
   E. Seed-borne fungi

4. Seed coat damage occurs only during harvest and cleaning of the seed.
   A. True
   B. False

5. Fungi infect the seed coat primarily:
   A. When seed diseases occur due to wet conditions
   B. When seed is stored below 13% grain moisture
   C. When harvest of the seed crop is delayed for several weeks
   D. A & C
   E. B & C

6. Which of the following practices will reduce seed viability?
   A. Moisture levels above 13% moisture
   B. Poor storage conditions (wet and warm)
   C. Excessive handling of seed
   D. All of the above
   E. None of the above
1. **Correct Answer: A, Introduction**
   **Explanation:** Obtaining optimum stands is essential to maximizing yields. The use of high-quality, disease-free seed is the first step in ensuring good stands.

2. **Correct Answer: E, Introduction**
   **Explanation:** Earlier planting, narrower rows, no-till, and incomplete seed-bed preparation are all factors for using high quality seed. Ultimately, the use of high-quality seed ensures fast-emerging seedlings that grow rapidly, are more tolerant to adverse weather conditions, and are able to better resist disease.

3. **Correct Answer: B, Introduction**
   **Explanation:** Sunlight does not have a direct affect on the quality of the seed but seed-borne fungi, insect feeding damage, poor seed storage (temperature and humidity too high), and damaged seed coats can affect seed quality.

4. **Correct Answer: B, Introduction**
   **Explanation:** Rough handling of the seed during harvest, cleaning, planting or any time during storage can damage the seed coat.

5. **Correct Answer: D, Introduction**
   **Explanation:** When harvest of the seed crop is delayed several weeks or when seed diseases occur due to wet conditions, seed quality may be reduced due to infection by fungi. Infected seed can be detected at harvest; it is discolored, shriveled or moldy.

6. **Correct Answer: D, Introduction**
   **Explanation:** Poor storage conditions reduce the viability of the seed drastically. Seed should be handled as little as possible and kept cool and dry. Moisture levels above 13% encourage the growth of fungi that reduce viability.
7. Small cracks in the seed coat assist the seed in germinating quickly.
   A. True  
   B. False

8. Proper seed treatment fungicides will increase germination of seeds if poor germination is the result of fungal infections.
   A. True  
   B. False

9. Fungicides are available which protect seed and young seedlings from all seed-borne pathogens.
   A. True  
   B. False

10. Under which of the following conditions will seed treatments be the most beneficial?
    A. Poor germination caused by excessive mechanical damage  
    B. Poor storage conditions  
    C. Fungal infections  
    D. Genetic or variety differences among seed  
    E. None of the above

11. Fungicide seed treatments always increase stands under poor germination conditions and ensure higher yields.
    A. True  
    B. False

12. Activity against certain soil-borne diseases lasts only as long as it takes the plant to emerge, which is generally less than two weeks under normal weather conditions.
    A. True  
    B. False

13. Since each planting situation is different, which of the following factors does not need to be considered in seed treatment?
    A. Soil moisture and temperature  
    B. Time of planting and planting rate  
    C. Planter type  
    D. Seed quality  
    E. Type of tillage
7. Correct Answer: B, Introduction
   Explanation: Small cracks in the seed coat increases the chances of seed rot by permitting water-soluble nutrients to escape into the soil, thereby activating soil-borne fungi, and providing a quick entryway for seed-rotting organisms.

   Explanation: This is a true statement.

   Explanation: Fungicides are available which protect seed and young seedlings from many, but not all seed-borne pathogens.

10. Correct Answer: C, Introduction
    Explanation: Seed infected by fungi before planting, or those planted in cool, wet soils or under conditions that delay emergence benefit the most from fungicide seed treatments. Poor germination caused by excessive mechanical damage to seed, poor storage conditions, genetic differences between variety or other non-pathological factors will not be affected by fungicide seed treatments.

11. Correct Answer: B, Introduction
    Explanation: Fungicide seed treatments generally increase stands under poor germination conditions, however seed treatments do not always ensure higher yields. Generally, increased yields occurs when the seed treatment prevents frequent skips in row of emerging seedlings.

    Explanation: This is a true statement. Because of these limitations, the grower must identify the potential disease problems associated with the seed and disease history of the field before planting.

13. Correct Answer: C, Introduction
    Explanation: Seed quality, planting rate, tillage and seed bed preparation, soil moisture and temperature, time of planting, and likelihood of rapid emergence are all factors to consider in each planting situation. In most cases, the planter type will remain constant from field to field.
14. Fungicides are chemicals which:

A. Are used to control diseases caused by fungi
B. May be fungicidal, meaning that the chemical actually kills the fungus
C. May be fungistatic, meaning that it slows the growth of the fungus or keeps it in check
D. All of the above
E. None of the above

15. Captan is which type of fungicide treatment when used to control seed-borne fungi?

A. Protectant
B. Surface disinfectant
C. Systematic disinfectant
D. All of the above
E. None of the above

16. Fungicides are marketed under an assortment of names. Which of the following statements are true about fungicide names?

A. Trade names are given to the product by the manufacturer
B. Common names are simple names given to the chemical in lieu of more complicated chemical names
C. The trade name of carboxin is Vitavax
D. An example of a fungicide chemical name is 5,6-dihydro-2-methyl-1,4 oxathiin-3-carboxanolide
E. All of the above

17. Which of the following statements concerning “broad spectrum” fungicides is false?

A. Most fungicides are useful in controlling a relatively narrow group of fungi
B. Fungicide mixtures expand control to a much broader group of fungi are called “broad spectrum” fungicides
C. A common practice is to use mixtures of different seed treatment fungicides
D. All broad spectrum fungicides have low toxicity
E. Vitavax 200, a common broad spectrum fungicide, contains two fungicides, thiram and carboxin

18. Which of the following is not a fungicide seed treatment formulation?

A. Solutions (S)
B. Flowables (F) and Liquids (L)
C. Emulsifiable Concentrates (EC)
D. Dusts (D) and Wettable Powders (W)
E. All of the above
14. **Correct Answer:** D, *Seed Treatment Facts*  
**Explanation:** All of the statements are true concerning fungicides.

15. **Correct Answer:** B, *Seed Treatment Facts*  
**Explanation:** Captan is a surface disinfectant used to kill fungi and fungi spores on the seed surface. Captan can sometimes be a protectant such as when used to prevent infection from soil-borne fungi like Pythium. Carboxin is a systematic disinfectant used to kill fungi already established within the seed. Maneb and Mancozeb are examples of protectant fungicides which are used to prevent infections of seeds and seedlings by soil-borne fungi.

16. **Correct Answer:** E, *Seed Treatment Facts*  
**Explanation:** All the statements are true.

17. **Correct Answer:** D, *Seed Treatment Facts*  
**Explanation:** Broad spectrum fungicides are just as toxic as the individual fungicides. All the other statements are true. In Vitavax 200, thiram is used on wheat to control seedling blights and carboxin is used to control loose and common smut. This fungicide combination controls all major seed-borne diseases of wheat.

18. **Correct Answer:** A, *Applying Seed Treatments*  
**Explanation:** Seed treatments come in a variety of formulations except Solutions (S). These materials may be used in slurry and mist-type seed treaters after mixing with water. Dust formulations have been developed for use as a planter box treatment by using special adhesives which adhere fungicide particles to the seed surface.
19. Pesticide treated seed requires special labeling if it is going to be sold.
   A. True
   B. False

20. Leftover treated seed can be mixed into animal feeds.
   A. True
   B. False

21. Which of the following fungicides are excellent, low toxicity, broad spectrum, largely protective contact fungicides used to control many plant diseases on barley, corn, oats, rye, sorghum, soybeans, and wheat? They are registered for use as wettable powders or flowable liquids.
   A. Captan + Carboxin
   B. Captan + Lindane
   C. Mancozeb and Maneb
   D. A & B
   E. None of the above

22. Which of the following fungicides is commonly combined with an insecticide such as Diazinon or Lindane formulated as a planter box treatment?
   A. Captan
   B. Benlate
   C. Carboxin
   D. Maneb
   E. Thiram

23. Which of the following is a systematic fungicide available as a seed treatment for the specific control of Pythium and Phytophthora?
   A. Thiram
   B. Metalaxyl
   C. Benomyl (Benlate)
   D. Diazinon
   E. Lindane

24. Which of the following organisms cause damping-off in plants?
   A. Fusarium
   B. Pythium
   C. Phytophthora
   D. Rhizoctonia
   E. All of the above
19. **Correct Answer:** A, *Requirements for Labeling*
   **Explanation:** If pesticide treated seed is to be sold it must be colored with a dye to prevent use for food or feed. In addition, the treated seed must be labeled with the chemical name of the pesticide used and a warning statement that the seed has been treated.

20. **Correct Answer:** B, *Safety Precautions*
    **Explanation:** Introducing treated seed with food and feed channels may cause serious injury to poultry, livestock and humans. Leftover treated seed should not be disposed of on soil surface where it might harm birds and wildlife. Destroy seed by burying at least 18” in isolated areas away from water supplies or according to label directions.

21. **Correct Answer:** C, *Fungicide Seed Treatments*
    **Explanation:** Both Mancozeb and Maneb fit this description. Their activities are fair against seed-borne smuts and barley stripe and fair to good against seed rots and seedling blights.

22. **Correct Answer:** A, *Fungicide Seed Treatments*
    **Explanation:** Captan is an excellent, low toxicity, broad spectrum fungicide used in combination with insecticides to control seed corn maggot, seed corn beetle and wireworm.

23. **Correct Answer:** B, *Fungicide Seed Treatments*
    **Explanation:** Metalaxyl (Apron 25W) effectively controls damping off of Pythium and Phytophthora during the first 10 to 14 days of seedling growth. Metalaxyl has no activity against seed-born Phomopsis or Rhizoctonia stem rot of soybeans. Etridiazol(Terrazole) plus PCNB are also effective for controlling Pythium and Phytophthora. Diazinon and lindane are insecticides. Thiram and benomyl (Benlate) are broad spectrum fungicides used to control seed decay and seedling blights.

24. **Correct Answer:** E, *Seed and Soil-Borne Diseases of Field Crops*
    **Explanation:** All of these organisms can cause damping-off. Damping-off disease is a general term used to describe the destruction of young seedlings by seed-borne or soil-borne organisms.
25. Damping-off disease is characterized by:
   A. Bare spaces where seed rotted or young seedlings were killed.
   B. Poor stands associated with soil fungi attacking seed in cold, wet soils when germination is slow.
   C. Wilting and death of seedlings after they emerge from the soil.
   D. Brown water-soaked, soft sunken areas on seedling stems near the soil surface.
   E. All of the above

26. Corn seedling diseases are more prevalent in cold wet soils than in soil with temperatures above 55 degrees Fahrenheit.
   A. True
   B. False

27. Fungicide seed treatment is recommended for all seed corn to prevent or reduce seed decay and seedling blights.
   A. True
   B. False

28. Corn smut, the leaf blights, stalk and ear rots, and virus diseases are controlled by seed treatment fungicides.
   A. True
   B. False

29. Which of the following fungicides can be used to treat sorghum to control seedling blights, loose kernel smut, and covered kernel smut?
   A. Captan
   B. Thiram
   C. Carboxin
   D. All of the above
   E. None of the above

30. Seed treatment of small grains is recommended to treat which diseases?
   A. Smut diseases
   B. Seed decay
   C. Seedling blights
   D. All of the above
   E. None of the above
25. **Correct Answer: E, Seed and Soil-Borne Diseases of Field Crops**
   
   **Explanation:** Pre-emergence damping-off disease is characterized by bare spaces where seed rotted or young seedlings were killed and poor stands associated with soil fungi attacking seed in cold, wet soils when germination is slow. Post-emergence damping-off is characterized by wilting and death of seedlings after they emerge from the soil with brown water-soaked, soft sunken areas on seedling stems near the soil surface.

26. **Correct Answer: A, Recommendations for Specific Crops, Corn**
   
   **Explanation:** This is a true statement. Therefore, early-planted corn especially needs the added protection of a good seed treatment fungicide.

27. **Correct Answer: A, Recommendations for Specific Crops, Corn**
   
   **Explanation:** This is a true statement. The germination and early growth of the seedling is a critical period in the life cycle of corn. Soil-borne organisms may invade and kill the embryo before germination or during the seedling stage. Surviving seedlings are often less vigorous.

28. **Correct Answer: B, Recommendations for Specific Crops, Corn**
   
   **Explanation:** These corn diseases are not controlled by fungicide seed treatments.

29. **Correct Answer: D, Recommendations for Specific Crops, Sorghum**
   
   **Explanation:** All of these fungicides are labeled for controlling seedling blights, loose kernel smut and covered smut. Head smut cannot be controlled by presently labeled fungicides. Most fungicides labeled for use on corn can be used on sorghum, however read the label to be certain of proper use and to determine whether the smut diseases are controlled.

30. **Correct Answer: D, Recommendations for Specific Crops, Small Grains**
   
   **Explanation:** Seed treatment is recommended for all of these diseases in small grains. The smut diseases include stinking smut (common bunt) of wheat, loose smut of wheat and spelt, and loose and covered smuts of oats and barley.
31. Which diseases of small grains contribute to poor stands and poor quality seed which causes lightweight, shriveled grain?
   A. Head scab
   B. Stinking smut
   C. Glume blotch
   D. A & B
   E. A & C

32. The major cause of poor quality soybean seed in Ohio is Pythium.
   A. True
   B. False

33. Seed treatment for soybeans is recommended for which of the following disease situations?
   A. For control of Rhizoctonia
   B. When poor quality seed is used for planting (germination below 80%)
   C. For early control of Phytophthora damping-off
   D. A & B
   E. B & C

34. When planted at recommended seeding rates, bin-run soybeans seed with greater than 80 percent germination, generally will not benefit from seed treatment.
   A. True
   B. False

35. Decisions to use poor-quality soybean seed should be based on the fact that any seed treatment fungicide effective against seed-borne diseases will not increase germination more than 30 percent.
   A. True
   B. False

36. Which of the following fungicides is not commonly used as a seed treatment in soybeans.
   A. Captan
   B. Thiram
   C. HCB (Hexachlorobenzene)
   D. Carboxin-thiram
   E. PCNB-terrazole

37. Phytophthora damping-off is a serious disease of soybean seedlings found in light, well-drained Ohio soils.
   A. True
   B. False
31. **Correct Answer:** E, *Recommendations for Specific Crops, Small Grains*
   **Explanation:** Seedling blight phases of head scab (*Gibberella zeae*) and glume blotch (*Septoria nodorum*) contribute to poor stands of small grains and poor quality seed, causing lightweight, shiveled grain.

32. **Correct Answer:** B, *Recommendations for Specific Crops, Soybeans*
   **Explanation:** Phomopsis is the major cause of poor quality soybean seed in Ohio.

33. **Correct Answer:** E, *Recommendations for Specific Crops, Soybeans*
   **Explanation:** Seed treatment for soybeans is recommended for two disease situations: 1) when poor quality seed is used for planting (germination below 80 percent) and 2) for early season control of Phytophthora.

34. **Correct Answer:** A, *Recommendations for Specific Crops, Soybeans*
   **Explanation:** This is a true statement. One sure way of getting good quality seed is to buy certified seed that has the percent germination listed on the certified label along with the variety name and the seed treatment material.

35. **Correct Answer:** B, *Recommendations for Specific Crops, Soybeans*
   **Explanation:** Decisions to use poor-quality soybean seed should be based on the fact that any seed treatment fungicide effective against seed-borne diseases will not increase germination more than 20 percent. If bin-run beans of 50 percent germination are treated with a fungicide, the grower should not expect over 70 percent germination in the field.

36. **Correct Answer:** C, *Recommendations for Specific Crops, Soybeans*
   **Explanation:** Captan, thiram, and carboxin-thiram and PCNB-terrazole fungicide combinations are the most widely used soybean seed treatment materials. See Table 3 for relative activity of these fungicides against seed and seedling diseases.

37. **Correct Answer:** B, *Recommendations for Specific Crops, Soybeans*
   **Explanation:** Phytophthora damping-off is a serious disease of soybean seedlings in the more heavy, poorly drained Ohio soils.
38. Which of the following procedures should be used to control Phytophthora in soybeans?

   A. Highly tolerant soybean varieties
   B. A fungicide like Apron 25W (Metalaxyl) to prevent damping-off
   C. Optimal drainage, tillage, rotation, and fertility
   D. All of the above
   E. None of the above

39. By itself, high tolerance to Phytophthora is good enough to control root rot.

   A. True
   B. False

40. Inoculation of soybean seed with nodulating bacteria (Rhizobium) is generally not necessary if a well-nodulated crop has been grown within the past five years.

   A. True
   B. False

41. Significant improvement in stand establishment of alfalfa has been noted in research plots when seeds were treated with metalaxyl for control of seedling damping-off caused by Phytophthora.

   A. True
   B. False

42. Germinating corn seed can be attacked by several seed-borne and/or soil-borne fungi. Pre-emergence and post-emergence damping-off caused by fungi is most common in poorly drained, cold soils.

   A. True
   B. False

43. Kernels with surface cracks caused by mechanical harvesting are especially susceptible to seed rots caused by soil-borne pathogens.

   A. True
   B. False
38. **Correct Answer: D, Recommendations for Specific Crops, Soybeans**  
**Explanation:** All of these factors affect the severity of Phytophthora root rot in soybeans. The backbone of integrated control is to use varieties with a high level of Phytophthora tolerance. **Tolerance** is the relative ability of susceptible varieties to survive and yield well when infected with Phytophthora. In contrast, resistant varieties do not become diseased by races to which they are resistant.

39. **Correct Answer: B, Recommendations for Specific Crops, Soybeans**  
**Explanation:** By itself, high tolerance to Phytophthora is not good enough to completely control root rot. Varieties with high tolerance appear to be very susceptible to early season damping-off. Research indicates that the use of highly tolerant varieties in combination with Apron seed treatment controls Phytophthora as well as multi-race resistance without the possibility of damage from development of new races.

40. **Correct Answer: A, Recommendations for Specific Crops, Soybeans**  
**Explanation:** This is a true statement. Fungicide seed treatment can be used if inoculation is necessary. Most fungicides have little or no adverse effect on Rhizobium bacteria if exposure before planting time is short. Plan to plant fungicide-treated soybeans seed within two hours of being inoculated with Rhizobium.

41. **Correct Answer: A, Recommendations for Specific Crops, Alfalfa and Other Small-Seeded Forage Legumes**  
**Explanation:** This is a true statement. In areas where Phytophthora root rot has caused a serious problem in reducing alfalfa stands or preventing establishment alfalfa, a variety with resistance to Phytophthora that has been treated with Apron seed treatment is highly recommended.

42. **Correct Answer: A, Seed & Soil Borne Diseases of Field Crops**  
**Explanation:** This is a true statement. Seed rots and seedling blights are commonly caused by Phythium and Fusarium species, and may be caused by Penicillium and Helminthosporium species. All of these fungi can rot seed before germination. Infected seedlings typically show a marked softening of stem tissue at the soil line.

43. **Correct Answer: A, Seed & Soil Borne Diseases of Field Crops**  
**Explanation:** This is a true statement. Broad spectrum, protectant-type fungicides are highly recommended for both corn and sorghum, especially when early planting in cold, wet soils is attempted.
Disclaimer

The information and suggestions in this publication are intended to provide guidelines for weed management in Ohio in the current calendar year only. Because of changing laws and regulations, The Ohio State University assumes no liability for the recommendations. The recommendations for using pesticides included in this guide are incomplete and should not serve as a substitute for pesticide labels. Complete instructions for the use of a specific pesticide are on the pesticide label. The pesticide user is responsible for applying pesticides according to label directions, as well as for problems that may arise through misapplication or misuse of the pesticide. Label changes, product cancellations, and changes in recommendations may have occurred since the publication of this guide. Check with your county Extension agent in agriculture if you are in doubt about a pesticide you plan to use. Trade names have been used in this guide for clarity, but do not constitute an endorsement by The Ohio State University, nor do they imply discrimination against other products.