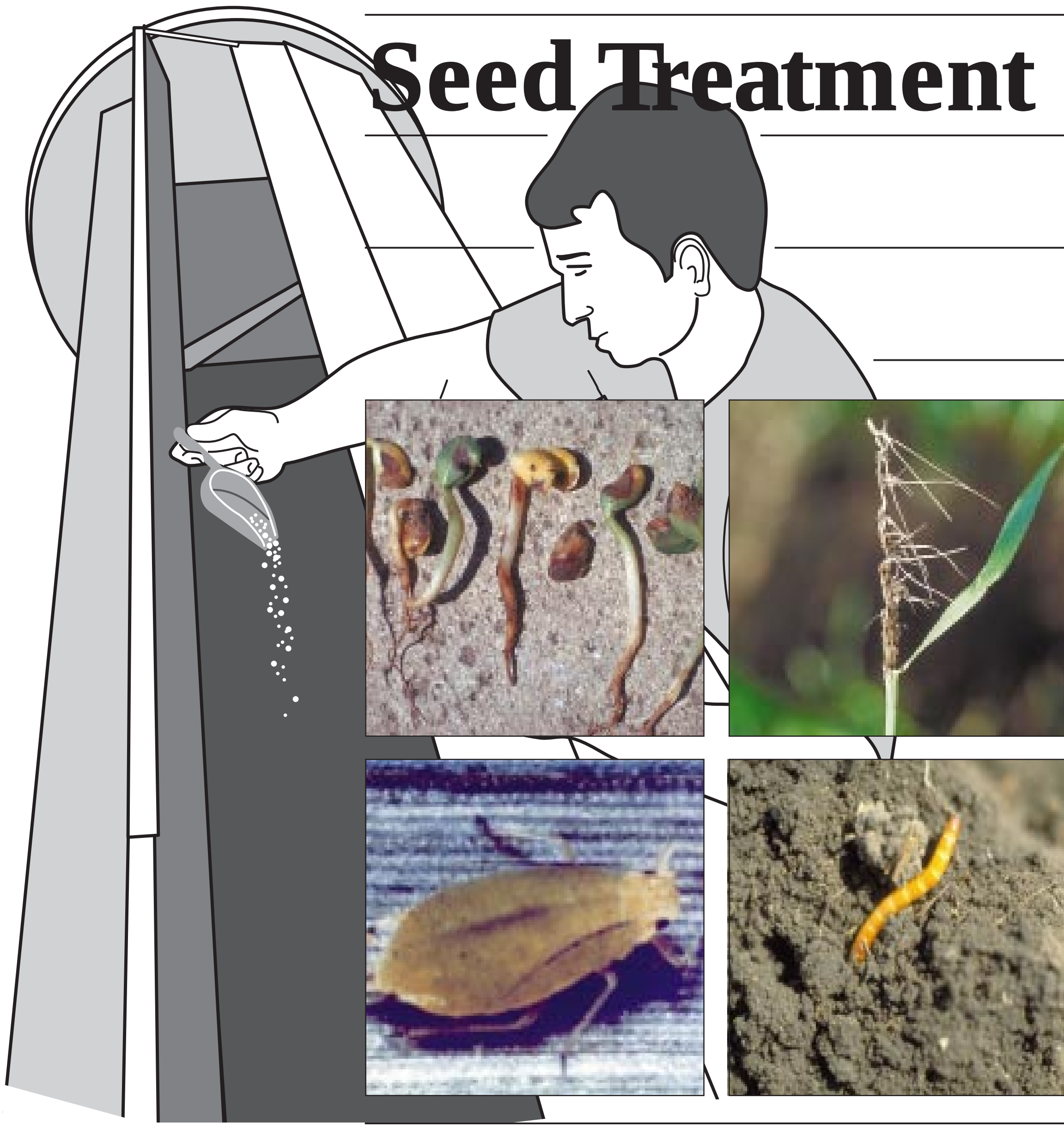
PESTICIDE APPLICATION TRAINING

Category 4

Seed Treatment



**Kansas State University Agricultural Experiment Station
and Cooperative Extension Service**

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Directions for using this manual

This is a self-teaching manual. At the end of each major section is a list of study questions to check your understanding of the subject matter. By each question in parenthesis is the page number on which the answer to that question can be found. This will help you in checking your answers.

These study questions are representative of the type that are on the certification examination. By reading this manual and answering the study questions, you should be able to gain sufficient knowledge to pass the Kansas Commercial Pesticide Applicators Certification examination.

Preface

This manual is intended as a self-training guide for commercial seed treatment applicators. It is designed to complement the General Manual (publication S-12). The General Manual contains important additional information on types of pests, pesticide use, labels, regulations, safety, etc.

The purpose of this manual is to provide general information on how to select, apply, handle, and dispose of seed treatments in a safe and effective manner. It is hoped that this information will benefit commercial applicators, agricultural producers, and ultimately, consumers. Specific recommendations are not included because available products change frequently. Consult your local K-State Research and Extension office for current seed treatment recommendations.

Introduction

History of seed treatments

Since ancient times, farmers have fought disease and insect pests. Beginning more than 300 years ago, seed treatments were added to the arsenal of pest control weapons. The first seed treatments were simple inorganic chemicals like brine or lime solutions. Through a combination of accident and trial and error, they were found to reduce the incidence of wheat stinking smut (common bunt). In the early 1800s copper sulfate solution was found superior to lime in controlling bunt. In the 1920s, copper carbonate dust began to replace copper sulfate dips because it was more convenient and safer for the seed. In the 1930s, organic mercurial seed treatments achieved great success against a number of seedborne diseases. These mercury-based treatments were abandoned in 1970 due to the risk of accidental mercury poisoning. After World War II, a variety of useful nonsystemic, organic chemical fungicides and insecticides were developed. Beginning in the 1960s and 1970s, several families of systemic organic chemical seed treatments were produced. In the 1980s and 1990s, researchers developed the first biological seed treatments based on biocontrol with living microorganisms.

What is a seed treatment?

For the purposes of this manual, seed treatments are defined as chemical or biological substances that are applied to seeds or vegetative propagation materials to control disease organisms, insects, or other pests. Seed treatment pesticides include bactericides, fungicides, insecticides, and herbicide antidotes (safeners). Most seed treatments are applied to true seeds, which have a seed coat surrounding an embryo. However, some seed treatments can be applied to vegetative propagation materials such as rhizomes, bulbs, corms or tubers.

What is not a seed treatment?

Treatments designed to protect stored food or feed grain are considered grain treatments rather than seed treatments. Therefore, stored grain treatments such as Reldan or Actellic are not included in this manual. Seed-applied growth regulators, micronutrients, and nitrogen-fixing *Rhizobium* inoculants are not included because they are not intended for pest control.

Benefits

Seed treatments are used on a large variety of crops to control a large variety of pests. Seed treatments are commonly used to ensure uniform stand establishment by protecting against soilborne diseases and insects. Seed treatments are considered so essential for corn stand establishment that virtually all corn seed is treated. Seed treatments have had phenomenal success in eradicating seedborne pathogens like smut or bunt from sorghum, wheat, barley and oats. Seed treatments can be used to suppress root rots in certain crops. Finally, new systemic seed treatments may provide an alternative to traditional broadcast sprays of foliar fungicides or insecticides for certain early season airborne diseases and insects.

Risks

Although seed treatments have important benefits, they also pose certain risks. One risk is accidental exposure of workers who produce or apply seed treatments. Another risk is contamination of the food supply by accidental mixing of treated seed with food or feed grain. A third risk is accidental contamination of the environment through improper handling of treated seeds or seed treatment chemicals. All of these risks can be minimized by proper training and proper use of seed treatment pesticides.

Introduction

Learning Objectives

- Understand the basic principles of pest management with seed treatments.
- Become familiar with common seed treatment ingredients.
- Know which crops typically receive seed treatments.
- Understand the basic principles of seed treatment application technology.
- Know the safety hazards and safety regulations for producing and handling treated seed.

Integrated Pest Management With Seed Treatments

Wheat common bunt

Wheat loose smut (healthy on right)

Soybean seed decay and seedling blight

Seed treatments should be considered as tools in an Integrated Pest Management (IPM) plan. IPM is the use of a combination of cultural practices, host resistance, biological control, and chemical control methods to simultaneously: (1) minimize economic losses due to pests, (2) avoid development of new pest biotypes that overcome pesticides or host resistance, (3) minimize negative effects on the environment, and (4) avoid pesticide residues in the food supply. An IPM plan should identify important pests, determine pest management options, and blend together various management options to achieve the goals listed above.

In order to use seed treatments effectively, it is important to understand the purposes of seed treatment, alternatives or supplements to seed treatments, and the various advantages and disadvantages of seed treatments.

Purposes of Seed Treatment

1. Eradication of Seedborne Pathogens

Seedborne disease-causing pathogens may occur on the surface of seed, hidden in cracks or crevices of seed, or as infections deep inside the intact seed. These seedborne pathogens may be very important for three reasons. First, some pathogens do not survive in soil or crop residue and are dependent on the seedborne phase for survival between crops. An example is the fungus that causes wheat loose smut. Second, even if a pathogen can survive in soil or residue, being seedborne may allow it to get a head start and, thus, result in more severe disease. An example would be the fungus that causes stagonospora leaf blotch on wheat. Third, seedborne pathogens may hitch a ride to new localities in seed shipments. An example is the fungus that causes Karnal bunt on wheat. Seed treatments can often be used to eradicate pathogens that occur on or in the seed. The choice of seed treatment may be dictated by whether the pathogen is borne externally or internally. For example, both systemic and nonsystemic (contact) fungicides can eliminate surface contamination of wheat seed by spores of the common bunt fungus. However, the fungus causing wheat loose smut is borne within the seed embryo and cannot be eradicated with contact fungicides. In that case, systemic fungicides are required to destroy internal infections. Curing of internal smut infections could be considered either eradication or disease therapy.

2. Protection of Seeds and Seedlings

Seeds and seedlings are vulnerable to many soilborne and airborne pests. Both insects and disease pathogens can decimate germinating seeds and young plants, which are relatively tender and lack food reserves to recover from injuries. For chronic diseases like leaf spots and root rots, the earlier infection takes place, the greater will be the damage.

Seed treatments can protect the seed and seedling from attack by certain insects and diseases. Nonsystemic fungicides or insecticides form a chemical barrier over the surface of the germinating seed. This barrier protects the developing seedlings from chewing insects like wireworms or soilborne diseases like damping-off. Systemic seed treatments can protect aboveground parts from sucking insects like aphids or airborne diseases like rust. Systemic fungicides and biological seed treatments can also protect young plants from infection by root rot. Although the duration of protection may be limited, this infection delay can reduce the losses.

Alternatives or Supplements to Seed Treatment

Usually, seed treatments are not the only available method to control a particular pest. Seed treatments should be compared to alternative pest control measures for cost, efficacy, safety, etc. Often, no single pest control method provides sufficient control. Seed treatments can often be supplemented with other control measures to achieve satisfactory results.

Biological control. Biological control is the use of natural predators or antagonists to suppress pests. For example, greenbug populations on sorghum often are devastated by natural predators.

Broadcast sprays. Although broadcast sprays of insecticides and fungicides have some disadvantages compared to seed treatments, they can provide control later in the season when seed treatments have dissipated.

Certified seed. Certified seed is checked for the presence of certain seedborne diseases. Therefore, treatments for seedborne pathogens may be unnecessary with certified seed. For example, Kansas certified wheat is checked for loose smut, common bunt and Karnal bunt.

Crop rotation. Crop rotation reduces the populations of many insects and disease pathogens that survive in soil or crop residue. Seed treatments may be less necessary where crop rotation is practiced.

Fertility management. Lack of micronutrients such as chloride and excess of major nutrients like nitrogen can favor certain diseases. Maintaining balanced fertility can reduce disease pressure.

Heat treatment. Hot water treatment can be used to rid seeds of certain seedborne pathogens while leaving the seed viable. For example, the fungi that cause black leg, downy mildew and anthracnose of cabbage can be eradicated by soaking seed at 122°F for 25 minutes. This treatment will also eliminate the bacteria that cause black rot. Immediately after treatment, seed must be cooled in cold water for several minutes. Then seed must be dried. Procedures must be carefully followed. If water is too cool, the seedborne pathogens will not be killed. If the water is too warm, the seed may be injured or killed. Because it is tricky, hot water treatment has limited use.

Planting date. Planting date affects the severity of some root rots, certain insects and some insect-borne viruses. The classic example is Hessian fly on wheat, which is more likely to occur with early planting. Take-all root rot of wheat and barley yellow dwarf are diseases that can be affected by planting date.

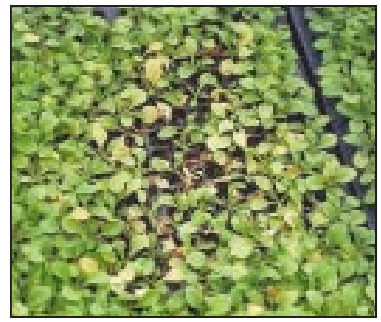
Variety resistance. Variety resistance may be available for certain pests. Examples include Hessian fly on wheat, Phytophthora on alfalfa and powdery mildew on wheat. Seed treatments may be unnecessary when high varietal resistance is available. However, seed treatments may be an important supplement when resistance is weak.

Volunteer control. Several insects and diseases use volunteer (self-sown) crop plants as a reservoir. Eliminating volunteer can reduce populations of Hessian fly, aphids, rust, etc.

Advantages and disadvantages of seed treatments

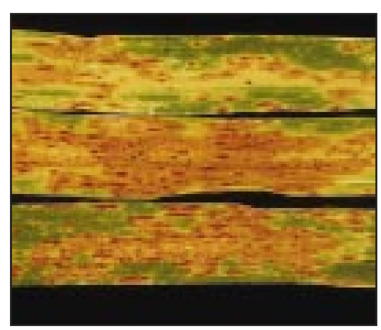
Advantages of Seed Treatments

- **Seedborne pathogens are vulnerable**. The seedborne phase is the weak link in the life cycle for many disease pathogens. Using seed treatments to eradicate seedborne pathogens is often very effective for disease control.
- **Precision targeting**. Seed treatments are not subject to spray drift. Because chemicals are applied directly to seeds, little is wasted on nontarget sites such as bare soil.
- **Optimum timing**. Seeds and seedlings are generally more vulnerable to diseases and insects than adult plants. Applying treatments to seeds allows pesticides to be present when needed most.
- **Low dose**. Relatively small amounts of pesticides are used in seed treatments compared to broadcast sprays. This reduces



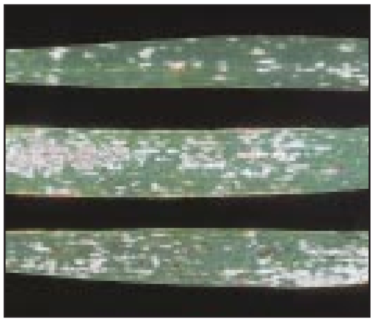
Petunia damping off

Phytophthora root rot of alfalfa

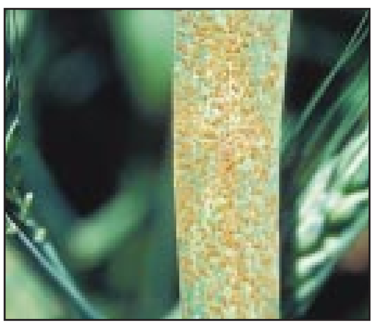


Stagonospora leaf blotch on wheat

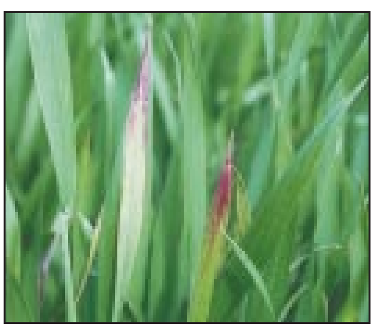
Integrated Pest Management With Seed Treatments



Wheat powdery mildew



Wheat leaf rust



Barley yellow dwarf on wheat

the cost and the potential environmental impact. It also reduces the probability of chemical residues in harvested grain.

- **Easy to apply**. Seed treatments are relatively easy and cheap to apply compared to broadcast sprays.

Disadvantages of Seed Treatments

- **Accidental poisoning**. Treated seed looks like food to some animals. Hungry livestock that find carelessly handled treated seed will probably eat it. Birds, like pheasants or quail, may consume spilled treated seed. Even young children may find and eat improperly stored treated seed.
- **Cropping restrictions**. Just like other pesticides, some seed treatments may have significant grazing or rotation crop restrictions.
- **Limited dose capacity**. The amount of pesticide that can be applied is limited by how much will actually stick to the seed.
- **Limited duration of protection**. The duration of protection is often short due to the relatively small amount of chemical applied to the seed, dilution of the chemical as the plant grows, and breakdown of the chemical.
- **Limited shelf life of treated seed**. Producing excess treated seed is undesirable because the shelf life of treated seed may be limited. Surplus treated seed cannot be sold for grain.
- **Phytotoxicity**. Pesticide injury to plant tissues is called phytotoxicity. Since seed treatments exist in high concentrations on the tender tissues of germinating seeds and seedlings, they generally have very low phytotoxicity. A few seed treatments are partly phytotoxic when applied at high rates. Lower germination and / or stunting may occur if application rates are not carefully controlled. Cracked, sprouted, and scuffed seeds may be particularly susceptible to toxic effects. A few seed treatments may reduce the length of the sprout and, therefore, affect the choice of planting depth.
- **Worker exposure**. In the course of treating and handling large volumes of seed, workers may be exposed to seed treatment chemicals as aerosols. Some, such as thiram, are irritating when inhaled.

Factors That Favor Use of Seed Treatments

- Field is for seed production.
- Low test weight or older seed.
- Planting in unfavorable germination conditions such as dry soil or cold soil.
- Planting into fields with history of stand establishment problems.
- Planting to precise populations.
- Replanting will not be feasible if first planting fails.
- Seed is expensive.
- Seed thought to carry seedborne pathogens.
- Yield potential of field is high.

Types of Pests Controlled

Seed treatment labels may list specific diseases controlled (e.g. damping-off), specific pathogens (e.g. *Pythium*), or general pest groups (e.g. soilborne fungi). Understanding the different types of pests will help in selecting the best seed treatments.

Bacteria

Bacteria are tiny single-celled microorganisms that lack a nucleus. Many different bacterial pathogens can be seedborne. Some of these can be controlled or suppressed with seed treatments. One example is:

- halo blight of beans (caused by *Pseudomonas*)

Fungi

Fungi are multi-celled, filamentous microorganisms that possess a nucleus. Seed treatments can be used to control or suppress many seedborne, soilborne and airborne fungi. Some examples of fungal diseases and the fungi that cause them are:

Seedborne

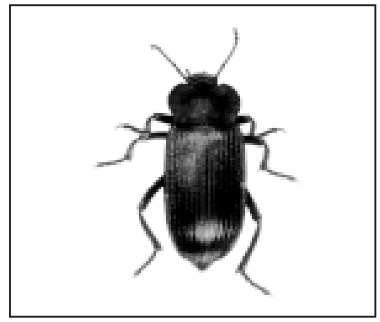
- bunt (caused by the fungus *Tilletia*)
  The bunts (also called stinking smuts) of cereals replace the developing kernels with fragile “bunt balls” containing masses of fishy smelling, dark powdery fungal spores. Bunt balls shatter during harvest and contaminate grain with fungal spores.
- loose smut (*Ustilago*)
  Loose smut of cereals replaces the chaff and grain with masses of black powdery spores. Spores soon blow away, leaving the bare rachis. Wind-blown spores infect young kernels during flowering. Infected kernels are symptomless, but produce smutted plants the next year.

Soilborne

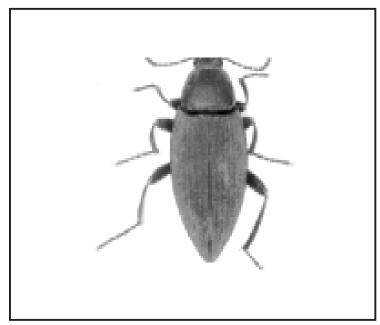
- seed decay (*Aspergillus, Fusarium, Penicillium* or *Pythium*)
  Seed may decay after planting when seed is of poor quality or when germination conditions are poor. In dry soils, *Aspergillus, Fusarium*, and *Penicillium* may be the culprits. *Pythium* attacks when soils are too wet.
- damping-off or seedling blight (*Fusarium, Pythium* or *Rhizoctonia*)
  With seedling blight, seedlings are stunted and frequently die due to invasion of roots and / or stems by pathogenic fungi. When diseases cause seedlings to suddenly collapse and melt away during wet conditions, it is called damping-off.
- root rot (*Fusarium, Phytophthora*, or *Rhizoctonia*)
  The symptoms of root rot are tan, brown, or black lesions on roots. The root system is usually stunted and unable to supply the plant with adequate water and nutrients.

Airborne

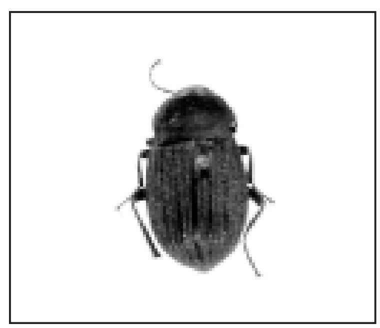
- downy mildew (*Peronospora*)
  Downy mildews often cause localized yellow leaf lesions with grayish downy fungal growth on the undersurface of the leaf. Some downy mildews can become systemic and cause deformities that look like herbicide injury.
- leaf spots (*Septoria* or *Stagonospora*)
  Numerous fungi can cause leaf spots. A few of these, such as Septoria and Stagonospora on wheat, can be suppressed with certain systemic seed treatments.
- powdery mildew (*Erysiphe* or *Blumeria*)
  Powdery mildew causes cottony white fungal growth on leaves, stems, and reproductive parts.
- rust (*Puccinia*)
  Rust pustules are typically orange and consist of thousands of spores erupting through the plant epidermis. Rust diseases can increase rapidly during favorable weather.



Elodes Suturalis



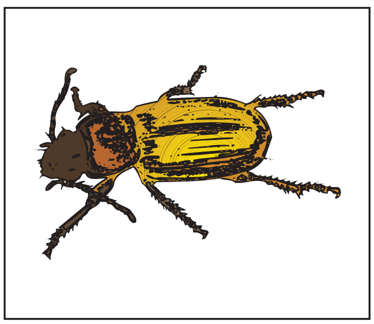
Elodes Opaca



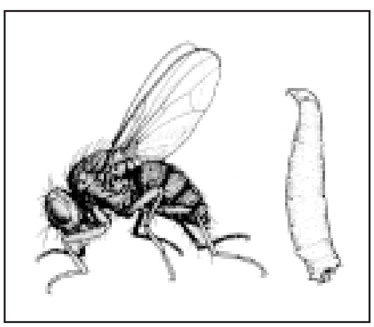
Elodes Tricostata

Types of Pests Controlled

False wireworm larvae



Seed corn beetle



Seed corn maggot

Viruses

Viruses consist of a small segment of genetic material (RNA or DNA) that is typically protected by a protein coat. There are currently no pesticides that directly control plant viruses. However, systemic insecticides can control certain insect vectors that carry viruses from host to host. Some virus diseases that can be controlled or suppressed by systemic insecticide seed treatments are:

- Barley yellow dwarf of wheat, barley and oats (carried by aphids)
- Curly top of sugar beet (carried by leafhoppers)

Weeds

A weed is any plant considered undesirable or out of place. There are currently no registered seed treatment pesticides that directly control weeds. However, seed treatment herbicide antidotes (safeners) allow the use of broadcast herbicides that would normally cause injury to a crop.

Insects

Insects are six-legged arthropods that possess a head, thorax and abdomen. Seed treatments can be used to control or suppress various insects that attack seeds or seedlings below ground or foliage above ground. Here are some examples:

Traditional seed-attacking insects subject to control with traditional contact (non-systemic) insecticides.

Small Grains

This group of insects are soil-inhabiting insects that readily attack planted seeds usually prior to germination. The target pests in question are determined in part by the crop grown, planting dates, weather patterns and a host of additional factors with varying degrees of importance.

- **False wireworms**. These native insects are the larvae of darkling beetles. They are not as common east of the Flint Hills as they are in western areas. They were typical inhabitants of the native prairies and further west in sage brush areas. Gradual destruction of the prairies deprived these insects of their native food sources and forced them to feed more on cultivated crops. The adults are dark colored, long legged, and heavy-bodied beetles that do not have functional wings. They are of greatest concern to wheat and other fall-planted small grains. Adults are noticeable during the summer, crawling and running over the ground. When disturbed, they have a habit of stopping, sticking their heads in the ground and positioning their tails up in the air. Females deposit their eggs in the soil. Weedy areas, fence rows and field margins are sometimes preferred as oviposition sites. In early days prior to combine harvesting, females often chose to lay their eggs around and under wheat shocks in the field. Later, the signs of larval damage would correspond to where the wheat shocks were located.

Several species occur in Kansas. Three of the most common species are (1) *Elodes suturalis,* (2) *Elodes opaca*, and (3) *Elodes tricostata*.

1. *Elodes suturalis* (no common name) is a large dark-colored beetle with a very faint reddish stripe down the center of the back. It is about 1 inch in length. Its wing covers are turned up at the sides. Damage is caused during its larval stage and is discussed below.

2. *Elodes opaca*, also known as the plains false wireworm, is smaller than *suturalis*. It is roughly ½ inch in length. These adults are dull gray to black colored, distinctly oval shaped, and pointed at both ends of the body. The larvae are active in both fall and spring. This species is more common in the western third of the state.

3. *Elodes tricostata* can be found at times throughout western Kansas. Records suggest that it is more common in prairies, less so in crops, but it occasionally damages grain.

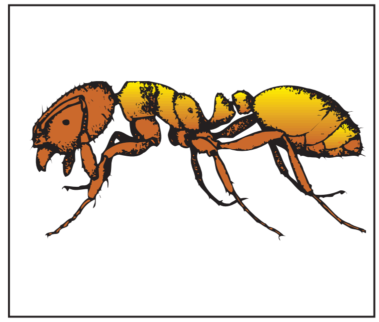
Types of Pests Controlled

False wireworm larvae (the stage causing the damage) are all similar in appearance. They are yellowish-brown, cylindrical and live in the soil and feed on plant seeds. Larvae cause their greatest injury between mid-September to mid-October. Larvae often follow the drill rows and cause stand loss by feeding on seeds prior to germination. Damage tends to be more severe during dry periods when germination is delayed. Infestations are rarely anticipated prior to the appearance of stand loss. Control must be based on prevention or on replanting damaged areas using treated seed. In areas with a history of recent problems, specific monitoring techniques may need to be employed. The procedure is to sample the soil in square foot units to a depth of about 4 inches by sifting the samples through a piece of quarter inch hardware cloth and recording the number of larvae per square foot in representative areas of the field.

Sorghum, Corn and Other Row Crops

A different group of insect pests are generally associated with row crops that are planted during the spring and summer.

- **Seed Corn Beetle.** The seed corn beetle is a small, dark brown beetle that commonly congregates around lights at night, and is often plentiful during the spring. While many insects are damaging in their larval (or wormlike) stage, it is the adults in this case that are injurious. Little is known about factors that influence seed corn beetle populations. The adult beetles are approximately ¼-inch in length, dark brown with a lighter tannish colored border that extends around the margins of the wing covers. The adults often are seen crawling on the soil surface in fields of sorghum and corn during the spring and early summer. Occasionally, large local populations develop. During such times the beetles may attack the seed sufficiently to result in significant stand loss. Damage is mostly to spring-planted crops. Sometimes injury to sorghum is greater than it is on corn. Related beetle species in this family are all predaceous and, therefore, beneficial. This is also true of seed corn beetle larvae. The probability of damage by seed corn beetle may be increased during periods of cool, wet weather following planting.
- **Seed Corn Maggot.** In its adult stage, the seed corn maggot is a small, grayish, to brownish fly that resembles a house fly, but is somewhat smaller. Adults appear early in the spring and lay eggs on moist soil, particularly those that are high in organic matter. It is attracted to vegetation. In its damaging stage, the seed corn maggot is a pale, yellowish-white, tapered, cylindrical maggot. It is legless, pointed at the front without a distinct head, but with small black mouth hooks. Mature larvae are slightly less than ¼ of an inch in length. Maggots feed and burrow into the seed and destroy the germ. Some injured seed that do germinate are stunted, weakened and soon die. Several generations develop over the course of a year although the first generation of the spring is the only one that is generally of economic importance. Seed corn maggots are occasionally a problem in corn and soybeans and less known as a concern to sorghum growers.
- **Kafir or Thief Ant.** These tiny, orange-colored ants have a history of attacking planted seed of sorghum and to some extent corn. Examining damaged seeds that are hollowed out, or have failed to sprout, show little starchy grains scattered through the soil around the kernels. Workers are only about 1⁄32 of an inch in length, and are often found in association with other ant colonies. The name, thief ant,



Thief ant

Wireworm

Types of Pests Controlled

Greenbug

Bird Oat–Cherry Aphid

is derived from its habit of stealing brood from other ant colonies. During the early 1900s in the Flint Hills region of Kansas, thousands of acres of sorghum had to be repeatedly replanted because of the ravages of this ant. Though damage still occurs from time to time, serious losses are rare.

- **Wireworms.** Wireworms are associated with small grains and are fairly common as pests of sorghum, corn and other row crops, vegetables, and sometimes on small grains. Like false wireworms, true wireworms are yellowish-brown, cylindrical larvae that live in the soil. These insects are the larvae of click beetles. Historically, wireworm damage has been associated more with crops following grass sod. Currently, there seems to be little association between wireworm infestation and field history, although soil type and cropping history may play a bigger role than is apparent. Several species of wireworms occur. Some complete their life cycle in a single year, others require two to five years to develop. Sometimes damage is primarily confined to the germinating seed. In other instances, wireworms bore into the stalks of developing plants near the soil level and damage or kill the growing point. Control, consistent with most seed and soil insects, is based on prevention. Light infestations can be controlled by seed treatment, but at times when numbers are numerous, more expensive soil applications of insecticides must be employed.

Insects Subject to Control by Systemic Seed Treatment Insecticides

While systemic pesticides have been available for some time, most of the older products require application at relatively high rates of application, more so than can be practically applied by means of seed treatment. Recently, one compound, imidacloprid (Gaucho) representing new chemistry. It is effective in small enough quantities to be useful by seed treatment application. Seed treated with this compound should control some or all of the traditional seed attacking insects—studies are still in progress. Imidacloprid, as labeled for use on wheat, claims to provide early season protection of seedlings against injury by aphids (various species), fall infestations of Hessian fly and wireworms. Length of control is influenced by the dosage used. For example, higher rates may be needed to control some species of wireworms and to reduce potential spread of barley yellow dwarf virus due to aphid vectors.

On sorghum imidacloprid is expected to provide early season protection of seedlings against injury by aphids including corn leaf aphid, greenbug, yellow sugarcane aphid, chinch bugs and wireworms. Currently, this compound is restricted by the manufacturer to application by commercial seed treaters only. This is unlike older conventional contact seed treatments which commonly could be applied commercially or by growers in planter box treatments.

Study Questions

1. (4) Seed treatments are chemical or biological substances applied to seeds to control:
   a. fungi
   b. insects
   c. bacteria
   d. all of the above
2. (4) Seed treatments are considered so essential to ________ stand establishment that virtually all of this seed is treated.
   a. wheat
   b. corn
   c. soybean
   d. all of the above
3. (6) The following are caused by seedborne pathogens:
   a. oat loose smut
   b. halo blight of beans
   c. wheat common bunt
   d. all of the above
4. (6) Seed treatment barriers protect developing seedlings from chewing insects such as:
   a. aphids
   b. leafhoppers
   c. wireworms
   d. spider mites
5. (9) A single-celled microorganism that lacks a nucleus is a:
   a. fungus
   b. bacterium
   c. virus
   d. insect
6. (9) An example of an airborne fungal disease is:
   a. bunt
   b. seedling blight
   c. powdery mildew
   d. Phytophthora root rot
7. (10) False wireworm larvae originally fed on:
   a. corn seeds
   b. sorghum seeds
   c. wheat seeds
   d. native prairies
8. (10) False wireworm females deposit their eggs in:
   a. weedy areas
   b. fence rows
   c. field margins
   d. all of the above
9. (11) False wireworm larvae cause their greatest injury between:
   a. mid-September to mid-October
   b. mid-December to mid-January
   c. mid-March to mid-May
   d. mid-July to mid-August
10. (11) Adult seed corn maggot females lay their eggs on:
    a. corn seeds
    b. moist soil
    c. seedling stems near the soil
    d. seedling leaves
11. (12) Wireworm damage consists of:
    a. attacking germinating seeds
    b. boring into stocks near soil line
    c. feeding on root hairs
    d. a and b above
12. (12) Seed treatments on sorghum are not labeled to control
    a. grasshoppers
    b. aphids
    c. chinch bugs
    d. wireworms
13. (7) Using certified seed may make seed treatment unnecessary to control:
    a. wireworms
    b. seed corn maggot
    c. seedborne pathogens
    d. soilborne pathogens
14. (7) An example of “planting date” as a method of pest control is:
    a. grasshoppers on corn
    b. Hessian fly on wheat
    c. black leg on cabbage
    d. Powdery mildew on wheat
15. (7) An advantage of seed treatment is:
    a. precision targeting
    b. optimum timing
    c. low dose
    d. all of the above
16. (8) A disadvantage of seed treatment is:
    a. accidental poisoning
    b. limited duration of protection
    c. limited shelf life
    d. all of the above

Seed Treatment Products

There are a large number of seed treatment products available. They may have different active ingredients, dose rates, additives, or formulations. The applicator must choose a product that suits both the pest problem and the application equipment.

Active Ingredients

Active ingredients can be divided into those that are systemic and those that are nonsystemic (contact). Systemic seed treatments penetrate the roots and germinating seed, then move up into stems and leaves. Nonsystemic treatments protect only the outside of the seed or seedling.

Different seed treatment ingredients are active against different types of organisms. Bactericides kill or inhibit the growth of bacteria. Fungicides kill or inhibit the growth of fungi. Insecticides kill or inhibit insects. Herbicide safeners allow the use of herbicides that would normally be injurious to the crop.

The degree of pest control depends on the dose rate of the active ingredient. Some pests may require higher rates than others to achieve control. Some seed treatment labels give a range of rates and indicate pest control responses that are expected for each rate.

Many seed treatment products contain a combination of active ingredients. This allows one product to control a broader spectrum of insects or diseases. If a particular pest is susceptible to more than one ingredient in the combination, control may be enhanced.

Following are common names and trade names of some seed treatment active ingredients.

Bactericides

- **Streptomycin** is an antibiotic that kills a broad spectrum of bacteria. It can be used to control seedborne populations of the halo blight pathogen on dry beans.

Fungicides

- **Benomyl** (trade name Benlate) is a broad-spectrum systemic fungicide in the benzimidazole group. Benomyl is used to control seedborne blackleg of cabbage and other crucifer crops. It is also effective against wheat common bunt. Some fungal pathogens have become resistant after repeated applications of benzimidazole fungicides.
- **Biological agents** consist of dormant microorganisms that are applied to seeds. Under favorable conditions, these microorganisms grow and colonize the exterior of the developing seed or seedling. Biocontrol agents may reduce seed decay, seedling diseases, or root rot either by competing with disease-causing microorganisms or by the production of antibiotics. Biocontrol organisms include the bacteria *Bacillus subtilis* and *Streptomyces griseoviridis*, and the fungus *Trichoderma harzianum*.
- **Captan** is a broad-spectrum nonsystemic fungicide. It is a standard seed treatment that is labeled for almost all field crops and many vegetables. It is probably the most commonly used seed treatment pesticide. It is used for control of seed rot, damping-off, and seedling blights. It is used against some seedborne smuts, but it is weak against common bunt.
- **Carboxin** (trade name Vitavax) is a systemic fungicide with good activity against bunts, smuts, and *Rhizoctonia*. It is commonly used to eradicate wheat embryo infections by the loose smut fungus. Carboxin is also used for *Rhizoctonia* seedling blight on soybeans, corn and cotton.
- **Difenoconazole** (trade name Dividend) is a broad-spectrum systemic fungicide in the ergosterol biosynthesis inhibitor (EBI) group. At low dose rates, it controls bunts and smuts of wheat. At high rates, it has activity against some fall-season root rots

and foliar diseases. Fall control of root rots and leaf diseases may or may not carry through to the following spring. Difenoconazole may be combined with metalaxyl to achieve control of *Pythium* damping-off.

- **Fludioxonil** (trade name Maxim) is a broad-spectrum nonsystemic fungicide. It is used against various seed decay and seedling blight fungi such as *Aspergillus, Fusarium, Penicillium* and *Rhizoctonia*. Fludioxonil may be combined with metalaxyl to achieve control of *Pythium* damping-off.
- **Imazalil** is a systemic fungicide. It is used against common or dryland root rot of wheat and barley caused by *Fusarium* and *Cochliobolus* (also called *Helminthosporium*).
- **Mancozeb and maneb** are broad-spectrum nonsystemic fungicides. They are used for control of seed decay and wheat common bunt.
- **Metalaxyl** (trade name Apron or Allegiance) is a narrow-spectrum systemic fungicide. It is effective only against *Pythium, Phytophthora,* and downy mildews.
- **PCNB** (trade name Terraclor) is a nonsystemic fungicide. It is especially useful against *Rhizoctonia* seedling blight and wheat common bunt.
- **Tebuconazole** (trade name RAXIL) is a broad-spectrum systemic fungicide in the EBI group. It controls bunts and smuts of wheat. It has activity against some fall-season root rots and some foliar diseases. Fall control of root rots and leaf diseases may or may not carry through to the following spring. Tebuconazole may be combined with thiram to improve control of seed rot and seedling blight.
- **Thiabendazole** is a broad-spectrum systemic fungicide in the benzimidazole group. At low doses, it is often used to control *Fusarium*. At higher doses, it controls wheat common bunt. Some fungal pathogens have become resistant after repeated applications of benzimidazole fungicides.
- **Thiram** is a broad-spectrum nonsystemic. Thiram is a standard seed treatment that is labeled for almost all field crops, many vegetables, and for ornamental bulbs and tubers. It is used to control seed decay, seedling blights, as well as wheat common bunt. Thiram can be irritating to the lungs.
- **Triadimenol** (trade name Baytan) is a broad-spectrum systemic fungicide in the EBI group. At low dose rates, it controls bunts and smuts of wheat. At high rates, it has activity against some fall-season root rots and foliar diseases. Fall control of root rots and leaf diseases may or may not carry through to the following spring. Triadimenol may be combined with a contact fungicide to improve control of seed decay and seedling blight.

Insecticides

- **Diazinon** is a nonsystemic insecticide used against seedcorn maggots and seedcorn beetles.
- **Imidacloprid** (trade name GAUCHO) is a systemic insecticide. It is effective against various aphids, chinchbug, fleabeetle, Hessian fly, leafhopper, thrips and whitefly. It reduces incidence of some virus diseases by controlling the insect vectors.
- **Lindane** is a nonsystemic insecticide used against soilborne insects such as seedcorn maggots, wireworms and false wireworms.

Herbicide safeners

- **Fluxofenim** (trade name Concep III) is a safener for sorghum seed that provides protection against the herbicides alachlor (Lasso or Partner), dimethenamid (Frontier), and metolachlor (Dual).

Seed Treatment Products

Additives

Seed treatment products usually contain a variety of additives in addition to the active ingredients. If important additives are lacking in a product, they often can be often added to the pretreatment mixing tank. Before using additives, consult the manufacturer's instructions.

- Colorants or dyes are added to mark treated seed and prevent mixing with food grain. Colorants improve the appearance and also help ensure uniformity of treatment coverage. Color-enhancing agents may be added to further improve the appearance.
- 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, approved by EPA, and are usually neutral in pH, nontoxic to humans and cause no apparent damage to the germination of the seed. They are added to increase the adherence of the pesticide to the seed, prevent dusting off, and / or cut down the dustiness in the processing plant.
- Anti-foam agents suppress formation of troublesome foam.
- Lubricants like graphite reduce the friction of seed flow through the planter.
- The micronutrient molybdenum may be added to soybean seed treatments.

Seeds Commonly Treated

Corn

Untreated corn seed is frequently subject to seed decay and seedling blight. Therefore, virtually all commercial corn seed is treated with a broad-spectrum fungicide seed treatment prior to sale. Captan and thiram have probably been the most commonly used fungicides. Some newer fungicides may replace them in the future. The addition of a supplemental fungicide or insecticide is helpful in some cases. For example, lindane may be added for control of seedcorn maggots. Corn smut cannot be controlled with seed treatments because it survives on the soil, then spores blow to upper plant parts. This bypasses seed treatments.

Sorghum

Like corn, untreated sorghum seed frequently suffers from seed decay and seedling blight. In addition, sorghum was formerly plagued by covered kernel smut and loose kernel smut. These two smuts are easily controlled with seed treatments. Today, virtually all sorghum seed is treated with a broad-spectrum fungicide prior to sale. Captan and thiram have probably been the most commonly used fungicides. Some newer fungicides may replace them in the future. Occasionally, over-treatment with specialty fungicide or insecticide seed treatments is useful. For example, the standard treatment can be supplemented by adding metalaxyl for *Pythium* control. Imidacloprid (Gaucho) can be added to control chinchbugs. Lindane is frequently added either commercially or by drill box treatment as an aid to wireworm control. Sorghum needs a seed treatment herbicide safener if the herbicides alachlor, dimethenamid, or metolachlor are used for weed control on the field.

Wheat

In the 1920s, Kansas suffered up to 10 percent statewide annual losses from wheat common bunt. Today, about a third of Kansas wheat is treated. The combination of seed treatments and seed certification programs has almost eliminated common bunt from commercial fields. Loose smut has also been greatly reduced by seed treatments. Grain producers who regularly buy certified seed probably don’t need to treat for these diseases. On the other hand, grain producers who plant bin-run seed year after year may run into a problem with bunt or loose smut. Seed producers should strongly consider a systemic seed treatment to help keep seedborne pathogens such as bunt and loose smut out of seed stocks.

Seed decay and seedling blights of wheat are not common in Kansas. They are sometimes seen when germination conditions are poor (very early or late planting; very dry or wet) or when seed quality is poor (old or scabby seed).

False wireworms can also reduce stands, especially when wheat is planted in dry soil. However, they are not common enough to routinely recommend seed treatment insecticides.

Systemic fungicide treatments give some suppression of take-all root rot, common root rot, and dryland root. Take-all is common on continuous wheat ground in Kansas. Common root rot is seen most often when wheat is planted early. Dryland root rot is seen during droughts. These systemic treatments are most likely to be economical when yield potential is high.

Systemic fungicide treatments also give fall season control of foliar diseases like leaf rust, powdery mildew, and Stagonospora nodorum leaf blotch. This effect may or may not carry through to spring.

Systemic insecticide treatments can give fall season control of bird cherry-oat aphids, English grain aphids, greenbugs, Russian wheat aphids, wireworms and Hessian fly. By controlling the aphid vectors, these treatments can control barley yellow dwarf virus. Pest pressure varies widely, and control is usually not complete.

Seeds Commonly Treated

Soybean

Most soybean seed in Kansas is not treated. Problems with seed decay, damping-off, or seedling blight may be encountered, especially when planting early or planting poor quality seed. Seed treatments are often recommended for fields with a history of stand establishment problems. Seed treatments may be good insurance for the new, expensive variety with genetically engineered traits.

Alfalfa

Alfalfa seed is increasingly being treated by seed companies with metalaxyl to reduce the risk of damping-off caused by *Pythium* and *Phytophthora*.

Vegetables

Many diseases of vegetables are carried on or in the seed, therefore, most commercially produced vegetables receive a seed treatment. In addition, the seed treatments provide protection from seed decay and damping-off.

Study Questions

1. (14) As a seed treatment, a "bactericide" kills or inhibits:
   a. bacteria
   b. fungi
   c. insects
   d. viruses
2. (14) ______ is a broad-spectrum, non-systemic fungicide and is probably the most common seed treatment
   a. Streptomycin
   b. Benomyl
   c. Captan
   d. Carboxin
3. (15) ______ is a narrow-spectrum systemic fungicide, only effective against *Pythium*, *Phytophthora*, and downy mildews.
   a. Maxim
   b. Metalaxyl
   c. Maneb
   d. Terraclor
4. (15) A systemic insecticide seed treatment is:
   a. diazinon
   b. lindane
   c. thiram
   d. Gaucho
5. (16) Additives to seed treatments may include:
   a. colorants
   b. binders
   c. anti-foam agents
   d. all the above
6. (16) Carriers, binders and stickers in seed treatment products are listed in the ______ section on the label.
   a. active ingredient
   b. inert ingredient
   c. method of application
   d. environmental hazards
7. (17) In the past, the most commonly used seed treatment fungicides on corn and sorghum were:
   a. Maxim and Terraclor
   b. Apron and Gaucho
   c. Captan and Thiram
   d. Baytan and Raxil
8. (17) Systemic insecticide seed treatments on wheat are used to control:
   a. greenbugs
   b. white grubs
   c. armyworms
   d. spider mites

Seed Treating Equipment

The selection, operation, and maintenance of seed treating equipment are important for effective pest control. Concerns such as nonuniform seed coverage, failure of a pesticide, and lowered seed germination are partially solvable through proper selection and operation of equipment.

Treating

Commercial seed treaters are designed to apply measured quantities of pesticides to a quantity of seed. Seed treatment rates are usually given as ounces of product per bushel or 100 pounds (cwt) of seed. Each seed should be uniformly coated with pesticide for effective pest control. Too much pesticide may reduce or delay seedling emergence and too little is often not effective. Improperly maintained or adjusted equipment may mechanically damage seed and or misapply the pesticide. Complete coverage is important on weaker and damaged seeds. These are more susceptible to attack by seedborne and soilborne organisms. Many problems are correctable by properly calibrating equipment.

Treaters

Seed treating equipment applies measured quantities of a pesticide to a volume or weight of seed. Seed treaters consist of three components: a mixing tank, a treater head and a coating chamber. The mixing tank, commonly referred to as the premix tank, is used to mix pesticide and water. Flowables, water dispersible granules, wettable powders, true liquids, or emulsifiable concentrate formulations may be mixed with water in a tank. A premix tank is usually equipped with agitation equipment to keep water insoluble pesticides in suspension. A pump is used to recirculate the mixture and to transport it to the treater head. Premix tanks normally are located at ground level for ease in filling and mixing. A mixing/loading pad may be required, if more than 100 pounds of pesticide active ingredients are used during a calendar year.

The treater head initially mixes known quantities of the seed being treated with pesticide. Seed measurement is controlled by a weigh pan, a flow gate, or a counter weight. A known dump weight is obtained by adjusting the counter weight on the weigh pan arm. Setting the flow gate or counter weight should result in a constant dump weight for a given seed. Each time the weigh pan trips, seed flows through the treater head and activates a mechanism to add a known volume of pesticide prior to the coating chamber.

The coating chamber is another component of a seed treater. Coating chambers blend the pesticide and seed in an auger-type mixer or a revolving drum-type mixer. Auger-type mixers use brushes, fingers, or solid flighting as the mixing element. Drum-type coating chambers use an open rotating drum or other internal mixing elements. Coating chambers are designed to handle seed gently while uniformly coating the seed with pesticide. The mixing chamber is fitted with an auger type agitator that mixes and moves seed to the bagging end of the chamber. The auger may be of several types—curved paddles, curved rods, or nylon brushes. The nylon brush auger is used for thin-coated seeds or seeds that have a tendency to mechanical injury, such as beans and corn. Further modifications to minimize seed injury can be made, such as rubber-coating the weighing pan and sides of the mixing chamber at the end where seeds are dumped. More uniform distribution is obtained at slower operating auger speeds.

Types of Formulations

Seed treatment pesticides are applied as a dust, a slurry, or a liquid. The principal objective is to effectively bring the pesticide into contact with the target organism(s).

Dusts are dry, powder formulation with no moisture added during application. It is more difficult to distribute dust pesticides uniformly

Seed Treating Equipment

Figure 1. Application of dust into a planter or drill box.

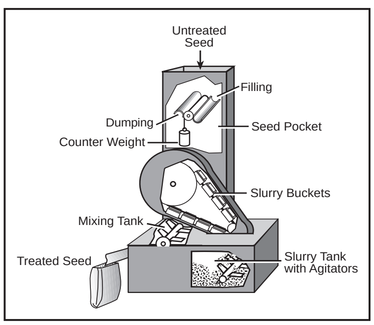


Figure 2. Slurry-type seed treater.

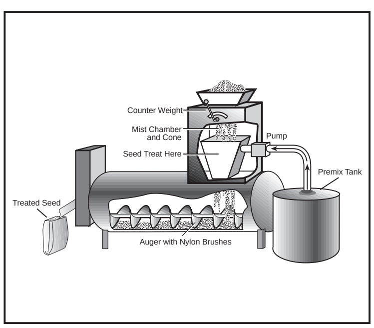


Figure 3. Metered slurry seed treater.

than liquid or slurry applications. Dry pesticides are designed for treating seeds, such as grass seed, which are fragile or absorptive. Powdered pesticide is continuously applied to seed using a calibrated vibrating or auger-type feeder. Dust treating equipment is easy to clean and operate because no water is used. Seed treating facilities need an adequate dust collection system to protect the employees because dust formulations tend to drift.

Some producers mix dry seed treatment pesticides with the seed in the planter or drill box. This reduces the possibility of using treated seed in animal feed or human food products. To ensure thorough mixing, place one-third to one-half the seed in the planter or drill box (Figure 1). (Do not exceed half the capacity.) One-third to one-half the recommended amount of dry pesticide is applied on the seeds surface. Mixing is accomplished by stirring the seed with a clean stick or paddle until the seed is covered. The remaining seeds and pesticide are added and the mixing procedures are repeated. No more than one-half of the seeds or pesticide should be added and mixed at a time. Good pest control requires uniform coverage so adequate mixing is critical. Precautions against inhalation and eye or skin contact should be taken with any methods of treating seeds (see safety section).

Wettable powders are applied to seed in a slurry-type seed treater (Figure 2 & 3). When the pesticide powder is mixed uniformly with sufficient water to make a thin pancake-like batter, it is called a slurry. This is metered using slurry cups and a seed dump pan. The treater introduces a given amount of slurry with each weight dump of seed into a coating chamber where they are blended. The water soon evaporates, leaving the seed coated with the pesticide. The small amount of moisture added to the seed, ½ to 1 percent of the weight of the seed, does not affect seed in storage since the moisture is added to the seed surface and is soon lost due to evaporation. The amount of pesticide is adjusted by the slurry concentration and the size of slurry cups. It is important that the proper concentration and cup size are used to apply the correct rate of pesticide to a given weight of seed.

Slurry cups may be attached to a revolving chain or belt that dips into the pesticide holding tank. Another method is a rocker arm assembly located in the treater head where the cups alternately fill by dipping into a small reservoir of pesticide solution. Either slurry cup arrangement dumps a cup of slurry onto seeds with each dump of the weigh pan. Slurry tanks 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. Slurry treaters are used to treat different seed types and varieties. They apply accurate application rates of wettable powders, slurries, or flowables with adequate mixing of seed coating.

Liquid or mist-type treaters apply a liquid (either undiluted or mixed with a small amount of water) to seed as a mist or spray. These treaters use the weight of seed to operate the seed and chemical measuring system. The quantity of seed is controlled by placement of a counterweight. The amount of seed treatment pesticide is determined by the chemical cup size.

Liquid treaters (Figure 4) apply undiluted liquid treatment. Instead of applying 140 ml. of material per bushel of wheat, as in slurry treaters , they apply 14 to 21 ml. (½ to ¾ ounces) per bushel of wheat. This small quantity of material is suitable only with liquid materials which are somewhat volatile and do not require complete, uniform coverage for effective action. Recent modifications of treaters include dual tanks that permit simultaneous addition of a fungicide and an insecticide, and adaptations for the application of slurries. The metering device is similar to that of the slurry treater, since it is attained through synchronization of a treatment cup and seed dump. Liquid treaters have an adjustable dump pan counter weight to adjust the weight of the seed dump. Newer treaters are equipped with a variable drive to maintain a constant level of seed in the coating chamber. They are constructed of stainless steel for easy clean-up and long life. Misting or spraying the seed with pesticide requires very small amounts of water. The seed can be planted almost immediately, without prolonged drying, or can be placed in storage until planting time.

Liquid seed treatment can pump pesticide directly from the pesticide container (Figure 5), require less space than other types of treaters, and they give good seed penetration and coverage. They are limited to application of liquid pesticide formulation and require a fume collection system. A liquid treater eliminates the possibility of self contamination often associated when handling dust pesticides.

Metered Pump Kit

Seeds may be treated using an electric metered pump kit. This unit pumps calibrated amounts of dust, flowable, or liquid pesticides into a grain auger (Figure 6). Untreated seed can be treated precisely and loaded directly into a truck or the drill box on a planter. A wide range of application equipment allows for flexibility in treating rates. A second pump may be added to the system, which doubles the pumping capacity, or two pesticides can be applied to the seed simultaneously. The metered pump kit operates using a 12 volt battery or a 110 volt power source. Mounting a unit on truck or trailer allows seed treatment in the field at planting time or while loading or unloading a seed bin. This type of treatment provides a convenient on-farm method of mixing fungicide, insecticide, or other pesticide with seed and reduces, but does not eliminate, the danger of exposure to toxic or irritating dust and fumes.

Suitable precautions against inhalation and eye and skin contact should be taken along with avoiding grain contamination. The auger should be used only for treating seeds to avoid potential contamination of grain intended for animal or human food consumption.

Calibration

Strict adherence to the dosage rate on the pesticide label is a requirement of the Federal Insecticide, Fungicide and Rodenticide Act. Calibration of the dry or dust type treater is similar to a slurry or liquid treater except that weight of powdered or dry chemical is used instead of volume of liquid or slurry. The calibration of the volumetric type treater, which uses volume of seed rather than weight of seed as a principle of calibration, is different. Calibration of the volumetric type treater involves changing pocket wheels on the seed delivery rate. The pocket wheels are different size, number, or pattern indentations. The chemical delivery rate is usually constant on the volumetric type treater.

Proper calibration of seed treating equipment requires knowing:

a. The label rate of the seed treatment pesticide.
b. How many pounds of seed are dumped when the weigh pan trips.
c. The size of the chemical cups being used or the amount of pesticide discharge each time the weigh pan trips.

There are a number of equally effective calibration methods which vary in their basic approach and degree of difficulty. Following is one procedure for calibrating a treater.

Procedure 1.

1. Determine the labeled rate of pesticide in millimeters (ml) to apply to 100 pounds of seed. If the label rate is expressed in ounces per hundredweight (cwt), convert ounces to ml by multiplying ounces per cwt by 29.6 (29.6 ml equals 1 oz). For example, if a seed treatment

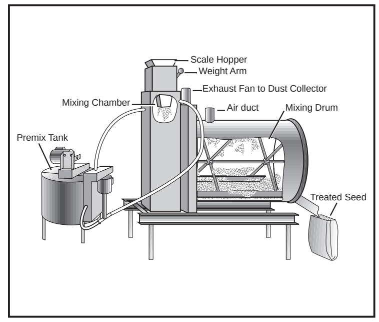


Figure 4. Liquid seed treater.

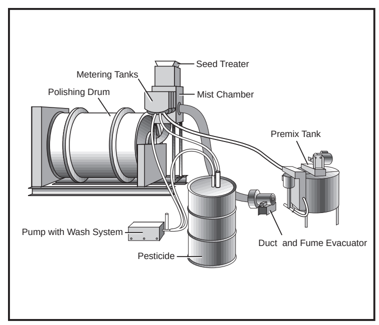


Figure 5. Liquid seed treater.

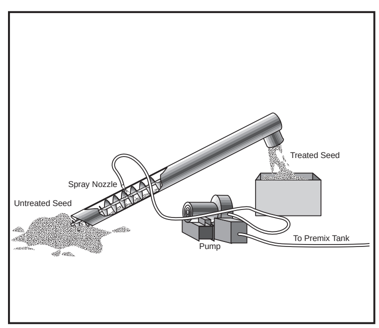


Figure 6. Treating seed with metered pump kit.

pesticide label recommends an application of 10 to 12 ounces of product per 100 lbs of seed; then the application rate in ml per 100 lbs is determined by

$$10 \text{ to } 12 \text{ ounces/cwt} \times 29.6 \text{ ml/oz} = 296 \text{ to } 355 \text{ ml/cwt}$$

2. Prior to treating with pesticide, run 100 lbs or a larger known quantity of seed through the treater and count the number of times the weigh pan arm trips. This test must be done using the same seed you intend to treat. It is desirable to have the weigh pan trip 40 to 45 times per minute. Smaller increments of seed passing through the treater head will provide a more even flow of seed and result in better distribution of pesticide.
3. Divide the number of lbs of seed run through the treater by the number of trips obtained in step 2. For example, the weigh pan arm tripped 25 times with 125 lbs of seed:

$$\frac{125 \text{ lbs seed}}{25 \text{ trips}} = 5 \text{ lbs seed per dump (trip)}$$

4. To determine the proper chemical cup size in ml, divide the label rate in ml (determined in Step 1) by the number of dumps per 100 lbs of seed (determined in Step 2).

$$\frac{100 \text{ lbs seed}}{5 \text{ lbs/dump}} = 20 \text{ dumps}$$

$$\frac{296\text{–}355.2 \text{ ml product}}{20 \text{ dumps/cwt}} = 14.8 \text{ to } 17.8 \text{ ml chemical cups size}$$

A 15 ml cup will apply 300 ml (15 × 20 dumps) of product per 100 lbs of seed when operating a treater delivering 5 lbs seed per dump. To ensure this rate of pesticide is being applied to the seed, check the output of the treater by using one of the following methods.

The first method collects the pesticide being delivered by the treater. While running seed through the treater, detach the chemical hose from the treater head and collect a minimum of 10 trips into a measuring cup. If the treater is equipped with 15 ml chemical cups, the measuring cup should have 150 ml of pesticide if there was 10 trips.

Another method compares the amount of pesticide used to treat a known quantity of seed. In the example, it was calculated that 15 ml of product will treat 5 lbs of seed. Therefore, if our treater is properly calibrated, a gallon (Note: 1 gallon equals 128 ounces or 3,789 ml) of product will treat 1,263 lbs of seed based on the following calculations.

Using 3,789 ml per gallon,

$$\frac{3{,}789 \text{ ml/gallon} \times 5 \text{ lbs of seed/dump}}{15 \text{ ml/dump}} = 1{,}263 \text{ lbs of seed gallon}$$

If this treater is dumping 40 times per minute, then it will treat 12,000 lbs of seed per hour (40 trips/min. × 5 lbs/trip × 60 min.) and should be using 9.5 gals of product (12,000 lbs divided by 1,263 lbs of seed per gal).

If the equipment is not delivering the desired rate, the output is adjusted by changing the chemical cup size, the counterweight position on the seed weigh pan, or the water dilution ratio of the pesticide in the premix tank.

When making either of the first two adjustments you'll need to repeat the calibration process. The water dilution ration of the pesticide can be changed without changing chemical cup size, seed counterweight position or having to recalibrate the treater. The treater will deliver the same weight of seed and volume of pesticide mix as already calibrated. The amount of pesticide in the newly diluted mix must be determined and, consequently, the new rate of pesticide being applied to seed.

Most wettable powder seed treatment chemicals are applied at a rate between one (1) and five (5) dry ounces per 100 pounds of seed. The actual dosage is obtained from the label. Normally, a chemical to water mixing ratio is not stated or suggested on the label. Following are two methods available to calculate the proper powder to water ratio to obtain the desired slurry dosage per 100 pounds of seed.

The correct amount of wettable powder chemical to use to make 1 gallon of liquid slurry is determined by dividing 128 (fluid ounces / gallon) by the number of fluid ounces of liquid you desire to apply per 100 pounds of seed; and then multiply the result by the number of dry ounces of the chemical labeled for 100 pounds of seed. Example:

128 fluid oz. / gallon × dry ounces of chemical desired
= Dry ounces of wettable powder / gal of slurry.
fluid ounces liquid applied per cwt

If application rate is 3.0 dry ounces of pesticide and the desired slurry rate is 15 fluid ounces applied per hundredweight, then 26.0 dry ounces of wettable powder must be added per gallon of slurry.

128 fluid ounces / gallon × 3 dry ounces desired
= 26.0 ounces / gallon slurry
15 fluid ounces / cwt

NOTE: Add the dry powder to a tank or gallon before adding the water. Adding the powder will "displace" some liquid volume. As a rule of thumb, most wettable powders "displace" about 7 fluid ounces of liquid volume per pound of powder added.

Some seedmen experiment to obtain a desirable slurry consistency. Once a powder to water mixture ratio is determined, they must know the number of dry ounces of wettable powder originally added to the water. This determines the number of hundredweights they must treat with the slurry volume they now have.

Example: A chemical is applied at the rate of two (2) dry ounces per 100 pounds of seed. The seedman has found that mixing five pounds of chemical (80 dry ounces) with one gallon of water, gives the desired slurry consistency. Assuming, 7 fluid ounces equals a pound of powder, the 5 pounds of chemical is equal to about 35 ounces or 0.27 gallons. Therefore, the total volume of the slurry mixture is equal to 1 gallon of water plus 0.27 equivalent gallon of product or about 1.27 gallons. This will treat 40 cwts (4,000 lbs) of seed since the original powder dosage is 2 dry oz. / cwt and 80 ounces of chemical are in the slurry.

The total slurry volume in ounces equals 1.27 gallons total slurry × 128 fl. oz. / gallon or 162.5 fluid ounces. The slurry application rate is equal to 162.5 fl. oz. divided by 40 cwts seed or 4 fl. oz. / cwt.

Safety

Treated grain may not be stored for grain going to commercial food or animal feed. An auger used to treat or transport treated seed cannot be adequately cleaned for use in transporting grain intended for animal or human food consumption. Once an auger is used for seed treatment, it should be used only for treating or augering seed for planting.

Installation

All seed should be cleaned and graded before being treated. The seed treater should be the last machine through which the seed pass before bagging. In most seed processing plants, the treater is permanently installed above the bagging bin. Treaters located in other parts of the plant may need separate handling equipment to ensure no cross-contamination.

Seed treaters are relatively lightweight when empty (300 to 600 pounds) and produce little vibration in operation. The weight of a treater increases by 8 pounds per gallon of liquid added to the storage tank. A small surge bin should be located above the treater to avoid premature tripping of the weighing pan. The treater should be level when in operation. When installed permanently, provision should be made for bypassing seed which need no treatment.

During the treating process, the reserve tank may need frequent refilling. The treater should be located so that additional materials can be pumped or poured into the treater without difficulty. Floor level reserve tanks equipped with electric or

Seed Treating Equipment

manual pumps are available. If the seed treatment material is mixed with water, a source of clean, filtered water must be readily available.

Locating a seed treater in the same line used to process nontreated seed requires a bypass around the treater, elimination of treatment spillage, and thoroughly cleaning the treating area before processing non-treated seed.

Color Treated Seed

Food and Drug Administration regulations require seeds treated with a pesticide formulations be colored with an approved dye to prevent their use as food or feed. This requirement provides a practical method of detecting the presence of treated seeds mixed with food or feed grains or products.

Most seed treatment pesticides manufacture with the dye added. Some seed processors add additional dye to enhance the color. Dyes approved for this purpose have little or no effect on seed germination. Coloring is not required for planter-box formulations; however, dyes are commonly used to ensure proper coverage. Dyes should be treated with the same degree of care as pesticide.

Shipment of food grain seeds treated with a pesticide formulation that is not colored, or grain that has a mixture of treated and nontreated seeds, are subject to seizure and possible destruction. In addition to financial loss to the owner of the shipment, the person responsible for the violation may be prosecuted.

Summary

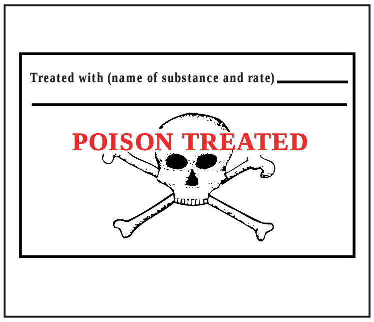
Many seed treaters are available that can apply a small amount of chemical and spread it uniformly over the surface of each seed. These vary in size and capacity from large commercial treaters to small ones suitable for farm use.

Seed Treating Equipment

Study Questions

1. (19) Seed treaters consist of three components: mixing tank, treater head, and _____
   a. run-off bin
   b. coating chamber
   c. anti-siphon valve
   d. dust trap
2. (19) There are two types of coating chambers, the auger-type and the
   a. screen-type
   b. shaker-type
   c. drum-type
   d. air blast-type
3. (20) Dry pesticide formulations are designed for treating seed such as:
   a. grass seed
   b. corn
   c. soybean
   d. sorghum
4. (20) Liquid treaters apply the chemical to the seed as a:
   a. hot soak solution
   b. cold soak solution
   c. dry slurry
   d. mist or spray
5. (21) An electrical metered pump can apply seed treatments as:
   a. dusts
   b. flowables
   c. liquids
   d. all the above
6. (21) Proper calibration of seed treatment requires knowing the label rate, the pounds of seed per dump, and ______
   a. type of chemical involved
   b. the atmospheric pressure
   c. size of the chemical cups
   d. the number of seeds per dump
7. (23) Safety for treated grain includes:
   a. do not store treated seed with grain for food or animal feed
   b. do not use a seed treatment augur for food or feed grain
   c. do not contaminate feed or food grain with treated seed
   d. all the above
8. (23) In most seed processing plants, the treater is permanently installed:
   a. above the bagging bin
   b. in the air-tight room
   c. in a dark room to prevent flying insect contamination
   d. none of the above
9. (24) The ______ regulations require dyeing treated seed to prevent their use as food or feed.
   a. US EPA
   b. Food and Drug Administration
   c. USDA
   d. Grain export

Seed Treatment Safety Regulations



Sample label for restricted highly toxic substances

Treated with (name of substance and rate) ______

DO NOT USE
for Food, Feed, or Oil

Sample label for general use substances

Pesticide Labels

Before using any pesticide, the information on the label should be studied and analyzed. The label contains detailed information about the product including: (1) active ingredient, (2) inert ingredients, (3) warning statement; such as Danger—Keep out of Reach of Children or Poison—Handle With Care, (4) antidotes, (5) type of seed and treatment rate, (6) kinds of pests controlled, (7) care in handling and use of treated seed, (8) disclaimer or warranty clause, (9) mixing instructions and (10) compatibility remarks.

Labeling Treated Seed

There are Federal and State seed laws for labeling treated seed. Information required to be shown on the label:

1. A word or statement in type no smaller than 8 points indicating that the seed has been treated.
2. The commonly accepted, coined, chemical or abbreviated chemical (generic) and name of the applied substance and rate of application.
3. A caution statement if the substance used in such treatment in the amount remaining with seed is harmful to humans or other vertebrate animals.
4. Seed treated with a “restricted use” 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.
5. Seed treated with a “general use” or low toxicity substance, 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 points, such as “Do Not Use for Food, Feed, or Oil.”

The two labels above are minimum requirements and the label may contain additional information; such as, (a) purpose of treatment, (b) antidotes, (c) safety precautions, and (d) procedure to follow in case of an accident.

Coloring Grain Seed

Since December 31, 1964, the Food and Drug Administration has regard as adulterated any interstate shipment of the food seeds: e.g. 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 in regulations promulgated pursuant to section 408 of the Federal Food, Drug and Cosmetic Act. Unless such seeds have been adequately denatured (given an unnatural appearance) by a suitable color to prevent their food for man or feed for animals.

Most seed treatment pesticides now come from the manufacturer with the dye or color added as a convenience to the operator. However, some seed processors prefer to add additional dye with the pesticides at their plants so the desired color may be obtained. Dyes approved by EPA cause no apparent injury to seed germination or danger to personnel processing or using the seed.

Handling and Disposal of Treated Seed

Treated seed must not be used for food, feed, or oil purposes. Care must be taken to prevent the accidental mixing of treated seed with untreated grain.

Careful planning of the quantity of seed you need is essential since disposal of treated seed may be a problem. One solution is to plant any unwanted seed and then disk it after it emerges if you do not want the crop. Otherwise, treated seed may have to be disposed of as a solid waste.

Treated seeds are not considered hazardous waste unless they exhibit one of the hazardous waste characteristics of ignitability, corrosivity, reactivity, or toxicity.

Before disposing of a large quantity of treated seed, you should check with the Kansas Department of Health and Environment.

Study Questions

1. (26) Before using any pesticide, you should:
   a. study the label information
   b. check with the wholesale outlet
   c. call the Governor
   d. call the Kansas Department of Agriculture
2. (26) Treated seed is considered adulterated by the Food and Drug Administration, unless:
   a. steam treated to kill all contamination
   b. double bagged to prevent leakage
   c. adequately denatured with a suitable dye color
   d. it is over eight years old
3. (26) Before disposing of a large quantity of treated seed you should check with:
   a. Kansas Department of Agriculture
   b. Kansas Department of Health and Environment
   c. Kansas Highway Patrol
   d. County Noxious Weed Department

Answers

Pages 4–12

1. d	2. b	3. d	4. c	5. b
6. c	7. d	8. d	9. a	10. b
11. d	12. a	13. c	14. b	15. d
16. d				

Pages 14–17

1. a	2. c	3. b	4. d	5. d
6. b	7. c	8. a		

Pages 19–24

1. b	2. c	3. a	4. d	5. d
6. c	7. d	8. a	9. b	

Page 26

1. a	2. c	3. b

We would like to thank the Department of Entomology, Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, for the use of the seed corn beetle, seed corn maggot and thief ant art.

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