SEED TREATMENT

PESTICIDE APPLICATION
AND
SAFETY TRAINING
STUDY GUIDE

UTAH DEPARTMENT OF AGRICULTURE

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SEED TREATMENT STUDY GUIDE

The educational material in this study guide is practical information to prepare you to meet the written test requirements. It doesn't include all the things you need to know about your pest-control profession. It will, however, help you prepare for your examinations.

Contributors include the Utah Department of Agriculture and Utah State University Extension Service. This study guide is based on a similar one published by the Colorado Department of Agriculture. Materials were prepared by Colorado State University Extension Service. Other contributors include: University Extension Service personnel of California, Kansas, New York, Oregon, Pacific Northwest, Pennsylvania and Wyoming; U.S. Department of Agriculture - Forest Service; the U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs; and the Department of Interior - Bureau of Reclamation and Metro Pest Management.

The information and recommendations contained in this study guide are based on data believed to be correct. However, no endorsement, guarantee or warranty of any kind, expressed or implied, is made with respect to the information contained herein.

Additional topics that may be covered in your examinations include First Aid, Personal Protective Equipment (PPE), Protecting the Environment, Pesticide Movement, Groundwater, Endangered Species, Application Methods and Equipment, Equipment Calibration, Insecticide Use, Application, Area Measurements, and Weights and Measures. Information on these topics can be found in the following books:

1. **National Pesticide Applicator Certification Core Manual,** Published by the National Association of State Departments of Agriculture Research Foundation.

2. **The Workers Protection Standard for Agricultural Pesticides – How to Comply: What Employers Need to Know.** U.S. EPA, Revised September 2005, Publication EPA/735-B-05-002.

These books can be obtained from the Utah Department of Agriculture or Utah State University Extension Service. Please contact your local Utah Department of Agriculture Compliance Specialists or Utah State University extension agent.

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INTRODUCTION

Seed treatment referred to in this study guide is the application to seed of any substance or mixture of substances intended to control diseases and insects. It includes control both while the seed is in storage and when it's in the soil after planting.

A person treating seed should not only know the kinds of seeds to be treated but also the diseases and insects to be controlled. They should also know which chemical products are effective and approved, and the chemical products their equipment can apply correctly.

Specific information should be obtained from the local extension agent, the equipment manufacturer, or the formulator of the pesticides.

DISEASE PESTS IN SEED

FUNGI AND BACTERIA

None of these disease organisms, except some smuts, need to be identified by applicators because there are some seed-surface disinfectant fungicides that control all seed rot and seedling-blight fungi and bacteria. Control of some smuts requires a specific fungicide that penetrates the seed as it begins to germinate and kills infection inside the seed, such as the loose smut of wheat and the brown loose smut of barley.

In barley stripe on the leaves, fungi are controlled by a specific seed treatment. Use only materials registered for control of the specific diseases. If smut or barley stripe is present in a field, the seed will require treatment to produce acceptable smut- or stripe-free grain in the next crop.

The following disease organisms may be found on or in seed.

Stored-grain pests and smuts:

- Alternaria
- Aspergillus
- Bacteria
- Cladosporium
- Curvularia
- Epicoccum
- Mucor
- Penicillium
- Rhizopus
- Sphaceloteca(smut)
- Tilletia(smut)
- Ustilago(smut)

Seed rots and seedling blights in soil:

- Diplodia
- Fusarium
- Helminthosporium
- Pythium
- Rhizoctonia

COMMONLY TREATED SEED DISEASES

Seed treatment with chemicals to control seed-borne and soil pests of small grains is a long-established, successful farming practice. Smuts and seedling-blight diseases can be reduced or eliminated by using effective fungicides.

WHEAT, OATS, BARLEY AND SORGHUM

Seed rots and seedling blights are caused by several seed and soil fungi. They attack germinating seeds and seedlings, especially if the seed is of poor quality and germination conditions are not ideal. Seed treatment protects young seedlings from attack and results in stronger plants and a more even stand.

Bunt (covered or stinking smut) of wheat and barley and black loose smut of barley are carried only on the seed surface. Control requires a seed-treatment seed-surface disinfectant.

Loose smut of wheat and bran loose smuts of barley infect the embryo and require systemic seed treatments (carboxin) for control. Barley loose smuts are very hard to detect, so systemic-fungicide seed treatment is advisable if loose smut was prevalent in the seed field. Barley-stripe fungus is also seed-borne and is controlled more effectively by systemic fungicides.

These problems make it more important to treat barley seed with systemic fungicide than any other small grains. Control requires a seed-treatment disinfectant that penetrates sprouting germs.

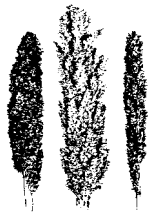
BARLEY SMUT

Covered and black smut require a seed-treatment fungicide that penetrates into all cracks and crevices of the seed. Brown smut requires one that penetrates and disinfects sprouting germs.

Oats are affected by two smuts. Both are carried on the seed surface, but some spores may lodge under the hulls, making control difficult. With resistance in most current oat varieties, the non-systemic, surface-acting fungicides will give adequate control. Systemic, surface acting fungicides will give adequate control. Systemic materials (carboxin) may be advisable where better control is desired, such as in certified seed where smut was observed in the seed field.

OAT SMUTS L to R:
Healthy head, loose smut, healthy head, covered smut. Controlled by a seed-treatment fungicide that penetrates into all cracks and crevices of the kernels.

SORGHUM-KERNEL SMUT
This smut is controlled by treating the surface of seeds. A smutted kernel has dark brown spores completely throughout, in contrast to saprophyte molds, which attack the surface of kernels in the field. These saprophytes don't reach all the way through the large kernels, leaving kernels white inside.



SORGHUM KERNEL SMUT
This smut controlled by treating surface of the seeds. A smutted kernel has dark brown spores completely through in contrast to saprophyte molds that attack surface of kernels in the field. These saprophytes don't reach all the way through thye large kernels leaving kernels white inside.

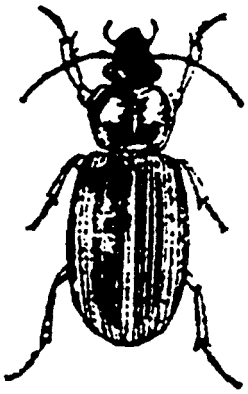
BARLEY-STRIPE DISEASE
This is controlled by a seed-treatment fungicide that penetrates into all cracks and crevices of the kernels.

HEAD SMUT OF SORGHUM
This isn't completely controlled by seed treatment, since the fungus lives in the soil and can invade seedlings below ground. Spores can be carried by the wind.

INSECT PESTS IN SEED

SOIL INSECTS

Insects that eat seed in the soil can only be controlled by treating the soil with a proper insecticide or treating the seed. Treating the seed is less expensive and puts less



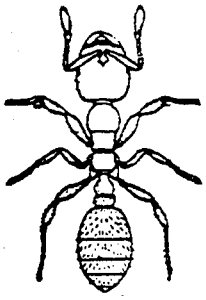
Seed corn beetle

chemical in the soil. The following are some of the common soil insects.

SEED-CORN BEETLES feed on corn or sorghum in the ground. A yellowish-brown beetle with black wing covers, it measures five-sixteenths inch in length, or a little less. The head is black, while antennae and legs are light brown. There are shallow furrows on the wing covers.

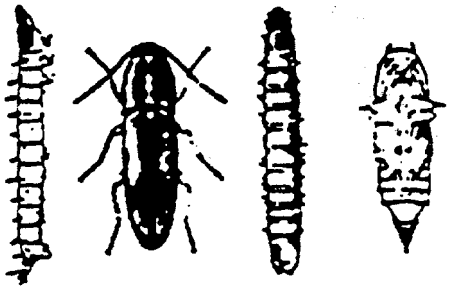
SEED-CORN MAGGOT is a small black or grayish-black fly one-eighth to one-fifth inch long. The pale or yellowish-white maggots of this fly attack germinating seeds and sprouts in cold, wet seasons.

KAFIR OR THIEF ANT is a tiny, reddish-brown ant that attacks seed of sorghum or corn, resulting in a weak, sickly sprout. The starchy part of the kernel is eaten out and scattered through the ground.



Kafir or Thief ant

TRUE WIREWORM larvae are similar to false wireworm in that they eat seeds and young plants. They are usually found in moist soil, unlike false wireworm.

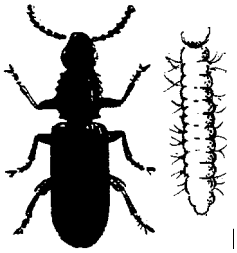


True wireworms

STORAGE INSECTS

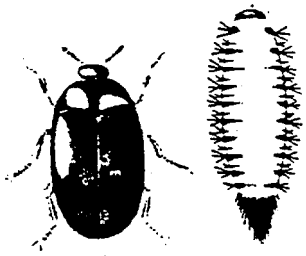
Storage insects are those that damage seed when stored in bulk or in bags. The following are examples with descriptions. Some others are pea-bean weevils, and spider beetles.

SAW-TOOTHED GRAIN BEETLE is a small, slender brown beetle. There are six saw-toothed projections on the thorax, from which this pest gets its name. This beetle attacks a variety of flour, meal, fruit, candy and grains. Eggs are laid in the food. The life cycle takes three to four weeks for completion.



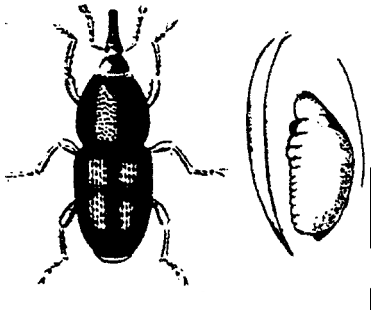
Saw-toothed grain beetle

DERMESTID BEETLES, LARGE CABINET BEETLE, AND OTHER SPECIES are scavengers on animal matter such as hides, furs and wool. They will also feed on stored grain and grain products. The larvae and pupae can survive rigorous environmental conditions. Under such conditions, the life cycle may be as long as two or three years.



Larger cabinet beetle

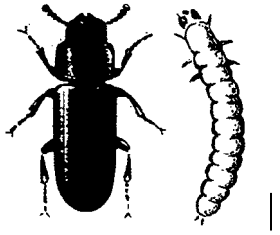
GRANARY AND RICE WEEVILS are the most common insects found infesting stored grain. Females lay their eggs in a hole cut in the intact kernel. Larvae hatch and feed inside the kernel, hollowing it out as they develop. Adults feed on whole or broken grain. A life cycle requires about four weeks for completion. Rice weevil adults fly. Granary weevil adults cannot fly.



Rice weevil

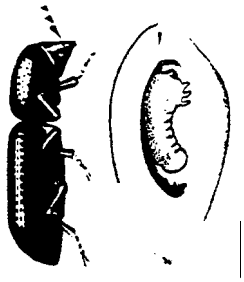
CONFUSED FLOUR BEETLE AND RED FLOUR BEETLE larvae and adults prefer to feed on

cracked grains, flour, and other cereal products. Eggs are laid loosely in the food material, and development takes place in the food. The life cycle takes about six weeks to complete.



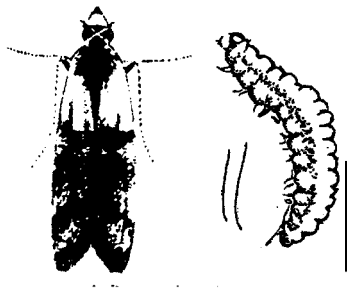
Red flour beetle

LESSER GRAIN BORER larvae are internal feeders on grain kernels. Eggs are laid outside the kernels; larvae hatch and bore into the kernels, hollowing them out as they grow. Adults can feed on whole and cracked grain. The life cycle takes three to four weeks to complete.



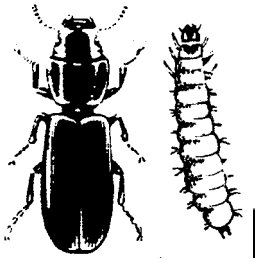
Lesser grain borer

INDIAN-MEAL MOTH larvae feed on grains, grain products, nuts, dried fruit, and other food. The adults are colored a characteristic coppery-brown on the wings. Eggs are laid singly or in groups on the food. The life cycle takes from six to eight weeks to complete.



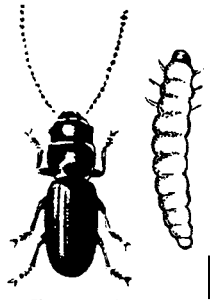
Indian-meal moth

CADELLE is one of the largest stored-grain insects. It is primarily a wood-boring insect but will also feed on whole grain, flour or meal. Both adults and larvae can survive without food for long periods of time, hidden in the woodwork of bins. When new grain is put in the bin, the insects then move into the grain. The life cycle may vary from a few months to two years, depending on conditions.



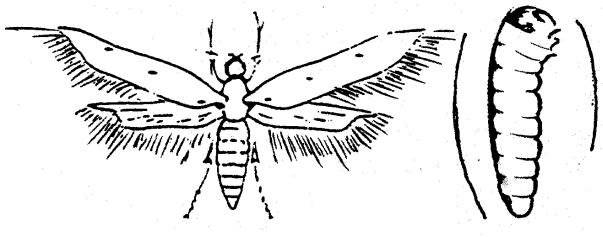
Cadelle

FLAT GRAIN BEETLE is one of the smallest grain-infesting beetles. Since it cannot feed on sound grain, it usually follows the attack of other insects. Under favorable conditions, the life cycle may require about five weeks.



Flat grain beetle

ANGOUMOIS GRAIN MOTH LARVAE are internal feeders on grain kernels. Females lay their eggs on the outside of the kernel, then the larvae bore in and develop inside the kernels. Beside the feeding damage, adults cover the inside of the bin and the surface of the grain with webbing.



Angoumois grain moth

Some of these stored grain insects are also **KITCHEN PESTS.**

The saw-toothed grain beetle, red flour beetle, larger cabinet beetle, and Indian-meal moth develop in flour, cake mixes, corn meal, breakfast foods, and similar products. The Angoumois grain moth infests popcorn.

SEED-TREATMENT PEST CONTROL

Disease- and insect-control seed treatments function in four ways, depending on the nature and purpose of the treatment.

1. **SEED-SURFACE DISINFECTION** -- Complete covering of the seed with a chemical that kills the spores and other forms of pathogenic organisms on the surface of the seed. Example: Killing stinking-smut spores or damping-off fungi that are on the seed.

2. **SEED PROTECTION** -- When a chemical on the seed protects the seed and young seedlings from pathogenic organisms or insects in the soil. Example: Control of seed-corn beetle or seed-rot and damping-off organisms.

3. **SEED DISINFECTION** -- Putting a chemical on the seed that penetrates into the seed, killing internal fungus growth or insects, besides killing organisms on the surface of the seeds. Example: Killing loose-smut fungus inside wheat seed or bean weevils inside the seed.

4. **SYSTEMIC ACTION** -- When a chemical on the seed penetrates the seed and extends into the plant as it grows, repelling or killing certain types of fungi or insects or preventing their feeding. Example: A systematic wheat-seed-treatment fungicide to control loose smut on wheat.

STORAGE INSECTS AND FUNGI

Most insects start to feed in sorted seed when temperatures are above 50 degrees F. and humidity is above 12 percent. However, some seed processors dry the seed to as low as eight percent. Since moisture content might increase in storage, it's a good practice to apply an insecticide. Low-level, non-hazardous materials are used.

An insecticide that becomes non-toxic is usually applied so that any leftover seed can eventually be used for food and feed. Other insecticides are applied near planting time to some seeds to keep soil insects from eating the seed. No fungicides are registered by EPA for control of fungi in stored seed.

SOIL INSECTS AND FUNGI

Seed treatment with a pesticide is necessary to control some diseases and insects in the soil that are not controlled by resistant varieties or by biological, cultural, physical or sanitary means. It is a preventative method and is recommended on kinds of seeds and in situations where research and experience in past years has shown it to be practical.

A pest may be a problem over the entire state, or it may be a problem in only some areas within a state. It may not be necessary to treat for each given problem in all localities. For example, some extension entomologists don't recommend treating wheat seed every year with an insecticide for soil insects. They know, from surveys, the areas where there are enough false wireworm beetles to produce sufficient larvae and where the soil is dry enough to cause a problem. The Extension Service can notify growers whether or not to treat; however, true wireworm population distributions are not known and may require treatment every year in nearly every location where seed is planted.

In contrast, damage to wheat seed from fungi on the seed and in the soil can't be predicted, and there is a reduction in seedling emergence of about ten percent or more in nearly all years when the seed isn't treated. Also, microscopic bunts or stinking-smut spores may be

on the seed without being seen. Since yields are increased by one to three bushels per acre from seed-rot and seedling-blight control, and because the cost for proper seed treatment is relatively inexpensive, it's recommended as a routine practice for each wheat crop.

Likewise, stands of plants are often doubled and plants are more vigorous when sorghum seed is treated with a fungicide. This has produced, on the average, at least ten bushels per acre more grain and 33 percent more forage. Entomologists recommend that all sorghum seed be treated with an insecticide just before planting to prevent seed- corn beetles, wireworms, or thief ants from eating planted seed. This problem isn't as easy to predict as false wireworm damage to wheat. The cost is only a few cents per acre, so it's recommended that all sorghum seed be treated with both a fungicide and an insecticide.

Seed treatment to prevent seed rots and seedling blight increases the yields of barley and oats an average of one to three bushels per acre and corn by seven bushels per acre. There would be large losses in vegetables and flowers from seed and soul fungi and insects without seed treatment. Less than half of the varieties of cereal grain used today are highly resistant to smuts. Seed treatment is necessary to keep these diseases at a non-destructive level.

APPLICATION

Mix the seed-treatment chemicals with seed thoroughly so every kernel is treated. None of the chemicals now approved are very volatile, so thorough mixing is especially important. Custom treaters should give better results than farm applications, especially if seed is cleaned and treated. However, drill-box applications are satisfactory if done carefully. Rates in the table are those given on labels and are usually at the bare minimum to be effective.

No really new chemicals have come into small-grain seed treatment usage for ten years. The "new" labels are different combinations and rates. Many companies have reduced label rates to be competitive, and this has resulted in poor control where disease conditions are moderate to severe.

The minimum effective rates of many fungicides for adequate disease control in wheat have been fairly well established. The rates of active ingredients for adequate control under moderate disease pressures are general guidelines. This will vary some with disease pressure from the weather and host susceptibility, but rates lower than these won't give satisfactory control in severe situations.

Minimum rates of common seed-treatment fungicides for adequate control.

Rate in oz./bu. of active ingredient

Chemical	Stand Increase	Bunt	Loose Smut
Captan	0.5	1.5	-
Maneb	0.5	1.0	-
Thiram	1.0	1.0	-
HCB	-	0.2	-
PCNB	-	0.4	-
Carboxin	0.5	1.0	0.3

Blanks mean either insufficient testing, not effective, or not labeled.

The amount of active ingredient per bushel of seed-treatment chemical can be calculated as follows for comparing rates:

1. If rates on labels are in ounces per bushel; active ingredients in oz./bu. can be calculated.

Multiply:

% active ingredient X oz./bu. of chemical = oz. of active ingredient/bu.

Example: Captan 75% at 0.67 oz./bu. on wheat.

0.75 X 0.67 = 0.5 oz./bu. active captan.

2. If rates on the label are in ounces per hundred weight, oz./bu. active ingredients can be calculated.

Multiply:

% active ingredients X oz/cwt X weight of 1 bu. in pounds*

100

= oz. active ingredient/bu.

Example; Vitavax 25 DB at 4.0 oz./cwt. on wheat.

$$0.25 \times 4.0 \times \frac{60}{100} = 0.6 \text{ oz. carboxin/bu.}$$

* Weights in lb./bu.: wheat, 60; barley, 48; oats, 32.

Most fluid or flowable seed treatments are heavier than water. Pesticide liquids are a little heavier than water, so liquid fluid-ounces will weigh more than an ounce by weight. Therefore, to be more precise, this weight difference must be considered, but this difference usually won't be more than ten to 15 percent.

Fungicides are less toxic than the "old mercuries," but they are still poisonous and should be handled with due precautions. DO NOT FEED TREATED SEED TO LIVESTOCK. DO NOT MIX TREATED SEED WITH MARKET GRAIN.

Don't buy more than you will use. If you have some seed left over, keep it to plant next year.

Sorghum

Seed-treatment fungicides are available that effectively control kernel smut, seed rot, and seedling blight of sorghum. The fungus that causes head smut of sorghum isn't controlled by seed treatment, as it infects the seedling above the seed.

Fungicide seed treatment has increased the yield of sorghum grain an average of more than ten bushels per acre and forage by more than 30 percent by controlling seed rots and seedling blights. A proper insecticide should be on the seed during storage. An insecticide and fungicide which are effective against soil insects should be applied before planting.

Corn

The smut of corn isn't controlled by seed treatment, because the spores are blown from the soil to any part of the plant and infect at a puncture or injury site.

Corn seed can be treated to protect against storage insects. It should also be treated with a fungicide to protect from seed rots and seedling blight of the soil. An insecticide can be applied to the soil to protect against seed-eating insects.

Sugar Beets

Both insecticides and fungicides are applied to vegetables and seeds to control storage insects and to control seed rots and seedling blights in the soil.

Sometimes tomato, crucifer, and eggplant seeds are hot-water-soak-treated to remove certain bacteria and fungus agents.

Compatibility

Most fungicides and insecticides registered for seed treatment are compatible when mixed. One should consult the label on each product for such information. A small slurry mixture of the materials should be made to test compatibility before the actual mixing and treating operation begins.

PESTICIDE LABELS

Before using any pesticide, study and analyze the information on the label. The label contains detailed information about the product, including:

1. Active ingredients
2. Inert ingredients
3. Warning statements, 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 of warranty clause
9. Mixing instructions
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 includes:

1. A word or statement in no smaller than eight-point type indicating that the seed has been treated.

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

3. Seed treated with a restricted-use toxic substance will be labeled to show a statement such as "poison treated" in red. In addition, the label will show a skull and crossbones.

   Sample label for restricted-use, highly toxic substances:

   THIS SEED TREATED WITH POISON.
   Treatment Used: Phorate

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, will be labeled to show a caution statement in no smaller than eight-point type, such as "Do Not Use for Food, Feed or Oil."

   Sample label for general-use substances:

   This seed treated with Captan. Do not use for food, feed or oil purposes

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) Procedures to follow in case of an accident.

Coloring Grain Seed

The U.S. Food and Drug Administration (FDA) regards as adulterated any interstate shipment of food seed, such as wheat, corn, oats, rye, barley and sorghum, if they bear a poisonous treatment in excess of an acceptable regulated level (see below) **unless** such seeds have been given an unnatural appearance by a suitable color to prevent their use by man or as feed for animals. This regulation is in Section 408 of the Federal Food, Drug and Cosmetic Act.

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 that the desired color is obtained. Dyes approved by EPA cause no apparent injury to seed germination or danger to personnel processing or using the seed.

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 the Environmental Protection Agency (EPA), usually neutral in pH, and nontoxic to humans, and they 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 dusty conditions in the processing plant.

SAFETY IN TREATING

Some precautions in custom-treating of seed are listed below.

1. The manager should supply the local medical doctors with a label for each toxic pesticide being used or sold. The manager should ask the doctors to have on hand antidotes for all products and be prepared in case of an emergency. For help in a chemical emergency involving a spill, leak, fire or exposure, a person can call day or night: CHEMTREC at 1-800-424-9300 (toll-free). This number is used nationally by the pesticide industry for emergencies.

2. The manager should have copies available of pertinent label information on pesticides he or she is applying to seed as a custom service or for sale in bulk so that a copy can be given to each customer to take home with the treated seed. Refer to the section in this study guide on PESTICIDE LABELS. There have been cases where children or animals have gotten into, handled or eaten treated seed, and

the parent or owner did not know what pesticides were on the seed. If the processor had supplied the customer with a sheet giving this information, the customer could immediately have given this information to the doctor by phone. General-use pesticides applied to seed are not sufficiently toxic to be a problem, but restricted- use materials can be.

3. A seed-treating facility should not be operated where pesticide dust or fumes reach food, feed or oil commodities or personnel such as office help who are not properly dressed to be protected from the dust or fumes. Lining the seed-treating room with polyethylene sheeting may be all that is needed.

4. The applicator should wear personal protective equipment (PPE) as specified on the label. Items that may be listed on the label of a pesticide container are: (a) a long-sleeved shirt and pants, (b) chemical-resistant headgear for overhead exposure, (c) protective eyewear, (d) a chemical-resistant apron when cleaning, mixing and loading, (e) chemical-resistant footwear plus socks, (f) chemical-resistant gloves, (g) respirator designed for use with the material. Respirator filters should be on hand at all times and changed as often as required in the filter instructions.

5. One or more copies of a container label should be available at all times at the entrance to the treating room for workers to read and refer to immediately in case of an accident or illness. IT MAY BE NECESSARY TO APPLY FIRST AID BEFORE A PHYSICIAN CAN BE REACHED.

6. Personnel should not stay in the treating room any longer than necessary to lessen possible contact with the pesticides. They should not inhale the dust or vapor or allow such material to contact their skin or eyes.

7. Operators should wash thoroughly with soap and water before eating, smoking or using the bathroom. Bathe immediately after work, and change all clothing. Wash clothing thoroughly with detergent and hot water before reuse. In case of pesticide contact, immediately remove contaminated clothing and wash skin thoroughly with soap and water for at least 15 minutes.

8. A safety shower should be installed in the immediate vicinity to the applicator.

9. An EXHAUST system should be installed to remove toxic vapors and dust from the operating area. The exhaust should discharge into a cyclone or bag-type dust collector.

10. Special, tightly woven bags or polyethylene- or foil-lined bags are recommended for some seeds treated with a restricted-use pesticide. Seed should be thoroughly dry before going into the bag, as excessive moisture can cause rapid deterioration of the seed.

11. Store treated seed in labeled containers in a dry cool place away from food or feed products. Refer to the PESTICIDE LABELS section.

12. Seed-treatment equipment should be thoroughly cleaned after use, as some pesticides are corrosive and others settle out and cause clogging of the equipment. If more than one pesticide is used, clean out thoroughly to avoid cross-contamination of the treated seed. The names of the cleaners and how to use them should be obtained from the formulator of the seed- treatment material. Do not run contaminated water into the public sewer. Check with proper authorities when large amounts of waste water are involved.

13. Application equipment should be checked periodically to insure proper calibration and application rates.

14. In communication before and during the treating season, the manager of a custom-application business should suggest to growers that they bring in for treatment a little less seed than is to be planted so they won't have leftover treated seed. A grower can treat, by the drill-box method, enough to finish the acreage. Growers should also be informed that any treated seed in a market grain can cause the grower's whole truckload of grain to be refused. Any treated grain in a freight car or truck can result in the whole carload being condemned.

15. Pesticide containers should only be reused if putting the same chemical back in. If not possible to reuse the container, triple-rinse it, puncture it so that it can't be used for other purposes, and send it to the landfill for disposal.

APPLICATION EQUIPMENT

Commercial seed-treaters are designed to apply accurately measured quantities of pesticides to a given weight of seed. Too much pesticide may injure seed, and too little is often not effective. Both are illegal, so equipment must be kept properly adjusted at all times. The equipment supplier should provide this help. There are three types of commercial seed-treaters on the market -- liquid treaters, slurry treaters, and dust treaters.

The following is a discussion of the operation of the treating equipment as supplied by a manufacturer.

Liquid Treaters

These are generally designed to apply true liquids. The treaters use the weight of the seed to operate the seed- and chemical-measuring system. The amount of seed measured is controlled by placement of the counterweight, while the amount of chemical measured at each trip of the weighpan is determined by the size of chemical cups used in the metering tank or concentration of the liquid used.

Each time the weighpan trips, seed goes to the retarding hopper, where it's gradually released to a dispersion cone. At the same time, chemical is delivered to the chemical cup receptacle and flows through a hose to a revolving disc that atomizes the chemical into penetrating mist. As seed falls over a dispersion cone and through the treating chamber, it's enveloped by chemical mist that contacts even the hard-to-reach indentations of the seed.

The liquid method is especially recommended when small amounts of chemical must be applied to relatively large quantities of seed.

Any free-flowing seed can be treated through a liquid treater. Seeds that are not free-flowing (certain grasses) can be treated by the liquid method with the cottonseed treater.

All liquid chemical products, ready-to-use fungicides and insecticides, slurry products, and inoculation materials can be applied through the liquid treaters. A special liquid treater for sugar-beet seed sprays fungicide, insecticide and dyes on seed as the seed is rotated in a large drum.

Slurry Treaters

These are generally designed to apply water suspensions of wettable powders. Like liquid treaters, metered slurry treaters use the weight of seed to operate the seed- and chemical-measuring system. The amount of seed measured is controlled by placement of the counterweight, while the amount of chemical is measured at each trip. The weighpan is determined by the size of chemical cups used in the metering tank and by the concentration of the pesticide in the slurry.

Each time the weighpan trips, seed flows through the measuring unit and into the film coater. At the same time, chemical is delivered to the chemical-cup receptacle and flows through a hose to the film coater, where it joins the seed.

As the seed and chemical are conveyed through the film coater to the discharge, they tumble together, producing an even coat of chemical on each individual seed. This mixing action before final discharge also allows some moisture in the slurry to evaporate from the seed, for easier handling after treating.

Dust Treaters

A specially designed machine treats beans, grasses and other commodities where such treating is still in demand. Measured amounts of powder are uniformly and continuously applied to the seed by use of a vibrating feeder from a control. The machine is equipped with a powder hopper with positive fluffing action and variable speed drive assembly on the film-coating unit.

THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) was passed by Congress to protect certain plants and wildlife that are in danger of becoming extinct. This act requires EPA to ensure that these species are protected from pesticides.

Formulation of the Utah Threatened and Endangered Species/Pesticides Plan is a cooperative effort between federal, state, and private agencies and producers/user groups, and is a basis for continuing future efforts to protect threatened and endangered species from pesticides whenever possible. Furthermore, this plan provides agencies direction for management policies, regulations, enforcement and implementation of threatened and endangered species/pesticide strategies.

EPA has therefore launched a major new initiative known as the Endangered Species Labeling Project. The aim is to remove or reduce the threat to threatened and endangered species from pesticide poisoning. EPA has the responsibility to protect wildlife and the environment against hazards posed by pesticides. The ESA is administered by the U.S. Fish and Wildlife Service (FWS) in the U.S. Department of Interior. The FWS will determine jeopardy to threatened and endangered species and report to EPA. EPA and FWS will work cooperatively to ensure that there is consistency in their responses to pesticide users and to provide necessary information. The Utah Department of Agriculture and Food is acting under the direction and authority of EPA to carry out the ESA as it relates to the use of pesticides in Utah.

Maps will show the boundaries of all threatened and endangered species habitats in affected counties. The maps identify exactly where, in listed counties, use of active ingredients in certain pesticides is limited or prohibited. Product labels will be updated as necessary. The updated labels will reflect any additions or deletions to the project. Because EPA's approach to the protection of threatened and endangered species was in the proposal phase at the time this guide was published, any and all of the above information on threatened and endangered species is subject to change and may not be valid.

WORKER PROTECTION STANDARDS

This final rule, which was proposed in 1988 and that substantially revised standards first established in 1974, affects 3.9 million people whose jobs involve exposure to agricultural pesticides used on plants; people employed on the nation’s farms; and in forests, nurseries and greenhouses. The standard reduces pesticide risks to agricultural workers and pesticide handlers. The standard is enforceable on all pesticides with the Worker Protection Standard labeling. The provisions became fully enforceable in January 1995.

Agricultural workers in Utah now have a far greater opportunity to protect themselves, their families and others. These workers will know, often for the first time, when they are working in the presence of toxic pesticides, understand the nature of the risks these chemicals present, and get basic safety instructions.

Among the provisions of the rule are requirements that employers provide handlers and workers with ample water, soap and towels for washing and decontamination and that emergency transportation be made available in the event of a pesticide poisoning or injury. The rule also establishes restricted-entry intervals -- specific time periods when worker entry is restricted following pesticide application -- and requires personal protection equipment (PPE) for all pesticides used on farms or in forests, greenhouses and nurseries. Some pesticide products already carry restricted re-entry intervals and PPE requirements; this rule raised the level of protection and requirements for all products.

Other major provisions require that employers inform workers and handlers about pesticide hazards through safety training, which handlers have easy access to pesticide-label safety information, and that a listing of pesticide treatments is centrally located at the agricultural facility. Finally, handlers are prohibited from applying a pesticide in a way that could expose workers or other people.

GROUNDWATER CONTAMINATION BY PESTICIDES

Utah has implemented a comprehensive and coordinated approach to protect groundwater from pesticide contamination.

Formulation of the Groundwater/Pesticide State Management Plan is a cooperative effort between federal, state, and private agencies and producers/user groups; it provides a basis for continuing future efforts to protect groundwater from contamination whenever possible. Furthermore, this plan provides agencies with direction for management policies, regulations, enforcement and implementation of groundwater strategies.

While it's recognized that the responsible and wise use of pesticides can have a positive economic impact, yield a higher quality of crops, enhance outdoor activities, and give relief from annoying pests, the Utah Department of Agriculture and Food is authorized by the U.S. Environmental Protection Agency (EPA) to enforce the protection of groundwater from pesticides. Product labels will be updated as necessary.

The Utah Department of Agriculture and Food, in concert with cooperating agencies and entities, admonishes strict compliance with all pesticide labels, handling procedures and usage to protect groundwater in the state.

Groundwater can be affected by what we do to our land. Prevention of groundwater contamination is important, because once the water is polluted, it's very hard and costly to clean up. In some instances, it's impossible, especially if it's deep underground. City and urban areas especially contribute to pollution because water runoff that contains pesticides runs into drainage tunnels, then into a river or an underground stream that drains into the river. For more complete information about what groundwater is and where it comes from, read the study manual "Applying Pesticides Correctly." Shallow aquifers or water tables are more susceptible to contamination than deeper aquifers. Sandy soils allow more pollution than clay or organic soils, because clays and organic matter absorb many of the contaminants.

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, establishes a policy for determining the acceptability of a pesticide use or the continuation of that use, according to a risk/benefit assessment. As long as benefits outweigh adverse effects, a pesticide can be registered by the EPA. Although the intent of a pesticide application is to apply the pesticide to the target or pest, part of the pesticide will fall on the area around the target or pest. Rain or irrigation water then can pick up the part that is not degraded or broken down and carry it to the groundwater via leaching.

The major factors that influence the amount of contamination that can get into water are the chemicals' persistence in soil, retention time or time it remains in the soil, the soil type, the time and frequency of the application(s), soil moisture, placement of the pesticide, and the ability of the chemical to persist once in the aquatic environment. Each of these factors will influence the amount of pesticide that can leave the root zone or soil surface and percolate to groundwater.

Although some pesticides may have a high absorption quality, when they are applied to sandy soil, they will still migrate to the water table because there are no fine clay particles or organic matter to hold them. The management and use of pesticides is up to the individual applicator and/or land owner as to whether safe practices are used. Water is one of our most valuable resources; we must keep it as pure as possible.

CALIBRATION INFORMATION

Conversion:

Units

One acre = 43,560 square feet	Example: ½ acre = 21,780 square feet
One mile = 5,280 feet	Example: ¼ mile = 1320 feet
One gallon = 128 fluid ounces	Example: ½ gallon = 64 fluid ounces
One quart = 2 pints = 4 cups = 32 fluid ounces	Example: 2 quarts = 64 fluid ounces
One pint = 2 cups = 16 fluid ounces	Example: ½ pint = 1 cup = 8 fluid ounces
One tablespoon = 3 teaspoons = 0.5 fluid ounces	Example: 2 tablespoons = 1 fluid ounce
One pound = 16 ounces	Example: ¼ pound = 4 ounces
One gallon = 231 cubic inches	Example: 2 gallons = 462 cubic inches

Weight

1 ounce = 28.35 grams
16 ounces = 1 pound = 453.59 grams
1 gallon water = 8.34 pounds = 3.785 liters = 3.78 kilograms

Liquid Measure

1 fluid ounce = 2 tablespoons = 29.573 milliliters
16 fluid ounces = 1 pint = 0.473 liters
2 pints = 1 quart = 0.946 liters
8 pints = 4 quarts = 1 gallon = 3.785 liters

Length

1 foot = 30.48 centimeters
3 feet = 1 yard = 0.9144 meters
16 1/2 feet = 1 rod = 5.029 meters
5280 feet = 320 rods = 1 mile = 1.6 kilometers

Area

1 square foot = 929.03 square centimeters
9 square feet = 1 square yard = 0.836 square meters
43560 square feet = 160 square rods = 1 acre = 0.405 hectares

Speed

1.466 feet per second = 88 feet per minute = 1 mph = 1.6 kilometers per hour (kph)

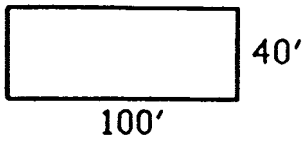
Volume

27 cubic feet = 1 cubic yard = 0.765 cubic meters
1 cubic foot = 7.5 gallons = 28.317 cubic decimeters

Area and Volume Calculations:

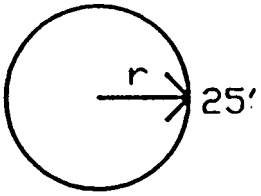
Area of Rectangular or Square Shapes

The area of a rectangle is found by multiplying the length (L) times the width (W).
(Length) x (Width) = Area
Example: (100 feet) x (40 feet) = 4000 square feet



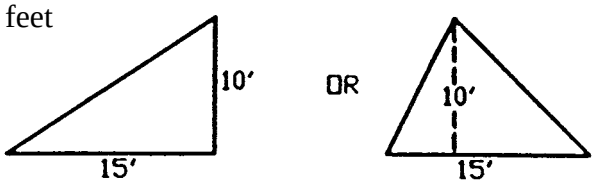
Area of Circles

The area of a circle is the radius (radius = one-half the diameter), times the radius, times 3.14.
(radius) x (radius) x (3.14) = Area
Example: (25 feet) x (25 feet) x (3.14) = 1962.5 square feet



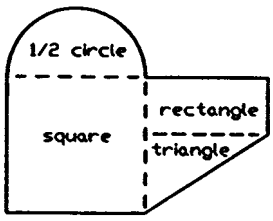
Area of Triangular Shapes

To find the area of a triangle, multiply ½ times the width of the triangle's base, times the height of the triangle.
(½) x (base width) x (height) = Area
Example: (½) x (15 feet) x (10 feet) = 75 square feet

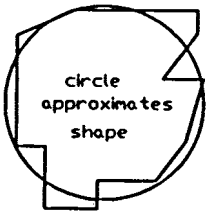


Area of Irregular Shapes

Irregularly shaped sites can often be reduced to a combination of rectangles, circles, and triangles. Calculate the area of each shape and add the values together to obtain the total area.
Example: Calculate the area of the rectangle, triangle, square, and one-half of a circle.

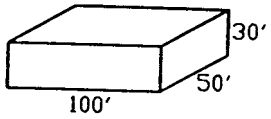


Another method is to convert the site into a circle. From a center point, measure the distance to the edge of the area in 10 or more increments. Average these measurements to find the radius, then calculate the area using the formula for a circle.
Example: Approximate the area by calculating the area of a similarly sized circle.



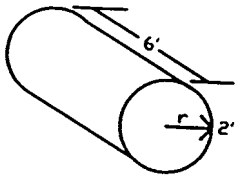
Volume of Cube and Box Shapes
The volume of a cube or box is found by multiplying the length, times the width, times the height.
(Length) x (Width) x (Height) = Volume

Example: (100 feet) x (50 feet) x (30 feet) = 150,000 cubic feet



Volume of Cylindrical Shapes
The volume of a cylinder is found by calculating the area of the round end (see formula for circle) and multiplying this area times the length or height.

Example: (radius) x (radius) x (3.14) = Area of Circle
(Area of Circle) x (Length) = Volume of Cylinder
(2 feet) x (2 feet) x (3.14) x (6 feet) = 75.36 cubic feet



Sprayer Calibration Formulas:

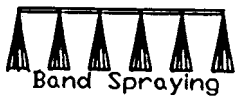
To Calculate Travel Speed in Miles Per Hour
The travel speed of a sprayer is determined by measuring the time (seconds) required to travel a know distance (such as 200 feet). Insert the values in the following formula to determine the miles per hour.

$$\frac{\text{Distance in Feet} \times 60}{\text{Time in Seconds} \times 88} = \text{Miles Per Hour}$$

Example: $\frac{(200 \text{ feet}) \times (60)}{(30 \text{ seconds}) \times (88)} = \frac{12{,}000}{2640} = 4.55$ mph

To Calculate the Gallons Per Minute Applied During Broadcast Spraying
The application rate in gallons per minute (GPM) for each nozzle is calculated by multiplying the gallons per acre (GPA), times the miles per hour (MPH), times the nozzle spacing in inches (W); then dividing the answer by 5940. For small adjustments in GPM sprayed, operating pressure is changed. For large adjustments in GPM sprayed, travel speed (miles per hour) is changed or nozzle size is changed.

$$\frac{\text{GPA} \times \text{MPH} \times \text{W}}{5940} = \text{GPM}$$



Example: $\frac{(12 \text{ GPA}) \times (4.5 \text{ MPH}) \times (24")}{5940} = \frac{1296}{5940} = 0.22$ GPM

To Calculate the Gallons Per Minute Applied During Band Spraying
Broadcast spraying applies chemicals to the entire area. Band spraying reduces the amount of area and chemicals sprayed per acre. To use the above formulas for band sprayer applications, use the band width (measured in inches) rather than nozzle spacing for the "W" value.

Pesticide Mixing:

Terminology

The ***active ingredients*** of a pesticide are the chemicals in a formulation that control the target pests. The ***formulation*** is the pesticide product as sold, usually a mixture of concentrated active ingredients and an inert material. Restricted use pesticides are purchased in formulations requiring ***dilution prior to application***. Formulations are diluted with inert substances such as water. The ***percentage of active ingredients*** in a pesticide formulation directly affects dilution and application rates. Given two pesticides, A = 50% active ingredients, B = 100% active ingredients; twice as much pesticide A formulation is required to equal pesticide B formulation.

To Determine the Total Amount of Pesticide Formulation Required Per Tank

To calculate the total amount of pesticide formulation needed per spray tank, multiply the recommended dilution, ounces/pints/cups/teaspoons/tablespoons/etc. of pesticide per gallon of liquid, times the total number of gallons to be mixed in the sprayer. A full or partial tank of pesticide spray may be mixed.

(Dilution Per Gallon) x (Number of Gallons Mixed) = Required Amount of Pesticide Formulation Example: (3 ounces per gallon) x (75 gallons) = 225 ounces

Note: 1 gallon = 128 ounces; through unit conversion 225 ounces = 1.76 gallons

To Calculate the Amount of Pesticide Formulation Sprayed Per Acre

The calculate the total amount of pesticide formulation sprayed per acre is determined by multiplying the quantity of formulation (ounces/pounds/pints/cups/teaspoons/tablespoons/etc.) mixed per gallon of water, times the number of gallons sprayed per acre.

(Quantity of Formulation Per Gallon) x (Gallons Sprayed Per Acre) = Formulation Sprayed Per Acre

Example: (1/2 pound per gallon) x (12 gallons per acre) = 6 pounds per acre

To Calculate the Amount of Active Ingredients Sprayed Per Acre

To calculate the total amount of active ingredients (AI) applied per acre, multiply the amount (pounds, gallons, ounces, etc) of pesticide formulation required per acre, times the percentage of active ingredients in the formulation (100%, 75%, 50%, 25%, etc.), and divide the value by 100.

$$\frac{\text{(Amount of Formulation Required Per Acre)} \times \text{(Percentage of AI)}}{100} = \text{Active Ingredients Per Acre}$$

Example: $\frac{\text{(4 pounds formulation sprayed per acre)} \times \text{(75\% AI)}}{100}$ = 3 pounds of AI sprayed per acre

Note: 75 % = 0.75

To Calculate the Gallons of Pesticide Mixture Sprayed Per Acre

The calculate the total amount of pesticide mixture sprayed per acre is determined by dividing the number of gallons sprayed by the number of acres sprayed.

$$\frac{\text{Gallons Sprayed}}{\text{Acres Sprayed}} = \text{Gallons Sprayed Per Acre}$$

Example: $\frac{\text{200 Gallons Sprayed}}{\text{10 Acres Sprayed}}$ = 20 gallons of pesticide mixture sprayed per acre