

Seed Treatment for Disease Control

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Most seed treatment products are fungicides or insecticides applied to seed before planting. Fungicides are used to control diseases of seeds and seedlings; insecticides are used to control insect pests. Some seed treatment products are sold as combinations of fungicide and insecticide.

Fungicidal seed treatments are used for three reasons: (1) to control soil-borne fungal disease organisms (pathogens) that cause seed rots, damping-off, seedling blights and root rot; (2) to control fungal pathogens that are surface-borne on the seed, such as those that cause covered smuts of barley and oats, bunt of wheat, black point of cereal grains, and seed-borne safflower rust; and (3) to control internally seed-borne fungal pathogens such as the loose smut fungi of cereals (Figure 1).

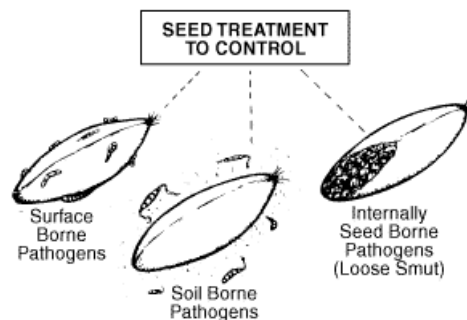


Figure 1. Reasons for seed treatment.

Most fungicidal seed treatments do not control bacterial pathogens and most will not control all types of fungal diseases, so it is important to carefully choose the treatment that provides the best control of the disease organisms present on the seed or potentially present in the soil. The degree of control will vary with product, rate, environmental conditions and disease organisms present. Some systemic fungicidal seed treatments may also provide protection against early-season infection by leaf diseases.

Fungicide-insecticide combination products or an addition of insecticide for wireworm control should be considered if planting newly opened land or land that has had a history of wireworms. Consult current recommendations for insecticides registered for wireworm control. A fungicide-insecticide combination also may be useful for dry beans. The insecticide used on dry beans should be one that provides control of the seed corn maggot.

Further information on seed treatment fungicides registered for the control of various types of disease is available in the current edition of [NDSU Extension Circular PP-622, Field Crop Fungicide Guide](#).

Seed Treatment Application

Fungicide seed treatment products come in a variety of formulations and in a variety of packaging sizes and types. Some are registered for use only by commercial applicators using closed application systems, others are readily available for on-farm use as dusts, slurries, water soluble bags, or liquid ready-to-use-formulations. Whatever the formulation used or application method chosen, some precautions should be taken to assure applicator safety and appropriate seed coverage.

Cautions

Follow label directions when handling seed treatment chemicals. These products are potentially poisonous if mishandled or misused. Extreme caution must be used when handling seed treatment chemicals: some are toxic, others may be irritating. An approved chemical respirator and goggles are recommended even if not specifically required by the fungicide label.

The rate of application prescribed by the label must be used: overtreatment may injure the seed and undertreatment may not provide good disease control. To apply the correct rate, it is essential to calibrate application equipment carefully and to check calibration frequently. Metering cups of commercial applicators should be cleaned daily to prevent a buildup of chemical that might result in reduced application rates.

An auger which has been used to treat seed cannot be cleaned up sufficiently for use in augering grain for food or feed. Once an auger is used for seed treatment, it should be used only for treatment or augering seed for planting. It should not be used to auger grain used for food or feed.

Treated seed should not be used for food or feed, and treated grain should not contaminate grain delivered to elevators or be placed in bins or in trucks delivering to elevators.

Containers should be triple rinsed with the rinse water added to the treatment mixture. The rinsed containers should be punctured and crushed for disposal in an approved landfill.

**Do Not Use Treated
Seed for Food or Feed!!**

Cereal Seed Treatments

Fungicidal seed treatments help control soil-borne pathogens that cause seed decay, seedling blight and root rot. Control of these diseases may result in better stands, more vigorous seedlings, and increased yields. Protectant fungicides such as captan, maneb, PCNB, thiram, or fludioxonil (Maxim) help control most types of soil-borne pathogens, except for common root rot and take-all. Protectant fungicides containing captan, maneb, or thiram are sold under various trade names. Fungicidal seed treatments to protect against the soil-borne fungi that cause common root rot and take all will be discussed under barley seed treatment.

Fungicidal seed treatment controls most, but not all, of the seed-borne diseases of small grains. Seed treatment should be used when the seed is contaminated with smut, scab, or black point fungi. Specific recommendations for these diseases are discussed under barley and wheat. No seed treatment is a substitute for good seed.

Barley

Barley has three smuts: covered smut, black semi-loose smut (nigra smut), and loose smut. Covered smut and black semi-loose smut are surface-borne fungal pathogens that infect the emerging seedling (Figure 2). These two smuts can be controlled by various protectant fungicides. Loose smut infects the embryo of the seed before harvest (Figure 3). Protectant fungicides do not control loose smut—only the systemic fungicides carboxin (Vitavax or Enhance), triadimenol (Baytan) or

tebuconazole (Raxil) will control loose smut in barley. These same products also will control the covered and semi-loose smuts of barley.

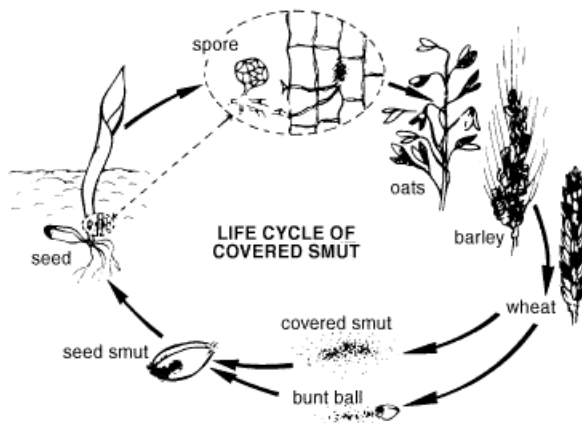


Figure 2. Life cycle of covered smut and bunt.

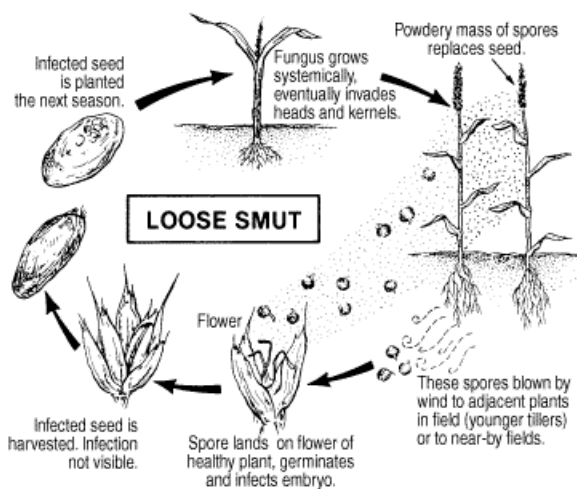


Figure 3. Life cycle of loose smut.

Covered smut. Seed of barley varieties susceptible to covered smut should be treated with a protectant fungicide or with carboxin, triadimenol or tebuconazole. At present (2000), all barley varieties recommended for production in North Dakota must be considered susceptible.

Black semi-loose smut. Many varieties are susceptible to this smut. It is indistinguishable from loose smut in the field, but it is borne on the seed surface and infects seedlings just as covered smut does. It is not detected by the embryo test, because it does not infect the embryo. It is controlled by seed treatment with a protectant fungicide or with carboxin, triadimenol, or tebuconazole.

Loose smut. Many of the barley varieties released in the late 1970s and early 1980s were resistant to the races of the loose smut fungus present at that time. In the mid-1980s, a new race of the loose smut fungus was detected in North Dakota. Now (2000), all commonly grown barley varieties are susceptible.

Seed treatment for loose smut in barley planted for seed production is especially important. Seed samples of susceptible barley varieties should be sent to the North Dakota State Seed Department for an embryo test to determine the percentage of loose smut infection. Losses from loose smut are about equal to the percent infection; 5 percent loose smut represents a

yield loss of about 4.3 percent. If the embryo test shows 2 percent or greater infection, the seed should be treated with carboxin, triadimenol or tebuconazole, or loose smut-free seed should be used for planting.

Common root rot. The fungus that causes common root rot is soil-borne and is widespread in North Dakota soils. The common root rot fungus increases under barley or wheat culture, and it often causes mature plant root rot. The fungus also may cause severe root infection in the seedling stage and if splashed to the leaves and head causes spot blotch and black-point infections, respectively.

A number of seed treatment fungicides are now labeled for wheat and barley for suppression of mature plant root rot and also for suppression of seedling blight due to the common root rot fungus. Imazalil is available under several trade names (Agsco RR, Flo-Pro, Nu-Zone). Triadimenol (Baytan) also is registered for suppression of seedling blight due to common root rot. Tebuconazole (Raxil) is registered for wheat and barley, and difenoconazole (Dividend) is registered only for wheat at the time of publication of this circular. The conditions in which seed treatment for common root rot would be most beneficial are: where continuous wheat or barley is grown, or if short rotations between these susceptible crops are practiced, and in soils where moisture stress is very likely.

Take-All. (see wheat)

Barley Stripe. This fungus disease is rarely seen in North Dakota but occasionally appears in two-row barley if contaminated seed is planted. The disease causes distinct yellow, then brown stripes that run the entire length of the leaves. The stripes join together and the leaves become split and frayed or shredded in appearance.

The fungus is seed-borne in the hull and seed coat. If seed from a suspected disease source is used, seed treatment with a carboxin + thiram or tebuconazole product provides some control of the barley stripe fungus. The systemic fungicide imazalil provides good control of barley stripe.

Scab (see wheat)

Corn

Corn seed is especially susceptible to attack by soil-borne pathogens when sown in cold (below 50 degrees Fahrenheit) wet soil, when the seed is in poor condition, when it is mechanically injured, or if it has been stored for two years or more. Seed treatment will protect against seed rot and reduce the danger of seedling blight. Sweet corn is more susceptible to attack than field corn, but both should be treated. Most field corn is already treated when purchased. A number of protectant and systemic fungicides are registered for control of seedling blights and seed rot in corn. See [PP-662, Field Crop Fungicide Guide](#), for specific products labeled for corn.

Wheat

Bunt or stinking smut. The fungus causing this disease adheres to the seed surface and then infects the emerging wheat seedling ([Figure 2](#)). The bunt fungus has a fishy odor and imparts the same odor to flour made from bunted kernels. The price of bunted wheat is discounted for this reason. Bunt is not known to occur in North Dakota at the present time, nor has it occurred in recent years. However, it occurs in other wheat-producing states in the Great Plains. Growers who purchase seed from out of state should use a seed treatment fungicide, since out-of-state seed could be infested with (carrying) bunt. Growers who have their crop custom combined and then save their own seed should use a fungicide, since the combine could be contaminated with bunt spores or bunt balls from states to the south. Many protectant, systemic, or combination products are available to control bunt.

Loose smut. Loose smut of wheat infects the embryo, as with loose smut of barley ([Figure 3](#)). However, the wheat loose smut pathogen does not infect barley and the barley loose smut pathogen does not infect wheat. No embryo test is available for detection of loose smut in wheat.

Counts of loose smut-infected heads can be made in wheat and durum fields to estimate the percent infection in the crop. Counts should be made at flowering time, as loose smut heads are hard to detect later. The counts provide information on the percent infection in the seed that was planted but are not a reliable estimate of the amount of infection in the seed of the harvested crop. If weather conditions are favorable, *i.e.* cool and wet, infection in the harvested seed could be considerably higher than in the seed that was planted. Carboxin, difenoconazole, tebuconazole, and triadimenol seed treatments control wheat loose smut.

Scab and black-point. Scab and black-point are fungal diseases that attack both wheat and barley seed. The scab fungus also may infect oats. The scab fungus infects the kernels during flowering if warm, wet conditions prevail. Black-point infection occurs from heading to maturity and also is favored by warm, wet weather.

Scabby seed is shriveled, light in test weight, and often has a chalky white or pink discoloration. When planted, scabby seed has poor germination and poor vigor. The scab fungus does not grow systemically from the seed through the plant to cause subsequent head scab infection. The source of head infection is spores from infected small grain or corn residue.

Black-pointed seed has a black to brown discoloration of the embryo or germ end, a discoloration which may extend around the kernel into the crease. When planted, black-pointed seed also may have low germination; if the seed germinates, the seedling roots are often infected by the fungus.

Protectant seed treatments, or protectants in combination with systemics, or systemic products alone have provided significant improvement in stand and vigor. Yield increases also have occurred with treatment of scabby and black-pointed grain. Seed treatment helps assure good stands and seedling vigor; it will not prevent possible scab or black-point infections of the head during the growing season.

Common root rot. (see barley)

Take-all. Take-all is a root disease of barley and wheat caused by a fungus that thrives in very wet soils. Take-all generally is not a serious or common disease in barley or wheat in North Dakota, unless the crop is grown under irrigation. Triadimenol (Baytan), difenoconazole (Dividend) and tebuconazole (Raxil) are registered for suppression of this disease.

Pythium

Damage to wheat from the *Pythium* fungus has not been well documented in North Dakota, but the fungus is common in agricultural soils and generally does more damage where wheat is planted into crop residues and soil temperatures are cool and soil moisture is high. Several seed treatment fungicides are registered for control of *Pythium* spp. in wheat, including difenoconazole + mefenoxam (Dividend XL), mefenoxam (Apron XL), and metalaxyl (Allegiance).

Oats

Smuts on oats have not been reported as a recent problem in North Dakota, although they have been serious in other states in the region. Oat smut can cause severe losses. Distinguishing between covered and loose smuts of oats in the field is not easy. Oat loose smut is more difficult to control with protectant fungicides than oat covered smut, because the loose smut spores are lodged under the hulls where they are difficult to reach. Carboxin and tebuconazole are registered for oat loose smut control.

Scab may infect oats, but it is not common in North Dakota. If scabby oats did occur, the recommendations for wheat would apply for oats.

Legumes

Alfalfa and Small Seeded Legumes

Alfalfa, clover and other small seeded legumes may be treated for seedling blight diseases and damping off. The extent of occurrence of these disease problems in North Dakota has not been documented. Captan or thiram products are registered for seedling blight control, while mefenoxam, metalaxyl, and oxadixyl products are registered for control of *Pythium* damping off and early season infections by *Phytophthora*.

Soybeans

Generally, seed treatment is not required for soybeans. However, it may pay to treat seed if: the germination is below 85 percent; the seeds are contaminated with fungi; the seeds are badly weathered or injured; or the seed coats are broken. If captan or PCNB treated seeds are to be inoculated with *Rhizobium* bacteria, the inoculant should be applied in-furrow. Thiram, fludioxonil, metalaxyl and mefenoxam have little or no effect on *Rhizobium* bacteria. Generally, inoculant is not used on soybeans planted on land that was previously cropped to soybeans.

In fields with *Rhizoctonia* problems, a seed treatment containing carboxin, chloroneb, or PCNB should be used.

Seed infested with *Sclerotinia* should be treated with fludioxonil, which will control infection of seedlings by the *Sclerotinia* fungus.

Dry Edible Beans

Most dry bean seed is treated prior to sale, often with a combination of fungicide, insecticide and bactericide. A fungicide protects against seed- and soil-borne fungi. The bactericide streptomycin controls surface-borne blight bacteria but will not control internally-borne blight bacteria. For *Rhizoctonia* control, see soybeans.

Chickpeas (garbanzo beans)

Several seed treatment fungicides are registered for use on chickpeas. Fludioxonil (Maxim) gives broad spectrum protection against soil-borne fungi; mefenoxam (Apron XL) and metalaxyl (Allegiance) provide very specific and highly effective protection against *Pythium* seed rot and seedling blight and early season *Phytophthora* root rot. Chickpea growers in some parts of western North Dakota have experienced severe difficulty with seed rot of untreated seed and should treat seed with mefenoxam or metalaxyl.

The most serious foliar disease of garbanzo beans is *Ascochyta* blight. *Ascochyta* can be seed-borne, usually at low levels. Wet weather may cause rapid spread of *Ascochyta* from a few infection centers. Thiabendazole (TBZ) is registered for use on garbanzo beans for eliminating seed-borne *Ascochyta*. Purchase of western grown seed that has been laboratory checked for *Ascochyta* also is desirable to minimize the danger of losses from this serious disease, but it should also be treated with thiabendazole.

Lentils

Lentils should be treated with captan, fludioxonil (Maxim), mefenoxam (Apron XL) or metalaxyl (Allegiance). Captan and fludioxonil provide broad spectrum protection against *Rhizoctonia* and *Fusarium* seedling blights. Mefenoxam (Apron XL) and metalaxyl (Allegiance) provide excellent control against *Pythium* seedling blight, but do not provide protection against *Rhizoctonia* or *Fusarium*.

The two most serious diseases of lentils are anthrac-nose and *Ascochyta* blight. Both can be seed-borne at low levels but seed transmission to developing seedlings has not been demonstrated for anthracnose. *Ascochyta* can spread rapidly in wet weather from a few infection centers. The *Ascochyta* that infects lentils is a different species than the one that infects chickpeas. No fungicide currently registered is effective for elimination of either of these disease fungi on the seed. Purchase of western grown seed that has been laboratory tested for *Ascochyta* is desirable to help minimize the danger of losses. Registration of thiabendazole (TBZ) for *Ascochyta* on lentils may occur by 2001 or 2002.

Flax

Flax seed can be attacked by seed- and soil-borne pathogens, especially when the weather is unfavorable for germination and growth or when the seed coats are cracked and split. Seed treatment with protectant fungicides captan, mancozeb, maneb or thiram will reduce the amount of seed rot and seedling blight. Yellow-seeded varieties are more susceptible to seed coat damage than are brown-seeded varieties. All varieties currently being grown are brown-seeded varieties except Omega, which is yellow-seeded.

Peas

Common seedling blights of peas can be controlled with captan, fludioxonil, PCNB or thiram. The water mold fungi *Pythium* and *Phytophthora* are common problems on peas and can be controlled with mefenoxam, metalaxyl or oxydixyl treatments. No seed treatment is registered for *Ascochyta* blight on peas, but data from Manitoba indicates that thiram provides good suppression of seed-borne *Ascochyta*.

Potato

Potato seed pieces are generally treated for disease control. See [NDSU Extension Circular PP-877, Disease Control Guidelines for Seed Potato Selection, Handling and Planting](#), for information on potato seedpiece treatment.

Safflower

Safflower rust is borne on the surface of the seed and produces infections on the hypocotyl of the emerging seedlings. Seed-borne rust can result in poor stands and reduced vigor of the seedlings. Fungicidal seed treatment of safflower with one of several available fungicides is recommended to control seed-borne safflower rust. Carboxin, mancozeb, and thiram are labeled for seed treatment use on safflower. The winter spores of safflower rust can survive from one season to the next in the soil but will not survive to the second season. Control of safflower rust requires seed treatment with a fungicide and crop rotation. Never plant safflower on land that had safflower the year before.

Sugarbeets

Pythium, *Aphanomyces*, and *Rhizoctonia* are fungi that may cause stand establishment and seedling disease problems in sugarbeets. The *Pythium* fungus occurs in most sugarbeet soils. It causes seed rot, pre-emergence damping off, and post-emergence damping off. Post-emergence damping off caused by *Pythium* may occur when the seedlings are so tiny that they dry up and blow away within a day or two. Consequently, *Pythium*-induced seedling death is seldom noticed by the grower. The only thing noticeable may be an unusually poor emergence and stand.

Aphanomyces and *Rhizoctonia* cause death of seedlings at a later growth stage, with plants progressively dying from the two to the eight leaf stage. Later in the season, both fungi may cause a root rot which weakens the plant and also reduces the weight and quality of beet roots. Both diseases are favored by warm soil conditions. *Aphanomyces* is favored by heavy soils with poor drainage, resulting in saturated or puddled soils. *Rhizoctonia* is favored by moist soils.

Most sugarbeet seed is sold treated, but different treatments vary in their effectiveness against these three fungi. Certain fungicides have specific activity: mefenoxam (Apron XL), metalaxyl (Allegiance) and oxadixyl (Anchor) are highly effective against *Pythium*; thiram is moderately effective against *Pythium*; PCNB, chloroneb and fludioxanil (Maxim) are effective against *Rhizoctonia*. Growers planting in fields with known *Rhizoctonia* problems may wish to request a special or supplemental seed treatment from their seed supplier or else use a planter box overtreatment. Hymexazol (Tachigaren) is effective against *Aphanomyces* and *Pythium*. It is available in specially pelleted seed; the 75 g rate provides protection for four weeks.

Canola

Blackleg is a fungus disease of canola that can cause severe losses. It is seed-borne and also spread by wind-borne as well as rain-splashed spores. The wind-borne spores come from canola crop refuse. Most long distance spread of the blackleg fungus is on seed. Most spread within a field or between fields is from wind-borne spores. The severe (highly virulent) strain of blackleg is common. Benomyl seed treatment provides excellent control of the seed-borne phase of blackleg. Registration of other seed treatments effective against blackleg may occur in 2000 or 2001. Seed treatment is highly recommended for all canola seed planted in areas that do not yet have the severe strain of blackleg. In areas where the severe strain is prevalent, it may be necessary to plant tolerant varieties of canola. Other seedling blights may be controlled with captan, fludioxanil or thiram.

Sunflower

Downy mildew is a soil-borne disease that can cause severe losses if excessive rains occur shortly after planting. The downy mildew fungus is wide-spread across North Dakota. It survives many years in the soil and infects emerging or recently emerged seedlings when the soil is saturated. Several new races have occurred in recent years and at present (2000) only one hybrid is resistant to all races. The downy mildew fungus has developed resistance to mefenoxam, metalaxyl and oxadixyl. Seed treatment with these products provides poor to fair control of downy mildew, depending on what percent of the downy mildew population is resistant. No suitable replacement fungicide was available for the 2000 growing season.

Biological Control

Kodiak

Kodiak concentrate contains *Bacillus subtilis* bacteria which colonize the developing root system, suppressing disease organisms such as *Fusarium*, *Rhizoctonia*, *Alternaria* and *Aspergillus* that attack root systems. When used with a chemical seed treatment, the combination of chemicals and Kodiak provides protection to the root for a much longer time than with chemicals alone. As the root system develops, the bacteria grow with the roots extending the protection throughout the growing season. As a result of this biological protection, a vigorous root system is established by the plant, which often results in more uniform stands and greater yields. Registered for seed and pod vegetables, soybeans, wheat and barley, and corn plus all other agricultural seeds.

[Quick Guide](#) to Small Grain and Row Crop Seed Treatment Fungicides (15KB Adobe Acrobat PDF file)

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