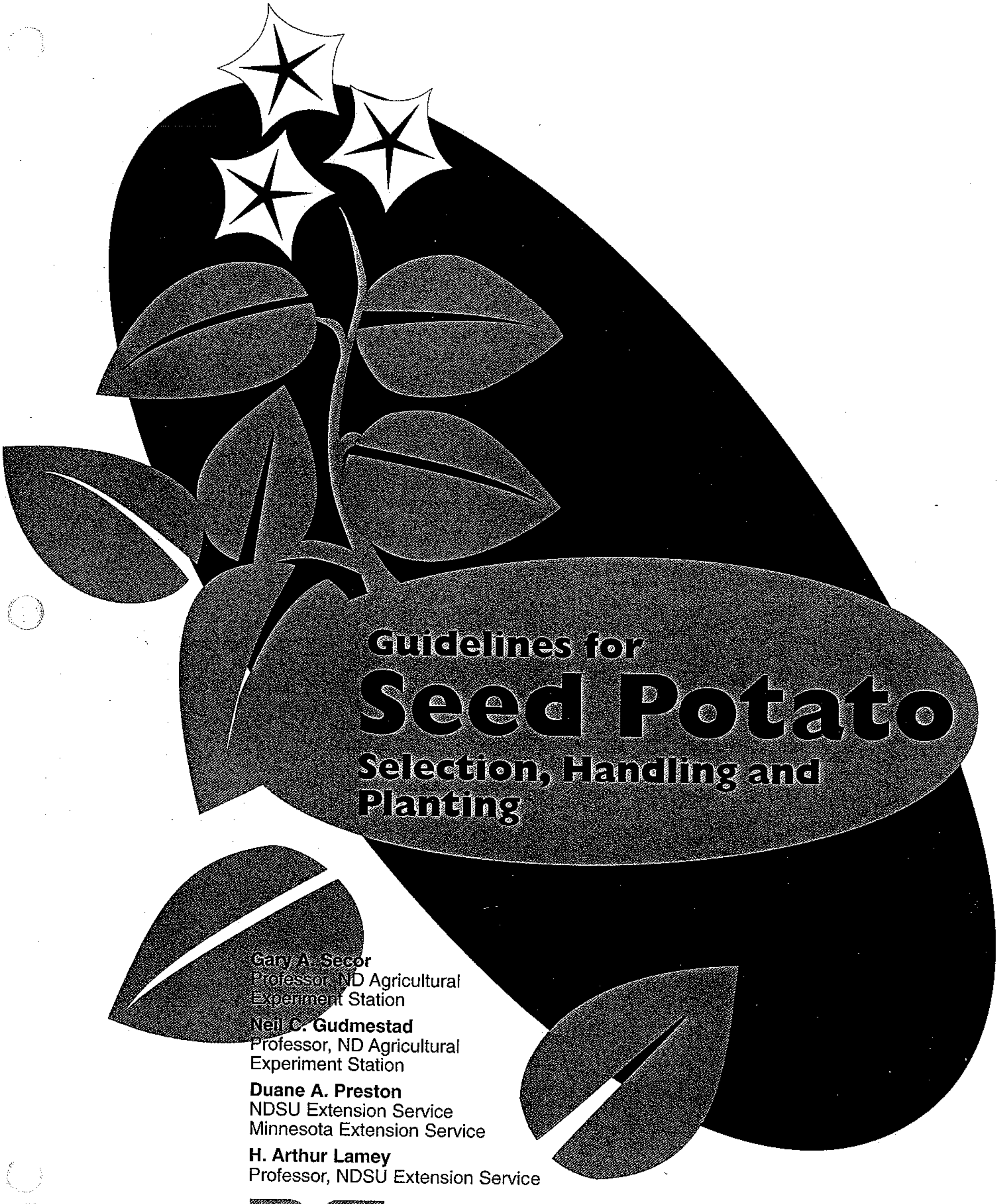
PP-877 (Revised)



Guidelines for Seed Potato Selection, Handling and Planting

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NDSU EXTENSION SERVICE

July, 1997

A major limiting factor in profitable potato production is disease, which can be seed-borne, soil-borne, or both. Vegetative propagation of potatoes and cutting prior to planting increases the chances for transmission of many yield-limiting diseases caused by fungi, bacteria, viruses and nematodes. Total control of many of these diseases is often impossible, and a combination of control strategies is necessary.

The seed potato industry and associated certification system with visible disease tolerances was formed as one strategy to minimize this disease. Even though certification schemes are primarily designed to verify varietal purity, the process also minimizes disease in seed potatoes by establishing disease tolerances. Planting certified seed does not guarantee freedom from disease or disease-causing agents. For example, the bacteria that cause ring rot and blackleg can often be present but in a latent condition (that is, not causing outward signs or symptoms of disease). Fungal organisms such as *Fusarium* and *Helminthosporium solani* may also be on or in the seed tuber. Viruses are invisible to us and may be present but undetected. The handling and sanitation procedures of the seed potato buyer have a strong impact on the performance of the seed lot, including the spread and expression of disease in the crop and the resultant quality and yield. This circular recommends general guidelines for disease prevention in selection, handling and planting of seed lots for the buyer of seed potatoes to help maximize production of a healthy and high quality potato crop.

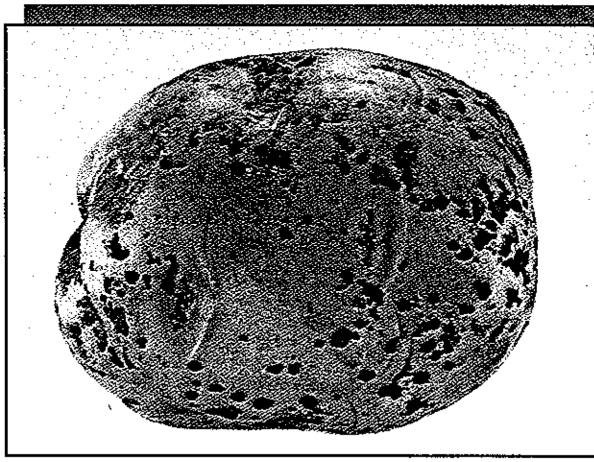


Figure 1.

Selecting Seed

Purchase certified seed. You can be assured that such seed conforms to guidelines of varietal purity, field inspections, and disease tolerances according to certification agency rules and regulations. Buying year-out-seed, culls, oversize or seconds may lead to problems. Ask about the pedigree of the seed; where did it originate, how many generations old is it, who increased the lot, etc. Examine field inspection reports, storage inspections and results of winter grow-out tests in Florida, California, or other southern grow-out areas. Pay particular attention to disease observations and remarks made by field inspectors on field inspection reports.

If possible, make a personal visit to seed growers you are considering purchasing seed potatoes from. Note the general appearance of their fields and storage facilities. The potatoes should be in dark, well-ventilated storage with high humidity but no free moisture, free from visual disease, and not excessively sprouted. Ask if the seed has been treated with Mertect or Dithane ST going into storage to protect from Fusarium dry rot. Ask if seed has been treated with Ridomil in the field to protect it from pink rot and leak (water rots). Ask if bacterial ring rot has been on the farm in the past three years. If so, be aware this disease could be present. Call or write the state certification agency for seed lot records from the past season; they are available to the public. Some facilities, such as the Seed Health Testing Lab at NDSU, offer testing services of seed lots for diseases and pathogens for a fee.

Examine Seed for Disease

There are several diseases to watch for and some simple tests to help evaluate seed lots for disease.

Virus diseases. Certification readings are the best gauges of virus content. Virus symptoms are generally not visible in tubers, except for leaf roll, which causes net necrosis in certain cultivars, notably russets. Some varieties, notably Shepody and Russet Norkotah, do not readily express visible mosaic symptoms, and virus can be present without detection. Serological tests (ELISA) are often conducted for PVY mosaic in these varieties, either in the production or winter grow-out fields. Such tests are routinely used for PVX.

Rhizoctonia. The black scurf stage on the tubers should not exceed 5% of the tuber surface (Figure 1). Coverage greater than this can result in yield and quality losses in the field. This disease is most active in cool soil and causes damage by pinching off the developing sprouts, which must regrow. This process delays emergence, lowers yield and increases off-grade tubers.

Figure 2. External

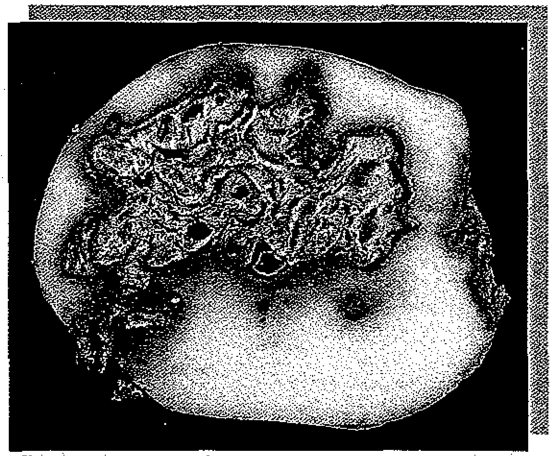


Figure 2. Internal

Fusarium dry rot. The seed should not have many tubers with symptoms of Fusarium dry rot (Figure 2). A 1 to 2% level is reasonable and should not be exceeded in most years; federal regulations allow 1% dry rot at shipping. *Fusarium* inoculum on tubers without dry rot can be determined by cutting 20-30 tubers in half, placing them in a large paper bag or box, and shaking. Read dry rot after 10-14 days incubation at 50-60°F in high humidity. This will indicate the potential for Fusarium seed piece decay and the possible necessity for a seed treatment. In recent years, many isolates of *Fusarium sambucinum* (synonym = *F. sulphureum*), the agent responsible for dry rot, from throughout the US and Canada have become resistant to thiabendazole, the active ingredient in Mertect, resulting in reduced disease control. A modification of this test to determine resistance is to treat cut tubers with TBZ prior to incubating the seed in paper bags or boxes.

Bacterial ring rot. Look for external symptoms of cracks in the skin (Figure 3); cut the stem end of suspect tubers for internal symptoms of ring rot. If no external symptoms are seen, cut the stem end of 100 or more tubers selected at random and look for characteristic ring rot discoloration in the vascular ring (Figure 3). Because other diseases (*Fusarium*) or disorders (freeze injury) may resemble ring rot, squeeze suspect tubers and look for cloudy bacterial ooze from the vascular ring. Suspect tubers should be sent to a competent official for confirmation of ring rot. Do not use seed lots known to be infected with ring rot; seed lots with ring rot are not eligible for certification. The bacteria causing ring rot may be latent in a seed lot without causing symptoms for up to two years, and may be at such a low incidence as to avoid detection during visual inspections. Tests are available to index seed lots for the presence of latent ring rot bacteria. This testing can be done at the Seed Health Testing Lab at NDSU for a fee.

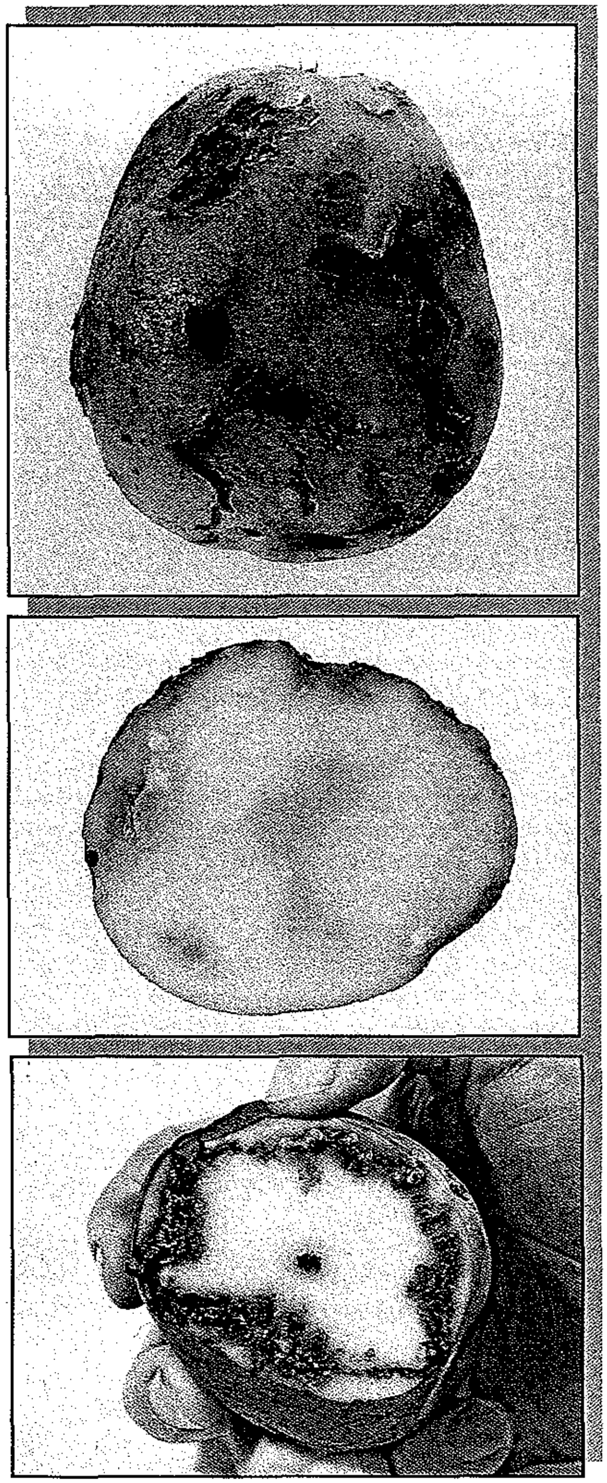


Figure 3.

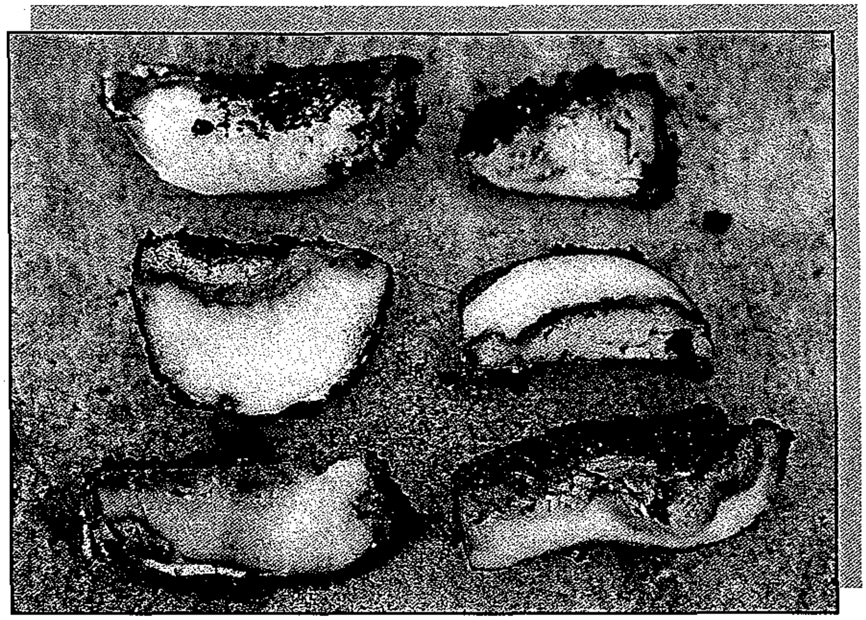
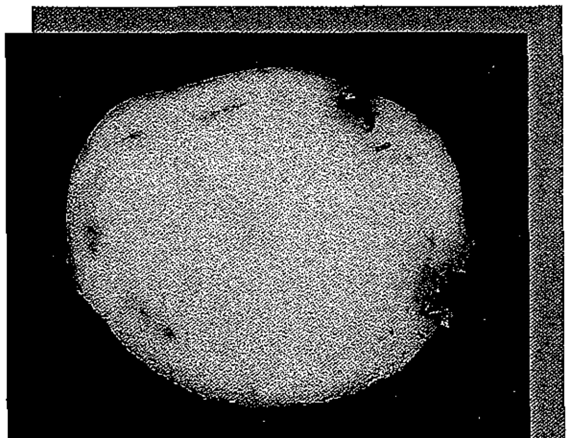


Figure 4.

Soft rot/blackleg. If more than 1% of the tubers show symptoms of soft rot or tuber blackleg (Figure 4), seed may have the potential for excessive seedpiece decay. *Erwinia* bacteria cause soft rot and wet seedpiece decay and can be latent. Because *Erwinia* can reside in the lenticels of the tuber, the number of tubers infested with (carrying) the bacterium gives an estimate of the potential for seed decay. This can be determined by wrapping 40-50 tubers in wet paper towels, and plastic wrap over that for 5-7 days at 50-60°F. A more severe test is to puncture 10 lenticels per tuber with a toothpick prior to wrapping. Soft rot should be odor free, mushy and wet but not sticky and stringy. A sticky, stringy decay with a bad odor indicates *Clostridium* decay and should not be scored. These tests will indicate the potential for soft rot seed piece decay if conditions are favorable for decay. Research results indicate that extra care is needed for seed lots with more than 50% tuber soft rot. If handled properly (see seed handling and planting recommendations), acceptable stands and yields can be obtained. Reducing bruising of seed during handling is the most important consideration for reducing soft rot in the seed.

Verticillium and Fusarium. These two fungal pathogens can cause wilt and early dying. They are easily visible as vascular discoloration in the stem end of the tuber (Figure 5). Internally borne inoculum is not as important as inoculum on the surface of the tuber or in the soil. For the Red River Valley, the amount of *Verticillium* or *Fusarium* in the seed does not contribute greatly to the amount of wilt that results in the field. However, tuber borne inoculum does act as a source of *Verticillium* that will contaminate the soil.



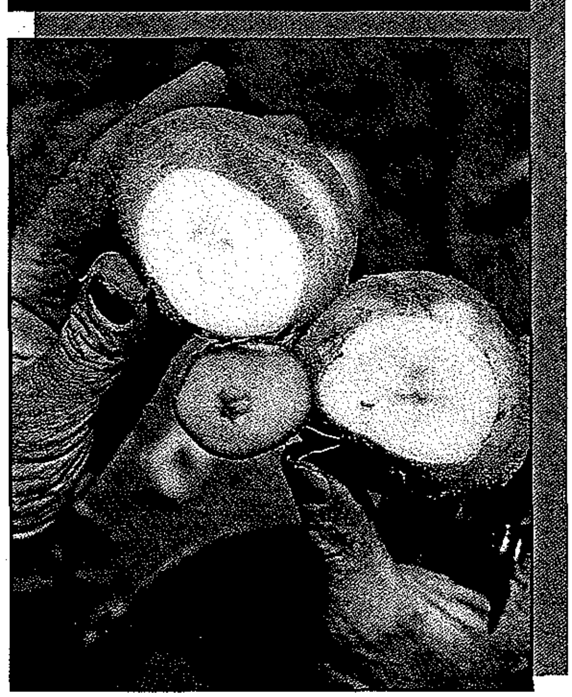


Figure 5.

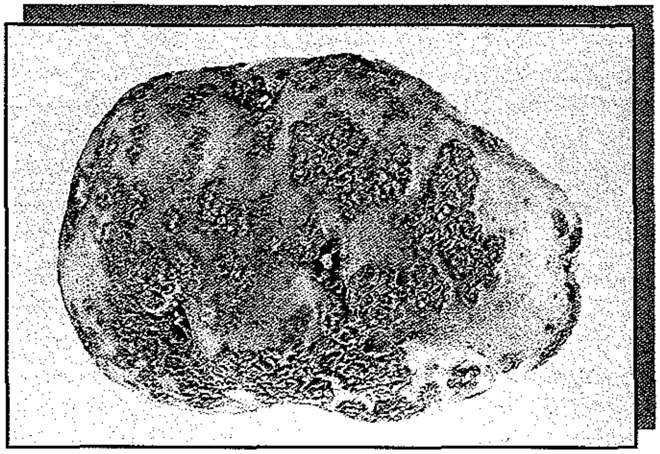


Figure 6.

Scab. This disease, caused by soil borne *Streptomyces*, is soil borne. Infected seed serves to introduce the scab organism into the field but does not provide inoculum for infected progeny tubers. Scab infection comes from scab in the soil, not the seed tubers. Excessively scabby seed is unattractive (Figure 6).

Silver scurf. This is primarily a seed-borne disease, although low levels of inoculum may survive in the soil from one season to the next. It is best to purchase seed with minimum amounts of visible scurf, but in reality, most seed lots have some silver scurf, and the disease may not be observed because many silver scurf lesions are too small to be seen. Silver scurf occurs as scattered golden/silver patches on the skin of the potato, primarily at the stem end (Figure 7). The fungus causing silver scurf, *Helminthosporium solani*, sporulates on seedpieces shortly after planting and moves to progeny tubers during the growing season. Silver scurf-affected tubers are sources of inoculum in storage, and the disease spreads in storage, even at seed holding temperatures. Selection of disease-free seed is desirable, but impractical. The use of seed treatment fungicides is a better option for managing seed-borne inoculum.

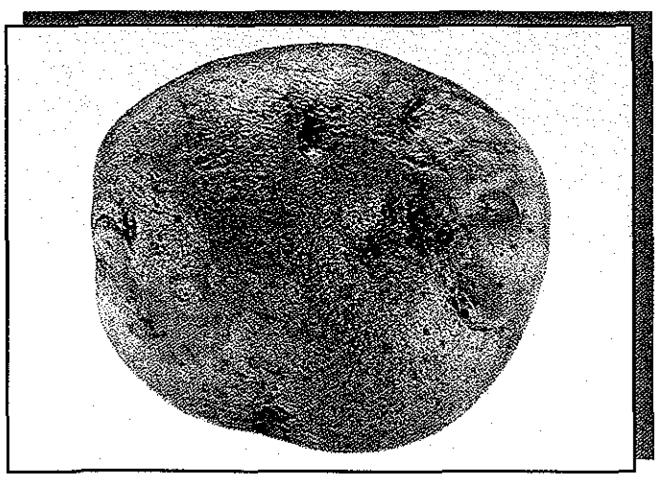


Figure 7.

Figure 8.

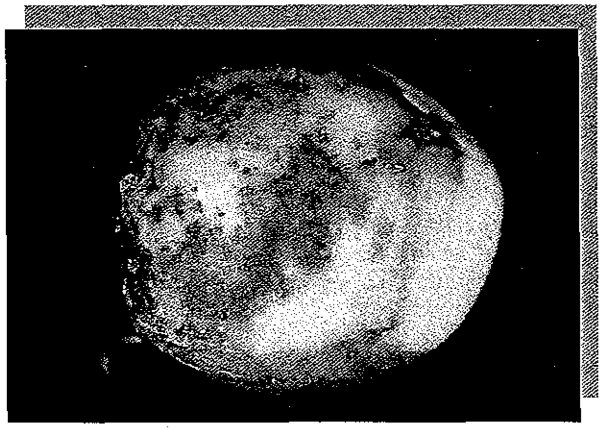


Figure 9.

Late blight. Presence of late blight in seed can be serious and lead to epidemics later in the season. Late blight can overwinter in infected seed and appears as irregular purplish lesions externally (Figure 8), and, if cut about 1/4 inch deep, as granular rust colored areas internally (Figure 9). Late blight tubers do not break down when stored cold (38F) and can act as one source of blight in the field when planted. Greater than 90% of late blight affected seed tubers decay due to secondary soft rot in the field at planting, but the few infected seed pieces that grow can start an epidemic under favorable conditions. Preliminary research has shown that late blight can be spread during cutting which can lead to infected plants early in the season. Seed treatment fungicides have been shown to reduce this infection. Federal regulations allow 1% late blight at shipping. If late blight is suspected, send a sample to a competent pathologist for confirmation. Late blight free seed is the best option.

Early blight. This is a soil-borne disease caused by Alternaria *solani* and is sometimes found in seed lots. It is not considered a seed-borne disease, but a severely infected seed lot may suffer stand and emergence problems due to secondary soft rot and dead eyes.

Nematodes are generally not a serious problem in the Red River Valley. However, certain areas may contain nematodes and more surveys are necessary to determine economic importance. Seed infected with nematodes should not be planted. Planting of nematode infested seed can be the initial source of field infestation which will increase in future years and be difficult to control.

Pink rot and leak. Most seed affected by these diseases, collectively called water rots, usually decays during the storage season and does not persist until spring for planting. However, affected seed should be removed at grading and not planted. Affected seed is watery and has a pink to charcoal black discoloration. Application of metalaxyl in the field when tubers are nickel to quarter in size provides excellent control of these diseases.

Prepare to Accept Seed

After you have selected the seed, agreed to a price and scheduled a delivery time, your storage should be prepared to accept the seed. What you do from here on determines to a large degree how well your seed will perform. Do not store seed in a storage where sprout inhibitors such as CIPC have been used unless the entire ventilation system, including plenums, flumes, fans, ducts, etc. have been thoroughly cleaned. The seed house must be thoroughly cleaned and disinfected to eliminate carryover of disease causing organisms. Ring rot bacteria can persist up to three years on dried surfaces and are capable of surviving freezing temperatures. Clean out all major trash (tubers, vines, dirt, broken boxes, old bags, etc.) and discard or burn. If potatoes are discarded, don't leave them near the storage or in a pile (cull pile). A cull pile is a potential source of many diseases (soft rot, ring rot, late blight, viruses). Instead, burn, chop, compost, freeze or bury discarded potatoes.

Disinfect

After a rough cleanup, thoroughly wash the storage bins, walls and floor with hot soapy water using a high pressure washer and rinse. Follow this with liberal application of disinfectant. In general, disinfectants must be in contact with the surface to be disinfested for a minimum of 10 minutes to kill bacteria. A foaming agent can be added to some disinfectants to help the chemical stay in place, such as on a wall, for 10 minutes. Table 1 lists disinfectant groups commonly recommended and some of their characteristics. There are literally hundreds of brand name disinfectants; most registered disinfectants are effective when used properly at the high label rate.

In addition to the disinfectants in the table, live steam can be used to sanitize. The temperature of the steam contacting the surface to be disinfected must exceed 150°F. Caution: Do not confuse condensed water vapor with colorless steam. Condensed water vapor (clouds) may be at less than the required temperature. Exposure time should be five seconds for fresh, wet bacterial material and 20 seconds for dried bacterial material. Steam must be used properly to be effective. Do not rush steam cleaning. Steam may be most useful for equipment rather than the entire storage because of the need for high temperatures and small surface area covered with the steam appliance.

Following any of the disinfection procedures, rinse well with cold or hot water, remove excess water, replace equipment and make necessary repairs. Wood surfaces can be treated with a wood preservative such as copper-8-quinolinolate, which is fungicidal and somewhat bactericidal. Do not use creosotes or coal tar since they have been canceled for this use in potato storages.

Seed Handling

A separate storage or bin(s) should be available for incoming seed. Keep lots separate if possible. When the seed arrives, inspect the load(s) to be sure it's what you ordered, including correct cultivar, lot and tags. Be sure it has not been damaged or frozen in transit. Store the seed in cool (40-42°F), well-ventilated bins at 85-90% humidity. Avoid or minimize bruising during the handling operation, as any breaks in the tuber skin may act as entry sites for disease. Bruising of the seed during handling is the main factor causing poor seed performance. Warm the seed 7 to 10 days prior to cutting and planting to lower the reducing sugars and give the sprouts a head start on growing. The recommended temperature is 50-55°F; this temperature, along with fresh air and humidity, hastens the wound healing process. The warming time varies depending on cultivar, but avoid excessive sprouts, which can spread disease during cutting. Alternatively, seed can be cut, then warmed seven to 10 days prior to planting, but in practice this may result in excessive decay from bacterial soft rot and Fusarium dry rot. Precut seed should be piled no more than 6 feet high at temperatures less than 60F with plenty of air for drying and wound healing. This practice is beneficial for cultivars such as Nooksack and Atlantic, which have erratic emergence due to long tuber dormancy.

Cutting

Use a clean disinfected cutter. Seed cutters with "open cell" sponge rollers that can absorb water can also absorb ring rot bacteria, which can persist in the sponge from one year to the next and cannot be killed by disinfection procedures. Therefore, use of cutters with water impermeable (closed-cell) sponge rollers is recommended. Keep the blades sharp and adjusted to deliver an average seedpiece weight of about 2 ounces. Clean and disinfect cutting equipment, preferably each day and definitely between seed lots. This will reduce the spread of bacterial disease such as ring rot and blackleg. Watch cut seed (at least spot check) for disease - especially ring rot. If ring rot is discovered, the seed lot should not be planted. Remove and destroy that seed lot, and thoroughly disinfect all cutting equipment and facilities. Provide workers with disinfectants and wash facilities to prevent bacteria from entering the seed cutting area. Dip pans are only effective for a 10 minute dip - a quick dip may not work. It may be better to keep a pair of rubber boots soaking in disinfectant and change boots when entering the warehouse. Provide workers with plastic disposable booties and new gloves daily.

Planting

The three main points of planting are: 1) get good seed, 2) handle it carefully, and 3) use cultural practices that encourage quick emergence. The following checklist of cultural practices to follow at planting seed potatoes will minimize disease and maximize emergence and stand:

- seed and soil should be the same temperature; 50°F is optimum
- avoid wet, soggy soils
- handle seed gently
- do everything possible to encourage quick emergence
- plant shallow and hill plants as they emerge

Seedpiece decay (SPD) can be a major problem in some years in all production areas. The two major causes of SPD are bacterial and fungal. The fungus *Fusarium* and the bacterium *Erwinia carotovora* are capable of causing SPD. *Fusarium* SPD tends to be dry, slow-moving decay whereas *Erwinia* SPD tends to be a wet, fast-moving decay. Both forms are capable of moving from the decaying seed piece into the vascular system of the plant causing wilt and blackleg.

Fusarium decay in the field is favored by a wide range of temperature and moisture conditions. Because this pathogen needs a wound to enter the tuber, it is important to speed the healing of cut seed. Seed containing *Fusarium* dry rot in storage will continue to decay when planted.

Most seedpiece decay is caused by *Erwinia* bacteria. *Erwinia* seedpiece decay (SPD) is favored by cool, wet weather. The cool weather slows down seedpiece growth and the moisture favors the bacterium, which is very sensitive to drying. Excess water also inhibits resistance of the potato to disease. *Erwinia* can enter not only through cut surfaces and wounds but, more importantly, resides in the lenticels (breathing pores) of the tuber. When conditions of low oxygen occur in the field (wet soil), the bacteria become active and can rapidly decay the seedpieces. Most potatoes, except those recently derived from stem cutting programs, contain *Erwinia* bacteria in the lenticels. In a sense, bacterial seedpiece decay is a disease waiting for the right conditions to trigger it.

There are two important factors that affect SPD: 1) the quality of seed - how clean (disease-free) the seed is, and 2) the environment it is planted in - moisture, temperature, soil type, etc. Based on these principles, the following planting recommendations have been formulated for control (or at least partial control) of SPD.

Treat the seed with a recommended seedpiece treatment chemical. There are many chemicals available - experience and the results of professional evaluations in your area should guide you to which one to use. Do not use thiabendazole compounds (TBZ, thiophanate methyl) as a seed treatment if Mertect has been used on the seed in and/or out of storage. Use of thiabendazole as a seed treatment in addition to prior treatment may cause abnormal sprouting disorders, such as tuber formation on the seed pieces instead of sprouting, and may result in poor stands. Some of the registered seed treatments contain captan, thiophanate methyl, mancozeb, bleach and fludioxonil, or mixtures of these compounds. Except for bleach, all seed treatments are fungicides. They are primarily aimed at the seed borne pathogens *Fusarium coeruleum* and *sambucinum*, *Helminthsporium solani* and *Rhizoctonia solani*. In recent years, many isolates of *H. solani* and *F. sambucinum* have become resistant to benzimidazole fungicides commonly used as seed treatments (thiabendazole and thiophanate methyl). Seed treatments containing these compounds as active ingredients are not as effective as they once were at reducing disease caused by resistant strains of these fungi.

The inert ingredients, or carriers, are part of the seed treatments and may play a role in seed treatment performance. Bark carriers, ground up bark of fir, alder or other trees, tend to absorb more moisture than mineral carriers such talc, gypsum or clay. The mineral ingredients may trap water, becoming gummy and cutting off oxygen, leading to more seed piece decay under wet soil conditions. Almost all seedpiece treatments are fungicides. None of the treatments will affect lenticel-borne *Erwinia*. However, because *Fusarium* infected seed is more susceptible to blackleg, controlling *Fusarium* indirectly helps control blackleg. None of the treatments affect fungi (especially *Fusarium*) already in the seedpiece. They affect only pathogens on the cut surface and in the soil close to the seedpiece.

Seed treatments can be used going into storage, at the time seed is removed from storage, or at cutting time. Application time will depend on the individual operation and the particular need for disease control. The usual application time is immediately after seed cutting; consult the product label to determine timing of the seed treatment. Various application methods are available for dust and liquid application of seed treatment fungicides, but more work is needed in the area of fungicide application for dust control and complete coverage of uncut and / or cut seed.

Blackleg can be minimized in a seed lot containing up to 50% of the tubers infested with Erwinia by bruise avoidance, warming the seed, planting in warm soil, and planting shallow to encourage rapid emergence and establishment on their own roots.

If all these recommendations are followed, the seed you bought has a better chance of performing as you think it should. Remember that no single control guarantees freedom from disease. All these recommendations should be combined in an integrated approach with the goal of minimizing losses to disease and maximizing seed performance.

Table 1. Disinfectants commonly recommended for potato handling equipment and storage facilities.

Disinfectant	Inactivated by organic matter	Inactivated by hard water	Corrosive to metal	Safety	Recommended concentration for use	Recommended exposure time	Shelf life	Comments
Quaternary ammonium compounds	Some	No	Slight	Use caution (see comments)	Label directions	10 min	1-2 yr	Diluted disinfectant relatively safe, concentrated form is poisonous. Stainless
Hypochlorites (5.25% bleach)	Yes	No (except iron)	Yes	Irritant, caustic	1:50 (0.1%) or 1:200 (see comments)	10 min	5.25% bleach stable 6 mo. at room temp.	Quick acting, inexpensive; caustic to skin and clothing. Use at 1:50 when mixing with water only. Is more effective at pH 7-8 than at normal pH of 10-11. For maximum effectiveness, use 1 part 5.25% bleach: 200 parts water, 0.6 parts white vinegar. Gives concentration of 256 ppm.
Iodine compounds	Some	No (except iron)	Yes	Relatively safe. Use caution.	Label directions	10 min	1-2 yr	Do not take internally. No longer effective if it loses Yellow-brown color. Tamed iodophor compounds work best.
Phenolic Compounds	Some; not greatly	No	No	Oral poison. Use caution.	Label directions	10 min	1-2 yr	Provides residual action. These have name "phenol" on label of ingredients.
Chlorine Dioxide	No	No	No	Non-toxic	Label directions	10 min	2 wks when mixed. 1-2 yrs in separate containers.	Use potentiated form by mixing base + activator. Broad spectrum activity against viruses, fungi, and and bacteria; does not produce THM.

This circular was produced with the cooperation and financial support of Novartis crop protection seed treatment business unit.

PP-877

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5M-7-97

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