6 Seed Potato Production Management

The Prairie Provinces annually produce more than 25,000 acres (10,000 ha) of certified seed potatoes. Seed potato production for commercial planting is primarily at the Elite 3, Elite 4 and Foundation classes (refer to table 6.1-1 for more information about the Seed Potato Production Pyramid).

The range of potato varieties produced in the Prairie Provinces varies with the demand and ultimate use of the raw potato. Most of the fields entered for certification are for the production of processing potatoes. Russet Burbank and Shepody are the main French fry processing varieties, while Atlantic, Norvalley and Snowden are the main chip processing varieties. The majority of these seed potatoes are grown under contract with potato processing companies. Other varieties are produced for the production of table potatoes. These include red skin, white skin and yellow flesh varieties. In addition, several novelty varieties are produced for the home garden trade.

This chapter was written to provide general information about seed potato certification in Canada. Any persons wanting more detailed information should contact the Canadian Food Inspection Agency (CFIA) local office or the CFIA website (www.cfia-acia.agr.ca).

6.1 Seed Potato Act and Regulations

(D. Kirkham)

In Canada, the inspection and certification of seed potatoes is governed by legislation contained in *Seeds Act and Part II of the Seeds Regulations.* A copy of the Act and Regulations can be obtained at the CFIA website.

The seed potato regulations define seed potatoes as: "potato tubers certified pursuant to Part II of the Seeds Regulations of the Seeds Act for reproduction purposes". Seed potatoes must, therefore, meet the standards set out by these regulations. Potato tubers that do not meet the seed potato standards do not qualify as seed potatoes and are defined as non-certified potatoes or table stock potatoes. Seed potatoes, which have been transported without official tags or a bulk-movement certificate, are also defined as non-certified potatoes (i.e. seed potatoes require an official label or documentation).

The Canadian Food Inspection Agency administers the *Seeds Act and Part II of the Seeds Regulations* and ensures that a uniform standard is applied across the country. CFIA headquarters in Nepean, Ontario, assumes the main administrative role for developing new policies and regulatory amendments in consultation with a national seed potato industry stakeholders committee. The Operations directorate of CFIA is responsible for seed inspections and issuing certification numbers and phytosanitary certificates.

Role of CFIA Officers and Inspectors

1. To approve or reject grower applications for crop inspection.
2. To inspect and verify the cleaning and disinfecting of equipment and storage used in seed potato production.
3. To inspect grower crops and to record and report the inspection results.
4. To pass, downgrade or reject the certification of fields entered for inspection.
5. To issue Growing Crop Certificates to fields passing inspection.
6. To issue Rejection Notices to fields failing to pass field inspection.
7. To revoke certification on crops which fail to continue to meet the certification requirements.
8. To inspect and verify that seed potatoes have been graded prior to shipment.
9. To issue official tags and bulk-movement certificates on seed being shipped.
10. To carry out tuber inspections when a request for re-inspection of a lot has been received.
11. To perform post-harvest inspections of winter grow out plots under disease evaluation
12. To accredit qualifying laboratory testing for seed potatoes.

Responsibilities of the seed potato growers

1. To apply for inspection on the official form.
2. To ensure that all equipment and storage facilities are cleaned and disinfected before being used in the production and storage of seed potatoes.
3. To ensure that only eligible seed potatoes are planted on the seed farm.
4. To ensure the crop is protected from varietal mixture and disease contamination.
5. To ensure the growing crop is well managed.
6. To rogue diseased and off-type plants from seed fields.
7. To ensure the harvested crop is stored in a manner that prevents varietal mixture, contamination by disease, loss of identity, and tuber deterioration.
8. To grade the seed potato tubers to regulatory quality standards and the prescribed size requirements prior to shipping.
9. To correctly label all seed potatoes sold using official tags or bulk-movement certificates.
10. To keep field rotation, varietal history, production & storage figures and sales records to document product activity.

Seed Potato Production Pyramid

Seed potato production in Canada uses a limited generation system, which means that seed passing inspection must advance to a lower class with each generation of production. A seed crop for each production generation cannot be maintained at a specific class or move to a higher class.

Nuclear seed is at the top of the seed potato production pyramid is Nuclear Seed. Nuclear seed must be produced from disease free parent stock in a protected environment (a growth room, greenhouse or screenhouse). The parent stock has been extensively tested to confirm the absence of potato pathogens. Nuclear stock production is subjected to a series of laboratory tests to confirm freedom from certain potato pathogens. These pathogens include: potato virus X (PVX), potato virus S (PVS), potato virus M (PVM), potato virus A (PVA), potato mosaic virus (PVY), potato leaf roll virus (PLRV), potato spindle tuber viroid (PSTV), and bacterial ring rot (BRR).

In the field, seed can be increased for seven years. There are therefore seven sequential classes of seed potatoes in the Canadian Seed Potato Certification system (Table 6.1-1). Each class has a defined tolerance level for the presence of certain diseases and foreign varieties. All classes must be completely free of spindle tuber and bacterial ring rot. The tolerance levels for the other diseases increase slightly with each class produced. Therefore, the class designation describes a precise seed quality based on parentage and the amount of disease detected in the growing crop. Parallel to the schedule of classes is a field generation designation (Table 6.1-1). Contrary to the class designation, the field generation does not involve disease tolerance levels and is not a quality designator. Generation is a term that identifies only the number of years that the seed has been grown in the field or the number of field production generations after Nuclear Seed.

Table 6.1-1 Seed Potato Production Pyramid.

Class		Field generation
Pre-elite	-	1st Generation Seed
Elite 1	-	2nd Generation Seed
Elite 2	-	3rd Generation Seed
Elite 3	-	4th Generation Seed
Elite 4	-	5th Generation Seed
Foundation	-	6th Generation Seed
Certified	-	7th Generation Seed

Application to become a new seed grower

Anyone interested in becoming a seed potato grower should contact the local office of the CFIA. This should be done at least three months prior to receiving seed supplies for the spring planting.

An application made by a new grower will only be approved when cleanup and an inspector of CFIA has verified disinfection of the premises and equipment. This must be carried out before the grower can receive seed potatoes. A new applicant should also be aware that land used for seed potato production must not have been in potato production during the previous two years.

Application for crop inspection

Applications for field inspection should be made on forms supplied by CFIA. The completed application, payment of assessed fees and other required information should be delivered to the address given in the application package for all interested seed potato growers. The application deadline for seed potatoes is June 15 of the current crop year. The following information must be provided for each potato field planted:

1. Variety
2. Hectares
3. Seed Potato Class and certification number
4. Weight planted (in cwt or kg)
5. Location of the field
6. Previous crop grown on the field

The CFIA must be made aware of all crops planted by a seed potato grower (i.e. all crops including those not being grown for seed production must be listed on the application.)

All potato fields planted by a seed potato grower must be planted with eligible seed. This includes Foundation or a higher-class seed, or if U.S. seed is planted it must be of a class equivalent to Foundation or higher. Certified class or non-certified potatoes cannot be planted on a seed potato farm. US seed potatoes must be tested for Bacterial Ring Rot in a Canadian accredited laboratory to qualify for official Canadian certification status.

Additional documentation is required when the applicant has planted seed potatoes originating from another farm. This documentation is required to provide evidence of seed eligibility. It also provides evidence of seed origin and of the quantity of seed planted. The necessary documentation includes:

1. An official tag from one container of those potatoes purchased in containers (The remainder of the tags from bagged seed must be retained by the applicant for inspection by the inspector).
2. A copy of the bulk-movement certificate in the case of seed potatoes purchased in bulk.
3. A copy of a nuclear stock certificate in cases where nuclear stock is planted.
4. An Import Permit from CFIA headquarters and a Phytosanitary certificate from the USA are necessary to import seed potatoes. In addition, for certification eligibility a Bacterial Ring Rot test

from an accredited Canadian laboratory is required and a North American Seed Potato Health certificate from the state of origin is recommended to determine class eligibility of the seed potatoes in the Canadian system.

A map of the exact location of each field should also be included with the application. The map should include as much information as possible about each field (such as landmarks, nearby commercial potato fields, and buildings on the property). Growers should also identify the access route to each field.

Conditions of Inspection

The following conditions may result in the rejection of a grower's application:

1. The total area entered for certification is less than 0.25 acres (or 0.1 ha) in size.
2. Bacterial ring rot infected potatoes were found in the field, buildings, or on equipment used by the grower.
3. An inspector did not verify cleanup and disinfection of the buildings and equipment.
4. Non-eligible potatoes have been planted on the farm. The following are identified to be non-eligible potatoes:
   a) Certified class seed potatoes
   b) US seed potatoes that do not have any Canadian class equivalency.
   c) Non-certified (table) potatoes
   d) Seed potatoes exposed to contamination by ring rot.
5. The crop is growing in a field where there has been an occurrence of bacterial ring rot. (Unless the inspector has verified that the field has been free of potatoes, including volunteers for the previous two years.)
6. The certification fee has not been paid.

An inspector may refuse to inspect a specific crop or field where:

1. A condition exists that interferes with an inspector's ability to conduct a visual inspection of the crop. This can include poor growth, lack of vigour or leaf injury brought about by late planting, lack of cultivation, the existence of excessive weeds, weather conditions, soil conditions, chemical injury, insect damage or pesticide damage.
2. The field is located within 197 feet (60 metres) of another field that has visible symptoms of a virus disease that exceeds the tolerance limits for the class of seed being produced.
3. The distance between adjacent seed potato fields is less than one blank row.
4. The crop is growing in a field where non-certified potatoes were planted in the previous two years.

The seed producer may be requested to submit all the official tags from the containers of seed potatoes that were purchased.

Potato fields entered for certification are inspected two or three times during the growing season by a CFIA inspector, prior to top-kill. At the time of inspection, the inspector will decide whether the crop meets the standards for the class to be produced. Before the inspection occurs, the seed grower should ensure that the seed fields are rogued of diseased plants. Potato fields that are not entered for inspection but are being grown by the seed grower for non-seed use may also be subject to a field inspection.

Disease Standards for Certified Seed Potatoes

The following are the final inspection tolerance levels for Elite 1, Elite 2, Elite 3, Elite 4, Foundation and Certified class seed:

Table 6.1-2 Disease standards for Certified Seed Potatoes

DISEASE & VARIETAL MIXTURE	E1	E2	E 3	E 4	FD	CERT
PSTV	0.0	0.0	0.0	0.0	0.0	0.0
RING ROT	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL VIRUSES	0.0	0.1	0.2	0.3	0.5	2.0
TOTAL BLACKLEG & WILTS	0.1	0.2	0.3	0.5	1.0	2.0
VARIETAL MIXTURES	0.0	0.0	0.0	0.1	0.2	0.5

Nuclear and Pre-Elite class seed have a 0.0% tolerance for all diseases on final inspection.

Nuclear and Pre-Elite class seed have a 0.0% tolerance for all diseases on final inspection.
Finally, a random tuber sample of Elite 2, Elite 3, Elite 4 and Foundation seed lots are subjected to a laboratory test and must be found NOT POSITIVE for the presence of *Clavibacter michiganensis subsp sepedonicus* (Bacterial Ring Rot) before it can be sold (Also see 6.4 *Post Harvest Testing* and Table 6.4-1).

Where an inspector has inspected crops in a seed potato farm and finds they meet the standards set out in the regulations, a "Growing Crop Certificate" will be issued to the grower. The Growing Crop Certificate specifies the following for each crop:

1. Class and variety,
2. Number of hectares that passed inspection, and
3. Certificate number.

Crop certificates will not be issued or may be revoked in the following cases:

1. An inspector learns that any one of the lots are infected with *Clavibacter michiganensis* subsp sepedonicus (Bacterial Ring Rot).
2. An inspector has determined that the crop does not meet the standards for any class of seed.
3. An inspector has determined that the crop has been infected with the potato spindle tuber viroid.
4. The crop has been treated with or exposed to a sprout inhibitor.
5. Any one of the lots has come into contact with used, shared or custom equipment that was used in the harvesting, storing or grading of a lot that was infected with ring rot bacteria.
6. The seed potatoes have lost their identity.
7. The seed has lost its ability to propagate.
8. The inspector determines that non-certified potatoes from another farm are stored with the certified seed potatoes or that the certified seed potatoes were stored, graded or handled with common equipment.

6.2 Early Generation Seed Production

This section to be included in future manual update.

6.3 Seed Potato Production Practices
(Dennis Lidgett)

Many of the practices used in seed production are similar to those used in commercial production. Only those practices that are specific to seed production are discussed in this section. The reader should read the commercial production section of this manual to obtain a more complete understanding of potato production and storage practices.

6.3.1 Seed Selection, Cutting, Planting, Fertility and Weed Control

Seed Selection and Handling

A potato crop is only as good as the seed. When purchasing seed, ensure the supplier has a reputation of delivering a quality product. Also, check that the growing area has a history of producing quality seed. A visit to prospective seed suppliers both during the growing season and once the crop is in storage will assist to ensure quality. Before buying any seed for re-certification, the grower should be satisfied that the seed is going to have a good chance of passing the certification inspections. It is generally fruitless to plant a seed lot having even a low incidence of disease with the expectation that the diseased plants can be removed through roguing. Check the results of field and storage inspections and insist on Post Harvest test results before agreeing to purchase seed. See section 6.4 *Post Harvest Testing* for more information. When negotiating purchase of a seed lot, determine the method of delivery, date of delivery, desired tuber size distribution, tuber temperature and degree of sprout development.

Check the results of field and storage inspections and insist on Post Harvest test results before agreeing to purchase seed.

Inspect the seed immediately (and frequently) during delivery to ensure that it meets the agreed upon quality stipulations. The buyer should contact both the seed potato grower and CFIA within two working days after receiving the seed potatoes, if not satisfied with the quality. If a re-inspection is requested it will be carried out by a CFIA inspector within five working days after receipt of the complaint. The buyer should have seed tags and some unopened sacks (for bagged lots) or the bulk-movement certificate (for bulk lots) on hand, so that the proper information can be conveyed to the inspector when lodging a complaint.

All machinery, transport and storage surfaces that the seed will contact should be cleaned and disinfected prior to receiving new seed. Sanitation consists of cleaning and disinfecting all equipment, storage, tools and pallet boxes that contact the seed potatoes. Since most disinfectants are inactivated by soil and plant debris, it is essential that this material be removed by thoroughly cleaning the equipment and storage with a pressure washer or steam cleaner before the disinfectant is applied. The seed storage and all equipment coming in contact with the seed lot should be disinfected with a quaternary ammonium compound such as Ag-Services Incorporated General Storage Disinfectant, Bardak 2210 Disinfectant Sanitizer, or DMR-23 Disinfectant. Surfaces must remain wet for at least 10 minutes for the disinfectant to destroy disease organisms.

Restrict contact between incoming seed lots and any potatoes left over from the previous year. Cull potatoes are a particularly important potential source of disease. Avoid sharing equipment between farms; sharing seed cutting equipment is particularly risky.

Whole Versus Cut Seed (Also see 3.2.2 Whole Versus Cut Seed)

Whole seed has many advantages over cut seed, particularly in the production of seed potatoes:

- The wounds produced by cutting seed presents entry points for many disease-causing organisms
- Seed cutting equipment contaminated with a disease pathogen spreads disease both within and between seed lots
- Where the seed regulations require tuber unit planting the planting of whole seed is an acceptable alternative
- Whole seed tends to produce large numbers of relatively small tubers, which is ideal for seed production
- Whole seed generally produces a more uniform stand both in emergence percentage and in growth characteristics, which makes more efficient use of the production inputs (irrigation water, fertilizers and pesticides)
- Whole seed eliminates the equipment and labour cost of cutting.

Seed Cutting (Also see 3.2.5 Seed Cutting and 3.2.6 Determining Cut-Seed Size)

Planting (Also see 3.3 Planting Management)

Timely planting is as important in seed production as in table or processing production. Plant early and plan on an early vine kill and harvest. This will reduce the risk of introduction and spread of viral diseases by late season winged aphid. Plant the highest generation seed

lots first to minimize risk of disease. Clean all equipment between seed lots. Cup type planters are less likely to spread disease within a seed lot than pick-type planters.

Seed spacing (Also see 3.3.2 In-Row Seed Spacing)
In-row spacing is the main factor controlling tuber size. Optimum seed spacing is based on varietal characteristics and climactic conditions. Closer in-row spacing is used in seed production to maximize yield of the desirable, smaller tuber sizes. In-row spacing of 6-12" (15-30 cm) are recommended for seed production, depending on variety, irrigated or rain-fed production, area in which the potatoes are grown and other climactic conditions

Fertility (Also see 3.4.4 Fertility and Fertilizers)
Fertility requirements for seed are generally comparable to other types of production. Highly vigorous, early-generation seed may require less fertilizer for optimum yields, particularly if the crop is grown under rain-fed conditions or is going to be top-killed early.

Weed control (Also see 3.6.3 Weed Management)
Uncontrolled weed growth in seed potato fields will:

- Interfere with proper inspection and roguing
- Restrict air flow through the canopy which increases the potential for disease development
- Provide alternate hosts for diseases and insects capable of spreading disease.
- Rob the crop of fertility and moisture
- Interfere with a timely and gentle harvest

Effective weed control in seed fields can be obtained through timely tillage and the application of approved herbicides. Note that some herbicides registered for use in table and processing potatoes are not recommended in seed crops. Caution should be exercised when applying herbicides to adjacent crops. Drift of certain herbicides can be translocated to the daughter tubers. The affected tubers lack vigour and produce plants displaying symptoms of herbicide injury. Herbicide residues from previous crops can also be taken up by the seed crop producing similar results.

6.3.2 Disease Prevention, Roguing and Insect and Irrigation Management

Disease Prevention (Also see 3.6.4 Disease Management)
In seed potato production it is imperative to maintain disease within levels tolerated by the certification system (Table 6.1-2). Failure to achieve the tolerated disease levels will result in either the downgrading or rejection of specific seed lots or in certain cases the rejection of the entire farm from certification. Bacterial ring rot is the most devastating disease since its presence will result in the rejection of the total farm.

Many disease pathogens are normally present in potato production areas. Consequently, there is a constant potential for the introduction of these pathogens into a seed crop. The seed grower must be constantly aware of the potential sources of disease introduction, the mechanisms of disease spread and the methods of preventing disease introduction. Grower reputation is built upon preventing or minimizing disease introduction and spread in the seed crop.

Preventing disease contamination of seed lots is the main objective of seed potato production. Disease contamination can occur from four sources:

1. The parent seed used to produce the crop.
2. The equipment and storage used in potato production and handling.
3. The soil used to produce the crop.
4. Insects transmitting disease from other potatoes in the crop production area.

Preventing disease contamination of seed lots is the main objective of seed potato production.

<u>Seed Source</u>
Many disease problems in a seed operation can be traced indirectly and sometimes directly to purchased seed. This is especially true with bacterial ring rot, although leaf roll and mosaic viruses are also frequently problems in purchased seed. Purchase seed from experienced growers who have a reputation for producing quality, disease free seed.

<u>Equipment Contamination</u>
Contaminated potato handling equipment is an important source of disease introduction and spread. Ring rot bacteria can contaminate equipment used in fieldwork or potato handling and potato structures through contact with diseased material. Dormant ring rot bacteria can survive several years in a desiccated state on the surfaces of equipment or storage structures. For these reasons, seed growers are discouraged from purchasing used equipment or from sharing equipment with other producers. If this type of equipment is used it must be thoroughly cleaned of dirt and debris with a high-pressure washer then disinfected under the supervision of a seed inspector. Parts with the potential to harbour disease inoculum such as the sponge or soft rubber rollers used on seed cutters, should be replaced.

When equipment is in need of a cleanup, the seed potato growers must use proper sanitation procedures and apply them rigorously. Sanitation consists of cleaning and disinfecting all equipment, storage, tools and pallet boxes that contact the seed potatoes. Since most disinfectants are inactivated by soil and plant debris, it is essential that this material be removed by thoroughly cleaning the equipment with a pressure washer or steam cleaner before the disinfectant is applied. The seed storage and all equipment coming in contact with theseed lot should be disinfected with a quaternary ammonium compound such as Ag-Services Incorporated General Storage Disinfectant, Bardak 2210 Disinfectant Sanitizer, or DMR-23 Disinfectant. Surfaces must remain wet for at least 10 minutes for the disinfectant to destroy disease organisms.

Field Borne Diseases

Certain potato diseases can survive from season to season in the field. Depending on the type of pathogen, it may survive in the resting form either in the soil or in potato plant debris, or in a living form in surviving potato tubers. On occasion, diseased tubers survive the winter and grow the following spring as diseased volunteer plants. These volunteer potatoes are a source of contamination for the current season crops. Most seed potato producers practice a three to four year rotation to minimize soil disease problems. Fields with a previous history of bacterial ring rot infection should not be used for potato production for a minimum of two years, and during those two years volunteer potato plants must be eliminated.

Growing Seed Potatoes in a Commercial Production Area (Also see 3.6.2 Insect Management)

Sucking and chewing insects carry many viral diseases of potatoes. For example, aphids transmit potato leaf roll and mosaic viruses from plant to plant. Aphids become infected with the virus while feeding on diseased plants and are capable of transmitting the virus to healthy seed plants. Attempts to control aphids in the seed fields may fail to prevent disease introduction. A virus-infected aphid may feed on a potato plant leaf and introduce the virus into the plant before it succumbs to an insecticide; however, insecticides do prevent disease transmission from continuing unchecked.

Seed growers who are producing in commercial production areas with the associated greater risk of disease inoculum should attempt to isolate their seed fields from potential sources of contamination. If that option is not available, then the grower should attempt to control viruliforous (virus-infected) aphids in the source field before winged aphids migrate to seed fields, spreading virus to the seed crop. If the seed field already has virus-infected plants then the application of pesticides will help prevent spread within the field.

Planting seed with low or zero incidence of virus as reported by a post-harvest test, and limiting the number of seed generations produced in areas of commercial production will help to limit virus spread within seed crops. Roguing all infected plants as early as possible prevents in field spread by aphids.

Roguing

Planting seed with low or zero incidence of virus as reported by a post-harvest test, and limiting the number of seed generations produced in areas of commercial production will help to limit virus spread within seed crops.

The purpose of roguing is to:

- Remove plants of a variety different from that planted in the field
- Remove diseased plants that will produce diseased seed tubers or which represent inoculum sources for disease spread within the field
- Ensure the seed field passes inspection.

Although roguing is a common practice in seed potato production it is only practical when the field is contaminated with a very low incidence of an off variety or diseased plants that are easily distinguishable. When rouging, remove plants, seed piece and daughter tubers from the field.

The process of roguing requires:

- Experienced individuals, who are capable of recognizing the symptoms of the important potato diseases
- Appropriate timing
- Environmental conditions which contribute to the expression of visible disease symptoms.

In addition, roguing is costly, as the field may have to be walked several times to remove the off variety or diseased plants.

Roguing for viral diseases is best done prior to flowering and during overcast weather.

Although roguing is considered to be a valuable tool in the maintenance of seed quality, it is rarely completely effective. Only those plants that are manifesting visually recognizable symptoms can be rogued. Symptom expression can be influenced by many factors including environmental conditions and varietal characteristics. In addition, not all pathogen-infected plants (even those from seed pieces cut from the same tuber) express disease

symptoms to the same degree or at the same stage of growth. The end result is that much of the roguing is conducted to provide a visually clean field that will satisfy the seed certification specifications.

Tuber-unit planting is a tool that has been used to improve the effectiveness of the roguing process. All seed pieces cut from a single tuber are manually fed into a planting mechanism, which places them consecutively in a row. A gap is sometimes left between the seed pieces generated from different tubers. If the plants originating from any of the seed pieces cut from a single tuber express symptoms of disease, then all the seed pieces cut from the tuber are removed from the field. This ensures that all seed is removed from the field even if only one piece is manifesting symptoms of disease or has characteristics of a foreign variety. Since tuber-unit planting is slow and very labour intensive, its use is limited to small plots of high value seed. This practice was a regulatory requirement for the first and second field generations of seed. Regulatory amendments approved in May 2002, resulted in the removal of this requirement from seed regulations, due to cost, and time consideration, relative to industry benefits. However, it is considered an important management tool for seed growers, particularly when a grower has concerns for the level of virus that may be present in seed planted.

Insect Management (Also see 3.6.2 Insect Management)
Certain types of aphids and leafhoppers have the potential to both introduce and spread viral diseases within a seed crop. Controlling the populations of theseinsects by the application of insecticides at planting or after crop emergence will reduce, but not completely eliminate, problems with insect-borne disease. Seed growers should monitor insect populations and if possible, plan on vine killing before insect numbers increase beyond acceptable levels. Isolation and planting clean seed will also reduce the risk of insects spreading disease within the seed crop.

Irrigation (Also see 3.5 Irrigation Management)
A continuous supply of an adequate amount of moisture via timely rainfall or irrigation is crucial for maximizing yields and quality of seed potatoes. Adequate moisture at tuber set is particularly important as it encourages setting of a large number of tubers and controls or reduces the severity of common scab. Over-irrigation increases susceptibility to late blight, blackleg, powdery scab and tuber rots. The wheels on wheel-move and centre pivot irrigation systems may contribute to the transmission of some viral or bacterial diseases within the field.

6.3.3 Harvest and Storage Management

Vine Killing: (Also see 3.8.3 Vine Killing)
The purpose of vine killing in seed production is to:

- Reduce the risk of late season virus transmission by winged aphids. Early generation seed should be killed by mid August
- Stop tuber growth to obtain a desirable tuber size profile
- Promote skin set and prevent bruising. A well-developed skin resists damage during harvest, which reduces the potential for infection to enter the tuber causing rot. Vines should be killed (dead and dry) for 10 to 14 days before harvesting to achieve maximum resistance to bruising and skinning
- Allow easy separation of the vine from the tubers during harvest

Vine killing will reduce the risk of late season virus transmission by winged aphids.

Bruise prevention (See 3.8.4 Bruise Prevention)

Seed Storage (Also see 3.9 Potato Storage Management)
Growers must ensure that each class and variety of seed is kept separate through harvest, grading and storage. Bin dividers can be used to sub-divide larger bins, allowing the safe storage of multiple seed lots. The contents of each bin should be clearly labelled to avoid accidental contamination with differing varieties or generations.

Seed cannot be treated with storage-applied sprout inhibitors such as CIPC. Due to the potential for drift, seed potatoes cannot be stored in the same building as any potatoes treated with CIPC. Similarly, seed should not be stored in buildings treated with CIPC in previous years as this volatile compound is absorbed into the storage structure.

Seed should be cured at 55-60°F (13-15°C) and 95% RH with good airflow for two weeks. Once curing is completed, reduce the ventilation rate and gradually cool the pile to a final holding temperature of 37-40°F (3-5°C) with 95% RH. The condition of the pile should be checked regularly during the storage period. Restrict access to the storage to reduce the potential for introducing disease.

6.4 Post Harvest Testing (D. Lidgett)

The purpose of the post harvest test (PHT) is to preview a seed lot's disease status for the next crop year. Late season virus transmission by aphids is difficult to detect in field inspections as they seldom produce recognizable symptoms. A reliable PHT identifies if virus infections have occurred and enables the grower to determine the crop's suitability for seed purposes. The PHT is performed on a random sample of seed tubers collected by the seed grower. Sample collection is discussed later in this section.

The PHT is not part of the Canadian Seed Potato Certification program. It is an industry-administered program designed to provide a level of assurance of seed potato quality, which is not achievable through the official certification program. Participation by growers in the PHT is voluntary. The value of the PHT is underestimated, since the test is not considered a condition of certification. Nevertheless, it is suggested that all seed lots and fields should receive a PHT.

The Post Harvest Test (PHT) identifies if virus infections have occurred and enables the grower to determine the crop's suitability for seed purposes. All seed lots and fields should receive a PHT.

There are three options for PHT available to the industry. These include:

1. Visual inspections of the growing plants at southern grow-out sites (California, Florida or Hawaii)
2. Visual inspections at the southern grow-out site combined with a laboratory test (E.L.I.S.A.) on leaf material collected at the southern site
3. A laboratory test (E.L.I.S.A.) of leaf tissue collected from plants produced in a growth chamber or greenhouse from tuber samples received from the grower.

The reliability of the PHT results depends upon the following:

- The quality of the sample collected. See below for more details.
- The post harvest test method. Both the grow-out and laboratory PHTs are capable of detecting viruses, but only the grow-out test can detect foreign varieties. The grow-out test is based on a visual assessment of disease symptoms. Expression of visual symptoms is subject to many external factors (i.e. growing environment and variety), which limits reliability. The laboratory test (E.L.I.S.A.) is more reliable at quantifying virus levels because it is not affected by external factors. Certain varieties such as Shepody and Russet Norkotah normally mask the field symptoms of mosaic. A laboratory PHT for PVY should be a standard practice for these cultivars.

Seed potato tubers for Post Harvest Testing (PHT) and for BRR testing must be selected at random to provide an unbiased sample that is representative of the whole field or lot. To ensure the samples submitted for testing truly represent the seed crop, it is suggested that seed growers collect a field sample of about 1000 tubers from each field. A test sample can then be randomly collected from the field sample.

The most efficient method of collecting a representative tuber sample from the crop is to collect the field sample during the harvest operation when all tubers are equally accessible. To ensure a representative sample is collected, one farm staff member should be given the training and responsibility for collecting the tubers. The sample collector should be instructed to collect a uniform number of suitably sized tubers (1 to 2 ounces (30-60 g) from every load delivered to the storage. The number of tubers collected per truck arriving at the storage will depend on the size of the field being harvested.

When the harvest of the field is complete, the field-samples should be bagged, labelled (inside and outside the bag), and placed into proper storage for safekeeping. This field sample will be later sub-sampled for the individual tests.

Four hundred (400) suitably sized tubers are required for most post harvest tests. These samples are randomly collected from the field-samples. It is suggested that the remaining portion of the field-sample be held in the storage as long as possible. This material may be useful if for testing for the presence of genetically modified organism (GMO) or BRR.

Four hundred (400) 1-2 oz (30-60 g) tubers are required for the grow-out PHT. The total weight of the sample should not exceed 50 lbs (22.7 kg). Note: Samples containing tubers in excess of 3" (7.6 cm) in diameter may be rejected for the grow-out PHT. All samples should be packed in new bags and labelled twice (inside and outside) with a tear proof label providing the following information:

- The grower's name
- The Variety
- The Class
- The Certification Number for current production year
- Grower field numbers.

Tubers submitted for the laboratory PHT or BRR test could be any size since only portions of the tubers are sent to the laboratory.

BRR Testing

The current regulatory requirement for testing for Clavibacter michiganensis subsp. sepedonicus, the causal bacteria of Ring Rot, is that all certified seed potato lots except for Pre-Elite, Elite I, and Certified classes, that are sold by a farm unit, must be tested. Contact the Canadian Food Inspection Agency (CFIA) for a list of BRR accredited laboratories.

The size of the BRR test sample required is based on the number of hectares that were entered for certification (Table 6.4-1). The following table identifies the number of tubers required for the test according to the field size.

Table 6.4-1 Field sample size for BRR testing.

TOTAL SIZE OF SEED POTATO FIELD	NUMBER OF TUBERS
larger than 1.000 hectare	400 tubers
between 0.500 and 1.000 hectare	200 tubers
between 0.250 and 0.499 hectares	100 tubers
between 0.025 and 0.249 hectares	50 tubers
less than 0.025 hectares	1 tuber each from 1% of number of plants harvested (minimum of 5 tubers maximum 50)

A note of caution: A negative BRR test is not a guarantee of freedom from ring rot and diligence is required when purchasing seed, since the producing farm's history with the disease is sometime more important than the results of the laboratory test.

6.5 Seed Grading and Marketing (D. Lidgett)

Make every effort to prevent bruising (see section 3.8.4 Bruise Prevention).

Seed potatoes should be sized to meet the market requirements. The standard method of sizing seed potatoes is based on weight. Tubers can also be graded by dimension. When sizing by dimension, screen sizes appropriate for each variety must be used.

All seed potato classes are subject to the same tuber standards (i.e. there is only one quality grade for Canada Seed Potatoes). The quality standards provide a tolerance for symptoms of disease, damaged tubers and varietal mixtures that could affect the quality of the seed. Tolerance for disease and defect in the graded stock is defined by the tuber standards [sections 48.1 (2) to (10)] in the seed potato regulation, which are summarized in Table 6.5-1.

Table 6.5-1 Seed potato grade tolerances.

Disease or Defect	Tolerance (% by count)	
	At shipping	At destination
Soft rot or wet breakdown	0.10%	0.50%
Dry rot, including late blight	1.00%	1.00%
Scab or Rhizoctonia light	10.00%	10.00%
Scab or Rhizoctonia - moderate	5.00%	5.00%
Stem-end discolouration due: to vine killing, frost, heat, or drought with a penetration from 6 - 13 millimetres.	4.00%	4.00%
Tubers malformed or externally damaged.	2.00%	3.00%

In addition, the tolerance for foreign varieties is as follows:

- Elite 3 or Elite 4 classes of seed - none
- Foundation class of seed - 0.05%
- Certified class of seed - 0.10%

In any lot of graded seed potatoes, at least 98% of the tubers shall be firm and well shaped.

Growers are encouraged to take samples of the graded stock regularly during the grading operation to ensure the grade requirements are being met. Where problems are identified, appropriate adjustments should be made at the grading line. These may include adding additional staff or reducing the speed of the conveyers.

Seed potatoes may be packed or shipped in a variety of container sizes, including the normal jute bag and bulk containers. Bagged seed potatoes must be labelled with an official tag that identifies the variety, class and certification number of the seed lot being shipped. The following tag colours identify the respective seed classes:

- Orange tags identify the Elite Classes of seed
- White tags identify the Foundation Class of seed
- Blue tags identify the Certified Class of seed

In the case of bulk loads, the regulations require loads to be accompanied by a bulk-movement certificate. Growers are responsible for the safe storage and correct use of official labels and to ensure the seed is correctly labelled.