On-farm potato disease fact sheet

SeedChange - November 2020

Since 2013, farmers across Canada have been a part of the Participatory Plant Breeding (PPB) Program for potatoes with the University of Manitoba, Agriculture and Agri-food Canada, and the Bauta Family Initiative on Canadian Seed Security. Farmers in the program are now exploring options for the material that they have been working with on their farms.

This document is meant to provide you with an initial glance at potato disease issues that you might need to consider as you decide what you would like to do with your PPB potato material. It is intended as an introduction to some of the main seedborne potato diseases, and some best practices to use on-farm to minimize problems from these diseases. The practices in this document do not guarantee absolute protection from seed borne disease nor do they ensure conformity with regulations in potatoes.

We will be sharing a more comprehensive guide covering the opportunities and challenges we feel are important to consider when deciding what to do with your PPB material. This guide will be available in the spring of 2021.

The following is a list of the topics covered in this document:

Special concerns regarding seedborne potato diseases

Potatoes are usually grown from seed potato tubers, as opposed to true potato seed. Any diseases carried by the seed potato will be present in the plant grown from that seed potato, and may spread to other plants. To avoid a cycle of disease from tuber to plant to daughter tubers, etc., and to ensure successful potato crops, it is best to use high-quality disease-free seed potatoes.

Generally, it is recommended to use certified seed potatoes. In Canada, potato certification follows a "pyramid" structure, where the first generation of tubers are produced from tissue-culture originated plants which are rigorously tested to be disease-free. These seed potatoes may then be grown to produce future generations of different classes of seed potatoes. After 7 generations, seed potatoes are no longer certifiable. Some important diseases are at a zero-tolerance level for all certification classes (generations), while other diseases may be increasingly tolerated with tuber generation.

Seedborne potato disease descriptions

Seedborne potato diseases are caused by a variety of organisms, including bacteria, fungi, viruses, and viroids. Plants can carry these pathogens without any symptoms (latent infection). Understanding the different pathogens will help decide how to manage the problem.

- Bacteria are single-celled microorganisms, which may survive in plant debris, in or on seeds, in association with other hosts, or even on machinery. They can spread throughout all parts of a plant (examples: bacterial ring rot, *Erwinias*).
- Viruses can only live and reproduce in living cells of their host, and require the aid of other organisms or the environment to spread to other plants. Most potato viruses can survive in other plants of the nightshade family (examples: Potato leaf-roll virus, Mosaic virus, PVY, PVX).
- Viroids are smaller than viruses and do not have a protein shell like viruses. They spread very easily between plants, and are also carried in true seeds and pollen. Insects are also important vectors (example: Potato spindle tuber viroid).
- Fungi cause the majority of potato diseases. Plant disease-causing fungi colonize their hosts and obtain nutrients from them. Some can survive in the soil for long periods of time even without their hosts (examples: black scurf, silver scurf, verticillium wilt, late blight, fusarium).

Disease Prevention Practices

There are very few products or tools that can effectively eliminate these diseases. These are some of the best preventative approaches for controlling potato diseases:

- Plant clean seed potatoes;
- If clean seed potatoes are not available, plant with extreme caution. These potatoes should not be integrated with other potato crops, even if they look healthy. Caution should be exercised with storage of their tubers and subsequent growing seasons in respective fields;
- Reduce potential sources of inoculum by removing surviving volunteer plants, rogueing infected plants as soon as possible, rotating crops;
- Sanitize any spaces or machinery used for potatoes (planting, harvest, storage, etc.);
- Control disease-spreading insects.

Tissue culture for the production of clean seed potatoes

Meristem tissue culture is a technique that enables the generation of virus-free tissue. It is based on the principle that certain viruses do not enter into the meristem (tissue found at the growing points of all plants). However, this method will not remove other pathogens, like bacteria or viroids, unless by chance. **Micropropagation** techniques are then used to rapidly multiply the meristem-derived plantlets. It is difficult, but possible, to do this in informal settings. The main challenges are in dissection of the meristem (difficult and requires experience & some special tools), and in controlling contamination without the use of sterile lab workspaces and materials. There are also companies who offer this service.

Summary of main steps in tissue culture and micropropagation (in a laboratory context):

1. Generation of virus-free tissue: Meristem Tissue Culture

* Tubers are sprouted in a controlled environment.
* Sprouts are removed and surface-sterilized. The shoot tip (meristem; preferably <0.2 mm) is carefully cut from the sprout under a dissecting microscope and transferred to a liquid growth medium under aseptic conditions. The meristem will grow into a plantlet.

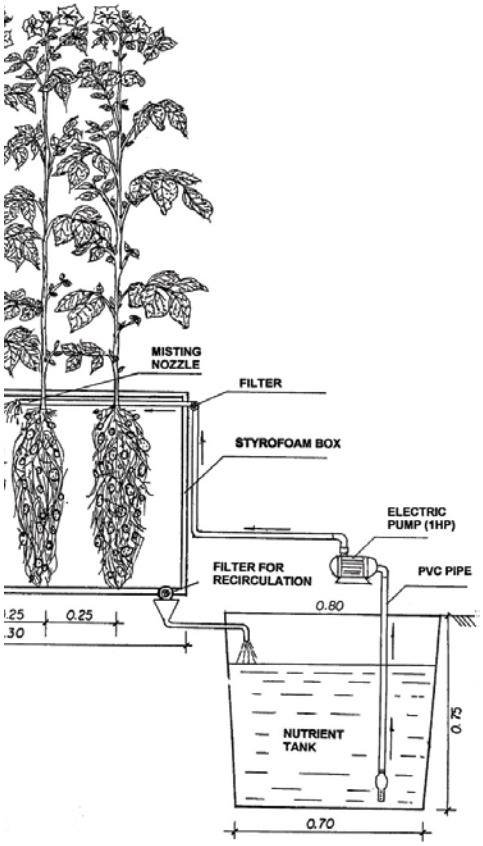
2. Multiplication of plants: Micropropagation

* The plantlet is cut into nodal sections. One section can be tested in a laboratory to ensure that the plantlet is indeed disease-free, while the other cuttings are planted in a solid growth medium to produce new plantlets. This can be repeated until the required number of plantlets is produced.

3. Production of minitubers

* Plantlets are transplanted into soil-free compost, protected from disease-spreading insects. Alternatively, they may be transplanted into clean soil in pots or into an aeroponics setup.

* After growing for up to 100 days (depends on cultivar), minitubers can be harvested.



Aeroponics is a soil-less technology that is being used with some success for the rapid multiplication of seed potato minitubers. The advantages are that a high density of plants can be grown without the need for pots or soil, and minitubers are easy to monitor and harvest. The plants grow in such a way that the roots & stolons are suspended in air, in the dark, and the plant gets its nutrients through regular misting of the "underground" portion of the plant.

The International Potato Center in Lima, Peru, has published a Manual on Quality Seed Potato Production, freely available online, with detailed information about building aeroponics setups and the components of nutrient solutions (cipotato.org/wp-content/uploads/2014/08/005447.pdf).

Table: Problems in seed potato production.

Problem	General Strategy	Formal Approach	On-Farm suggestion
Soil-borne disease	Crop rotation. Reduce sources of inoculum.	At least a 3 or 4-year rotation. Eliminate volunteer potato plants, diseased debris.	At least a 3 or 4-year rotation. Eliminate volunteer potato plants, diseased debris.
Sources of inoculum in fields	Reduce potential sources of inoculum.	Remove surviving volunteer plants and any diseased debris. Rogue infected plants as soon as possible.	Remove surviving volunteer plants and any diseased debris. Rogue infected plants as soon as possible.
Insect-transmitted disease	Control pests (e.g. virus-spreading aphids, leafhoppers).	Apply appropriate insect controls (e.g. pesticides, biopesticide, biocontrol). Plant early and plan on an early vine kill and harvest (to avoid infection by late season winged aphids).	Isolation using aphid-proof screen tents. Plant early and plan on an early vine kill and harvest (to avoid infection by late season winged aphids).
Infection of seed potatoes by diseases from nearby market potatoes	Avoid diseases spreading from one to the other, usually (but not only) by insect vectors.	Isolate seed potato production in regions that do not produce market potatoes. Attempt to control virus-infected aphids in source fields before winged aphids migrate to seed fields. If virus-infected plants are already present, then application of insect controls will reduce spread within the field.	Isolate seed potato production using aphid-proof screen tents. If possible, attempt to control virus-infected aphids in source fields before winged aphids migrate to seed fields. If virus-infected plants are already present, then application of insect controls will reduce spread within the field
Seed potato stock is infected already	Identify disease and generate clean tissue if possible.	Meristem tissue culture and micropropagation (for some viral diseases).	Could try meristem tissue culture and micropropagation. Could outsource meristem tissue culture (some farms have small labs where they could do this for you).

PROBLEMS IN SEED POTATO PRODUCTION (CONT'D)			
Problem	**General Strategy**	**Formal Approach**	**On-Farm suggestion**
Seed potato stock is infected and cleaning is not possible	Avoid introducing diseases	Do not use. Or plant in quarantine.	Do not use. Or, use with extreme caution, away from other potato crops. Store separately from other seed potatoes.
Potato seed pieces become infected and decay or give rise to diseased plants	Prevent infection of cut tubers	Treat cut tubers with fungicides & allow to dry. Or, use whole seed potatoes.	Use whole seed potatoes as opposed to cut tubers.
Prefer to harvest uniform small sized seed potatoes	Maximize yield of desirable smaller tuber sizes	Reduce in-row spacing: *e.g.* 6-12" spacing is recommended for seed production of some cultivars (but depends on other factors)	Reduce in-row spacing: *e.g.* 6-12" spacing is recommended for seed production of some cultivars (but depends on other factors)

Total glycoalkaloid (TGA) level in potatoes for consumption

Glycoalkaloids are naturally occurring secondary metabolites that can be found in potatoes and other plants of the Solanaceae family. If consumed at high levels, they can have toxic effects in humans. Health Canada regulates the amount of total glycoalkaloids (TGA) that are acceptable in potatoes. They are not regulated as a potato disease by the Canadian Food Inspection Agency (CFIA), but we have included a brief summary of the topic here because they are of concern to anyone selling potatoes for human consumption. Health Canada provides a summary on the topic of glycoalkaloids here. Different potato varieties will naturally express different levels of TGA due to their genetic makeup. The expression of TGA will also be affected by a number of other factors, such as growing conditions, storage and light exposure. TGA will be more present in the peel than in the flesh. All registered potato varieties have been tested to ensure they do not naturally express excessive levels of TGA. Health Canada sets standards for total glycoalkaloid (TGA) levels for potatoes sold for human consumption. As of September 2020, the acceptable TGA limit is 20 mg total glycoalkaloids per 100 g (fresh weight) of potato tuber.

There are two unofficial indicators for the presence of elevated levels of TGA in potatoes. The first indication is greening and sunburn on the potato flesh. However, greening can also be the product of certain growing conditions or too much post-harvest light exposure. The second indicator is bitter taste in the potato. These two indicators, however, are not a sufficient

substitute for testing using a recognized method. Health Canada does not accept informal ways of checking for TGA as proof of regulatory compliance.

If a producer is growing a potato variety that is not registered in Canada (e.g. a landrace variety or a new variety the producer has selected on-farm) it has not necessarily been tested for TGA levels. According to Health Canada: "Selling potatoes for consumption which have excess of permitted TGA tolerances is in contravention of Health Canada regulations". The CFIA monitors TGA levels in products sold in the marketplace when deemed necessary on a consumer complaint-driven basis. If you, as a producer, have any concerns about the TGA levels in the potato varieties you are consuming or sharing with others, it is your responsibility to ensure that it is within the acceptable limit set by Health Canada. There are private laboratories in Canada that will conduct TGA testing for a fee. If you would like to be referred to a list of these laboratories, you may contact your Bauta Family Initiative on Canadian Seed Security program coordinator, or the CFIA.