Early Generation Seed Potato Production & Certification

Original source: PAA Commercial Production Handbook, Joe Sieczka and Bob Thornton
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http://www.css.orst.edu/Classes/CSS322/select.htm

Potato is one of a number of vegetatively propagated crops. Potato tubers that either are planted whole or have been mechanically cut are the propagating material. The process of vegetative propagation can cause unique problems in maintaining varietal purity and in the management of "seed-borne" diseases. Disease pathogens present in the propagative material will, with all probability, be transmitted to the progeny. Additionally, the cut surfaces of seed potato tubers are large wounds that can act as infection courts for pathogenic organisms from other sources.

In an effort to provide the commercial potato industry of North America with potato seedstocks that are varietally pure and relatively free of disease-causing organisms: an elaborate system evolved, that of seed potato certification. The process of seed certification has changed a great deal during the past twenty years. Technological advances enabling the rapid multiplication of seedstocks under laboratory and greenhouse conditions as well as sophisticated and sensitive pathogen testing techniques have revolutionized the seed potato industry.

Concept of Seed Potato Certification

Seed potato certification in North America was first discussed during the First Annual Meeting of the Potato Association of America in 1914. By 1920, 12 states and all Canadian provinces were engaged in seed potato certification. In Canada, seed certification is under the general control of the federal government. In the United States, however, seed potato certification is the responsibility of either a land-grant university, a state department of agriculture or a grower (crop improvement) association. As a result, a great deal of diversity exists among states in the rules and regulations that govern the certification process.

The certification agency is generally responsible for conducting all required inspections, be they field, storage or at shipping point. Since participation in seed certification is voluntary, the responsibility to carry out all recommendations and to follow seed certification regulations rests solely with the grower. Interaction and communication between the seed certification agency, the seed potato grower and the commercial potato industry they serve is critical.

In the beginning, the primary purpose of seed potato certification was to provide reasonable assurances of varietal purity. However, that rapidly changed in order to meet the demand of reducing the incidence of seed-borne, virus-caused diseases. Viruses were responsible for the phenomenon known at the time as the "running out" of varieties. Today, in addition to assuring varietal purity, the establishment of disease levels within fields entered into the certification process requires a major effort on the part of certification agencies.

In the past, tubers from individual plants or hills that appeared to be visually free of disease problems were saved for replanting. These hill selections were frequently planted together as a "tuber-unit." In a tuber-unit, a tuber from a hill is cut into seed pieces and planted sequentially in a unit. This unit is followed by the remainder of the tubers from the hill which are also planted as units. If a disease problem appeared in any plant of a tuber-unit, the entire unit would be destroyed (Fig. 9). This procedure was used for several decades as a means of producing and multiplying seed stocks that were relatively free of major disease problems.

Tuber unit consisting of four seed pieces. The four seed pieces are planted as a unit in the field. A sizeable space separates units within the field.

Tuber unit plants in the field showing healthy and diseased units. The diseased units can be identified and eliminated easily.

A number of disease-causing pathogens, however, can remain latent or symptomless within a seed tuber and go visually undetected during the seed certification and inspection process. There have been instances when the disease problem was not detected until the seed lot was purchased by a commercial grower, resulting in severe economic losses. This resulted in the development and adoption of new laboratory testing and seed stock multiplication techniques that have dramatically affected the quality of certified seed potatoes. Today, nearly all certified potato seed stocks originate from meristem tissue-culture plantlets produced under laboratory conditions.

Meristem Tissue-Culture Seed Stock Development

The advent of tissue culture, in which plants are grown in artificial media under sterile conditions in the laboratory, has revolutionized nuclear seed stock development. Most certification agencies currently operate tissue culture laboratories that produce the initial stocks of pathogen-free planting material. A number of private companies throughout the United States also produce meristem-derived, pathogen-free seed. These companies either market their seed stocks locally or on a national scale.

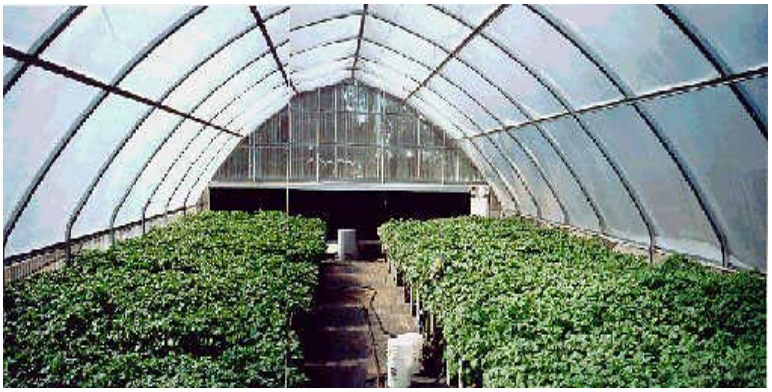
The tissue culture procedure involves the removal of the small growing point or meristem, approximately the size of a flake of black pepper, from a tuber sprout or stem of a potato plant. The meristem is placed in a test tube or other vessel with media containing all of the necessary macro- and micronutrients, carbohydrates, growth regulators and salts required for growth and development into a plantlet. Once the plantlet is growing, it is ready for nodal cutting and pathogen testing (Fig. 10).

A nodal cutting from a tissue culture plantlet is a stem segment containing an axillary growing point and a leaf. Since a tissue culture plantlet has its own leaves, it is capable of producing its own food. Therefore, the nodal cutting is placed on a different medium that promotes root and shoot development. The nodal cutting process will be repeated many times in order to increase and obtain the number of tissue culture plantlets needed for minituber production.

Meristem Culture in Oregon: The apical meristem together with one to three young leaf primordia , measuring 0.1-0.5mm, has been referred as meristem-tip. It is well known that the distribution of viruses in plants is uneven. In infected plants the apical meristems are generally either free or carry a very low concentration of the viruses. Meristem-tip culture although mainly used for virus elimination , it has also enabled plants to be freed from other pathogens, including mycoplasmas, bacteria, and fungi. Although the apical meristems are often free of viruses, there are evidences that suggest some viruses actually invade the meristematic region of the growing tips. Potato Virus S (PVS) and Potato virus X (PVX) are difficult to eliminate by thermotherapy or meristem-tip culture alone. In such cases it has been possible to obtain virus-free plants by combining meristem-tip culture with thermotherapy. Anti viral chemicals have also been used to eliminate viruses alone or in combination with meristem culture or heat treatment. In our laboratory we have combined meristem-tip culture with heat treatment and chemotherapy to achieve a high percentage of plantlet regeneration & eradication of viruses.

←Tissue culture plantlets in test tubers. The plantlets have to grow in an environment designed to produce disease-free planting stock.

Minituber Production Greenhouse →



During the initial nodal cutting process, pieces of the plantlet are retained for laboratory testing for the presence of disease-causing pathogens. Each plantlet of each variety is exhaustively tested for the pathogens causing soft rot, blackleg, ring rot and spindle tuber. In addition, each plantlet is tested for potato leaf roll virus, potato virus Y. potato virus X, potato virus S. potato virus A, and potato virus M. At this stage, 100% of all tissue culture seed stock is tested for disease-causing pathogens. During latter stages of seed stock development, seed certification agencies test 0.5-25% of the plants.

Once the laboratory has produced the desired number of plantlets for each variety, they are ready for tuber production. These plantlets can be planted outdoors directly into the field if great care is taken but are most commonly planted into beds in a greenhouse or screenhouse for minituber production. Under the controlled conditions of a greenhouse or screenhouse, the plantlets can be carefully cultivated and monitored. Several months, after planting, minitubers can be harvested and stored until the following growing season. Minitubers range in size from 1.3 - 5.1 cm (0.5 - 2.0 in) and are priced accordingly (Fig. 11). Microtubers, tubers produced in tissue culture medium, are also being marketed for their use in the production of disease-free seedstocks. At the current time, microtubers appear better suited for planting in greenhouses and screenhouses rather than in the field due to their extremely small size.

Mini tubers derived from greenhouse production of tissue culture plants. Mini tubers range in size from 1.3 to 5.1 cm.

Minitubers or tissue culture plantlets planted into the field are the initial source of certified seed potato lots. These lots will be multiplied and increased until a sufficient quantity is available for commercial use. During the increase process, the seed lots are subjected to visual field inspections and further disease testing. The number and intensity of which is greatly dependent upon the certifying agency in which the seed is being produced. However, all states and Canadian provinces have either a voluntary or mandatory limited generation system, depending on the seed production area.

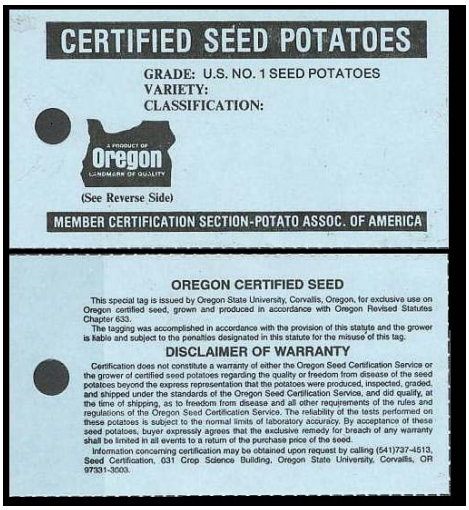
Limited Generation Seed Production

During potato production, seed or commercial, the plant is constantly exposed to sources of contamination by disease-causing pathogens. The probability of a seed tuber or seed lot becoming contaminated with pathogenic organisms increases every year the seed lot is in production. To minimize this, seed certification agencies have enacted regulations that basically restrict or limit the number of years the seed lot can be eligible for the seed certification process. This system is referred to as limited generation. Limited generation systems are handled differently in each seed production area. Additionally, the name of the seed class or number of the seed lot generation varies considerably among seed certification agencies.

Seed lots are limited in the number of years that they can be produced in the field after the tissue-culture derived material has left the laboratory or greenhouse. This varies from five to nine years, depending upon the seed production area (Table 13). Seed certification agencies also differ in what term is used to describe the generation of the seed lot. Much of this variation is influenced by whether or not the tissue culture plantlets or minitubers were produced on a state or provincially operated farm or on individual seed grower farms. Maine, New York, Wisconsin and Canada all operate seed farms. In general, seed produced from these farms does not receive a generation number until it leaves the farm and is grown by individual seed potato mowers. Some seed certification agencies also have specific criteria relating to disease tolerances and other regulations for each successive field planting. Since this can be very confusing, even to seed certification personnel, commercial growers are encouraged to contact the certification agency responsible for seed certification in the production area in question.

←Certification Inspection

Certification Tag →



Limited generation certified seed potatoes: field planting equivalency.[1]

	Term used by Agency for seed potatoes harvested from field planting number[2]							
Agency	1[3]	2	3	4	5	6	7	8
Alaska	G1	G2	G3	G4	G5	G6	--	--
California	N	G1	G2	G3	F	C	--	--
Colorado	G1	G2	G3	G4	G5	G6	--	--
Idaho	N	G1	G2	G3	G4	G5	G6	--
Maine	(MPBF)*			G1	G2	G3	G4	G5
Michigan	N	G1	G2	G3	G4	G5	--	--
Minnisota	N	G1	G2	G3	G4	G5	--	--
Montana	N	G1	G2	G3	G4	--	--	--
Nebraska	N	G1	G2	G3	G4	G5	--	--
New York	(UF)*		FU1	FU2	FU3	F	--	--
No. Dakota	N	G1	G2	G3	G4	G5	--	--
Oregon	N	G1	G2	G3	G4	G5	--	--
Utah	G1	G2	G3	G4	G5	G6	--	--
Washington	N	G1	G2	G3	G4	--	--	--
Wisconsin	(U of W)*		FG2	FG2	FG3	FG4	--	--
Canada	PE	E1	E2	E3	F	C	--	--

*MPBF=Maine Potato Board Farm, UF=Uihlein Farm, U of W=University of Wisconsin Farm

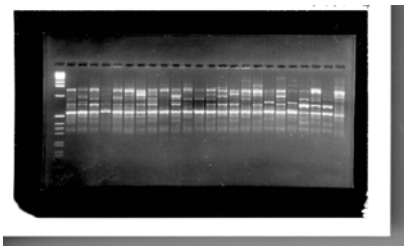
[1]The purpose of this table is to express equivalency of terms used by various certification agencies for seed potatoes harvested from a series of successive field plantings. For specific criteria relating to disease tolerances and other requirements, the reader is referred to the certification regulations of the agency in question.

[2]C=certified, E=elite, F=foundation, N=nuclear, U=Uihlein, PE=pre-elite, G=Generation.

[3]The first field planting utilizes laboratory tested stocks which may be tissue cultured plantlets, greenhouse produced minitubers, stem cuttings or line selections. Contact agencies for details as to types of stocks planted in their programs.

DNA fingerprinting for Variety Identification

Potato plants produced by meristem-tip culture, or micro propagation, are generally uniform in nature, and rare variants are usually attributed to spontaneous mutation. Chances that variations occur are much greater if the system is based on adventitious shoot formation, and still greater with embryogenesis, callus and cell systems. With any propagation system, no method can guarantee 100% true-to-type plants. However, there is a need to produce high quality & uniform plants to be competitive in potato industry**.**



Traditionally identification of potato cultivars depends on key morphological traits such as tuber type, leaf type, growth habit flower color etc. However, only a limited number of traits are stable over all environments, and several months maybe required to observe the distinguishing characteristics. Recently, a number of polymerase chain reaction (PCR) -based techniques have been developed for the analysis and isolation of genetic markers. Random amplified polymorphic DNA (RAPD) and more recently, the amplification of highly polymorphic microsatellite or simple sequence repeat (SSR) sequences have become popular choice because of their simplicity & ease of use for exploring genetic polymorphism's. To ensure genetic purity & uniformity of our stock plants in our laboratory we have combined RAPD and microsatellite markers to identify potato cultivars.