SEED CERTIFICATION-THE GENERATION AND FLUSH-THROUGH SYSTEM, DOES IT EFFECT SEED PERFORMANCE?

by
Neil C. Gudmestad
Department of Plant Pathology
North Dakota State University

Introduction

Potato is one of a number of vegetatively propagated crops. The material used in planting the crop are potato tubers that either are planted whole or that have been mechanically cut. 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 seed stocks 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 seed stocks under laboratory and greenhouse conditions as well as sophisticated and sensitive pathogen testing techniques have revolutionized the seed potato industy. The purpose of this presentation is to demonstrate what current seed production systems mean to the commercial potato producer.

Meristem Tissue-Culture Seed Stock Development

The techniques involved in the production of potato seed stocks that are relatively free of disease-causing pathogens has changed a great deal in the past two decades. 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. This procedure was used for several decades as a means of producing and multiplying seed stocks that were relatively free of major disease problems.

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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.

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. Nearly all 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 regeneration into a plantlet. Once the plantlet is regenerated, it is ready for pathogen testing and eventual increase in the laboratory and in the greenhouse.

Minitubers, microtubers or tissue culture plantlets planted into the field are initially the source of certified seed potato lots. These lots will be multiplied and increased until a sufficient quantity is available for field planting. 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 dependant upon the state in which the seed is being produced. However, all states and Canadian provinces have 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 a 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. 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 growers. 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.

Effect of Generation on Seed Performance

The effect of generation on seed performance was studied in the field over a three year period. Six potato cultivars were included in the study; Russet Burbank, Russet Norkotah, Shepody, Norgold Russet, Monona and Norchip. Seed lots of these varieties were collected from seed farms in which several generations of each variety could be obtained on a single farm to minimize the effect of physiological age on seed performance. Approximately ten seed lots of each variety were planted each year. Seed sources were either from a tissue-culture derived source or from the classical tuber-unit method of seed multiplication without a pathogen clean up process.

Seed lots were collected and maintained at 5C until planting. One hundred tubers of each seed lot were evaluated for contamination levels of Erwinia carotovora, cause of soft rot and blackleg. The experiment was planted dryland each year of the three year study and under irrigation in two years of the study. Incidence of E. carotovora-caused disease and yield were collected during each year of the study.

We observed great fluctuations in the amount of contamination of soft rot and blackleg bacteria in each generation of seed lot. However, contamination by soft rot and blackleg bacteria generally increased as a seed lot became further removed from the laboratory pathogen clean up process. Individual farms where the seed was produed also varied greatly in the amount of E. carotovora contamination in seed lots. This is presumably caused by differences in location and sanitation practices on the farm. The amount of E. carotovora recovered from seed lots produced in the 'old' tuber unit process were significantly higher than any seed lot derived from tissue culture. This is presumably because the tuber unit produced seed lots were never subjected to a pathogen eliminating process. There was no correlation between variety and the amount of seed lot contamination.

To determine the effect of generation on yield, we averaged each generation of seed lot of each variety over the three year period. We found that little differences existed in yields of seed lots in generation 1-4. However, after generation 4, yield appeared to drop off dramatically. We also noted that some potato varieties respond more positively in lower generations of seed than others. For example, low generation seed lots (generations 1-3) of Shepody, Monona and Norgold Russet were significantly better than higher generation seed lots (generation 4-6). Russet Burbank was affected least by generation of seed.

Summary

Significant changes have occurred in the past ten years in the production of certified seed potatoes throughout North America. Tissue culture-derived potato seed stocks coupled with limited generation systems make todays production of seed very high quality. These changes have led to a seed product that will perform better in the field for the commercial potato producer. Low generation seed (generation 2-4) generally out-yields higher generation seed and will also have greater freedom from disease. Potato varieties differ in their response to this system of seed production with those varieties more susceptible to bacterial disease contamination most positively affected.

LIMITED GENERATION CERTIFIED SEED POTATOES

Field Planting Equivalency Table[1]
Prepared by the
Certification Section of the Potato Association of America

	Term[2] used by Agency for seed potatoes harvested from field planting number							
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	(Maine Potato Board Farm)			G1	G2	G3	G4	G5
Michigan	N	G1	G2	G3	G4	G5	--	--
Minnesota	N	G1	G2	G3	G4	G5	--	--
Montana	N	G1	G2	G3	G4	--	--	--
Nebraska	N	G1	G2	G3	G4	G5	--	--
New York	(Uihlein Farm)		FU1	FU2	FU3	F	--	--
North 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 Farm)		FG1	FG2	FG3	FG4	--	--
Canada	PE	E1	E2	E3	F	C	--	--

[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.