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POTATO CULTIVAR RESPONSE TO LATE BLIGHT AS AFFECTED BY CLONAL SELECTION AND *IN VITRO* CULTURE

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Abstract

Response to foliar late blight for Superior and Sebago was not affected by the two potato seed selection and multiplication methods. Kennebec and Russet Burbank potato plants derived through *in vitro* tissue culture techniques had significantly more late blight damage on only 4 of 7 and 2 of 7 observation dates, respectively, than plants derived through a clonal selection system. In practical terms, the disease response differences between the two seed propagation methods were minimal. Similarly, disease response differences among the 2 and 3 years of field multiplication for Russet Burbank and Kennebec, respectively, did not demonstrate any significant disease response trends. In general, *in vitro* culture plots had slightly higher yields than clonal plots but only Kennebec had a significant yield response. The incidence of late blight storage rot was generally not significantly different but clonally selected Kennebec potatoes had significantly more disease than those produced through *in vitro* culture.

Introduction

Production and maintenance of high quality seed potatoes for the potato industry has developed, in the last 20 years, into a technologically advanced system as outlined during a recent symposium (3). In the past, "healthy" potato tubers with various "desirable" qualities were selected annually from "seed plots" by the seed grower. Following field multiplication of this clonally selected material, it would be distributed to commercial potato producers. However, advances in disease detection methods, increasing restrictions on the importation and planting of diseased potatoes, and demands from the potato industries for rapid introduction of sufficient quantities of new potato cultivars have forced those involved with the maintenance and multiplication of initial seed stocks to adopt new potato culture methods.

Presently for most "elite" seed farm operations, original potato seed sources are not maintained solely in the field (1). Early generation material is cultured *in vitro* as test-tube plantlets or greenhouse/screenhouse grown

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plants. The original source of potato for this system is no longer only a field grown potato tuber but rather is often a meristem from the growing tip of a plant part or a stem cut from an *in vitro* cultured plantlet or plant. These are used to produce new plantlets and subsequently plants or tubers for field planting. This *in vitro* potato tissue culture system provides greatly improved opportunities for maintaining and rapidly producing material for the field, having almost complete freedom from infection and infestation by many types of bacteria, fungi, and viruses.

During the past ten years, potato producers in the Maritime provinces and States of northeastern North America have been cultivating more potatoes derived from the *in vitro* culture potato seed propagation system than from the more traditional clonal selection method. "Healthier" plant appearance and greater tolerance to environmental stress has been reported with *in vitro* culture derived potatoes than with clonal selection material (2). But, some potato producers in Prince Edward Island, New Brunswick, Quebec, and Maine are finding other differences that are less pleasing (personal communication, seed farm, extension and research personnel). Concerns are expressed regarding fertilizer requirements with reduced rates for *in vitro* culture seed often suggested. This may be explained as *in vitro* culture material is generally less contaminated with plant pests than clonal selected material, since it has not been exposed to natural conditions to the same extent. However, complaints about the *in vitro* derived seed having greater susceptibility to late blight, storage rots, and tuber skinning are not as easily understood. To examine these concerns studies were conducted in the field and in potato storage to determine the different potato late blight disease responses of four cultivars the seed of which had either been derived through the traditional clonal selection method or from the more advanced *in vitro* culture system.

Materials and Methods

Elite seed potato tubers of Superior, Kennebec, Russet Burbank, and Sebago were obtained from the Prince Edward Island Potato Board, Fox Island Elite Seed Farm, Alberton, P.E.I. The seed was derived from either a clonal selection or an *in vitro* culture system of propagation. Clonal selection method involved screenhouse and field tuber multiplication procedures while the *in vitro* culture method involved *in vitro* potato tissue multiplication (meristem test-tube culture, stem cutting and greenhouse/screenhouse propagation) prior to introduction of tubers to the field. Tubers had been field grown in seed multiplication plots for 2, 3, or 4 years, tested serologically for bacterial and viral diseases, and rogued to ensure disease-freedom. Seed was available for only years 2 and 3 for Russet Burbank and year 4 for Sebago.

For each treatment, four replicate plots consisting of five rows (7.5 m in length, spaced 0.9 m apart) were established in a randomized complete

block design in 1987. The inner 3 rows were planted with the appropriate test cultivar and the outer 2 rows were planted with the late blight susceptible cultivar Green Mountain. All five-row plots were separated by two buffer rows (cv. Green Mountain) for tractor operations. Whole (35-55 mm), greensprouted seed tubers were hand-planted 30 cm apart on 20 May and recommended crop management practices were followed (fertilizer 17-17-17 at 800 kg/ha; herbicides- metribuzin 75WP, 0.73 kg/ha; fungicides- none; insecticides- endosulfan 400EC, 1.5 l/ha; deltamethrin 2.5EC, 0.25 l/ha; top desiccant- diquat 20SN, 2.25 l/ha) during the growing season. Plant emergence counts on the center row of each five-row plot were made on June 29 and were 100%.

A sporangial suspension (20,000 spores/ml) of the pathogen, *Phytophthora infestans* Mont. de Bary (races 1,4 - cultured on leaves of Green Mountain) was applied (backpac sprayer) to the foliage of plants (approx. 150 ml/plant) in the two outer rows of each five-row plot on July 24. Plots were mist irrigated (3-5 mm/hr for 2-4 hr periods) as needed during July and August to maintain the disease in the inoculated rows. Disease determinations (amount of infected foliar and stem tissue visually assessed as a percent of total plant foliage) of plants in the center row of each five-row plot were estimated regularly throughout August and September.

Top desiccant was applied on September 12 and plots were harvested and graded on 2 October for size (0-54 mm, 55-85 mm). Harvested tubers were then size graded and washed to remove all soil. Twenty healthy tubers (55-85 mm) were selected and divided into 4 replications of 5 tubers for storage rot studies. Holes (2 mm wide and 6 mm deep) were punched (nail tip protruding through a block of wood) into the stem-end, side (mid-point between ends) and eye-end of each tuber which was then immersed in an inoculum suspension (15,000 sporangia/ml) for 1 minute. As controls, some tubers were immersed in water. Five tubers were then placed in open mesh "onion" bags and stored at 5 C for about 35 days. After storage, tubers were cut to fully expose the length of the holes and rated (scale=0-4) on the basis of: 0 = no late blight symptoms in the tuber tissue; 1 = trace (1-2 mm of tuber tissue discoloration); 2 = slight (3-4 mm); 3 = moderate (5-10 mm); and 4 = severe (more than 10 mm). In addition, the tuber surface area not associated with the three wound sites was assessed for the degree (scale = 0-4) of late blight tuber rot symptom development. This allowed assessment of disease establishment under non-wound tuber infection conditions.

All data were subjected to factorial analysis and mean separation tests for each cultivar. For foliar late blight response data, analyses were conducted on non-transformed and arcsin transformed values but as no differences were found non-transformed data values are presented. For storage rot data, the 5 tuber sub-samples for each replicate were averaged and assessments for "water" check tubers were subtracted from assessments for inocu-

lated tubers prior to analysis. In addition, prior to analyses, assessed values for the three wound sites (stem-end, eye-end, and side) were used to calculate a mean tuber rot index ([[(# tubers rated 1)*1]+[(# tubers rated 2)*2]+[(# tubers rated 3)*3]+[(# tubers rated 4)*4)]/[(# tubers rated)*4)]) for each cultivar.

Results and Discussion

Potato late blight caused by *Phytophthora infestans* remains a major disease that can rapidly destroy a crop in the field or in storage if not controlled properly. Thus, it is important for potato producers to fully understand the disease response and disease control requirements for the cultivar being grown. Foliar late blight response in Superior and Sebago was not affected by the type of propagation method used. *In vitro* tissue culture derived Kennebec seed had a significantly greater late blight susceptibility response than clonal selection derived material (Table 1). However, the differences were small and do not imply that, for *in vitro* culture material, late blight susceptibility and disease control requirements are greater in practice than clonal selection material. Similarly, while significant differences in late blight response of Kennebec occurred among the different years of field multiplication, the disease response differences were minimal. Occasionally differences in seed propagation method and in number of years of field multiplication for Russet Burbank were found. But, as with Kennebec, these differences are considered to be too small to support the theory that *in vitro* culture results in more susceptibility to late blight than clonal selection.

Yield improvements with the *in vitro* potato propagation systems have been reported elsewhere (1). While all 4 cultivars had slight increases with *in vitro* culture, only Kennebec total yields were significantly greater than for clonal (Table 2). Although not presented, seed size (0-54 mm) and tablestock (55-85 mm) yields also demonstrated this trend favoring *in vitro* culture but the differences were not significant. Total yield in Russet Burbank had a significant year effect for which year 2 had greater yields than year 3, but when graded into seed and tablestock yields the differences were not significant. In general, no significant trends were observed among the years of field propagation of the majority of the cultivars.

Storage rot losses are also of major concern to the potato industry as a high yield and quality crop in the field is only valuable if it can be stored without significant losses prior to use. As with field disease responses, late blight storage rot incidences varied according to cultivar, years of field multiplication, and propagation method. For Superior, Russet Burbank, and Sebago no significant differences between clonal and *in vitro* culture treatments were found for the mean index of the 3 tuber wound sites and for tuber surface rot (Table 2). Mean tuber rot index and surface tuber rot were significantly greater with clonal than with *in vitro* culture for Kennebec. The contradiction of increased foliar and decreased tuber late blight response

TABLE 1.—*Effects of clonal selection and* in vitro *culture on foliar late blight response of 4 cultivars.*

Treatment	Late Blight Foliar Damage (%) by Day/Month						
	6/8	11/8	17/8	21/8	27/8	2/9	8/9
Superior							
Y2	47.5	93.7	100	100	100	100	100
Y3	38.1	89.4	100	100	100	100	100
Y4	43.7	90.0	100	100	100	100	100
LSD (P=0.05)	6.96	ns	ns	ns	ns	ns	ns
Cl	44.2	90.4	100	100	100	100	100
Tc	42.1	91.7	100	100	100	100	100
LSD (P=0.05)	ns	ns	ns	ns	ns	ns	ns
Kennebec							
Y2	25.6	40.6	70.0	75.6	82.5	87.5	91.9
Y3	16.9	40.0	72.5	83.1	87.5	90.0	95.6
Y4	16.9	38.1	62.5	72.5	80.0	83.7	90.6
LSD (P=0.05)	5.12	ns	6.27	7.19	4.89	4.35	3.79
Cl	19.2	36.2	65.4	73.3	81.2	86.2	92.1
Tc	20.4	42.9	71.3	80.8	85.4	87.9	93.3
LSD (P=0.05)	ns	4.82	5.12	5.87	3.99	ns	ns
Russet Burbank							
Y2	23.7	45.0	73.7	85.6	88.1	91.2	95.0
Y3	18.7	43.7	70.0	86.2	90.0	90.6	95.0
LSD (P=0.05)	4.03	ns	ns	ns	1.29	ns	ns
Cl	21.2	43.7	71.2	84.4	88.1	90.6	94.4
Tc	21.2	45.0	72.5	87.5	90.0	91.2	95.6
LSD (P=0.05)	ns	ns	ns	2.15	1.29	ns	ns
Sebago (Y4 only)							
Cl	3.0	21.2	30.0	45.0	60.0	63.7	76.3
Tc	4.0	20.0	33.7	46.2	55.0	62.5	75.0
LSD (P=0.05)	ns	ns	ns	ns	ns	ns	ns

Note: Y = years since original seed source selection. Cl = clonal selection method. Tc = *in vitro* tissue culture method.

of Kennebec from *in vitro* culture is not easily explained. Others have reported enhanced plant vigor with *in vitro* culture material (2, 4). A dense foliar canopy can result in higher moisture conditions which would favor foliar late blight development. The reductions in tuber rot with *in vitro* material may be a result of tuber maturity effects or they may be a result of conditions during the single year of study. More investigations are required to confirm these differences found with Kennebec but not the other cultivars.

TABLE 2.—*Effects of clonal selection and* in vitro *culture on cultivar yield and response to late blight storage rot.*

Treatment	Yield (t/ha)	Mean Index	Surface
Superior			
Y2	26.69	0.77	3.07
Y3	28.30	0.74	3.00
Y4	27.18	0.58	2.65
LSD (P = 0.05)	ns	ns	0.28
Cl	26.97	0.73	2.83
Tc	27.81	0.67	2.98
LSD (P = 0.05)	ns	ns	ns
Kennebec			
Y2	37.00	0.83	2.40
Y3	39.83	0.41	2.11
Y4	39.33	0.46	2.77
LSD (P = 0.05)	ns	0.25	0.26
Cl	36.93	0.75	2.58
Tc	40.54	0.39	2.28
LSD (P = 0.05)	2.87	0.20	0.21
Russet Burbank			
Y2	35.30	0.69	2.92
Y3	33.10	0.73	3.10
LSD (P = 0.05)	1.90	ns	ns
Cl	34.80	0.57	2.95
Tc	33.60	0.85	3.07
LSD (P = 0.05)	ns	ns	ns
Sebago (Y4 only)			
Cl	43.70	1.00	1.62
Tc	44.50	0.95	1.70
LSD (P = 0.05)	ns	ns	ns

Note: Y = years since original seed source selection. Cl = clonal selection method. Tc = *in vitro* tissue culture method. Mean index = mean tuber rot index for 3 tuber wound sites. Surface = mean rot on tuber surface.

Significant differences among the years of field propagation were only found in two cultivars. Tuber surface rot for Superior decreased as years increased while for Kennebec surface rot was significantly greater in year 2 than year 3 but then increased significantly in year 4. This variability is difficult to explain and suggests a need for further study.

Although these results are based on only one year of investigation, they do not indicate that growers could expect major late blight problems with the use of seed derived from *in vitro* culture. In fact, with some cultivars late blight problems may be reduced.

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