University of Minnesota
Department of Plant Pathology

2006
Potato Disease Report

Potato Pathology and Genomics
http://ppg.coafes.umn.edu/

James Bradeen
Dimitre Mollov

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Section I. Evaluating Potato Germplasm for Disease Resistance

SUMMARY: Disease screening plots were established at two locations (Rosemount and Becker, MN) in 2006. Entries were screened for resistance to late blight (caused by the Oomycete *Phytophthora infestans*; UMore Park, Rosemount, MN) and common scab (caused by the Actinomycete *Streptomyces scabies;* Sand Plain Research Farm, Becker, MN). Wild potatoes, *Solanum bulbocastanum* and *S. polyadenium* were screened for late blight resistance at UMore park. Germplasm was produced by the University of Minnesota Potato Breeding Program (98 entries tested for late blight, 131 entries tested for common scab), the University of Minnesota Potato Pathology and Genomics Program (74 entries tested for late blight, 36 plus 144 mapping population entries tested for common scab), or was contributed by researchers throughout the Quad-State Region (26 entries tested for late blight and 27 for common scab) and North Central Region (18 entries tested for late blight and common scab). Eighteen entries were tested as part of the National Late Blight Trial (Rosemount) and 20 entries were tested as part of the National Scab Trial (Becker). Two methods of field inoculation with the late blight pathogen were compared in our Rosemount nursery in an effort to streamline management practices for future disease resistance screening. Four populations from each of ten wild potato species were screened for tolerance to five different herbicide treatments at Becker in an effort to streamline management practices for future disease resistance screening.

Table 1. Source and number of entries screened at the late blight and common scab nurseries in 2006.

Source	**Late Blight** (UMore Park, Rosemount, MN)	**Common Scab** (Sand Plain Research Farm, Becker, MN)
UMN Potato Breeding	98	131
UMN Potato Pathology & Genomics	129 /+100 wild sp genotypes/	36 /+144 genotypes mapping population
North Central Trial	18	18
Quad-State Trial	26	27
National Late Blight and Scab Trial	23	20

(A) Late Blight – Rosemount, MN

Late blight, caused by the fungus *Phytophthora infestans*, was responsible for the Irish Potato Famine of the mid-1800's. The disease is characterized by brown to black water-soaked lesions on potato leaves and stems. Under cool, humid conditions, late blight can destroy an entire field within 10-14 days. When sporangia or zoospores are washed into the soil, they can infect potato tubers. Tuber infection is characterized by a dry, brown, granular rot. Secondary pathogens, such as *Erwinia carotovora* (soft rot), *Phytophthora erythroseptica* (pink rot), and *Pythium* spp. (leak) frequently follow. Late blight is currently managed by intensive fungicide applications. This approach is expensive and not environmentally sustainable. Genetic resistance derived from cultivated or wild potato is a promising means to reduce pesticide dependency, risk to the environment, and costs to potato growers.

Resistance to late blight is evaluated at UMore Park (Rosemount, MN) in cooperation with Phil Larsen (Director), James Rowe (Administrative Professional), Jim Karelis (Sr. Research Plot Technician) and Kimon Karelis (Research Plot Coordinator). The UMore Park is geographically isolated from commercial potato farms allowing intentional inoculation with the late blight pathogen. Because the spores of the pathogen are air-borne, inoculations and late blight screening is restricted to non-production areas. To further protect regional growers, the Late Blight Nursery is planted 4 to 8 weeks later than commercial production fields in Minnesota and Wisconsin.

Two different ways of disease inoculation were tested in 2005 and again in 2006. Comparison of using spreader border row of susceptible variety vs. direct inoculation without border rows had effect only on the rate of disease progression but not on final decision of resistance or susceptibility. Disease screening methods are detailed in Appendix A. Complete results for individual entries from the University of Minnesota Potato Breeding Program, University of Minnesota Potato Pathology and Genomics Program, National Late Blight, North Central Region, and Quad State Region for 2005 are listed in Appendix B. Table 2 summarizes our findings.

Table 2. Number of entries in each late blight resistance class based on infection 28 days after inoculation with the potato late blight pathogen at Rosemount, MN 2006

Sources of entries	No. (percent) of entries 28 DAI
UM Potato Pathology & Genomics	
Resistant	10 (7.8%)
Moderately Resistant	25 (19.4%)
Moderately Susceptible	26 (20.1%)
Susceptible	68 (52.7%)
UM Potato Breeding	
Resistant	0 (0%)
Moderately Resistant	1 (1%)
Moderately Susceptible	12 (12.3%)
Susceptible	78 (79.6%)
n/a	7 (7.1%)
National Late Blight Trial	
Resistant	6 (26.1%)
Moderately Resistant	5 (21.7%)
Moderately Susceptible	2 (8.7%)
Susceptible	10 (43.5%)
North Central Trial	
Resistant	0 (0%)
Moderately Resistant	1 (5.6%)
Moderately Susceptible	2 (11.1%)
Susceptible	15 (83.3%)
Quad-State Trial	
Resistant	0 (0%)
Moderately Resistant	3 (11.5%)
Moderately Susceptible	3 (11.5%)
Susceptible	20 (77%)
All Entries	
Resistant	16 (5.6%)
Moderately Resistant	35 (12.2%)
Moderately Susceptible	45 (15.7%)
Susceptible	191 (66.5%)

(B) Common Scab

Common scab, caused predominantly by the ubiquitous soil-borne bacterium *Streptomyces scabies,* is a disease of several root crops. In potato, symptoms include the development of corky lesions on the tuber that significantly reduce tuber quality and marketability, particularly for table stock varieties. In severe cases, common scab appears as deep sunken lesions ("pit scab") that invite secondary infection. Alkaline and dry soils exacerbate disease development. Genetic tolerance is sought after by potato breeders in Minnesota and throughout the US. The Sand Plain Research Farm is an ideal location for germplasm screening for resistance to common scab. In 2005 and continuing in 2006, two field plots were established for common scab resistance screening:

(a) As in previous years, the Potato Pathology and Genomics program cooperated with the UM Potato Breeding Program and potato breeding programs at Michigan State University, University of Wisconsin, and North Dakota State University to screen breeding materials for tolerance to common scab. We also served as a test site for the replicated National Scab Trial. In 2006 we continued efforts to characterize heirloom potato cultivars as sources of resistance to common scab.

(b) Our existing common scab testing site was established approximately 30 years ago and has been continuously cropped with potatoes since then. As the plot has aged, the microbial communities in the soil have changed and the plot is becoming "suppressive", a natural phenomenon by which disease-causing microbes are replaced by non-pathogenic strains. As a result, disease severity has decreased. Eventually, the plot will not be useful for germplasm testing. With this in mind, in 2005, we initiated efforts to establish a new plot for common scab testing. The new plot is physically isolated from the existing test site. Lime was applied to the soil to raise soil pH and the plot was planted with the common scab susceptible potato cultivar 'Red Pontiac'. We anticipate the new plot will be fully functional for germplasm testing by 2008.

Resistance to common scab is evaluated at the Sand Plain Research Farm located in Becker, MN in cooperation with Ronald Faber (Farm Manager) and Scott Garvin (Research Plot Technician). Detailed disease screening methods are listed in Appendix A. Severity and coverage ratings for all entries are listed in Appendix B. Table 3 summarizes our findings.

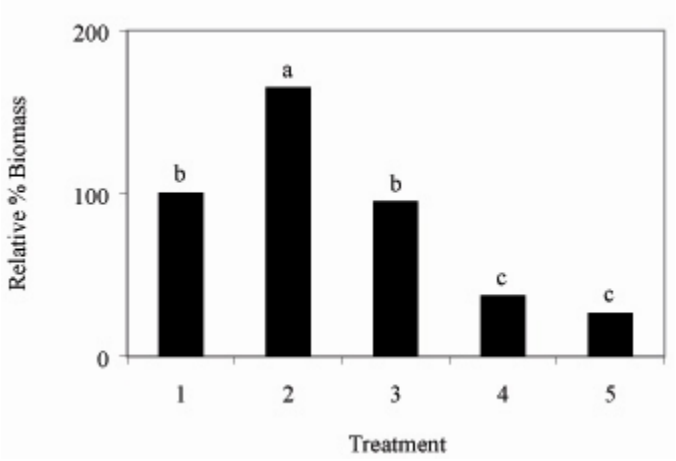
All 'Red Pontiac' plots that were planted next to test plots developed high levels of common scab, indicating disease pressure was fairly uniform throughout the plot. Coverage evaluations did not always correlate well with severity evaluations. Any tuber that received a 0 for severity also was scored with a 0 for coverage. However, scab lesions could range from superficial (severity = 1) to very deep (e.g. severity = 5) and only have 5% or less of the tuber surface covered (coverage = 2). Therefore, several entries that received a severity rating of 3 or 4 had coverage ratings of only 1 or 2. Since tubers can be rejected for sale when common scab lesions are severe, regardless of the degree of coverage, severity is a better measure of resistance in processing-type potatoes. Coverage may be the better assessment for fresh market reds.

Table 3. Number of entries in each common scab resistance class based on Severity and Coverage Ratings at Becker, MN 2006

Sources of entries	Severity Rating (%)	Coverage Rating (%)
UM Potato Pathology & Genomics		
Resistant	1 (2.8%)	0 (0%)
Moderately Resistant	8 (22.2%)	9 (25%)
Moderately Susceptible	3 (8.3%)	14 (38.9%)
Susceptible	24 (66.7%)	13 (36.1%)
UM Potato Breeding		
Resistant	1 (0.8%)	1 (0.8%)
Moderately Resistant	13 (9.9%)	12 (9.2%)
Moderately Susceptible	26 (19.8%)	38 (29%)
Susceptible	91 (69.5%)	80 (61.1%)
National Scab Trial		
Resistant	0 (0%)	0 (25%)
Moderately Resistant	5 (25%)	3 (15%)
Moderately Susceptible	7 (35%)	8 (40%)
Susceptible	8 (40%)	9 (45%)
North Central Trial		
Resistant	0 (0%)	0 (0%)
Moderately Resistant	3 (16.7%)	4 (22.2%)
Moderately Susceptible	2 (11.1%)	4 (22.2%)
Susceptible	13 (72.2%)	10 (55.6%)
Quad-State Trial		
Resistant	0 (0%)	0 (0%)
Moderately Resistant	5 (18.5%)	2 (7.4%)
Moderately Susceptible	1 (3.7%)	11 (40.7%)
Susceptible	21 (77.8%)	14 (51.9%)
All Entries		
Resistant	2 (0.9%)	1 (0.4%)
Moderately Resistant	34 (14.7%)	30 (12.9%)
Moderately Susceptible	39 (16.8%)	75 (32.3%)
Susceptible	157 (67.7%)	126 (54.3%)

(C) **Wild Potato Germplasm Screening for Tolerance to Common Herbicides**

Wild *Solanum* species are rich sources of disease resistance genes. Our program works to identify, characterize, and utilize for potato improvement, disease resistance genes from diploid wild potatoes. Our efforts necessitate field screening of wild species, but the cultural conditions of wild germplasm can be very different from those of cultivated potato. In the past, fearing that wild potato might be susceptible to broad-leaf herbicides commonly used for potato production, we have hand weeded wild potato plots—a time consuming and costly endeavor. In 2005, we initiated a two year study looking at herbicide tolerance in wild potato. In total, 10 wild potato species were tested. Four seedlings of each of four different populations for each species were planted at the Sand Plain Research Farm under five different herbicide treatments: no broad-leaf herbicide, half strength Linuron, full strength Linuron, half strength Sencor, and full strength Sencor. Each plot received herbicide for grass control. Other cultural practices were identical. Plots were visually assessed on a biweekly basis. After six weeks, the above ground biomass for each experimental unit was measured and recorded. Our research points to differential susceptibility to herbicides. Some species were killed by Linuron and Sencor at all concentrations. Others were susceptible to one but not to both herbicides. For some species, certain genotypes are susceptible while others are resistant.



Average response of 10 wild potato species to herbicide treatment. Treatments: 1 = no broadleaf herbicide; 2 = Linuron at ½ strength; 3 = Linuron at full strength; 4 = Sencor at ½ strength; 5 = Sencor at full strength. Data are fresh weight of above ground tissues at six weeks post seedling planting. All data are expressed as a percentage relevant to control (experiment 1) plants of the same population. Letters above data bars indicate significance groupings; data bearing the same letter are not significantly different from each other. This two year experiment provides the first assessment of these wild potato species for herbicide tolerance and will direct future efforts to discover disease resistance genes in these materials.

References

Davis, J. R., and Garner, J. 1978. Common scab of potato. University of Idaho Agricultural Experiment Station current information series No. 386. University of Idaho, Moscow, Idaho.

Henfling, J. W. 1987 Late blight of potato: *Phytophthora infestans*. Technical Information Bulletin 4. International Potato Center, Lima, Peru.

King, R. R., and Lawrence, C. H., and Clark, M. C. 1991. Correlation of phytotoxin production with pathogenicity of *Streptomyces scabies* isolates from scab infected potato tubers. Am. Potato J. 68:675-680.

Appendix A: Disease Screening Methods

(A) Late Blight

Tubers were planted on June 7. Entries were submitted by the University of Minnesota Potato Pathology and Genomics Program, the University of Minnesota Potato Breeding Program, the National Late Blight Trial (conducted by Dr. Kathleen Haynes, USDA/ARS, Beltsville, MD), the North Central Region trials, and the Quad State Trials. Admire 2F insecticide was applied in furrow at a rate of 16 fl. oz./acre to all planted potatoes. No fungicides were applied to the field at any time during the season.

Two different ways of inoculation and evaluation were compared during the 2006 season. Two blocks were planted with same material from the Potato Pathology and Genomics Program and the University of Minnesota Potato Breeding Program. The first block was planted with single row experimental lines surrounded from each side with susceptible border cultivar "Norchip". The second block had no border rows.

All border rows in block one and all experimental lines in block two were inoculated with a suspension of *P. infestans* (US-8 strain) zoospores and sporangia at a concentration of 1000 sporangia /ml in the late evening of August 8. Inoculum was applied with a CO_2 sprayer at 20 psi using a single nozzle (6502 tip) wand. Plots were irrigated for 1 hour prior to inoculation. Sprinkler irrigation was applied the next morning and thereafter, 4 to 6 times per week depending upon weather conditions for 1 hour to prolong natural dew periods. All irrigation was accomplished using a low-volume, overhead mist-type sprinkler system.

Evaluations were initiated 14 days after inoculation and were made every 3 to 5 days until 31 days after inoculation (6 readings total). Each entry was visually scored for disease severity using the CIP scale (Henfling, 1987). The CIP rating system is as follows:

CIP	% Late Blight	
Rating	Mean	Limits
1	0	0
2	2.5	Trace to 5
3	10	5 to <15
4	25	15 to <35
5	50	35 to <65
6	75	65 to <85
7	90	85 to <95
8	97.5	95 to <100
9	100	100

After all disease ratings were made, the CIP ratings were categorized based on readings taken 28 DAI as follows:

Resistance Class	Score
Resistant	<2.5
Moderately Resistant	2.5-4.99
Moderately Susceptible	5-7.49
Susceptible	>7.5

(B) Common Scab

Potato seed pieces were planted on May 3 by hand and Admire 2F insecticide was applied in furrow at a rate of 16 fl. oz./acre. Each entry consisted of 4 seed pieces spaced 12 inches apart, followed by a four-foot space, then two seed pieces of 'Red Pontiac' 12 inches apart, followed by another four-foot space. The 'Red Pontiac' was used as a susceptible check, to measure disease pressure throughout the plot.

For evaluation, all potato hills were lifted from the ground and dropped back on the ground using a one-row potato harvester. Harvest was done on September 15 and evaluations were made on September 27, after a natural rainfall had washed much of the soil from the tubers. All tubers from the four hills were rated as a group using the following scale:

Rating	Severity	Coverage
0	No scab visible	No scab visible
1	Scab <= 1 mm deep	Trace or 1-2 lesions less than 1 cm^2
2	Scab 2-3 mm deep	1 to 5 % tuber surface covered
3	Scab 3-4 mm deep	>5 to 50% tuber surface covered
4	Scab 4-5 mm deep	Over 50% tuber surface covered
5	Scab over 5 mm deep	---

Entries were considered resistant if the severity and coverage ratings were 0, moderately resistant for severity and coverage ratings of 1-2, moderately susceptible for severity and coverage ratings of 3, and susceptible for severity ratings of 4-5 or a coverage rating of 4.

Appendix B. Field Plot Data

(A) Late Blight: Disease resistance scores for entries in the (1) National Late Blight Trial, (2) North Central Trial, (3) Quad-State Trial, (4) University of Minnesota Potato Breeding Program, and (5 and 6) University of Minnesota Potato Pathology and Genomics Program.

1. National Late Blight Trial

Trial	Clone	Score	Class
NLB	LBR9	1	R
NLB	AWN86514-2	1.5	R
NLB	B0767-2	1.5	R
NLB	LBR8	1.5	R
NLB	97A-51	2	R
NLB	B0718-3	2	R
NLB	AND 9552-10	2.5	MR
NLB	B0692-4	2.5	MR
NLB	MSI152-A	2.5	MR
NLB	AND 9552-7	4	MR
NLB	LBR10	4.5	MR
NLB	A93157-6LS	5.5	MS
NLB	Castile	6.5	MS
NLB	BD410-87	7.5	S
NLB	LBR1R2R3R4	7.5	S
NLB	LBR3 tbr	8	S
NLB	LBR5	8	S
NLB	A91790-13	8.5	S
NLB	Mountain Rose	8.5	S
NLB	Colorado Rose	9	S
NLB	LBR2	9	S
NLB	LBR4	9	S
NLB	Purple Majesty	9	S

2. North Central Trial

Trial	Clone	Score	Class
NCR	MSJ461-1	2.5	MR
NCR	ND7882b-7Russ	6	MS
NCR	ND5775-3	7	MS
NCR	MSA8254-2BRUS	7.5	S
NCR	ND5002-3R	8	S
NCR	W2133-1	8	S
NCR	CV97006-1	8.5	S
NCR	MSI005-20Y	8.5	S
NCR	ND7818-1Y	8.5	S
NCR	W1879-1Rus	8.5	S
NCR	W2324-1	8.5	S
NCR	W2683-2Rus	8.5	S
NCR	WV3667-1	8.5	S
NCR	AND98324-1Russ	9	S
NCR	CV97050-3	9	S
NCR	CV97065-1	9	S
NCR	ND4659-5R	9	S
NCR	W3140-3Rus	9	S

3. Quad-State Trial

Trial	Clone	Score	Class
QS	MSM171-A	4	MR
QS	MSM182-1	4	MR
QS	W3160-5rusLB	4.5	MR
QS	MSL268-D	5.5	MS
QS	W3162-3rusLB	6	MS
QS	MSL183-AY	7	MS
QS	AND00618-2Russ	7.5	S
QS	ND8428b-1	7.5	S
QS	MK498-1Y	8	S
QS	W2564-2	8	S
QS	AND00272-1R	8.5	S
QS	W2982-1	8.5	S
QS	MSL007-B	9	S
QS	MSM060-3	9	S
QS	ND5124c-1R	9	S
QS	ND7196c-18	9	S
QS	ND7519-1	9	S
QS	ND7799c-1	9	S
QS	ND8165b-1	9	S
QS	ND8178-1Y	9	S
QS	ND8314-1R(A)	9	S
QS	W2309-7	9	S
QS	W2438-3Y	9	S
QS	W2717-5	9	S
QS	W2841-1	9	S
QS	W3328-1rus	9	S

4. University of Minnesota Potato Breeding Program

Trial	Clone	Score	Class
Int	ATMN 03527-1	4	MR
Adv	MN 02 419	5.5	MS
Int	**AOMN 03102-1(Filler)**	6	MS
Int	NDMN 03376-1	6	MS
Int	NDMN 03379-1	6	MS
Int	AOMN 03188-2	6.5	MS
Int	MN(DE) 03 14-4	6.5	MS
Int	AOMN 03163-1	7	MS
Int	AOMN 03179-1	7	MS
Int	**AOMN 03211-1(Filler)**	7	MS
Int	COMN 03020-5	7	MS
Adv	MN 02 467	7	MS
Int	NDMN 03339-4	7	MS
Int	COMN 03020-2	7.5	S
Adv	MN 02 452	7.5	S
Adv	MN 02 598	7.5	S
Int	NDMN 03410-2	7.5	S
Chk	**R. Pontiac**	7.5	S
Int	COMN 03008-3	8	S
Int	COMN 03049-5	8	S
Adv	MN 02 422	8	S
Adv	MN 02 510	8	S
Adv	MN 02 536	8	S
Adv	MN 02 582	8	S
Adv	MN 02 618	8	S
Adv	MN 02 703	8	S
Elite	MN 96072-4	8	S
Int	MN(DE) 03 4-3	8	S
Int	NDMN 03324-4	8	S
Int	NDMN 03334-2	8	S
Int	NDMN 03378-9	8	S
Int	NDMN 03382-2	8	S
Chk	**R. Burbank**	8	S
Chk	**Shepody**	8	S
Int	AOMN 03102-2	8.5	S
Int	AOMN 03230-1	8.5	S
Chk	**Atlantic**	8.5	S
Int	COMN 03020-3	8.5	S
Int	COMN 03031-2	8.5	S
Elite	MN 00177-5	8.5	S
Elite/NCR	MN 00307-1	8.5	S
Elite	MN 00317-1	8.5	S
Adv	MN 02 480	8.5	S
Adv	MN 02 588	8.5	S
Adv	MN 02 633	8.5	S
Adv	MN 02 644	8.5	S
Adv	MN 02 645	8.5	S
Adv	MN 02 678	8.5	S

Adv	MN 02 696	8.5	S
Elite/NCR	MN 18710	8.5	S
Elite	MN 99460-21	8.5	S
Int	MN(DM) 03 36-1	8.5	S
Int	NDMN 03359-1	8.5	S
Int	AOMN 03102-5	9	S
Int	AOMN 03219-11	9	S
Int	AOMN 03247-1	9	S
Int	COMN 03019-3	9	S
Int	COMN 03019-4	9	S
Int	COMN 03021-1	9	S
Int	COMN 03027-1	9	S
Chk	**Dk Red Norland**	9	S
Elite/NCR	MN 00177-6	9	S
Elite	MN 00467-4	9	S
Adv	MN 02 417	9	S
Adv	MN 02 458	9	S
Adv	MN 02 515	9	S
Adv	MN 02 524	9	S
Adv	MN 02 529	9	S
Adv	MN 02 586	9	S
Adv	MN 02 587	9	S
Adv	MN 02 589	9	S
Adv	MN 02 616	9	S
Adv	MN 02 689	9	S
Adv	MN 02 709	9	S
Elite	MN 15620	9	S
Elite	MN 18153	9	S
Elite	MN 19298	9	S
Elite	MN 99380-1	9	S
Elite/NCR	MN 99460-14	9	S
Int	MN(DE) 03 14-2	9	S
Int	MN(DE) 03 4-4	9	S
Int	MN(DM) 03 1-2	9	S
Int	MN(DM) 03 1-4	9	S
Int	MN(DM) 03 1-5	9	S
Int	NDMN 03337-1	9	S
Int	NDMN 03374-1	9	S
Int	NDMN 03412-3	9	S
Chk	**NorValley**	9	S
Chk	**R. Norkotah**	9	S
Chk	**Snowden**	9	S
Chk	**Y. Gold**	9	S
Int	COMN 03039-1	n/a	
Adv	MN 02 537	n/a	
Adv	MN 02 574	n/a	
Int	MN(DM) 03 8-2	n/a	
Int	NDMN 03314-1	n/a	
Int	NDMN 03334-1	n/a	
Int	NDMN 03399-3	n/a	

5. University of Minnesota Potato Pathology and Genomics Program

Clone	Score	Class
SP2211	1	R
SP2210	1.33	R
SP1453	1.67	R
SP2105	1.67	R
SP2113	1.67	R
SP2182	2	R
SP2184	2	R
SP2193	2	R
SP2213	2	R
SP918	2.33	R
SP2212	2.67	MR
SP2587	2.67	MR
SP2633	2.67	MR
SP905	2.67	MR
SP2511	3	MR
SP2662	3	MR
SP2178	3.33	MR
SP2366	3.33	MR
SP2520	3.33	MR
SP2671	3.33	MR
SP2564	3.67	MR
SP2575	3.67	MR
SP922	3.67	MR
SP951	3.67	MR
SP966	3.67	MR
SP2466	4	MR
SP2576	4	MR
SP2577	4	MR
SP2665	4.33	MR
SP2423	4.67	MR
SP2588	4.67	MR
SP2424	5	MS
SP2565	5	MS
SP2574	5	MS
SP2572	5.67	MS
SP2586	5.67	MS
SP2663	5.67	MS
SP2561	6.33	MS
SP2573	6.33	MS
SP2585	6.33	MS
SP2534	6.67	MS
SP2664	6.67	MS
Kathadin	7	MS
SP2515	7	MS
SP2582	7	MS
SP2531	7.67	MS
SP998	7.67	MS
DRN	8.33	S

SP2514	8.33	S
SP946	8.33	S
Superior	8.33	S
SP2361	9	S

6. University of Minnesota Potato Pathology and Genomics heirloom trial

Clone	Score	Class
Atzimba	4.5	MR
Brodick	4.5	MR
Hooksack	6	MS
Reda	6	MS
ARRAN CONSUL	6	MS
ARRAN VICTORY	6	MS
Zarevo	6	MS
AC Blue Pride	6.5	MS
AC Brador	6.5	MS
AC Domino	7	MS
Garnet Chile	7	MS
Albys Gold	7.5	S
Augsburg Gold	7.5	S
Pimpernel	7.5	S
AC Red Island	7.5	S
ARRAN PILOT	7.5	S
French Fingerling	7.5	S
Mrs. Moehlers	7.5	S
NorQueen	7.5	S
Alturas	7.5	S
All Blue	8	S
Denali	8	S
German Butterball-Hancock	8	S
Huckleberry	8	S
Saginaw Gold	8	S
LUMPERS	8	S
Dakchip	8	S
Butte	8.5	S
Carola-Hancock	8.5	S
Carola-Ronnigers	8.5	S
German Butterball-Ronnigers	8.5	S
Inca Gold	8.5	S
BEAUTY HEBRON	8.5	S
BINTJE	8.5	S
PURPLE VIKING	8.5	S
RED BEAUTY	8.5	S
Bison	8.5	S
R4	8.5	S
All Red	9	S
Bake King	9	S
Butterfinger	9	S
Candy Cane	9	S

Caribe	9	S
Gold Nugget	9	S
King Edward	9	S
Pink Pearl	9	S
Princess Laratte	9	S
Red Thumb	9	S
Rose Gold	9	S
Ruby Crescent-Hancock	9	S
Ruby Crescent-Ronnigers	9	S
Russian Banana	9	S
Sieglinde	9	S
Yellow Finn	9	S
Yukon Gold	9	S
Epicure	9	S
Red Warba	9	S
Rose Gold	9	S
AK FROSTLESS	9	S
BELLE DE FONTANY	9	S
FORTYFOLD	9	S
GREEN MOUNTAIN (COR)	9	S
Corne de Moutan	9	S
La RATTE	9	S
Snow Flake	9	S
Nordak	9	S
Norgleam	9	S
Norchief	9	S
NorKing	9	S
US W482	9	S

Common Scab: Disease severity and coverage scores for entries in the (1) National Late Blight Trial, (2) North Central Trial, (3) Quad-State Trial, (4) University of Minnesota Potato Breeding Program, and (5) University of Minnesota Potato Pathology and Genomics Program.

1. National Scab Trial

Trial	Clone	Severity	Coverage
N Scab	Blazer Russet	1.7	2.0
N Scab	CO95051-7W	1.7	2.7
N Scab	MSJ126-9Y	1.7	2.3
N Scab	MSJ036-A	2.3	3.7
N Scab	MSJ316-A	2.3	3.0
N Scab	Russet Burbank	2.7	2.3
N Scab	VC1002-3 W/Y	2.7	2.7
N Scab	A93157-6LS	3.0	2.7
N Scab	AF1758-7	3.0	3.3
N Scab	VC1009-1 W/Y	3.0	3.7
N Scab	CO95172-3RU	3.3	2.7
N Scab	MSK061-4	3.3	3.0
N Scab	A95109-1	3.5	2.5
N Scab	A9045-7	4.3	3.7
N Scab	AF2291-10	4.3	3.7
N Scab	Ranger Russet	4.3	4.0
N Scab	Superior	4.7	4.0
N Scab	AF2211-9	5.0	3.7
N Scab	AF2215-1	5.0	4.0
N Scab	Atlantic	5.0	4.0

2. North Central Trial

Trial	Clone	Severity	Coverage
NCR	W2683-2Rus	0.5	1
NCR	MSA8254-2BRUS	1.5	1.5
NCR	W1879-1Rus	1.5	2
NCR	ND4659-5R	2.5	2.5
NCR	W3140-3Rus	3	3
NCR	MSI005-20Y	3.5	2
NCR	ND5002-3R	3.5	3
NCR	W2133-1	3.5	3.5
NCR	CV97006-1	4	3.5
NCR	ND5775-3	4	3.5
NCR	ND7818-1Y	4	4
NCR	ND7882b-7Russ	4	3
NCR	CV97065-1	4.5	3.5
NCR	MSJ461-1	4.5	4
NCR	AND98324-1Russ	5	4
NCR	CV97050-3	5	3.5
NCR	W2324-1	5	4
NCR	WV3667-1	5	4

3. Quad-State Trial

Trial	Clone	Severity	Coverage
QS	W3160-5rusLB	1.5	1
QS	AND00618-2Russ	2	2.5
QS	MSL007-B	2	2.5
QS	ND7799c-1	2	2.5
QS	W2564-2	2	2.5
QS	ND8428b-1	3	4
QS	W2438-3Y	3.5	3.5
QS	W3328-1rus	3.5	3
QS	MK498-1Y	4	3.5
QS	ND5124c-1R	4	3
QS	ND7519-1	4	4
QS	ND8178-1Y	4	3
QS	AND00272-1R	4.5	3.5
QS	MSL268-D	4.5	3
QS	ND8165b-1	4.5	3
QS	W2309-7	4.5	4
QS	W2982-1	4.5	3
QS	**Filler- All Blue**	5	4
QS	MSL183-AY	5	3.5
QS	MSM060-3	5	2
QS	MSM171-A	5	3.5
QS	MSM182-1	5	4
QS	ND7196c-18	5	3.5
QS	ND8314-1R(A)	5	4
QS	W2717-5	5	3.5
QS	W2841-1	5	3
QS	W3162-3rusLB	5	4

4. University of Minnesota Potato Breeding Program

Trial	Clone	Severity	Coverage
Elite/NCR	MN 18710	0	
Adv	MN 02 422	0.5	1
SG06030	E14/9B	1	1
Elite	MN 00467-4	1.5	3
Elite/NCR	MN 00307-1	1.5	2.5
SG06007	E10/20A	1.5	2
SG06010	E10/13H	1.5	2.5
SG06020	E10/19C	1.5	2
SG06038	E10/15A	1.5	2.5
Adv	MN 02 480	2	2
Elite	MN 00317-1	2	3
SG06015	E14/13A	2	1.5
SG06026	E14/2A	2	2.5
SG06034	E10/7B	2	2
Adv	MN 02 458	2.5	4
Adv	MN 02 467	2.5	1.5
Int	MN(DE) 03 14-2	2.5	4
Int	NDMN 03399-3	2.5	4
SG06004	E10/21A	2.5	3.5
SG06005	E14/14A	2.5	3
SG06009	E10/10A	2.5	2.5
SG06011	E10/8A	2.5	2.5
SG06012	E14/3B	2.5	2.5
SG06013	E10/13G	2.5	1.5
SG06016	E10/13E	2.5	3
SG06022	E10/7A	2.5	2
SG06023	E14/4B	2.5	2.5
SG06024	E10/10C	2.5	3
SG06035	E14/15A	2.5	2
Elite	MN 99380-1	3	3
Int	AOMN 03188-2	3	4
Int	MN(DM) 03 1-2	3	1.5
Int	NDMN 03314-1	3	4
Int	NDMN 03378-9	3	3
Int	NDMN 03379-1	3	3.5
Int	NDMN 03382-2	3	3.5
SG06001	E10/2E	3	3.5
SG06032	Wild-Type	3	3
SG06037	E14/6A	3	3
SG06039	E14/2E	3	2.5
Adv	MN 02 616	3.5	3
Elite/NCR	MN 00177-6	3.5	3
Int	AOMN 03179-1	3.5	4
Int	ATMN 03527-1	3.5	4
Int	COMN 03039-1	3.5	3.5
Int	MN(DM) 03 36-1	3.5	3.5
Int	NDMN 03376-1	3.5	3.5
Int	NDMN 03412-3	3.5	3

SG06003	E10/13B	3.5	3
SG06008	E10/6A	3.5	2.5
SG06019	E10/4D	3.5	4
SG06021	E10/15C	3.5	2.5
SG06036	E10/3A	3.5	3
Adv	MN 02 598	4	3
Chk	Dk Red Norland	4	3.5
Chk	NorValley	4	4
Chk	R. Norkotah	4	3
Chk	Shepody	4	3.5
Elite	MN 99460-21	4	4
Int	AOMN 03102-1	4	2.5
Int	COMN 03019-3	4	3.5
Int	MN(DE) 03 14-4	4	4
Int	MN(DM) 03 1-4	4	3.5
Int	NDMN 03324-4	4	3.5
SG06014	E10/4B	4	3
SG06017	E10/3B	4	3
SG06018	E10/F10	4	3.5
SG06027	E10/2F	4	4
SG06031	E14/12A	4	3.5
SG06033	E10/16E	4	2.5
Adv	MN 02 515	4.5	4
Adv	MN 02 536	4.5	2.5
Elite	MN 19298	4.5	3.5
Elite/NCR	MN 99460-14	4.5	3
Int	AOMN 03247-1	4.5	3.5
Int	COMN 03019-4	4.5	4
Int	COMN 03020-5	4.5	4
Int	COMN 03021-1	4.5	4
Int	COMN 03049-5	4.5	3.5
Int	NDMN 03334-2	4.5	3.5
Int	NDMN 03339-4	4.5	3
SG06006	E10/4C	4.5	3.5
Adv	MN 02 417	5	4
Adv	MN 02 419	5	4
Adv	MN 02 452	5	4
Adv	MN 02 510	5	4
Adv	MN 02 524	5	4
Adv	MN 02 529	5	4
Adv	MN 02 537	5	3
Adv	MN 02 574	5	3
Adv	MN 02 582	5	4
Adv	MN 02 586	5	4
Adv	MN 02 587	5	3.5
Adv	MN 02 588	5	4
Adv	MN 02 589	5	4
Adv	MN 02 618	5	4
Adv	MN 02 633	5	4
Adv	MN 02 644	5	3.5
Adv	MN 02 645	5	3.5
Adv	MN 02 678	5	4
Adv	MN 02 689	5	4
Adv	MN 02 696	5	4

Adv	MN 02 703	5	3
Adv	MN 02 709	5	4
Chk	R. Pontiac	5	4
Chk	Snowden	5	3.5
Chk	Y. Gold	5	4
Elite	MN 00177-5	5	3.5
Elite	MN 15620	5	3.5
Elite	MN 18153	5	3.5
Elite	MN 96072-4	5	3.5
Int	AOMN 03102-2	5	4
Int	AOMN 03102-5	5	4
Int	AOMN 03163-1	5	4
Int	AOMN 03211-1	5	3.5
Int	AOMN 03219-11	5	4
Int	AOMN 03230-1	5	3.5
Int	COMN 03008-3	5	4
Int	COMN 03020-2	5	4
Int	COMN 03020-3	5	4
Int	COMN 03027-1	5	4
Int	COMN 03031-2	5	4
Int	MN(DE) 03 4-3	5	3.5
Int	MN(DE) 03 4-4	5	4
Int	MN(DM) 03 1-5	5	3.5
Int	MN(DM) 03 8-2	5	3.5
Int	NDMN 03334-1	5	4
Int	NDMN 03337-1	5	4
Int	NDMN 03359-1	5	4
Int	NDMN 03374-1	5	3
Int	NDMN 03410-2	5	4

5. University of Minnesota Potato Pathology and Genomics Program

Clone	Severity	Coverage
NorQueen	0.33	1
Nooksack	0.67	1
NorKing	0.67	1
Krantz	2	1.33
Bison	2	1.67
LUMPERS	2	1.67
La RATTE	2.33	2
Mrs. Moehlers	2.33	2
AK FROSTLESS	2.33	2.33
Corne de Moutan	3.33	2.67
ARRAN VICTORY	3.33	3.33
Brodick	3.33	3.33
PURPLE VIKING	3.67	2.67
Snow Flake	3.67	3
AC Domino	3.67	3.33
ARRAN PILOT	3.67	3.33
French Fingerling	3.67	3.33
AC Brador	3.67	3.67
Reddalle	4	2.67
BELLE DE FONTANY	4	3
ARRAN CONSUL	4.33	3.33
Dakchip	4.33	3.67
GREEN MOUNTAIN (COR)	4.33	3.67
Nordak	4.33	3.67
AC Red Island	4.67	3
FORTYFOLD	4.67	3.67
RED BEAUTY	4.67	3.67
AC Blue Pride	4.67	4
Garnet Chile	5	3
Viking	5	3
BEAUTY HEBRON	5	3.67
BINTJE	5	3.67
Norchief	5	3.67
Norgleam	5	3.67
Red Warba	5	3.67
All Blue	5	4