Response of Central European *Pyrus* Germplasm to Natural Fire Blight Infection and Artificial Inoculation

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Abstract. Of 133 *Pyrus* accessions (predominantly *P. communis* L.), collected in Central Europe and previously rated in the resistant U.S. Dept. of Agriculture (USDA) blight scores 10–6, only 77 (57.0%) remained in these scores after an additional 5 years of exposure to fire blight [*Erwinia amylovora* (Burr.) Winsl. et al.]. Of these, 24 originated from three states in former Yugoslavia. Following several years of severe blight epiphytotic, only 5 (10.4%) of 52 accessions released from quarantine since 1986 and planted at Appalachian Fruit Research Station scored 6 or above. All accessions were highly susceptible to artificial blossom inoculation, and only 10 accessions were at least moderately resistant to artificial shoot inoculations.

During 1976–80, T.Z. made three plant exploration trips to five countries of Central Europe (Czech Republic, Hungary, Poland, Romania, and several states in former Yugoslavia) to collect *Pyrus* germplasm (van der Zwet et al., 1987, 1989). Based on the experience of Yugoslavian collaborators and additional information from the Univ. of Belgrade, major emphasis was placed on Yugoslavia, in particular, the states of Serbia, Montenegro, and Macedonia. At the time of the collections, fire blight had not been detected in this region. One of the reasons for the germplasm exploration in the Balkans was to obtain data on fire blight resistance of indigenous pear germplasm well in advance of natural disease occurrence.

During the past 5 years, fire blight entered Macedonia from Greece and has spread northward into Serbia and Montenegro, reaching the southern border of Croatia (Panic and Arsenijevic, 1993). In Fall 1992, the disease was noticed for the first time in two locations in Romania (Baicu et al., 1994). To date, fire blight has been reported in all of Central Europe, except Slovakia, Hungary, Slovenia, Croatia, and Albania. Fire blight infections have continued to increase in frequency and severity in this part of Europe. The disease has not been reported from any of the former Russian states.

The collected budwood was sent to the National Plant Germplasm Quarantine Center (NPGQC) at Glenn Dale, Md., and the resulting trees were exposed to natural fire blight. The U.S. Dept. of Agriculture (USDA) fire blight scoring system (van der Zwet et al.,

1970) was used to estimate tree damage from fire blight during the first 8 years at NPGQC (van der Zwet and Bell, 1990). Since the first report, fire blight infections were observed in previously noninfected trees and continued to progress in previously infected trees. In addition, release of some of the germplasm has allowed us to evaluate fire blight susceptibility through artificial inoculations. We report herein natural infection scores and the results of artificial blossom and shoot inoculations of 52 accessions released from quarantine, as well as updated natural infection scores for those 133 accessions previously rated at NPGQC as at least moderately resistant (van der Zwet and Bell, 1990).

Materials and Methods

Plant material. A total of 133 accessions of pear (primarily *Pyrus communis* L.) were rated in 1990 as at least moderately resistant to fire blight (USDA score ≥ 6). With the exception of a few accessions released from NPGQC be-

ginning in 1985, one to two trees of surviving accessions were maintained at the quarantine center pending virus indexing or further evaluation. A total of 52 accessions released from NPGQC were propagated at the Appalachian Fruit Research Station (AFRS). Three plantings were made: 30 accessions were planted in 1986, 29 in 1989 (two orchard blocks), and 18 in 1990, with duplication of 14 accessions among plantings or in the two 1989 orchards. The germplasm included two *P. communis* accessions introduced independent of the 1976–80 germplasm collections: PI 483381, a wild seedling from Czechoslovakia, and ‘Spina Carpi’ from Italy. The number of trees per accession varied from one to 13, with all but four accessions replicated by one to five trees.

Epiphytotic infection. Natural infection was recorded yearly at both NPGQC until Fall 1993 and at AFRS until Fall 1994. The lowest (i.e., most severe) score for each tree was used as the measure of response. Analyses of variance of the data from AFRS were performed on fixed-effect factorial models with accession and either block or year of planting as main effects; mean separation of differences among accessions was performed using the Waller–Duncan *t* test with a *k* ratio = 100. Differences between block or year were tested with Tukey’s HSD. In the 1989 planting, five accessions were replicated in two orchard blocks. Differences among accessions were significant ($P = 0.003$), but the difference between blocks and the interaction of accessions with blocks were nonsignificant. Therefore, data from these blocks were combined. Differences among accessions were significant in all three planting years. For three accessions replicated in 1986 and 1990 (‘Anniversarea’, ‘Batjarka’, and ‘Topka’), differences among year of planting and the accession $\times$ year of planting interaction were significant ($P = 0.0001$ and 0.001 , respectively). The fire blight scores were significantly higher for the 1990 planting, with many noninfected trees. Therefore, data for this planting will not be reported. Five accessions (‘Anniversarea’, Krupen Burnus’, PI 483383, ‘Spina Carpi’, and ‘Zelinka’) were replicated in the 1986 and 1989 plantings. While differences between

Table 1. Summary of shift of percent distribution of fire blight resistance in Central European *Pyrus* germplasm in four USDA blight scoring classes.^z

Country and no. accessions	Rating score							
	1981–88				1989–94			
	10	9–8	7–6	5–1	10	9–8	7–6	5–1
Proportion in category (%)								
Yugoslavia (n = 231)	21.6	12.1	5.3	61.0	5.2	8.2	5.2	81.4
Romania (n = 86)	11.6	8.1	9.4	70.9	2.3	8.1	10.5	79.1
Poland (n = 44)	7.0	13.9	9.3	69.8	4.5	9.1	9.1	77.3
Hungary (n = 12)	25.0	8.3	0.0	66.7	25.0	8.3	0.0	66.7
Czech Republic (n = 11)	0.0	9.1	18.2	72.7	0.0	9.1	18.2	72.7
Overall (n = 384)	17.2	11.2	6.8	64.8	4.9	8.1	7.5	79.4

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^zUSDA fire blight scoring classes: 10 = no blight; 9–8 = 1% to 6%; 7–6 = 7% to 25%; and 5–1 = 26% to 100% of tree blighted.

Table 2. Rating of *Pyrus* germplasm from former Yugoslavia, Romania, Poland, Hungary, and Czech Republic for susceptibility to natural fire blight infection at Glenn Dale, Md., or Kearneysville, W.Va. (1989–93).²

Score 10 ^a
Istambulsko Ahce (Y-18, Y-270) ^x , Karamanka (Y-20), Koreljaci (Y-53), Lubenicarka (Y-5), Maslinka (Y-85), Sijerak (Y-68) ^w , Smokvarka (Y-25) ^w , Tiranka (Y-97), Tursija (Y-122), Vodenjak (Y-4); Pere gutui (R-6), Rosii Untoase (R-77); Q21404 (P-8), Q21419 (P-23); Arabitka G (H-3), Legkorabi (H-4), Bohus (H-8).
Score 9–8
Asanovka (Y-133), Clementinka (Y-23), Eniseyka (Y-21), Jeribasma (Y-59, Y-63), Karamanka (Y-119), Krupna lubenicarka (Y-111), Krvavica, (Y-80), Lubenicarka (Y-102), Maslinka (Y-76), Maznikojka (Y-10), Poloska (Y-52), Zimnjak (Y-252) ^x , Zutica (Y-99), Q22031 (Y-131), Q22064 (Y-164), Q22129 (Y-226) ^w , Q22170 (Y-256); Decana Krier (R-53), Dulci de vara (R-54), Fetite (R-4), Margareta Krier (R-98), Pere de iarna (R-5), Q21278 (R-1), PI506381 (R-12) ^x ; Gdula (P-22), Radcowka (P-Q20215), Q21402 (P-6); Kalman (H-17); Libovicka maslovka (C-8).
Score 7–6
Arapka (Y-158), Ilinjaca (Y-135, Y-211), Jeribasma (Y-79), Letna arapka (Y-108), Obican vodenjak (Y-120), Ranac (Y-194), Stambolska (Y-251), Zimorka (Y-15, Y-237) ^w , Q22051 (Y-151), Q22147 (Y-233) ^x ; Alamii (R-4), Aniversarea (R-42), Busuioace de Voinesti (R-45), Galbene de Demsus (R-58), Imparatesti (R-24), Professor Krier (R-97), Voratice para seminte (R-17), Zaharoasa de vara (R-90), PI506382 (R-13) ^x ; Erabasma (P-Q20205), Krolenka (P-Q20211), Q21417 (P-21); Krvavka morovska (C-7), Rihova bezjaderka (C-9).
Score 5–1
Arapka (Y-139) ⁱ , Bostanka (Y-223), Crna poloska (Y-125), Crvenuska (Y-249), Europejsko Ahce (Y-272), Grocanka (Y-156), Ilinjaca (Y-155, Y-179), Jakovka (Y-188), Jeribasma (Y-143, Y-148, Y-195, Y-205), Jesnji vodenjak (Y-37), Jutarac (Y-181), Karamanka (Y-190, Y-267), Kraljevka (Y-152), Krivopeteljac (Y-218), Krupna iz vinograda (Y-115), Krupna takisha (Y-149), Lederka (Y-157), Lubenicarka (Y-159, Y-187), Maslinka (Y-198), Medunac (Y-208), Mirisavac (Y-215), Mustabej (Y-22, Y-271), Pecanka (Y-219), Pitoma Slanopadja (Y-96) ^w , Pozni medunac (Y-216), Projnaca (Y-107), Prosjenica (Y-199), Prosinci (Y-209), Ramaganlija (Y-203), Salganka (Y-14), Saprani II (Y-213), Simka (Y-204), Stjepanka (Y-145), Takisha (Y-138), Vidovaca (Y-153), Zimorka (Y-244) ^w , Zimska (Y-220, Y-221), Zitnjaca (Y-172), Q22060 (Y-160), Q22127 (Y-224); Boieresti (R-34), Cantalupesti (R-46), Galbena (R-57), Pere de vin (R-31), Tamioase de calineste (R-83), PI506378 (R-9), PI506380 (R-11); Ananasowka czeska (P-Q20198), Wilenska plenna (P-Q20222), PI483386 (P-26).

²Germplasm entries reported here are those previously listed in USDA scores 10–6 (van der Zwet and Bell, 1990), updated into the four resistance classes. Ratings were based on data from both National Plant Germplasm Quarantine Center, Glenn Dale, Md., and Appalachian Fruit Research Station, Kearneysville, W.Va.

³USDA fire blight scoring system arranged into four classes: 10 = no fire blight; 9–8 = 1% to 6%; 7–6 = 7% to 25%; and 5–1 = 26% to 100% of tree blighted (van der Zwet et al., 1970).

⁴Codes in parentheses after accession name indicates original collection number: Y = former Yugoslavia, R = Romania, P = Poland, H = Hungary, and C = Czech Republic; Q = plant quarantine clone number; PI = plant introduction number. All entries were identified as *Pyrus communis*, except footnotes w through s:

^w*Pyrus amygdaliformis* or hybrid.

^x*Pyrus elaeagnifolia* or hybrid.

^y*Pyrus nivalis*.

^z*Pyrus pyraeaster*.

¹*Sorboopyrus* sp.

plantings were nonsignificant, the accession × year interaction was significant ($P = 0.005$). Pairwise t tests of accession–planting year means indicated that the interaction was due to the fire blight score (8.0) for the single tree of PI483383 in the 1989 planting. Therefore, this entry was deleted from the data, and the 1986 and 1989 data were combined to compute mean accession fire blight scores. Minimum scores from AFRS were combined with similar data from NPGQC to indicate the most severe infection observed for an accession.

Inoculum preparation. Three virulent isolates of *Erwinia amylovora*, AFRS 208 (MO-9), AFRS 260 (NY 273), and AFRS 581 (WV), were removed from silica gel storage (–20°C), and grown on nutrient yeast dextrose agar (NYDA) for 3 days. Pathogenicity of the isolates was verified by inoculating immature pear fruit. Each isolate was grown for 24 h on NYDA slant cultures and suspended in 0.2 M phosphate buffer (pH 6.5); the concentration of each suspension was adjusted photometrically using a Klett–Summerson colorimeter (Klett Manufacturing Co., New York) and standard calibration curve to 10^8 cfu/ml. The

suspensions were mixed in equal proportions before inoculation.

Blossom inoculation. A total of 38 accessions at AFRS had sufficient bloom for inoculation in 1993. In most cases, one tree per accession was inoculated, but two to three trees were available for some accessions. At full bloom, 10 flower clusters on each tree were thinned to four blossoms and inoculated with the bacterial suspensions using a hand spray bottle. Because of variation in bloom date, one set of trees was inoculated each on 23, 25, or 30 Apr. Percentage of infected clusters was determined 1 week after inoculation. Severity of blight symptoms in each cluster was recorded 4 weeks postinoculation with a separate scoring system, designed specifically to measure degree of infection from the blossom, through the pedicel and bloom cluster, into woody tree tissue. The scores were 0 = no blight, 1 = into floral cup only, 2 = into ovary, 3 = into pedicel, 4 = into basal tissue of cluster, 5 = into spur or 1-year-old wood, and 6 = into 2-year or older wood. When individual blossoms differed, the most severely damaged bloom (i.e., highest) score

was assigned to the cluster. The mean percentage of infected clusters and severity were separated by Waller–Duncan k ratio t test with k ratio = 100.

Shoot inoculation. Actively growing shoots on one to four trees of 42 clones at AFRS were inoculated by hypodermic needle (26-G 3/8) on 20 May 1993. Five to 10 shoots per tree were inoculated, depending on tree size and number. Twenty-three accessions were represented by a single inoculated tree. Lesion length and length of current-season's shoot were recorded 8 weeks after infection. Lesion length was divided by current-season's shoot length to express disease reaction as a proportion. In addition, the number of lesions extending into older wood and age of infected wood were recorded. Preliminary analysis showed that the percentage of noninfected shoots varied from 0% for 26 accessions to 100% for two accessions; 10 accessions had 20% or fewer noninfected shoots. Because of the relatively small number of noninfected shoots in most accessions, mean lesion lengths were calculated on the basis of all inoculated shoots. Previous experience has shown that this method

Table 3. Natural fire blight infection scores for Central European *Pyrus* accessions at Kearneysville, W.Va.

Accession	Collection no. ²	No. trees	Mean score ³
Urehelnite	R-88	1	10.0 a
PI-483384	P-17	1	9.0 a
PI-506382	R-13	4	8.5 ab
Poznica	Y-284	5	7.8 a-c
PI-506381	R-12	9	6.5 a-d
Batjarka	Y-36	2	5.5 b-e
Tamioase de Calinesti	R-83	5	4.8 c-f
PI-483381	---	5	4.6 c-g
Erabasma	P-Q20205	4	4.0 d-h
Petrovka	Y-178	5	4.0 d-h
Sapranj I	Y-57	13	3.2 d-h
Para de Zahar de Bihor	R-96	5	3.0 e-h
Coadesele	R-49	4	2.7 e-h
Kajzerka	Y-101	6	2.7 e-h
PI-506378	Y-167	5	2.6 e-h
Kalebasa plocka	P-Q20209	2	2.5 e-h
Krupen burnusus	Y-11	3	2.3 e-h
Zimska	Y-282	1	2.0 f-h
PI-506379	R-10	5	2.0 f-h
Zelinka	Y-42	4	2.0 f-h
Aniversarea	R-42	5	1.8 f-h
Roosevelt	Y-130	8	1.5 f-h
Winiowka saska	P-Q20223	4	1.2 gh
Grusza od nagovskiego	P-Q20206	4	1.2 gh
PI-483383	P-14	4	1.2 gh
PI-506373	Y-167	5	1.2 gh
Kiselac	Y-35	3	1.0 h
Mednik	Y-100	2	1.0 h
Crna poloska	Y-125	4	1.0 h
PI-483386	P-26	2	1.0 h
Panadjurka	Y-34	5	1.0 h
Ilinka	P-Q20207	1	1.0 h
Jesnji vodenac	Y-37	4	1.0 h
PI-506380	R-11	4	1.0 h
Krolewka	P-Q20211	1	1.0 h
Aromata de Bistrita	R-43	4	1.0 h
Prague No. 1	C-1	2	1.0 h
Projnjacka	Y-107	2	1.0 h
Republica	R-75	3	1.0 h
Bera wysmienita	P-Q20202	1	1.0 h
Lucele	R-2	4	1.0 h
Sapranj II	Y-58	3	1.0 h
Smederevka	Y-66	1	1.0 h
Spina Carpi	---	4	1.0 h
Pitoma slanopadj	Y-96	4	1.0 h
Tonkowitzka	P-Q20218	1	1.0 h
Topka	Y-33	3	1.0 h
Ananasowka czeska	P-Q20198	2	1.0 h
Verbeln	P-Q20220	2	1.0 h
Wilenska plenna	P-Q20222	3	1.0 h
Mustabej	Y-22	1	1.0 h
Prague No. 2	C-2	3	1.0 h
Bojka	P-Q20203	3	1.0 h

²Y = former Yugoslavia, R = Romania, P = Poland, H = Hungary, and C = Czech Republic; Q = plant quarantine clone number; PI = plant introduction number. Accession numbers without a collection number were received by mail independently of plant exploration trips in 1978 and 1980.

³USDA fire blight scoring system (van der Zwet et al., 1970). Lowest (most severe) score per tree recorded over 7- and 4-year periods, respectively, for the 1986 and 1989 plantings. Mean separation by Waller-Duncan k ratio t test (k ratio = 100). Minimum significant differences = 2.5 for the 1986 planting and 5.4 for the 1989 planting.

Table 4. Blossom blight scores for artificial inoculations of Central European *Pyrus* germplasm at Kearneysville, W.Va.

Cultivar name/PI no.	Collection no. ²	No. clusters inoculated	Mean blight score ³
Pitoma			
slanopadja	Y-96	30	3.30 a
PI 483381	---	20	3.90 b
Jesnji vodenac	Y-37	10	3.90 b
Ananasowka			
czeska	P-Q20198	10	4.00 bc
Bera wymienta	P-Q20202	10	4.20 b-d
Projnjava	Y-107	10	4.20 b-d
Grusza od			
nagovskiego	P-Q20206	30	4.33 b-d
Bojka	P-Q20203	10	4.40 b-d
Mustabej	Y-22	10	4.50 c-e
Tonkowiecka	P-Q20218	10	4.50 c-e
Ilinka	P-Q20207	10	4.60 d-f
Tamioase de			
Calinesti	R-83	20	4.75 d-g
PI 483383	P-14	30	5.00 e-h
Kiselac	Y-35	20	5.10 f-i
Prague No. 1	C-1	10	5.10 f-i
Wilenska			
plenna	P-Q20222	20	5.30 g-j
Petrovka	Y-178	10	5.40 h-k
Zelinka	Y-42	9 ^x	5.56 h-l
Aniversarea	R-42	10	5.60 i-l
PI 506373	Y-167	20	5.65 i-l
PI 483386	P-26	20	5.75 j-l
Krolenka	P-Q20211	10	5.80 j-l
PI 506379	R-10	10	5.80 j-l
Para de Zahar			
de Bihor	R-96	20	5.85 j-l
Sapranii I	Y-57	20	5.90 kl
Crna poloska	Y-125	20	5.90 kl
Kalebasa			
plocka	P-Q20209	20	5.90 kl
Prague No. 2	C-2	30	6.00 l
Erabasma	P-Q20205	10	6.00 l
Kajzerka	Y-101	10	6.00 l
Lucele	R-2	10	6.00 l
Roosevelt	Y-130	10	6.00 l
Mednik	Y-100	20	6.00 l
Verbeln	P-Q20220	10	6.00 l
Sapranii II	Y-58	10	6.00 l
Coadesele	R-49	7 ^x	6.00 l
Panadjurka	Y-34	10	6.00 l

²Y = former Yugoslavia, R = Romania, P = Poland, H = Hungary, and C = Czech Republic; Q = plant quarantine clone number; PI = plant introduction number. Accession numbers without a collection number were received by mail independently of plant exploration trips in 1978 and 1980.

³Mean blossom blight score per cluster. Blossom blight scoring system: 0 = no blight; 1 = into floral cup; 2 = into ovary; 3 = into pedicel; 4 = into blossom cluster base; 5 = into spur or 1-year-old wood; and 6 = into 2-year-old or older wood. Mean separation by Waller-Duncan k ratio *t* test (k ratio = 100). Minimum significant difference = 0.58.

^xSome inoculated clusters were missing.

provides a more accurate ranking of disease reaction of resistant genotypes (Bell et al., 1990).

Although the accessions inoculated in the 1986 and 1989 plantings were distinct groups, differences in susceptibility might be attributed to differences in age. The combined data were analyzed as a hierarchical model with accessions nested within planting and tree nested within accession within planting. Means in this and all subsequent analyses were separated by the Waller-Duncan k ratio *t* test, with a k ratio = 100. Accessions and trees were considered to be random effects. The mean shoot length ($P = 0.09$), lesion length ($P = 0.91$), proportional lesion length ($P = 0.48$), or age of wood infected ($P = 0.36$) in each planting did not differ significantly. Therefore,

accessions from the two plantings were combined for further analysis and presentation.

Results and Discussion

Epiphytotic infection. Fire blight was severe during the 5-year period, 1989–93, and many pear accessions listed in 1990 in the resistant USDA scores 10 through 6 (van der Zwet and Bell, 1990) had considerably lower scores (Table 1), especially in the former Yugoslavian collection, where the number of accessions in the susceptible USDA 5–1 class increased by 20.4%. This increase is reflected in a corresponding 20.3% decrease in the USDA 10 and 9–8 class entries. For Romanian germplasm, these changes are 8.2% and 9.3%, respectively, and for Poland, 7.5% and 7.3%,

respectively. The severity scores for the small *Pyrus* collections from Hungary and the Czech Republic did not change.

The individual accessions, arranged by their USDA fire blight classes, are listed in Table 2. Of the seven accessions of 'Jeribasma' previously reported in the resistant USDA blight scores 10–6, only three remained after the 1993 season. Similarly, of the four 'Karamanka' and 'Ilinjaca' accessions, only two remained in each group.

Mean lowest (i.e., most severe) natural fire blight scores for the 52 accessions in the 1986 and 1989 plantings at AFRS varied from a high of score of 10 for 'Urehelnite' to a score of 1.0 for 27 accessions (Table 3). Only five accessions (10.4%) had mean scores of 6 or above. The mean score for all accessions was 2.3.

Blossom inoculations. All Central European pear accessions were highly susceptible to blossom infection (Table 4). Only one cluster on 'Zelinka' escaped infection (data not shown). Preliminary analysis indicated no significant difference among replicated trees of the same accession, even if those trees differed in age. Those least susceptible (mean score <4.0) were 'Pitoma Slanopadja', a putative *P. communis* × *P. amygdaliformis* hybrid (Stancevic et al., 1984), and PI 483381 and 'Jesnji Vodenac', both *P. communis*. In 30 accessions, at least half of the inoculations resulted in infection into the spur or 1-year-old or lateral shoots; and in 21 accessions, more than half of the infections progressed into 2-year-old wood. Resistance to blossom infection in pear is extremely rare. Even genotypes with high degrees of resistance in shoot tissue are usually susceptible in blossoms (Le Lezec et al., 1985; unpublished data). This collection is similar in this respect to West European germplasm.

Shoot inoculations. Mean shoot length ranged from 607 mm for Sapranii II to 214 mm for 'Tonkowiecka'. Analysis of the proportional lesion length data indicated that, while differences among accessions were significant ($P = 0.02$), differences between trees within accessions also were significant ($P = 0.04$). This result is reflected in the mean separation classes (Table 5) and may be due to the small number ($n = 5$) of shoots inoculated per tree in the 1989 planting. Proportional lesion length varied from 4.2 for 'Panadjurka' to 0.0 for PI 506382 (putatively *Sorbo-pyrus*) and 'Roosevelt'.

During the 15 years when 384 pear accessions, collected in five countries of Central Europe (mainly former Yugoslavia), were exposed to fire blight in the United States, 80% have now proven highly susceptible to the disease. During this same period, fire blight has spread into all countries of Eastern Europe, except Hungary. Since 1986, 56 *Pyrus* accessions have been released from NPGQC, of which 89% have succumbed to fire blight. The remainder are being reevaluated for blight resistance. Presently, 73 accessions in USDA blight score classes 10–6 remain at Glenn Dale, Md., for potential evaluation and future release.

Table 5. Mean shoot blight and age of wood infected of Central European *Pyrus* accessions artificially inoculated with *Erwinia amylovora* at Kearneysville, W.Va.

Accession	Collection no. ^z	No. shoots	Mean shoot blight ^y	Age of wood infected
Roosevelt	Y-130	5	0.00 a	0.0 a
PI 506382	R-13	10	0.00 a	0.0 a
Poznica	Y-284	5	0.05 a	0.0 a
Kalebasa plocka	P-Q20209	13	0.49 ab	0.2 a
PI 483381	---	20	0.62 a-c	0.3 a
Mustabej	Y-22	10	0.81 a-d	0.5 ab
Erabasma	P-Q20205	10	0.87 a-e	0.2 a
PI 506381	R-12	5	0.90 a-f	0.6 ab
Sapranj I	Y-57	15	0.91 a-f	0.5 ab
Kajzerka	---	10	0.97 a-f	0.4 ab
Mednik	Y-100	10	1.00 a-f	0.4 ab
Zelinka	Y-42	16	1.06 a-g	0.2 a
Lucele	R-2	10	1.16 b-h	0.6 ab
Tonkowitzka	P-Q20218	10	1.21 b-i	0.2 a
PI 483383	P-14	30	1.27 b-j	0.5 ab
Bojka	P-Q20203	10	1.31 b-j	0.8 ab
Petrovka	Y-178	10	1.33 b-j	1.0 ab
Wilenska plenna	P-Q20222	26	1.33 b-j	0.4 ab
Coadesele	R-49	5	1.35 b-j	0.6 ab
Projnaca	Y-107	10	1.36 b-j	0.7 ab
Ilinka	P-Q20207	10	1.39 b-j	0.8 ab
Para de Zahar de Bihor	R-96	10	1.42 b-j	1.2 ab
Sapranj II	Y-58	10	1.44 b-k	1.1 ab
Aniversarea	R-42	25	1.50 b-l	0.7 ab
PI 506378	R-9	10	1.57 c-m	0.9 ab
PI 506373	Y-167	20	1.58 c-m	0.9 ab
Grusza od nagovskiego	P-Q20206	5	1.68 c-m	0.8 ab
Tamioase de Calineste	R-83	5	1.75 d-m	0.8 ab
Anasowka ceska	C-4	10	1.77 d-m	0.6 ab
Winiowka saska	P-Q20223	5	1.93 e-n	1.0 ab
Prague No. 2	C-2	26	1.94 f-n	1.1 ab
PI 483386	P-26	19	2.08 g-n	1.0 ab
Kiselac	Y-35	20	2.10 g-n	0.8 ab
Jesnji vodenjac	Y-37	10	2.18 h-n	1.1 ab
Verbeln	P-Q20220	5	2.22 h-n	1.2 ab
Krolenka	P-Q20211	10	2.23 i-n	1.2 ab
Crna poloska	Y-125	10	2.29 j-n	0.8 ab
PI 506379	R-10	10	2.50 k-n	1.1 ab
PI 506380	R-11	10	2.57 l-n	1.4 ab
Pitoma slanopadja	Y-96	25	2.60 mn	1.1 ab
Prague No. 1	C-1	10	2.95 n	1.4 ab
Panadjurka	Y-34	5	4.15 o	2.0 b

^zY = former Yugoslavia, R = Romania, P = Poland, H = Hungary, and C = Czech Republic; Q = plant quarantine clone number; PI = plant introduction number. Accession numbers without a collection number were received by mail independently of plant exploration trips in 1978 and 1980.

^yShoot blight, 8 weeks postinfection, expressed as a proportion of current-season's shoot length. Mean separation by Waller-Duncan k ratio *t* test (k ratio = 100). Minimum significant difference = 1.07 for mean shoot blight and 0.6 for age of wood.

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