

The Differences among Pear Genotypes to Fire Blight (*Erwinia amylovora*) Attack, Based on Observations of Natural Infection

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Abstract

Fire blight, caused by the bacterium *Erwinia amylovora*, is one of the most damaging diseases of pear in the world. In Cluj-Napoca area, situated in central Transylvania, Romania, fire blight was observed first in 1994, very late comparative with the other countries from occidental Europe. The response of the pear cultivars and species from National Pear Collection from Cluj-Napoca to fire blight attack, assessed in natural conditions of infection, range on a large scale of variability, which denotes a strong influence of the genotype in expression of resistance or sensitivity to disease. From all genotypes, about 20.5% have not presented symptoms of attack, among them being the following: 'Blanquet precoce', 'Klementinka', 'Severianka', 'Beurré Bachelier', 'Kieffer Seedling', 'Er Shi Shinge', 'Beurré Amanlis', 'Bristol Cross', 'Beurré Liegel', 'Beurré Lucon', 'Grand Champion', 'Magness', 'Mericourt' etc. and several ancient autochthonous cultivars ('Pere malaiete', 'De zahar de Bihor', 'Cu miez rosu', 'Clopotele', 'Garoafa mare', 'Craiese', 'Para de apa'). Also, there were identified several species of *Pyrus* with no attack, as *P. pollveria*, *P. common pear*, *P. lindlezi*, *P. malifolia*, *P. persica*, *P. ussuriensis*, *P. variolosa*. The remarked genotypes could be potential sources for further breeding programmes and increase the number of genotypes available for breeding new pear cultivars resistant to *Erwinia* attack.

Keywords: attack degree, breeding, *Erwinia*, genotypes, pear, species

Introduction

Fire blight, caused by the bacterium *Erwinia amylovora*, is one of the most damaging pear diseases in the world (Bell and Zwet, 1993). In Romania, fire blight was noticed for the first time in 1992, in two different locations in the south and south east of the country (Severin et al., 1999), very late comparative with the other countries from occidental Europe. In the north of the country, in Cluj-Napoca area, central Transylvania, fire blight was observed first in 1994, but the debut of disease was very suddenly and extreme, forcing to clear cut in the same year the trees form an orchard of 30 hectares near Cluj-Napoca. Since 1994, the fire blight attack in Transylvania was different, from one area to another, and with a large scale of damaged among cultivars, but not as really severe so much that to compromise orchards.

Regarding the disease seriousness, the pear breeding for resistance to fire blight is a priority in obtaining new cultivars (Gunen and Misirli, 2003; Sestras, 2004). For this reason it is necessary to identify resistant genotypes which can be used as genitors is artificial hybridisations (Zwet et al., 1974; Zwet and Bell, 1990; Bell, 1991; Bell et al., 1982, 2005; Sestras et al., 2007).

Resistance to fire blight in traditional cultivars of pear was found by Hevesi et al. (2004) from among Hungarian varieties; they found high resistance in Sikulai and Szemes

alma cultivars, which were proposed for use as sources of fire blight resistance in breeding programmes and also grown in organic orchards. But the research for a fire blight resistant genotypes of pear has been undertaken in the United States since the beginning of the XX century and the resistant parents were firstly chosen in oriental species: *Pyrus pyrifolia*, *Pyrus ussuriensis* or in hybrids between *Pyrus communis* and these species (Thibault and Paulin, 1984). In France, the first crosses were made (Thibault, 1981) between a parent of good quality, but susceptible (General Leclerc, Notaire Lepin) and a parent with good resistance to fire blight (Maxine, Mac, Dawn etc.).

Materials and methods

The study was carried out at the Fruit Research Station from Cluj-Napoca, in Central Transylvania, Romania. In Romania, there are two germplasm collections (National Collections), at Fruit Research Station Cluj-Napoca and Fruit Research Institute Pitesti - Maracineni.

At FRS Cluj-Napoca, in the last ten years, the response to fire blight attack was assessed on more than 15000 genotypes of pear, from among more than 350 being cultivars and *Pyrus* species (grouped in National Collection of Pear from Romania), more than 140 clonal selections and remainder of them being seedlings. In National Collection, every genotype was represented by three trees grafted on

franc pear (seedling rootstock) and planted in 1992 on 4 m between rows and 3 m between trees on row. Clonal selections were placed in trials with different number of trees per variants, ages and distances of planting and rootstocks: quince, franc, Curé and Beurré Hardy as intermediate. The seedlings were represented by F_1 - F_n hybrids, by own roots, with different origin and pattern of hybridizations.

The response of genotypes to fire blight attack was assessed in natural conditions of infection, with the same currently treatments as in commercial orchards, uniformly applied to all the cultivars and selections, except seedlings fields where no treatments were effectuated.

In the last three years, in National Collection the fire blight attack was very intense and causing severe losses, so there were determined Frequency (F%) and Intensity (I%) attack and thus the Attack Degree (AD%), representing express the extension of the attack's seriousness. AD% was calculated by the formula: $AD\% = (F\% \times I\%) / 100$ (Cociu and Oprea, 1989) as mean for the three trees analyzed per genotype in the last three years. In the field with selections and seedlings the estimation of fire blight level was made by notation of scale 1 (no attack) to 9 (complete scorching and tree death), corresponding with AD% classes.

Results and discussion

In National Collection of Pear, the fire blight had a very fast and severe evolution, the attack being very intense and causing severe losses, with evident differences depending of genotypes.

After Frequency and Intensity attack were determined for the last three years, there were calculated the Attack Degree - AD% (Table 1).

Considerable variation in resistance or sensibility to fire blight attack was observed with cultivars and species, ranging from highly susceptible to highly resistant.

Regarding to *Erwinia amylovora* attack, the analyzed genotypes were framed in nine classes (Table 2).

Table 1 The fire blight attack on different pear genotypes (365 cultivars and species), appreciated by AD%

Genotype	AD%
Ahrenberg	0
Beurré Amanlis	0
Beurré Bachelier	0
Beurré Durondeau	0
Beurré Liegel	0
Beurré Lucon	0
Beurré Superfin	0
Blanquet Precoc	0
Boieresti	0
Bristol Cross	0
Buttira di Roma	0
Carrick	0

Genotype	AD%
Cerovka	0
Chen-Chu-Mi	0
Cj 20-11-20	0
Clopotele	0
Collete	0
Conference	0
Conseiller a la Cour	0
Craiese	0
Cu miez rosu	0
Curcubete	0
D'Alencon	0
De Zahar de Bihor	0
Decaisne Henrick	0
Deutleur Vaj Korte	0
Down	0
Erbina	0
Er-Shi-Shange	0
Ewerd	0
Garoafa Mare	0
General Osmanwill	0
Geneva 7620	0
Ginese	0
Grand Champion	0
HWJ 3-241	0
Kieffer Seedling	0
Klementinka	0
Laurence	0
Magness	0
Matyo	0
Mericourt	0
Napoleon	0
Orel	0
Otecestvena	0
P 6-20-71	0
P 2-26-97	0
Panasat	0
Para de apa	0
Pere Malaiete	0
Pere Pergament	0
Phileson	0
Precoc de Celles	0
Precoc de Trevaux	0
Precoc Trottier	0
<i>Pyronia</i> Veitkii	0
<i>Pyrus</i> Carnot	0
<i>Pyrus common pear</i>	0
<i>Pyrus lindlezi</i>	0
<i>Pyrus malifolia</i>	0
<i>Pyrus persica</i>	0
<i>Pyrus pollveria</i>	0

Genotype	AD%	Genotype	AD%
<i>Pyrus variolosa</i>	0	Dorset	10.1
R. C. Wurtenberg	0	<i>Pyrus longipes</i>	10.7
Rakmanis Triumf	0	Bergamotte Crassane	10.8
Seigneur Essperen	0	Kostliche Von Germen	11.1
Severianka	0	Van Mons	11.1
Sierra	0	Moldoveanca	12.2
Tirriote	0	Jeribasna	13.0
TN 30-44	0	Mehmedkca	13.9
Tomnatice	0	<i>Pyrus korshinski</i>	14.2
Wileenska Plenna	0	Kiparijska	14.4
Williams	0	Thomson	15.2
Williams Bovey	0	Lucii galbene	15.7
Zaharoasa de Vara	0	Marculesti 41//32	16.3
Cantalupesti	0.3	Para de mai	18.0
Enie	0.3	Pultney	18.6
<i>Pyrus communis</i>	0.4	Gute Craue	20.5
Rousselet de Stuttgart	0.4	Marculesti 43//10	20.7
Marculesti 243	0.6	Orzatice	20.7
Zorca	0.7	H 3-1010	25.0
Bacsa Korte	1.1	Alexandre Lucas	33.3
Drymon	1.4	Aniversare	33.3
Beurré Bosc	1.6	Belle des Arbres	33.3
Margareta Krier	1.6	Beurré Diel	33.3
Muscat Strauss	1.6	Boieresti	33.3
Para de vin	1.6	Doyene G. Boucher	33.3
June Gold	2.2	Early Harvest	33.3
Miez de paine	2.6	Er-Jang -Li	33.3
Limonca	2.8	Falca rosie	33.3
Cure	3.1	IP -2542	33.3
<i>Pyrus eleagrifolia</i>	3.2	Jo-Kung-Li	33.3
Imperiale	3.3	Kristalli	33.3
Laxton Superb	3.8	Le Lectier	33.3
Antig	4.0	Lincoln	33.3
Travicescaia	4.2	Local mic de livezi	33.3
Juliusi Selimesi	4.9	Lorentz Kovacs	33.3
De Chemontel	5.4	Loumenjuli Isletes	33.3
Large Winter	5.6	Mariana	33.3
Dulci de vara	5.7	Messir Jean	33.3
Beurré Bremen	6.1	Nina de Visani	33.3
Balansoie	6.5	NJ 13	33.3
Artass	8.3	Piparate de toamna	33.3
Gutuiesti	8.3	<i>Pyrus Drovara</i>	33.3
Madame Balet	8.3	<i>Pyrus ussuriensis</i>	33.3
Rock 4-116	8.3	Rosior pietros	33.3
Tamaioasa de Calinesti	8.3	Sheldon	33.3
Arabitka	8.7	Souvenir du Congres	33.3
Erdei voj Korte	8.8	Tang-Li	33.3
Favorita lui Clapp	8.8	Timpurie de Dimbovita	33.3
Takisa	9.1	Veitkii	33.3
Varatice	9.1	Dulci	33.4

100

Genotype	AD%
Helmerhus Lyran	33.5
Rosii	34.0
Epine du Mas	34.2
Geneva 4883	34.9
Haydeca	35.4
Precoce de Trivale	35.9
General Leclerc	36.6
Maria Romana	37.4
Murphy Red Bartlett	37.4
Pierre Corneille	37.4
Old Homme	37.5
Cantari	38.3
Japoneze	38.3
Triomphe de Tourraine	38.6
Republica	38.8
Calebasse Plocka	39.4
Napoca	39.7
Beurré Naghewitz	40.0
Ducesa Pitmaston	40.0
Busuioace	40.2
P 6-16-22	40.4
Sorbopyrus	41.1
Untoasa de Tg. Mures	41.5
President Heron	42.4
Tamaiosa Robert	42.8
Postatele	43.3
Devoe	43.5
Argessis	43.8
Triomphe de Vienne	46.6
Muscat Allemand	48.6
Bergamotte Esperen	50.0
Beurré Starckman's	50.0
Beurré Vauban	50.0
Blumenbacs Butterbirne	50.0
Codita	50.0
Dr. Lucius	50.0
Ina Estival	50.0
Kekicka	50.0
King Sobieski	50.0
Noiabriscaia	50.0
Rousselet de Reims	50.0
Sparbirne	51.1
P 6-16-96	52.8
Moonglow	54.2
Mora IP 112	54.6
President Mass	54.9
Untoasa de Ardeal	56.0
Fondanta de Poiana	56.2
Decana N. Krier	57.3
Fondanta de Padure	57.8
Ciuda	62.0

Genotype	AD%
Pringalle	62.5
Eserasca 2001	64.3
Furnicoase	64.5
Untoasa de Transilvania	67.0
Dulci de seceris	68.0
Mindenre Jo Korte	68.3
Aarska	66.6
Abbe Fetel	66.6
Ananasova	66.6
Beurré Czei	66.6
Bezsemanca	66.6
Bonne Louise d'Avranches	66.6
Chang-Pa-Li	66.6
Charlotte de Rocour	66.6
Cj 4-73-73	66.6
Csaszar Korte	66.6
Decana Comisie	66.6
Galbene	66.6
Holtzfarbig	66.6
Max Red Bartlett	66.6
Mici rosii	66.6
Okusanchiki	66.6
Olivier de Serres	66.6
Pere cu doua recolte	66.6
<i>Pyrus betulaefolia</i>	66.6
<i>Pyrus cordata</i>	66.6
Rosior de Dambovita	66.6
Triumpf	66.6
Untoasa de Geoagiu	66.6
Williams Rosu	66.6
Zorca	66.6
Bunte Julibirne	66.9
Veitkii	66.9
Vastavocinaia	68.8
Salamuer	69.5
Beierschmidt	71.6
Urechelnite	73.3
Fulvie	74.0
Para de iarna	74.0
Babane	74.2
<i>Pyrus eleagrifolia</i>	74.2
Williams cu miez rosu	74.2
Boiereasca Mare	75.0
P 6-19-36	75.0
Rising Summer	75.0
Vidocka	75.0
Fermuti	75.5
Lettnai Cure	76.6
Aramiu de Somes	78.6
Ovid	79.0
Fragrante	79.7

Genotype	AD%
<i>Pyrus canensis</i>	80.9
Karamanek	83.7
HWY 3248	85.3
Pepenii	88.5
Beurré Hardenpont	92.9
Alamai	100.0
Arabka	100.0
Aromata de Bistrita	100.0
Beurré Gelin	100.0
Boierasca Mica	100.0
Busuioace	100.0
Carpica	100.0
Cetatui	100.0
Cj 72-17-11	100.0
Cj 99-7-51	100.0
Coadese	100.0
Crab	100.0
Cure	100.0
Daciana	100.0
Decana del Friuli	100.0
Delbar exquisite d'hiver	100.0
Doina	100.0
Doyenne d'Juillet	100.0
Doyenne Gaubalt	100.0
Dr. Jules Goyot	100.0
Ecimianka	100.0
Euras	100.0
Eva	100.0
Fertility	100.0
Frumoasa de Brosteni	100.0
Galbene de Bratca	100.0
Galbene de Vitomiresti	100.0
Gatlane	100.0
Ghindaoane	100.0
Globuloase mari	100.0
Goloman de vara	100.0
Graslin	100.0
Grumkower Butterbirne	100.0
Harbuzesti	100.0
Haydeca	100.0
Hentze	100.0
Highland	100.0
Ina Estival	100.0
Jeanne d'Arc	100.0
Johantrop	100.0
Kostliche	100.0
Liche Gustav	100.0
Lucii timpurii	100.0
Lucii Verzi	100.0
Maslovia	100.0
Mednic	100.0

Genotype	AD%
Meton Belle	100.0
Michigan 437	100.0
Morettini 64	100.0
Notair Lepin	100.0
Nv 2480	100.0
Ny 8760	100.0
Orzatice	100.0
P 6-20-71	100.0
Para de paine	100.0
Para de toamna	100.0
Passe Colmar	100.0
Passe Crassane	100.0
Pautalia	100.0
Pastravioare	100.0
Pastravioare de Valcea	100.0
Pere Piparate De Vara	100.0
Piparate de vara	100.0
Pletoase	100.0
President Drouard	100.0
President Mas	100.0
President Rooswelt	100.0
Productive de Iulie	100.0
<i>Pyronia</i> Luxemburgiana	100.0
<i>Pyrus nivalis</i>	100.0
<i>Pyrus salicifolia</i>	100.0
<i>Pyrus sikinensis</i>	100.0
<i>Pyrus sinaica</i>	100.0
<i>Pyrus syriaca</i> Boiss	100.0
Regale	100.0
Remy Chatenay	100.0
Rock 4-181	100.0
Rotilate	100.0
Santilesti	100.0
Sokrovisce	100.0
Solaner	100.0
Somesan	100.0
Sommereierbirne	100.0
Spadona d'Estate	100.0
Tarda IP 1836	100.0
Tari	100.0
Tamaiosa Mica	100.0
Teri Vilmos	100.0
Travicesc	100.0
Trivale	100.0
Untoasa de Sanchetru	100.0
Varatice	100.0
Vrabiute	100.0
Wilder	100.0
Williams Precoce Morettini	100.0
Zucher Bird	100.0

Table 2 The response of pear genotypes from National Collection of Cluj-Napoca to *Erwinia amylovora* attack

Class	Attack appreciation	Attack Degree (AD%)	Number of genotypes	Percent of total genotypes
1	No attack	0	75	20.5
2	Very low attack	0.1-5.0	22	6.0
3	Low attack	5.1-10.0	15	4.1
4	Medium attack	10.1-20.0	15	4.1
5	Supra medium attack	20.1-40.0	54	14.8
6	Strong attack	40.1-60.0	31	8.5
7	Very strong attack	60.1-80.0	52	14.3
8	Extreme strong attack	80.1-99.9	5	1.4
9	Complete scorching (trees dead)	100	96	26.3

The response of the 365 species and cultivars to fire blight attack was very different, in extremely classes being included the most genotypes: 20.5% with “No attack” and 26.3% with “Complete scorching (trees death)”. Between

Table 3 *Pyrus* species and cultivars framed in extremely classes for response to *Erwinia amylovora* attack

Genotypes with no attack (AD%=0)		Genotypes total scorching (AD%=100)	
Species	Chen Chu Mi	Species	Another cvs.
Pyrus Veitkii	Collete	Pyrus salicifolia	Beurré Gelin
Pyrus Carnot	Conference	Pyrus sikiensis	Curé
Pyrus common pear	Conseiller a la Cour	Pyrus sinaica	Decana del Friuli
Pyrus lindlezi	D'Alencon	Pyrus syriaca Boiss	Delbar exquise d'hiver
Pyrus malifolia	Decaisne Henrick	Ancient Romanian cvs. Alamai	Doyenné d'Juillet
Pyrus persica	Deuteur Vaj Korte	Boiereasca mica	Dr. Jules Guyot
Pyrus pollveria	Down	Busuioace	Ecimianka
Pyrus ussuriensis	Erbina	Cetatu	Eva
Pyrus variolosa	Er-Shi-Shange	Coadese	Fertility
Ancient Romanian cvs.	Ewerd	Frumoasa de Brosteni	Graslin
Boieresti	General Osmanwill	Galbene de Bratca	Hentze
Clopotele	Geneva 7620	Galbene de Vitomiresti	Highland
Craiese	Ginese	Gatlane	Jeanne d'Arc
Cu miez rosu	Grand Champion	Ghindaoane	Johantrop
Curcubete	Kieffer Seedling	Globuloase mari	Kostliche
De zahar de Bihor	Klementinka	Goloman de vara	Liche Gustav
Garoafa mare	Laurence	Harbuzesti	Merton Belle
Panasat	Magness	Lucii timpurii	Michigan 437
Para de apa	Matyo	Lucii verzi	Morettini 64
Pere malaiete	Mericourt	Orzatice	Notair Lepin
Pere pergament	Napoleon	Para de paine	Passe Colmar
Tomnatice	Orel	Para de toamna	Passe Crassane
Zaharoasa de vara	Otecestvena	Pastravioare	Pautalia
Another cvs.	Phileson	Pastravioare de Valcea	President Drouard
Ahrenberg	Precoce de Celles	Pere piparate de vara	President Mas
Beurré Amanlis	Precoce de Trevaux	Piparate de vara	President Roosevelt
Beurré Bachelier	Precoce Trottier	Pletoase	Productive d'Julliet
Beurré Durondeau	R. C. Wurtenberg	Rotilate	Remy Chantenay
Beurré Liegel	Rakmanis Triumf	Santilesti	Sokrovisce
Beurré Lucon	Seigneur Essperen	Tari	Solaner
Beurré Superfin	Severianka	Tamaiosa mica	Sommereierbirne
Blanquet Precoce	Sierra	Untoasa de Sanchetru	Spadona d'Estate
Bristol Cross	Tirriote	Varatice	Tarda IP 1836
Buttira di Roma	Wileenska Plenna	Vrabiute	Teri Vilmos
Carrick	Williams		Wilder
Cerovka	Williams Bovey		Williams Prec. Morettini
			Zucher Bird

the extreme classes the values of Attack Degree the percentages varied from 1.4% to 14.8%.

For the extreme classes to fire blight attack there were registered both *Pyrus* species and different cultivars, some of them ancient, autochthonous, cultivated on small areas on different regions of Romania, and some more or less spread in the world (Table 3).

There was noticed a certain inconstancy of the cultivars reaction to *Erwinia* attack, some known as resistant or tolerant being susceptible or contrary. 'Williams' ('Bartlett') considered highly susceptible was included in no attack class. At the same class was 'Williams Bovey', while 'Williams Precoce Morettini's' trees were completely killed. Several cultivars known as resistant were identified as susceptible at fire blight attack in Cluj-Napoca conditions; eg. 'Old Home' was registered with AD% = 37.5 and 'Moonglow' with AD% = 54.2. Some cultivars analyzed in different fields, including ones created at Cluj-Napoca ('Haydeea', 'Ina Estival'), there were registered with a very large scale of AD%, between 0-100%.

Surprising, unlike the cultivars from National Collection, the selections and seedlings from experimental fields, placed on the same perimeter of 10 hectares, were not affected only on a small rate, the attack being sporadic. Fire blight manifested only at 1-5% from the total genotypes in trials and hybrids fields, with low marks (2 or 3) reflecting very low attack or low attack.

The results obtained confirms the information from specialized literature according to the majority of the cultivars are susceptible to *Erwinia amylovora* attack (Zwet and Beer, 1995; Zwet and Bell, 1990; Sestras, 2004) and the infection could spread so rapidly through the tree that trees could not be saved.

Unfortunately, even though all the measures of control were tried (chemical control, sanitation, pruning, and eradication) they were not efficient and many genotypes from National Collection of Cluj-Napoca were lost. It is tried to remake the collection but probably some of the cultivars, especially the ancient autochthonous ones will be lost because at Fruit Research Institute Pitesti the fire blight compromised a part of the collection. In Romania, the saving of pear germplasm collections becomes a very acute problem.

Conclusions

The response of pear genotypes to fire blight attack emphasised a large variability within 365 pear genotypes tested in National Collection at the Fruit Research Station in Cluj-Napoca, Central Transylvania, Romania, which denotes a strong influence of genotype in expression of resistance or sensitivity to disease. The variation limits for the attack degree on trees were estimated between 0% ("No attack") and 100.0% ("Complete scorching - trees death"). Out of all genotypes, 75 of them, representing 20.5% were registered with "No attack", while 96 of them, representing

26.3% were extremely sensitivity, the trees being killed by fire blight attack. Several species and cultivars registered with "No attack" and considered as tolerant to disease could be used as potential sources for further pear breeding programmes.

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