EVALUAREA REZISTENŢEI LA ARSURA BACTERIANĂ A UNOR NOI SOIURI DE MĂR ÎN CONDIŢII DE INFECŢIE NATURALĂ

EVALUATION OF SOME APPLE VARIETIES TO FIRE BLIGHT (*ERWINIA AMYLOVORA*) SUSCEPTIBILITY IN NATURAL FIELD CONDITIONS

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Abstract

Fire blight (*Erwinia amylovora*) is a very important disease that need to be carefully managed as it is classified as a ''quarantine disease'' and can spread itself very quickly when the conditions are favorable (presence of focus, high air humidity and high temperatures, presence of susceptible organs like flowers or long young twigs,..). The study was carried out at Research Institute for Fruit Growing Pitesti, Genetic and Breeding Department, during 3 consecutive years (2010-2012), including 36 apple cultivars, old and newly bred. In this study, we present the response of the apple cultivars to fire blight attack, assessed in natural conditions of infection, range a large scale of variability, which denotes a strong influence of the genotype in expression of resistance or susceptibility to disease.

Keywords: apple cultivars*, Erwinia amylovora,* fire blight resistance
Cuvinte cheie: soiuri de măr, *Erwinia amylovora,* rezistenţa la arsura bacteriană

1. Introduction

Fire blight, caused by the Gram-negative enterobacterium *Erwinia amylovora*, infects many mebers of the *Rosaceae* family and is a major economic threat to pear, apple and quince production worldwide (Bell and Van der Zwet, 1993). Since it was described in the Eastern USA in 1780, fire blight has spread throughout North America, and to, New Zealand, Western and Central Europe and Middle East (Bonn and Van der Zwet, 2000).

In Romania, fire blight was noticed for the first time in 1992 by T. Baicu in an apple orchard from Braila district and, than, by N. Branişte (1992) and A. Richiţeanu (1992) at Research Institute for Fruit Growing Pitesti, in the pear collection, very late comparative with the other countries from Europe (Şerboiu, 1995). In the Northern part of the country, in Cluj Napoca area, central Transylvania, the fire blight was observed firstly in 1994, but the debut of disease was very suddenly and extreme, forcing to clear cut in the same year the trees from an orchard of 30 hectares near Cluj Napoca (Sestras, 2008).

When the conditions like presence of focus, high air humidity and high temperatures are favourable, the bacterium attacks flowers, leaves, branches, roots and fruits and in severe cases entire trees and orchards can be devastated within a season. The occurrence and severity of fire blight is determined by the interaction between the pathogen, favourable weather conditions and host plant susceptibility / tolerance (Thomson, 2000). In Romania, the risk is accentuated by the presence in apple orchards of ‘Jonathan’ cultivar, which is very susceptibility to this disease.

Along with ‘Jonathan’, the most susceptible apple varieties are 'York', 'Rome Beauty', ‘Winter Banana’, 'Jonagold', 'Idared', 'Tydeman's Red', 'Gala', 'Fuji', 'Braeburn' and 'Lodi'. 'Stayman' and 'Golden Delicious' cultivars are moderately resistant and all strains of 'Delicious' are highly resistant to fire blight, except when tissues are damaged by frost, hail or high winds (Braniste and Andries, 1990; Janick, 1996). Several wild *Malus* species have been identified as potential sources for fire blight resistance, including *M. robusta*, *M. sublobata*, *M. atrosanguinea*, *M. prunifolia* and *M. fusca* (Aldwinckle and Beer, 1979). A promising level of resistance has also been observed in some *Malus x domestica* cultivars, such as ‘Nova Easygro’ and ‘Florina’ (Aldwinckle and Van der Zwet, 1979; Fischer and Fischer, 1999). Monogenic resistance to fire blight has not identified in apple and it is thought that disease resistance is a quantitative trait loci (QTL) (Dondini et al., 2004).

In this study, we present the response of the new apple cultivars to fire blight attack, assessed in natural conditions of infection, range a large scale of variability, which denotes a strong influence of the genotype in expression of resistance or sensitivity to disease.

2. Material and methods

The study was carried out at Research Institute for Fruit Growing Pitesti, Genetic and Breeding Department, during 3 consecutive years (2010-2012), including 36 apple cultivars, old and newly bred. The trees were planted in 2006, grafted on M106, spaced at 4/4 m. Each genotype is a variant and each variant has 3 replications (3 trees = 1 replication), Table 1.

In the field, the observations and estimation of fire blight level were made by notation of scale 1 (no visible symptom) to 9 (maximum infection, tree completely affected, nearly dead), according to the evaluation descriptors for *Malus x domestica* (ECPGR),Table 2, Figure 1.

In the last three years, the fire blight attack was intense, so there were determined frequency (F%) and intensity (I%) attack and thus the attack degree (AD%), using the formula AD% = (F% x I%) / 100 (Cociu and Oprea, 1989).

The aim of the present study was to investigate and compare the susceptibility to *Erwinia amylovora* of 13 Romanian cultivars and introduced apple varieties, 5 of them Moldavian, 5 French, 5 American, 2 Italian, 2 New Zealand, 1 Czech, 1 Swiss, 1 Japanese, 1 English.

3. Results and discussions

Climatic data for the vegetation season (March – October) over the study period 2010 - 2012, registered at Research Institute for Fruit Growing Pitesti, are presented in Table 1. The evaluation of the response of the different apple cultivars to fire blight, carried out in debut of July, showed than the main factor in the development of the disease was the genotype and the meteorological conditions.

Based on the visual assessments and related to *Erwinia* attack, the cultivars were grouped in 6 attack classes, most of them (23 cvs.) showing no visible symptoms.

Among the Romanian cultivars, the most severe attack was registered with ‘Auriu de Bistrita’ cv. In 2011, respectively AD%=57.8, with an average attack degreed of 39.96. The symptoms were also registered with ‘Romus 5’ cv. In 2011 and 2012, with an average attack degree of 3.46 which did not surpass the control, ‘Florina’ cv.

Among foreign cultivars tested, under Pitesti conditions, the French cultivar ‘Dalinco’ the only one included in the class 6 (strong attack) with Ad=44.93, showed the most severe symptoms. Also, another French cultivar 'Dalinbel®Antares' showed *Erwinia* symptoms, class 3, both French cultivars having the same genitors. ‘Florina’ cv. The most grown apple in Romania, having a scab genetic resistance of Vf type, showed fire blight symptoms on shoots under weather conditions of 2012, with an attack degree of 1.8.

'Topaz', a cultivar of Czech origin showed fire blight symptoms in all 3 years of study but the most severe ones were observed in 2012 when many branches were damaged for a great number of trees.

Summarizing the results of the studies carried out we can conclude that the French apple cultivars 'Dalinco' is more susceptible to fire blight versus 'Auriu de Bistrita' cv., reconized as the most susceptible Romanian to fire blight, having the same response in various fruit growing areas from our country. Also, the Czech cultivar 'Topaz' demonstrated a high sensitivity to fire blight.

4. Conclusions

The different response of apple cultivars to fire blight attack, tested at Research Institute for Fruit Growing Pitesti, Romania, denotes a strong influence of genotype in expression of resistance or sensitivity to disease.

Out of all 23 apple foreign cultivars studied, 52.17% of them, were registered with ”No visible symptom”.

The most susceptible to fire blight is 'Dalinco' cv., which it is not recommended to be grown in climatic conditions from Mărăcineni, Arges.

Of Romanian varieties studied, the most susceptible to fire blight is 'Auriu de Bistrita' cv.

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Tables and figures

Table 1. Meteorological data, registered during 2010 - 2011 at the RIFG Pitesti

	Year	Months							
		Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
Temperature (°C)	2010	4.6	10.7	15.2	19.4	21.3	22.6	15.8	7.8
Temperature (°C)	2011	4.4	10.2	14.8	19.1	21.1	20.8	18.9	8.9
Temperature (°C)	2012	5.4	12.3	16.1	21.2	24.6	21.9	17.8	
Humidity (%)	2010	73.5	73.1	79.6	79.2	78.2	74.9	77.4	81.7
Humidity (%)	2011	75.4	65.9	78.4	77.3	77.1	72.1	68.7	75.1
Humidity (%)	2012	63.8	71.0	81.8	74.0	62.4	64.8	67.4	
Rainfall (mm)	2010	38.4	52.0	128.8	154.6	99.2	39.4	20.6	70.2
Rainfall (mm)	2011	54.5	34.6	77.4	107.4	99.4	33.8	0.0	44.8
Rainfall (mm)	2012	2.0	90.8	107.0	67.8	29.2	76.6	28.4	

Table 2. Apple varieties included in fire blight evaluation

No.	Variety	Origin	Genitors
1	Enterprise	Illinois, USA	PRI 1661-2 X PRI 1661-1
2	Goldrush	Illinois, USA	Coop 17 x Golden Delicious
3	Crimson Crisp	Illinois, USA	PCFW 2-134 x PRI 669-205
4	Falstaff	East Malling, UK	James Grieve x Golden Delicious
5	Braeburn	New Zeeland	Granny Smith x Lady Hamilton
6	Hillwel	New Zeeland	Mutation Braeburn
7	Fuji	Japan	Ralls Janet x Golden Delicious
8	Choupette® Dalinette	Angers, France	Sel. X 4598 x Sel. X 3174
9	Dalinbel®Antares	Angers, France	Elstar x X 3191
10	Dalinco	Angers, France	Elstar x X 3191
11	Galarina	INRA Angers, France	Gala x Florina
12	Ariwa	Wadenswil, Switzerland	Golden Delicious x A 849-5
13	Topaz	Strizovice, Czeck Republic	Rubin x Vanda
14	Golden Orange	Trento, Italy	Ed Gould Golden x Sel. PRI 1956-6
15	Golden Lasa	Trento, Italy	Ed Gould Golden x Sel. PRI 1956-6
16	Coreventa	Republic of Moldova	
17	Coremodet	Republic of Moldova	OR33T90 x Mantuaner
18	Coredar	Republic of Moldova	Slava Peremoţiam x OR32T41
19	Coreprim	Republic of Moldova	
20	Coredana	Republic of Moldova	Mantuaner x OR33T90
21	Rebra	Pitesti, Romania	Prima x Florina
22	Rustic	Pitesti, Romania	Florina x Pionier
23	Romus 3	Pitesti, Romania	Interspecific hybrid F4
24	Romus 4	Pitesti, Romania	Romus 3 x Prima
25	Romus 5	Pitesti, Romania	Romus 3 x Prima
26	Bistriţean	Bistriţa, Romania	Starkrimson x Prima
27	Auriu de Bistriţa	Bistriţa, Romania	Golden Delicious x Parmain d'or
28	Aura	Bistriţa, Romania	Prima x BN 33/39
29	Goldprim	Bistriţa, Romania	Golden Delicious x Prima
30	Starkprim	Bistriţa, Romania	Starkrimson x Prima
31	Jonaprim	Bistriţa, Romania	Prima x Jonathan
32	Ciprian	Voinesti, Romania	Prima x Starkrimson
33	Redix	Voinesti, Romania	Goldspur x irradieted pollen Prima
34	Florina (Control 1)	Angers, France	612-1 x Jonathan
35	Idared (Control 2)	Idaho, USA	Jonathan x Wagener Premiat
36	Golden Delicious (Control 3)	Westvirginia, USA	Grimes Golden x Golden Reinette?

Table 3. Global assessment scale for the evaluation of infection to fire blight (Lateur, 1999)

Scale	Observation in the orchard	Approximate proportion of branches infected by fire blight (%)	Attack Degree (AD%)
1	No visible symptom	0	0
2	One or very few small infections, detectable only on close scrutiny of the tree	[0-1]	0.1 – 5.0
3	Directly apparent infections without important consequences for the tree	[1-5]	5.1 - 10.0
4	X	X	10.1 - 20.0
5	Disease widespread over the branches, inducing the death or the ablation of a large part of the crown	± 25	20.1 - 40.0
6	X	X	40.1 - 60.0
7	Heavy infection; about half of the crown is badly affected with risk of ablation or death	± 50	60.1 - 80.0
8	X	X	80.1 - 99.9
9	Maximum infection, tree completely affected, nearly dead	> 90	100

X = intermediate rating

Table 4. The fire blight attack on different apple cultivars, appreciated by AD%

No.	Variety	AD%			
		2010	2011	2012	Average
1	Enterprise	0	0	0	0
2	Goldrush	0	0	0	0
3	Crimson Crisp	0	18.6	18.0	12.20
4	Falstaff	0	0	0	0
5	Braeburn	2.2	2.6	1.4	2.06
6	Hillwel	4.2	9.1	3.8	5.70
7	Fuji	9.1	18.6	8.8	12.16
8	Choupette® Dalinette	0	0	0	0
9	Dalinbel®Antares	4.9	9.1	9.1	7.70
10	Dalinco	18.6	62.0	54.2	44.93
11	Galarina	0	0	0	0
12	Ariwa	0	0	0	0
13	Topaz	9.1	40.0	54.2	34.43
14	Golden Orange	0	8.7	4.9	6.80
15	Golden Lasa	0	0	0	0
16	Coreventa	4.9	8.8	8.7	7.46
17	Coremodet	0	0	0	0
18	Coredar	0	0	0	0
19	Coreprim	0	0	0	0
20	Coredana	0	0	0	0
21	Rebra	0	0	0	0
22	Rustic	0	0	0	0
23	Romus 3	0	0	0	0
24	Romus 4	0	0	0	0
25	Romus 5	0	8.8	1.6	3.46
26	Bistriţean	0	0	0	0
27	Auriu de Bistriţa	18.6	57.8	43.5	39.96
28	Aura	0	0	0	0
29	Goldprim	0	0	0	0
30	Starkprim	0	0	0	0
31	Jonaprim	0	0	0	0
32	Ciprian	0	0	0	0
33	Redix	0	0	0	0
34	Florina (Control 1)	0	0	1.8	0.6
35	Idared (Control 2)	4.0	8.3	6.1	6.13
36	Golden Delicious (Control 3)	0	0	0	0

Table 5. The response of apple cultivar to fire blight attack under RIFG Pitesti conditions

Class	Attack appreciation	Attack Degree (AD%)	Number of genotypes	Percent of total genotypes
1	No visible symptom	0	23	63.89
2	One or very few small infections, detectable only on close scrutiny of the tree	0.1 – 5.0	3	8.33
3	Directly apparent infections without important consequences for the tree	5.1 - 10.0	5	13.88
4	Medium attack	10.1 - 20.0	2	5.56
5	Disease widespread over the branches, inducing the death or the ablation of a large part of the crown	20.1 - 40.0	2	5.56
6	Strong attack	40.1 - 60.0	1	2.78
7	Heavy infection; about half of the crown is badly affected with risk of ablation or death	60.1 - 80.0	0	0
8	Extreme strong attack	80.1 - 99.9	0	0
9	Maximum infection, tree completely affected, nearly dead	100	0	0

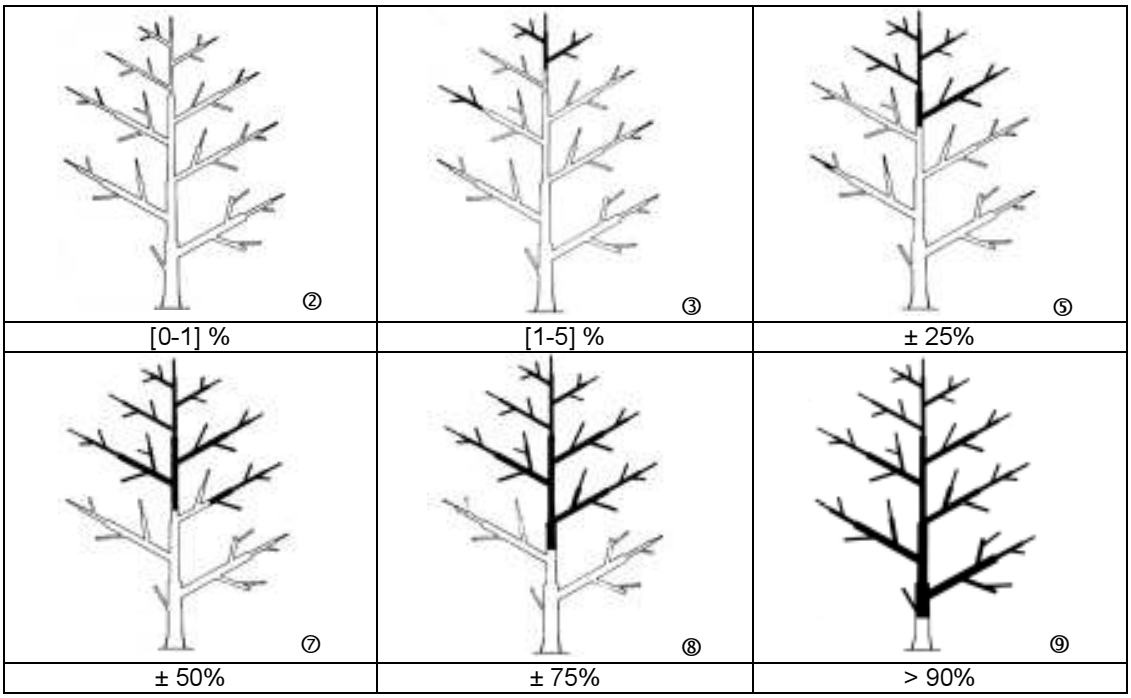

Figure 1. Illustration of the assessment scale for the evaluation of fire blight symptoms on apple. Proportion of tree volume killed by the disease after having cut the infected branches (Van der Zwet et al., 1970)

Photos. Apple cultivars with fire blight symptoms