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Susceptibility of European pear genotypes in a gene bank to pear psylla damage and possible exploitation of resistant varieties in organic farming

Benedek, P.[1], Szabó, T.[2], Nyéki, J.[3], Soltész, M., Szabó, Z.[3] & Konrád-Németh, C.[4]

[1]*University of West Hungary, Faculty of Agricultural ad food Sciences,*
H-9200 Mosonmagyaróvár, Vár 4. (e-mail: benedek@mtk.nyme.hu)
[2]*Research and Extension Centre for Fruit Growig, H-4244 Újfehértó, Vadastag 2.*
[3]*Institute of Extension and Development, University of Debrecen, H-4032 Debrecen, Böszörményi út 138.*
[4]*Gyümölcskert Zrt., H-8800 Nagykanizsa, Csengery út 90.*

Summary: We evaluated 285 pear genotypes (commercial cultivars, ancient local varieties, unnamed local strains, seedlings, wild seedlings) in the largest gene bank of pear in Hungary from the point of view of psylla resistance to explore their possible exploitation in organic farming. We have found some 10 new resistant types (*Bókoló körte, Bőtermő Kálmán, Füge alakú körte, Nagyasszony körte, Nyári Kálmán, Rozs nyári körte, Viki körte, Pb-242, Pb-299, 0-632*) and 7 highly tolerant ones (*Cure-6, Kései Kálmán, Kieffer, Kieffer Éd, Steiner, Téli Kálmán, II. B-3-6/4, 96-16/5*) (*Table 1*). These made up 3.5 + 2.8 per cent of the investigated genotypes, while 93.7 per cent of them were susceptible to pear psylla damage. Taking earlier and present results into account we can list more than 30 European pear cultivars being resistant or highly tolerant to pear psylla infestation and damage. In fact, the list of resistant and highly tolerant cultivars may serve as a basis selecting pear cultivars fitting to the specific requirements of the organic farming. By the end we can conclude that there is some real hope to exploit some resistant or highly tolerant ancient or local cultivars in organic farming but further investigations are needed to estimate their yield capacity and fruit quality.

Key words: pear genotypes, pear psylla, resistance, susceptibility, organic farming

Introduction

Since the time when *Westigard* et al. (1970) have discovered that Asian pear species – *Pyrus betulifolia*, *P. calleryana*, *P. faurieri*, *P. ussuriensis*, *P. x bretschneideri* – are resistant to the pear psylla (Cacopsylla species) there is an increasing interest towards the possible resistance of different pear genotypes against this very serious pests of pear production. *Harris* (1973) investigated the psylla resistance of interspecific pear hybrids and established their resistance to this pest. Although interspecific hybrids have been found to be resistant to pear psylla in other studies, too (*Bell & Zwet* 1998, *Robert & Raimbault* 2005, *Bell* 2009), the bad quality of their fruit limits their usefulness in breeding programmes (*Robert & Raimbault* 2005) and in commercial production.

Quamme (1984) evaluated several pear species and also a number of European per cultivars from the point of view of psylla resistance and has found some of them to be more or less resistant to this pest. Several authors investigated great many further European pear genotypes in the past twenty five years (*Quarta & Puggioni* 1985, *Briolini* et al. 1988, *Butt* et al. 1988, *Berrada* et al. 1995, *Puterka* et al.1993, *Kocsisné* et al. 2005, *Robert & Raimbault* 2005, *Bell & Stuart* 1990, *Bell* 1992, 2003, *Bell & Puterka* 2004, *Sestras* et al. 2009, *Bell* 2009) and detected several cultivars, clones, wild seedlings, ancient and local genotypes to be resistant or highly tolerant to this pest. Most studies were made with field observations (*Quarta & Puggioni* 1985, *Briolini* et al. 1988, *Berrada* et al. 1995, *Puterka* et al.1993, *Kocsisné* et al. 2005, *Robert & Raimbault* 2005, *Sestras* et al. 2009, *Bell* 2009) and great many studies were made in the laboratory, too, by rearing psylla larvae on plant material (*Harris* 1973, *Butt* et al. 1988, *Bell & Stuart* 1990, *Bell* 1992, 2003, *Puterka* et al 1993, *Bell & Puterka* 2004).

Most authors agree that commonly grown European pear cultivars are highly susceptible to the pear psylla damage (e.g. *Quarta & Puggioni* 1985, *Robert & Raimbault* 2005). No more than a minor part of the investigated genotypes have been found to be resistant or at least of low susceptibility (e.g. *Quarta & Puggioni* 1985, *Bell & Stuart* 1990, *Robert & Raimbault* 2005, *Sestras* et al. 2009). One Italian cultivar, *Spina Carpi*, that was found to be of low susceptibility by *Quarta & Puggioni* (1985), was regarded to be resistant by other authors, too (*Briolini* et al. 1988, *Robert & Raimbault* 2005).

As far as the reasons of resistance to pear psylla damage are concerned *Harris* (1973) has pointed out that it is the consequence of ovipositional dispreference and increased nymphal mortality on resistant genotypes. *Butt* et al. (1988)

stated that in laboratory studies psyllas probed to feed on resistant genotypes but finally they left the plant or died after little feeding. Similarly reduced larval feeding as well as increased larval mortality or increased movement off the plants was detected on resistant genotypes in a number of other studies (*Bell & Stuart* 1990, *Bell* 1992, 1993, *Puterka* et al. 1993, *Bell & Puterka* 2004). Accordingly, inspection of larval mortality on psylla larvae reared on plant material seems to be the most reliable method to test host resistance in the laboratory (e.g. *Butt* et al 1988, *Bell & Stuart* 1990).

Bell & Puterka (2004) reviewing the modes of host plant resistance to pear psylla damage have shown that it is a rather a complex phenomenon. They established that the host resistance is a combined consequence of three different effects. The first effect is ovipositional antixenosis because adults lay much less eggs on resistant genotypes. The second factor is feeding atixenosis because psyllas show reduced frequency of feeding on resistant pear. The third factor is antibiosis that is a complex phenomenon itself, comprised of increased larval mortality, delayed (elongated) larval development, reduced larval (nymphal) weight and reduced fecundity of females. Feeding antixenosis has been established as the key factor of resistance because it is associated with reduced egg laying and increased larval mortality as well as delayed larval development.

So there are results in the literature hold out a promise to utilize resistant pear genotypes in organic farming where traditional plant protection measures are greatly restricted and resistant genotypes would help to neglect pesticide applications. Unfortunately, the fruit quality of many resistant European pear germplasms is poor (*Bell & Zwet* 1998), similarly to the resistant interspecific hybrids (*Robert & Raimbault* 2005). Hence we decided to evaluate pear genotypes in the largest gene bank of pear in Hungary from the point of view of psylla resistance to explore their possible exploitation in organic farming. The main intention in this study was to classify all the examined genotypes according to their resistance, tolerance or susceptibility and to find out completely resistant strains with acceptable fruit quality, if possible. However, the investigated gene bank contained few widely grown commercial cultivars, because most of the trees belonged to ancient cultivars, local varieties, unnamed local strains, seedlings, and wild seedlings. Therefore we made some additional observations on some greatly favoured commercial pear cultivars in a big fruitgrowing farm.

Material and method

We carried out field investigations in the largest gene bank of pear in Hungary that situated in the experimental area of the Research and Extension Centre for Fruit Growing at Újfehértó, North-Eastern Hungary. The gene bank was planted at a sandy area being typical of the region.

The trees (two trees of each genotype) were planted from 1984 to the recent years. There are 486 pear genotypes in the collection. More than half of the trees were at least 10-12 years old in 1996 when we started the observations but the rest of them were younger. We selected those 285 genotypes for investigations the trees of which were relatively uniform in age; all of them were 10–12 years old when the investigations were begun. Younger trees were not included in the research. Trees were medium sized; most of them were grafted to quince as rootstock.

Investigations were made during two periods of time, the first period was from 1996 to 1999 and the second period from 2004 to 2008. This is nine years altogether. Most genotypes were observed all along the nine years, but a part of them was neglected for one year and some others for two years for the lack of necessary manpower. So, most genotypes were observed during 9 years, some ones for 8 and a portion of them for 7 years.

The gene bank received an integrated plant protection program all along the experimental period; it received greatly reduced pesticide application with pesticides being relatively safe to the environment. The pesticides applied changed slightly during the long period of experimentation because pesticide regulations changed meanwhile for EU decisions.

All trees were sampled for psylla infestation in mid-August each year because this is the top period of psylla infestation in this region. We counted the ratio of infested shoots at the four points of the compass at each tree using a 5 grade scale as follows:

0: no infestation
1: ratio of infested shoots is 1–3%
2: ratio of infested shoots is 3–8%
3: ratio of infested shoots is 8–15%
4: ratio of infested shoots is 15–50%
5: ratio of infested shoots is 50–100%

Evaluating the results we calculated the mean infestation levels of each genotype for the two periods of investigations (1996–1999, 2004–2008) and for the total time of observations (9, 8 or 7 years). All mean infestation levels and also the minimum and maximum infestation scale values during the whole observation period were taken into account during the analysis. Taking all these figures into account all investigated genotypes were classified into the following categories of resistance/susceptibility:

I. Resistant (no infestation): Mean scale values of infestation were 0.0 during the 9, 8 or 7 years of investigations, because no infestation occurred during the whole period (scale value 0), when other genotypes – usually adjacent trees – were moderately or highly infested.

II. Highly tolerant (negligible infestation): Mean scale values of infestation were as low as 0.1–0.4 during the 9, 8 or 7 years of investigations. There was no infestation in most years (scale value 0), and negligible, minor infestation (scale value 1) appeared in one or two years only during the whole period of observations.

III. Slightly susceptible (light damage): Mean scale value of infestation was 0.4–1.0 during the 9, 8 or 7 years of investigations. There were some years with no infestation at several genotypes (scale value 0) but in other years we found some infestation (scale values 1 or 2, and exceptionally 3), the highest values of infestation were scale values 2, or exceptionally 3.

IV. Susceptible (medium damage): Mean scale values of infestation were 1.1–2.1 during the 9, 8 or 7 years of investigations. Infestation values varied between scale values 0 to 5 in different years, but scale value 0 occurred very rarely (in at least one year during the whole observation period). In fact, infestation levels were greatly varying during consecutive years.

V. Highly susceptible (heavy damage): Mean scale values of infestation were 2.2–2.9 during the 9, 8 or 7 years of investigations. Infestation values varied between scale values 1 to 5 in different years, but scale value 1 occurred very rarely (in at least one year during the whole observation period).

Additional observations were made on four widely grown commercial pear cultivars (*Packams' Triumph, Bosc kobak, Bartlett* [Hungarian name: *Vilmos körte*], *Abate Fétel*) with good yield capacity and good fruit quality in a large commercial farm in South-Western Hungary, Gyümölcskert Kft., Nagykanizsa. The plantations were situated at two sites fairly close to each other. Pear psylla infestation was inspected three to four times during the growing season. Two trees were sampled for each cultivar at each inspected orchards and the ratios of infested shoots at the four points of the compass were registered using the same 5 grade scale as above. All the four inspected cultivars were found to be highly sensitive to pear psylla damage in earlier studies made at different part of Europe. The inspected cultivars received intense, standard plant protection treatments according to the best farm technology elaborated to this region.

Results

Pear psylla infestation was rather changeable during the long period of observations. Slight infestation was measured in the years of 1998–1999 and 2004–2005, while much heavier damage occurred in 1996–1997 and 2006–2008. It was very important that the period of observations was as long as 9 (or 7–8) years because this way we were able to inspect the reaction (susceptibility) of genotypes to pear psylla infestation under various pressures of infestation. When infestation pressure was low little differences were detected among genotypes but when the infestation pressure rose to be high definite differences could be detected.

We have found 10 genotypes to be resistant to pear psylla damage (*Table 1*) that gave 3.5 per cent of the inspected cultivars (*Table 2*). Seven of these are ancient local cultivars, fortunately most of them with acceptable yield and fruit quality. The remaining 3 genotypes were unnamed wild seedlings from different localities.

The number of highly tolerant genotypes was only 7 (*Table 1*) that gave 2.8 per cent of the cultivars investigated (*Table 2*). There were 4 ancient cultivars among them (one of these was represented by two types from different localities) and 2 unnamed genotypes.

As much as 28 genotypes were falling into the category of slightly susceptible that suffered only light damage by pear psylla during the years of observations (*Table 2*). These genotypes collectively made up 9.8 per cent of the investigated types of pear (*Table 2*). Most of them were ancient local varieties, no more than two of them were widely grown cultivars and a single one was an unnamed genotype.

The bulk of the genotypes investigated were classified as susceptible, because all of them suffered medium damage by pear psylla during the years of investigations. The number of susceptible genotypes was as much a 208 of the 285 ones investigated (*Table 1*), that made up 72.7 per cent of the investigated types (*Table 2*). There were 8 widely grown commercial cultivars among them and 11 unnamed genotypes, while the vast majority of them (189) were local varieties or ancient cultivars of some specific geographical regions.

The number of highly susceptible cultivars, that suffered heavy damages by the pear psylla in most years, was 31 (*Table 1*), that was 10.9 per cent of all of the cultivars investigated (*Table 2*). Most of these were local varieties and ancient cultivars but there were 3 widely grown cultivars and a single unnamed genotype, too.

Pear psylla infestation of the four widely grown sensitive, commercial cultivars (*Packams' Triumph, Bosc kobak, Bartlett* [Hungarian name: *Vilmos körte*], *Abate Fétel*) inspected in the large commercial fruit growing farm was well measurable (*Table 3*) despite the effect of standard (intense) plant protection measures applied at this farm for commercial production. Although most (generally 64 to 78 per cent) of the shoots were free of this pest all along the season, a good deal of them was slightly (scale values 1 and 2) or moderately infested (scale values 3) and some heavily infested trees/shoots occurred too (scale value 4 and 5) at least in a small per cent ratio (*Table 3*). This meant that with the help of intense plant protection applications we were able to control pear psylla damage at an acceptable level but we were unable to prevent infestation because of the susceptibility of cultivars.

Discussion and conclusions

The method we applied can be considered as subjective ratings (scoring) of infestation. *Bell* (2009) who compared both subjective ratings and objective counts (of eggs and nymps) concluded that subjective rating having been made in consecutive years were correlated fairly well (high or moderately high correlations) to the objective counts. So it can be stated that subjective scoring of infestations during several year periods can result in reliable results on resistance or susceptibility of pear genotypes to pear psylla infestation and damage. We have found – and other authors also reported (e.g. *Kocsiné* et al. 2005, *Bell* 2009) – that infestation level can be greatly different in consecutive years. For this reason, “in site” investigation in the orchards

Table 1. Susceptibility of pear genotypes (commercial cultivars, ancient local varieties, unnamed local strains, seedlings, wild seedlings) to pear psylla infestation and damage (Újfehértó gene bank: 1996–1999, 2004–2008)

Resistance/susceptibility level of genotypes					
I. Resistant (no infestation)	**II. Highly tolerant (negligible infestation)**	**III. Slightly susceptible (light damage)**	**IV. Susceptible (medium damage)**		**V. Highly susceptible (heavy damage)**
Bókoló körte	Cure-6	Adonyi körte	Adonyi I.	Móri császár	Alma körte
Bőtermő Kálmán	Kései Kálmán	Adonyi téli körte	Alcsevica	Móri nyári körte	Aurora
Füge alakú körte	Kieffer	Alma alakú körte	Alma alakú korai	Mosolygós körte	Bácskai nagy szegfű
Nagyasszony körte	Kieffer Éd	Angonlemi Szentendre	Anna körte	Muskotályos körte	Császár körte
Nyári Kálmán	Steiner	Bálint őszi körte	Arabitka	Nagovitza	Dániel körte
Rozs nyári körte	Téli Kálmán	Bikedi őszi körte	Árki vadkörte	Nagy szegfű körte	Debreceni nagy körte
Viki körte	II. B-3-6/4	Cukor körte	Árpás körte	Napoca	Fülöp bergamott
Pb-242	96-16/5	Cserlevelű császár	Árpás körte nagy	Noszvaj körte	Gornelis Budaörs
Pb-299		Droudard	Augusztus elején érő	Nyakas körte	Grand Champion
0-632		Eliz asszony	Augusztusban érő piros	Nyári körte	Júliusi lapos cukor
		Fillér körtéje	Augusztusi hegyes	Nyári zöld kobak	Király körte
		Gerjén nyári körte	Augusztusi nagy	Nyári vajkörte	Kerek körte
		Gheler	Augusztusi palack körte	Noszvaj vadkörte	Melló bárónő
		Hosszúréti ókörte	Augusztusi szegfű	Olasz császár körte	Montreal
		Korai Klapp	Ananász	Olasz körte	Marianna
		Muskotályos vajkörte	Bachelier vajkörte	Óriás pisztráng körte	Naika
		Nyári bergamott	Bajai bőtermő	Orient	Nocika körte
		Nyári Nagytétény	Bajai 6	Őszi cukor körte	Őszi parázs körte
		Nyári Nyakas Bicske	Bara miniszter	Őszi kormos körte	Őszi vajkörte
		Óriási körte Bicske	Berakó körte	Őszi körte	Piros búzás körte
		Pomázi nyári	Besztercei	Őszi pálinka körte	Ráckevei körte
		Pöttyös körte	Betler vajkörte	Őszi piros körte	Saint Waast
		Téli zöld körte	Bíbor körte	Őszi vajkörte	Sárga Bácska körte
		Új Pointeau	Bicskei amalisz	Őszi III. 100	Sarolta
		Váraljai körte	Bikedi nyári	Ötvös körte	Solani vajkörte
		Zsír körte	Boisbunel	Pantalia	Solymári cukor
		2/8.	Bori körte	Papkörte	Tihanyi vadkörte
			Bosc kobak	Papkörte bőtermő	Társulati esperes
			Bosc kései klón	Párisi gróf	Vecsei II.
			Bőr körte	Pettend P2	Zöld Magdolna
			Brassey Mária	Pettend P3	4/6
			Búzás körte	Piros Budaörs	
			Cigány körte	Pismányi vajkörte	
			Citrom körte	Pirosbélű körte	
			Csepeli I.	Pomázi füge körte	
			Csákvári nyári	Pomázi júliusi	
			Csákvári téli	Pusztavári magas	
			Csokros muskotály	Ráckeve 1/1	
			Császár körte	Ráckeve 1/9	
			Császár körte bicskei	Ráckeve 2/6	
			Császár 18/20	Ráckeve 2/7	
			Csatár körte	Republica	
			Cukor körte	Révész Bálint	
			Decaishe Henrich	Rózsavölgyi	
			Delfosse Antal	Salague Panache	
			Diósd őszi körte	Sándor körte	
			Dorogmai	Sárkörte	
			Dupuit	Serres Oliver	
			Erdei körte	Solymári cukor	
			Fehérvári körte	Sós körte	
			Fertőd 30048	Spadóniai téli	
			Fertődi körte	Stuttgarti	
			Fétel apát	Szekszárdi körte	
			Fontenay	Szentesi körte	
			Fülöp körte	Szentlőrinci körte	
			Gatya krte	Szeptemberi körte	
			George Bousher	Szeptemberi óriás	
			Gerjéni vérbélű	Szőke körte	
			Gortkai	Szücsi körte	
			Győrbölyi	Szücsi őszi körte	
			Hardenpont	Talpas körte	

Table 1. continued

Resistance/susceptibility level of genotypes					
I. Resistant (no infestation)	**II. Highly tolerant (negligible infestation)**	**III. Slightly susceptible (light damage)**	**IV. Susceptible (medium damage)**		**V. Highly susceptible (heavy damage)**
			Héber körte	Tehénláb körte	
			Hertich	Téli Csíkos körte	
			Hindenburg	Totleben tábornok	
			Hofmanné féle körte	Totyakos császár	
			Hóka körte	Vadkörte	
			Homoki körte	Váli körte	
			Horváth körte	Vanguelin	
			Hosszú zöld körte	Váraljai nyári körte	
			Janne	Váraljai 4.	
			Jó körte	Vécsi I.	
			Kabosdi körte	Vérbélű	
			Kakas körte	Véres körte	
			Károlyi körte	Vérteskozmai	
			Kedves körte	Vertné körtéje	
			Kelenvölgyi körte	Vilmos körte	
			Késői bőr Pákozd	Virgonkuse	
			Klára trió körte	Vörös búza körte	
			Kongresszus	Wienne diadala	
			Korai szagos körte	A4-15/2-II.	
			Korai vérbélű	B/1	
			Köcsög körte	B/2-18/2	
			Körte 215	B/3	
			Körte 219	K-14	
			Kravas	K-21	
			Leányfalusi piros	K-28	
			Lincoln	K-35	
			Lipcsei retek	K-36	
			Lőrinc körte	K-40	
			Lucas Sándor	K-63	
			Macskafejű körte	K-66	
			Mandula körte	K-67	
			Mária Lujza	K-69	
			Márianosztrai	SzU-1	
			Mézes körte	2/3	
			Mézes körte Budaörs	9/8	
			Mézkörte Érd	3-30.TA	
			Méznár	3-32-TA	
			Miklós	3-38-TA	
			Mogyoródi körte	3-51-TA	
			Mogyoródi 2.	500-169	
			Monchallard	30060	
			Moonalen	II.A3-3/5	
				II.A4-1/2-2	

Table 2. Distribution of pear genotypes (commercial cultivars, ancient local varieties, unnamed local strains, seedlings, wild seedlings) according to their susceptibility to pear psylla infestation and damage (Újfehértó gene bank: 1996–1999, 2004–2008)

Resistance/ susceptibility level	**Number of genotypes**	**Per cent ratio**
I. Resistant (no infestation)	10	3.5%
II. Highly tolerant (negligible infestation)	8	2.8%
III. Slightly susceptible (light damage)	28	9.8%
IV. Susceptible (medium damage)	208	73.0%
V. Highly susceptible (heavy damage)	31	10.9%

can give reliable results when the investigation period is long enough to cover different years with slight and heavy infestations, too. Differences in resistance and susceptibility are much more conspicuous in years with heavy than with slight infestations. We found that resistant genotypes can be practically free of pear psylla infestation in the orchard even when other (susceptible) varieties suffered moderate or heavy damages in years of heavy infestations. In years with slight or weak infestations, on the other hand, both resistant and susceptible genotypes can evenly be free of damage. However, results of our additional observations in a large commercial fruitgrowing farm proved that highly susceptible commercial cultivars can be more or less infested even under the pressure of intense plant protection applications.

Table 3. Pear psylla infestation to some widely grown European pear cultivars under the pressure of standard plant protection practice (Gyümölcsöskert Kft. 2009)

Cultivar and the site	Date of observation	Infestation level at the shoots of pear trees per cent distribution of shoots after scale values					
		scale 0	scale 1	scale 2	scale 3	scale 4	scale 5
Cultivar: Packams' Triumph	13 April	70	12	8	6	4	0
Site: Feketesár	19 May	72	12	8	6	2	0
	08 July	70	12	10	6	2	0
	12 August	64	16	10		4	0
Cultivar: Bosc kobak	13 April	46	18	10	10	6	0
Site: Feketesár	19 May	70	10	14	4	2	0
	08 July	74	10	8	6	2	0
	12 August	76	10	8	4	2	0
Cultivar: Bosc kobak	10 April	76	12	6	1	1	4
Site: Bánfapuszta	24 May	76	8	6	5	3	2
	06 July	68	10	8	8	4	2
Cultivar: Bartlett (Vilmos körte)	13 April	68	12	8	8	4	0
Site: Feketesár	19 May	68	12	8	8	4	0
	08 July	64	14	10	8	4	0
	12 August	66	14	10	8	2	0
Cultivar: Bartlett (Vilmos körte)	10 April	68	12	10	6	4	0
Site: Bánfapuszta	24 May	74	10	8	6	2	0
	06 July	64	14	10	8	4	0
Cultivar: Abate Fétel	10 April	80	10	6	3	1	0
Site: Bánfapuszta	24 May	78	14	6	1	1	0
	06 July	78	10	6	4	2	0

Analysing 285 different European per genotypes (commercial cultivars, ancient local varieties, unnamed local strains, seedlings, wild seedlings) originating from many different sites of Hungary we have found some 10 new resistant types (*Bókoló körte, Bőtermő Kálmán, Füge alakú körte, Nagyasszony körte, Nyári Kálmán, Rozs nyári körte, Viki körte, Pb-242, Pb-299, 0-632*) and 7 highly tolerant ones (*Cure-6, Kései Kálmán, Kieffer, Kieffer Éd, Steiner, Téli Kálmán, II. B-3-6/4, 96-16/5*) (*Table 1*). Most of them are ancient local cultivars, and the rest are unnamed local strains. These made up 3.5 + 2.8 per cent of the investigated genotypes (that is 6.3 per cent altogether), while 93.7 per cent of the investigated genotypes were susceptible to pear psylla damage (*Table 2*). Some 10.9 per cent of the susceptible genotypes was highly susceptible and suffered the heaviest damage each year. Recent results corroborate to earlier statements that no more than a minor portion of European per genotypes show resistance or high tolerance to pear psylla damage.

One of the earlier studies (*Kocsisné* et al. 2005) reported on similar observations, partly made in the same gene bank where we made or own investigations. However, their observations were made in other period of time (between the years of 1998–2003) when the pear psylla infestation was very low, as the authors clearly stressed it in their paper. This condition resulted in peculiar results, very different from the results of the present analysis. Namely, *Kocsisné* et al. (2005) stated that great many inspected genotypes (as much as 31% in their study!) were resistant and half of the cultivars were only scarcely infested (51%). They regarded no more than 17% of the genotypes as "medium infested" and only 1% as "strongly infested". They regarded the low infestation levels as resistance or tolerance. These results completely contradict to any other surveys reported in world literature and also to our present analysis. For example *Quarta & Puggioni* (1985) found no more than 12% of the 136 inspected genotypes (cultivars and selections) of low susceptibility and no one of them was immune (resistant). Additionally, we have to say that no more than 3.5% of the genotypes that we investigated proved to be resistant in our study and only 2.8 per cent of them were highly tolerant to pear psylla damage in the same gene bank (*Table* 2), instead of 31% as stated by *Kocsisné* et al. (2005). They classified great many such genotypes to be resistant that we found to be at least slightly susceptible or susceptible during our longterm investigations. They investigated all the available 486 genotypes in the gene bank irrespective of the ages of trees that were planted continuously from 1984 to present years. They compared older trees to younger ones and to those too that were few years old only. Contrarily, we made observation on those genotypes only the trees of which were relatively uniform in age; all of them were 10–12-years years old when we started our study, and younger trees were neglected. So, unfortunately, the results of *Kocsisné* et al. (2005) were unacceptable for various reasons, first of all because their statements were based on exceptionally low infestation levels that did not allow drawing any reliable conclusions on the resistance or tolerance of genotypes to pear psylla damage.

Taking earlier and present results into account – ignoring the abovementioned single publication – we can list several European pear cultivars being resistant or highly tolerant to pear psylla infestation and damage (*Table 4*). In the list we ignored those unnamed genotypes and wild seedlings that were not utilized as traditional or modern cultivars in the fruit growing practice. Majority of the listed cultivars are ancient local varieties grown traditionally is small gardens around the house and have not been tried to exploit in commercial plantations so far. For this reason no reliable information is available on their yield capacity and fruit quality. However, watching the two trees available of each inspected genotypes at the gene bank we inspected we have got the impression that most of the local varieties we have found to be resistant or highly tolerant seem to produce acceptable yield and acceptable fruit quality. No similar observation results are

Table 4. Resistant pear cultivars discovered in different countries

Author	Resistant/tolerant cultivars detected	Geographical origin of resistant genotypes
Quarta and Puggioni 1985	***Low susceptibility:*** Monglow Sirrine Spina Carpi	Italy
Bell and Stuart 1990	***Resistant:*** Erabasma Karamanlika Katman Krupen Burnusus Mednik Obican Vodenac Smokvarka Topka Zelinka	former Yugoslavia (mostly present Serbia)
Bell 1992	***Resistant:*** Bartjarka Lucele Kajzerka	former Yugoslavia (mostly present Serbia)
Bell 2003	***Resistant:*** Jerisbasma Karamanka Vodenjac	former Yugoslavia (mostly present Serbia)
Robert and Raimbault 2005	***Resistant:*** D'Aout Lamer Doyenné de Poitiers ***Low susceptibility:*** Spina Carpi (Italian cultivar)	France
Sestras et al 2009	***Resistant:*** Haydeea ***Weakly susceptible:*** Cantari Imperiale Lorencz Kovacs Triomphe de Jodoigne Severinka	Romania (Transsylvania)
Present study	***Resistant*:** Bókoló körte Bőtermő Kálmán Füge alakú körte Nagyasszony körte Nyári Kálmán Rozs nyári körte Viki körte ***Highly tolerant:*** Cure-6 Kései Kálmán Kieffer Kieffer Éd Steiner Téli Kálmán	Hungary

available on non-Hungarian cultivars listed in *Table 4*. In fact, the list of resistant and highly tolerant cultivars in *Table 4.* may serve as a basis of selecting pear cultivars fitting to the specific requirements of the organic farming. However, different cultivars originating from different countries can react different way to local ecological conditions in countries other than their home region. Accordingly, cultivars listed in *Table 4.* should be planted and observed in other regions where any intention to grow them in organic farms. By the end we can conclude that there is some real hope to exploit some resistant or highly tolerant ancient or local cultivars in organic farming but further investigations are needed to estimate their yield capacity and fruit quality.

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