

Resistance in Eastern European *Pyrus* Germplasm to Pear Psylla Nymphal Feeding

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Abstract. 'Fifty-nine cultivars and wild seedlings of pear (*Pyrus* spp.) from Eastern Europe were evaluated for resistance to feeding by early instar pear psylla [*Cacopsylla pyricola* (Foerster)] in a 24-hour assay. 'Bartlett' (*P. communis* L.) and NY 10352 (*P. communis* × *P. ussuriensis* Maxim. BC₁ hybrid) were used as susceptible and resistant controls, respectively. A high degree of resistance, measured as increased mortality and reduced frequency of feeding, was found in 11 plant introductions: 'Erabasma' (PI 483370), 'Krupan Burnus' (PI 483387), 'Topka' (PI 484489), 'Zelinka' (PI 483393), 'Mednik' (PI 483399), 'Karamanlika' (PI 502165), 'Katman' (PI 502172), 'Smokvarka' (PI 502176), 'Obican Vodenac' (PI 502177), a clone thought to be 'Smiljerka' (PI 502178), and an unnamed seedling (PI 506382).

The pear psylla is one of the most serious arthropod pests of pear in North America and Europe. All of the cultivars of the European dessert pear (*P. communis* L.) grown commercially are susceptible. Currently, biological controls are of limited effectiveness (Westgard and Zwick, 1979), and resistance to insecticides has developed rapidly (Croft et al., 1989). Host plant resistance would therefore be a valuable control strategy, significantly reducing production costs. Resistance to the pear psylla has been demonstrated in East Asian pear species, *P. betulifolia* Bunge, *P. calleryana* Decne., *P. faunei* Schneid., *P. ussuriensis* Maxim., and *P. × bretschnideri* Rehd. (Quamme, 1984; Westgard et al., 1970), and in *P. ussuriensis* × *P. communis* hybrids (Harris, 1973; Harris and Lamb, 1973; Quamme, 1984). Small fruit size or gritty or coarse texture limits the usefulness of some of this germplasm for rapid incorporation of their high levels of resistance into new cultivars with European-type fruit quality. Resistance has been reported for a few genotypes of *P. nivalis* Jacq., the "snow pear" (Westgard et al., 1970), and in 'Pitoma Slanopadja', presumably a *P. communis* × *P. amygdaliformis* hybrid (Stancevic et al., 1984). Moderately high host plant resistance within *P. communis* has been reported only for 'Spina Carpi' (Quarta and Puggioni, 1985; Briolini et al., 1988), a cultivar of poor fruit quality.

All of the high-quality cultivars of *P.*

communis currently in production are of western European origin. The domesticated forms of the species are thought to have originated in the Caucasus Mountains and Asia Minor (Vavilov, 1951), from which they spread westward. Eastern Europe, Yugoslavia in particular, contains a wealth of diversity of *Pyrus* germplasm, both as domesticated cultivars and wild seedling populations (Stankovic and Mistic, 1978; van der Zwet et al., 1987). This germplasm may belong to populations different from or more diverse than those from which current cultivars are derived. A collection of germplasm was made in 1978 and 1980, during which many indigenous cultivars were observed to be relatively free of insect pests, in particular, the pear psylla. In addition to *Cacopsylla pyricola*, the species found in North America, *C. pyri* (L.) and, in the more northern areas of Europe, *C. pyrisuga*

Table 1. Analysis of variance of pear psylla nymphal feeding.

Data set	Source	df	Mean square	Probability >F
1	Trial	4	8.1	0.2223
	Genotype	39	145.9	0.0001
	Error	156	5.6	
2	Trial	4	18.1	0.1465
	Genotype	22	117.8	0.0001
	Error	88	10.3	

(Foerster) are endemic in the collection areas. It was assumed that the host-related biology of these closely related pear psyllids would be similar.

The principle modes of resistance are antixenosis, observed in the insect as ovipositional nonpreference, and antibiosis, which results in nymphal mortality and delayed development (Westgard et al., 1970; Harris, 1973; Harris and Lamb, 1973). Feeding inhibition or reduced feeding frequency leads directly to nymphal mortality and delayed development (Butt et al., 1989). A rapid nymphal feeding bioassay has been developed to screen pear germplasm for antibiosis-based resistance (Butt et al., 1988).

This study was undertaken to evaluate pear germplasm introduced from Eastern Europe for resistance to pear psylla nymphal feeding. Sources of resistance within this gene pool might be, used more effectively in a breeding program than sources from East Asian species because of the similarity in fruit characteristics within *P. communis*.

Germplasm, bioassay, and experimental design. The germplasm examined consisted of 59 accessions of pear from Eastern Europe released from plant quarantine since 1978. Brief descriptions have been published (van der Zwet et al., 1987, 1989). The bioassay procedure was modified from techniques described previously (Butt et al., 1988). First or second instar pear psylla nymphs, emerged within 24 hr, were obtained from a laboratory colony maintained on 'Bartlett' seedlings. The colonies were founded in Mar. 1988 and 1989 from field-collected adults; new

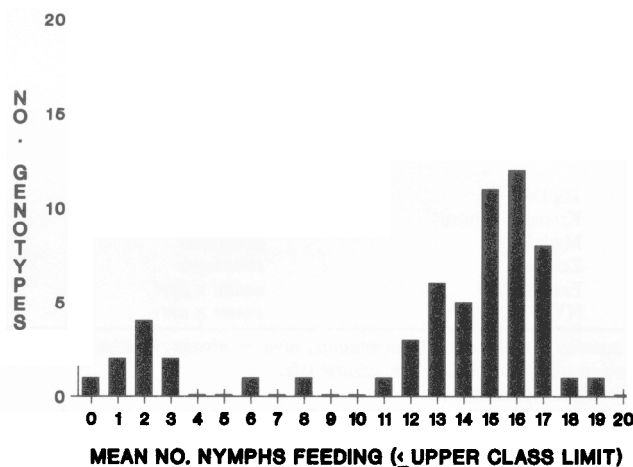


Fig. 1. Frequency distribution of mean number of pear psylla [*Cacopsylla pyricola* (Foerster)] nymphs feeding on eastern European accessions of pear (*Pyrus* spp.). Bioassay sets 1 and 2 are combined and controls excluded. Individual accessions with means greater than a whole number were combined as a class with the next highest whole number.

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Table 2. Mean number of feeding pear psylla nymphs on 59 plant introductions of pear from Eastern Europe, a susceptible control ('Bartlett') and a resistant control (NY10352).

P.I. no.	Name	Species ^a	Mean ^b
Set 1			
506373	---		18.2
506388	Poznica	<i>communis</i>	17.4
506385	Para de Zahar de Bihor	<i>communis</i>	17.0
483398	Maslinka	<i>communis</i>	17.0
506374	Petrovka	<i>communis</i>	16.8
483396	Smederevka	<i>communis</i>	16.8
506383	Tamioase de Calinesti	<i>communis</i>	16.6
---	Bartlett	<i>communis</i>	16.4
506384	Coadesele	<i>communis</i>	16.4
502173	---	<i>communis</i>	16.2
502179	Sbkta 20/77	<i>comm</i> × <i>niva</i>	16.2
483368	Bera Wysmienita	<i>communis</i>	16.0
506378	---	<i>communis</i>	16.0
506386	Takisha	<i>communis</i>	16.0
502168	Tikvaca	<i>communis</i>	15.8
483376	Tonkowitzka	<i>communis</i>	15.8
502167	Sarajka	<i>communis</i>	15.8
483404	Aromate de Bistrita	<i>communis</i>	15.6
506377	Winiowka Saska	<i>communis</i>	15.4
506376	Sapranii II	<i>communis</i>	15.2
506372	Roosevelt	<i>communis</i>	15.0
506371	Panajurka	<i>communis</i>	14.8
502169	Zimska	<i>communis</i>	14.6
502170	Edmundka	<i>communis</i>	14.4
502174	Rosii Untoase	<i>communis</i>	14.4
506379	---	<i>pyraster</i>	14.2
506380	---	<i>pyraster</i>	14.0
483397	Tiranka	<i>communis</i>	13.8
502180	---	<i>communis</i>	13.8
502175	Urechelnite	<i>communis</i>	13.6
506375	Sapranii I	<i>communis</i>	12.8
502166	Saafaranja	<i>communis</i>	11.8
483385	---	<i>communis</i>	11.8
...	NY10352	<i>comm</i> × <i>uss</i>	4.8*
502172	Katman	<i>communis</i>	3.0*
502178	Smiljerka (?)	<i>communis</i>	2.4*
502165	Karamanlika	<i>communis</i>	1.4*
502177	Obican Vodenac	<i>communis</i>	0.8"
506382	---	<i>nivalis?</i>	0.6"
502176	Smokvarka	<i>comm</i> × <i>elae?</i>	0.0"
Set 2			
483372	Ilinka	<i>communis</i>	15.6
483386	---	<i>communis</i>	15.4
483381	---	<i>communis</i>	15.3
483390	Kiselac	<i>communis</i>	15.0
...	Bartlett	<i>communis</i>	15.0
483388	Mustabej	<i>communis</i>	14.8
483377	Verbeln	<i>communis</i>	14.8
483378	Wilenska Plenna	<i>communis</i>	14.8
483382	Ananaska Ceska	<i>communis</i>	14.2
483392	Jesnji Vodenac	<i>communis</i>	13.2
483405	Pitoma Slanopadja	<i>comm</i> × <i>amyg</i> ^a	13.0
483380	Prague No. 2	<i>communis</i>	13.0
483371	Grusza od Nagorskiego	<i>communis</i>	12.8
483374	Krolewna	<i>communis</i>	12.5
483400	Projnijaca	<i>communis</i>	12.2
483369	Bojka	<i>communis</i>	11.5
483383	---	<i>communis</i>	10.4
483389	Topka	<i>communis</i>	7.6*
483387	Krupan Burnus	<i>communis</i>	5.2*
483399	Mednik	<i>communis</i>	2.0"
483393	Zelinka	<i>communis</i>	2.0*
483370	Erabasma	<i>comm</i> × <i>pyri</i>	1.8*
---	NY10352	<i>comm</i> × <i>uss</i>	1.6*

^aAbbreviations for species names: *comm* = *communis*, *niva* = *nivalis*, *elae* = *elaeagrifolia*, *amyg* = *amygdaliformis*, *pyri* = *pyrifolia*, and *uss* = *ussuriensis*.

^bMean of five single-plant replicates.

^cThe species background of this cultivar is disputed; *P. elaeagrifolia* maybe involved.

*Significantly different from the susceptible control ('Bartlett') by Dunnett's two-tailed t test at $P = 0.05$.

field-collected adults were introduced at 2-month intervals. Because all accessions were

not available at the same time, the experiments were conducted in two sets. The first

set of 39 was assayed from 26 May to 27 June 1988 and the second set of 21 was assayed from 26 June to 13 July 1989.

Trees of the accessions and controls were budded onto 'Bartlett' seedling rootstock and grown in a greenhouse until used in the bioassays. Ten nymphs were transferred to each of the top two fully expanded leaves of actively growing budded trees, ≈ 50 cm in height. After artificial infestation, the trees were maintained in a laboratory growth room at a constant 25 ± 1 C and a photoperiod of 16 hr/8 hr (L/D). After 24 hr, the number of actively feeding nymphs was recorded. Active feeding was determined by the presence of excreted honeydew droplets. Because all genotypes could not be examined at one time, the experimental design was a randomized complete block, in which five independent trials (i.e., blocks) consisted of single trees of each of the accessions plus single trees of a susceptible control, 'Bartlett', and a moderately resistant control, NY 10352.

Data analysis. The number of nymphs feeding was analyzed as the measure of resistance. For each set, homogeneity of variance was confirmed by Bartlett's test. Normality of residual error was tested by the Shapiro-Wilk statistic *W*. Data transformation was found to be unnecessary. Analyses of variance were performed to test the significance of trial and genotypic effects. A mixed model was assumed, in which trial effects were random and genotype effects were fixed. Dunnett's two-tailed *t* test was used to test genotypic means for the significance ($\alpha = 0.05$) of differences from the susceptible and resistant controls. Differences between the two sets were tested by a factorial analysis of variance of data for the two control genotypes.

The overall mean of both controls was significantly greater in set 1 than set 2 (10.8 vs. 8.4; $P = 0.002$). The interaction between sets and control genotypes was not significant ($P = 0.19$). There was no significant difference between sets in mean nymphal feeding on 'Bartlett' ($P = 0.15$), but feeding on NY10352 was significantly less in set 2 than in set 1 ($P = 0.004$). Therefore, the results are reported separately for each set. In both sets, differences among trials were nonsignificant, while differences among genotypes were significant (Table 1).

Six of the accessions in set 1 were significantly more resistant to nymphal feeding than 'Bartlett', and an additional five resistant accessions were identified in set 2 (Table 2). All 11 plant introductions found to be more resistant than 'Bartlett' were also not significantly different from NY10352, the resistant control. These clones represent nearly 19% of the accessions released from quarantine thus far. The genotypes were not chosen for virus-indexing and release on the basis of resistance presumed from the original collection records. Thus, we might expect that additional resistant clones will be discovered when additional germplasm from this collection is indexed and released from plant quarantine.

The combined distribution of means for

both sets is bimodal (Fig. 1). Too many assumptions are required to speculate on the genetic basis of this distribution. However, the original collection records and the release notices indicate that the resistant clones were collected over a wide geographic area (van der Zwet, unpublished data; van der Zwet et al., 1987, 1989) and, thus, do not represent a sample from a distinct random mating population. In contrast to the published description of 'Pitoma Slanopadja' (Stancevic et al., 1984), our data indicate that this genotype is susceptible to pear psylla.

An examination of the foliar characteristics of the greenhouse-grown plants suggested that this was a diverse group of germplasm. 'Erabasma' is an interspecific hybrid with *P. pyrifolia* from a research station in Poland. Although it cannot be considered indigenous germplasm, it was included in the analysis because the *P. communis* parent is not known and may have been a genotype of Polish origin. PI 506382 is a clone of *P. nivalis*, with the highly pubescent cordate leaves characteristic of the species. 'Smokvarka' is probably an interspecific hybrid of *P. communis* with *P. elaeagrifolia*, judging from the lanceolate pubescent leaves. Westigard et al. (1970) also found a clone of *P. nivalis* to be resistant, but their clone of *P. elaeagrifolia* was susceptible. The remaining eight resistant clones appear to be *P. communis*.

Pubescence is not a major factor in feeding deterrence. Although 'Smiljerka', 'Smokvarka', and PI 506382 are pubescent and resistant, three glabrous genotypes were also resistant: 'Krupan Burnusus', 'Karamanlika', and 'Zelinka'. The remaining resistant clones had pubescent young leaves that became glabrous upon expansion and aging. In addition, PI 502179, presumably *P. nivalis* or an interspecific hybrid with *P.*

communis, was quite susceptible but pubescent.

Additional data are needed on fruit characteristics to better assess the usefulness of this germplasm for breeding, but a preliminary evaluation of 35 of the pure *P. communis* genotypes indicates that 'Mednik', 'Topka', and 'Zelinka' have fruit of at least 5 cm in diameter. Hybridization of these cultivars with genotypes of large fruit size should allow selection of seedlings with acceptable fruit size.

We have identified eight *P. communis* clones with resistance to pear psylla nymphal feeding. Although studies of oviposition and longer-term observations of development and mortality are needed to more completely characterize the resistance in these genotypes, our previous experience with "*P. ussuriensis*-derived sources of resistance, which also elicit nymphal feeding inhibition, leads us to conclude that the level and type of resistance in this germplasm will be valuable. The eastern European germplasm is a new source, of resistance from a gene pool not previously extensively evaluated or available to breeders in Western Europe and North America. Incorporation into breeding programs will broaden the genetic base of host plant resistance to the pear psylla.

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