Late blight resistance of Solanum species and potato hybrids: the evidence from coupled phytopathological and molecular study

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Materials:

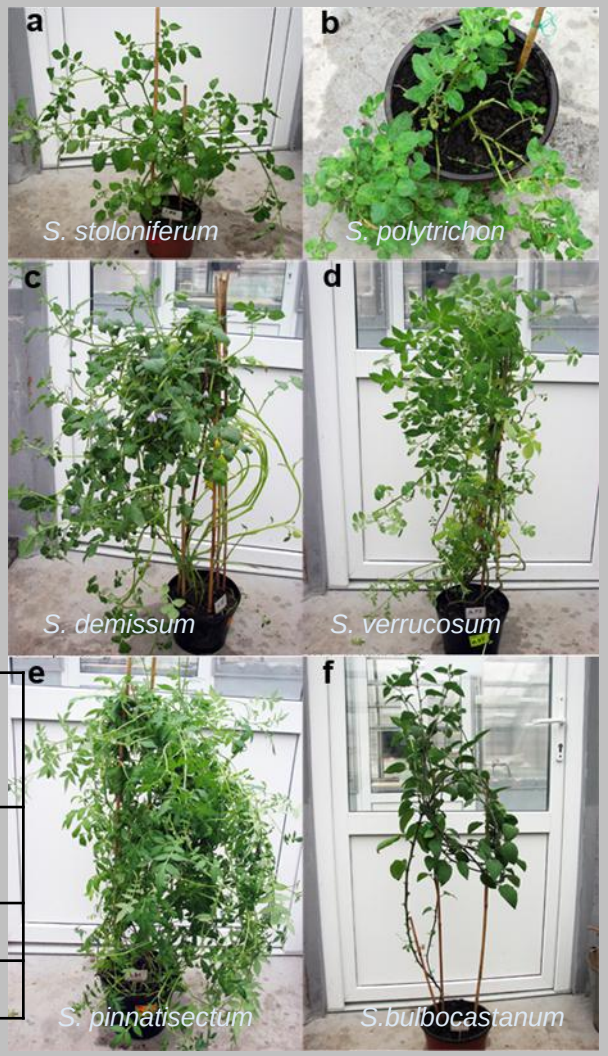
- over 200 accessions of 21 *Solanum* species
- 26 genotypes of potato interspecific hybrids incorporating wild *Solanum* germplasm

(*S. bulbocastanum, S. verrucosum, S.stoloniferum, S. polytrichon, S. pinnatisectum, S. acaule, S.alandiae, S. spegazzinii, S. microdontum, S. berthaultii, S. andigenum, S. rybinii, S. phureja)* and demissoid cultivars

Methods: coupled phytopathological and molecular screens

Field trials in 2008 and 2009 under natural infection conditions on a site situated in the North-Western part of Russia

Detached-leaf trials using two locally isolated highly aggressive complex races of *P. infestans* virulent to all 11 *R* genes of *S. demissum,* in concentration 30 × 1000 zoospores ml

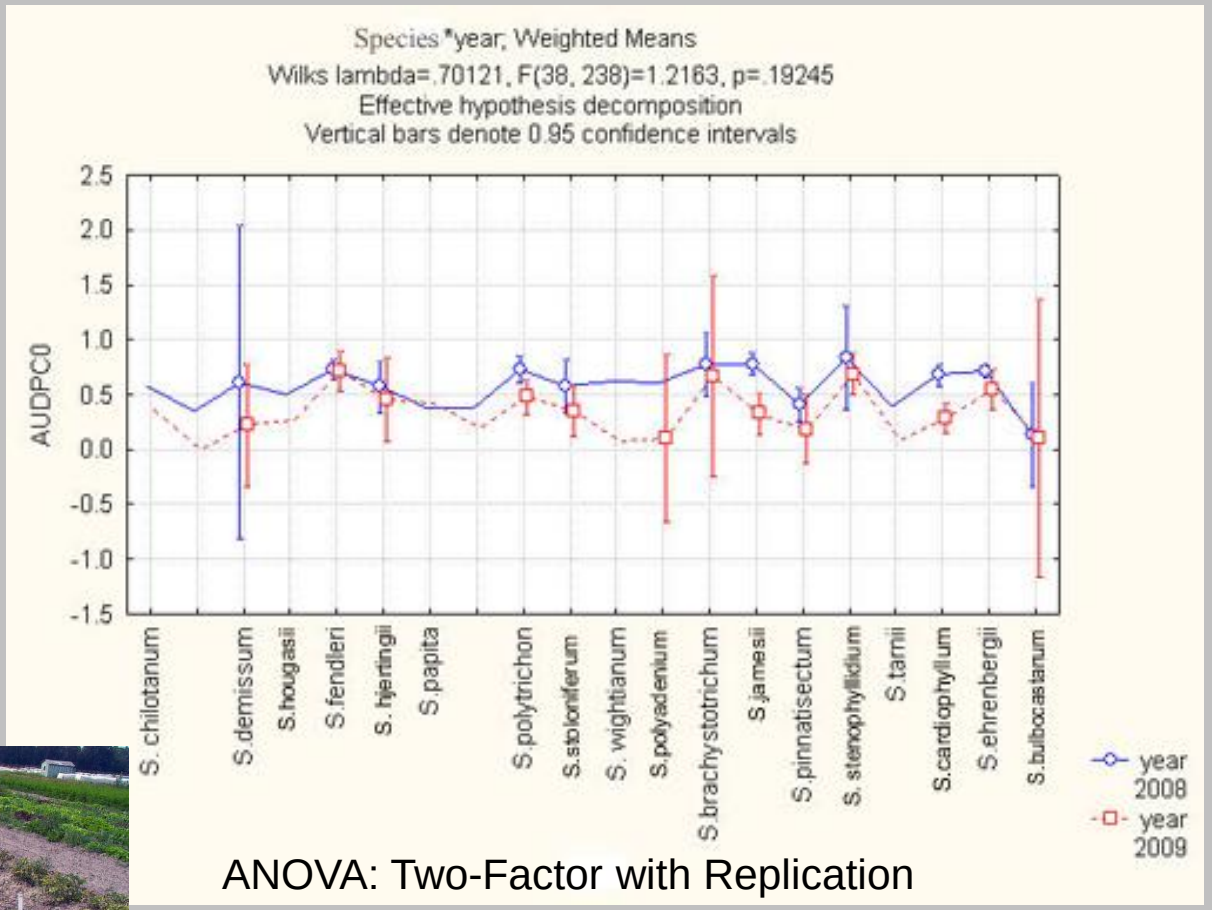


SCAR markers for the *R* genes for LB resistance

Marker; size, bp	Prototype clone	Reference	Chromo-some	Position in the prototype clone
RB-638/ RB-629*	AY336128	Beketova et al., 2007; Pankin et al., 2011	8	585-1223
R1-1205**	AF447489	Sokolova et al., 2011	5	5126-6331
R3-1380*	AY849382	Sokolova et al., 2011	11	1677-3056

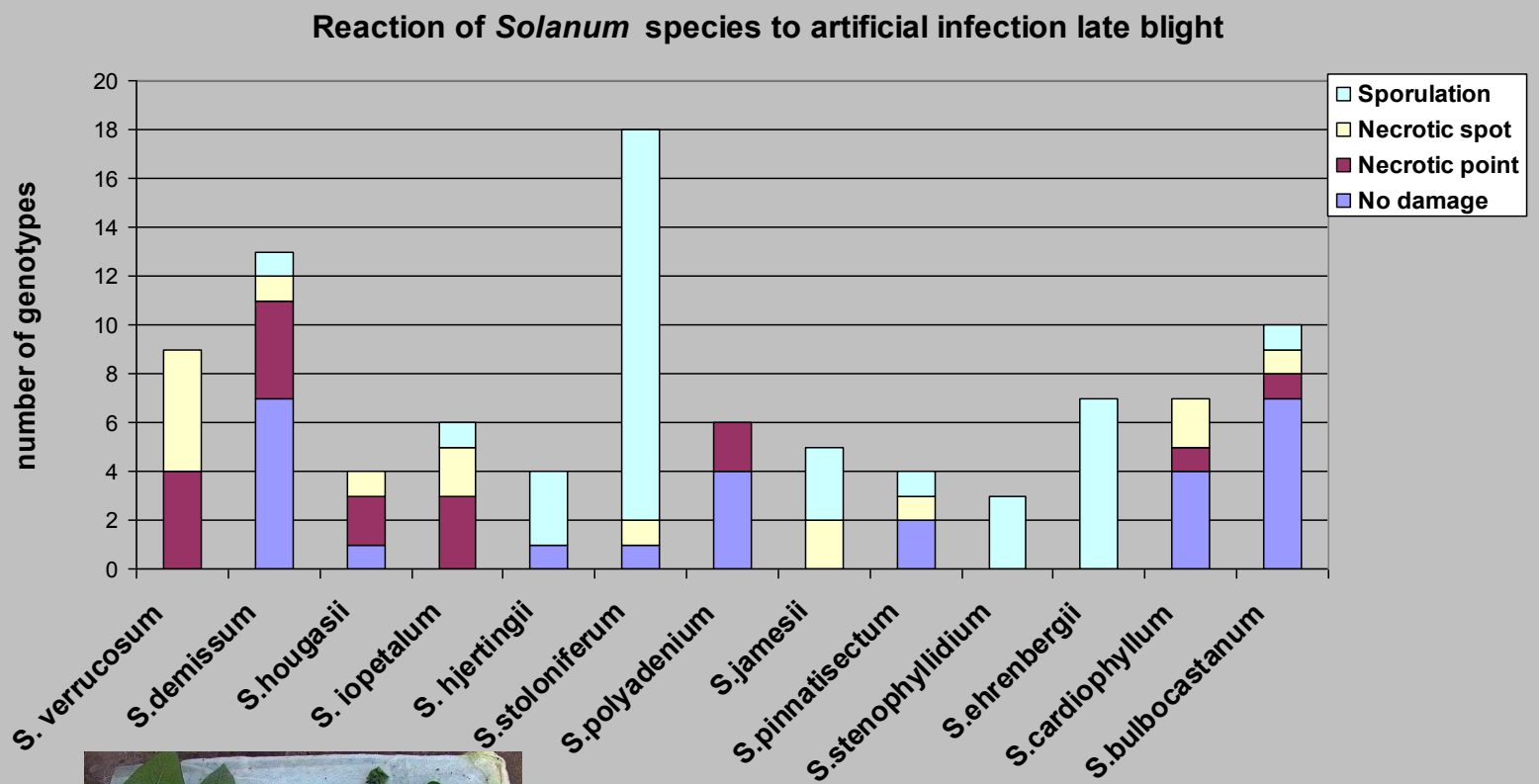
*Developed by the authors; **modified by the authors.

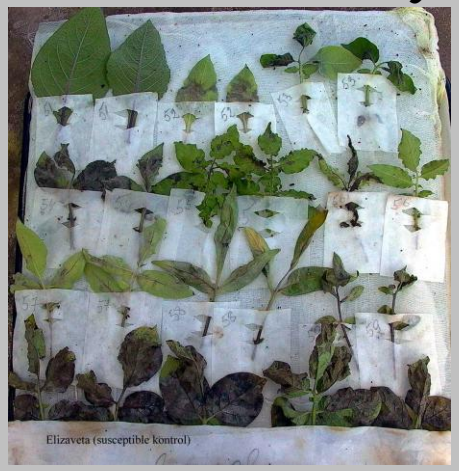
Field trials of accessions of *Solanum* species in 2008-2009



ANOVA: Two-Factor with Replication

Detached-leaf trials of accessions of *Solanum species*

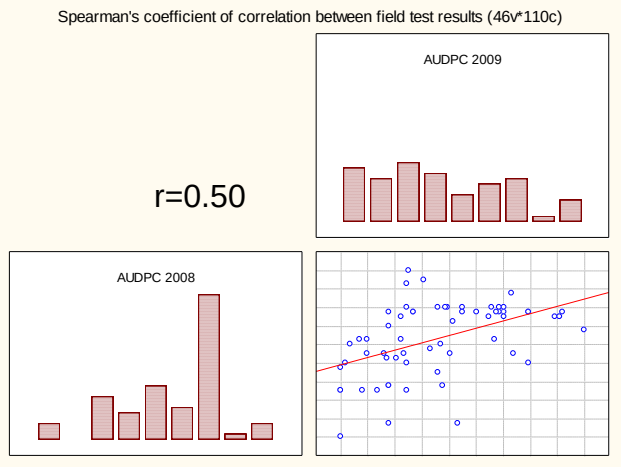


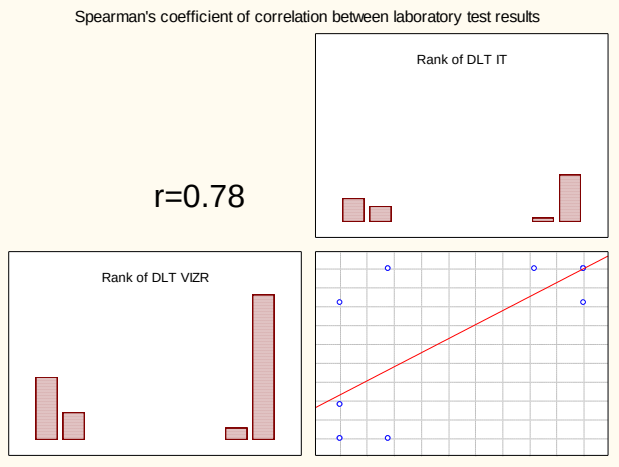


Distribution of wild *Solanum* accession by LB resistance

Field / Laboratory	Resistant	Moderately-resistant	Moderately-susceptible	Susceptible
Resistant	*S. brachycarpum 2830* *S. demissum 15173* *S. hjertingii 24223* *S. cardiophyllum 24207* *S. bulbocastanum 19981, 21266,*	*S. stoloniferum 21618* *S. polyadenium 23553* *S. cardiophyllum 16828, 18086, 24206, 24375*	*S. demissum 18521* *S. jamesii 24397*	
Moderately-resistant	*S. pinnatisectum 24239*	*S. hougasii 8818*	*S. pinnatisectum 24243*	*S. fendleri 23841*
Moderately-susceptible	*S. papita 24417* *S. stoloniferum 21547*	*S. jamesii 22619*	*S. stoloniferum 23652* *S. jamesii 15203*	*S. jamesii 23398*
Susceptible	*S. polytrichon 24463* *S. pinnatisectum 21955*	*S. hjertingii 24387* *S. papita 16889* *S. brachystotrichium 24197* *S. ehrenbergii 24373*	*S. chilotanum 1671* *S. polytrichon 23561, 24298, 24462* *S. stoloniferum 19196* *S.cardiophyllum 4464* *S. ehrenbergii 23279*	*S. fendleri 24221* *S. polytrichon 16905* *S. stoloniferum 24420* *S. stenophyllidium 20105, 24255* *S. ehrenbergii 18225*

Spearman's coefficients of correlation between field and laboratory test results: significant at *P*=0.05





Markers of the *R*-genes and germplasms of *Solanum* species section *Petota*

Series	Total number of accessions	Total number of accessions comprising the particular marker				
		R1-1205	**R3-1380**	**Ssto-449***	**RB-638/629**	**Sblb-509****
***S. tuberosum* ssp. *tuberosa* (Chilotanum forms and cultivars free of *dms*/*sto* germplasm)**	19	0	0	0	0	0
Diploid *Tuberosa*	21	2	1	ND	5	0
Demissoid cultivars	161	57	55	51 of 61	0	0
Demissa	45	19 of 44	8	20 of 29	7 of 19	0 of 29
Longipedicellata	52	5 of 51	5 of 51	27 of 42	35 of 42	0 of 50
***Polyadenia* (*S. polyadenium*)**	6	0	0	1 of 5	2 of 5	0
Pinnatisecta / Cardiophylla	47	0 of 46	4 of 46	1 of 36	22 of 38	0 of 43
***Bulbocastana* (*S. bulbocastanum*)**	23	0	6	0 of 16	11 of 18	15 of 17

ND – no data;
*an anonymous marker discerning germplasms of *S. demissum* and *S. stoloniferum* = *S. papita*;
** an anonymous marker specific for *S. bulbocastanum* germplasm.

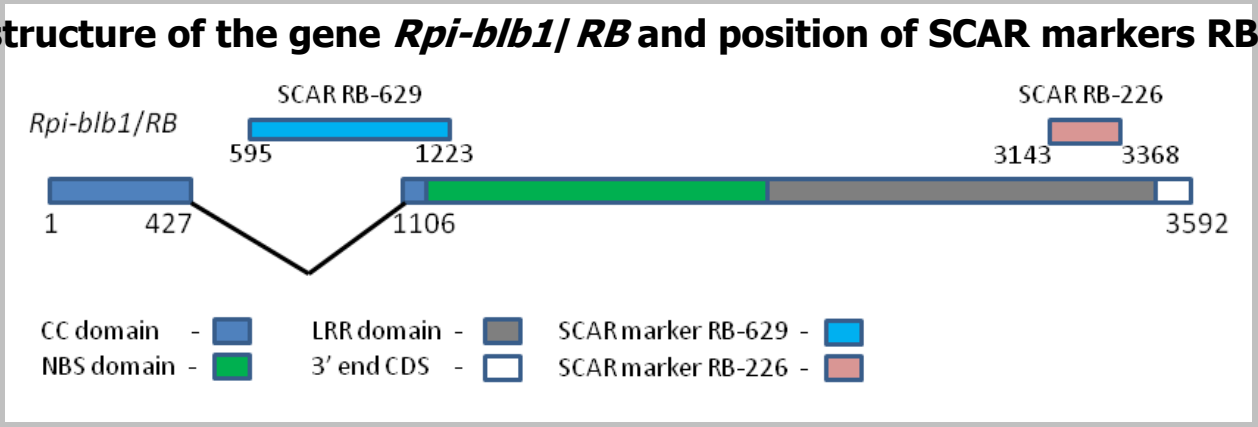
Sokolova et al. (2011)

The presence of markers for *R*-genes in *Solanum* genotypes resistant to *P. infestans* inoculation

Series of Solanum ssp.	Number of tested accessions	Including resistant accessions	number of accessions comprising the particular marker			
			R1-1205	**R3-1380**	**RB 638/629**	**RB 213/226**
Verrucosa	**2**	**2**	**0**	**0**	**0**	**0**
Demissa	**5**	**5**	**1**	**1**	**3**	**0**
Longipedicellata	**19***	**3**	**0**	**0**	**3**	**3**
Polyadenia	**2**	**2**	**0**	**0**	**2**	**0**
Pinnatisecta	**13***	**4**	**0**	**0**	**3**	**0**
Cardiophilla	**14***	**5**	**0**	**1**	**1**	**0**
Bulbocastana	**6**	**5**	**0**	**0**	**4**	**2**

* Some susceptible genotypes contain RB 638/629 and RB 213/226 markers

The structure of the gene *Rpi-blb1*/ *RB* and position of SCAR markers RB-629 and RB-226



Pankin et al. (2010)

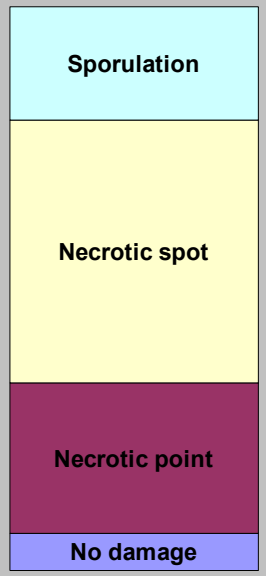
Field trials of potato interspecific hybrid clones and varieties in 2007-2009

159-1 Nevskyi

Bintje 97-80-1

Detached-leaf trials of potato interspecific hybrid clones and cultivars

Relative frequencies of different rections to Ph. infestans among interspecific hybrid clones



97-162-5 **Bintje**

Disease assesments of potato cultivars carried out for 7 days following inoculation:

Bintje, Bobr and **Elizaveta**– sporulation

Nevskyi – necrotic spot

159-31

160-40

160-1

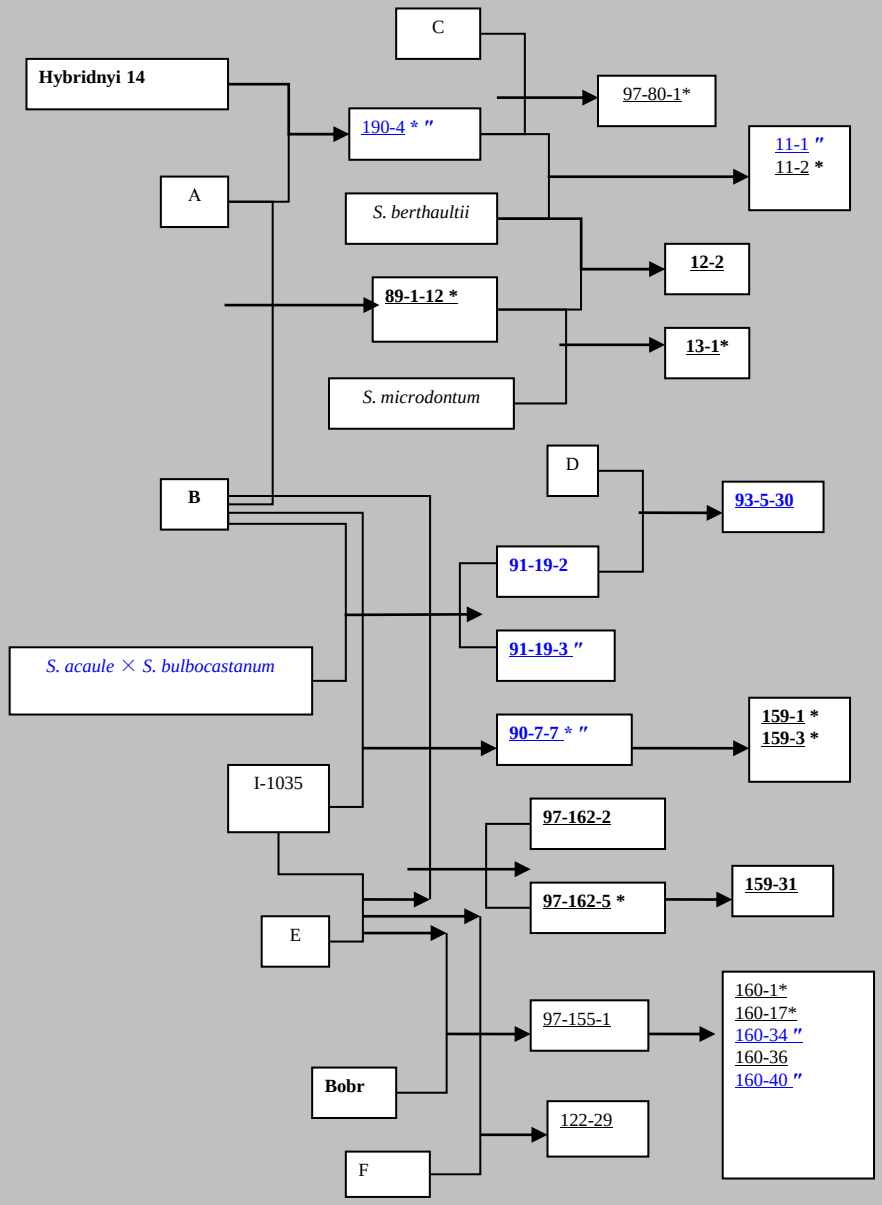
159-1

159-3

159-2

160-17

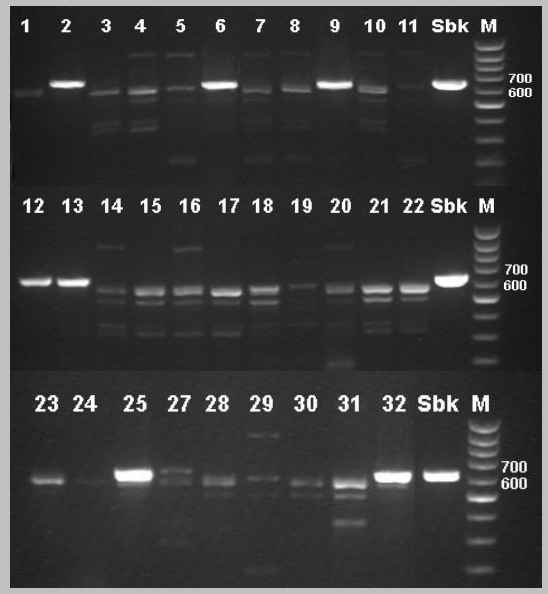
Elizaveta



*** SCAR markers *R1-1205***

″ SCAR markers *RB 638/629*

in potato interspecific hybrids



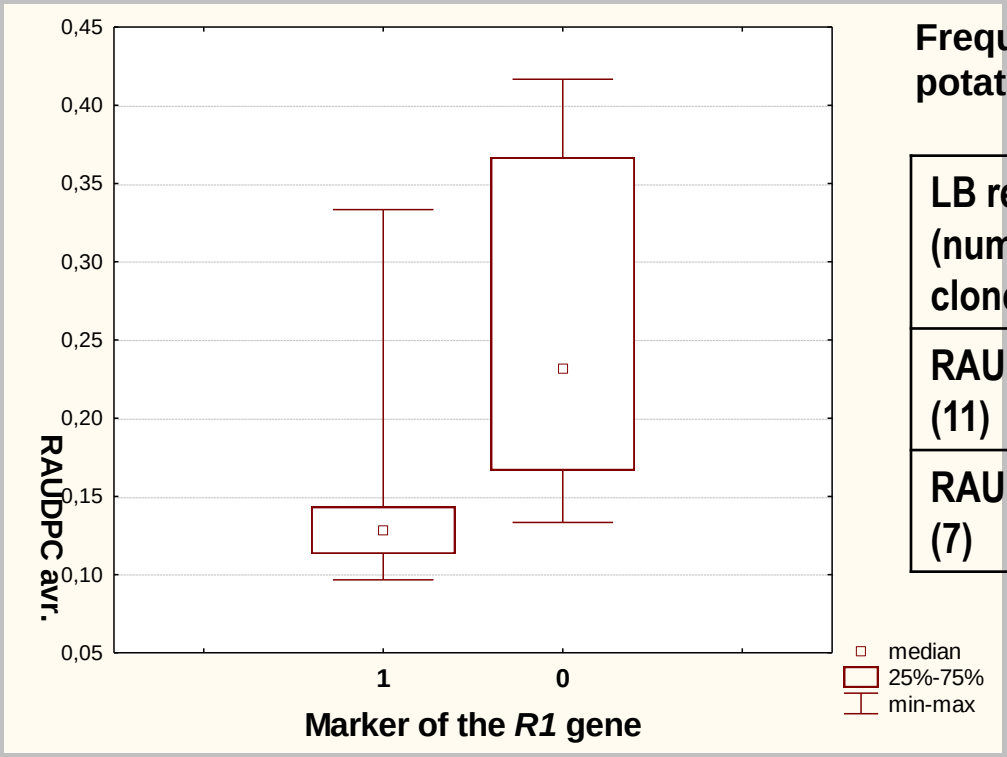
1– susceptible control, 2 – 190-4, 3 – 97-155-1, 4 – 97-80-1, 5 – 93-5-30, 6 – 160-34, 7 – 97-162-2, 8 – 24-1, 9 – 91-19-3, 10 – susceptible control , 11 –11-2, 12 – 11-1, 13 – 160-40, 14 – 97-162-5, 15 – 89-1-12, 16 –160-17, 17 – susceptible control , 18 – 160-36, 19 – 122-29, 20 – 159-1, 21 – 159-31, 22 и 23 – susceptible control , 24 – 24-2, 25 – 160-40, 27 – 12-2, 28 – 13-1, 29 – 93-5-30, 30 – 160-17, 31 – 160-1, 32 – 90-7-7, Sbk – *Solanum bulbocastanum*, M –Gene Ruler 100 bp DNA Ladder Plus.

Rogozina et al. (2007)

Hybrid clones **89-1-12, 12-2, 13-1, 97-162-2, 97-162-5, 159-31, 90-7-7, 159-1, 159-3**, 91-19-2, 91-19-3, 93-5-30 comprise genetic material of S. stoloniferum (and genetic material of S. bulbocastanum)

Association of LB resistance in the clones of potato hybrids with the presence of the *R*-gene markers

Mann-Whitney U-test, significantly different at *P*=0.05



Frequencies of the markers of *R*-genes in potato interspecific hybrid clones

LB resistance (number of hybrid clones)	R1	RB	R1+RB
RAUDPC 0,09-0,20 (11)	0,45	0,36	0,55
RAUDPC 0,23-0,42 (7)	0,14	0,28	0,43

the presence of *R* -genes (*R1, R10, R11*) in potato cultivars is associated with higher field indices of LB resistance
(Stewart et al., 2003; Gebhards et al., 2004; M. Beketova et al., 2006; Sokolova et al, 2010)

Conclusions

RB-like sequences are neither species- nor wild potato-specific as they are distibuted among a wide range of *Solanum* species and advanced hybrid clones

SCAR-marker *R1* -1205 indicates LB resistance of potato cultivars and interspecific hybrid clones having a diverse backgrounds.

SCAR marker RB-638/629 was maintained for 5-6 meiotic generations and matches the active *RB* forms among genetically different material.

Clonal collection of wild *Solanum* and potato hybrids incorporating wild *Solanum* germplasm is a valuable source of LB resistant material for breeding.

ISTC-USDA-ARS project 3714 p, EurAsEC project ITP15

Thanks for your attention!