Chosen characteristics of Polish *Phytophthora infestans* isolates

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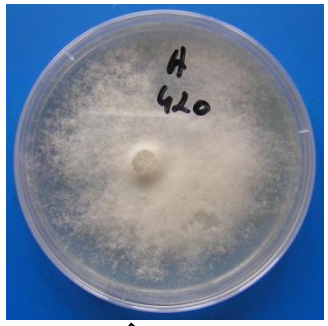
P. infestans isolates collection

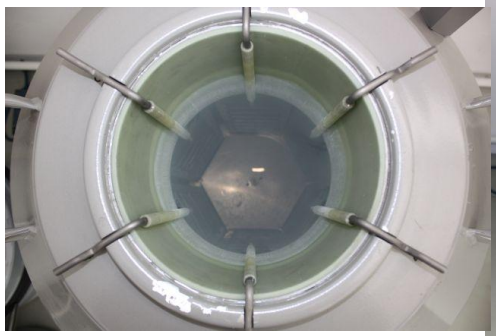


668 polish isolates
46 from other countries

231 isolates

714 isolates

Isolates from 2009 - 175

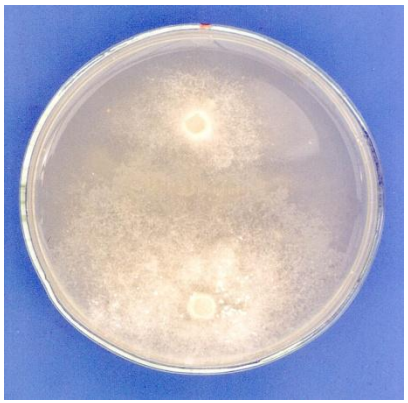


Isolates to
2009 - 56

Characterisation of isolates for

phenotypic traits

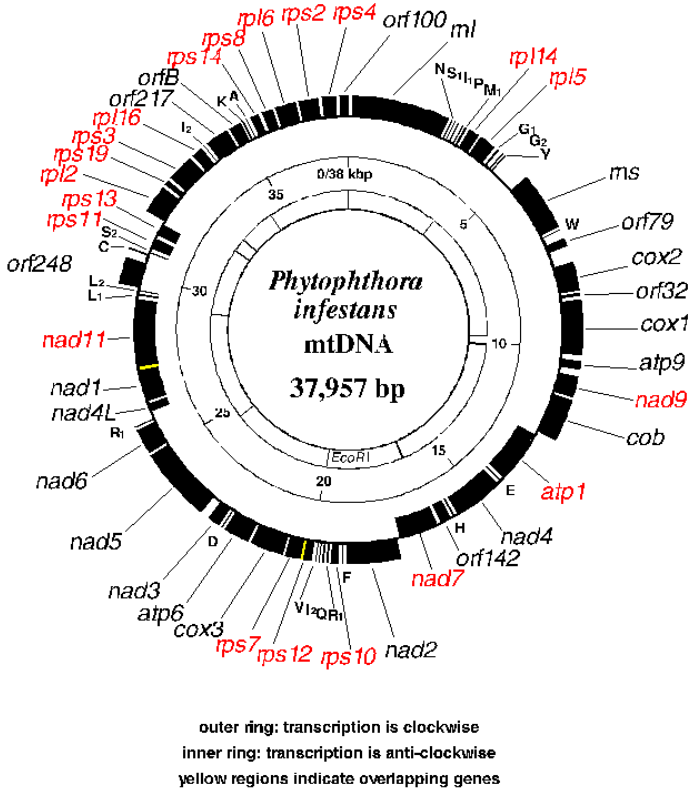
- methalaxyl resistance
- virulence
- agressiveness
- mating type



Lebecka et al., 2007

molecular methods

- Simple Sequence Repeats (SSR)
- mitochondrial haplotype – mtDNA



outer ring: transcription is clockwise
inner ring: transcription is anti-clockwise
yellow regions indicate overlapping genes

Lise Forget & B. Franz Lang (1995)

Locations sampled in 2007

1-5 isolates

6-10 isolates

11-15 isolates

16-20 isolates

20-25 isolates

26-30 isolates

31 and more isolates

Total locations:
18
Total isolates:
45

made using GoogleMaps, 2010

Locations sampled in 2008

1-5 isolates

6-10 isolates

11-15 isolates

16-20 isolates

20-25 isolates

26-30 isolates

31 and more isolates

Total locations:
19
Total isolates:
85

made using GoogleMaps, 2010

Locations sampled in 2009

1-5 isolates

6-10 isolates

11-15 isolates

16-20 isolates

20-25 isolates

26-30 isolates

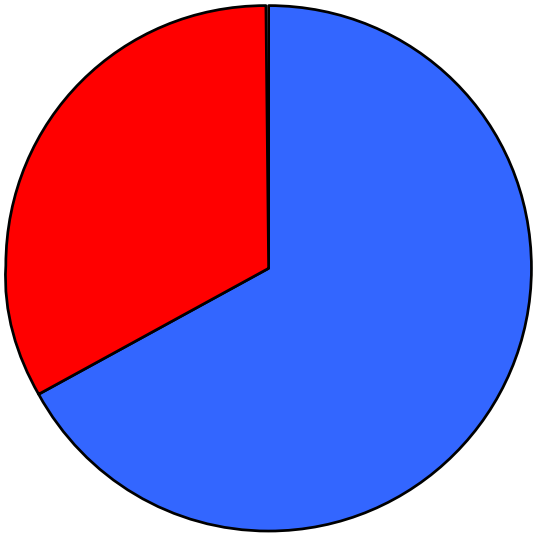
31 and more isolates

Total locations:
35
Total isolates:
227

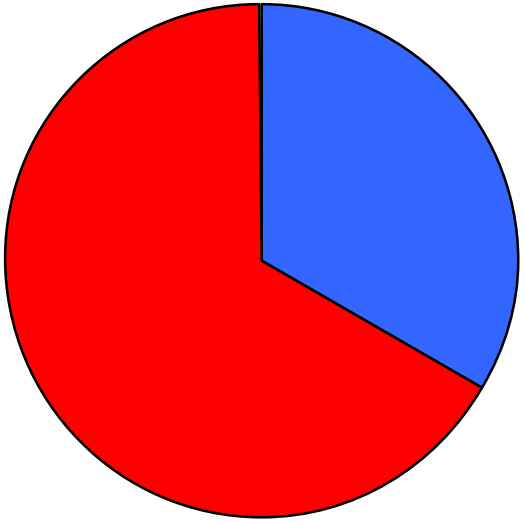
made using GoogleMaps, 2010

Mating type of *P. infestans* isolates

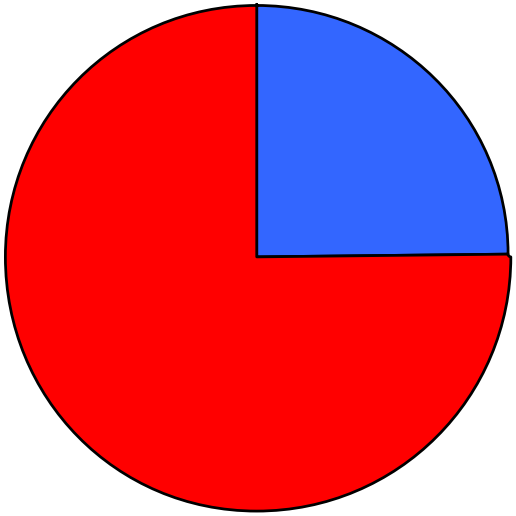
1996 to 2006
(n=1033)
A1 – 692
A2 – 340

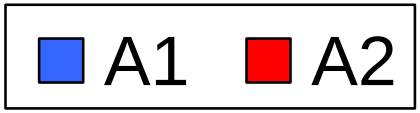


2007
(n=36)
A1 – 12
A2 – 24



2008
(n=84)
A1 – 21
A2 – 63

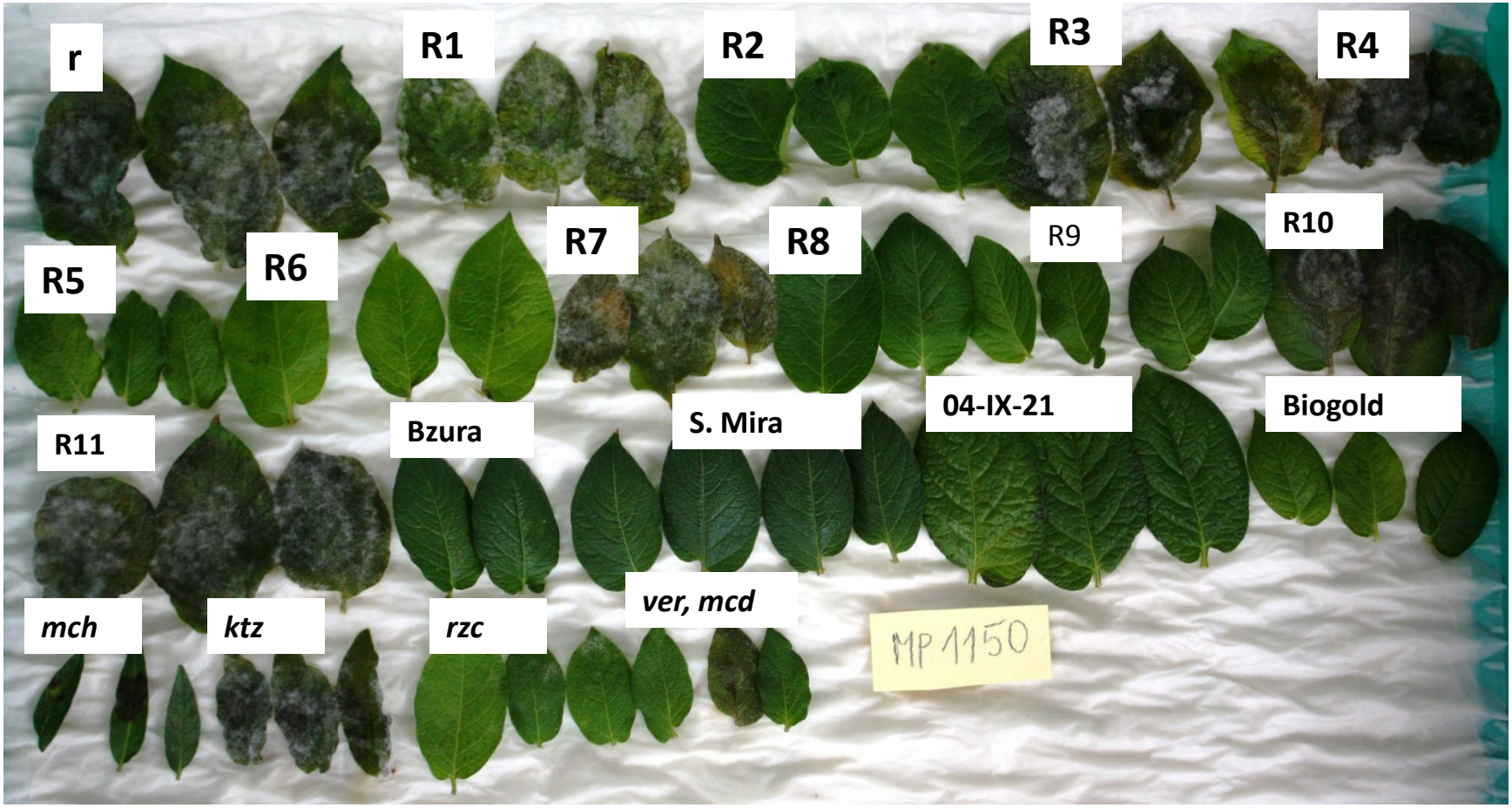




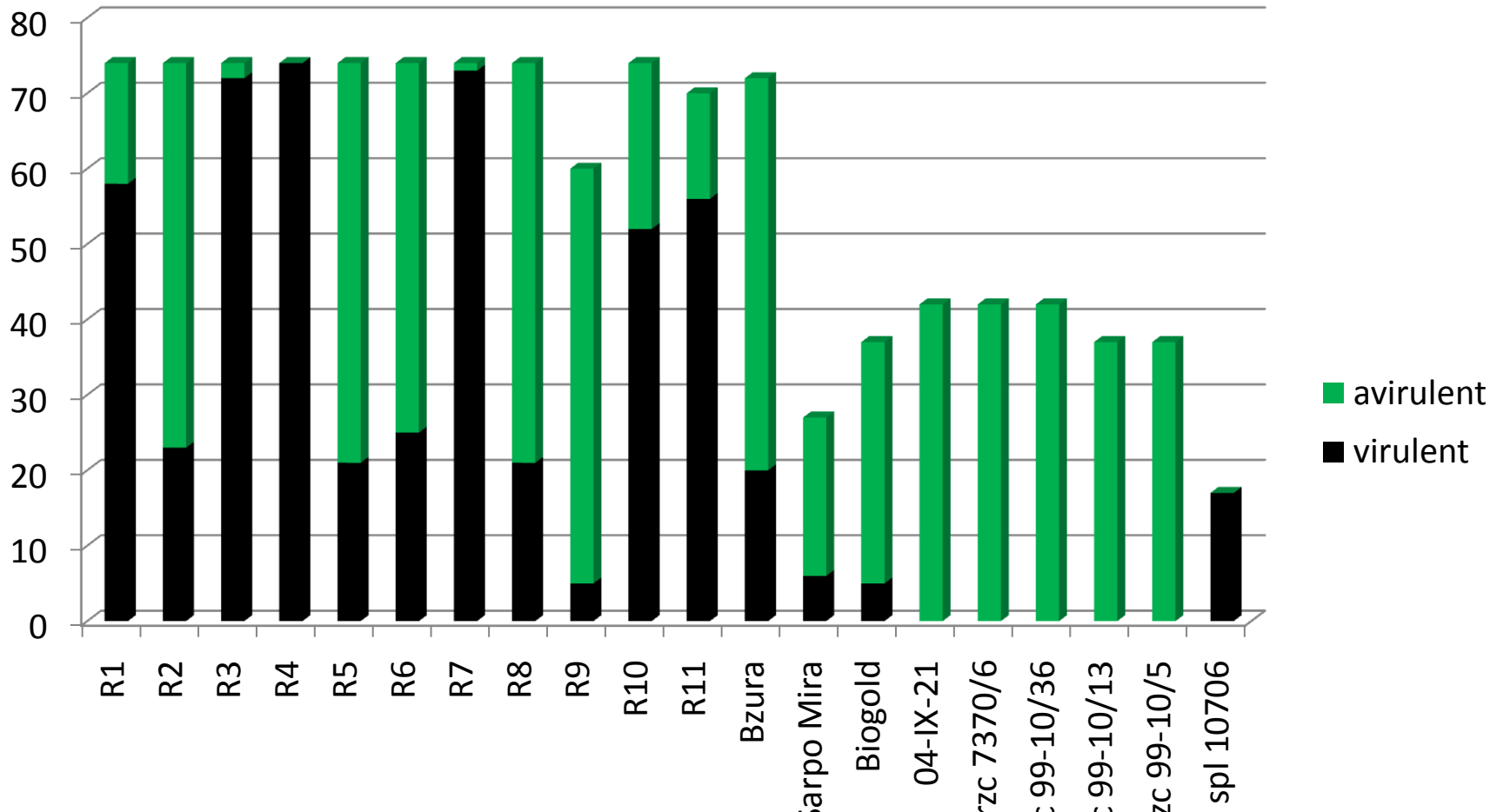
Virulence

- Black's differential set (SASA) R1-R11
- Cv. Sarpo Mira
- Cv. Bzura
- Cv. Biogold
- 04-IX-21 (containing *Rpi-phu1* syn. *Rpi-vnt1*)
- *Solanum ruiz-ceballosii* syn. *S. sparsipilum* (*rzc* 7370/6 *rzc* 99-10/36 *rzc* 99-10/13 *rzc* 99-10/5)
- *S. sparsipilum* (*spl* 10706)
- *S. michoacanum* (*mch* 99-12/8)
- *S. kurtzianum* 99-6/30
- 85-3411 *S. tuberosum* hybrid with *S. verrucosum* and *S. microdontum*

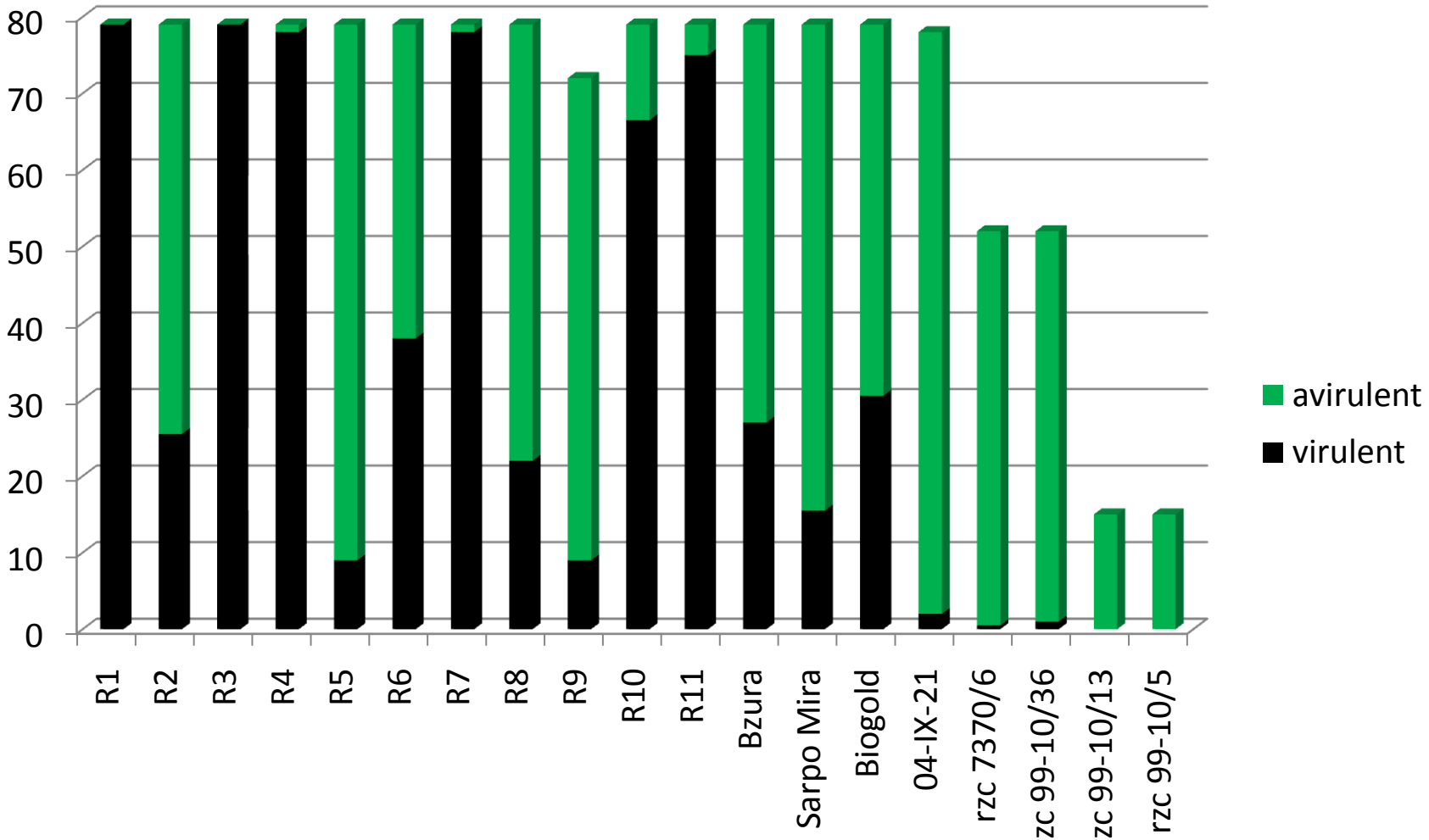
Virulence - example from 2009, 1 of 2 replicates x 3 leaflets



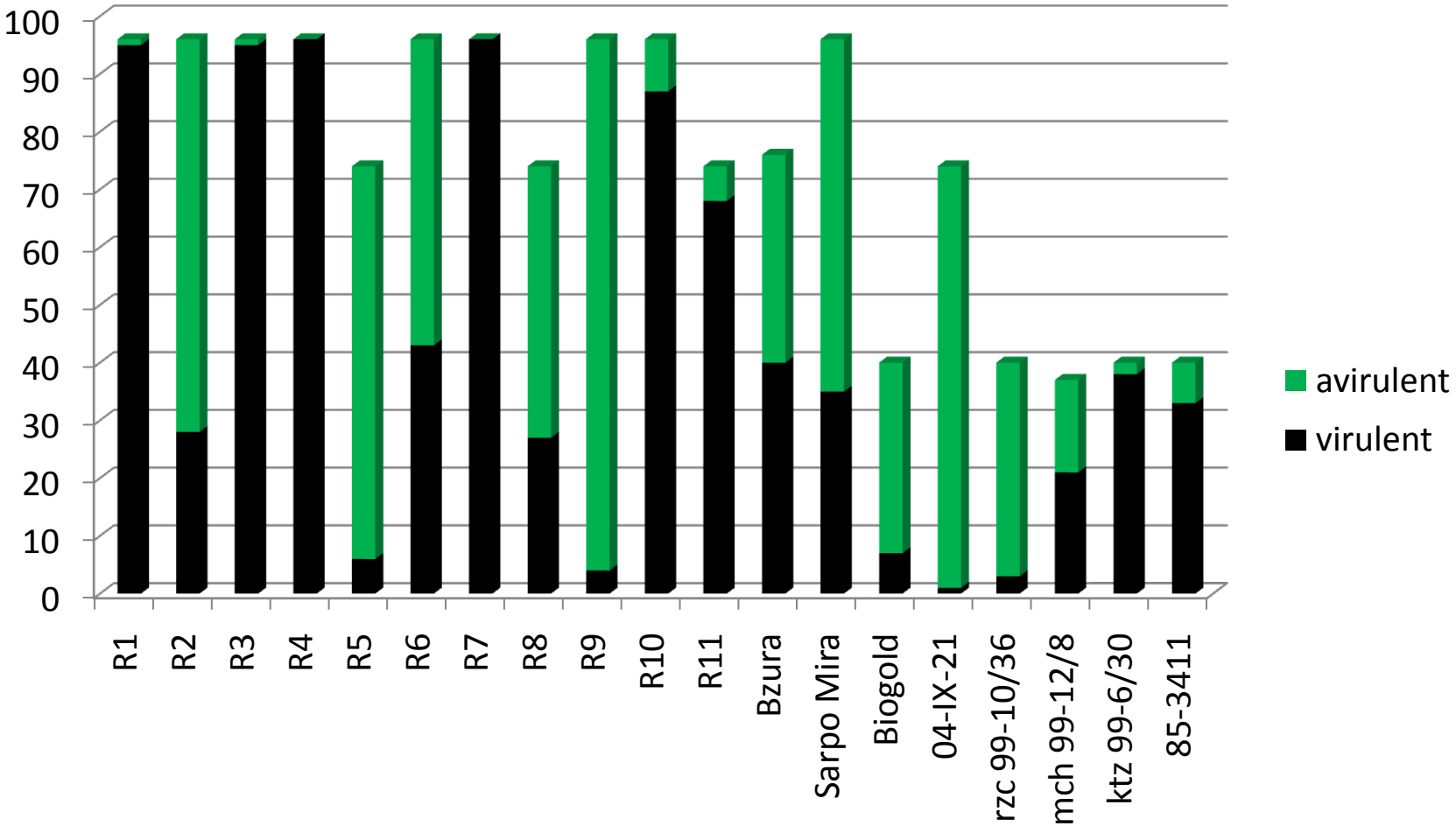
Virulence 2007



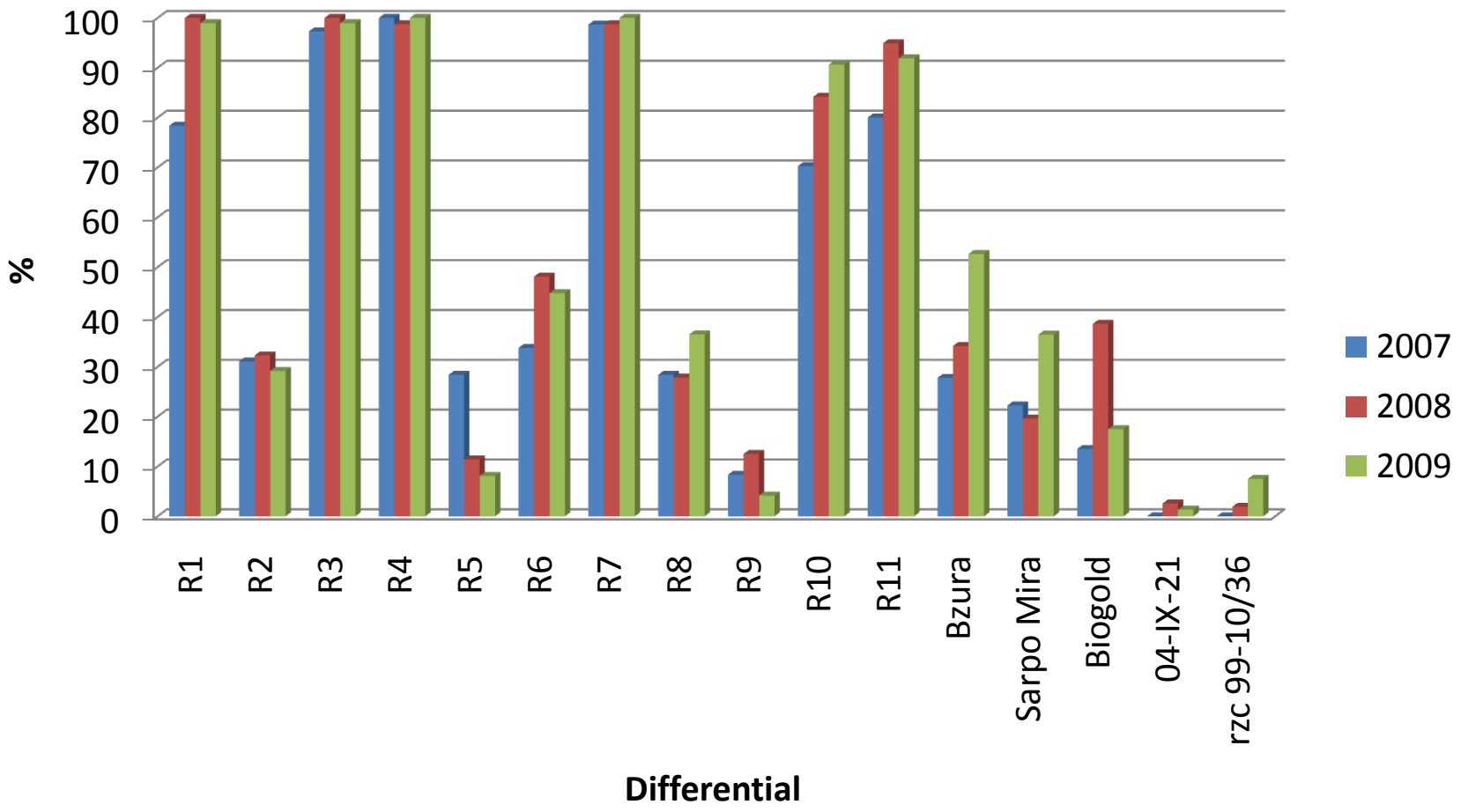
Virulence 2008



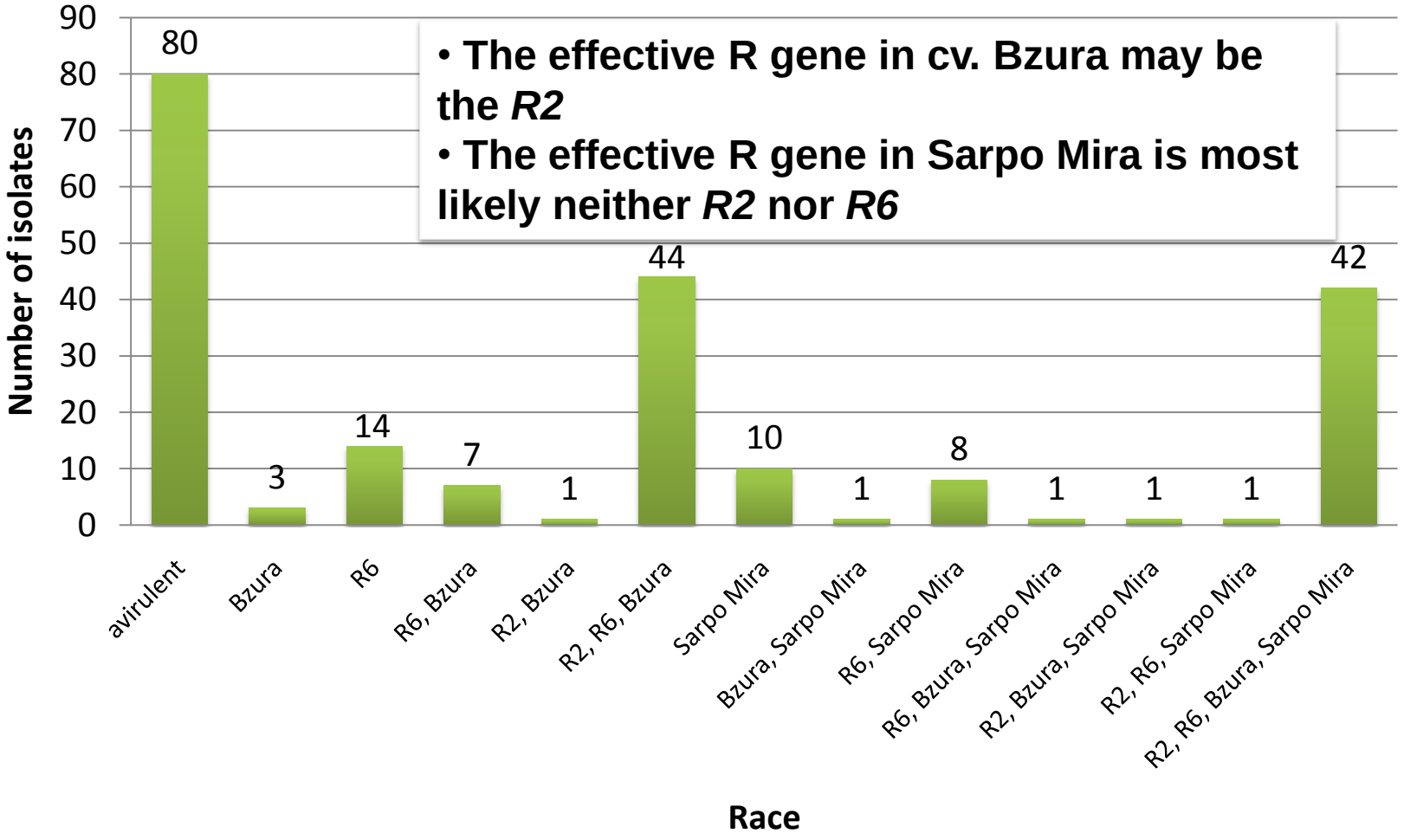
Virulence 2009



Percentage of virulent isolates in years 2007-2009

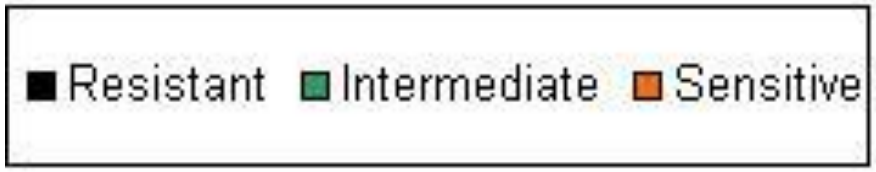


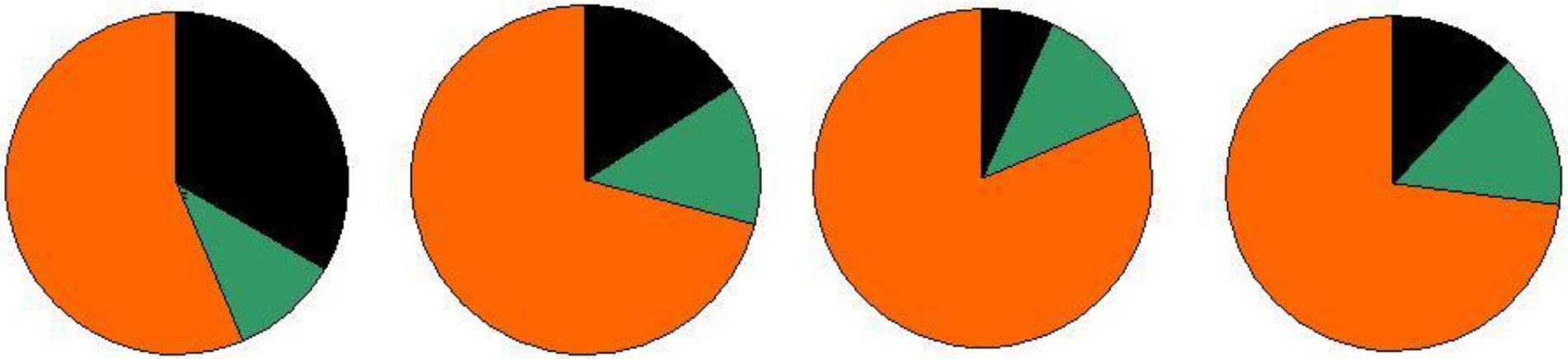
Virulence on R2, R6, Bzura and Sarpo Mira (N=213)



Resistance to metalaxyl of *P. infestans* isolates

2006	2007	2008	2009
n=85	n=31	n=85	n=165
R – 28	R – 5	R – 6	R – 20
I – 8	I – 4	I – 10	I – 25
S – 49	S – 22	S – 69	S – 125



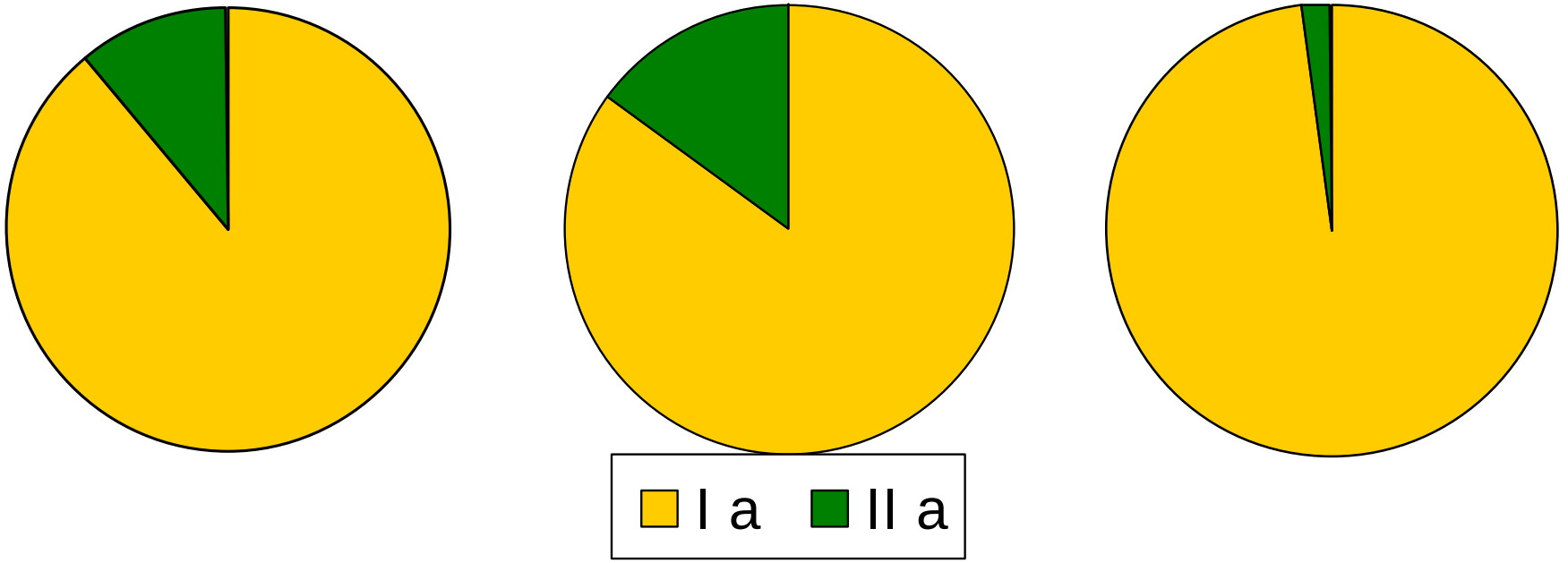


Haplotype of mitochondrial DNA of *P. infestans* isolates

1997 to 2006
(n=74)
Ia – 66
IIa – 8

2007
(n=33)
Ia – 28
IIa – 5

2008
(n=50)
Ia – 49
IIa – 1



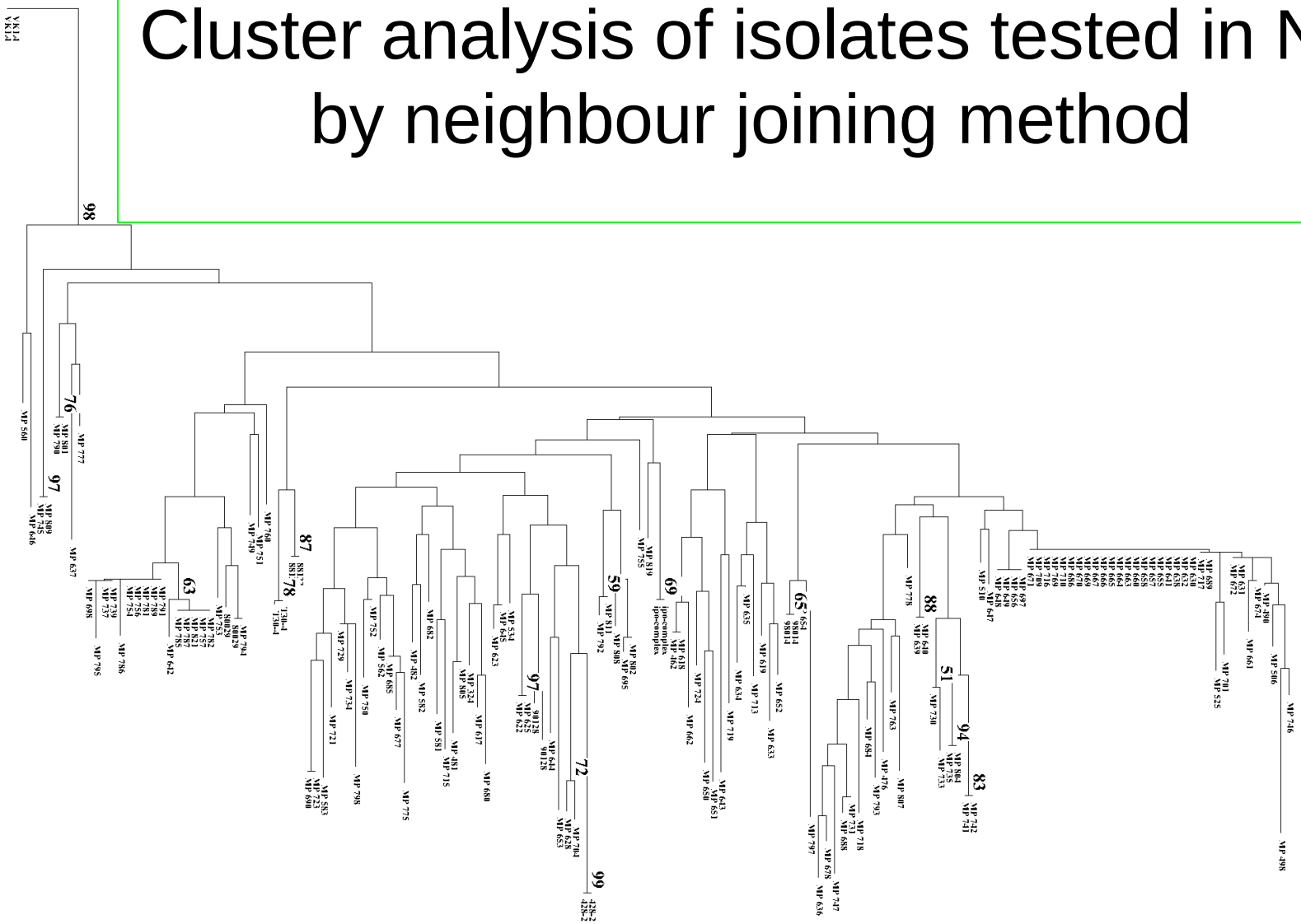
Genotyping of *P. infestans* isolates with SSR markers

	Tested in Scotland in collaboration with D. Cooke, A. Lees	Tested in Netherlands in collaboration with T. van der Lee	common
Number of isolates	88	112	43
Regions/ locations	11/26	15/44	10/18
Isolates/ years	1997 – 2003: 14 2004: 27 2005: 48	1997 – 2003: 6 2004: 3 2005: 51 2006: 52	1997 – 2003: 4 2004: 3 2005: 36

Genotyping of *P. infestans* isolates with SSR markers

	Tested in Scotland	Tested in Netherlands
Number of markers	12	8
Polymorphic markers	10	8
Number of alleles (mean, range)	3,7 (2-12)	3,4 (2-5)
Number of different genotypes	51	72
Number of different genotypes in common part	29	28

Cluster analysis of isolates tested in NL by neighbour joining method



T. Van der Lee, 2009

SSR results

SampleYear	RegionID	OriginalName	Pi02	Pi02	Pi16	Pi16	Pi33	Pi33	Pi56	Pi56	Pi63	Pi63	Pi63	Pi66	Pi66	Pi66	Pi70	Pi70	Pi89	Pi89	Pi4B	Pi4B	Pi4B	G11	G11
2005	Łódzkie	MP 639	162	164	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Małopolskie	MP 648	162	164	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Małopolskie	MP 649	162	164	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Małopolskie	MP 656	162	164	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Małopolskie	MP 697	162	164	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2002	Podkarpackie	MP 506	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Swiętokrzyskie	MP 632	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 663	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 665	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 666	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 667	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 669	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 670	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 671	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162
2005	Podkarpackie	MP 709	162	162	176	178	203	206	174	176	148	151	157	228	229		192	192	179	179	205	217		156	162

Among 43 isolates which have full SSR results we found two genotypes which occured in isolates from more than one location - according to SC SSR markers. But…

SSR results

SampleYear	RegionID	OriginalName	SSR1	SSR1	SSR1	SSR2	SSR2	SSR3	SSR3	SSR3	SSR4	SSR4	SSR4	SSR6	SSR6	SSR6	SSR7	SSR7	SSR11	SSR11
2005	Łódzkie	MP 639	238	242		169	169	269	271		288	294		217	219	221	197	197	337	337
2005	Małopolskie	MP 648	238	242		169	169	269	271		288	293		217	219	221	197	197	337	337
2005	Małopolskie	MP 649	238	242		169	169	269	271		288	293		217	219	221	197	197	337	337
2005	Małopolskie	MP 656	238	242		169	169	269	271		288	293		217	219	221	197	197	337	337
2005	Małopolskie	MP 697	238	242		169	169	269	271		288	293		217	219	221	197	197	337	337
2002	Podkarpackie	MP 506	238	238		169	169	269	269		288	293		217	219		197	197	337	337
2005	Świętokrzyskie	MP 632	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 663	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 665	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 666	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 667	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 669	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 670	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 709	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337
2005	Podkarpackie	MP 671	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337

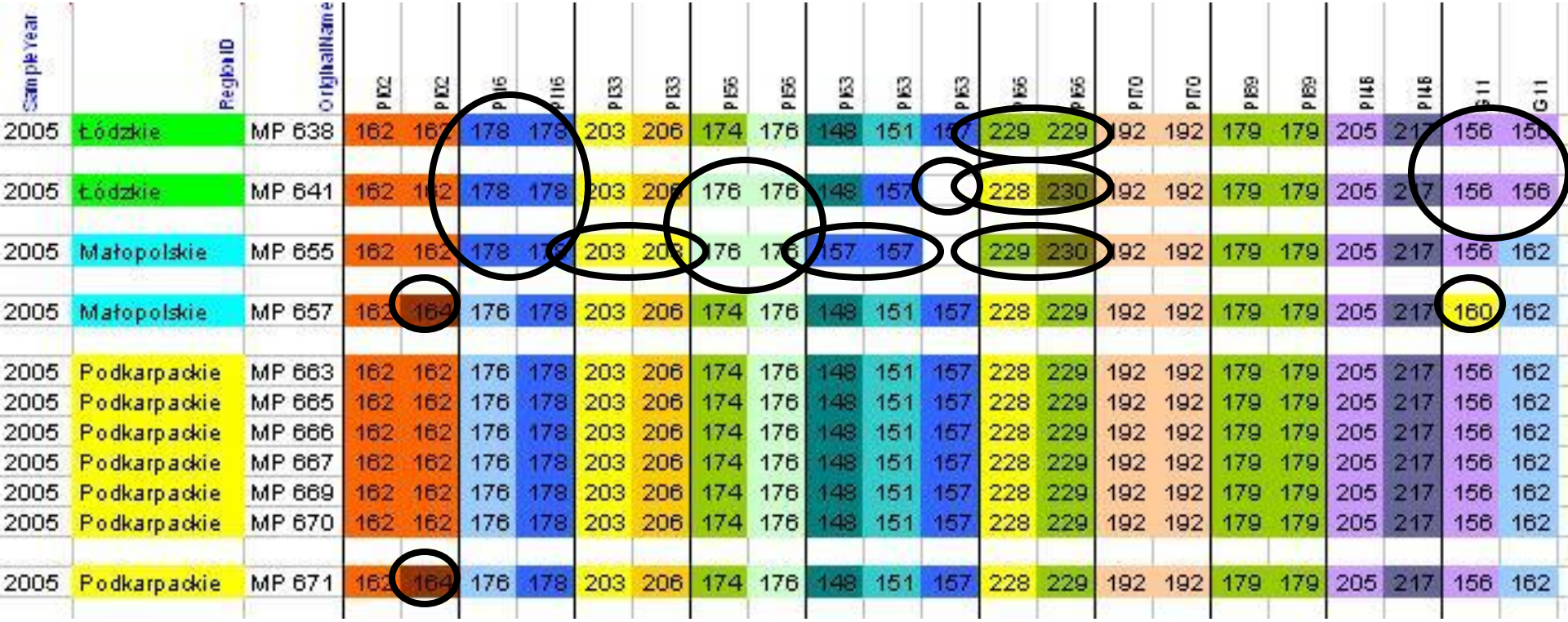
Those genotypes tested using NL SSR markers appeared to be not two but four different genotypes

SSR results

SampleYear	RegionID	OrginalName	SSR1	SSR1	SSR1	SSR2	SSR2	SSR3	SSR3	SSR3	SSR4	SSR4	SSR4	SSR6	SSR6	SSR6	SSR7	SSR7	SSR11	SSR11	SSR11
2005	Łódzkie	MP 638	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Łódzkie	MP 641	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Małopolskie	MP 655	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Małopolskie	MP 657	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 663	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 665	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 666	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 667	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 669	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 670	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 671	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Małopolskie	MP 658	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Świętokrzyskie	MP 630	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Świętokrzyskie	MP 632	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Świętokrzyskie	MP 710	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 660	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 664	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 686	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2005	Podkarpackie	MP 709	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2006	Warmińsko-Mazurskie	MP 716	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	
2006	Podkarpackie	MP 769	238	242		169	169	269	269		288	293		217	219	221	197	197	337	337	

We also found one genotype, which occured in five different locations – according to NL SSR markers. But…

SSR results



SampleYear	RegionID	OrigInalName	P102	P102	P116	P116	P133	P133	P156	P156	P163	P163	P163	P156	P156	P170	P170	P159	P159	P146	P146	G11	G11
2005	Łódzkie	MP 638	162	162	178	178	203	206	174	176	148	151	157	229	229	192	192	179	179	205	217	156	156
2005	Łódzkie	MP 641	162	162	178	178	203	206	176	176	148	157		228	230	192	192	179	179	205	217	156	156
2005	Małopolskie	MP 655	162	162	178	178	203	206	176	176	157	157		229	230	192	192	179	179	205	217	156	162
2005	Małopolskie	MP 657	162	164	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	160	162
2005	Podkarpackie	MP 663	162	162	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162
2005	Podkarpackie	MP 665	162	162	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162
2005	Podkarpackie	MP 666	162	162	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162
2005	Podkarpackie	MP 667	162	162	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162
2005	Podkarpackie	MP 669	162	162	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162
2005	Podkarpackie	MP 670	162	162	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162
2005	Podkarpackie	MP 671	162	164	176	178	203	206	174	176	148	151	157	228	229	192	192	179	179	205	217	156	162

Those genotypes tested using SC SSR markers appeared to be not one but six different genotypes

Characterisation of Polish population of *P. infestans* - summary

- A2 mating type dominated among tested isolates
- Frequent virulence factors against: R1, R3, R4, R7, R10 and R11
  Moderately frequent against: R2, R6, R8, cv. Bzura and cv. Sarpo Mira.
  Rare against: R5, R9, 04-IX-21 and *rzc* 99-10/36
- Resistance to metalaxyl was relatively low
- Ia mitochondrial haplotype dominated among tested isolates, we found none of Ib or IIb
- High genetic diversity among isolates from 2005 – of 43 isolates tested on two SSR marker groups only 3 genotypes occurred in more than one isolate

What next?

- Hunt for Blue_13 in Polish population of *P. infestans*
- Search for *P. infestans* dsRNA virus
- Characterisation of isolates which will be collected in 2010-2012 – around 150 isolates/year

Acknowledgements

We would like to thank the Main Inspectorate of Plant Health And Seed Inspection for their help regarding collection of isolates

Thank you for your attention