Russian isolates of *Phytophthora infestans:* *genotypes, virulence and resistance to fungicides*

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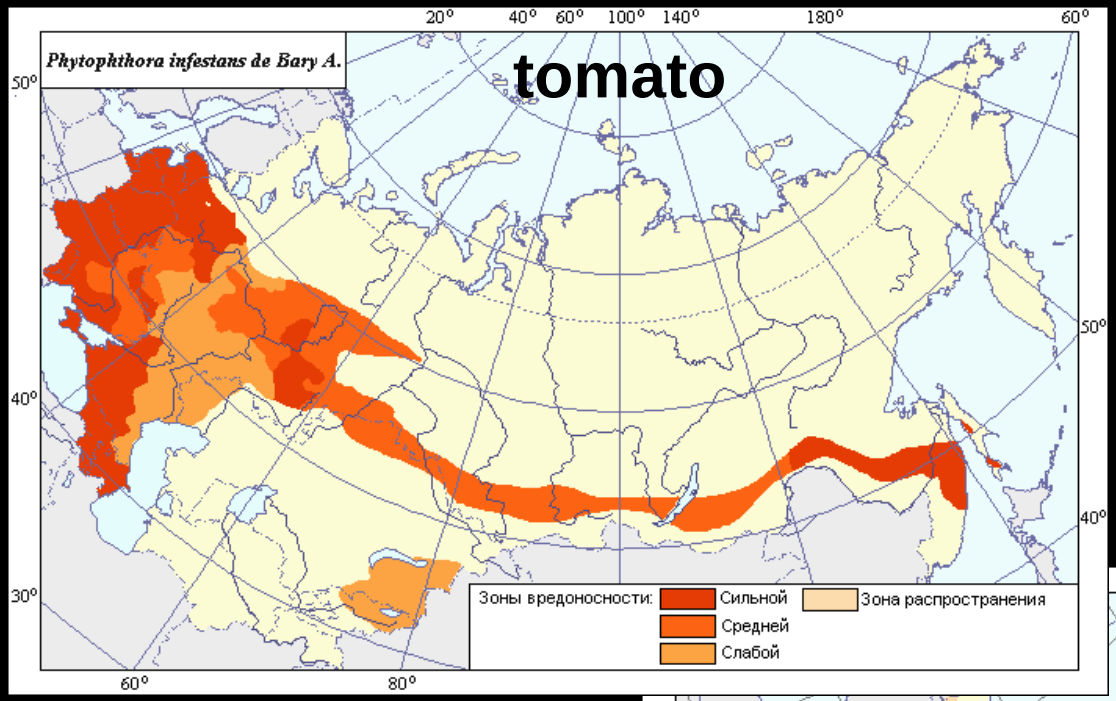
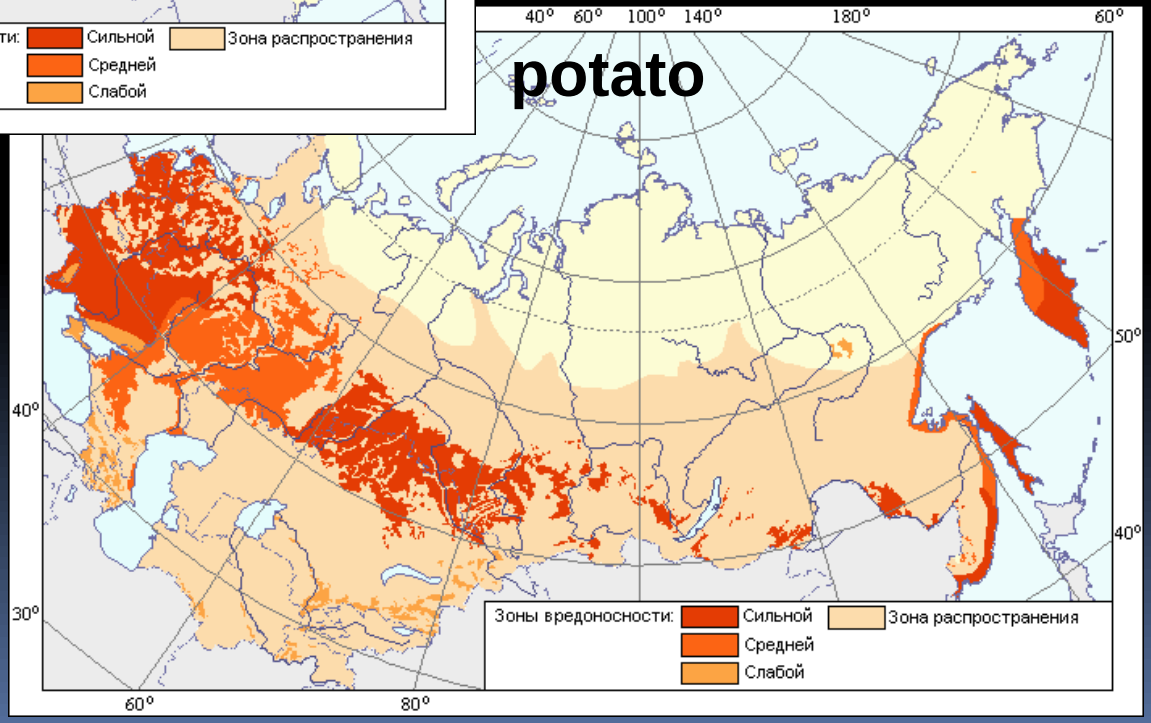
Distribution of potato and tomato late blight in Russia





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Genotypic analysis 1997-1998

Location of sampling sites

Genotypes of Russian *P. infestans* isolates

Clonal lineage	Place of collecting	TC	*GPI*	*Pep 1*	RG 57 fingerprint	mtDNA	Number of isolates
Isolates from potato							
SIB 1	*[1]	A1	100/100	100/100	100010001100110100011001 1	IIa	31
SIB 2	Khabarovsk	A2	100/100	100/100	100010000100110100011001 1	IIa	5
SIB 3	Vladivostok	A1	100/100	100/100	110010101000110100011001 1	IIa	1
MO 1	M1 (97)	A2	100/100	100/100	100010001100110100011001 1	IIa	1
MO 2	M1 (97)	A2	100/100	100/100	100010000100110100011001 1	Ia	1
MO 3	M1 (97)	A1	100/100	100/100	101010000100110100011001 1	IIa	1
MO 4	M1 (97)	A1	100/100	92/100	101011101100110100011001 1	IIa	3
MO 5	M2 (97)	A1	100/100	100/100	100010100100110101011001 1	IIa	1
MO 6	M2 (97)	A1	100/100	100/100	101010100100110100011001 1	Ia	1
MO 7	M4 (97)	A1	100/100	92/100	100010001100110000011001 1	IIa	1
MO 8	M4 (97)	A1	100/100	92/92	101011000100110000011001 1	IIa	1
MO 9	M1 (98)	A1	100/100	92/100	100010000100110100011001 1	IIa	1
MO 10	M2 (98)	A1	100/100	100/100	101011000000110000011001 1	Ia	1
MO 11	M3 (98)	A1	100/100	92/100	101010100100110000011001 1	Ia	1
MO 12	M3 (98)	A2	100/100	100/100	101010100100110100011001 1	Ia	1
Isolates from tomato							
SIB 2	Birobidjan	A2	100/100	100/100	100010000100110100011001 1	IIa	3
MO 13	M2 (97)	A1	100/100	100/100	101010100000110100011001 1	Ia	1
MO 14	M3 (98)	A1	100/100	100/100	001010100100110000011001 1	Ia	1
MO 15	M3 (98)	A1	100/100	100/100	011011100100110001011001 1	Ia	1
MO 16	M3 (98)	A1	100/100	100/100	100010000000110100011001 1	IIa	1
Isolates from old collections							
US 1	M3 (93)	A1	86/100	92/100	101010101100110100011001 1	Ib	2
SIB 1	несколько[2]	A1	100/100	100/100	100010001100110100011001 1	IIa	5

[1] Sib 1 was found in Sakhalin, Omsk, Vladivostok, Chita, Irkutsk, Ekaterinburg, Krasnoyarsk, Tomsk.

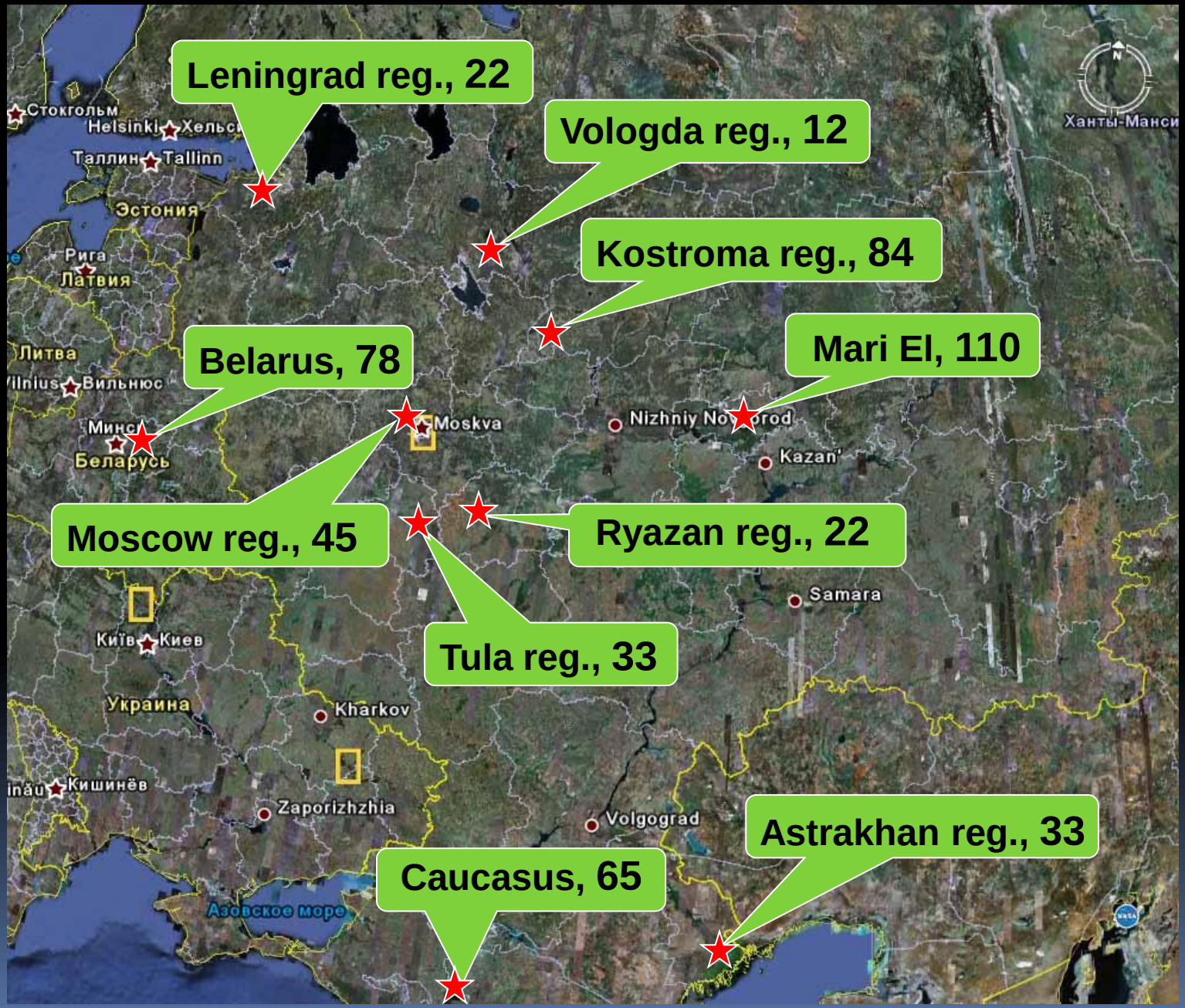
Number of genotypes in regional populations

RG 57, haplotypes, mating types, GPI 1, and Pep1 were tested

Ratio of strains with different mating types in regional populations (A1/ A2)

Genotypic analysis 2001-2009

Location of sampling sites and number of collected isolates

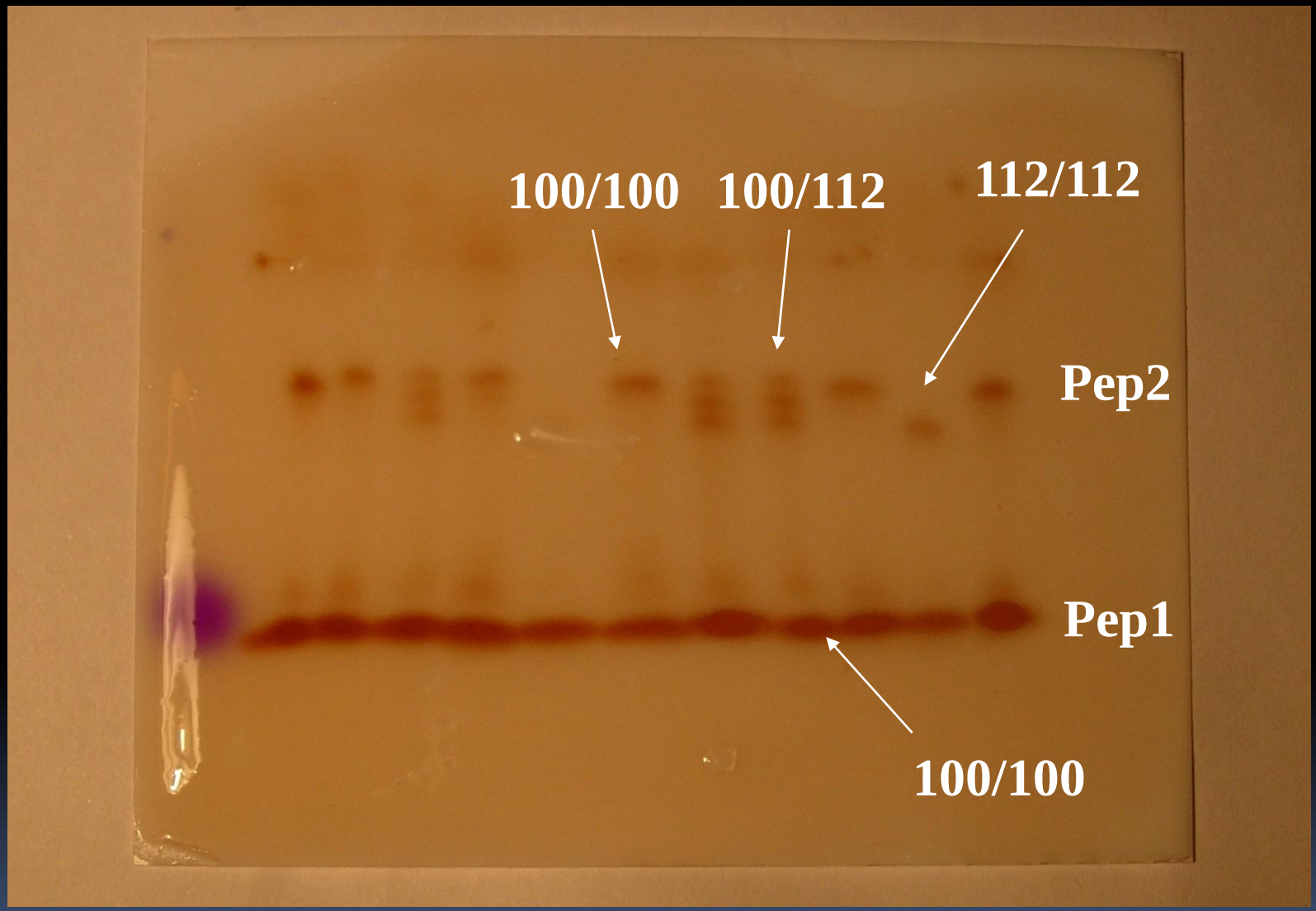


In total:

549 strains

10 regions

Allozyme structure of peptidase (Pep 1 and Pep 2 loci)



Allozyme structure of peptidase, mtDNA haplotypes, and mating types were tested

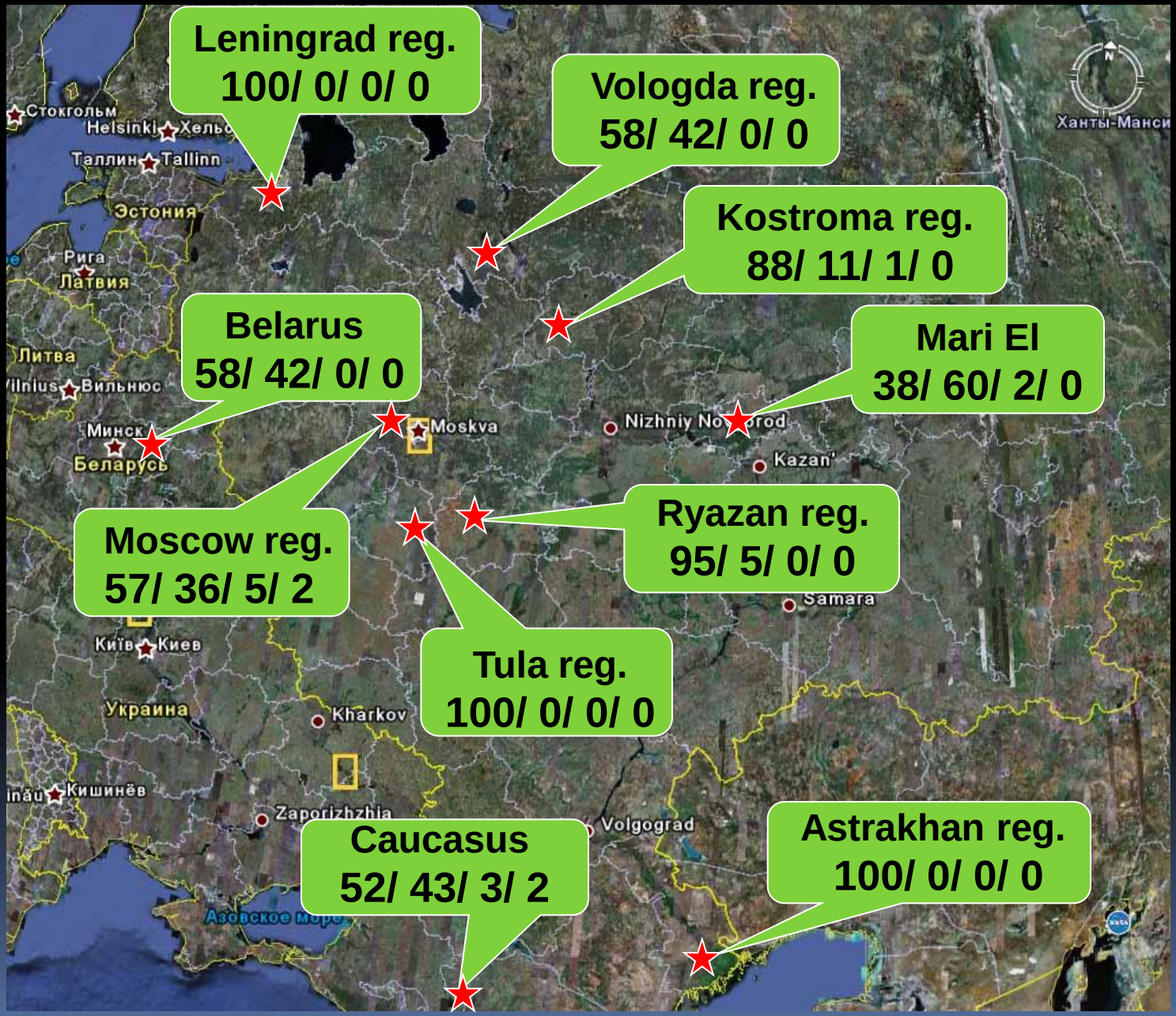
The most frequent genotypes in Russian field populations

Mating type	Markers		MtDNA haplotype	Number of populations*
	Pep 1	Pep 2		
A2	100/100	100/100	IIa	10
A1	100/100	100/100	Ia	10
A1	100/100	100/100	IIa	8
A2	100/100	100/112	Ia	7
A1	100/100	100/112	IIa	6
A2	100/100	100/112	IIa	5
A2	100/100	100/100	Ia	5
A1	100/100	100/112	Ia	4
A1	100/100	112/112	Ia	4
A2	100/100	112/112	IIa	4
A2	92/100	100/100	Ia	3
A2	92/100	100/100	IIa	3
A1	100/100	112/112	IIa	2
A2	92/92	112/112	Ia	1
A1	100/100	112/112	Ia+IIa	1
A1	92/100	100/100	Ia	1
Other 11 genotypes				1

* 18 field populations were tested

Number of genotypes in regional populations

Ratio of mating types in regional populations (A1/ A2/ A1A2/ 00)



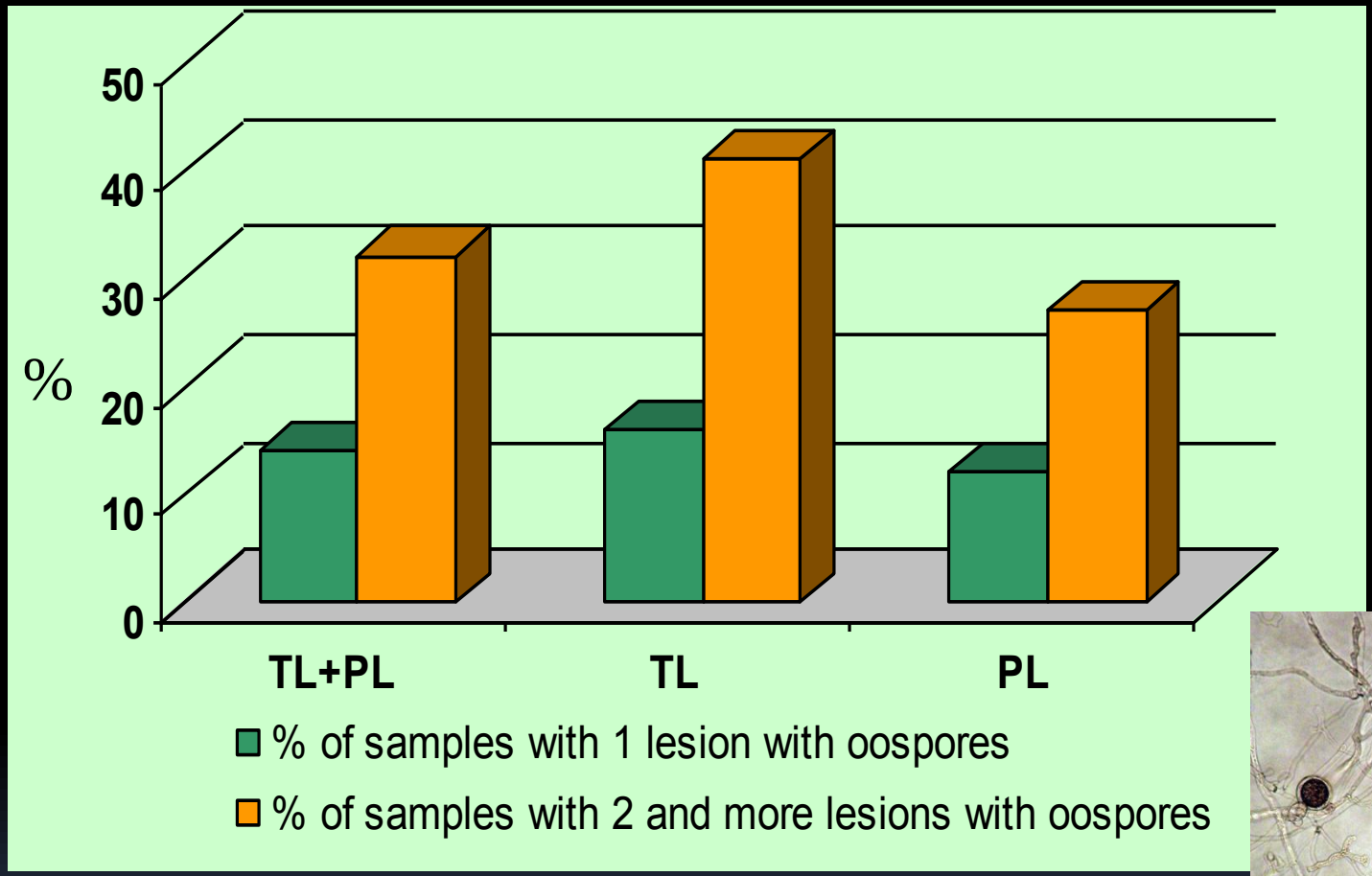
Number of *P. infestans* populations from the Moscow region with various A1:A2 ratios

Per cent of *P. infestans* strains with A2 mating types in population, %	Number (%) of populations with a certain A2 percentage
0 or 100	5 (12%)
1-29 or 70-99	19 (46%)
30-69	17 (41,6%)
Total number of tested populations in the Moscow region	41 (100%)

Average number of genotypes in *P. infestans* populations with various A1:A2 ratios

Per cent of *P. infestans* strains with A2 mating type in population, %	Number of populations with a certain percentage of strains with A2 mating type	Average number of genotypes per a population
0 or 100	3	1
1-29 or 70-99	6	2,5
30-69	8	**6,9**

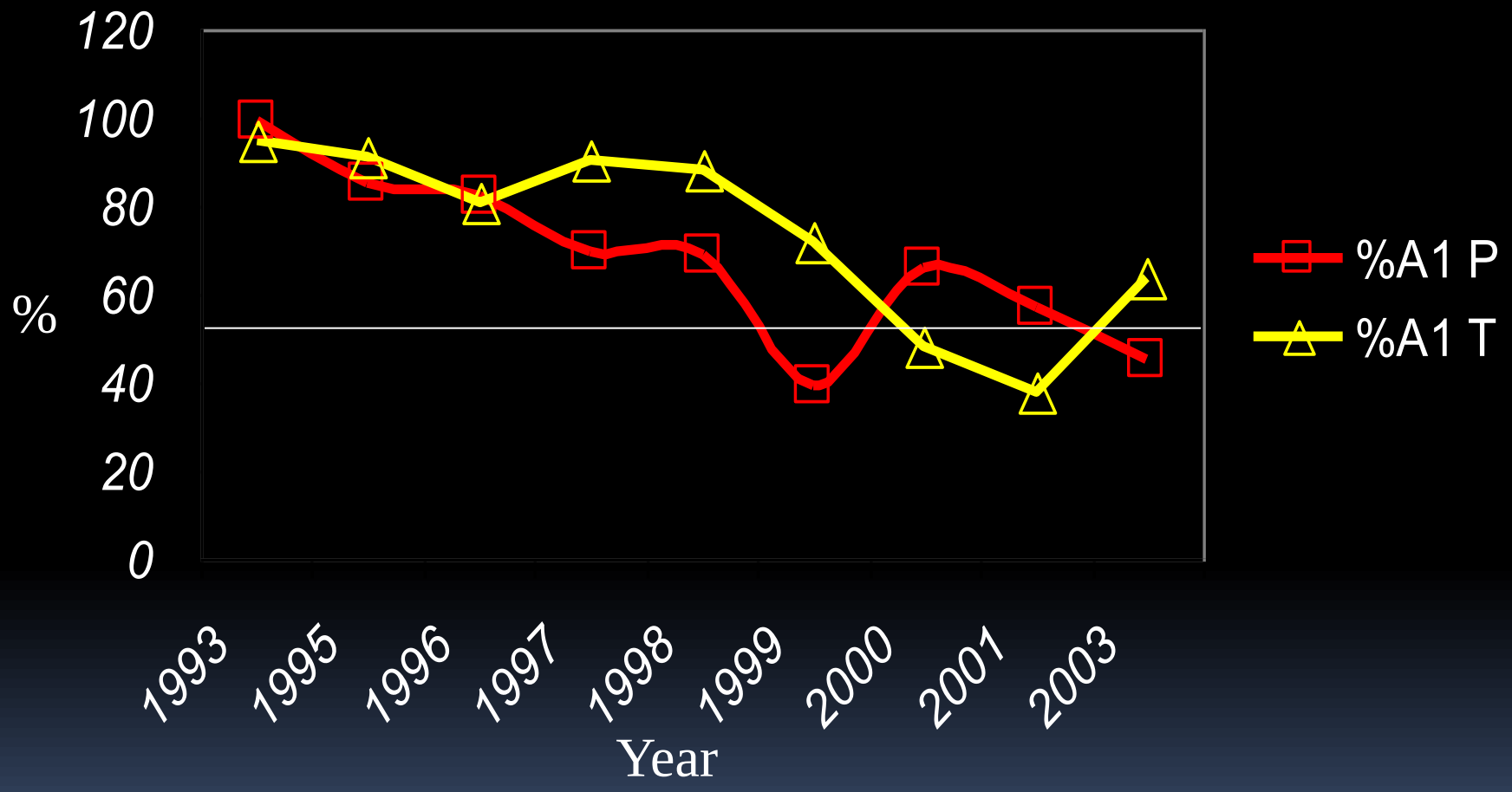
Oospores in samples with different number of lesions



Ratio A1:A2 in “tomato” population was as 57:43,
in “potato” – 45:55

Annual dynamics of strains with A1 mating type in the Moscow region

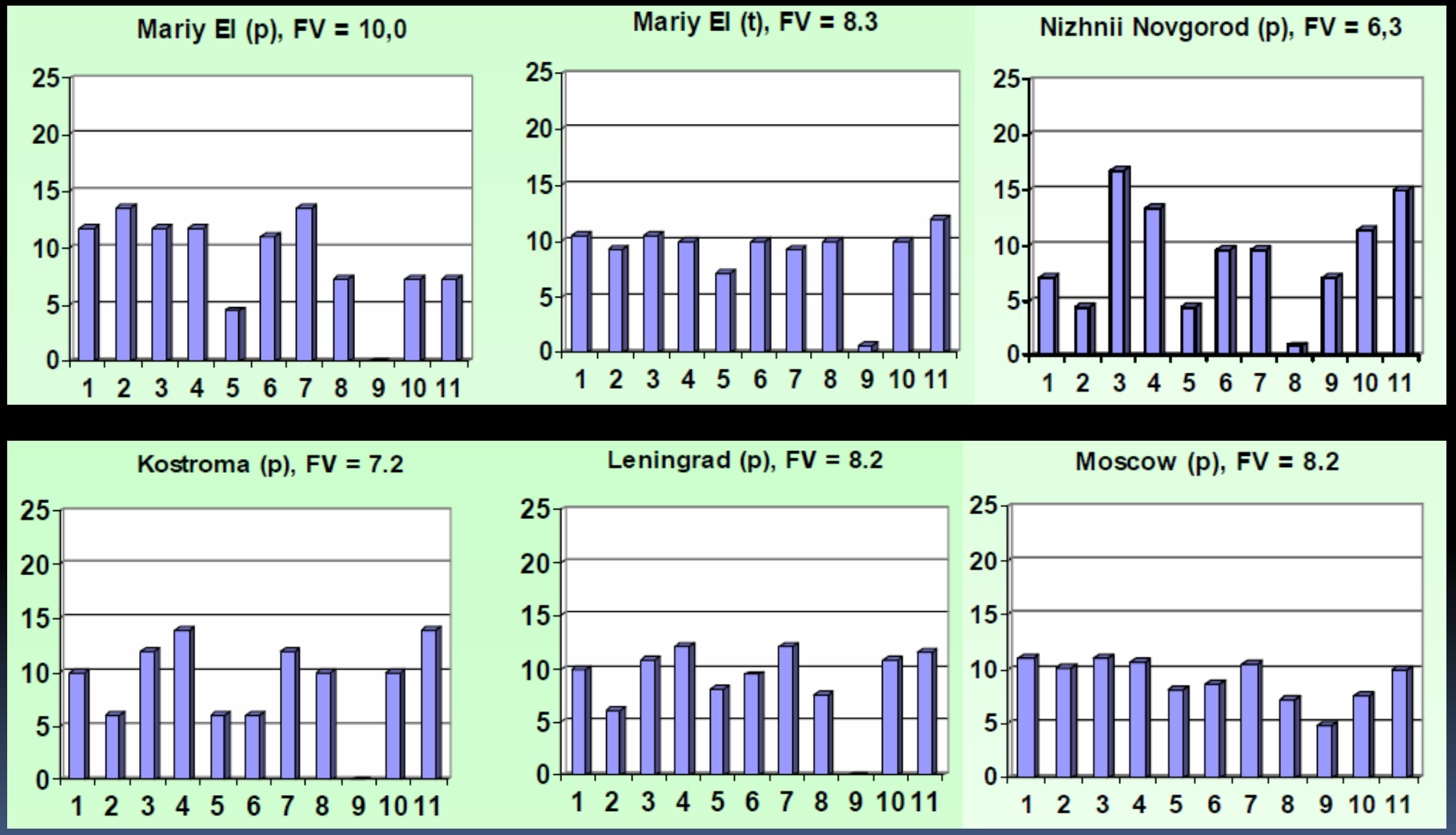
1850 isolates were tested in 1993 - 2003



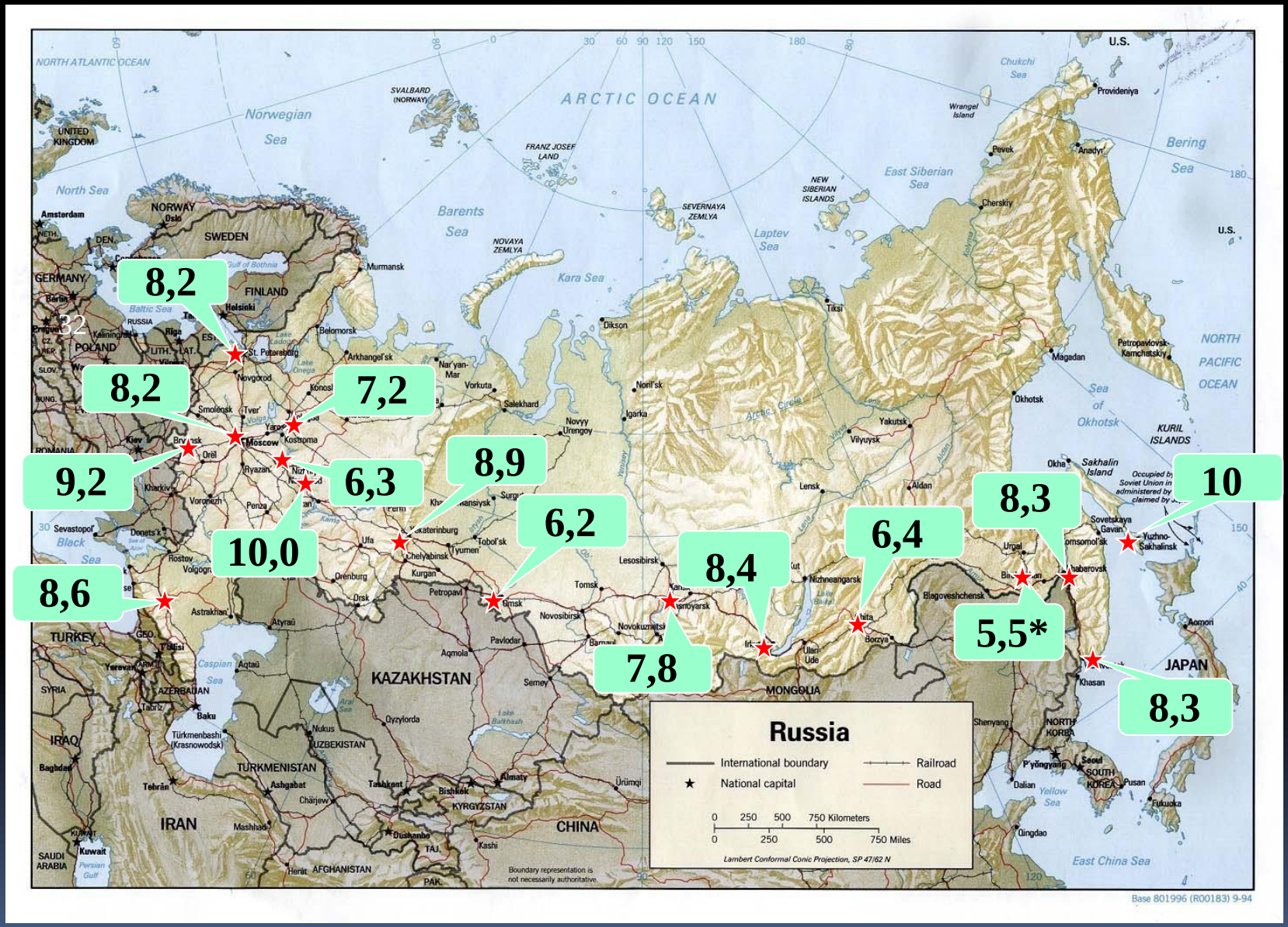
Slow decrease of A1 strains in 1993 – 1999 and oscillating around 50% (A1:A2=1:1) in 1999 – 2003 in both tomato and potato populations

Specific compatibility (virulence) to potato R-genes

Frequencies of separate virulence genes in the studied *P. infestans* populations



Average number of virulence/ isolate

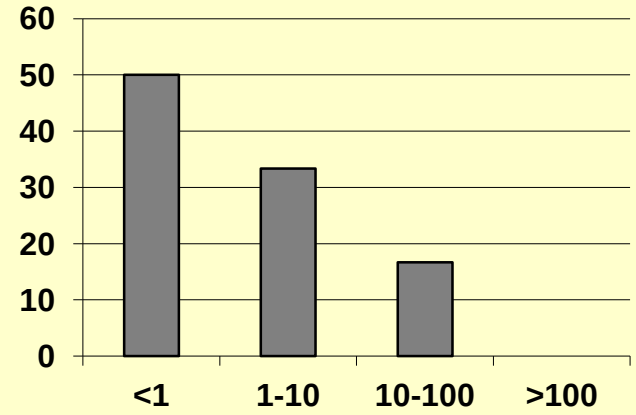


*11 R-gene were tested: 1,2,3,4,5,6,7,8,9,10,11; * - isolates from tomato*

Resistance of *P. infestans* strains from different regions to fungicides


Kostroma region
Финляндия
Стокгольм
Helsinki
Хельсинки
Таллин
Tallinn
Эстония
Рига
Латвия
Литва
Vilnius
Вильнюс
Минск
Беларусь
Moskva
Nizhniy Novgorod
Kazan'
Samara
Київ
Киев
Украина
Kharkov
Кишинёв
Zaporizhzhia
Volgograd
Азовское море
Ханты-Манси

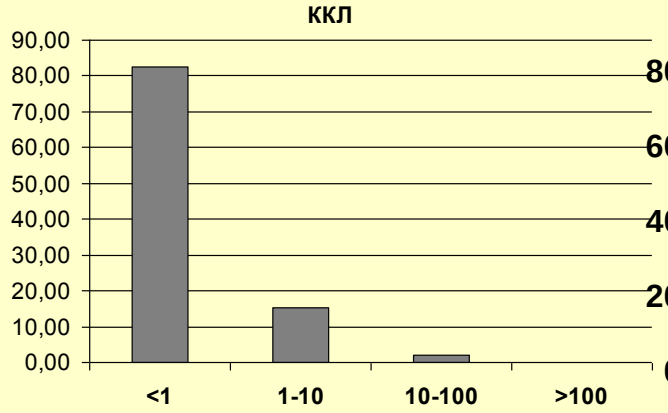
Kostroma region



Chlorothalonil

Average 2,2

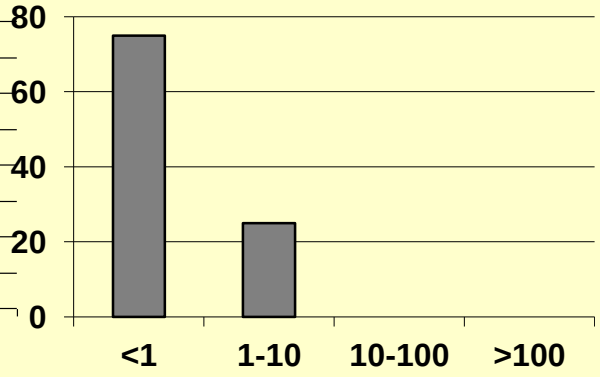
Variab. 0,7 – 5,0



Metalaxyl

1,7

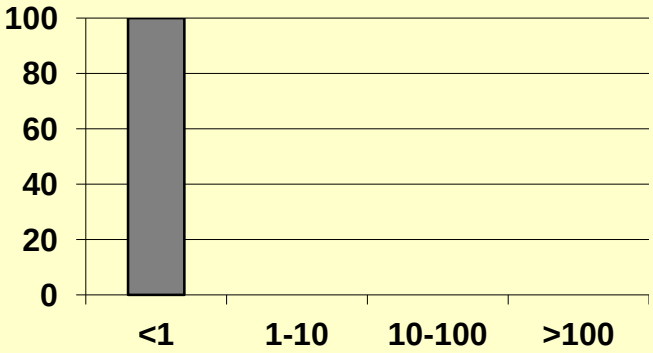
0,5 – 38,0



Fluazinam

1,4

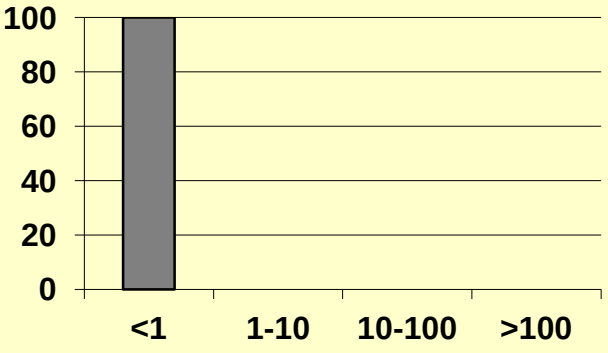
0,5 – 4,8



Azoxystrobin

Average < 0,05

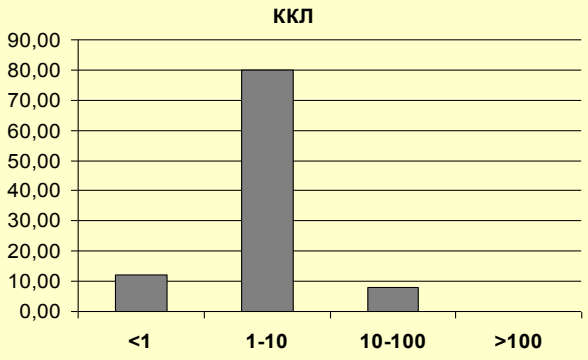
Variab. < 0,05



Dimethomorph

< 0,05

< 0,05



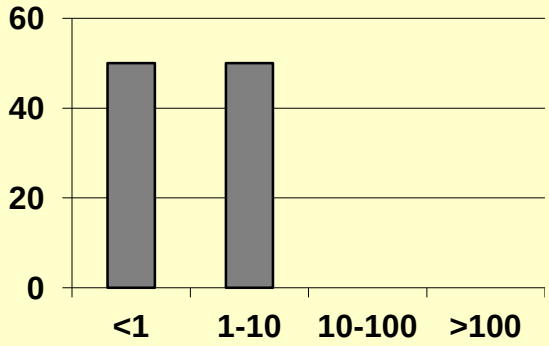
Mancozeb

6,5

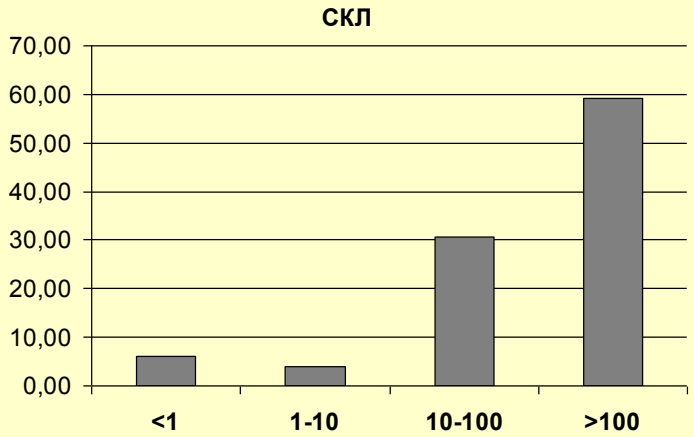
0,5 – 25,6


Smolensk region
Финляндия
Стокгольм
Helsinki
Хельсинки
Таллин
Tallinn
Эстония
Рига
Латвия
Литва
Vilnius
Вильнюс
Минск
Беларусь
Moskva
Nizhniy Novgorod
Kazan'
Samara
Київ
Киев
Украина
Kharkov
Кишинёв
Zaporizhzhia
Volgograd
Азовское море
Ханты-Манси

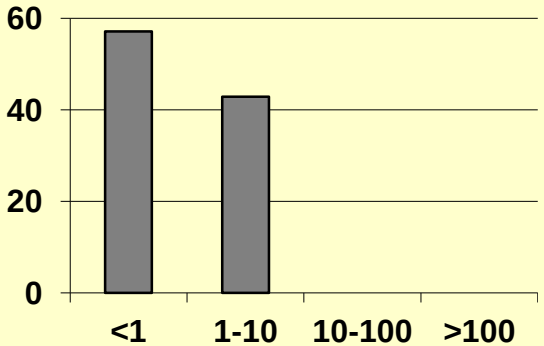
Smolensk region



Chlorothalonil



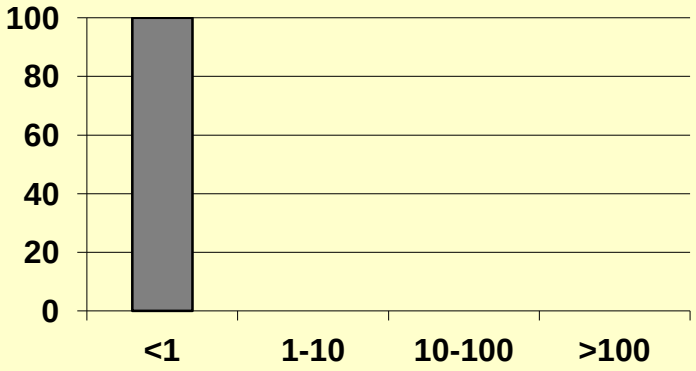
Metalaxyl



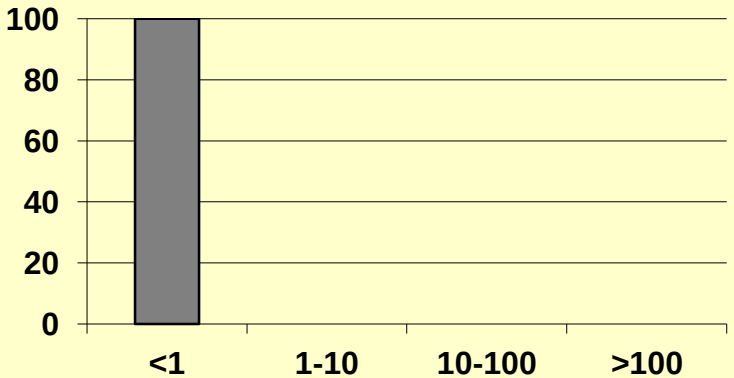
Fluazinam

Average 2,2 175,2 2,7

Variab. 0,7 – 5,0 0,5 – 380 0,5 – 6,8



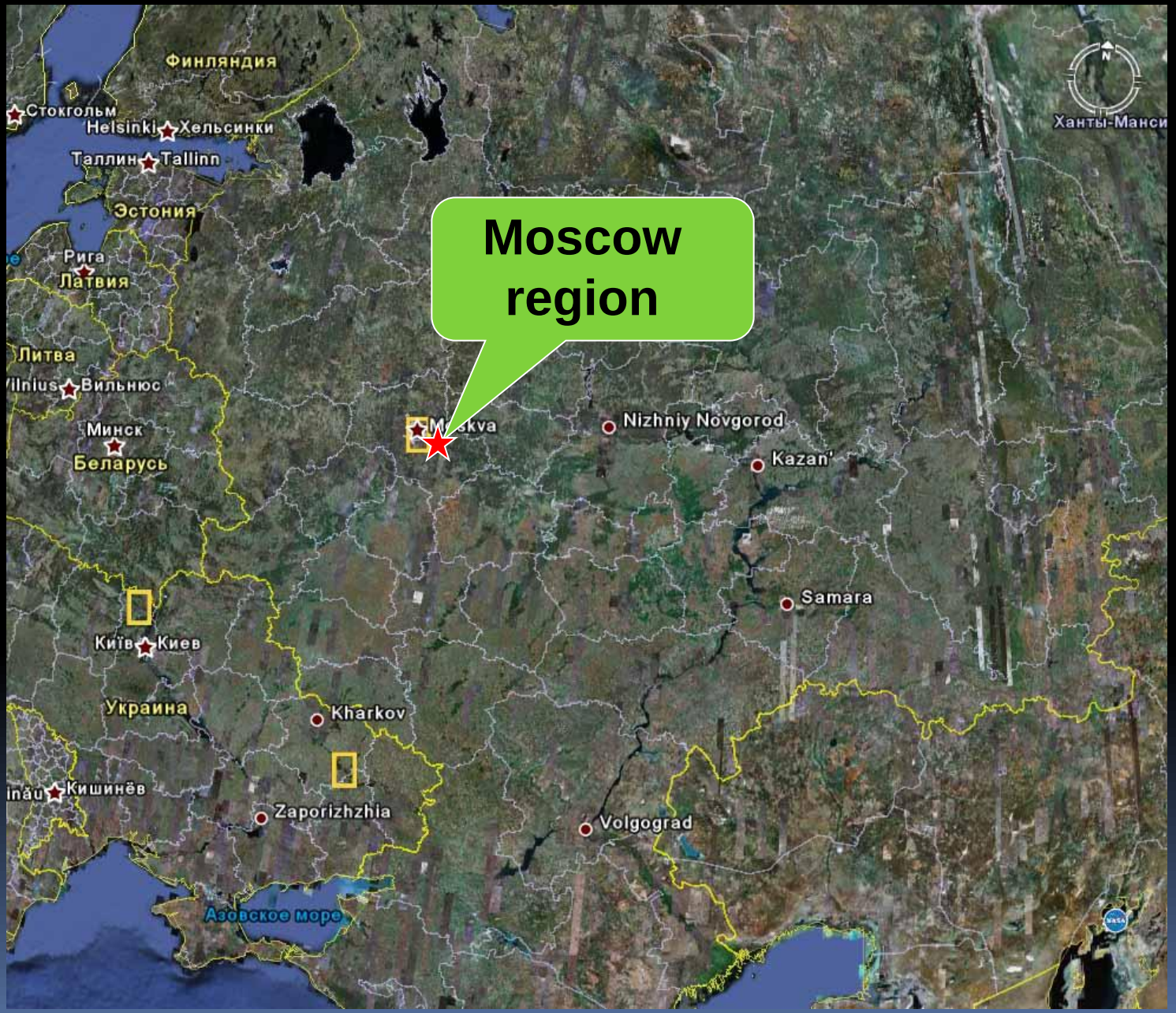
Azoxystrobin



Dimethomorph

Average < 0,05 < 0,05

Variab. < 0,05 < 0,05


Moscow region
Финляндия
Стокгольм
Helsinki
Хельсинки
Таллин
Tallinn
Эстония
Рига
Латвия
Литва
Vilnius
Вильнюс
Минск
Беларусь
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Samara
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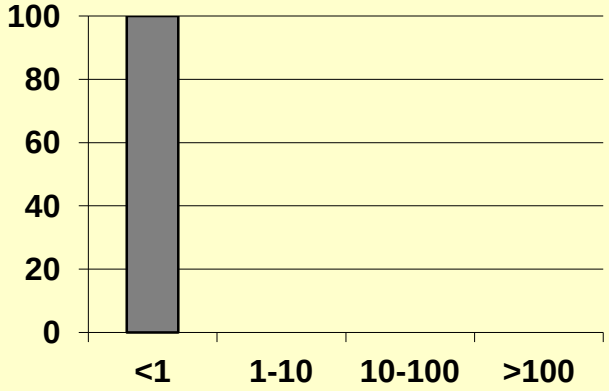
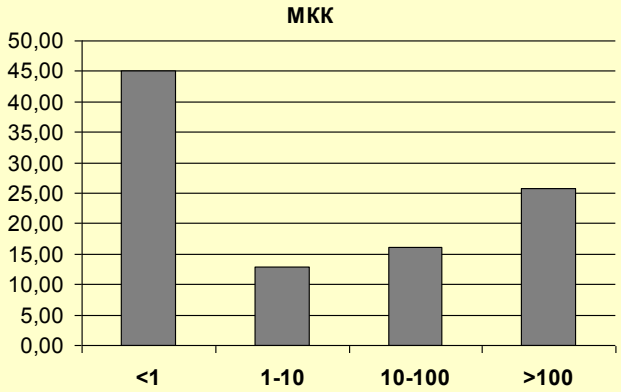
Кишинёв
Zaporizhzhia
Volgograd
Азовское море
Ханты-Манси

Moscow region



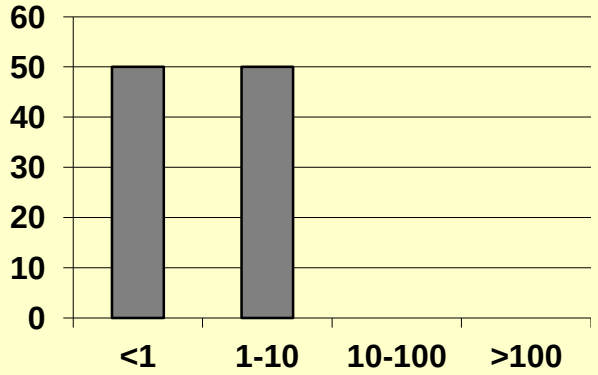
Chlorothalonil

Average 0,6
Variab. 0,5 – 0,8



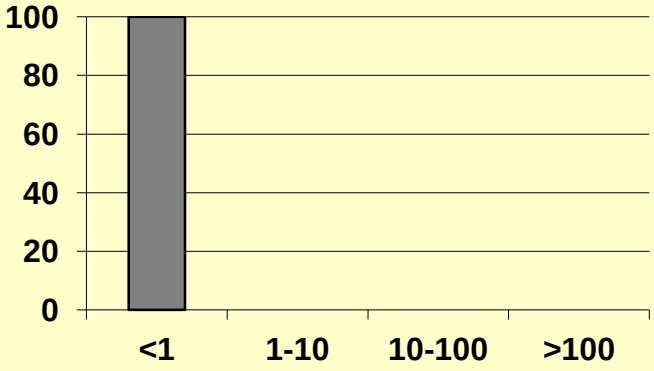
Metalaxyl

99,0
0,5 – 398



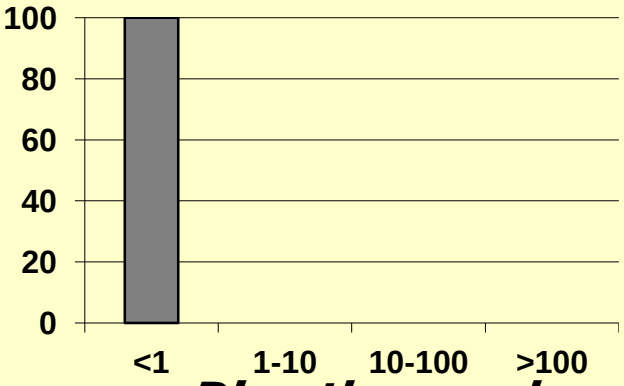
Fluazinam

2,1
0,5 – 5,2



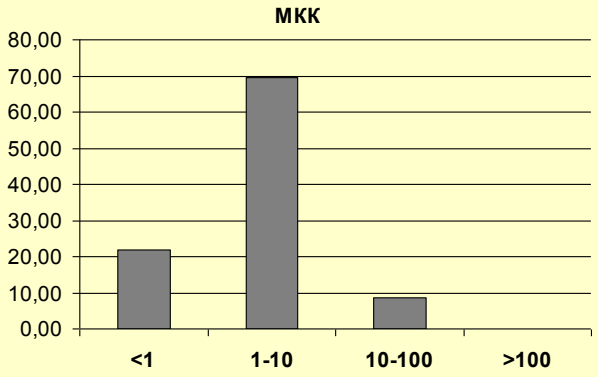
Azoxystrobin

Average < 0,05
Variab. < 0,05



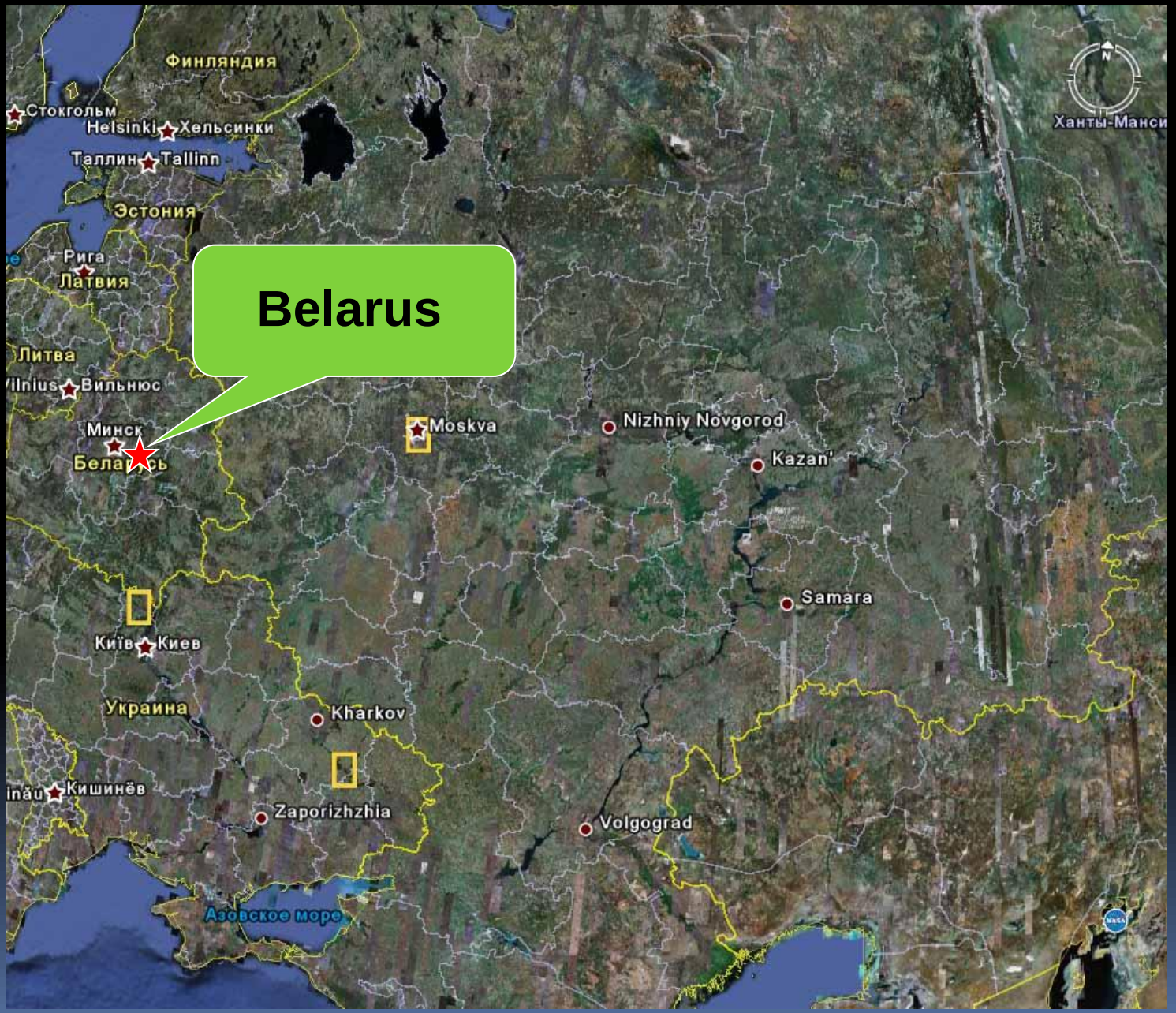
Dimethomorph

0,06
0,05 – 0,09



Mancozeb

5,5
0,6 – 22,4


Финляндия
Стокгольм
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Tallinn
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Рига
Латвия
Литва
Vilnius
Вильнюс
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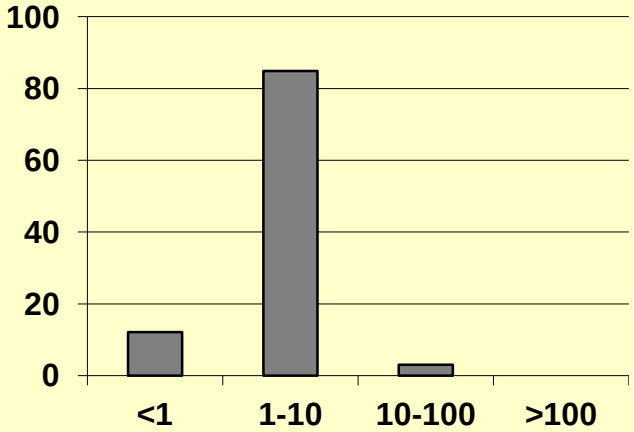
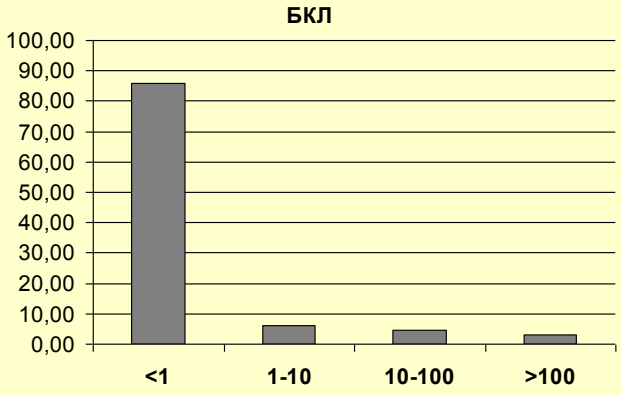
Азовское море
Ханты-Манси
Belarus

Belarus



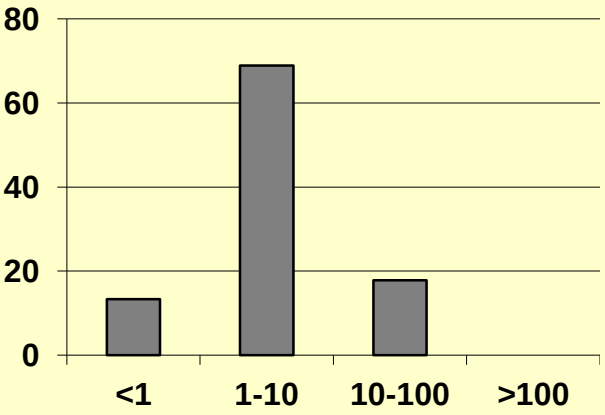
Chlorothalonil

Average 5,7
Variab. 0,7 – 151,5



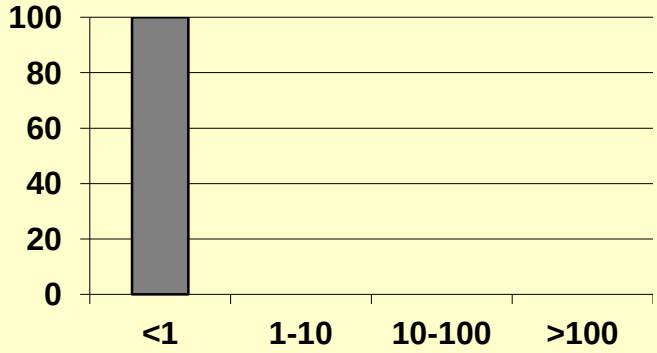
Metalaxyl

Average 175,2
Variab. 0,5 – 380



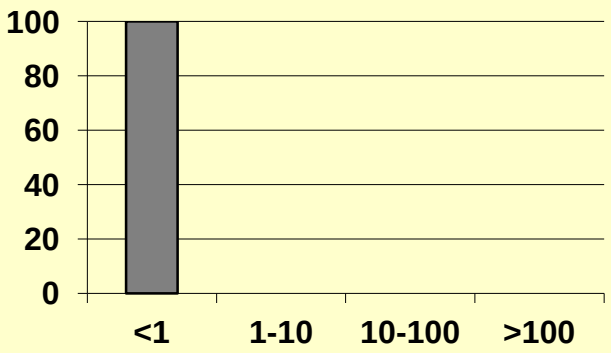
Fluazinam

Average 7,0
Variab. 0,5 – 21,8



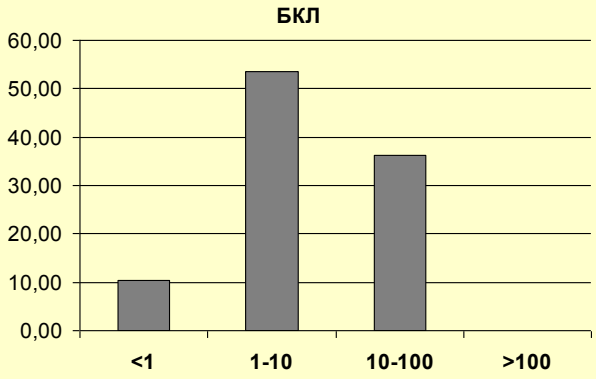
Azoxystrobin

Average < 0,05
Variab. < 0,05



Dimethomorph

Average < 0,05
Variab. < 0,05



Mancozeb

Average 10,3
Variab. 0,6 – 30,6

Selected publications:

Elansky S., A. Smirnov, Y. Dyakov, A. Dolgova, A. Filippov, B. Kozlovsky, I. Kozlovskaya, P. Russo, C. Smart, W. Fry Genotypic analysis of Russian isolates of *Phytophthora infestans* from the Moscow region, Siberia and Far East // J. Phytopathology, 2001, 149 (10), p. 605-611.

S.N. Elansky, M.A. Pobedinskaya, M.P. Plyakhnevich, N.V. Statsyuk, and Yu.T. Dyakov ***Phytophthora infestans populations from the European part of Russia and Belarus: genotypic structure and metalaxyl resistance*** //
J. Phytopathology, 2011, in press.

N.V. Statsyuk, M.A. Kuznetsova, I.N. Kozlovskaya, B.E. Kozlovsky, S.N. Elansky, E.V. Morozova, E.V. Valeva, and A.V. Filippov *Characteristics of the Phytophthora infestans population in Russia* // Proceedings of the 12 EuroBlight Workshop, 3-6 May, 2010, Arras, France. P. 247-254.

S.N. Elansky, Yu.T. Dyakov, D.I. Milyutina, V.P. Apryshko, M.A. Pobedinskaya, A.V. Filippov, B.E. Kozlovsky, M.A. Kuznetsova, A.N. Rogozhin, N.V. Statsyuk *Late blight of potato in Russia* // Potato production and innovative technologies. Ed. A.J. Havenkort, B.V. Anisimov, Wageningen Academic Publishers, The Netherlands, 2007, P. 262-274.

Other participants of the project:

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All-Russian Research Institute of Phytopathology, Moscow region, Russia

Yu.T. Dyakov, M.A. Pobedinskaya, M.Y. Kokaeva, D.I. Milyutina, A.N. Smirnov, A.V. Dolgova
Department of Algology and Mycology, Biological Faculty, Moscow State University, Moscow, Russia

W. Fry, C. Smart
Department of Plant Pathology, Cornell University, Ithaca, NY, USA


Thank you
for your
attention!