



# Bioengineering for future plants

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# Crop losses\* in Russian Federation, 2008



Crops	Gross yield, thousand tons	weeds		pests		viruses		Total
		losses, thous. tons	%	losses, thous. tons	%	losses, thous. tons	%	%
Wheat	63800	11484	18	8294	13	4466	7	31
Sunflower	7400	1406	19	1406	19	-	-	38
Sugar beet	29000	7830	27	3190	11	2900	10	48
Potatoes	28800	4608	16	3456	12	4320	15	43
Corn (for grain)	6700	1340	20	1005	15	-	-	35
Canola	752	128	17	150.4	20	-	-	37

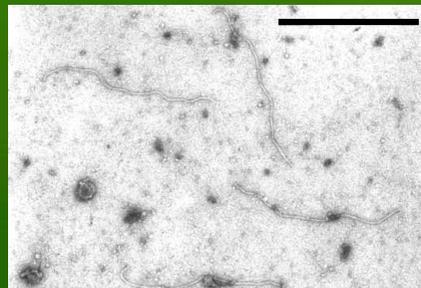
\*Statistical Brief«Agriculture of Russian Federation», Moscow, Russian Ministry of Agriculture, 2009 (<http://www.mcx.ru/navigation/docfeeder/show/164.htm>)



# **Development of Russian sugar beet varieties, resistant to viral infection**

- ✓ viral resistance
- ✓ herbicide resistance

# Beet yellows virus (BYV)



**Total crop weight loss caused by BYV is up to 40%, with sugar reduction of 8-10%**

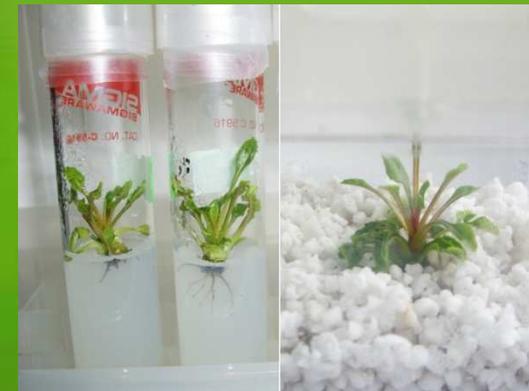
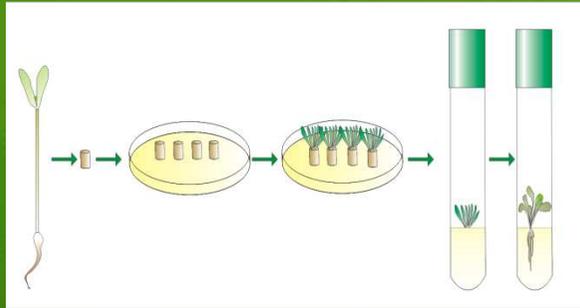
# Beet necrotic yellow vein virus (BNYVV)



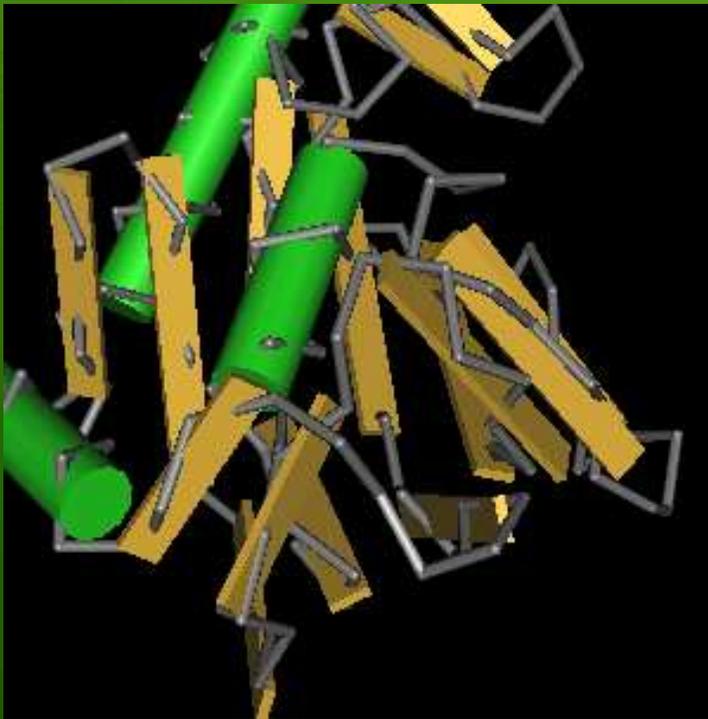
**BNYVV infections may cause reduction of crop weight and sugar content of up to 50-70%**

**Rhizomania distributed over most sugar beet growing areas in the world: Asia, China, Japan, the USA, Europe countries and Russia**

# Transgenic sugar beet obtaining

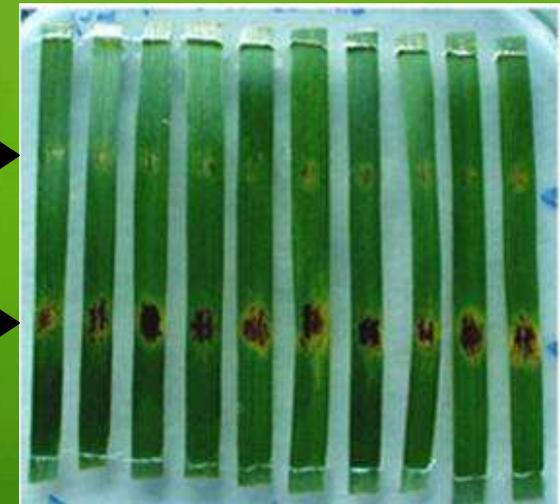


# Elicitor activity of MF3-protein tested on wheat leaves of variety Mironovskaya 808 against fungus *Septoria nodorum*



MF3-protein  
1.25 mg/ml

Reference  
(water)

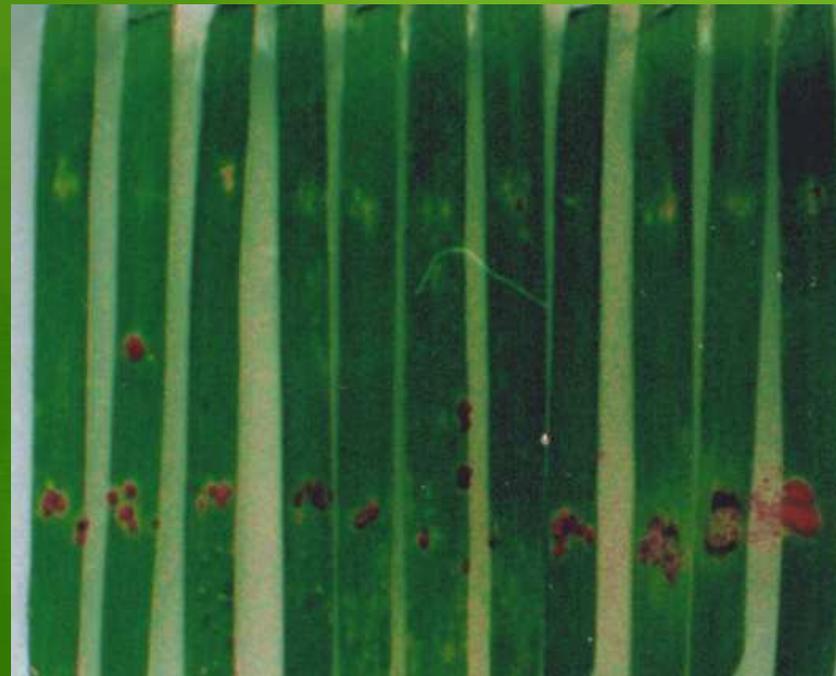


**Elicitor activity of MF3-protein tested on  
wheat leaves of variety Mironovskaya 808  
against fungus *Puccinia graminis***

**MF3-protein  
1.25 mg/ml**



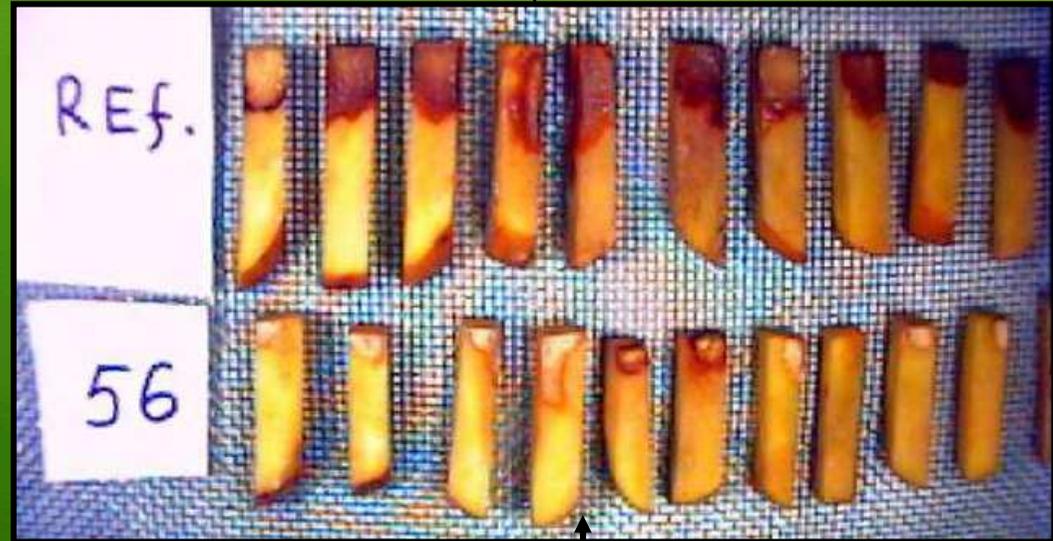
**Reference (water)**



# Resistance of transgenic potato plants' tubers to *Erwinia carotovora*

Potato tuber pieces of non-transgenic variety Nevsky

Potato tuber pieces of transgenic variety Nevsky line 56



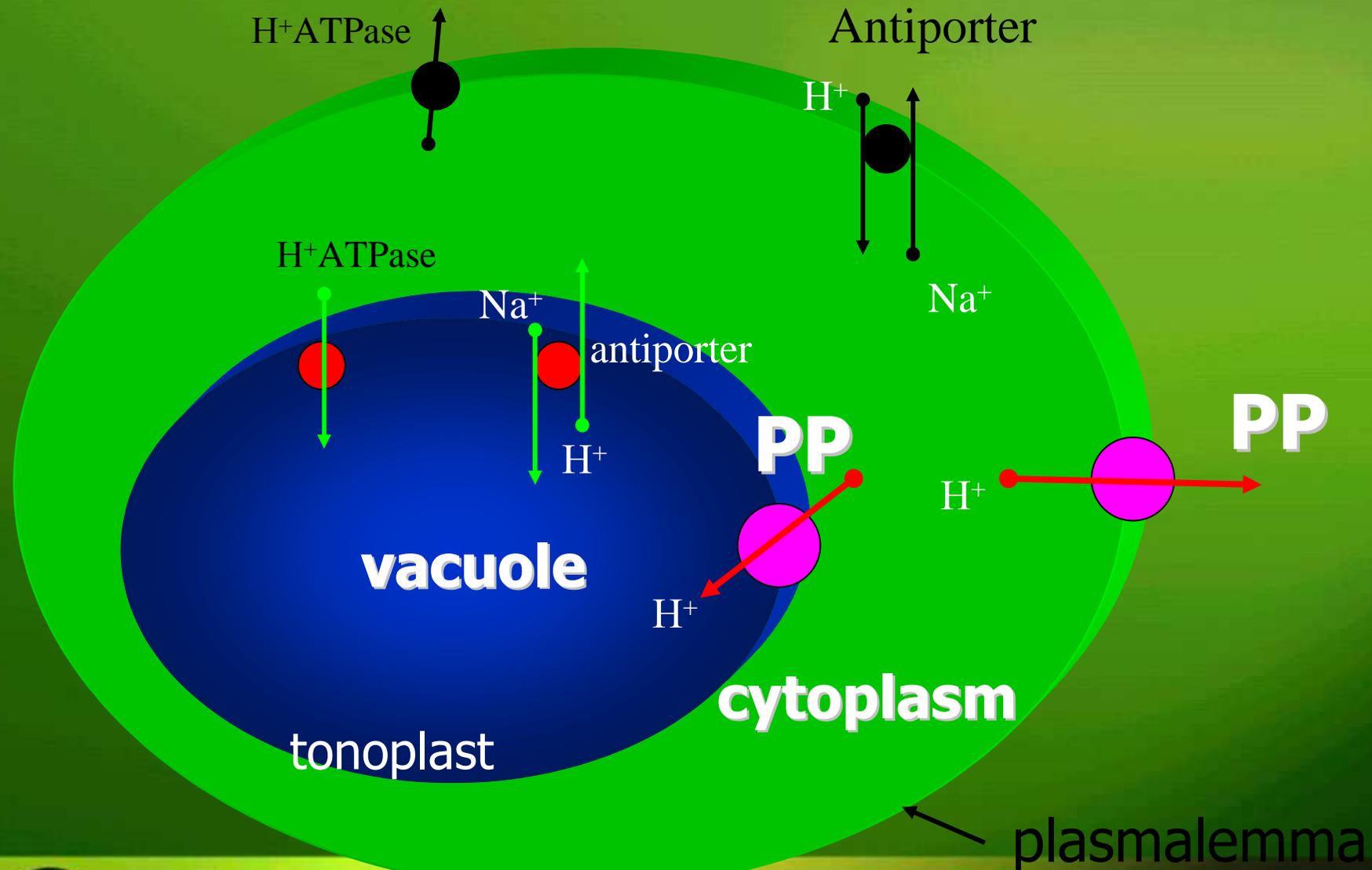
Potato tuber pieces, place in a Petri dish on moist sterile filter paper, and inoculate with 0.1 - 1 of the bacterial suspension (ca.  $10^6$  CFU/ml). Incubate at 20-27°C for 48h and probe the tissue surrounding the inoculation site with a spatula to determine whether decay and tissue maceration has occurred.

# Development of salt-tolerant plants

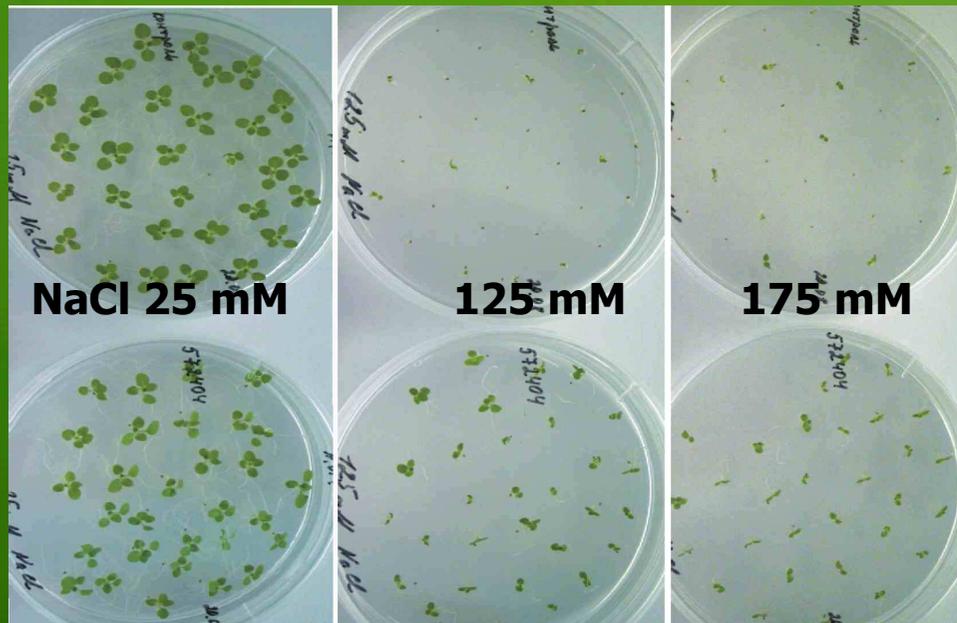


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# Possible H<sup>+</sup> -pyrophosphatase localization in plant cell



# Salt tolerance of transgenic tobacco expressing H<sup>+</sup> pyrophosphatase gene from *Rhodospirillum rubrum*



Control plants

Seed germination efficiency at different NaCl concentrations

Transgenic plants

Growth of control and transgenic plants at different NaCl concentrations



Control Plants,  
150 mM NaCl

Transgenic Plants,  
mM NaCl

150

# Development of Russian potato varieties, resistant to Colorado beetle



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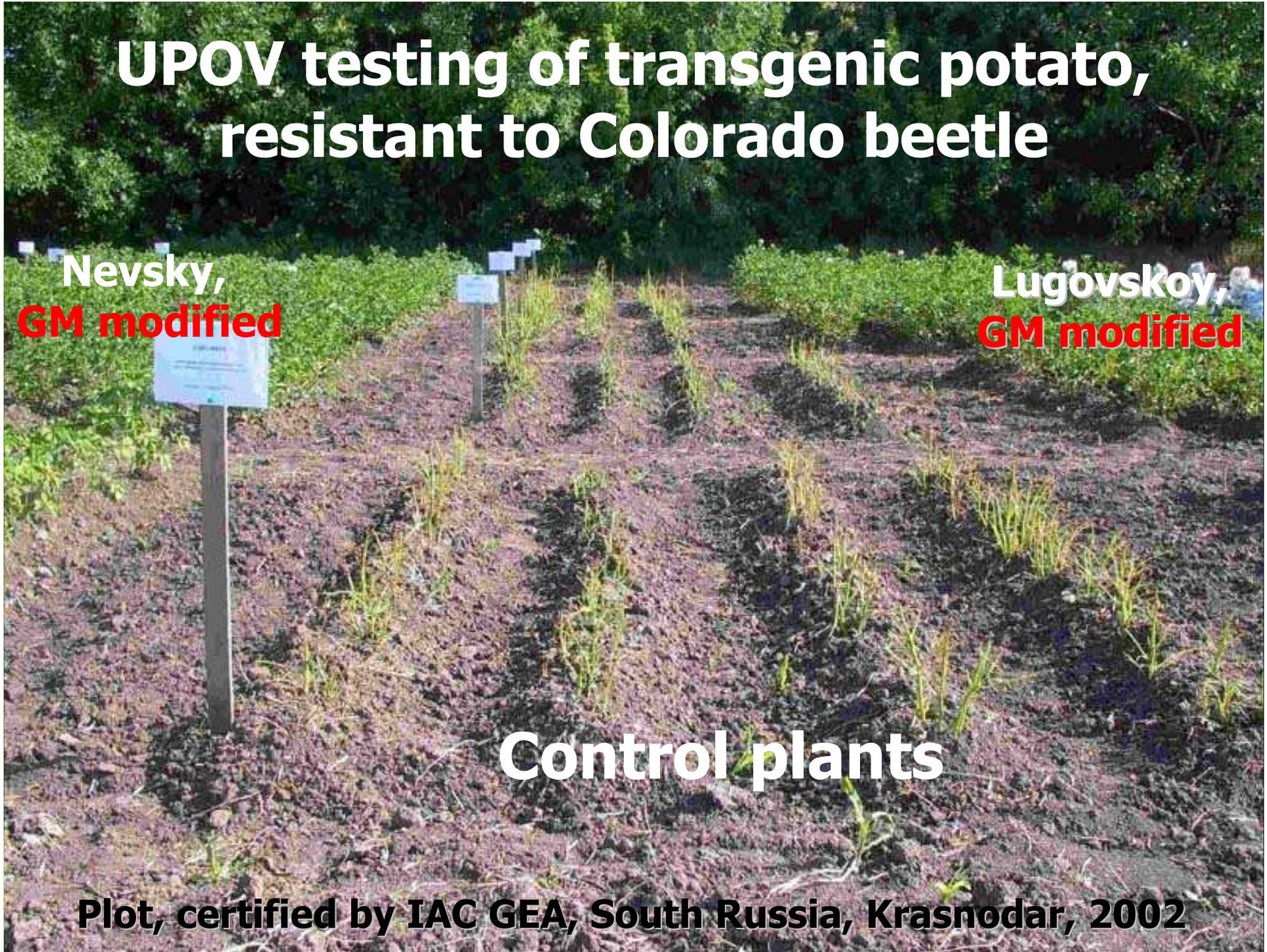
# UPOV testing of transgenic potato, resistant to Colorado beetle

**Nevsky,  
GM modified**

**Lugovskoy,  
GM modified**

**Control plants**

**Plot, certified by IAC GEA, South Russia, Krasnodar, 2002**





**UPOV**

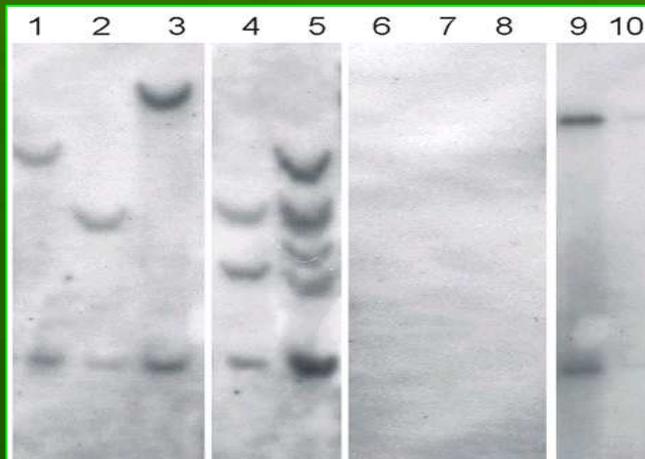
**ESTIMATION OF CHARACTERISTICS OF  
GM POTATO LINES**

**Plot, certified by IAC GEA, Moscow region - 2002**

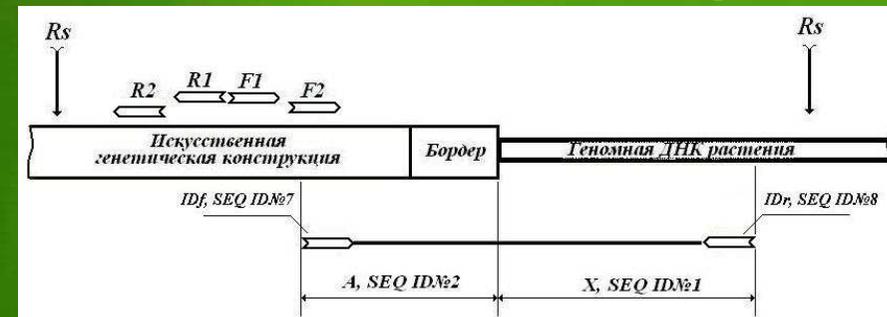
# Transgenic potato obtaining



## Southern-blot analysis



## Border identifiers for Bt-potato



X+A sequences for Lugovskoy+ Elizaveta+ and Nevskiy+ were used in patent as unique border identifiers

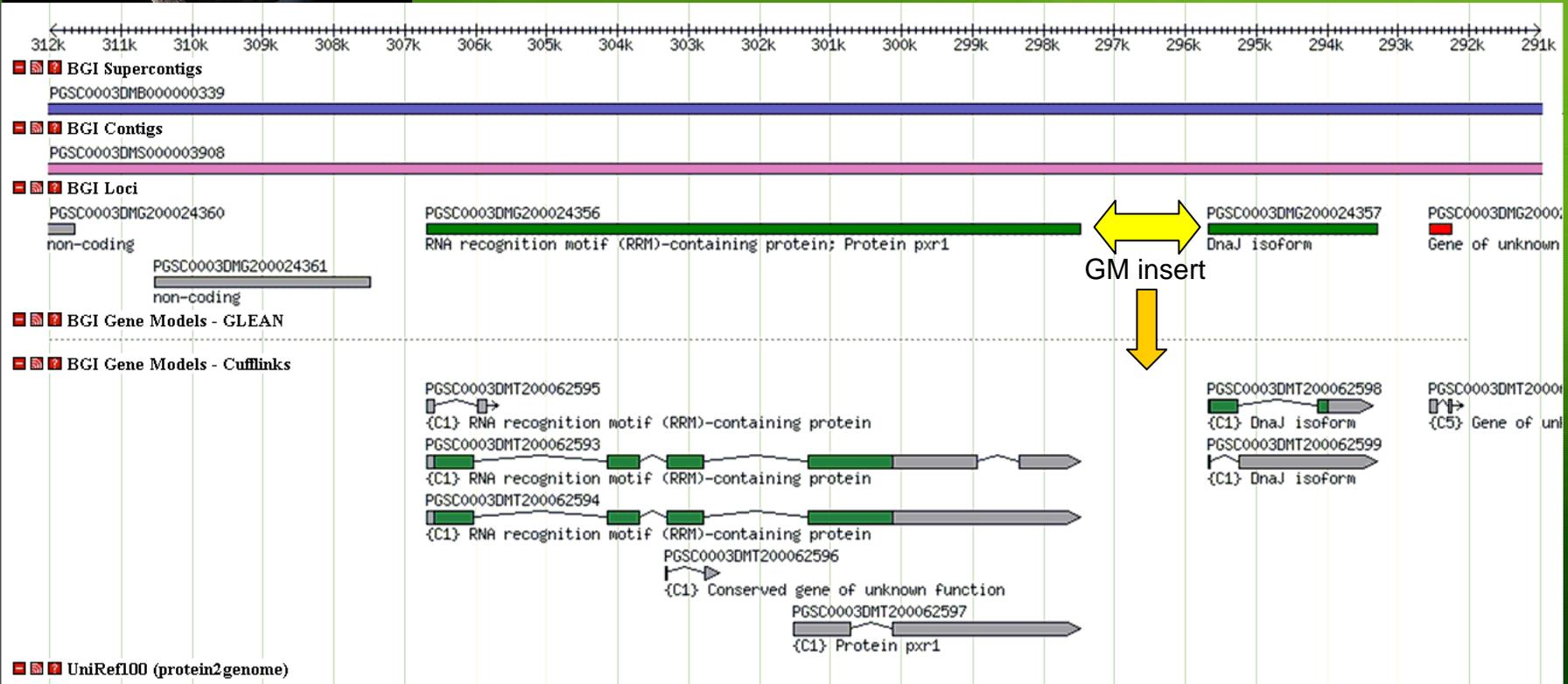
# GM potato IPR protection



# GM potato genomics



THE POTATO GENOME SEQUENCING Consortium



# Food certificates

# 77.99.26.11.Y.6088.7.06 (07 July 2006)	Lugovskoy 1210 amk event
# 77.99.11.11.Y.14145.12.05 (14 December 2005)	Elizaveta 2904/1 kgs event

## Patents

# AND DATE OF PRIORITY	THE REGISTRATION DATE	ISSUE
# 2231550 24 April 2002	27 June 2004	obtain GM plants of Lugovskoy variety
# 2231549 24 April 2002	27 June 2004	obtain GM plants of Nevskiy variety
# 2231251 27 June 2004	27 June 2004	obtain GM plants of Elizaveta variety
# 2286385 23 November 2004	27 October 2006	Recombinant DNA sequence including Elizaveta variety genome plant DNA and transgenic insert
# 2286386 14 February 2005	27 October 2006	Recombinant DNA sequence including Nevskiy variety genome plant DNA and transgenic insert
# 2007110779 26 March 2007		Recombinant DNA sequence including Lugovskoy variety genome plant DNA and transgenic insert

# Evolution of the regulatory framework in Russia (genetic engineering)

<b>1996</b>	Federal law "On State regulation of genetic engineering activity"
<b>2000</b>	Amendments in respect of gene therapy and genetic diagnostics to Federal law "On State regulation of genetic engineering activity"
<b>2000</b>	Instruction by the RF Chief State Sanitary Physician : "On the order of hygienic expertise of food products, derived from GMOs"
<b>2001</b>	Government Act "On state registration of GMOs", <i>Non upgraded till now</i>
<b>2002</b>	Government Act "On state registration of GM feed", <i>upgraded 2006</i>
<b>2002</b>	"On protection of natural environment" (2002 )
<b>2003</b>	The order by the RF Chief State Sanitary Physician : "On the order of microbiology molecular-genetic expertise of GM microorganisms, used in food production"
<b>2005</b>	Federal act "On protection of consumer's rights", <i>amended in 2007, 2008</i>
<b>2010</b>	Amendments in respect of state registration of GMOs to Federal law "On State regulation of genetic engineering activity"
<b>2004 - now</b>	Ongoing technical regulation reform. Ongoing administrative reform.

# Russian Federation: Biotech food labeling

## “Labeling law” (2002, 2007)

- **First step:** September 2002- Sanitary and Epidemiol. Rules 2.3.2 1078-01 2002 – Mandatory labeling. **5%** threshold.
- **Second step:** Sept 2007 - Sanitary and Epidemiol. Rules
- Mandatory labeling for product consists of, contains or is produced from GMOs. **0,9%** threshold (ingredients considered individually)
- Mandatory labeling for product is produced from GMOs irrespective of the detectability of DNA
- Adventitious presence if transformation events are no more than **0,9%** weight

# Russian Federation: Biotech feeds

## Thresholds for unintended or technically unavoidable presence of GMO's in Feeds

**Letter of Federal Service for Veterinary and  
Phytosanitary Surveillance  
(FS-AS-2/4393 of 07 May 2008)**

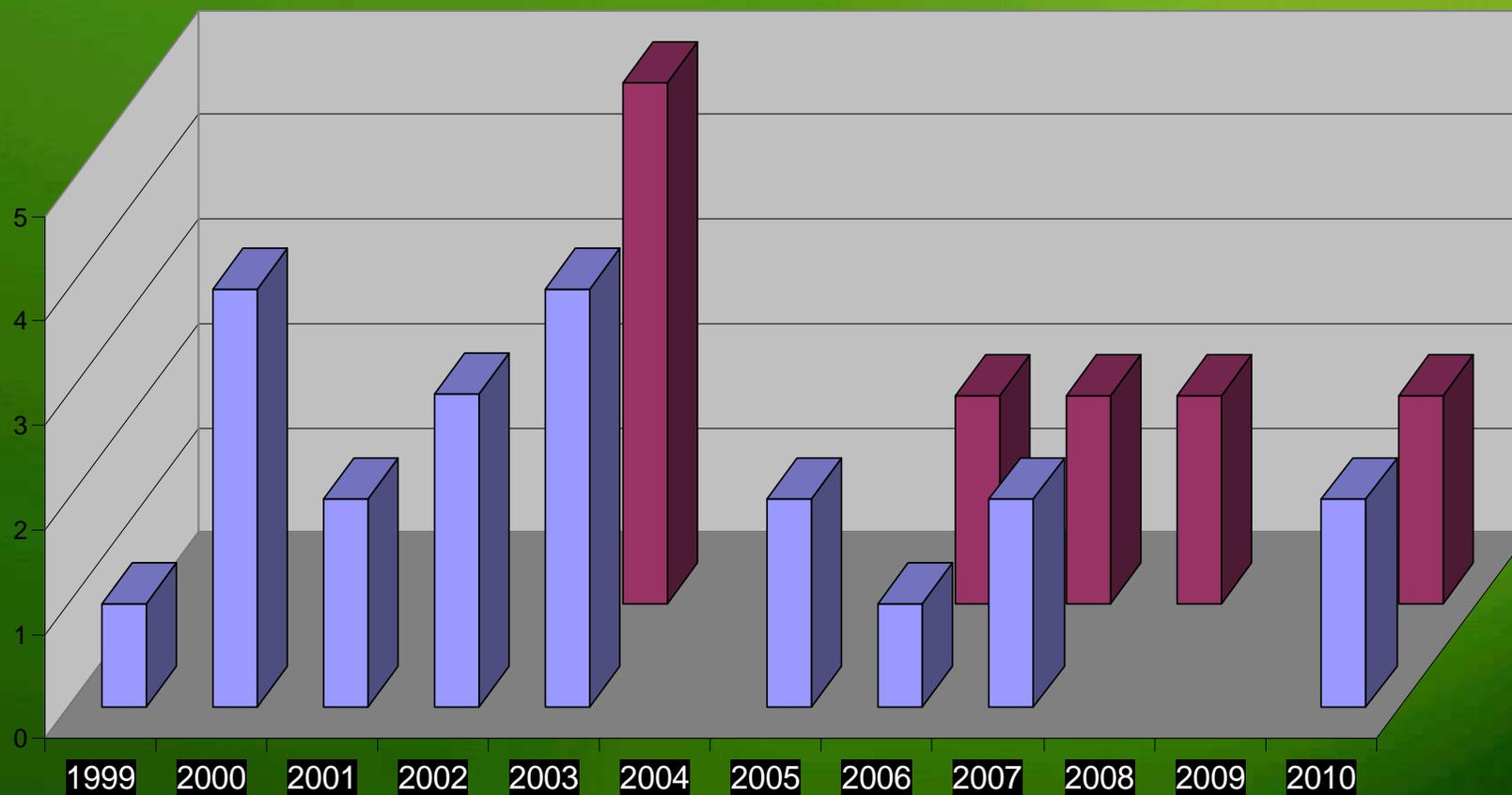
➤ **0.5% or less** of each unregistered GMO component,  
and

➤ **0.9% or less** - of each registered GMO

Feed containing unintended or technically unavoidable amount of  
GMO's **are not subject to the state registration.**

# Dynamics of GM foods and feeds registration

Number of registered transformation events/year



■ GM Foods    ■ GM feeds