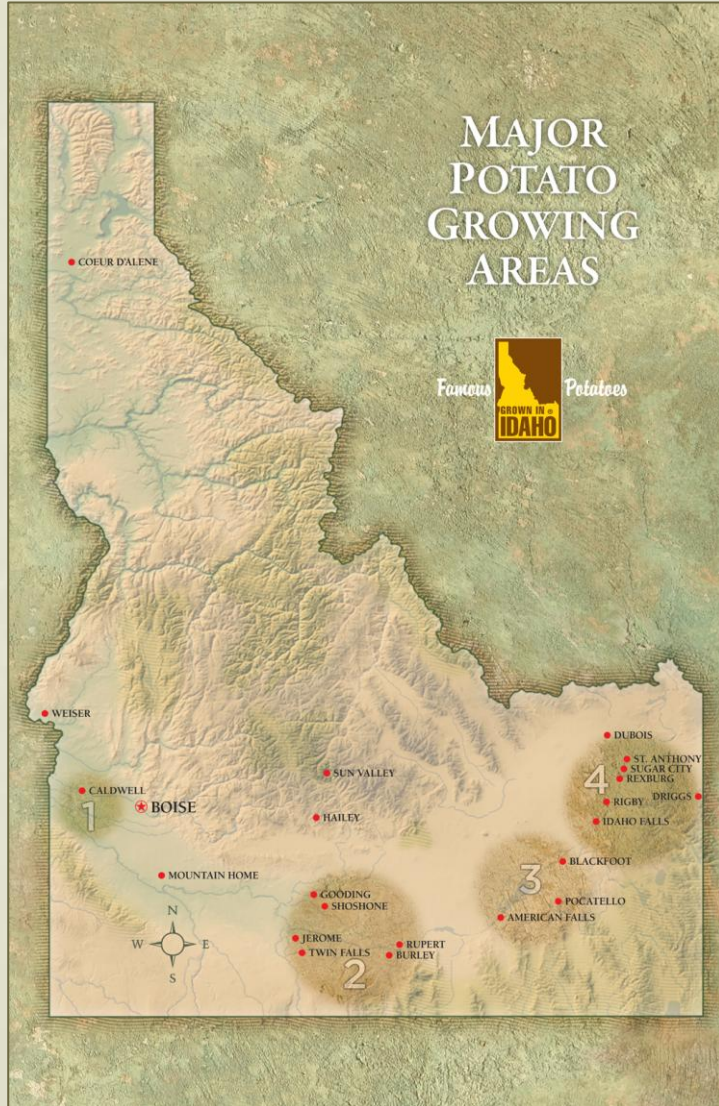


*Potato virus Y: a new
problem in potato*

Alexander V. Karasev
University of Idaho

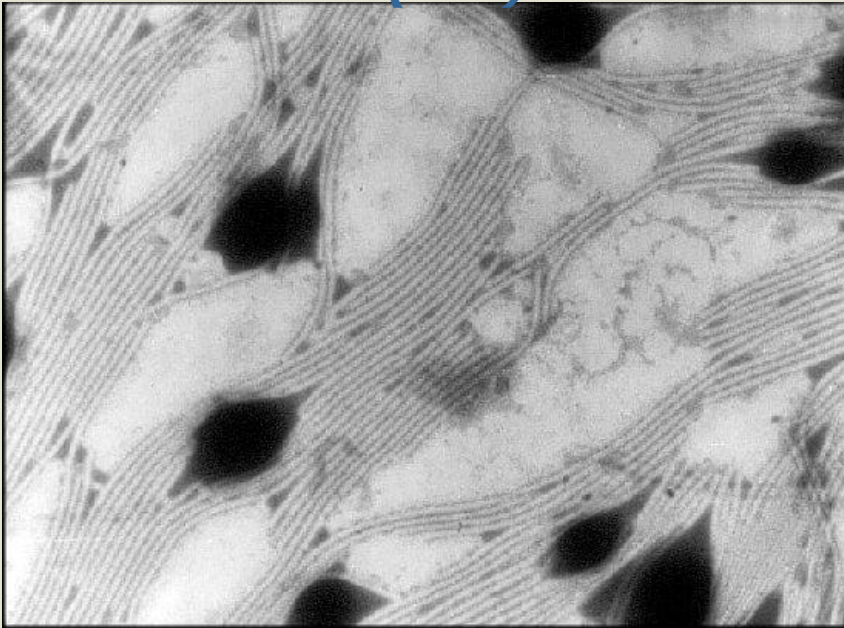
Main crops in Idaho



- Potato - #1 in the U.S.
- Barley - #1
- Wheat - #5
- Sugar beet - #2
- Common beans
- Cool season legumes
- Wine and table grapes

Potato virus Y - background

Potato virus Y (PVY)



Kerlan (2006)

- *Potyviridae (Potyvirus)*
- Particles: flexuous filaments
- Wide natural host range (*Solanaceae*)
- Transmission: mechanical, through seed, by aphids
- Aphid transmission: non-persistent (very quick)
- Exists as a complex of strains

PVY affects potato yield



Ririe, ID

- 1% of infection = 0.17 t/ha loss
- 1% of infection = \$17 per 1 ha
- 2008: 1% = \$6.3M for U.S.

Estimates after Nolte et al., 2004

Potato tuber necrotic ringspot disease (PTNRD)



Progression

Affects cultivars susceptible to PTNRD, like Yukon Gold, Alturas, Waneta

An international problem



Ditta – Gilat Research Center



Jelly – Southern Israel

PVY strain classifications

- Genetic – based on HR induction in standard potato cultivars
 - Five genotypes: PVY^O, PVY^C, PVY^N, PVY^Z, and PVY^E
- Molecular– based on sequence homology and recombinant structure
 - Multiple recombinants: PVY^{Wi}, PVY^{N:O}, PVY^{NTN}, PVY-NE11, etc.

Genetic classification

Non-recombinant

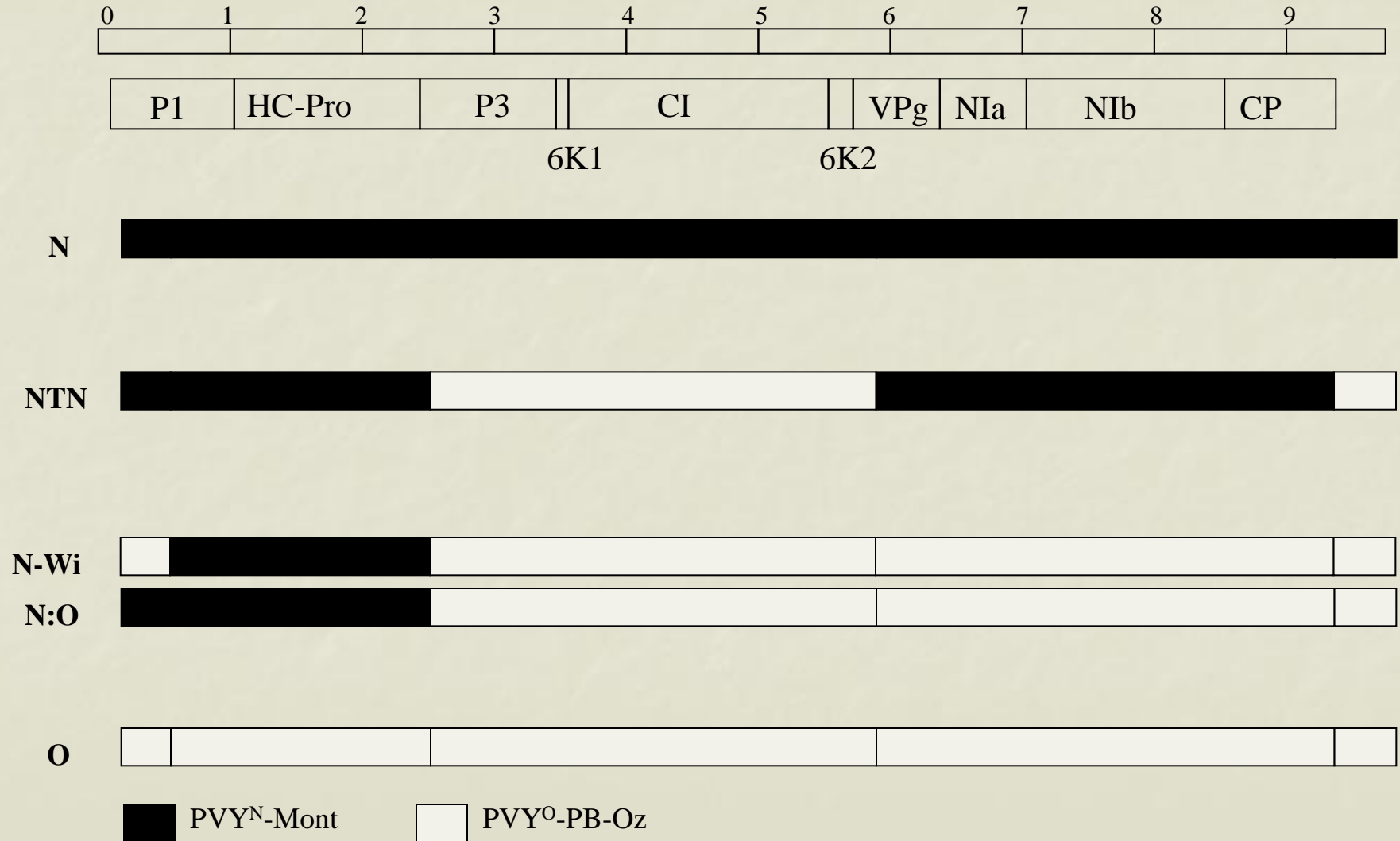
	PVY ^O	PVY ^C	PVY ^Z	PVY ^N	PVY ^E
Desiree (<i>nc:Ny:nz</i>)	HR	S	S	S	S
King Edward (<i>Nc:ny:nz</i>)	S	HR	S	S	S
Maris Bard (<i>Nc:Ny:Nz</i>)	HR	HR	HR	S	S
Tobacco	S	S	S	vn	S

Singh *et al.* (2008) Arch. Virol. 153, 1-13.

Relative incidence of PVY strains

- PVY^C – almost disappeared from potato
- PVY^N – very rare in Europe and North America
- PVY^O – rare in Europe, common in North America
- PVY^Z and PVY^E – originally found in Europe

PVY recombinants



PVY^O symptoms (PB-Oz)

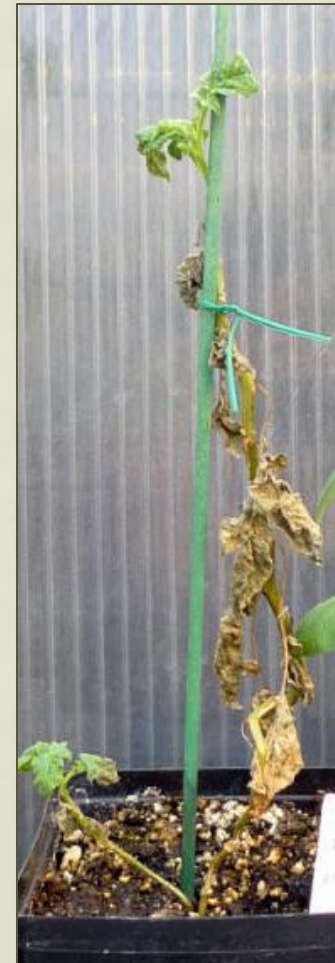


Desiree – necrotic lesions on inoculated leaf



Maris Bard – necrotic lesions on inoculated leaves

Maris Bard – leaf drop on systemic leaves



PVY^N symptoms (Mont)



Desiree – symptomless
infection

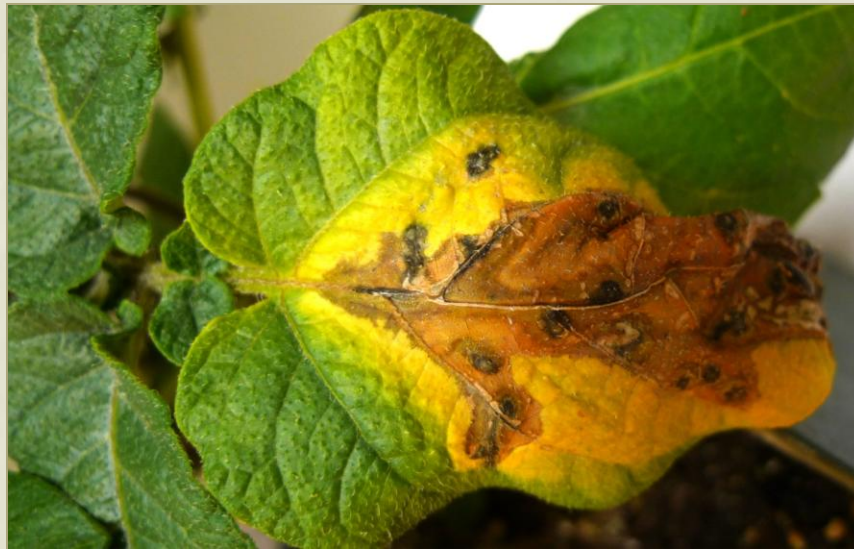


Maris Bard – symptomless
infection

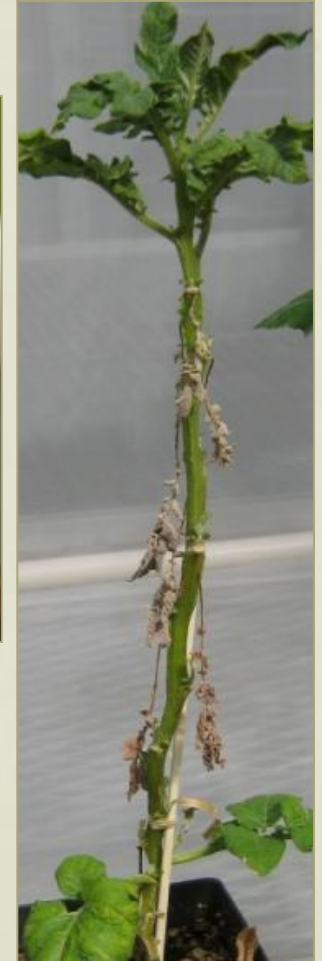
PVYZ symptoms (L26)



Desiree – no symptoms



Maris Bard – local and systemic necrosis



PVY^{NTN} symptoms (HR1)



Desiree – systemic mosaic,
no necrosis



Maris Bard – local and
systemic necrosis



Genetic classification

	PVY ^O	PVY ^C	PVY ^{Z-NTN}	PVY ^N
Desiree (<i>nc:Ny:nz</i>)	HR	s	s	s
King Edward (<i>Nc:ny:nz</i>)	s	HR	s	s
Maris Bard (<i>Nc:Ny:Nz</i>)	HR	HR	HR	s
Tobacco	s	s	s/vn	vn

Kerlan *et al.* (2011) *Phytopathology* 101, 1052-1060.

Practical consequences of the HR response

- Virus induces HR in an inoculated leaf
 - Under certain conditions, it may restrict virus movement and prevent systemic infection
- Occasionally, despite the HR response, a systemic infection is established
 - In this case HR response becomes systemic
 - Infected plant may eventually die, and will not serve as a good host for the virus vector

Additional PVY recombinants



PVY recombinants: genetic classification

	PVY ^N	PVY ^E	PVY ^Z
	Mont	PVY-MON	L26
Desiree (<i>nc:Ny:nz</i>)	S	S	S
King Edward (<i>Nc:ny:nz</i>)	S	S	S
Maris Bard (<i>Nc:Ny:Nz</i>)	S	S	HR
Tobacco	VN	S	S

Kerlan *et al.* (2011) *Phytopathology* 101, 1052-1060.

Galvino-Costa *et al.* (2012) *Plant Pathol.* 60, 388-398.

Connecting the dots

	PVY ^O	PVY ^C	PVY ^Z	PVY ^N	PVY ^E
Desiree (<i>nc:Ny:nz</i>)	HR	s	s	s	s
King Edward (<i>Nc:ny:nz</i>)	s	HR	s	s	s
Maris Bard (<i>Nc:Ny:Nz</i>)	HR	HR	HR	s	s
Tobacco	s	s	s/vn	vn	s
Recombination	nr	nr	NTN	nr	NTN/NE-11

Connecting the dots

- With some PVY recombinants genetically typed, it may be possible:
 - To locate genetic determinants for interactions with HR genes (*Ny* and *Nz*)
 - To narrow down genome regions involved in PTNRD

Suggested PVY strain classification

Genotype or strain	Serotype	Synonyms	<i>N</i> gene elicited in potato	Tobacco reaction	Molecular structure	PTNRD reaction
PVY ^C	O	PVY ^{C1} , PVY ^{C2}	<i>Nc</i>	M, VCI	NR	No
PVY ^O	O	PVY ^O -FL	<i>Ny</i>	M, VCI	NR	No
	O/O5	PVY ^{O5} , PVY ^O -RB	<i>Ny</i>	M, VCI	NR	No
PVY ^N	N	PVY ^{EU-N} , PVY ^R , PVY ^{-TVN}	?	VN	NR	No
PVY ^E	N or AST	PVY ^{ZE}	?	M, VCI, or VN	R, parents - PVY ^{NTN} and PVY-NE11	Yes
PVY ^Z	N or AST	EU-PVY ^{NTN} , Eu-PVY ^{NTN} , PVY ^{EU-NTN} , PVY ^{NN}	<i>Nz</i> (putative)	VN	R, parents - PVY ^O and PVY ^N	Yes
	N or O	PVY ^{NTN} , PVY ^{NTN-NW}		M, VCI, or VN		
PVY ^{N:O}	O	PVY ^{N-Wilga} , PVY ^{N-W} , PVY ^{N-Wi-P} ,	?	VN	R, parents - PVY ^O and PVY ^N	No
PVY ^{N-Wi}	O	PVY ^{N-Wilga} , PVY ^{N-W} , PVY ^{N-Wi-P} , PVY ^{N:O}	?	VN	R, parents - PVY ^O and PVY ^N	No
PVY ^{NA-N}	N	NA-PVY ^N , PVY ^{NA-NTN} , NA-PVY ^{NTN}	?	VN	NR	Yes
PVY-NE11	N		?	VN	R, parents - PVY ^N and unknown	Yes

Recombinants to be characterized

- Not found in recombinants:
 - PVY⁰-O5 genomes
- Parents still not identified/found:
 - PVY-NE11 genome

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- Xiaojun Hu – SAIC, Inc.

Funding

- USDA-NIFA-NRI
- USDA-NIFA-SCRI
- USDA-ARS, National Potato Council
- Idaho Potato Commission
- Washington State Potato Commission
- US Potato Board