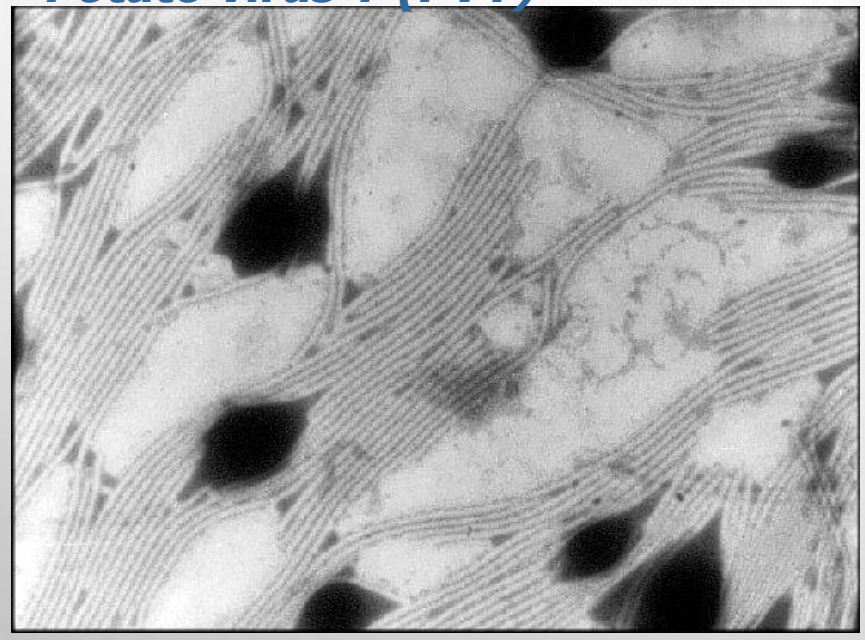
Strain-specific and other types of resistance to PVY

Alexander V. Karasev

Potato virus Y - potato

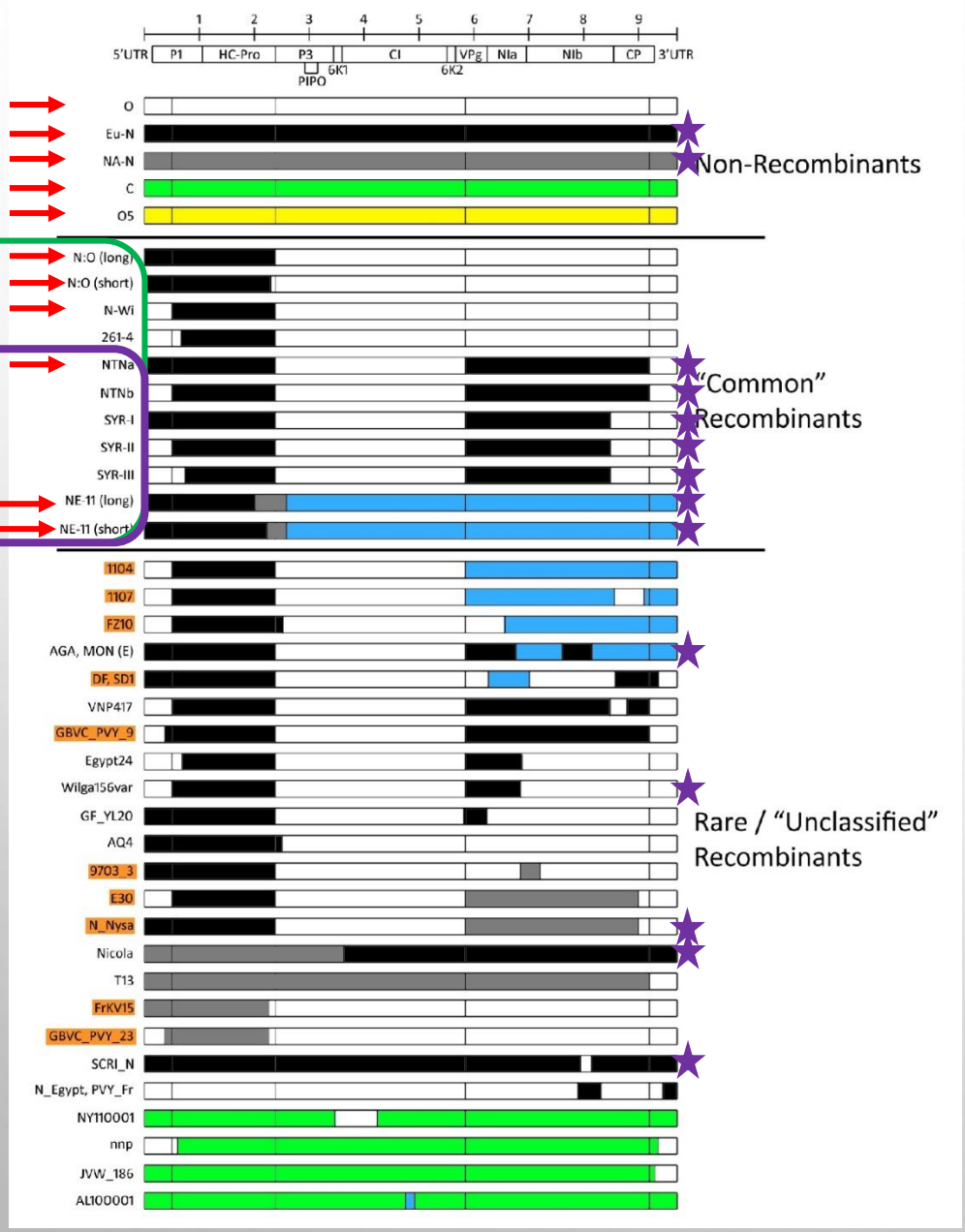
Potato virus Y (PVY)



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 genetic diversity



Green *et al.* (2018)

- Five non-recombinant parents
- One recombinant parent
- 36 recombinant structures ("strains")
- Only 6 recombinant strains found in the U.S. Potato
- Only 3 recombinants associated with PTNRD
- And only one of these recombinants, PVY^{NTN}, is prevalent in the U.S. potato

Severe mosaic in Russet Burbank

“Leaf-drop” in Ranger

Mosaic and crinkling in Russet Burbank

Chlorotic mosaic in Ranger

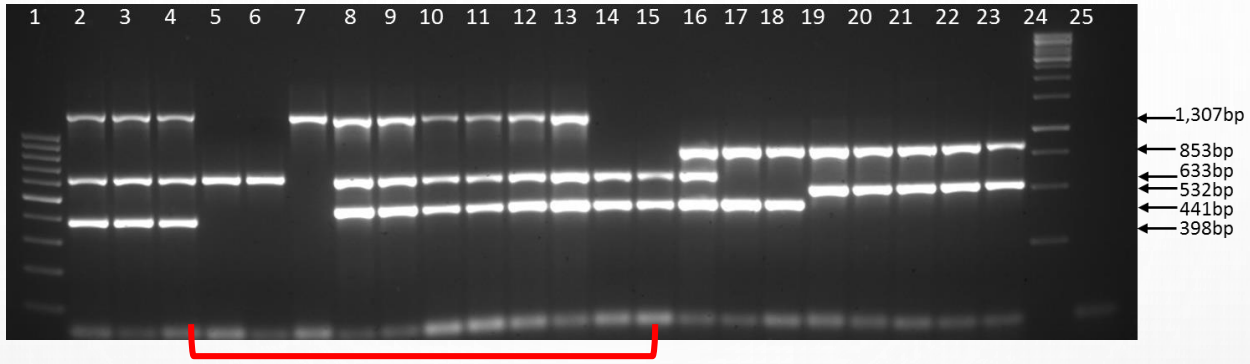
Columbia Basin seed lot trials

- WA produces 20% of the U.S. Potato
- Unlike ID or MT, WA has small seed potato industry
- Hence, WA must import lots of seed potato
- These seed potatoes are tested in Othello and in Hermiston
- When we test potato lots in Othello, we test potato from many states
- **This is ideal for PVY strain surveillance**

How to monitor and evaluate PVY strain composition in Washington potato seed lot trials?

- Need to analyze large number of seed lots
  - Each year up to 350 seed lots are submitted for trials
- Need to identify PVY-positive samples and then type them to strain
  - Up to 14 different genome structures are known for PVY, 9 strains established
- This testing needs to be conducted each year of trials, to see any dynamic changes
- **We conducted testing of the PVY strain composition in the Othello grow-outs between 2011 and 2019**

PVY typing – RT-PCR



Chikh-Ali et al., 2013

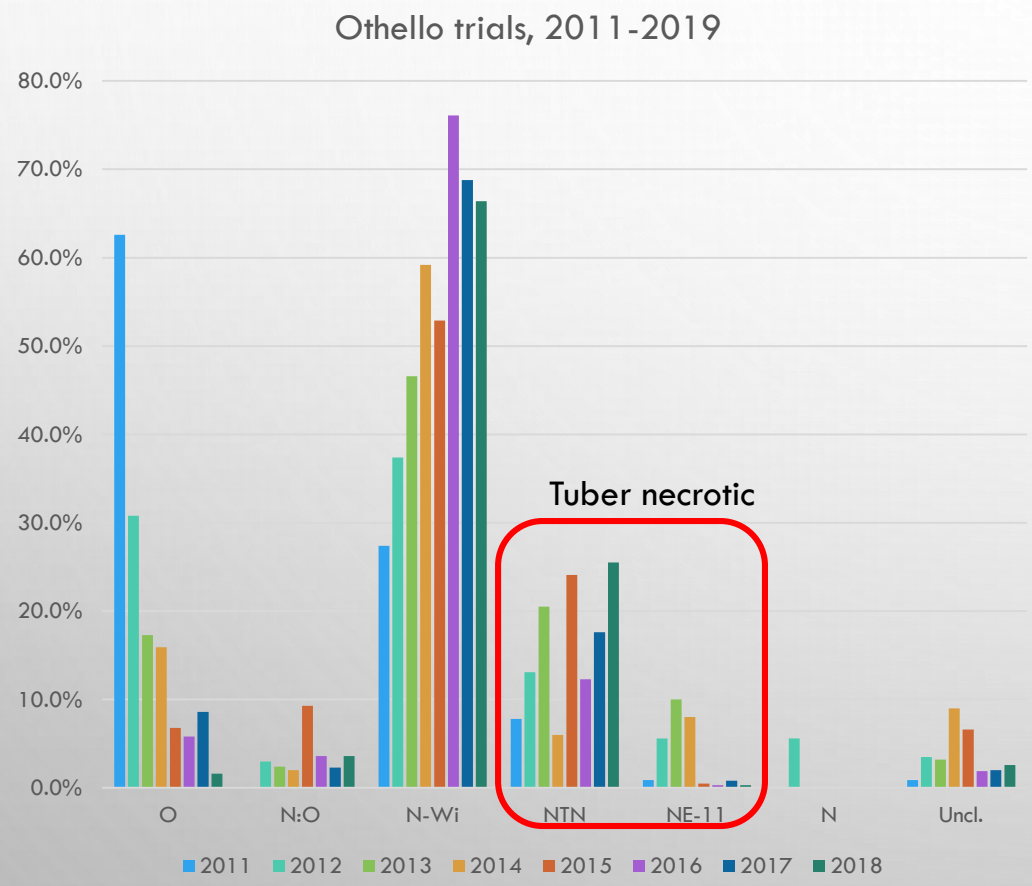
Testing of seed potato – Othello grow-out

Leaf samples analyzed

	Total samples	PVY-positive, %
2011	246	88
2012	235	84
2013	283	88
2014	222	91
2015	431	93
2016	362	85
2017	317	81
2018	384	83
2019	353	82

- 200-tuber samples from each seed lot are submitted by growers
- These tuber samples are planted in Othello, WA, and read/tested in June
- Symptomatic leaf samples are taken to UI-Moscow for testing and typing
- **Samples are typed using ELISA with monoclonal antibodies, O and N specific**
- **PVY-positive samples are typed using immuno-captured RT-PCR**

PVY strain composition in Columbia Basin: 2011-2019



Funke et al. (2017)

- In the past few years, prevalence of PVY^{O} decreased dramatically
- Prevalence of recombinants reached over 90%
- $PVY^{N\text{-}Wi}$ is the most prevalent type currently, at above 60%
- However, the set of recombinants remains stable

Types of resistance to PVY in potato

- Extreme resistance or immunity (R_{adg}, R_{sto}, R_{chc})
  - Broad, strain non-specific, durable
- Hypersensitive resistance (*Ny*, *Nc*, *Nz*, etc)
  - Strain-specific, sensitive to temperature
- Age-related (mature) resistance
  - Is dependent on the age of the plant
  - Older plants exhibit resistance to the virus
- Can we use mature resistance to manage PVY?

Questions for the current season PVY management:

- What is the critical period for the vector management?
- Is it early in the season, when aphids bring the virus to the field and establish reservoirs in the field?
- Or is it late in the season when aphids spread the virus which goes directly to tubers?
- And if it is late season spread, where is this mature resistance?

Pilot experiment in 2017-2018

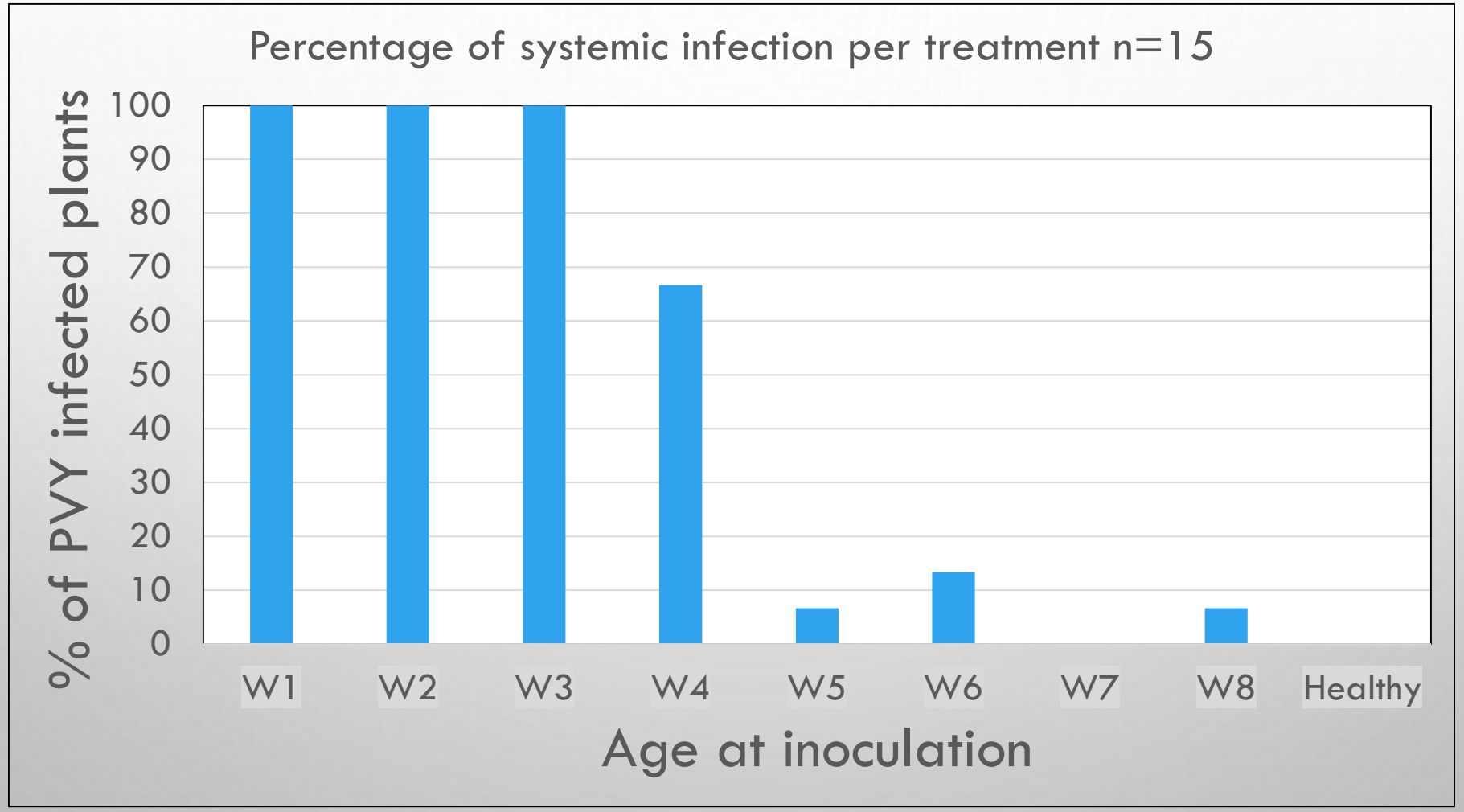
- One potato cultivar – Yukon Gold
- One PVY strain – PVY^{NTN}
- Potato plantlets planted into soil (greenhouse), and infected with PVY^{NTN} every week for eight weeks
- Each time point is analyzed for systemic infection, and tuber quality at harvest and 1 month storage – current season
- Collected tubers for each plant are planted to test for a seed-borne infection – “translocation to tubers without systemic infection” control

Foliar symptoms

- W1-4 local HR and systemic HR and mottle
- W1-6 local and systemic HR
- W7-8 local HR and occasional systemic HR

Chikh-Ali et al. (2019) Plant Dis., in press.

Systemic infection in potato foliage measured at 4 wpi



Efficiency of virus translocation: yield loss and PTNRD at harvest time

Healthy **W8** **W7** **W6** **W5** **W4** **W3** **W2** **W1**

Chikh-Ali et al. (2019) Plant Dis., in press.

Grow-out data – secondary systemic infection

Plant age at inoculation	2017	2018
W1	20/20	25/25
W2	28/28	21/21
W3	24/29	25/26
W4	8/30	17/30
W5	6/30	2/30
W6	2/30	3/30
W7	0/26	0/30
W8	1/30	0/30
Healthy	0/30	0/30

- Two tubers from each primary-inoculated plant
- Planted into a 1-gallon pot
- Grown until flowering
- Systemic infection determined by ELISA, and PVY strain typed by RT-PCR
- Up to 30 plants per timeof primary inoculation

PTNRD at harvest time



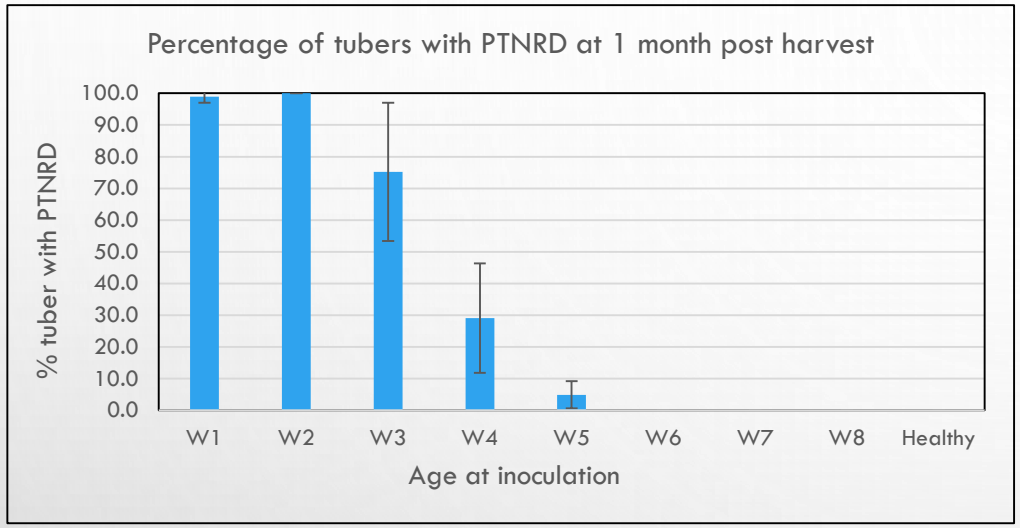


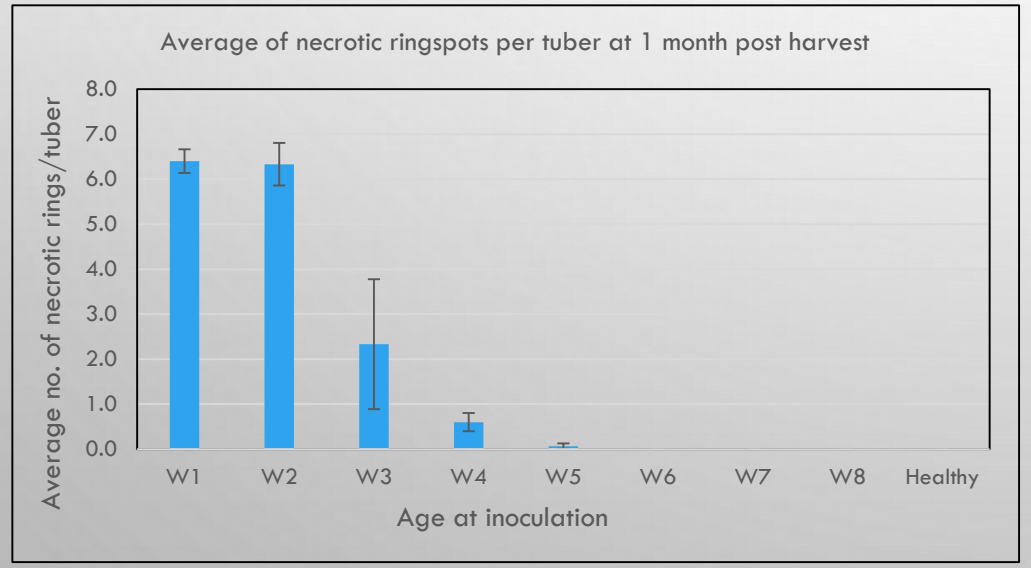

W4 and W6 appeared at 1 mph but not at harvest time

Chikh-Ali et al. (2019) Plant Dis., in press.

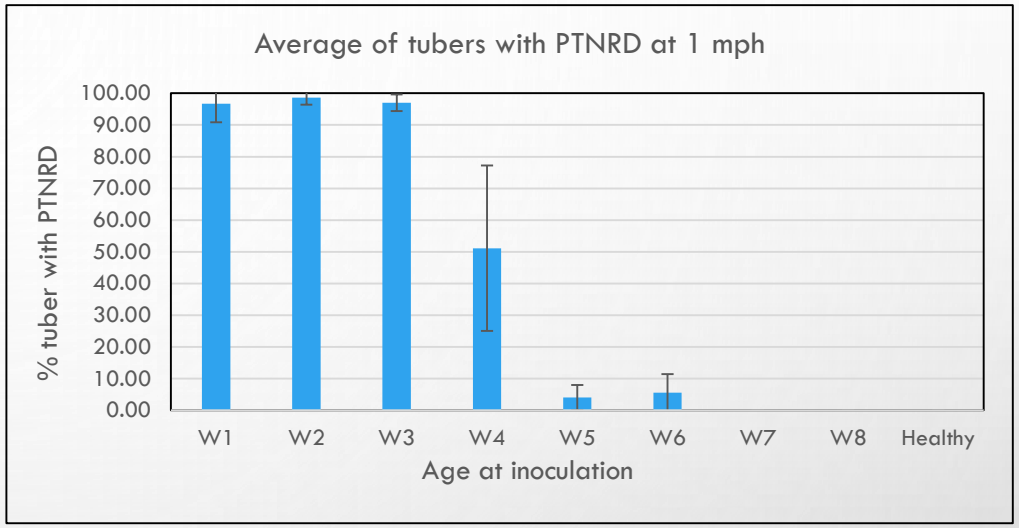
PTNRD data

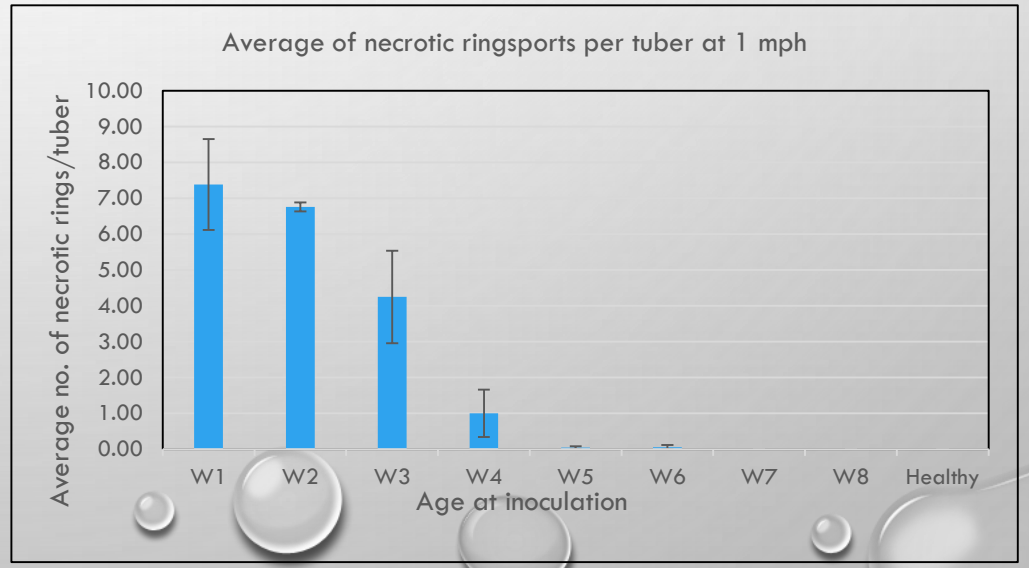
2017





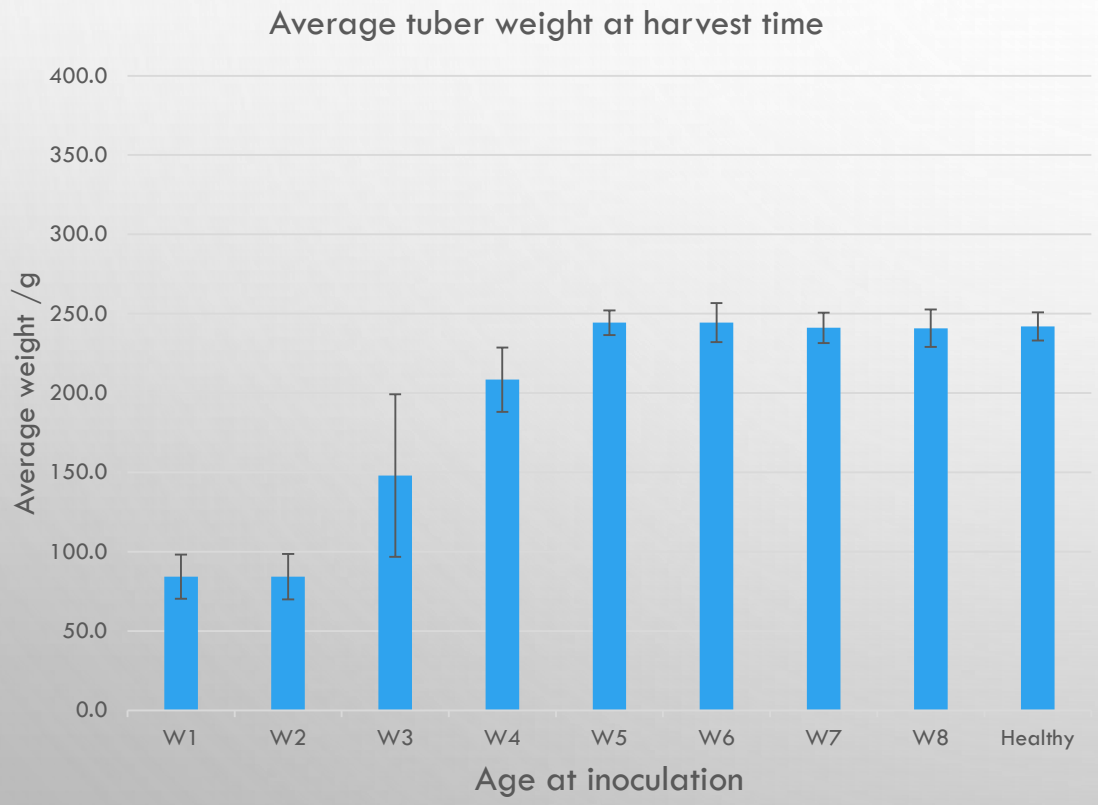
2018



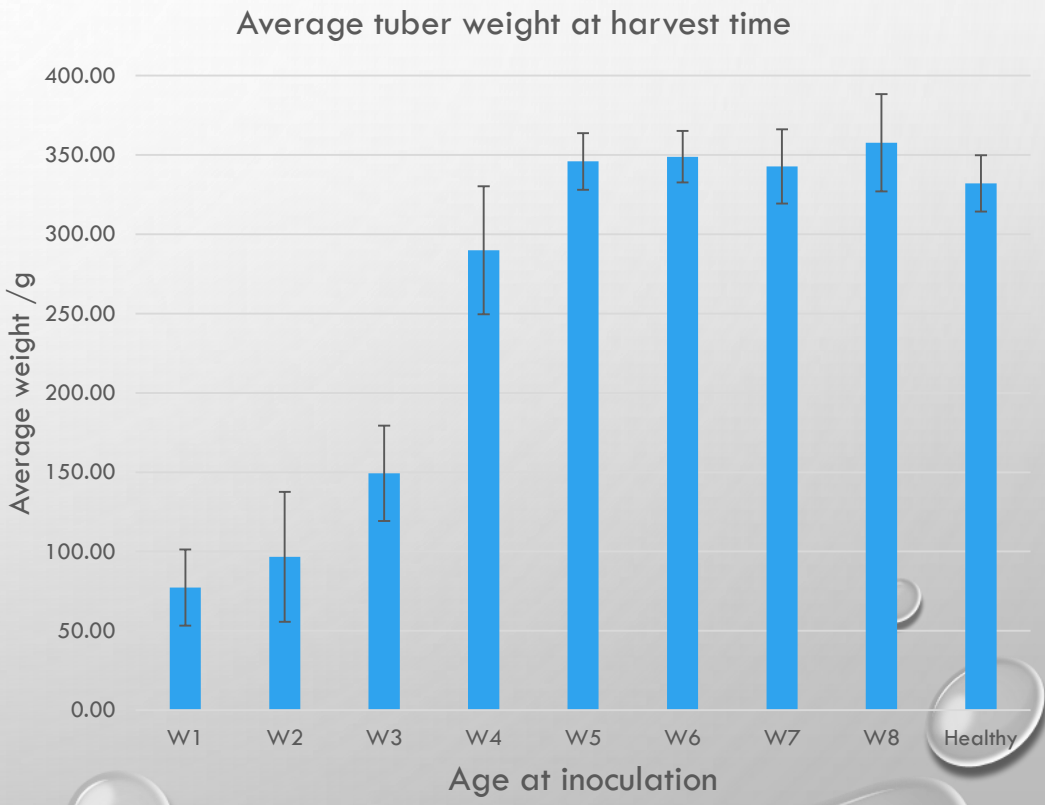


Yield loss as a function of time of infection

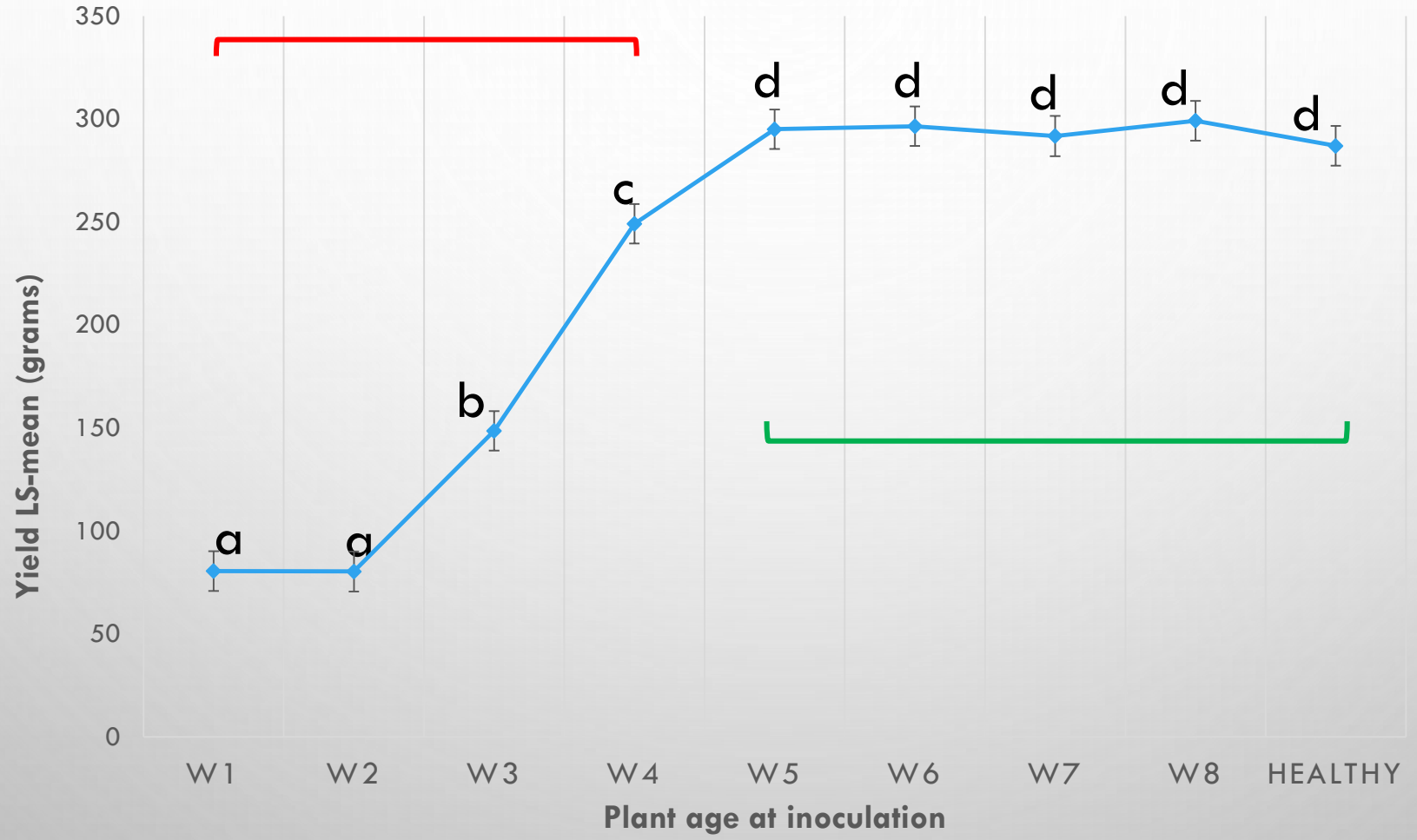
2017



2018



Yield 2017 and 2018



Chikh-Ali et al. (2019) Plant Dis., in press.

Preliminary conclusions

- Age-related (mature) resistance is expressed by Yukon Gold against PVY^{NTN}
- It is very efficient, almost 100% after 3 weeks post-transplantation in a greenhouse experiment
- This age-related resistance blocks systemic infection of the virus, but also virus translocation to tubers
- Take-home message: it may be the early stage of the plant development which is critical and in need of protection
- Later in the season, plant may not need additional protection

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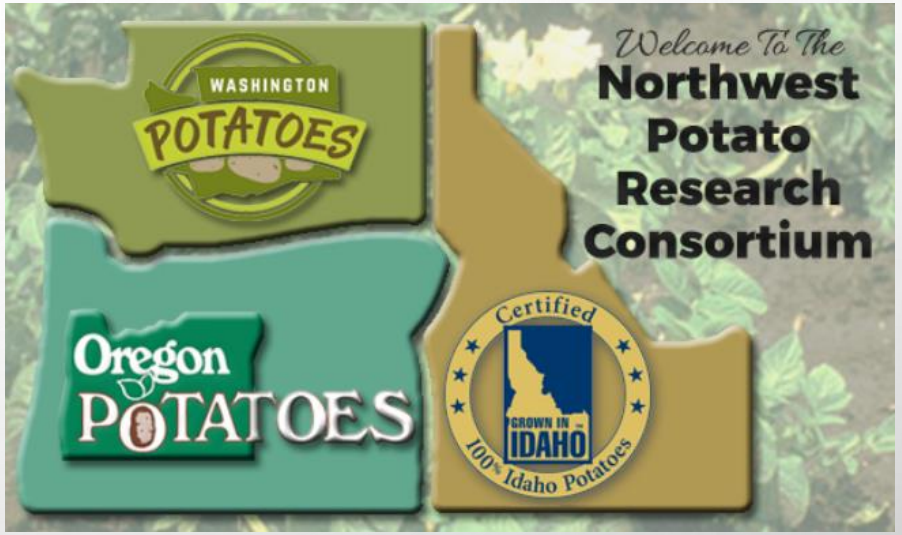
- The Idaho Agricultural Experiment Station



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