PVY: Why was 2022 such a challenging year?

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Fredericton, NB

13 February 2023

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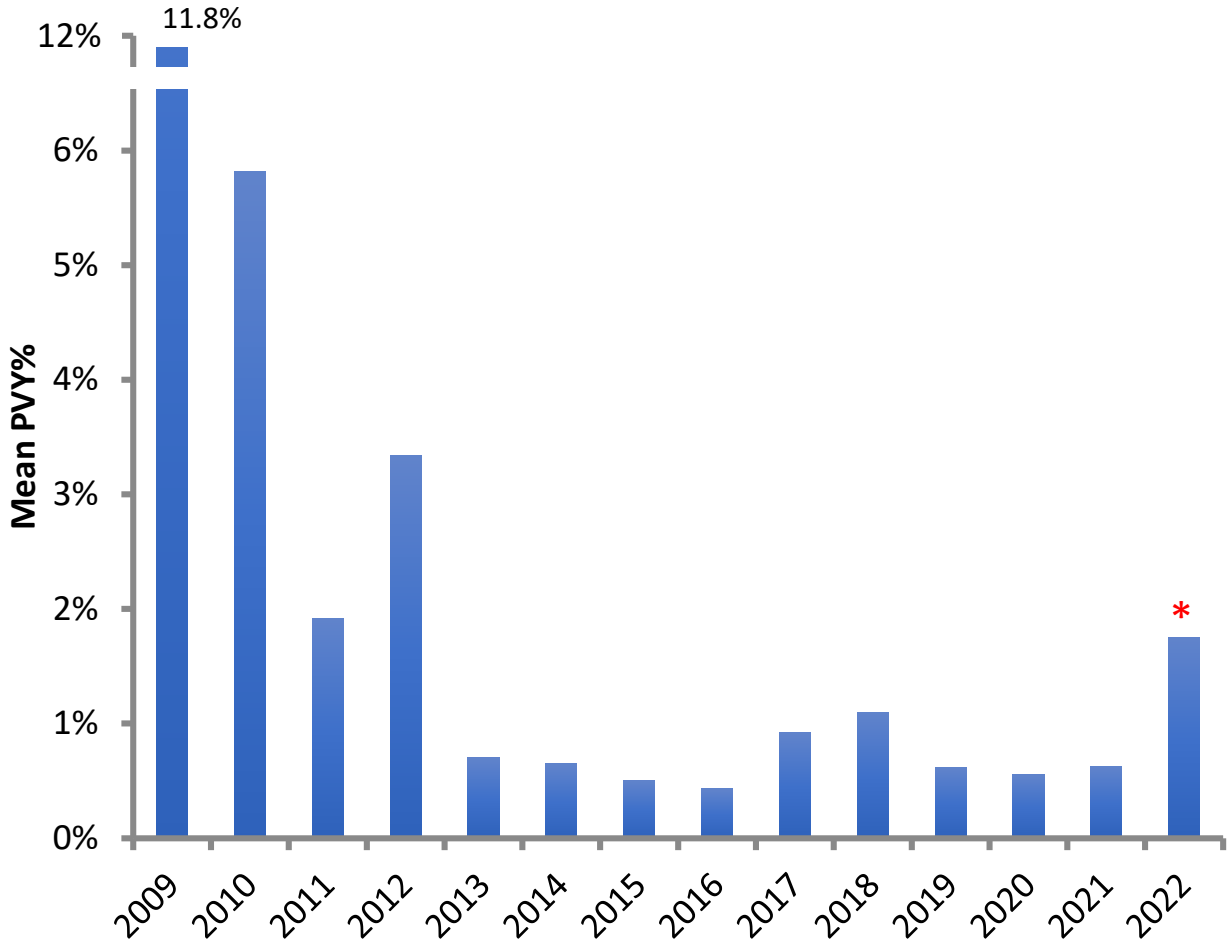
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

PVY levels over years in NB



year	Number of tested lots	Average PVY %
2009	501	11.81%
2010	685	5.82%
2011	533	1.92%
2012	566	3.34%
2013	479	0.70%
2014	576	0.65%
2015	573	0.50%
2016	559	0.43%
2017	546	0.92%
2018	460	1.10%
2019	441	0.62%
2020	419	0.55%
2021	428	0.60%
2022	327	1.75%* interim

PVY level in 2022 is interim value **and calculated as the average of 87% of the year's samples. 7% of the samples showed unusually extreme values that were excluded here because they skewed the distribution of the majority of growers' samples. Nearly 6% of samples also have not yet been processed.**

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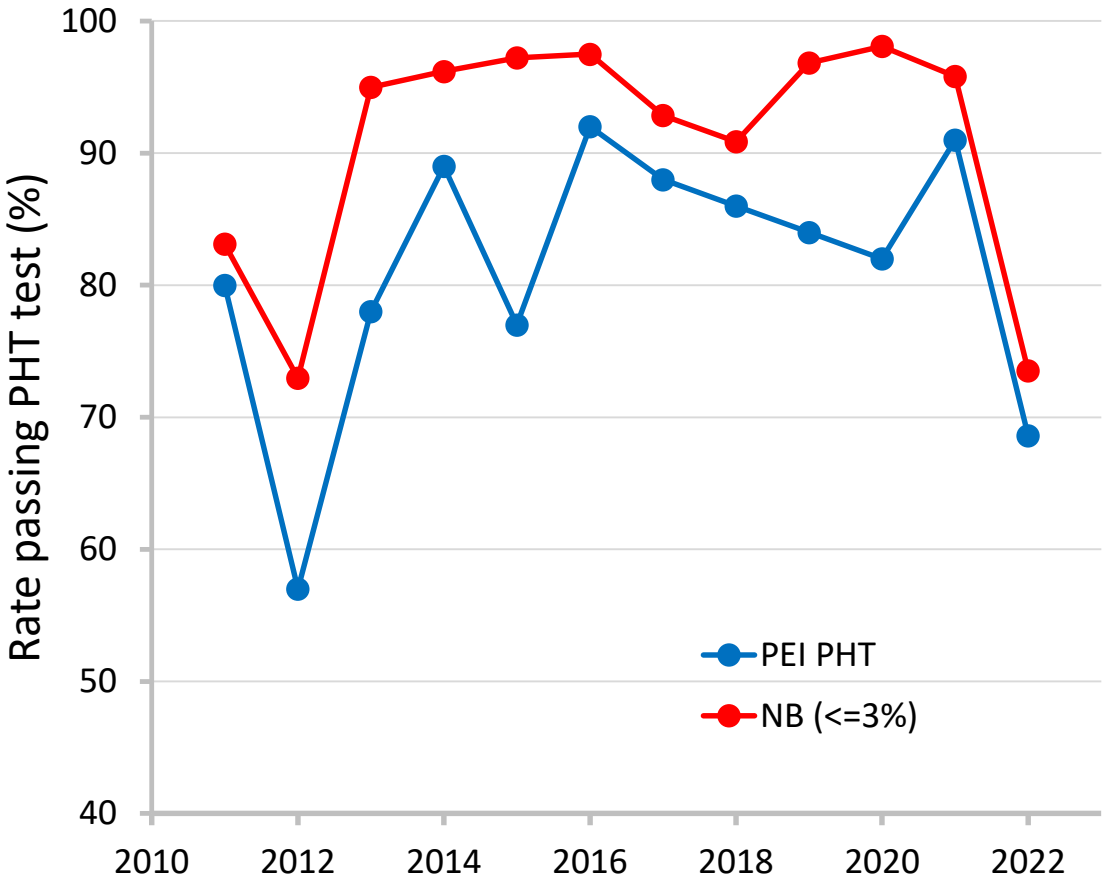
Sample lots passing Post-harvest PVY test in PEI and NB



Over the years, pass-rates of seed lot samples in Post-harvest testing for PVY (PHT) have been generally trending higher.

PVY levels that qualify are different in NB and PEI, but here we display the rate of PHT samples testing at or below 3% PVY (the passing cap in PEI).

In 2023, however, PVY levels were far higher than experienced for at least a decade, causing a substantially lower pass-rate in both provinces.

Reportedly, similar PVY problems have also occurred in Maine and other Canadian provinces in 2022.

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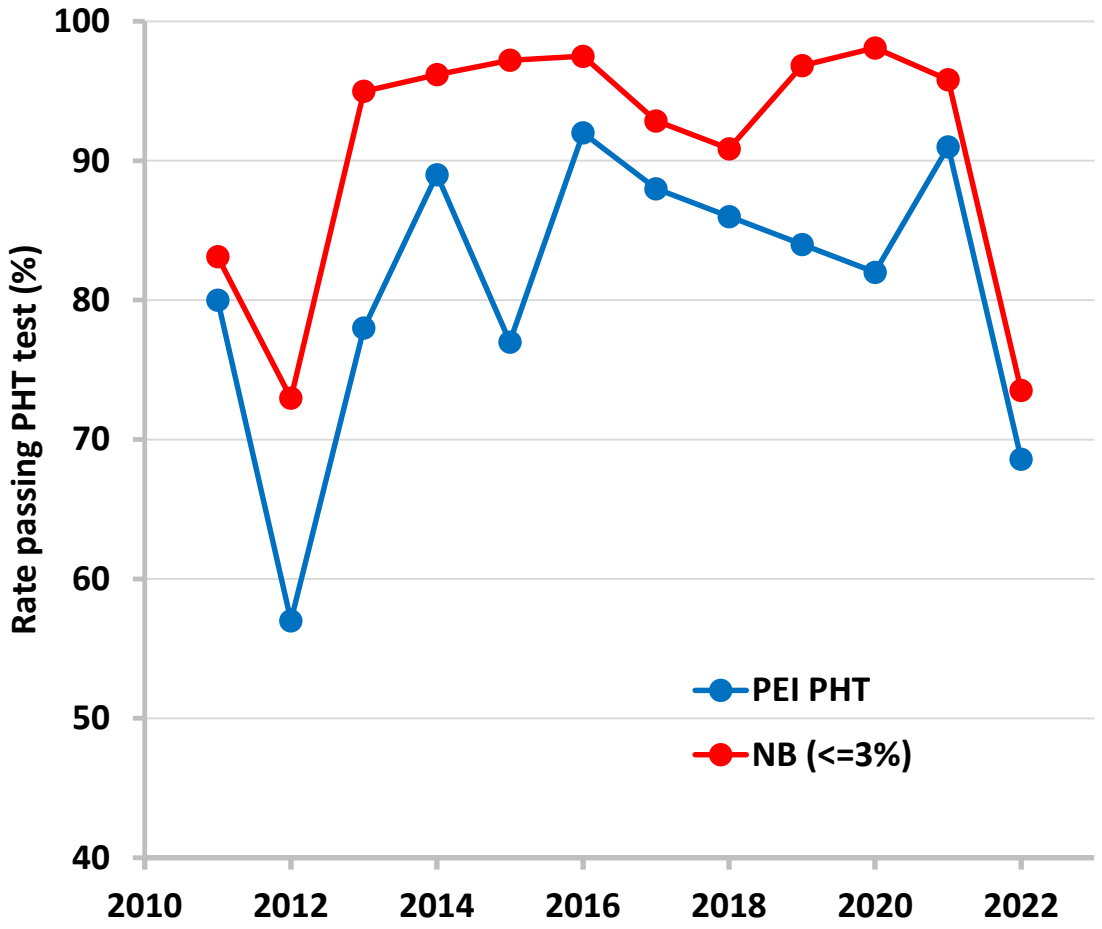
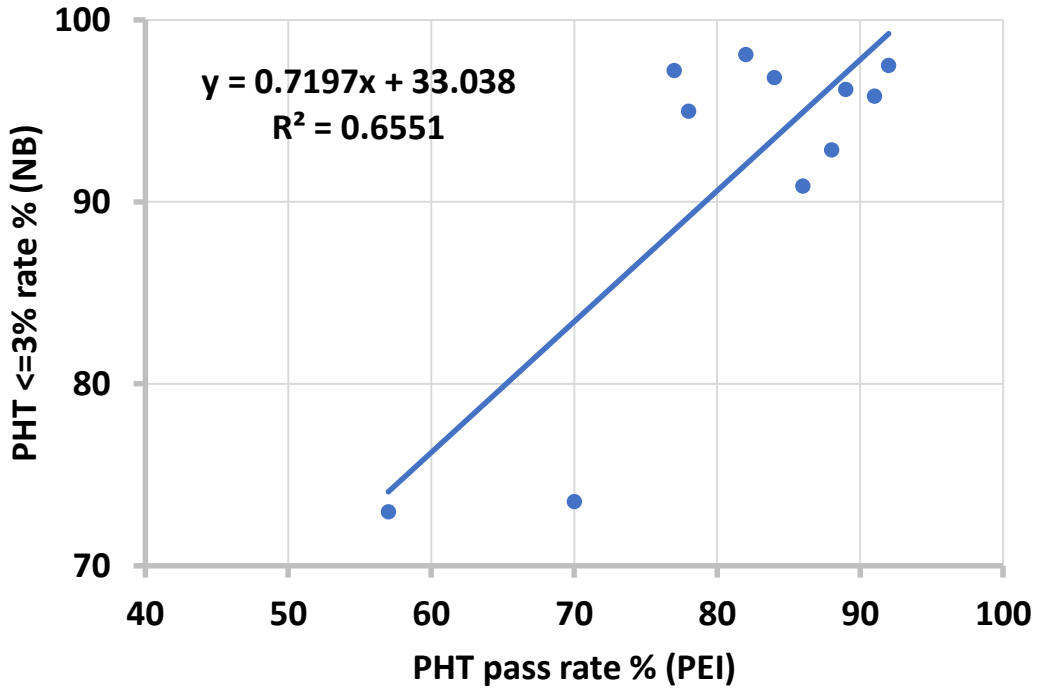
Sample lots passing Post-harvest PVY test in PEI and NB



PVY pass-rates are well correlated in NB and PEI, suggesting similar factors determine the PVY levels of seed potato crops in both provinces.

What shared factors could these be?

We have been researching factors influencing PVY level in NB, which may be directly applicable to the PEI situation.



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Why was PVY high in 2022?

Possible factors:

- What was planted in the field?
- Aphids as vectors for PVY transmission?
- Changes in the virus? Different PVY strains?
- Changes in management by growers?

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Higher harvested PVY becomes higher PVY seed

Over last decade, PVY inoculum **planted in the field** has steadily declined. During this time, tighter limits on maximum PVY in marketed seed, price premium of cleaner seed, and value recognition by growers reduced PVY.

% of Acres planted

Clean seed = 0% PVY

% PVY	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0	18.35	26.32	27.12	41.34	42.04	53.76	59.98	42.96	38.61	36.88	49.47	55.92
.1-1	16.74	28.7	20.21	42.42	41.98	37.51	31.28	28.13	38.34	37.65	35.18	23.80
1-<2	7.67	19.25	17.83	10.54	9.36	4.01	6.45	17.08	15.48	17.45	9.96	11.65
2-<3	9.93	14.11	9.14	3.14	5.08	2.7	2.27	8.13	3.62	7.06	4.75	6.18
3-<4	8.08	6.33	8.72	1.97	0.67	2.02	0.02	3.02	2.66	0.81	0.65	1.84
4-<5	6.56	0.94	11.34	0.59	0.86	0	0	0.68	1.29	0.15	0	0.60
5-<6	9.17	1.44	5.65	0	0	0	0	0	0	0	0	0
6-<11	10.87	2.91	0	0	0	0	0	0	0	0	0	0
>11%	12.63	0	0	0	0	0	0	0	0	0	0	0

Clean harvest -> Clean seed

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Planted Mean PVY %	4.51	1.12	1.14	0.51	0.46	0.43	0.32	0.64	0.73	0.58	0.47	0.45
Harvested Post-harvest PVY %	1.92	3.34	0.70	0.65	0.50	0.43	0.92	1.10	0.63	0.55	0.60	

Mean PVY planted in the fields was lower in 2022…

…though much of the PVY that was planted was concentrated in higher levels

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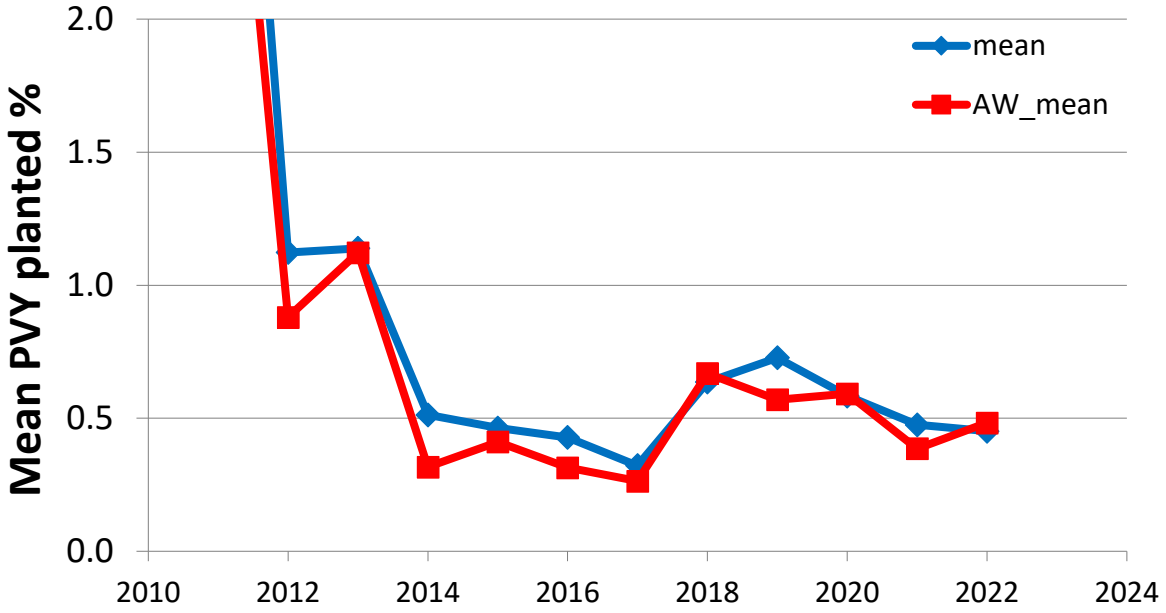
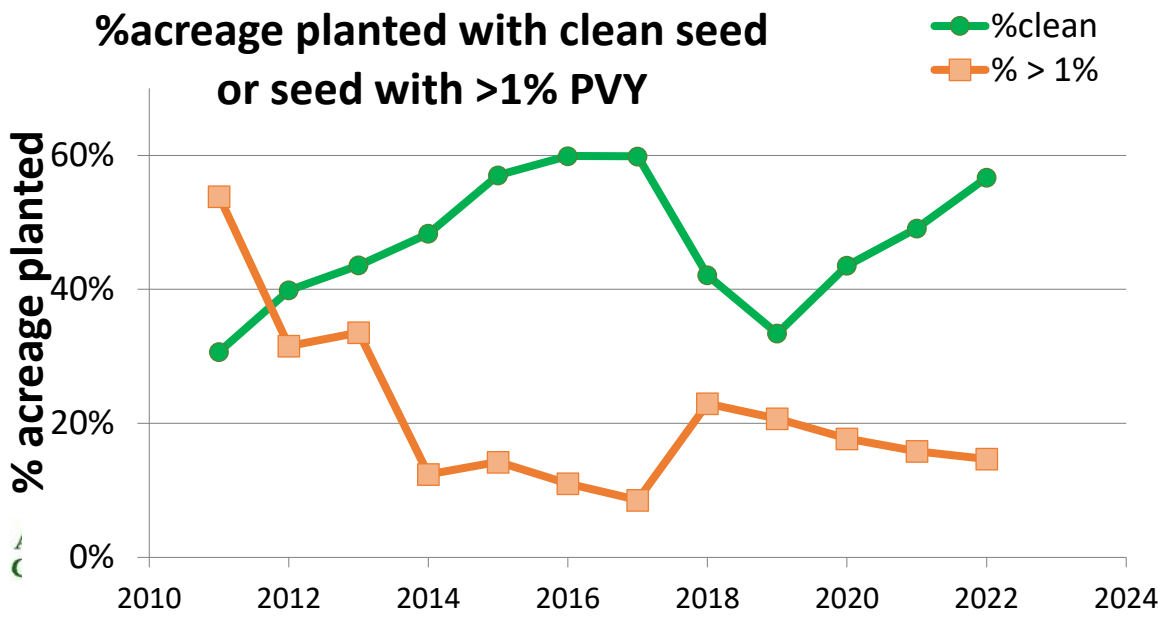
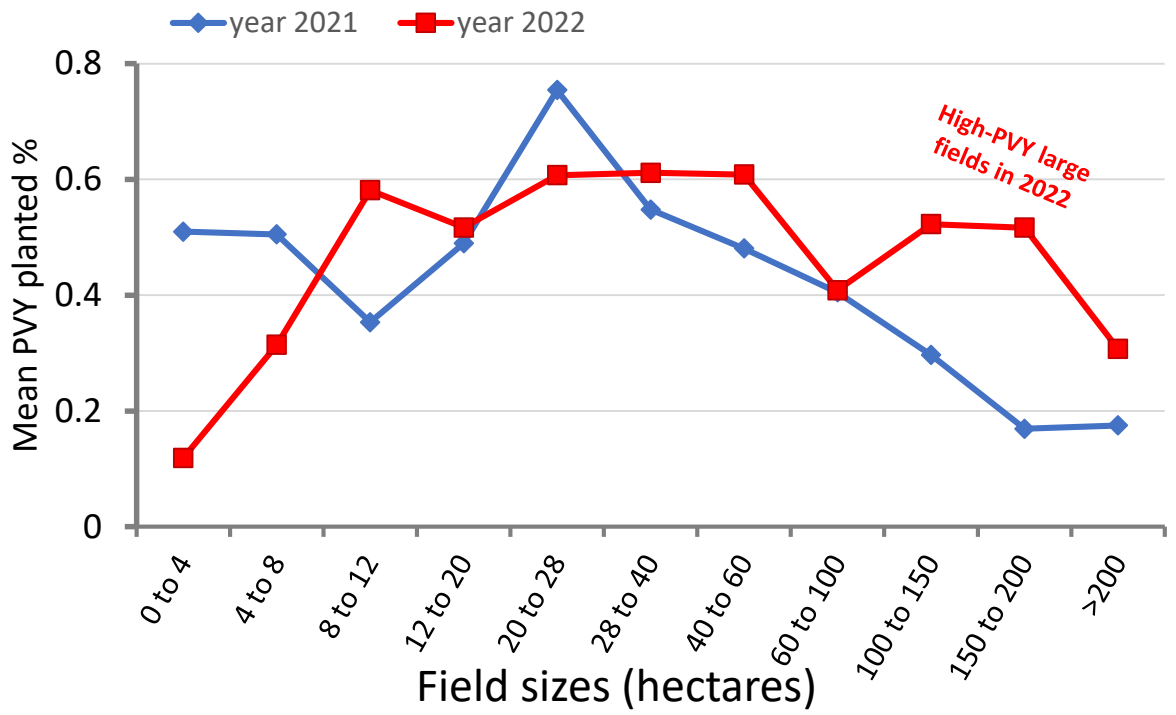
PVY planted summary





Even though mean PVY in planted crop is similar to last year, that hides a large 2022 increase in seed at elevated PVY levels in larger fields (AW_mean is mean PVY weighted by area of field, which is higher than the conventional mean of the samples regardless of field size).

In 2022: fields in >28 ha sizes had much higher PVY levels than 2021; 2021 PVY peak levels in moderate size fields (20-28 ha) and small fields (0-8 ha). Weighted for field size (proportional to harvested tubers) high PVY in large fields is far more dangerous.



Is the small-scale retail garden market a source of PVY?

New Nouveau Brunswick CANADA

November 23, 2021

Post-Harvest Laboratory Virus Testing is Required for Seed Potatoes Planted in New Brunswick, Canada

Issue: Some seed potatoes sold in garden centers and grocery stores in New Brunswick in 2021 were found to have high levels of Potato Virus Y (PVY) up to 19%, which exceed the maximum PVY level allowed in seed potatoes destined for planting in New Brunswick (4%). This poses a real threat and high risk to the quality and yield of seed potatoes produced on NB potato farms, and consequently negatively impacts our local and export markets.

Action Required:

Supplier of Seed: Ensure that any seed potatoes sold in New Brunswick meet the PVY level requirement set by New Brunswick's Minister of Agriculture, Aquaculture and Fisheries which does not exceed 4%. Any deviation from this requirement is considered an actionable offense under the *Potato Disease Eradication Act*.

Home Gardener: Do not plant potatoes produced in your garden the previous year. PVY accumulates in potato plants during the growing season and transmits to seed. Each year you plant your own seed, the virus level increases, and your potato plants can become a source of inoculum to neighboring potato farms. Only buy and plant certified seed potatoes.

Potato Virus Y (PVY): PVY is one of the most damaging potato viruses. It can cause mosaic on potato leaves and affect yield and quality. Yield losses range from 10% to 80%. Affected tubers are unusable for propagation. Symptoms in potato vary from extremely mild mosaic to severe foliar necrosis to death of infected plants. Tuber quality is also affected. The main sources of infection from the virus is infected potato seed.



Regulation under the Potato Disease Eradication Act: In order to manage and reduce the level of PVY in the Province's potato crop, the New Brunswick Regulation 82-70 of the *Potato Disease Eradication Act* has been amended to include Mandatory Post-Harvest Laboratory Testing for PVY of all seed potatoes that are to be planted in New Brunswick. Testing must be done in a laboratory recognized for seed potato certification testing by the CFIA, USDA-APHIS, or other laboratories deemed equivalent.

For further information contact the Potato Development Centre at (506) 392-5199.

Published reports show the retail market for private gardens can be a substantial source of PVY (e.g. recently in Pacific-Northwest USA)

- Retail buyers not discriminating about source, not PVY experts
- Scale is small and distributed
- Lax enforcement

In 2021 PVY was discovered in a private garden in NB, leading to a small survey of retail seed potatoes

- 858 seed potatoes – 5 lots
- Sourced from retail store that supplied private garden
  - *all seed from PEI*
- 3 of 5 lots >4% PVY, ranged 0% to 19%
  - 10.7% of all tubers tested had PVY!

…lead to NBDAAF bulletin and full-scale research survey in 2022

Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

Is the small-scale retail garden market a source of PVY?

In spring of 2022, we purchased 48 lots of seed from retail garden-market outlets from throughout SJ river valley, testing a total of 7406 tubers from 13 varieties

	Domestic NB seed	Imported seed (west)
Garden & Farm supply stores	Sample sets = 19 **Average PVY = 0.58%** (range 0% - 4.02%)	(none imported)
Seasonal Markets	Sample sets = 11 **Average PVY = 0.24%** (range 0% - 2.25%)	(none imported)
”Big Box” stores	(none sourced from NB)	Sample sets = 18 **Average PVY = 0.28%** (range 0% - 1.32%)

No PEI this year

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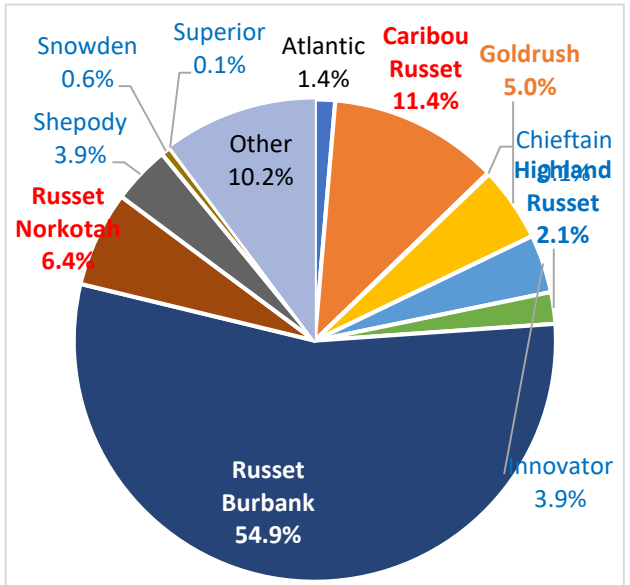
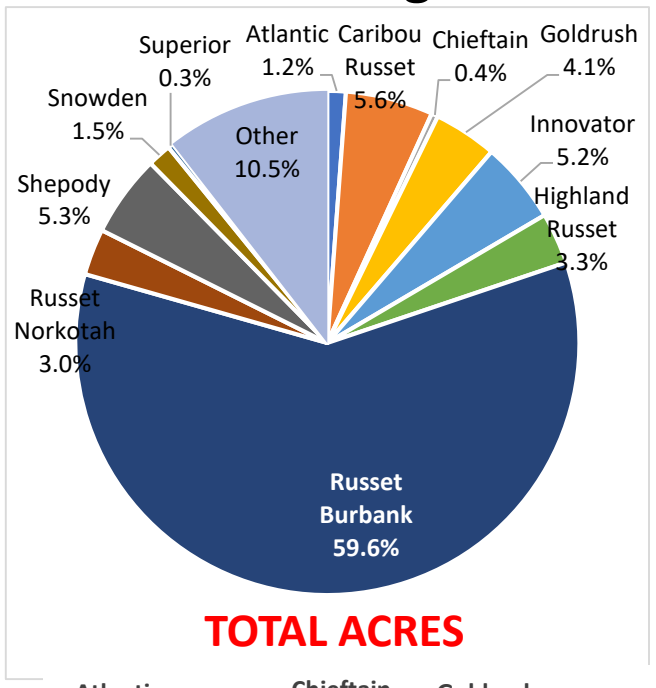
Is PVY concentrated in certain varieties?

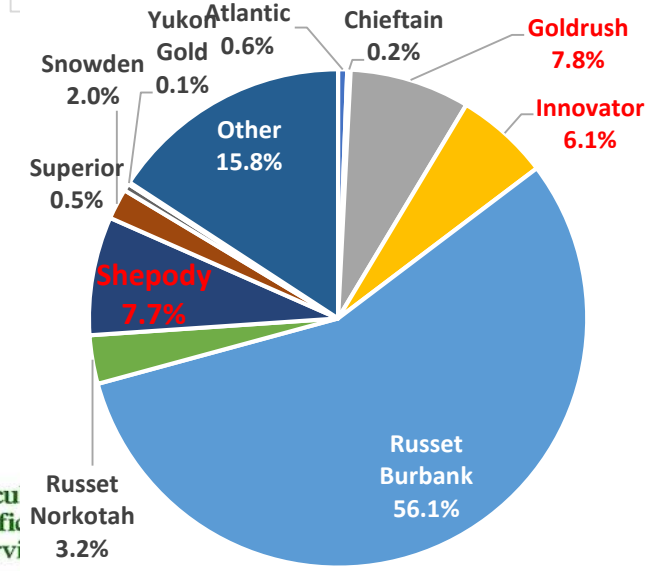
Yes BUT not consistently **– some varieties are higher than others, but these vary each year**

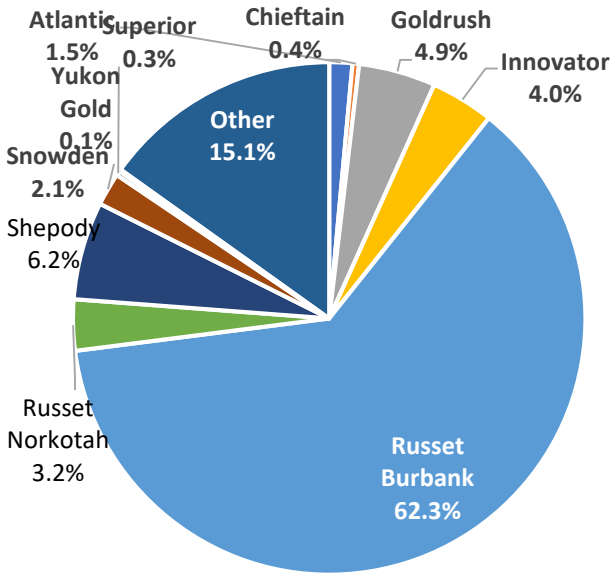


TOTAL PVY



TOTAL ACRES





2022

- **Disproportionately high PVY:**
  - **Caribou Russet, Russet Norkotah**
  - **Goldrush (slightly)**
- **Low PVY:**
  - **Chieftain, Innovator, Shepody, Snowden, Superior**
- **BUT: largest component of PVY is Russet Burbank (because it is greatest acreage)**

2021

- **High: Goldrush, Innovator, Shepody (slightly)**
- **Low: Atlantic, Chieftain**

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Clearly, PVY was high in 2022

Why?

Possible factors:

- **What was planted in the field?**
- Aphids as vectors for PVY transmission?
- Changes in the virus? Different PVY strains?
- Changes in management by growers?

Planted PVY and **variability in different varieties** were *not* very different from recent years

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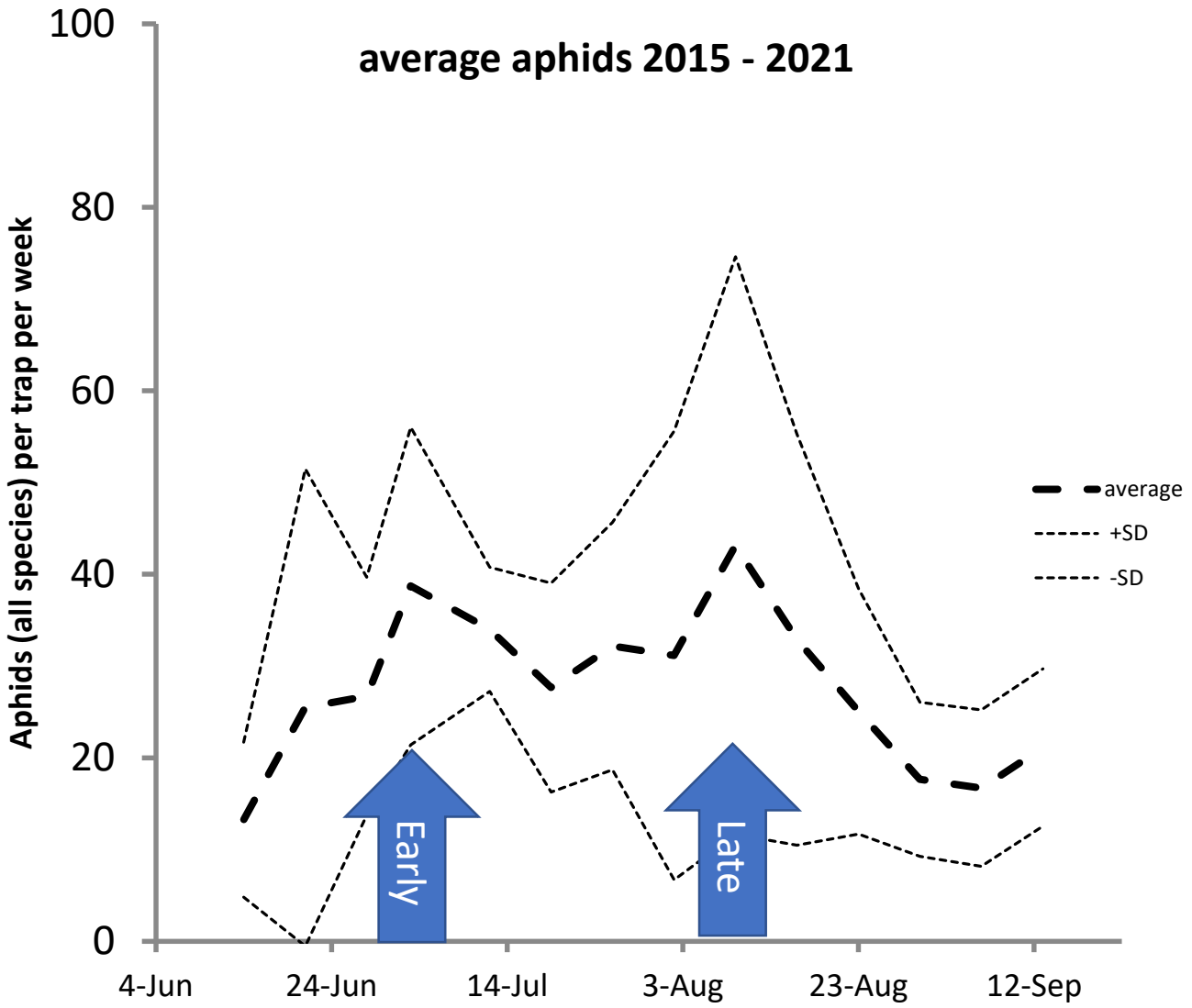
How are aphids influencing PVY?



Aphids transmit PVY from one potato plant to another, and their abundance and species composition varies from year to year.

Typically:

- **Aphids peak in two periods**
  - **EARLY at the end of June**
  - **LATE in mid-August**
- **Some years are exceptional in abundance and timing of arrival**
- **Colonizing species that are most efficient at PVY transmission arrive later in the year**

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Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

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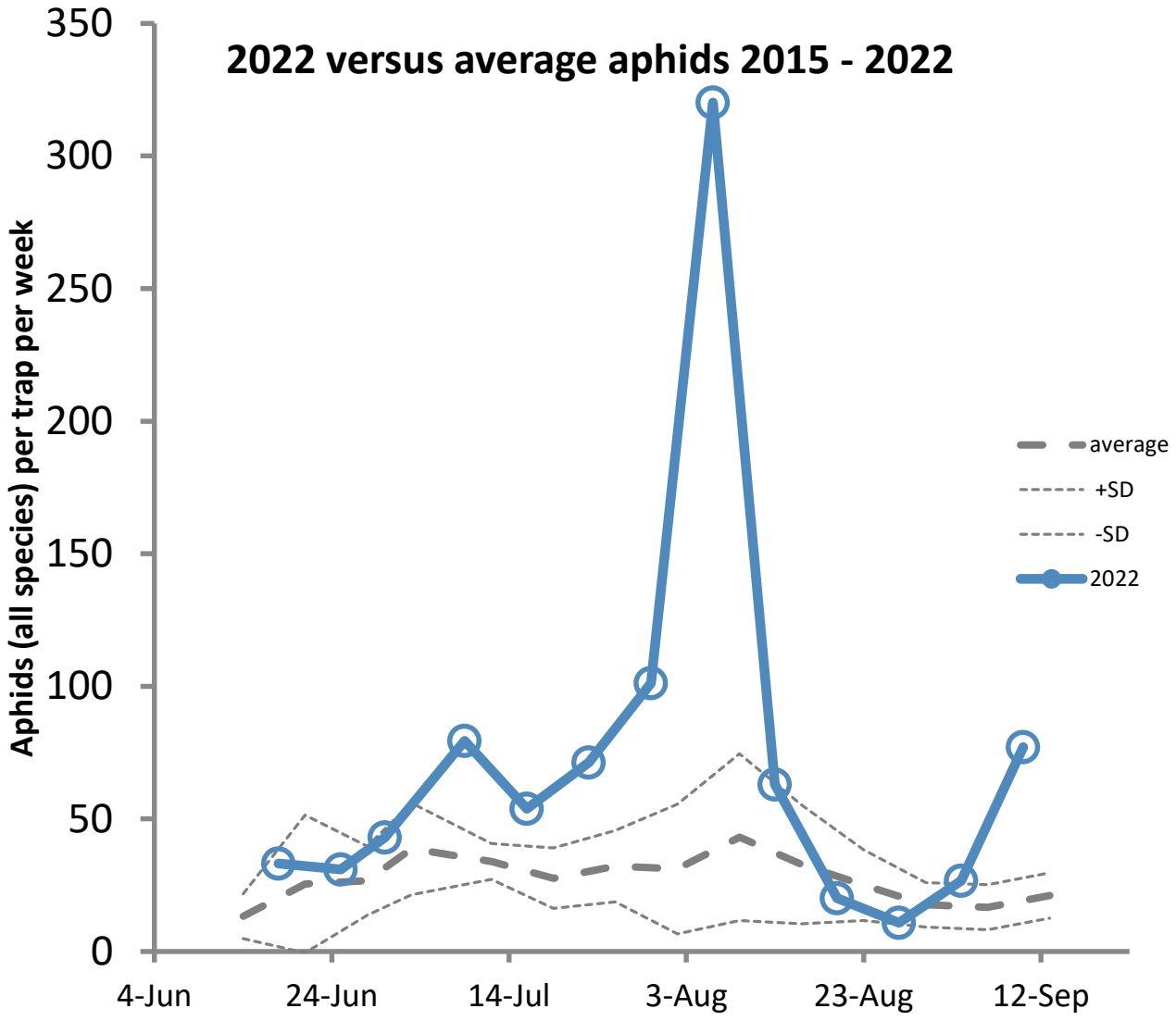

2022 was an EXCEPTIONAL year!

- Early peak was high (1st week July)
- Late peak (early Aug) *higher than ever observed before*

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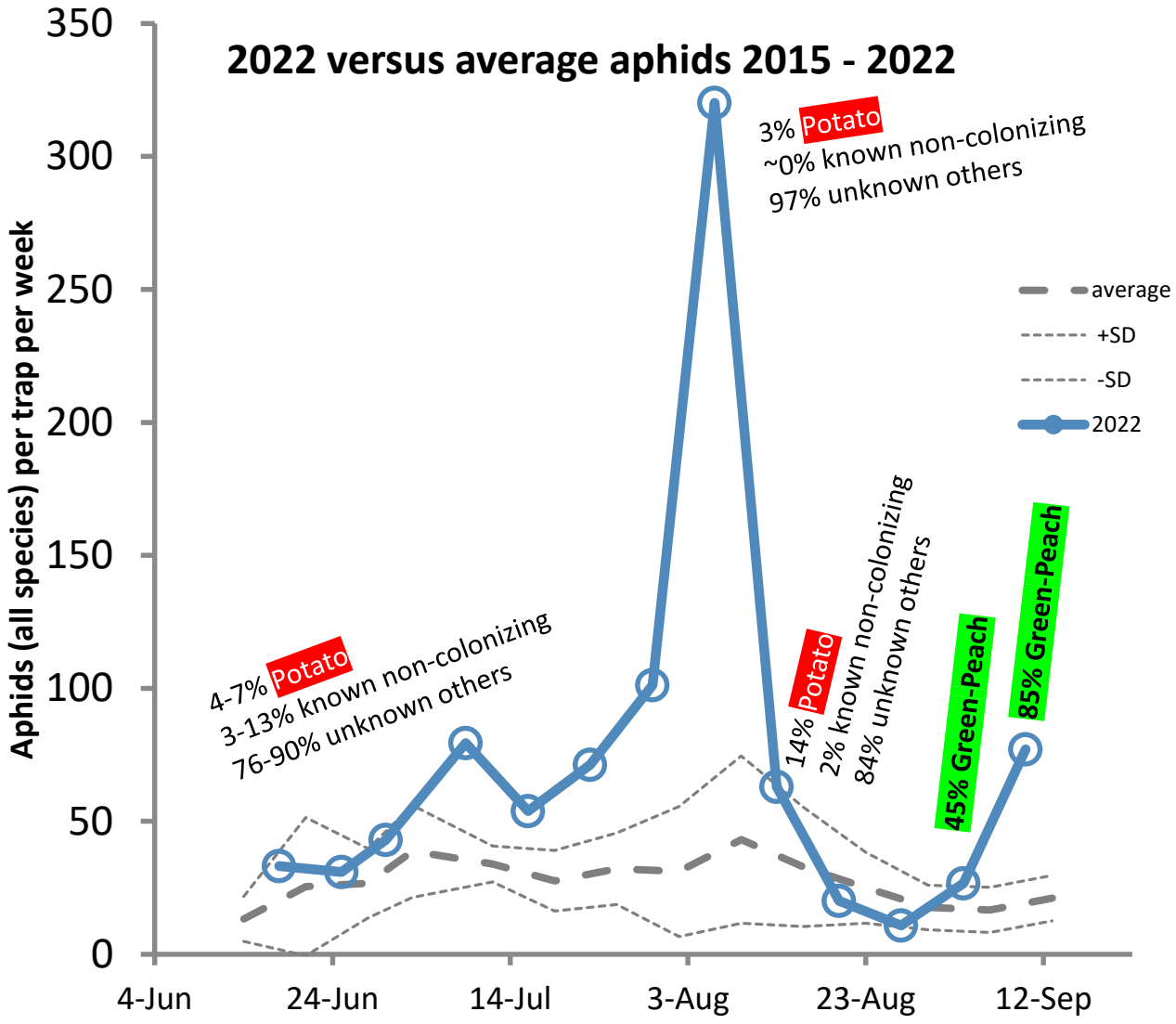

- Early and Late peaks mostly consisted of non-colonizing or unidentified species
- Colonizing Potato Aphids peaked in August
- High levels of Green Peach Aphid (most efficient PVY vector) in end of season

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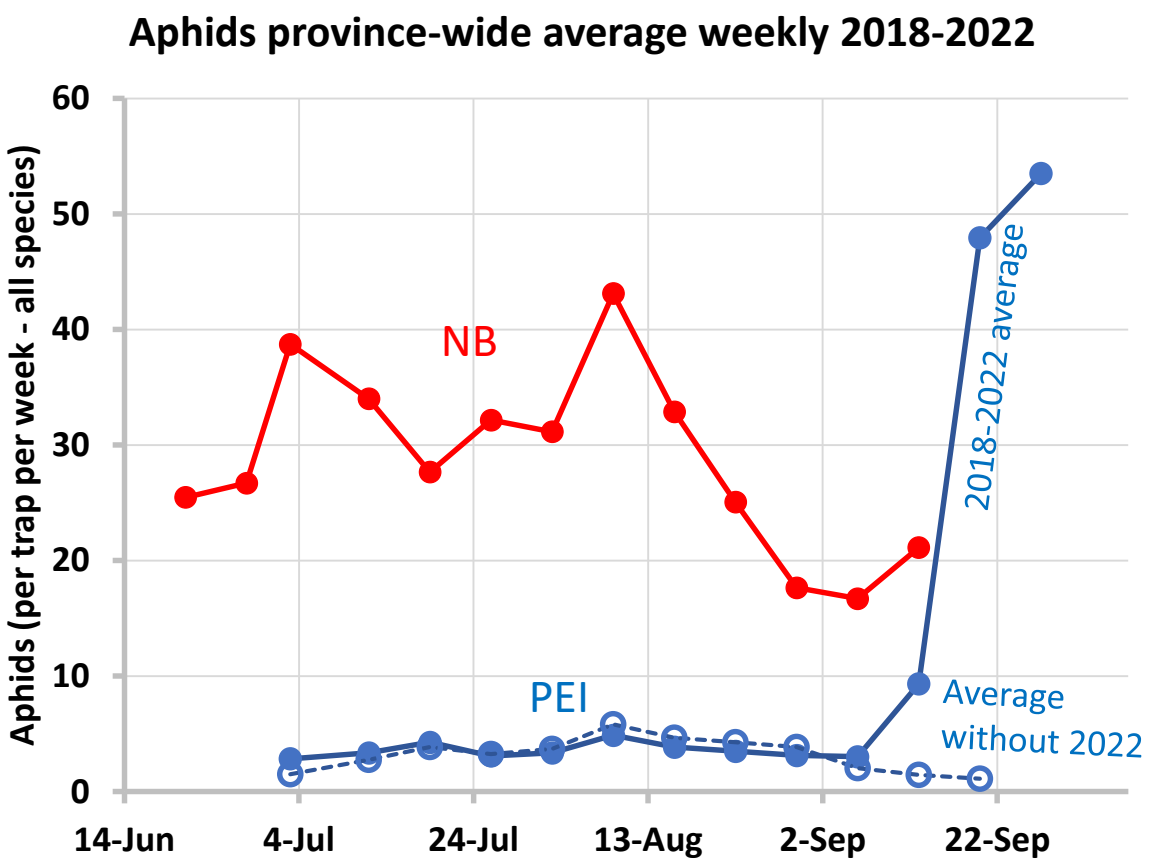
Comparison of aphids in NB and PEI



Weekly aphid captures in NB and PEI are very different (ALL SPECIES)

- NB on average shows ~10 times the aphids captured per week
- The times they are monitored in each province do not perfectly overlap
- Abundances are not just different in scale, they are generally not correlated in pattern, except:
  - There is weak correlation from year-to-year when comparing aphid abundance in NB to that in PEI 2 weeks to a month later
  - A strong shared rise in aphids late in season ONLY IN 2022, and only due to Green Peach Aphid
  - Normal years in PEI have low aphids in September

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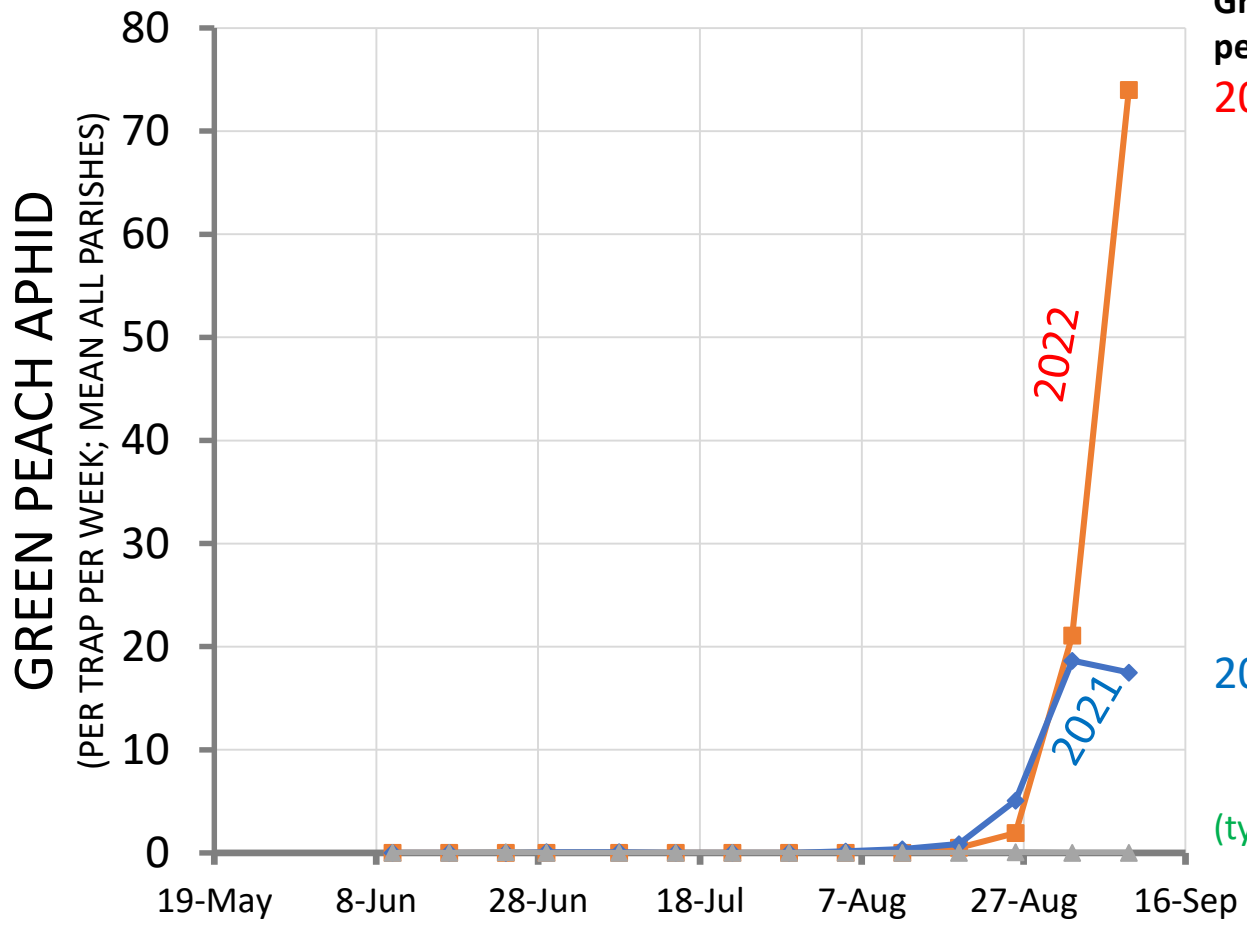
Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

Arrival of Green Peach Aphid (GPA)

Abundances of GPA are 25 to >1000 times higher at the end of the season (mid-Aug to mid-Sept) than typical years in the past decade; like all years, GPA is practically absent earlier in season.



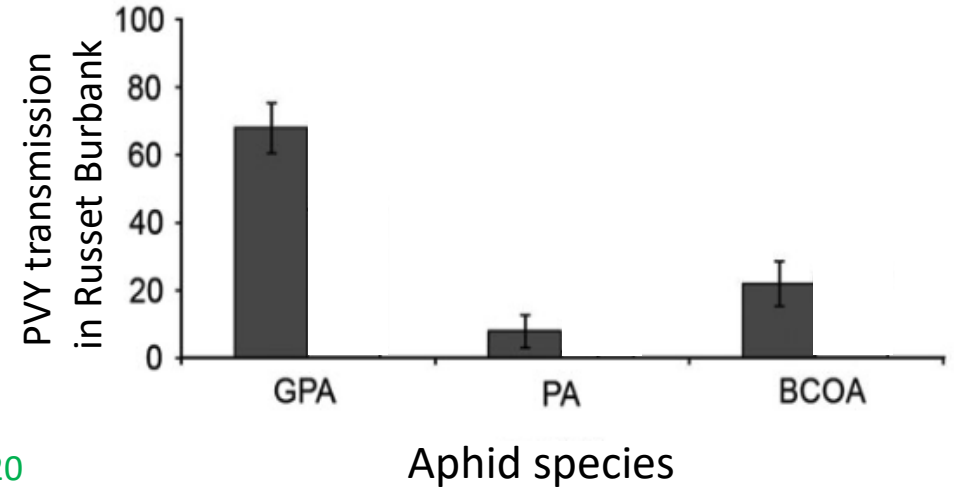
Green Peach per trap per week peak levels

2022 = 74

2021 = 19

(typical) 2018-2020 = range 0.07 to 1.5

GPA has been uncommon in NB until the last few years – but it is a very concerning species



Entomologia Experimentalis et Applicata

DOI: 10.1111/eea.12404

Comparison of transmission efficiency of various isolates of *Potato virus Y* among three aphid vectors

Shaonpius Mondal[1#], Erik J. Wenninger[2]*, Pamela J.S. Hutchinson[1], Jonathan L. Whitworth[4], Deepak Shrestha[1§], Sanford D. Eigenbrode[3] & Nilsa A. Bosque-Pérez[3]

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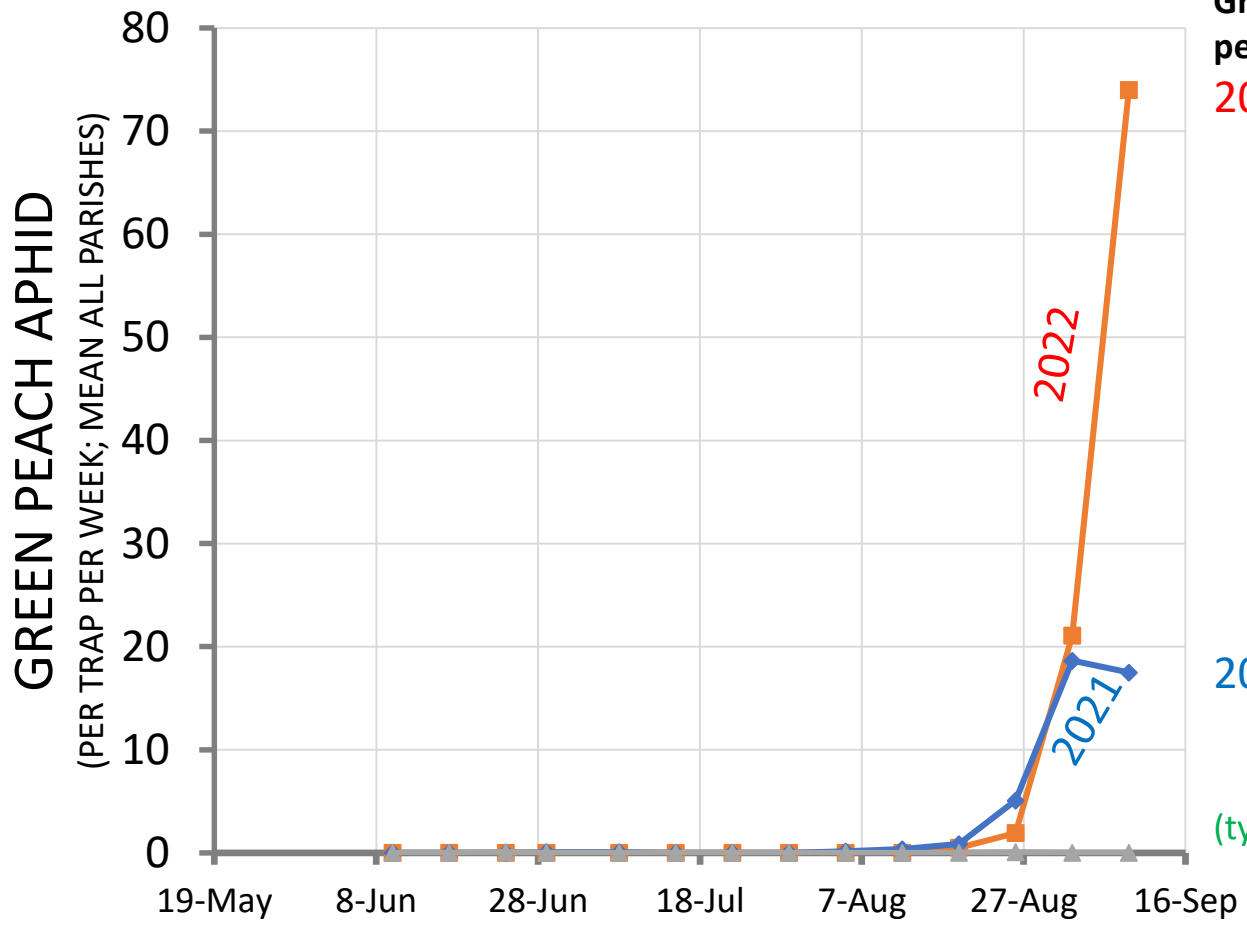

Green Peach per trap per week peak levels

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(typical) 2018-2020 = range 0.07 to 1.5

Number of Parishes with GPA

	2	2	1	12	13
	2018	2019	2020	2021	2022
Aberdeen	17	0	0	88	28
Andover	0	0	0	1	8
Brighton	0	0	0	0	285
Denmark	0	2	1	61	77
Drummond	0	0	0	193	246
Gordon	0	0	0	0	0
Grand Falls	0	1	0	2	138
Kent	0	0	0	12	21
Perth	0	0	0	23	222
Richmond	0	0	0	42	191
Saint Andre	0	0	0	14	3
Saint Quent	0	0	0	0	0
Simonds	0	0	0	3	10
Wicklow	0	0	0	3	26
Wilmot	0	0	0	11	13
Woodstock	33	0	0	0	0

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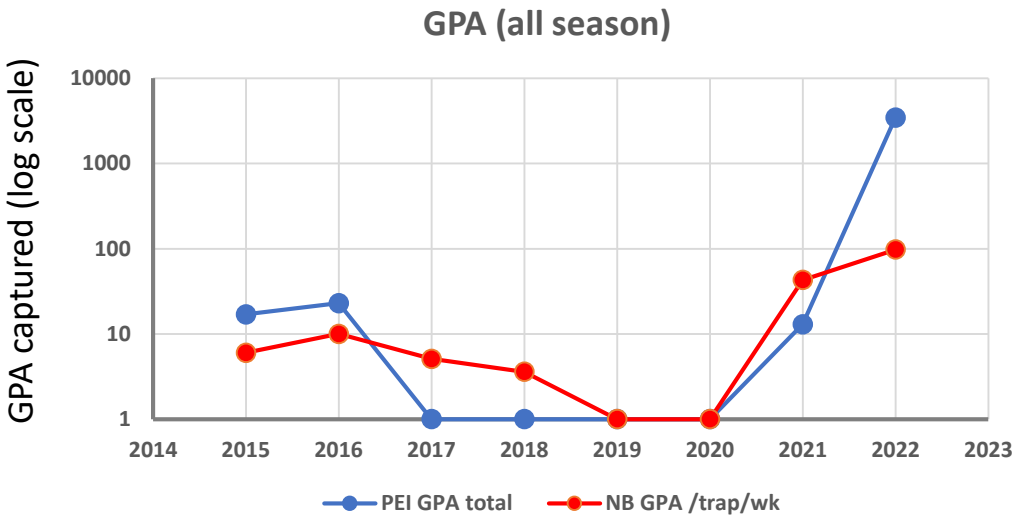
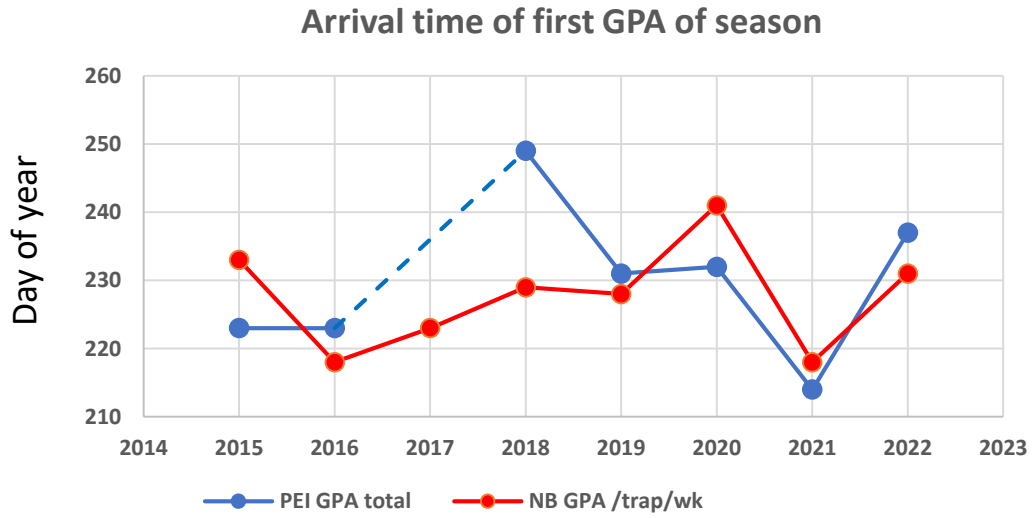
Comparison of Green Peach Aphids in NB and PEI



Low and High GPA years are similar in the both provinces… (note logarithmic scale)



…as was their arrival time in the late part of the season

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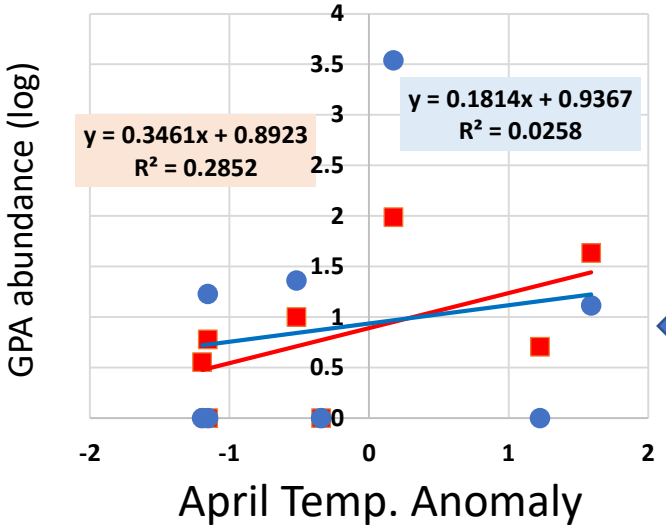
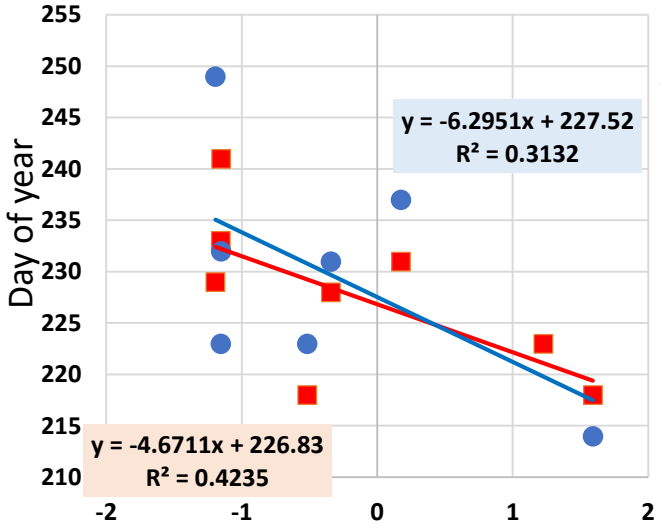
Comparison of Green Peach Aphids in NB and PEI



NB

PEI



We've found that the <u>temperature anomaly in April</u> is correlated with aphid abundance and PVY spread more than any other climate factor tested.

Weak correlation with <u>GPA abundance</u>…

…but strong correlation with <u>timing of GPA arrival</u> (warm April -> earlier arrival)

<u>Temperature anomaly</u> is the average difference in daily temperatures in April of each year compared to the long term average of 1981-2010. The past decade in Woodstock NB has ranged between 1.2˚ cooler and 1.6˚ warmer than that previous thirty year baseline.

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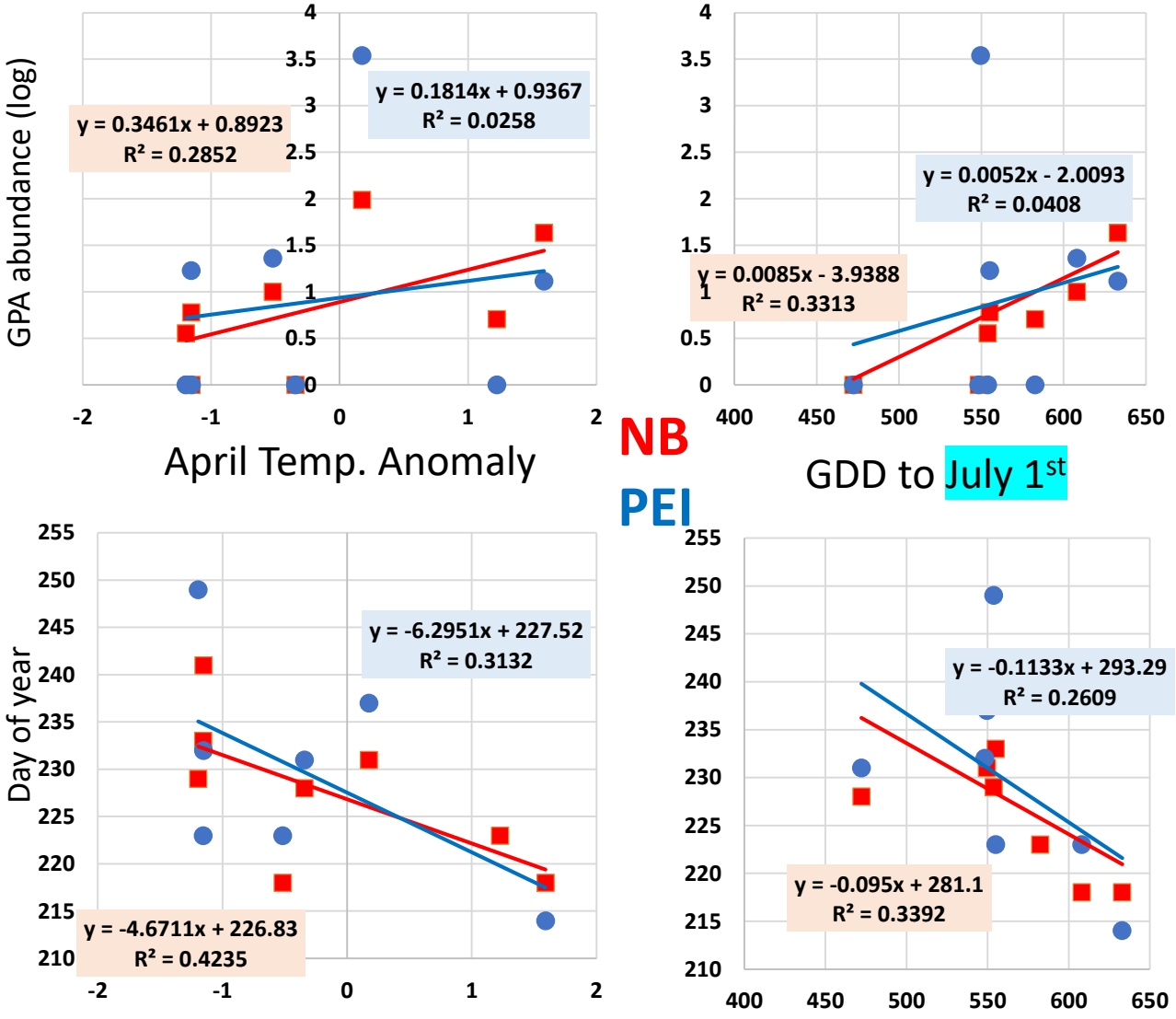

Growing Degree Days (GDD) accumulated to July 1st also correlates well with GPA abundance and arrival time.

GDD quantifies the relative "warmth" of different years over a span of time during the development of crops or their pest populations.

GDD to July 1st focuses on *warmth in spring and early summer.*

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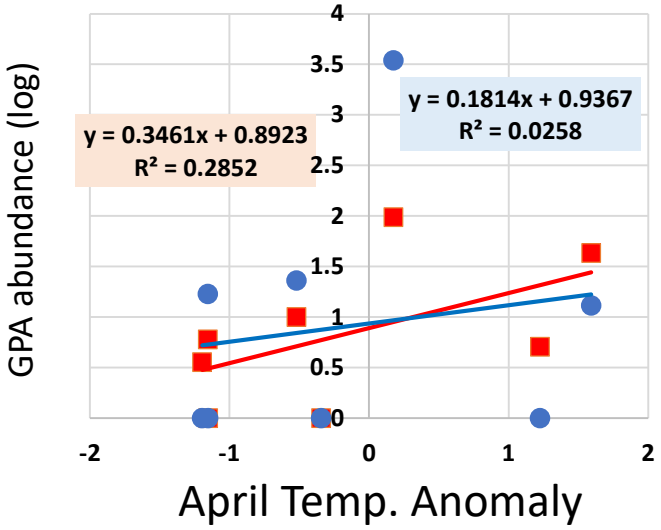
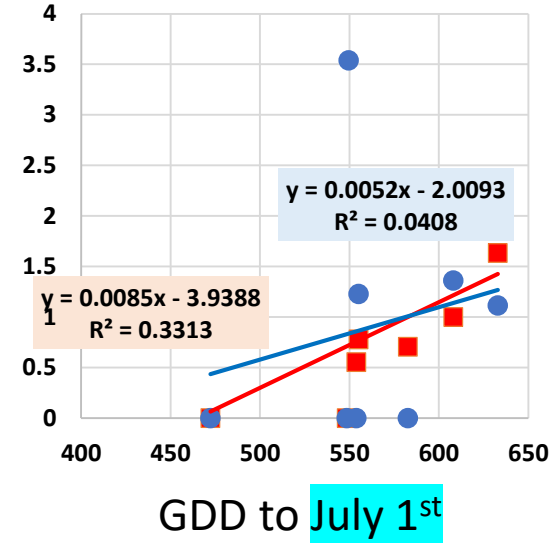
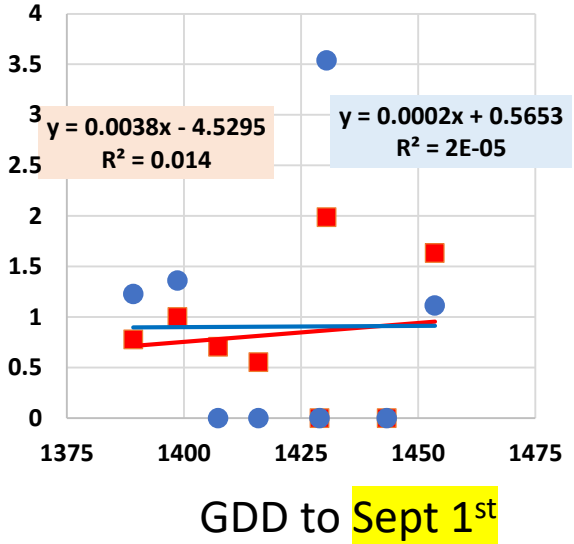
Comparison of Green Peach Aphids in NB and PEI

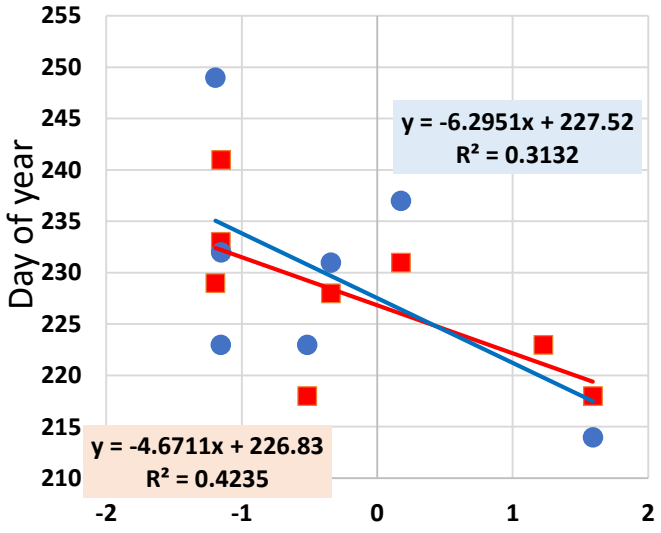


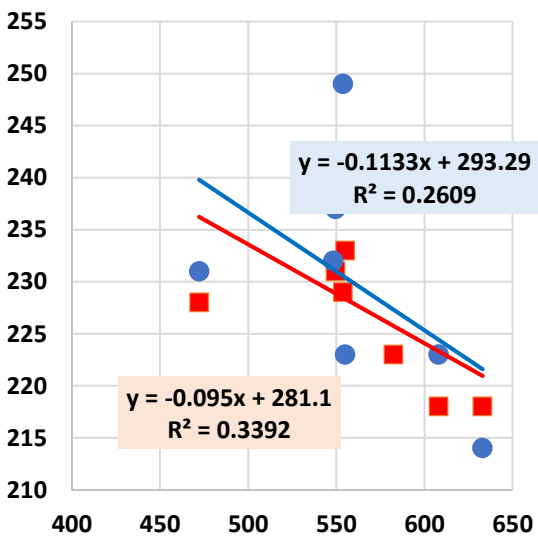


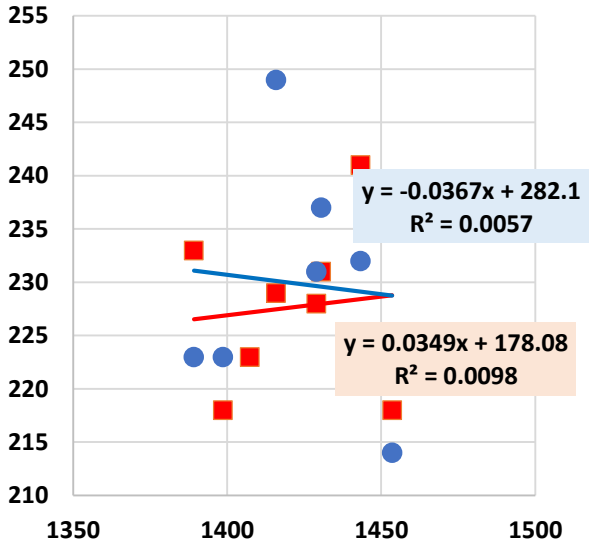


NB

PEI







Growing Degree Days accumulated to July 1st correlates well also, but NOT GDD accumulated out to 1 Sept…

Spring temperatures seem to be most important to abundance and arrival time of GPA much later in the season

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The future does not look promising

Monthly temperature anomalies – Woodstock NB

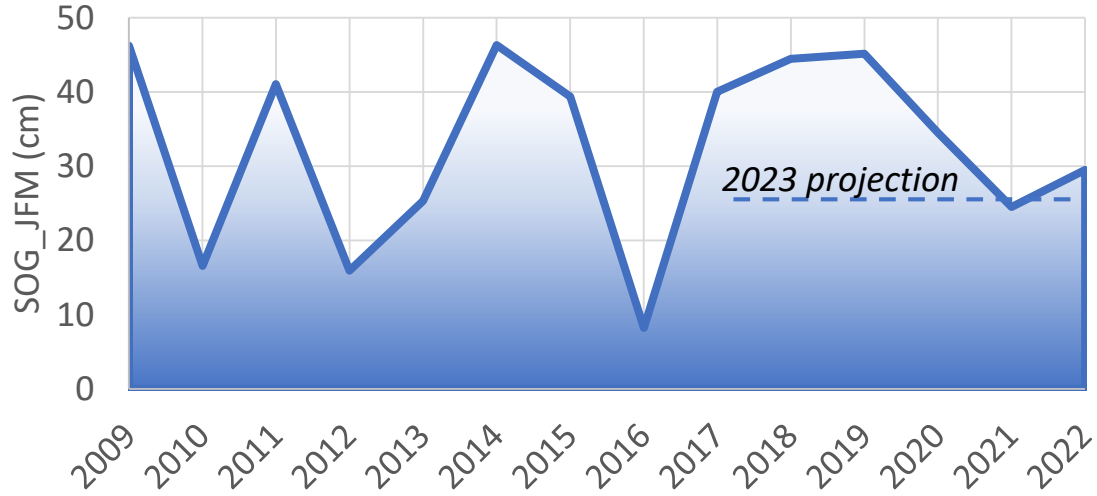
year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	2.027	0.245	0.781	0.002	-0.132	-0.274	0.920	0.832	1.850	1.979	3.359	2.555
2012	2.366	1.407	3.752	0.965	0.463	-0.912	0.792	1.994	0.129	1.572	-0.007	0.798
2013	0.921	1.490	2.252	-0.198	0.642	-0.888	1.301	-0.691	0.430	1.224	-0.955	-2.985
2014	0.979	-0.941	-4.986	-0.445	-0.522	0.196	1.144	0.048	0.474	2.256	-1.525	3.433
2015	-0.598	-6.197	-2.799	-1.155	1.871	-2.211	-0.815	2.045	3.327	-0.637	1.719	5.552
2016	4.524	3.447	0.975	-0.518	0.605	-0.319	0.079	0.368	1.412	1.578	2.143	-0.524
2017	4.305	1.645	-2.348	1.225	-0.200	-0.038	-0.435	-0.497	3.057	4.892	-0.148	-2.593
2018	1.447	3.779	1.781	-1.195	0.833	-2.018	1.933	1.477	0.594	-1.892	-2.685	-0.809
2019	-0.411	-1.186	-0.506	-0.342	-2.196	-1.104	0.762	-0.571	-1.043	1.253	-2.291	1.362
2020	3.359	0.566	0.426	-1.152	-0.815	0.068	1.189	0.407	-0.064	0.102	1.806	3.992
2021	4.756	0.990	0.901	1.592	-0.655	1.576	-2.279	1.677	1.040	3.043	0.602	1.813
2022	-1.711	0.783	0.917	0.175	0.723	-1.111	0.265	0.774	0.344	3.079	2.162	4.021
2023	5.444											

In NB, but likely reflective of PEI too:

- **January 2023 was warmest in over a decade – increased aphid survival**
- **Snowpack is 80% of normal so far – protective for aphids**
- **Ice in Gulf in January was tied for lowest in recorded history (tied with Jan 2021 at 16% of normal) – remainder of winter will likely be warmer than normal (April 2021 was warmest in over a decade following low-ice winter), *especially in PEI***

Winter snowpack

Snow-on-ground mean Jan-Mar annually – Woodstock NB



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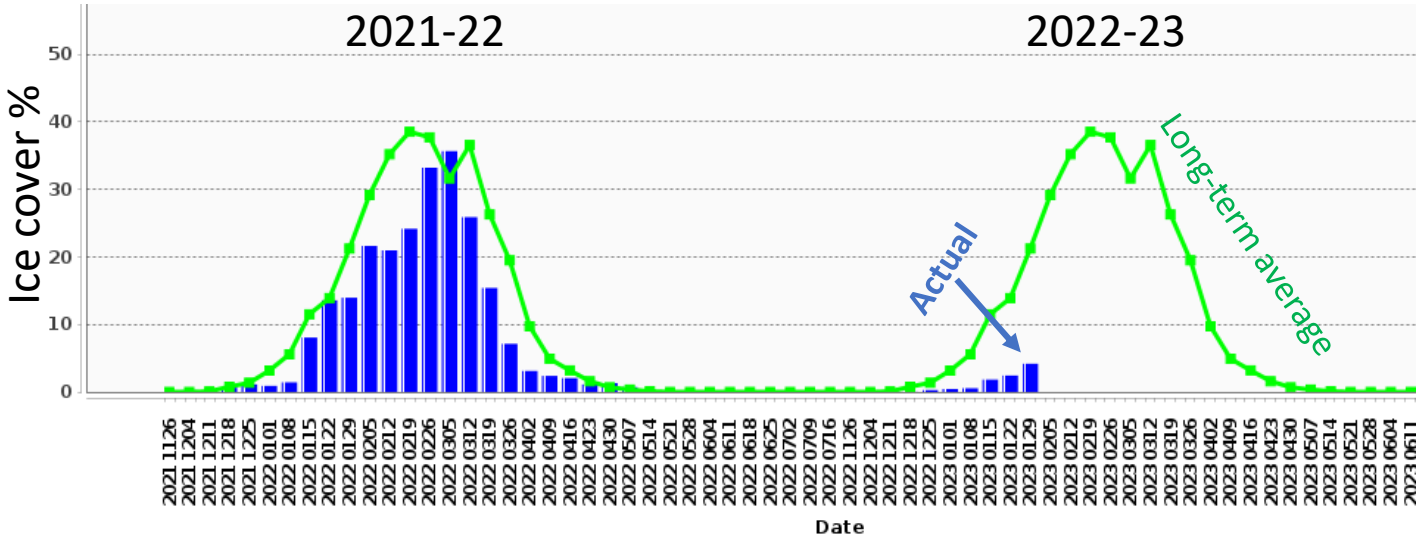
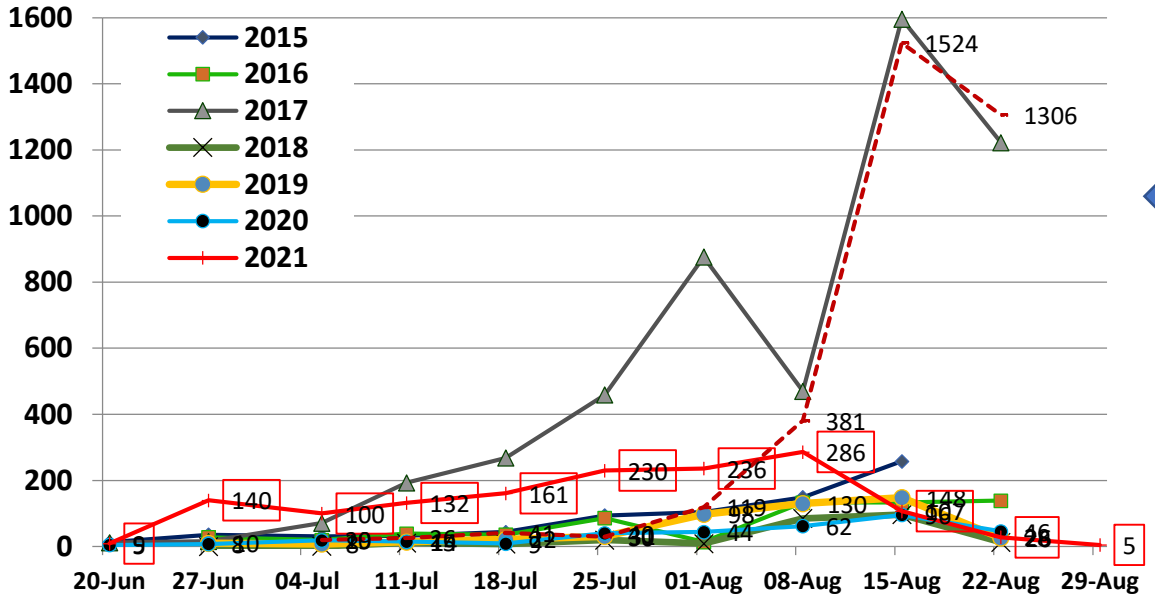
Gulf of St. Lawrence Ice Coverage

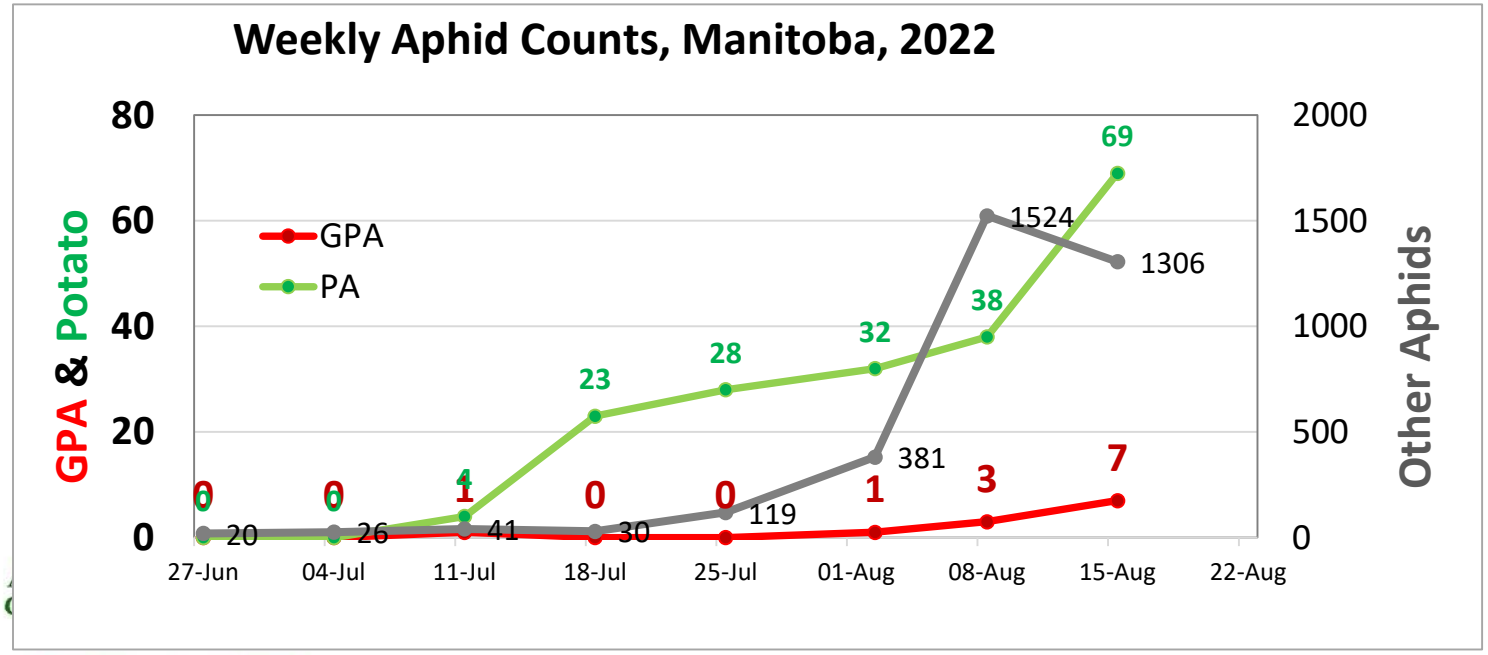


Do aphids change like this in other places?



Manitoba also shows some years with unusually high aphids, including this year.

But: not due to GPA like in NB or PEI



courtesy of Dr. Vikram Bisht
Manitoba Agriculture

Many aphids in NB are resistant to insecticides

In 2015-2016 we surveyed aphid populations to screen for genetic resistance (mutations) to common pyrethroid insecticides (e.g. Silencer, Decis, Cypermethrin, etc.)

Aphid species	% of resistant individuals (# tested)	
	2015	2016
Green Peach Aphid	76% (58)	96% (100)
Pea Aphid	0% (12)	20% (25)
Corn Aphid	(none tested)	17% (12)
Cotton-Melon Aphid	0% (7)	13% (8)
Potato Aphid	(none tested)	0% (5)
Bird Cherry-Oat Aphid	0% (3)	0% (2)
Others	4% (47)	11% (79)

-Significant populations of aphids from numerous species were found to have insecticide resistance mutations.
-Green Peach Aphid was greatest, with the majority of tested individuals genetically resistant.
-Resistance may be growing over time, as rates were higher in 2016 than 2015 in both GPA and other non-GPA aphids.
GPA 76% in 2015 -> 96% in 2016
Non-GPA 4% in 2015 -> 11% in 2016

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Clearly, PVY was high in 2022

Why?

Possible factors:

- What was planted in the field?
- **Aphids as vectors for PVY transmission?**
- Changes in the virus? Different PVY strains?
- Changes in management by growers?

Aphid levels were very high, including concerning Green Peach Aphid, making **a greater potential for PVY spread** *if not managed well*

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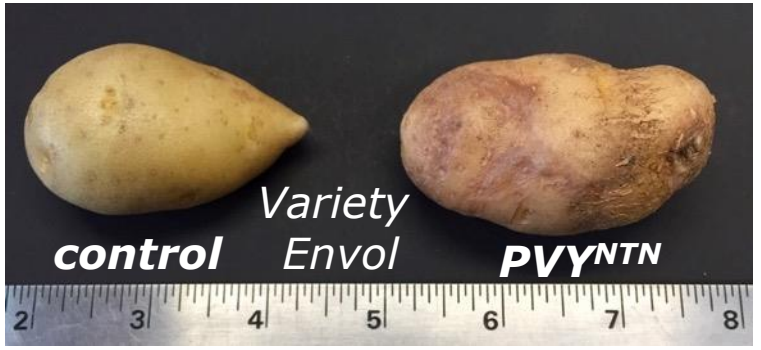
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

PVY is a complex of virus strains

At least four strains of PVY occur in potato fields that show different rates of spread, have distinct visual symptoms and effects on tuber yield and quality:

- **PVY^{O} – the "ordinary" traditional strain**
- **$PVY^{N:O}$ and PVY^{NTN} – newer recombinant strains that became dominant last decade**
- **PVY^{N-Wi} – another recombinant genetically similar to N:O only recently discovered in NB**

Control	PVY^{O}	$PVY^{N:O}$	PVY^{NTN}
No symptoms	Mosaic & curled	No symptoms?	Mild mosaic



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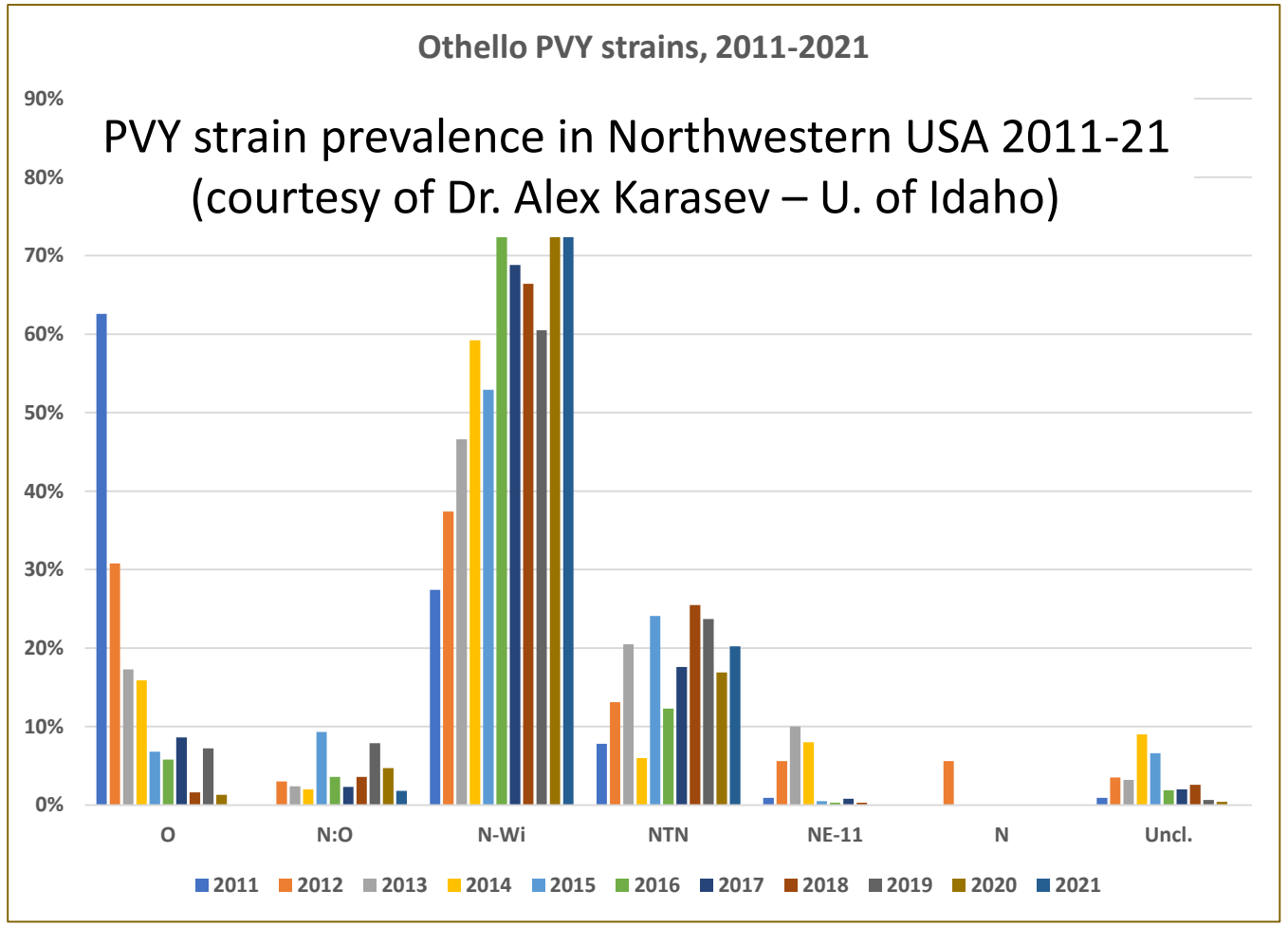
Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

PVY strains are changing in NB and elsewhere



PVY strains across Canada (2014-17)

2014	PVY^{O}	$PVY^{N:O/N-Wi}$	PVY^{NTN}
BC	**58%**	17%	25%
MB	11%	**50%**	39%
NB	24%	9%	**67%**

2015	PVY^{O}	$PVY^{N:O/N-Wi}$	PVY^{NTN}
BC	0%	**50%**	**50%**
MB	5%	0%	**95%**
NB	20%	16%	**64%**

2016	PVY^{O}	$PVY^{N:O/N-Wi}$	PVY^{NTN}
BC	15%	**85%**	0%
MB	0%	0%	**100%**
NB	13%	23%	**64%**

2017	PVY^{O}	$PVY^{N:O/N-Wi}$	PVY^{NTN}
BC	6%	**88%**	6%
MB	0%	11%	**89%**
NB	16%	14%	**70%**

Tran et al. (2022) Plant Dis. 106: 810-817. https://doi.org/10.1094/PDIS-08-21-1852-SR

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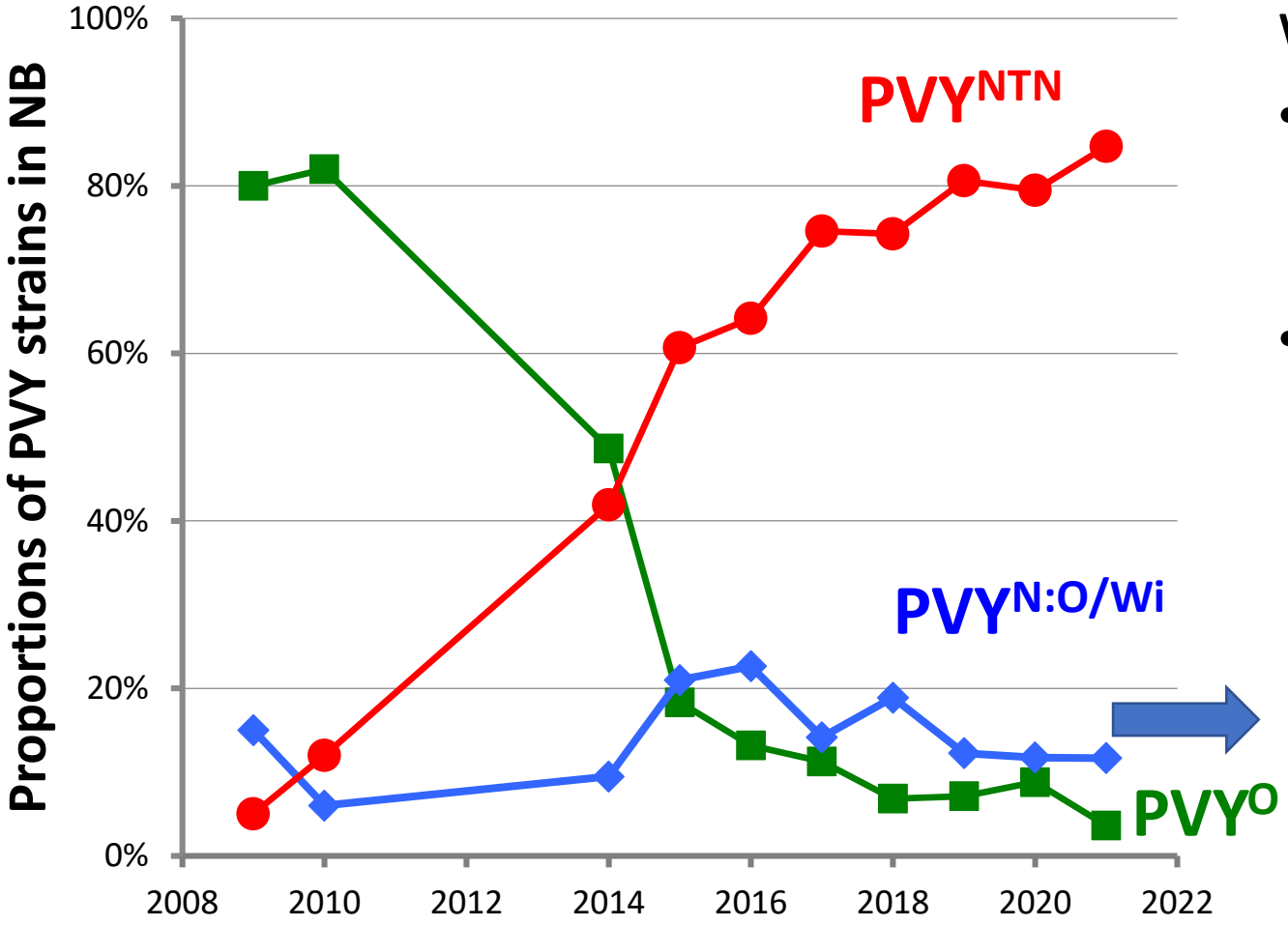
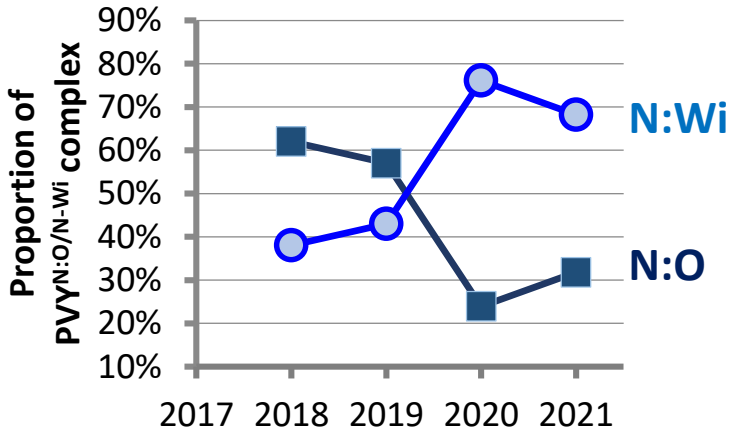
PVY strains are changing in NB and elsewhere



PVY^{NTN} is most dominant in NB

Why is this a problem?

- PVY^{NTN} has cryptic symptoms that make it hard to detect and rogue from fields
- PVY^{NTN} spreads plant→plant more easily than other strains



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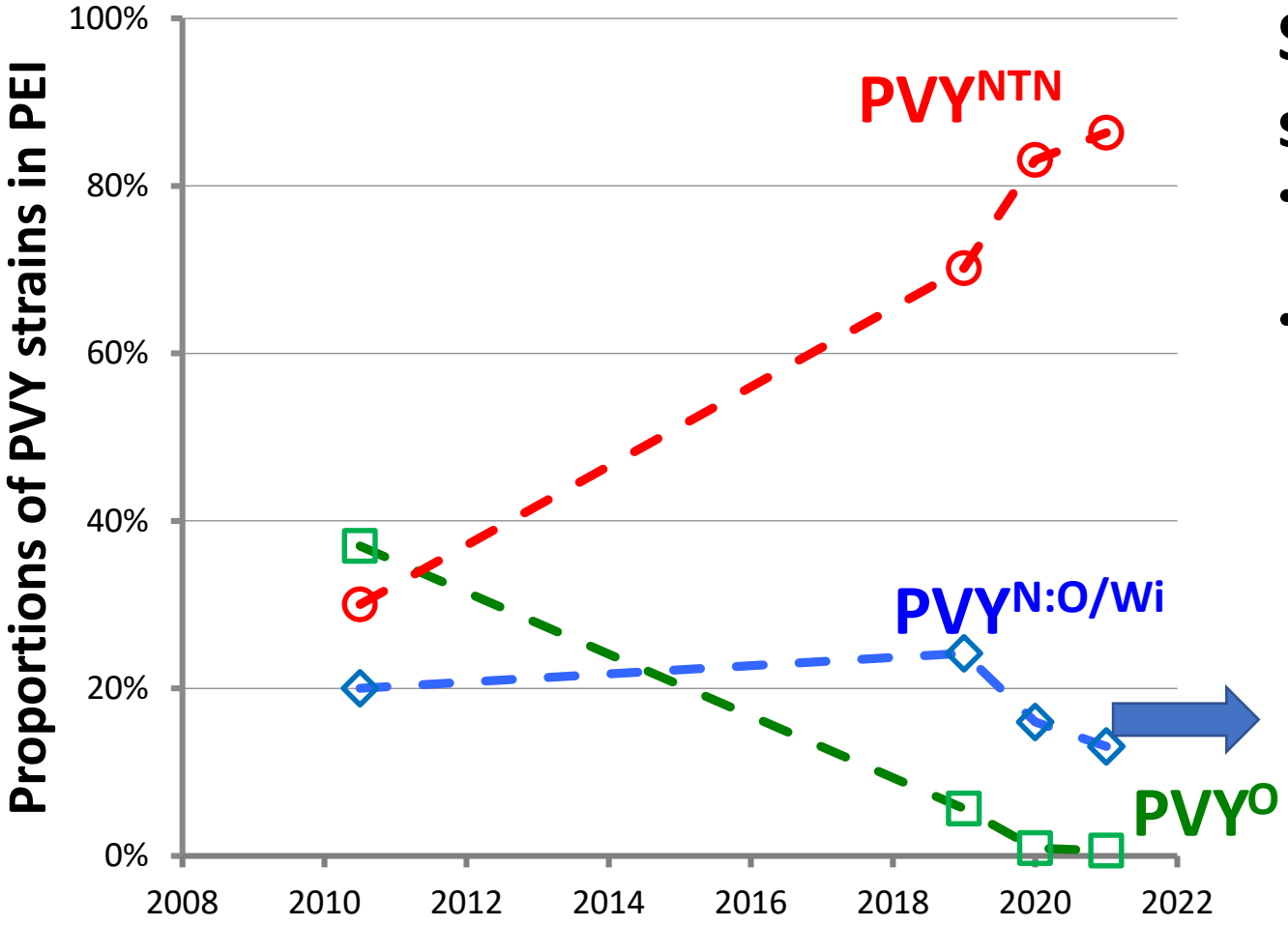
Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

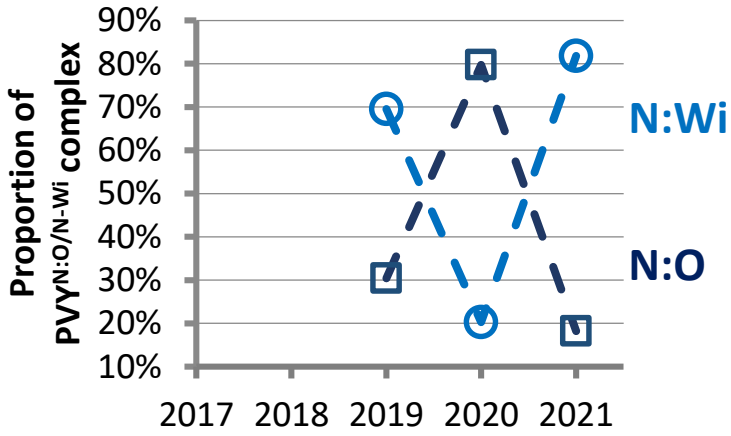
PVY strains are changing in NB and elsewhere



PVY^{NTN} is most dominant in NB & PEI

Strain changes in NB and PEI are very similar, but:

- Change from PVY^{O} to recombinant strains was earlier in PEI
- Shifts in N:O vs. N-Wi are more extreme in PEI



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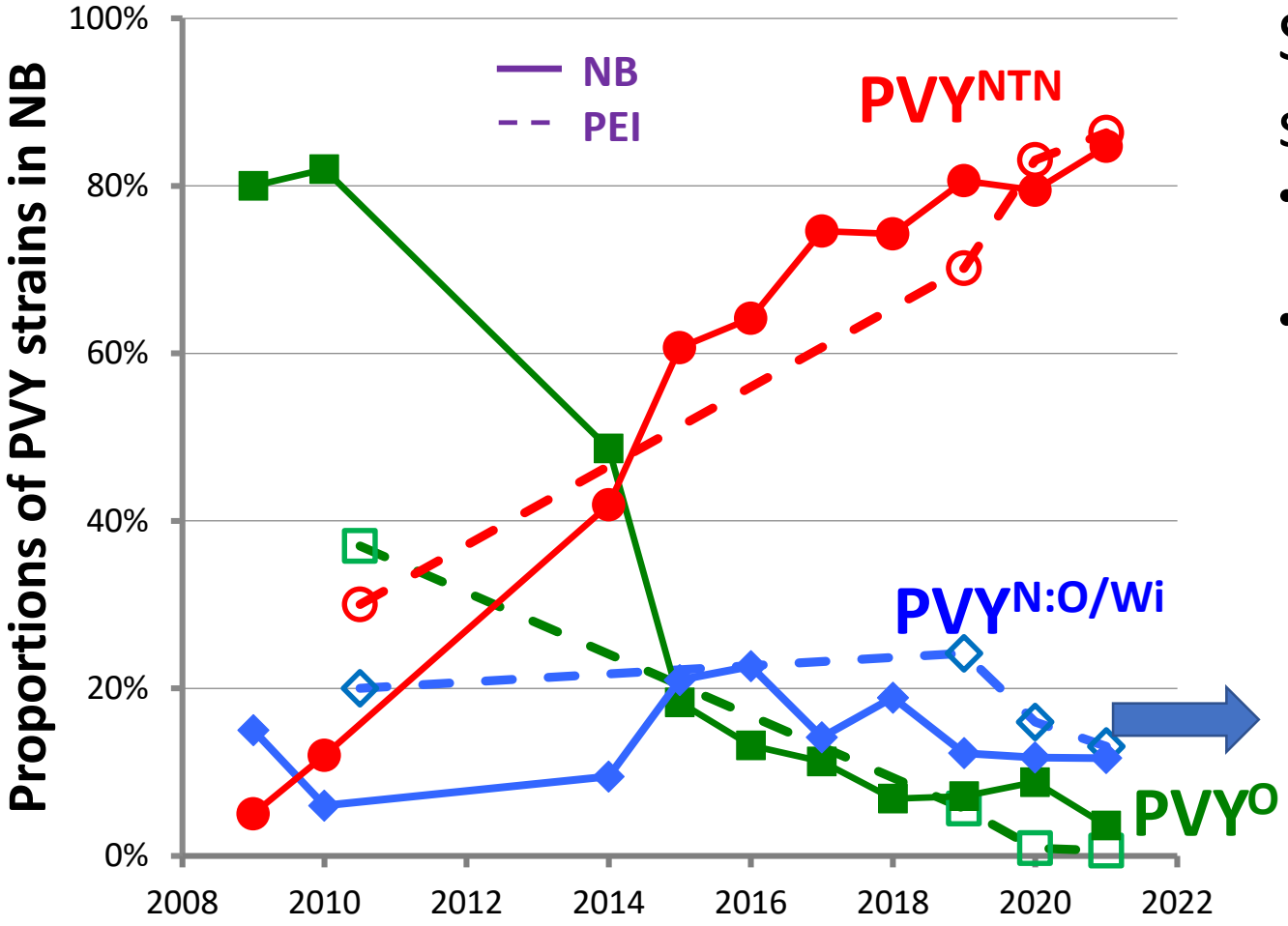
*courtesy of Dr. Huimin Xu (CFIA)

Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

PVY strains are changing in NB and elsewhere



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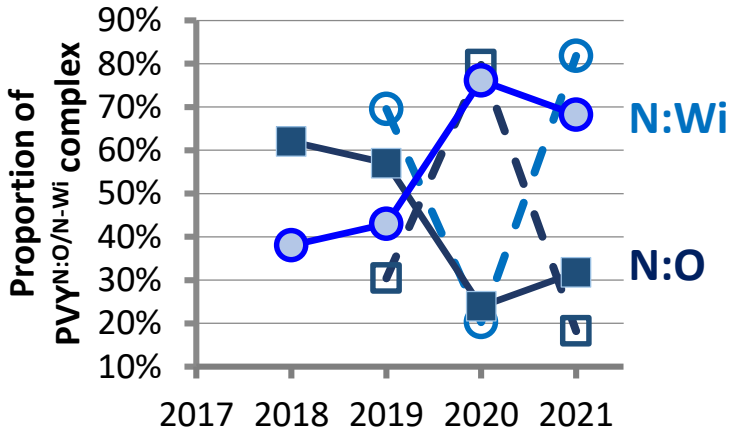

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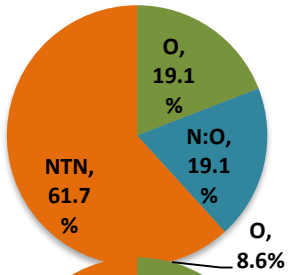
*courtesy of Dr. Huimin Xu (CFIA)

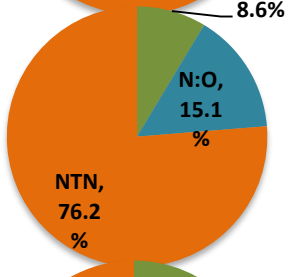
Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

Differential spread of PVY strains (field trials)

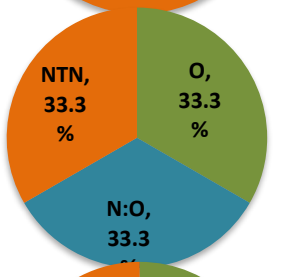
Inoculum



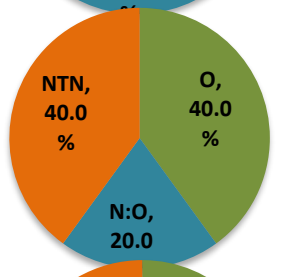
2014 Russet Burbank 1500 plants



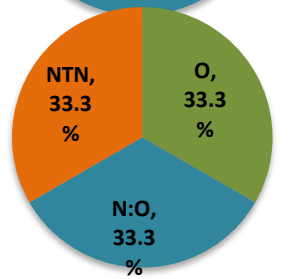
2014 Goldrush 1000 plants



2015 Goldrush 1000 plants

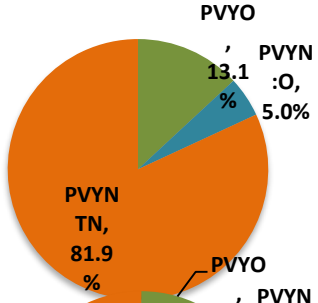


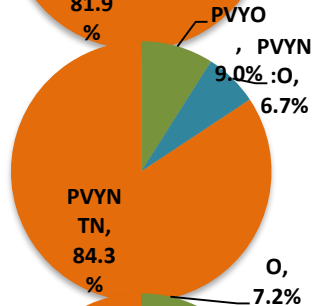
2015 Russet Burbank 1000 plants

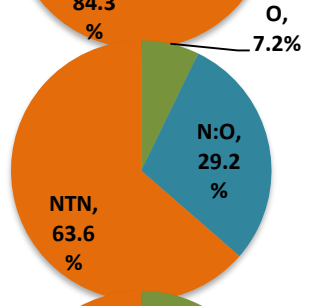


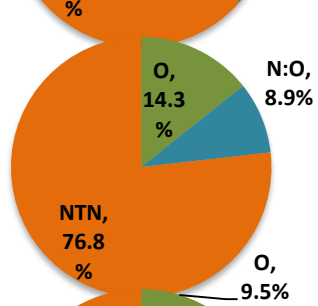
2016 Goldrush 1000 plants

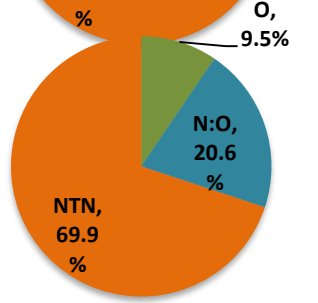
Plants at harvest



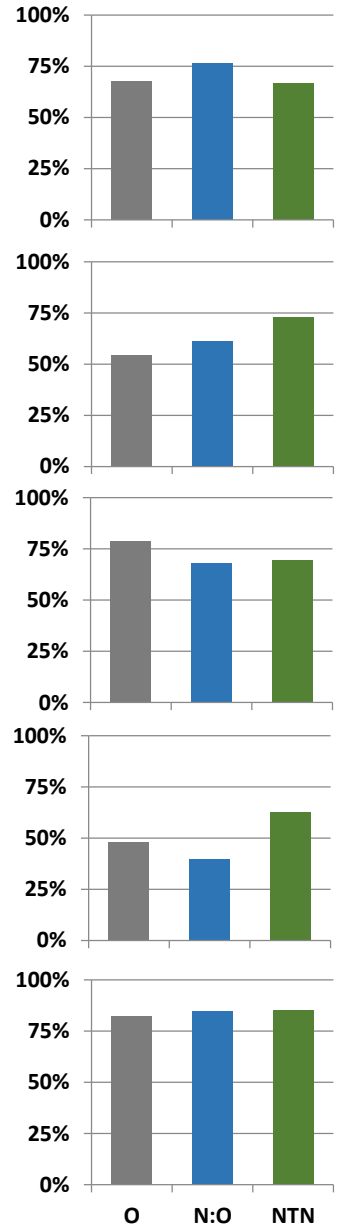








Proportion of infected tubers per plant



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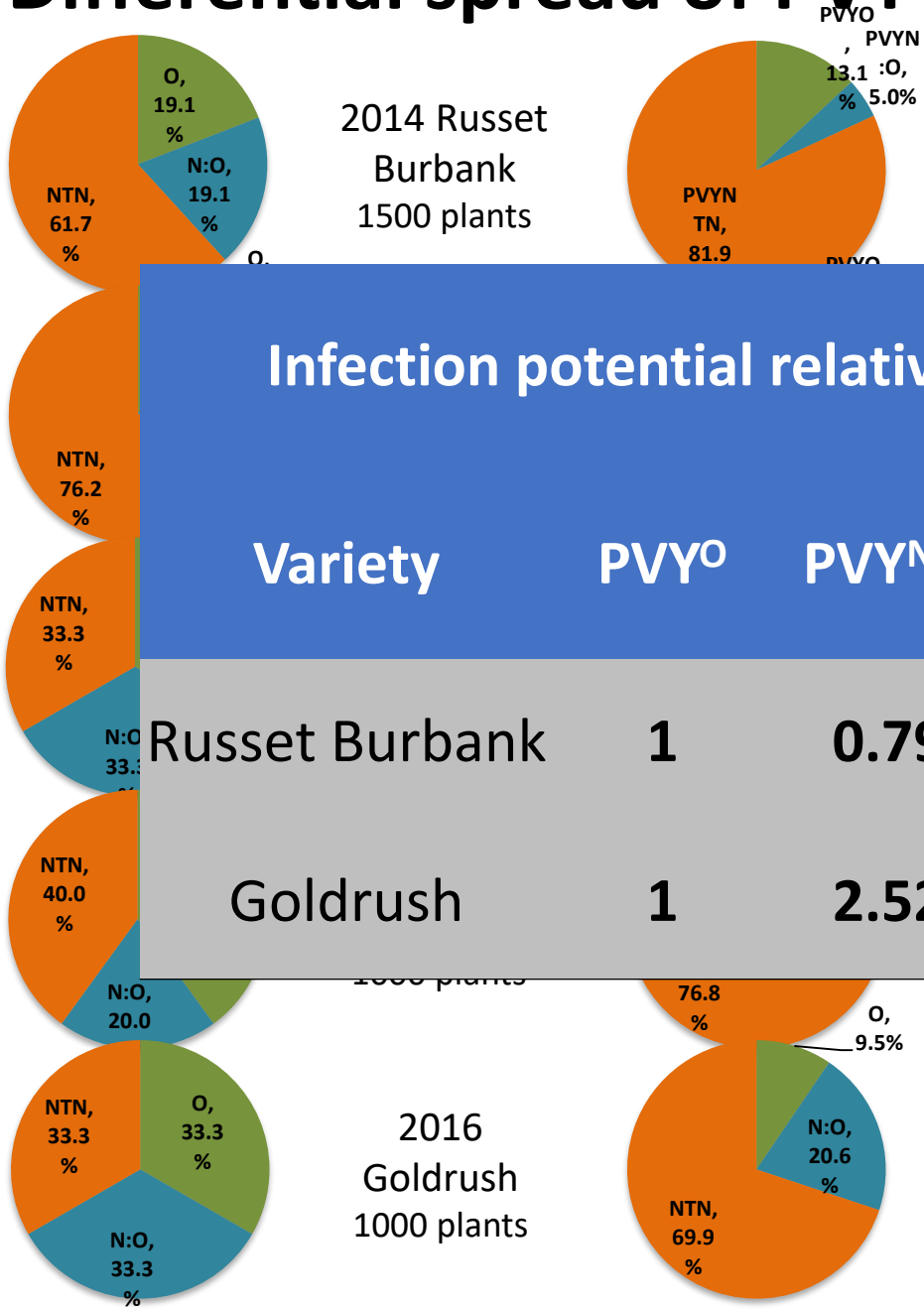
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

Differential spread of PVY strains (field trials)

Inoculum



Infection potential relative to PVY^{O}

Variety	PVY^{O}	$PVY^{N:O}$	PVY^{NTN}
Russet Burbank	1	0.79	3.11
Goldrush	1	2.52	6.68

Proportion of infected tubers per plant

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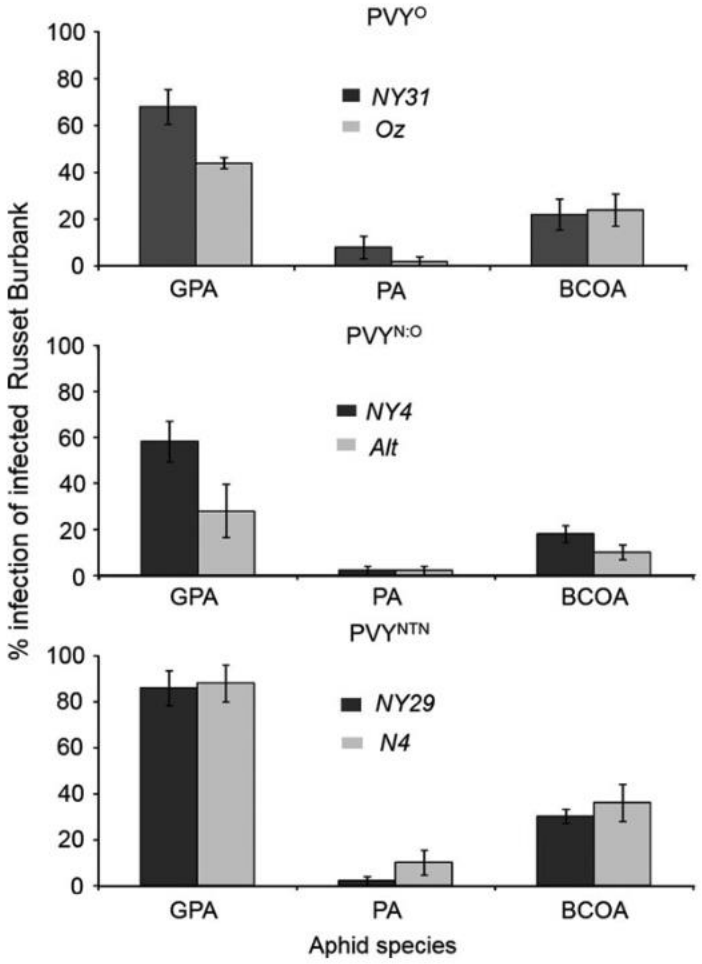
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

Entomologia
Experimentalis et Applicata

DOI: 10.1111/eea.12404

Comparison of transmission efficiency of various isolates of *Potato virus Y* among three aphid vectors

Shaonpius Mondal[1#], Erik J. Wenninger[2]*, Pamela J.S. Hutchinson[1], Jonathan L. Whitworth[4], Deepak Shrestha[1§], Sanford D. Eigenbrode[3] & Nilsa A. Bosque-Pérez[3]



Different species of aphids spread strains of PVY with different efficiency

Depending on the virus strain (or even different isolates of the same strain [grey bars]) and the species of aphid, efficiencies of PVY infection can vary by >10 times.

PVY Transmission Modes

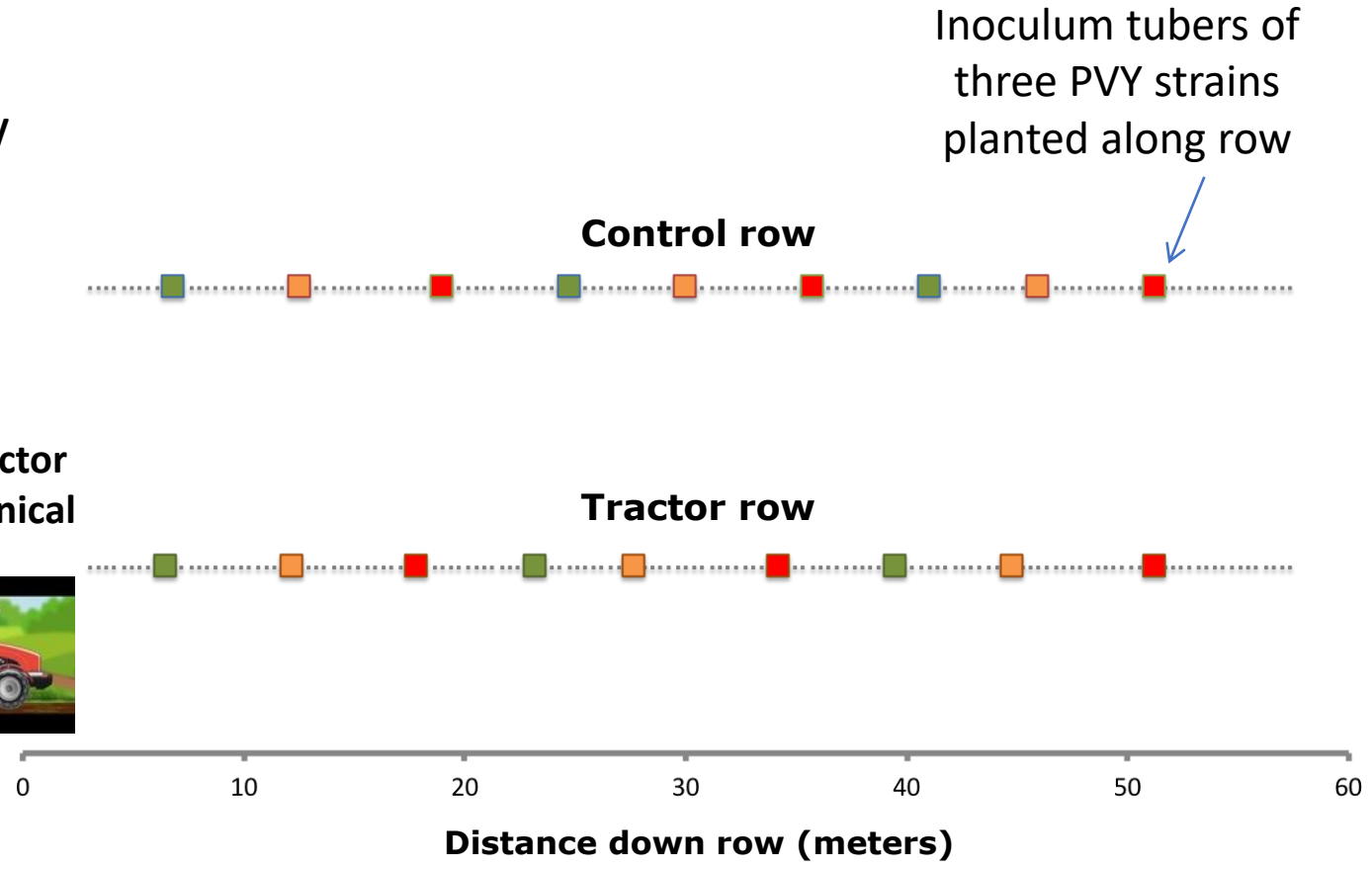
By aphid vector naturally

Also, mechanically (contact/wounding)

Aphid vector only

Aphid vector + Mechanical

+



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PVY Transmission Modes

By aphid vector naturally

Also, mechanically (contact/wounding)

Aphid vector only

Harvest tuber test:
11.2% new PVY control row

Control row

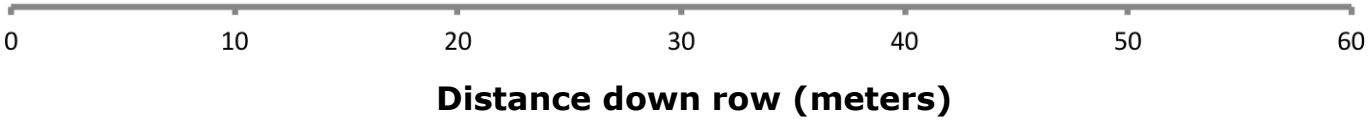
Aphid vector
+ Mechanical

+

Tractor row

over twice as much spread in tractor row

Harvest tuber test:
26.6% new PVY tractor row



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Mechanical PVY transmission does not depend on potato variety, and is not caused by exciting aphid flights – it is only in rows the wheels touch

PVY spread:

Seed-borne PVY	Goldrush	Tractor row:	25.1%	row adjacent:	0%
		Control row:	3.2%	row adjacent:	1.6%
Primary-infected PVY	Russet Burbank	Tractor row:	48.5%	row adjacent:	4.0%
		Control row:	6.8%	row adjacent:	3.5%
	Innovator	Tractor row:	19.7%	row adjacent:	2.7%
		Control row:	1.9%	row adjacent:	4.1%

PVY spread localized to mechanical rows
= not by tractor causing aphid flights

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Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

Clearly, PVY was high in 2022

Why?

Possible factors:

- What was planted in the field?
- Aphids as vectors for PVY transmission?
- **Changes in the virus? Different PVY strains?**
- Changes in management by growers?

Newer recombinant strains show milder symptoms, spread faster by aphids and mechanically so Growers must plant clean seed, if possible. Isolate and change management practices for PVY in the growing crop

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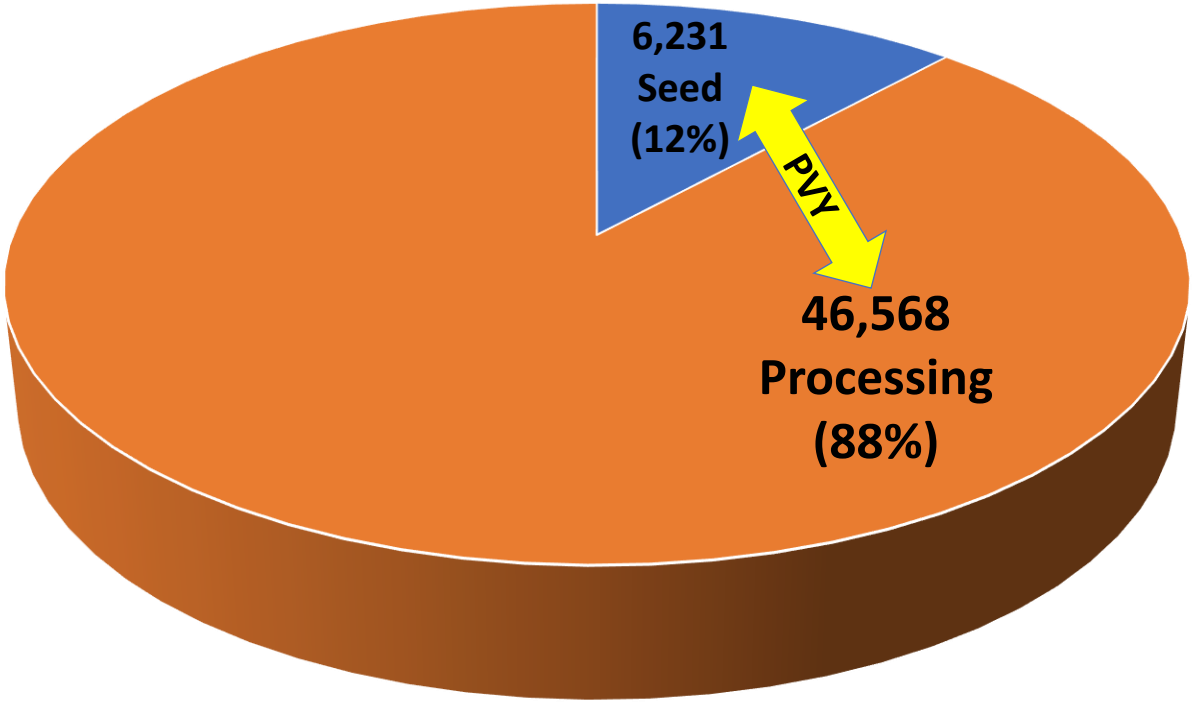
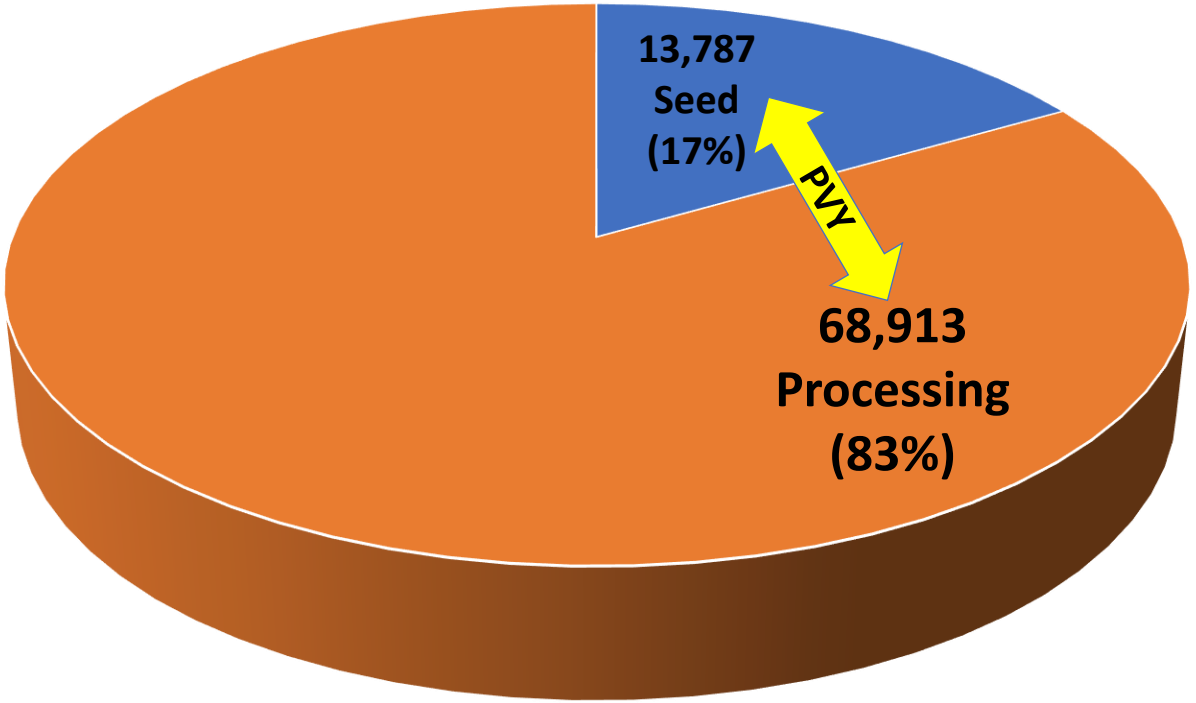
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

The NB and PEI potato industries are a mix of seed and processing production

NB - 52799 acres



PEI - 82700 acres



Concern about intermingling of crop sectors allowing PVY to get into seed crop

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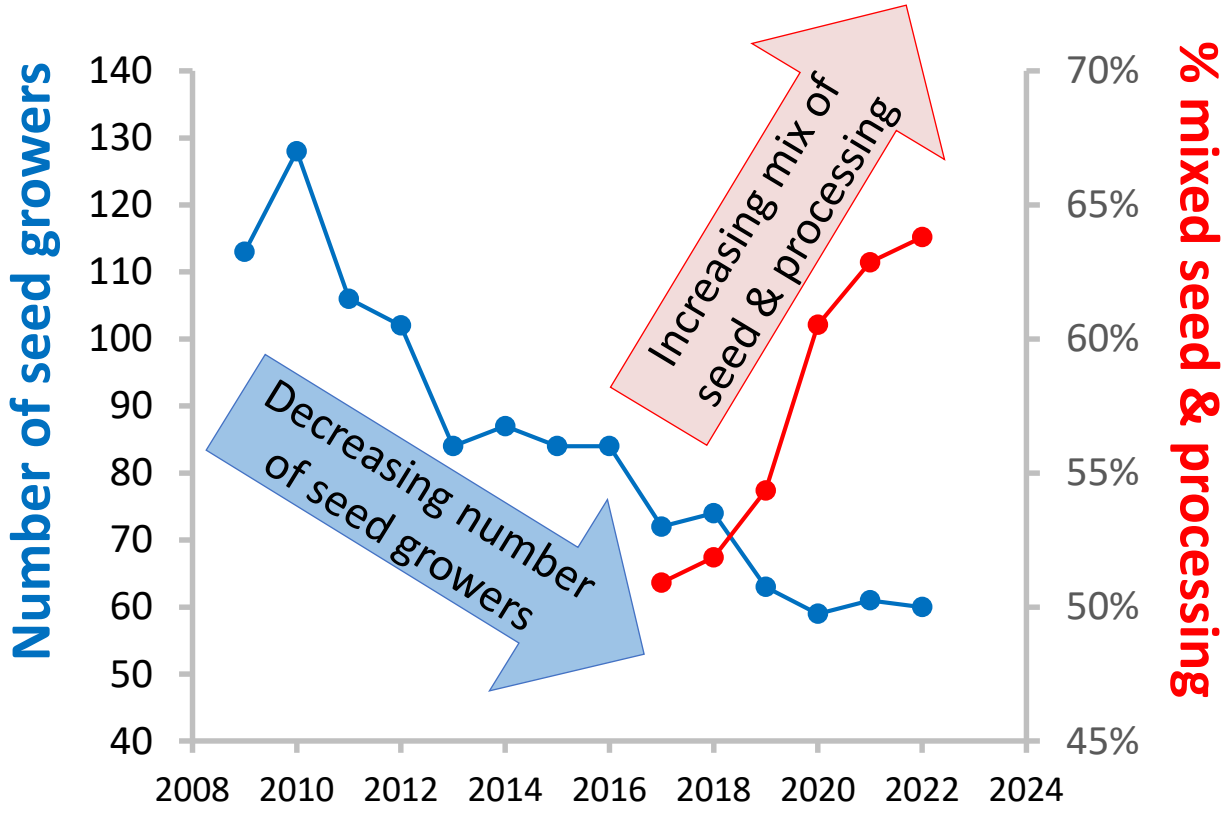
Potatoes Pommes de terre NB NEW/NOUVEAU-BRUNSWICK

Industry trends to 2022



Total number of growers submitting samples for PHVT, and % of total acreage under management of seed growers that are non-seed crops (processing/table stock)

Grower's producing SEED POTATOES, but have acreage also in processing potatoes show higher levels of PVY in their SEED fields (previous slides)

This is even worse in a high-PVY year like 2022

Over the last decade, the number of seed potato growers in NB has declined dramatically, and they have greatly consolidated seed and non-seed crops within their operations.

Non-seed crops are not as intensively managed for PVY, could get very high in a year like 2022 and serve as a ***virus source for neighbouring seed-production fields****.*

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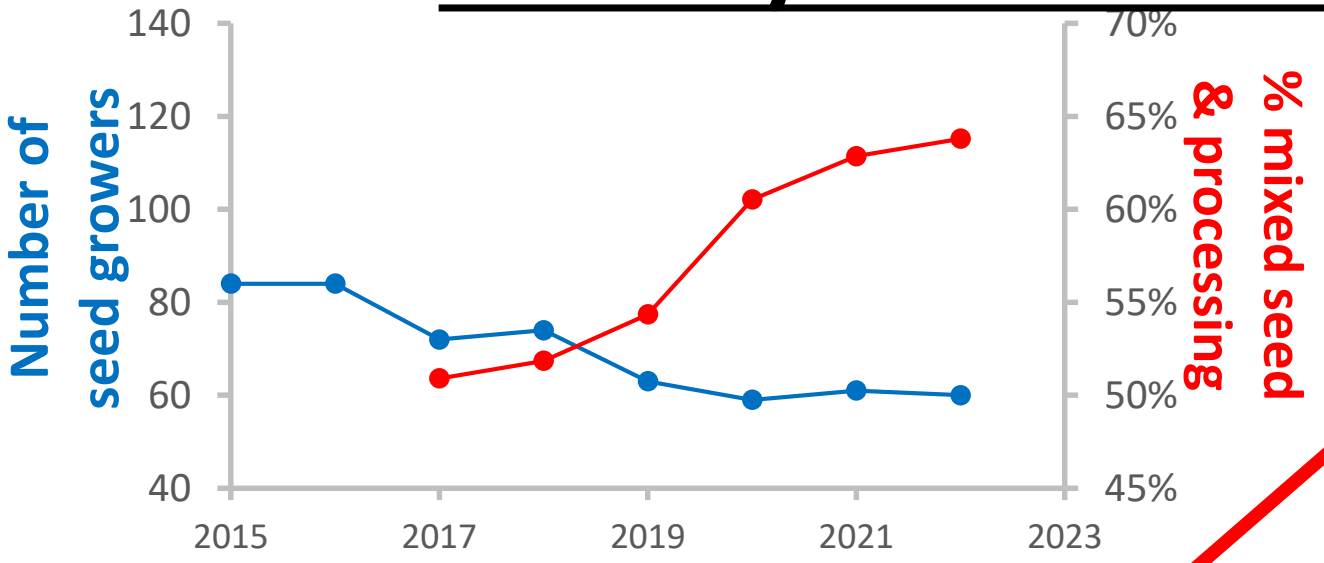
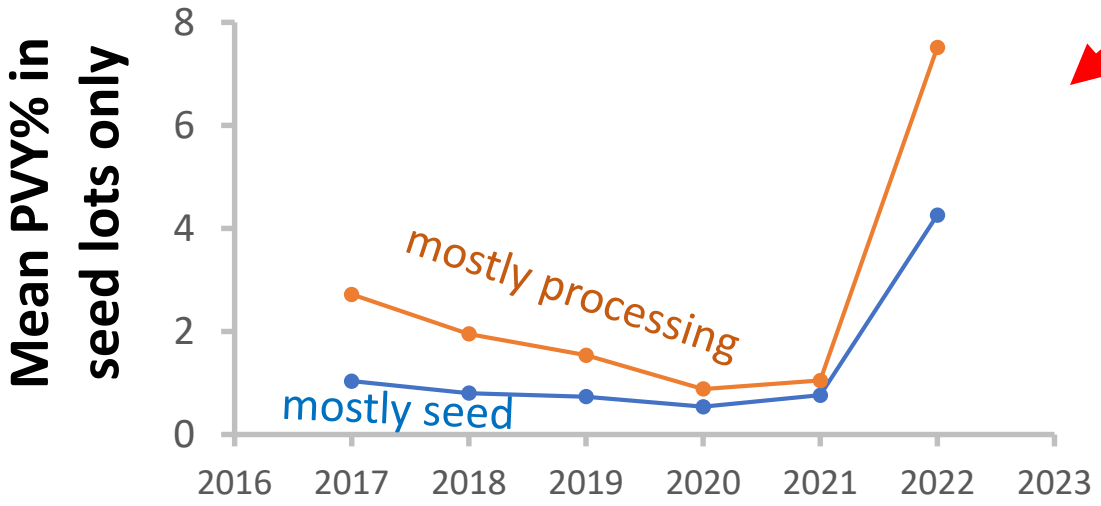
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

Industry trends to 2022





Growers with mostly processing/ table stock show 37% to 162% more PVY *IN THEIR SEED LOTS ONLY* than growers producing mostly seed.

Bottom line: MIXED-CROP GROWERS must be extra careful with PVY management.

- **Neighbouring processing fields may become inoculum in seed fields**
- **EXTRA intense management of spread**
- **Critically important *checking early for PVY symptoms* and *spraying during early-season peak aphid flights***

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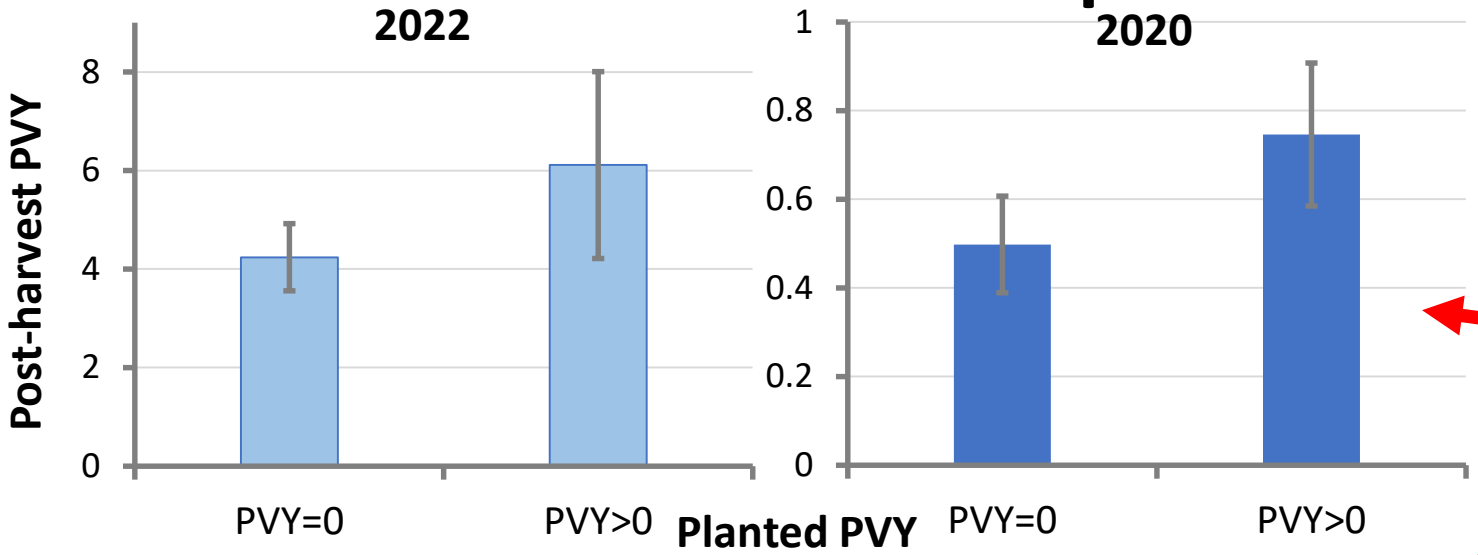
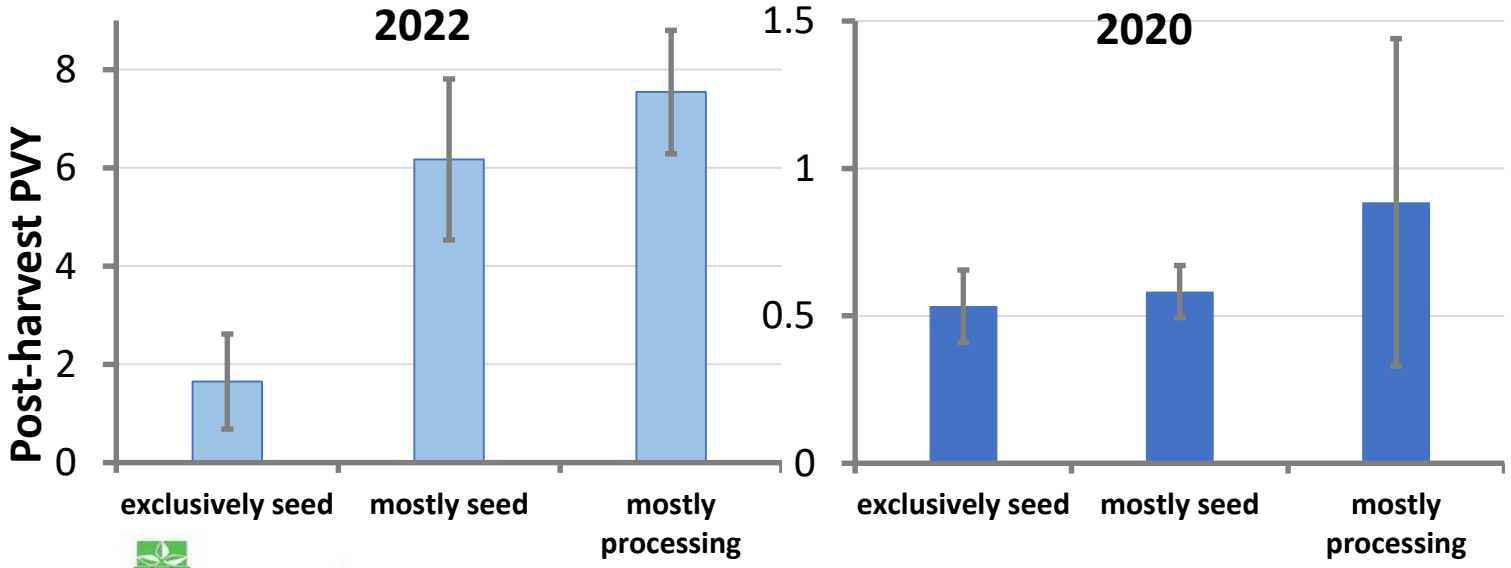
Potatoes Pommes de terre NEW/NOUVEAU-BRUNSWICK

Decisions of Growers affect post-harvest PVY – GROWER SURVEY 2022



Growers can control many factors that can reduce PVY

- Variety choice (previous slides)
- Planting clean seed
- Concentrating on seed production, isolated from processing or table stock fields



Seed vs. non-seed growers

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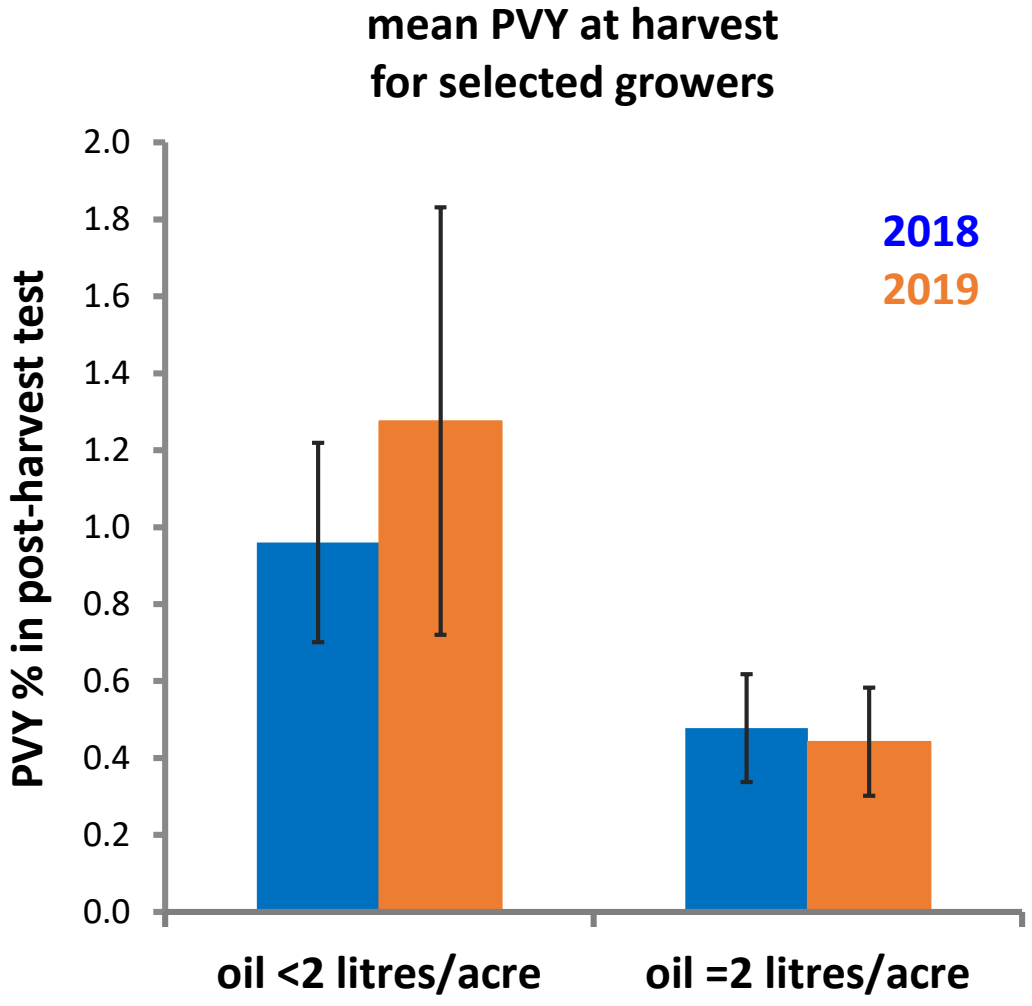
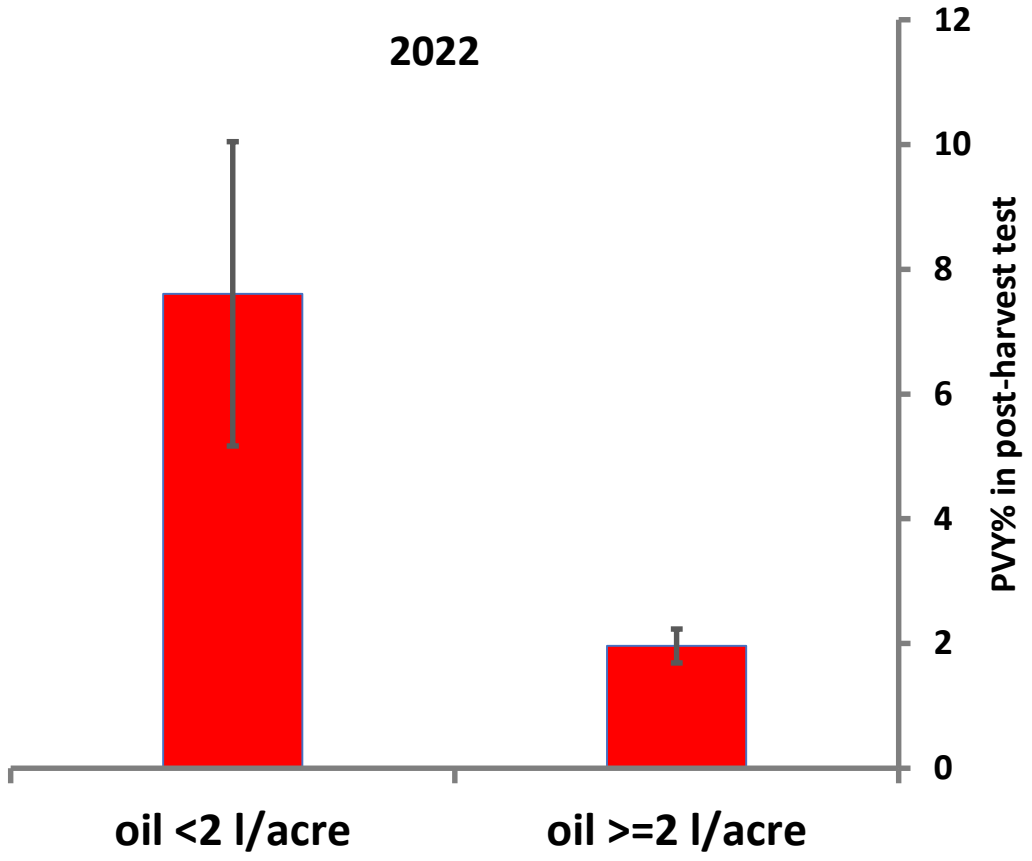
Concentration and frequency of oil spray affects PVY

Lower concentration of mineral oil sprayed weekly on crops is not very effective in preventing PVY spread.





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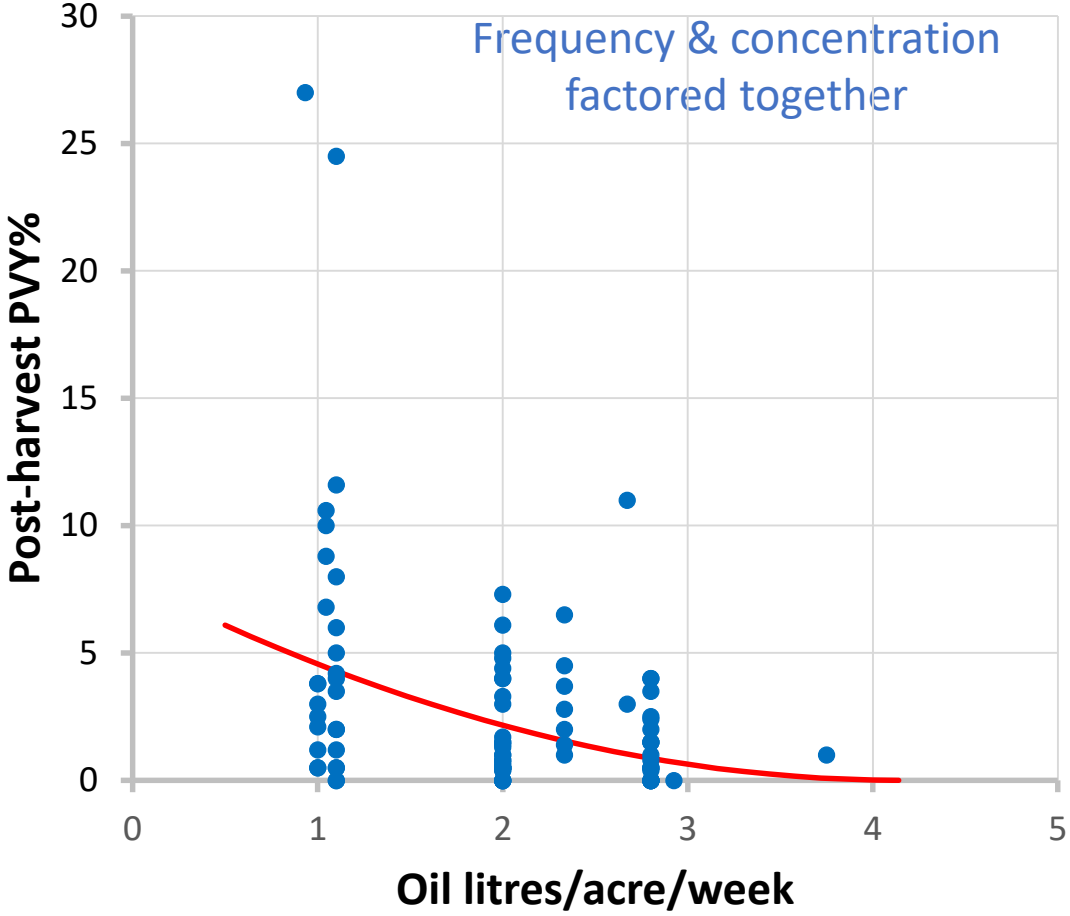
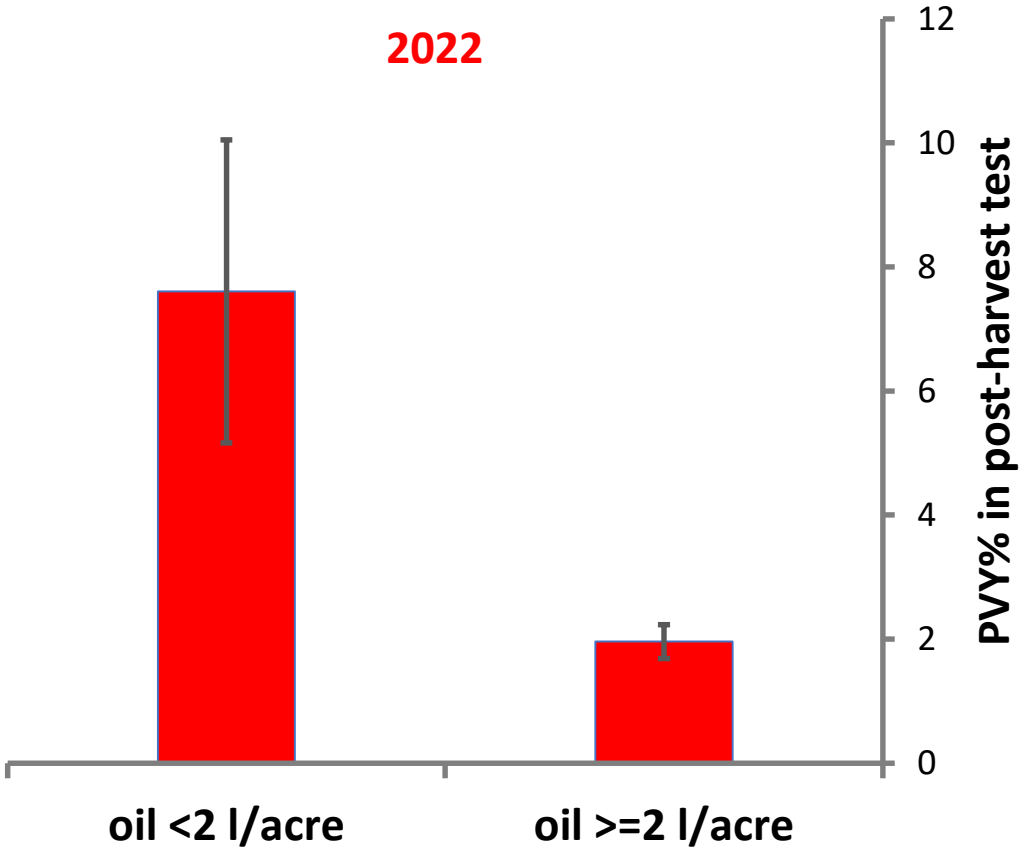
Concentration and frequency of oil spray affects PVY

Lower concentration of mineral oil sprayed weekly on crops allows for more PVY spread.





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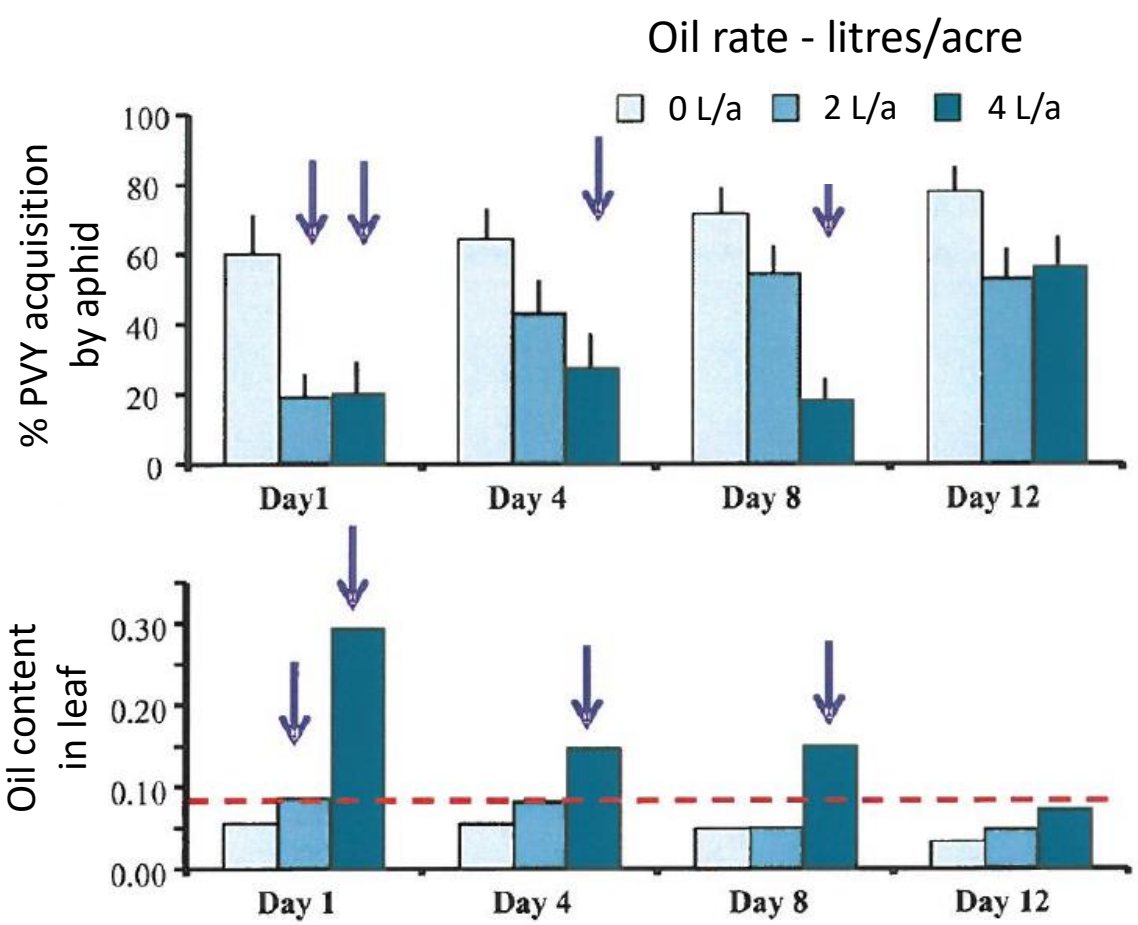
Concentration and frequency of oil spray affects PVY



High *rate* and more *frequent* (<weekly) spraying reduces PVY acquisition by aphids.

Measured concentration of oil in leaves changes in days after spraying, in a pattern matching the protection against PVY acquisition observed above.

Entomologia Experimentalis et Applicata

DOI: 10.1111/eea.12070

Effect of mineral oil on *Potato virus Y* acquisition by *Rhopalosiphum padi*

Sébastien Boquel[1]*, Marie-Andrée Giguère[2], Catherine Clark[2], Upeksha Nanayakkara[3], Jianhua Zhang[2] & Yvan Pelletier[3]

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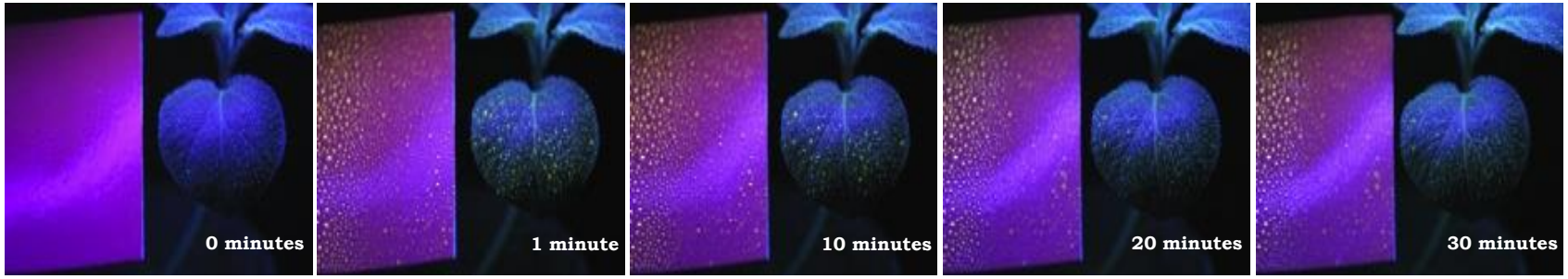
Concentration and frequency of oil spray affects PVY

Mineral oil rapidly penetrates the leaf



Pest Management Science

SCI where science meets business

Research Article

Quantification of mineral oil accumulation and movement in potato plants and its significance in potato virus Y management

Manphool Fageria, Sébastien Boquel, Gaetan Leclair, Yvan Pelletier

Acquisition of PVY by aphids increases with time after treatment with mineral oil, but is ***slowed by higher concentrations*** of oil

AND when insecticides are combined with oil, they last longer than when insecticides are sprayed alone.

Hypothesis: oil-soluble insecticides adhere on or in leaves better and increase time of protection from aphids

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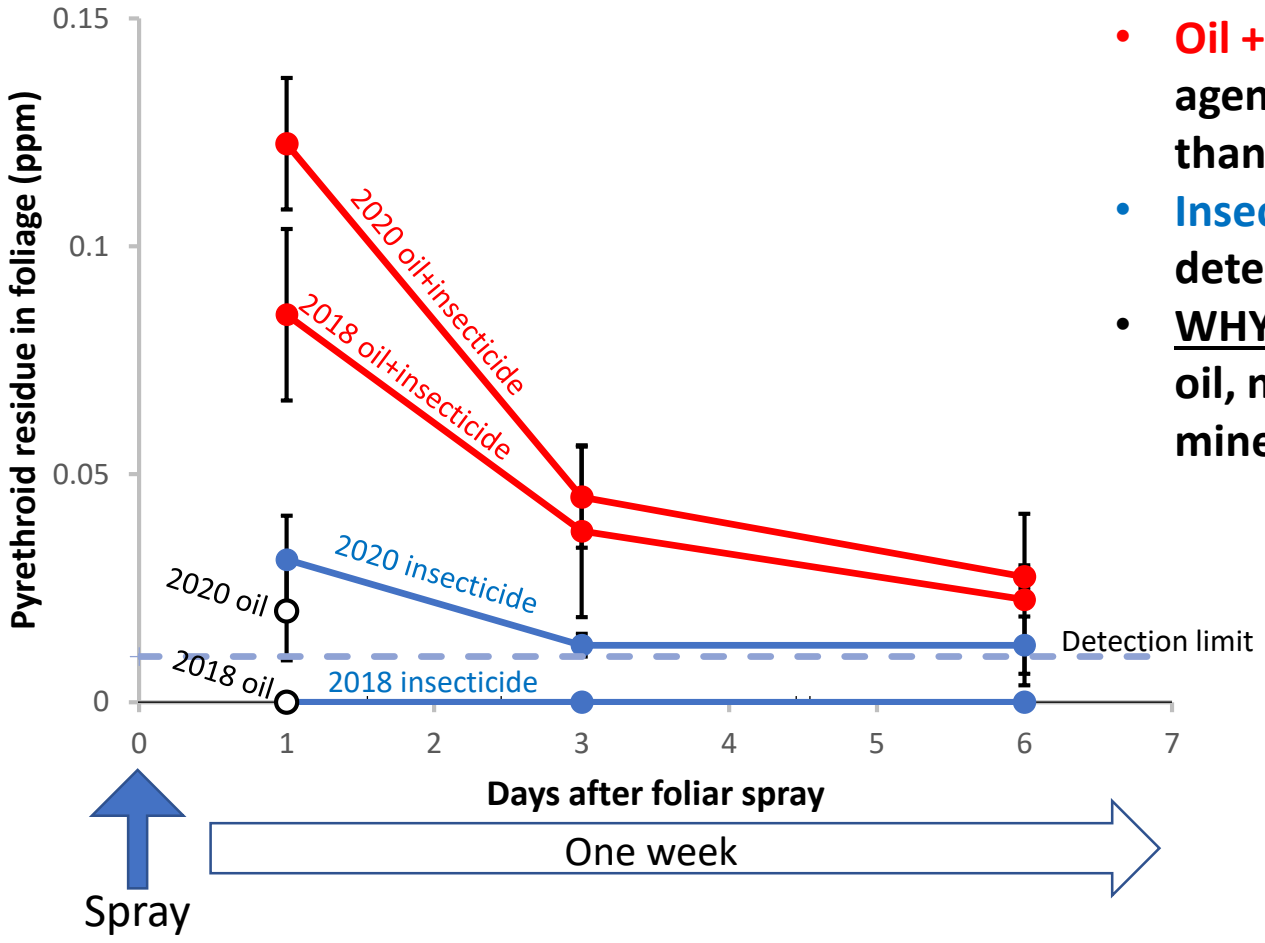
Insecticide lasts longer when sprayed with oil



Leaves sprayed with insecticide (Silencer) alone or tank-mixed with oil.

- **Oil + insecticide retained pyrethroid agent at higher levels, for longer time than insecticide alone**
- **Insecticide was at or below (in 2018) detection limit quickly after spray**
- **WHY? Pyrethroid insecticide is soluble in oil, may be is carried into foliage by mineral oil?**

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Date	#1 Oil Only 1.5 l/a	#2 Oil Only early 3 l/a later 1.5 l/a	#3 Oil & 5 Insecticide 1.5 l/a	#4 Oil & 5 Insecticide early 3 l/a later 1.5 l/a	#5 Oil & 11 Insecticide oil 1.5 l/a	#6 Oil & 11 Insecticide inc. Fulfil oil 1.5 l/a	#7 Oil & 11 Insecticide inc. Concept oil 1.5 l/a	#8 5 Insect-icide no oil	#9 11 Insect-icide no oil	#10 No-spray Control
4-Jun	planting	planting	planting	planting	planting	planting	planting	planting	planting	planting
12-Jun	Lorox L	Lorox L	Lorox L	Lorox L	Lorox L	Lorox L	Lorox L	Lorox L	Lorox L	Lorox L
26-Jun	Oil 1.5	Oil 3	Oil 1.5 Silencer	Oil 3 Silencer	Oil 1.5 Silencer	Oil 1.5 Silencer	Oil 1.5 Silencer	Silencer	Silencer	
1-Jul	Oil 1.5	Oil 3	Oil 1.5 Silencer	Oil 3 Silencer	Oil 1.5 Silencer	Oil 1.5 Silencer	Oil 1.5 Silencer	Silencer	Silencer	
6-Jul	Oil 1.5	Oil 3	Oil 1.5 Beleaf	Oil 3 Beleaf	Oil 1.5 Lagon	Oil 1.5 Lagon	Oil 1.5 Lagon	Beleaf	Lagon	
11-Jul	Oil 1.5	Oil 3	Oil 1.5	Oil 3	Oil 1.5 Decis	Oil 1.5 Decis	Oil 1.5 Decis		Decis	
16-Jul	Oil 1.5	Oil 3	Oil 1.5	Oil 3	Oil 1.5 Lagon	Oil 1.5 Lagon	Oil 1.5 Lagon		Lagon	
21-Jul	Oil 1.5	Oil 3	Oil 1.5	Oil 3	Oil 1.5 Beleaf	Oil 1.5 Fulfil	Oil 1.5 Concept		Beleaf	
26-Jul	Oil 1.5	Oil 3	Oil 1.5	Oil 3	Oil 1.5	Oil 1.5	Oil 1.5			
31-Jul	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5 Silencer	Oil 1.5 Silencer	Oil 1.5 Silencer		Silencer	
5-Aug	Oil 1.5	Oil 1.5	Oil 1.5 Beleaf	Oil 1.5 Beleaf	Oil 1.5 Decis	Oil 1.5 Decis	Oil 1.5 Decis	Beleaf	Decis	
10-Aug	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5 Beleaf	Oil 1.5 Beleaf	Oil 1.5 Beleaf		Beleaf	
15-Aug	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5			
20-Aug	Oil 1.5	Oil 1.5	Oil 1.5 - Silencer	Oil 1.5 - Silencer	Oil 1.5 Movento	Oil 1.5 Movento	Oil 1.5 Movento	Silencer	Movento	
25-Aug	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5			
30-Aug	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5	Oil 1.5 Thionex	Oil 1.5 Thionex	Oil 1.5 Thionex		Silencer	
4-Sep	Top Kill	Top Kill	Top Kill	Top Kill	Top Kill	Top Kill	Top Kill	Top Kill	Top Kill	Top Kill

Matador, Lambda-Cyhalothrin, Contact

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Typical management programs for experimental trials

From 2022 surveys:

Growers that used many, diverse insecticides cut PVY nearly in half!

Management	Average PVY test
One insecticide type Sprayed <10 times Combined with oil 2L/a	2.0 %
Multiple insecticides Sprayed ***>10*** times Combined with oil 2L/a	1.2%

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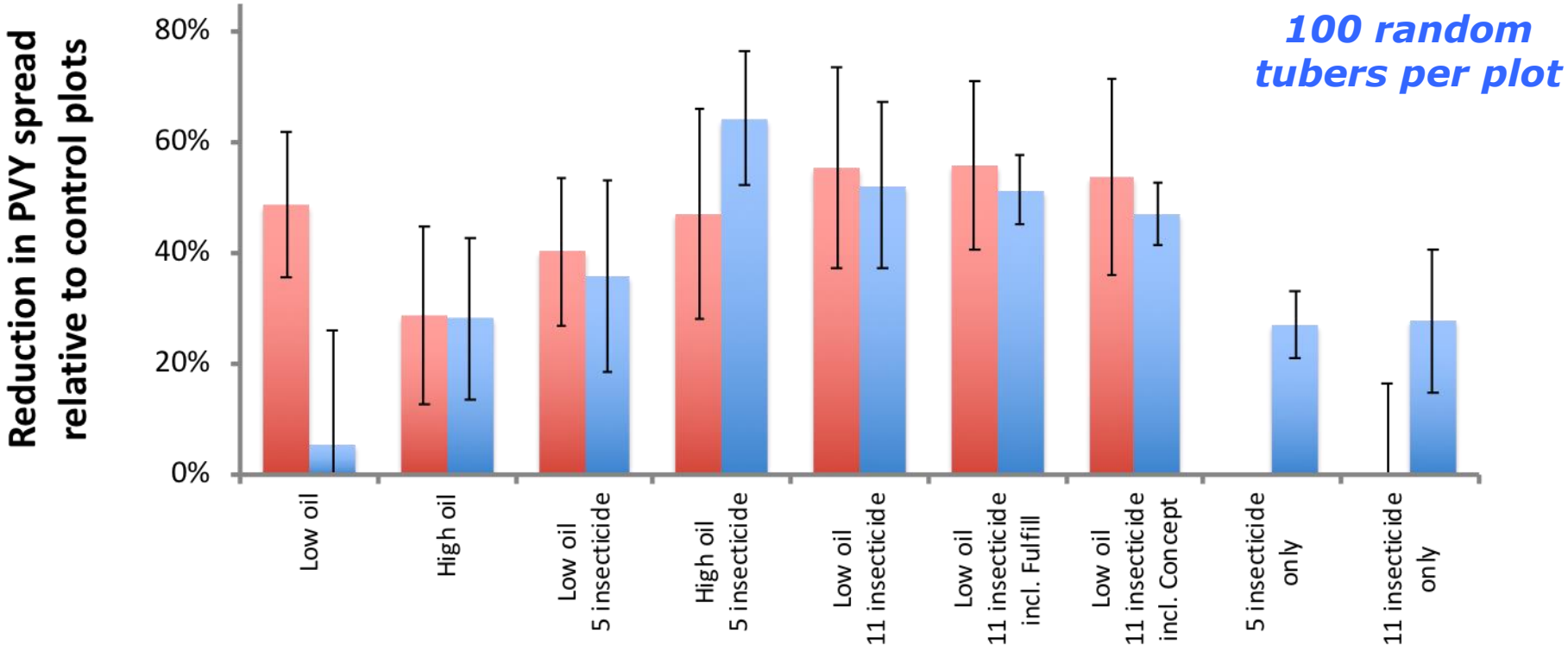
Managing PVY spread – NB trials

Two-year results were consistent in NB, and consistent with other studies conducted in grower fields



Spread in control plots:
2014 = 11% 2015 = 22%

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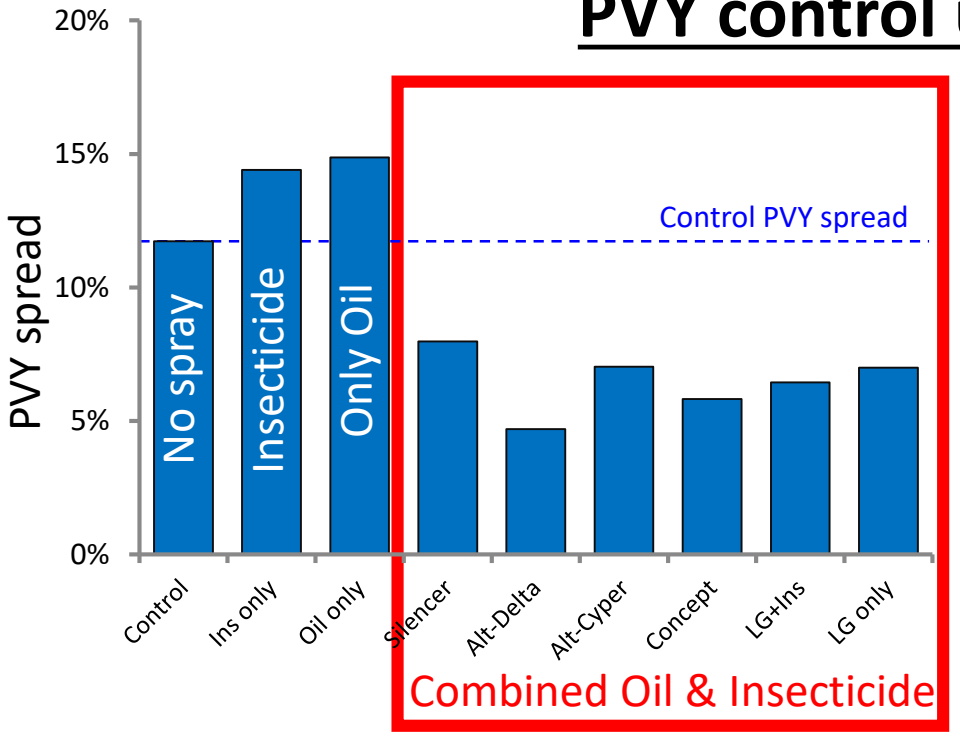
PVY control under different spray treatments



Combined mineral oil and insecticide sprays effectively reduce PVY spread

- Frequent & strong (weekly @ 2L/a)
- All-season
- Rotate chemistries
- Confirmed in <u>experimental plots</u> and <u>growers fields</u>

Spraying schedules tested (*colour coding shows different insecticide chemistries*)

Control	Ins only	Oil only	Silencer	Alt-Delta	Alt-Cyper	Concept	Bio & Ins	Bio only
no oil, no insecticides	no oil	weekly 2 litres/acre oil	weekly 2 litres/acre oil	weekly 2 litres/acre oil	weekly 2 litres/acre oil	weekly 2 litres/acre oil	weekly 2 litres/acre oil	weekly 2 litres/acre oil
	Silencer		Silencer	Decis	Up-Cyde	Concept	LifeGard	LifeGard
	Silencer		Silencer	Decis	Up-Cyde	Concept	Pounce	
	lagon		lagon	lagon	lagon	lagon	Lagon+LifeGard	LifeGard
	Beleaf		Beleaf	Beleaf	Beleaf	Beleaf	Beleaf	
	Silencer		Silencer	Decis	Up-Cyde	Concept	LifeGard	LifeGard
	lagon		lagon	lagon	lagon	lagon	lagon	
	Beleaf		Beleaf	Beleaf	Beleaf	Beleaf	Beleaf+LifeGard	LifeGard
	Pounce		Pounce	Pounce	Pounce	Pounce	Pounce	

Input ($/acre)	$75	$104	$179	$189	$174	$197	$210	$145
Cost per 1% PVY reduction	*No reduction*	*No reduction*	$46.36	$26.42	$36.28	$30.52	$38.97	$34.97

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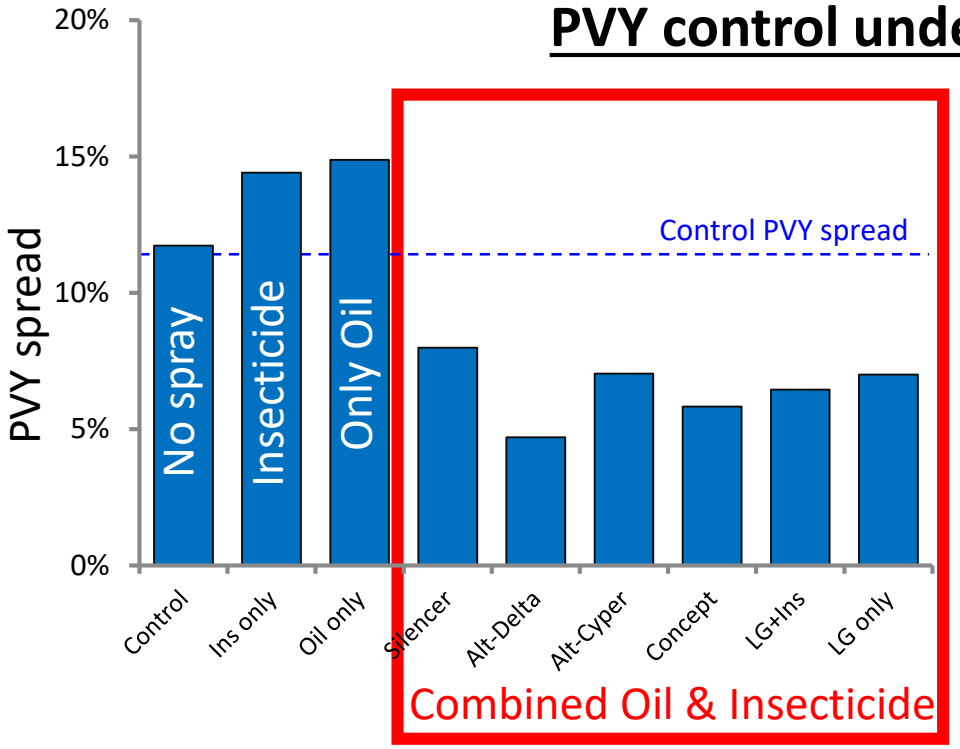
PVY control under **different** spray treatments



Combined mineral oil and insecticide sprays effectively reduce PVY spread

- Frequent & strong (weekly @ 2L/a)
- All-season
- Rotate chemistries
- Confirmed in <u>experimental plots</u> and <u>growers fields</u>

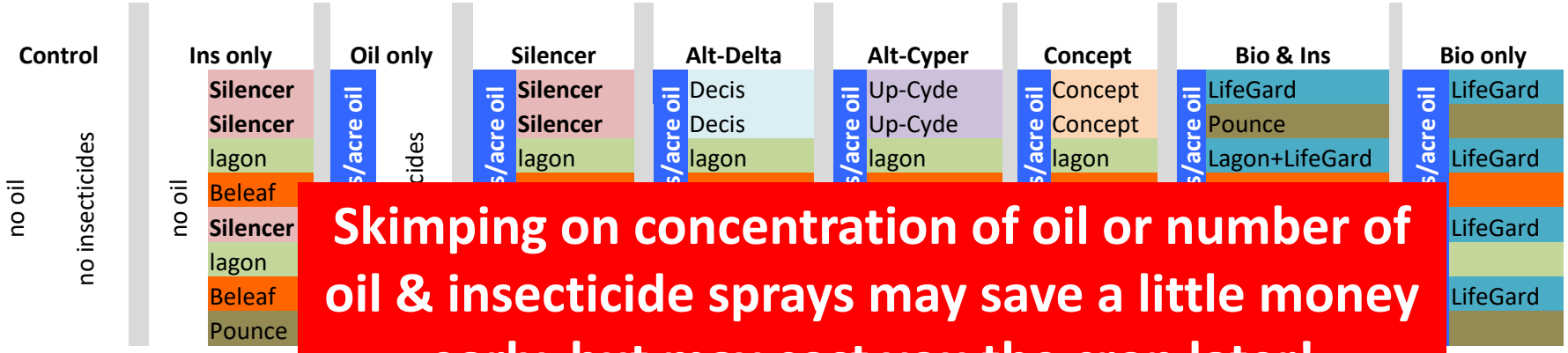
2022 Grower Surveys showed:

- Many using <2 L/ac oil
- Sometimes not frequent, or full season spraying
- Lacking diversity of insecticides

e.g. if you spray a field 3 times each with **Silencer**, **Matador** and **Labamba**, then you are just spraying nine times *<u>with the same lambda-cyhalothrin chemical</u>*…

…and many aphids are resistant to it!

Spraying schedules tested (*colour coding shows different insecticide chemistries*)



Skimping on concentration of oil or number of oil & insecticide sprays may save a little money early, but may cost you the crop later!

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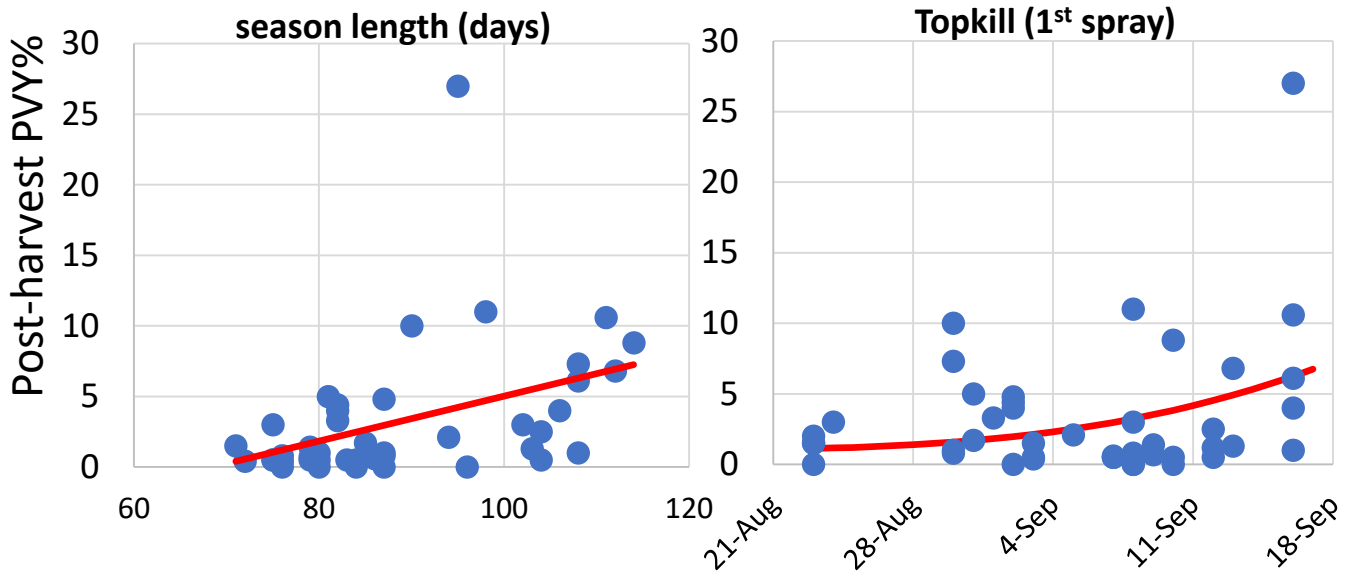
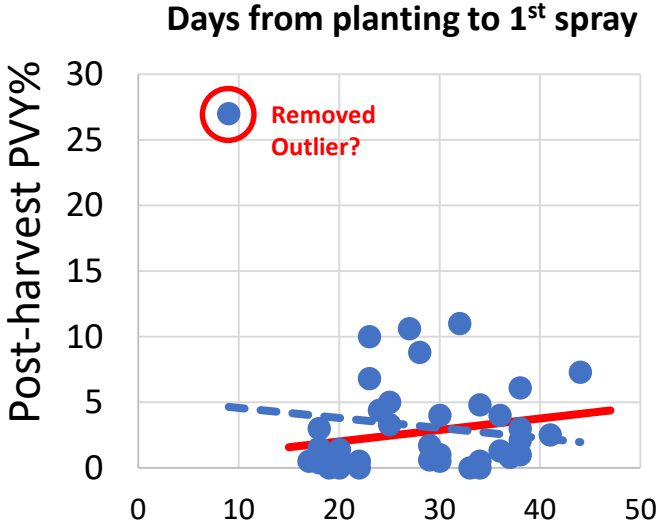
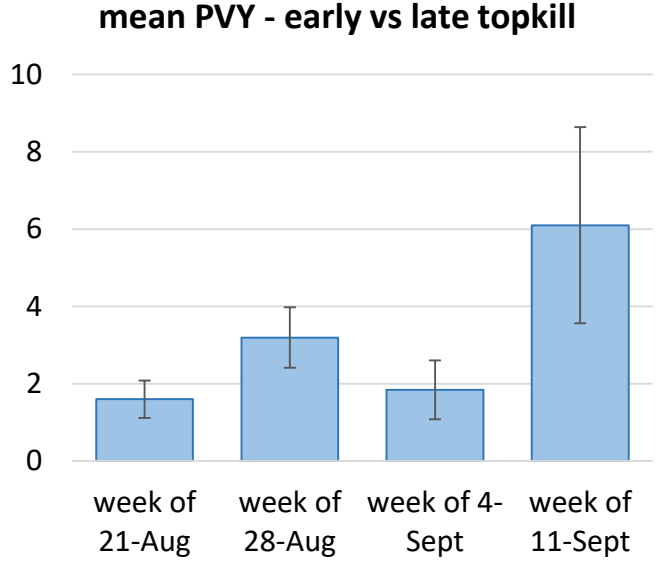
Timing of crop planting, spraying and topkill affect PVY exposure







Aphids are a threat for transmitting PVY in potato crops throughout the growing season

PVY levels in crops can increase with:

- **Length of time plants are growing in the field**
- **Length of time from planting until first foliar mineral oil/insecticide spray**
- **Later topkill**

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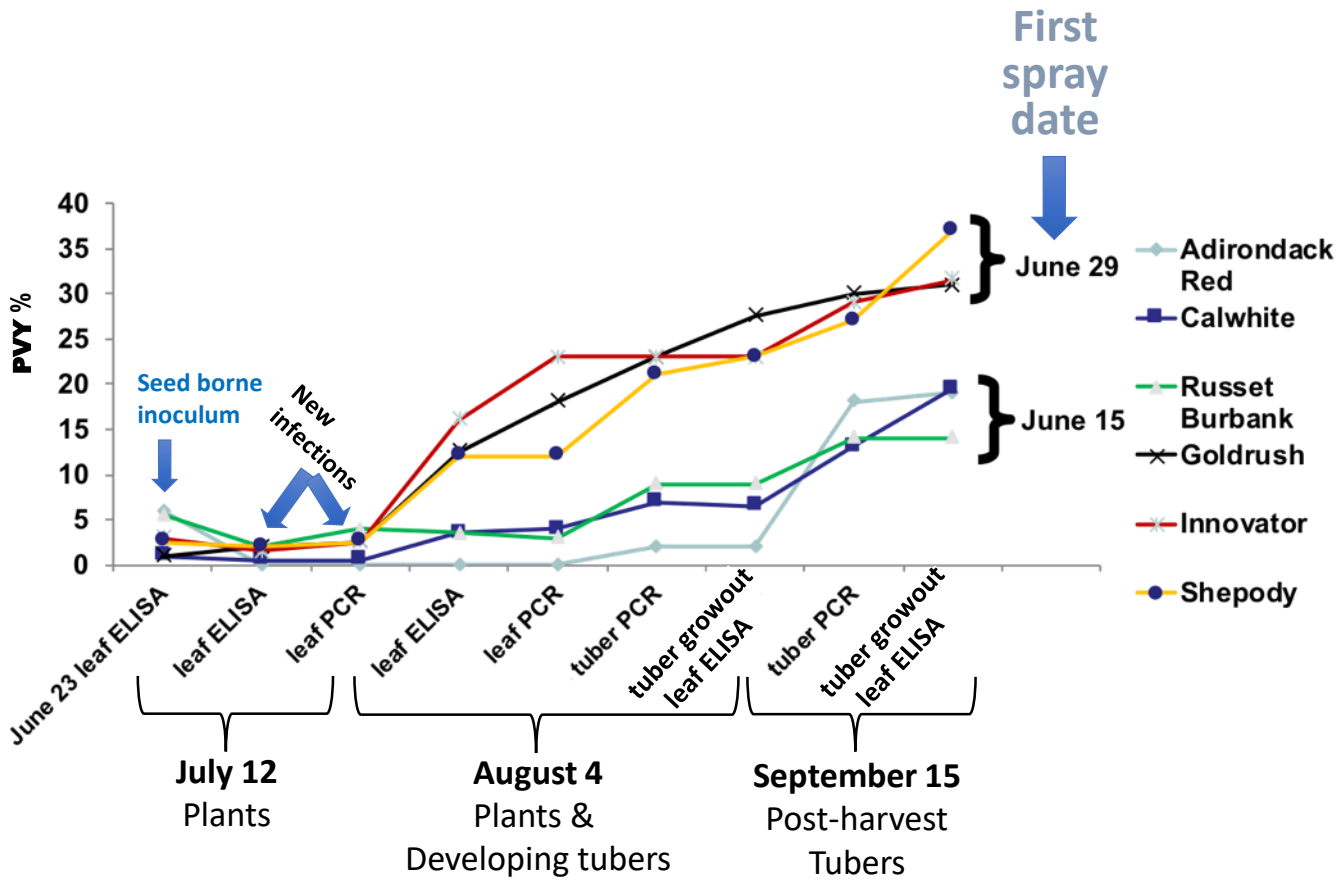
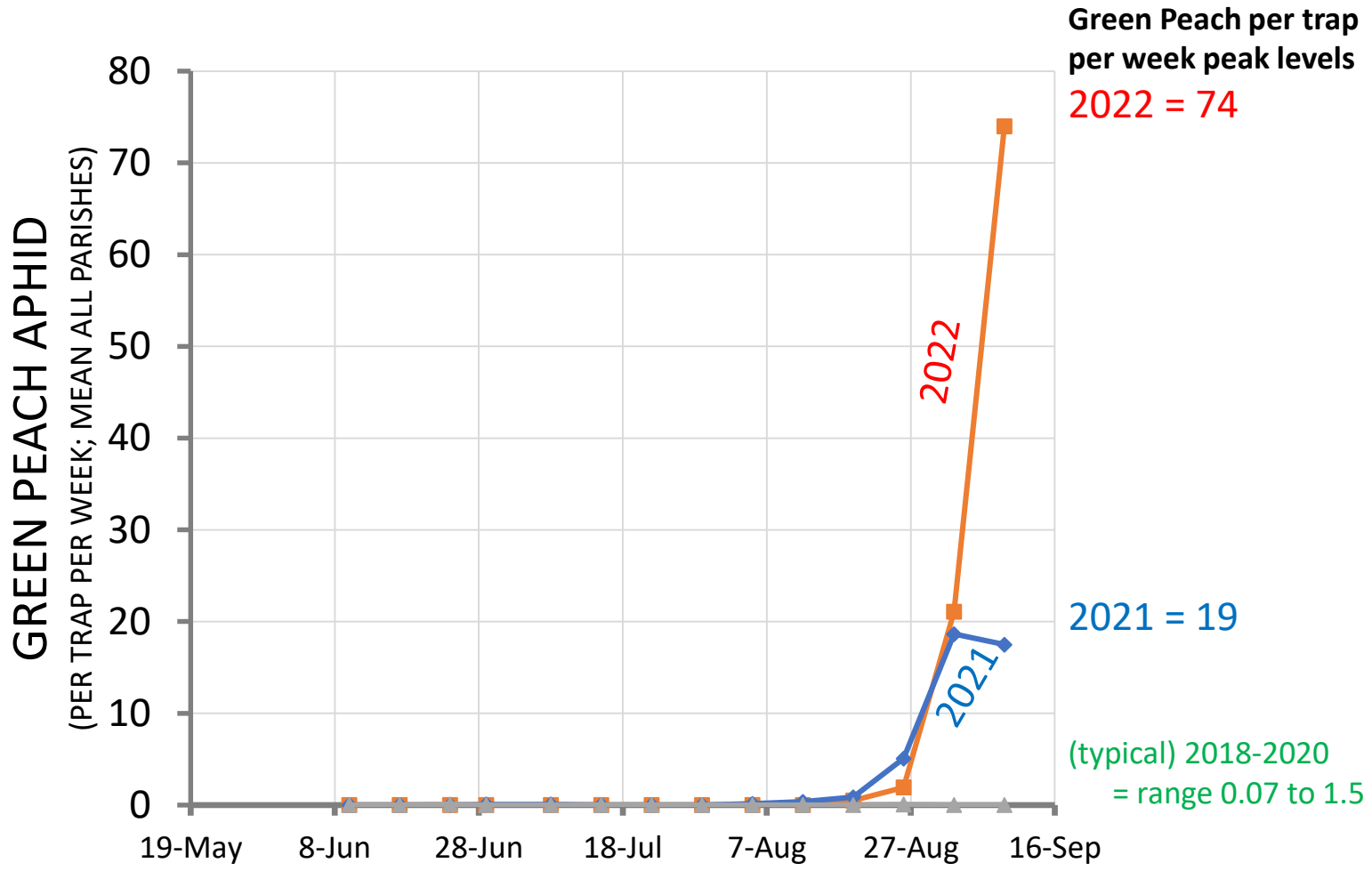
Timing of combined oil & insecticide spray



PVY spread starts early and continues through the season.

Early timing of foliar spraying is critical to protection against PVY spread

Green Peach Aphid may be responsible for high-PVY with later topkill

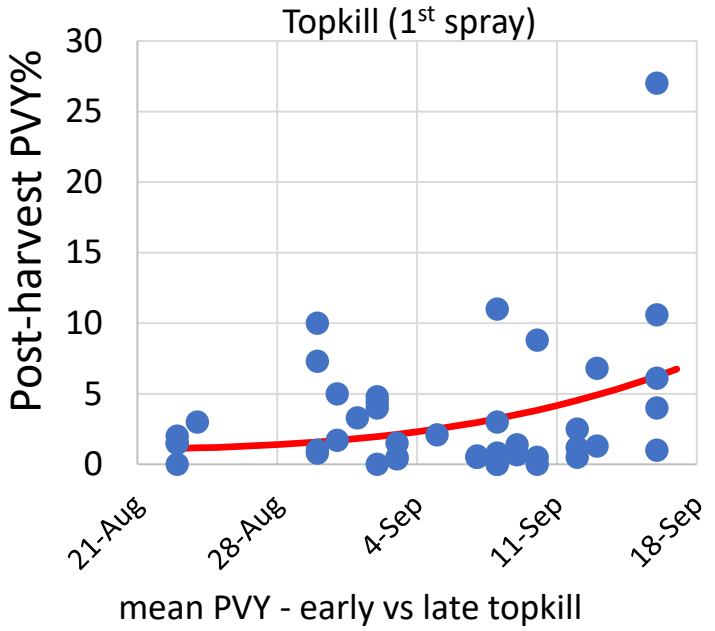


Green Peach per trap per week peak levels

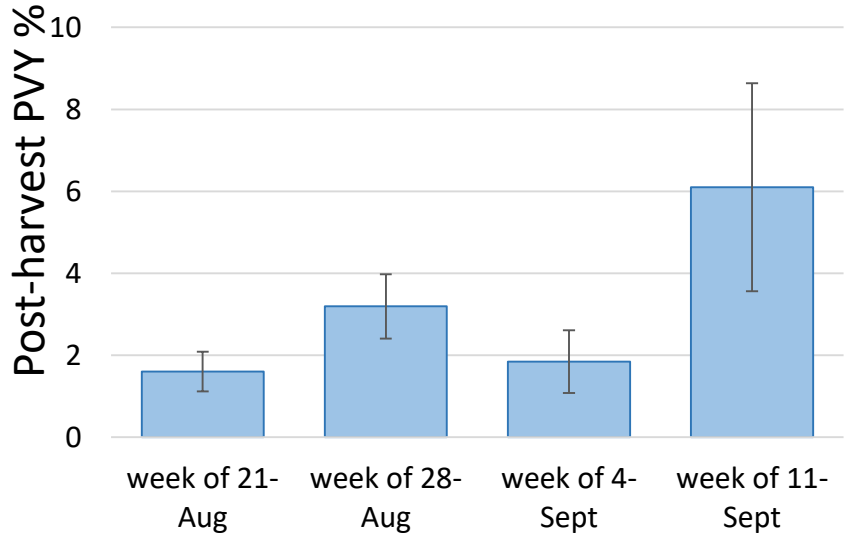
2022 = 74

2021 = 19

(typical) 2018-2020 = range 0.07 to 1.5



mean PVY - early vs late topkill



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Clearly, PVY was high in 2022

Why?

Possible factors:

- What was planted in the field?
- Aphids as vectors for PVY transmission?
- Changes in the virus? Different PVY strains?
- **Changes in management by growers?**

Growers must be vigilant in management for PVY in the growing crop

Intensity (e.g. oil & insecticides)

Timing (planting, sprays, topkill)

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Conclusions and Recommendations

PVY levels in the 2022 seed crop were high

- It was widespread, with practically *all varieties and growers averaging higher* than in previous few years
- PVY in the *seed planted* in 2022 was not unusual, but *aphid levels* were very high – including the particularly worrisome Green Peach Aphid
- *Management intensity* varied between growers and correlated with PVY
  - Growers that focus *mostly or exclusively on seed production* did well
  - Growers that used *higher oil concentrations, more frequently* did well
  - Growers using *diverse insecticides* together with oil did well
  - Growers with *shorter season crops*, and *topkill early* did well
- Everyone dealt with unusually high aphids in 2022, some kept PVY low in their crop and some did not
  - What management was sufficient in earlier low-PVY years may not have been sufficient in 2022 so in 2023 it has to be more aggressive.

Acknowledgements

Project staff and collaborators:

- Tyler MacKenzie, Angela Gallagher, Anna-Beth Cormier – ACS Inc.
- Xianzhou Nie – FRDC, AAFC
- Jacques Lavoie, Mitchell Smith and Suzanne Banks – NBDAAF
- Many anonymous NB potato growers for sharing information

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- NB Enabling Agricultural Research and Innovation (EARI)
- PotatoesNB
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