

The Canadian Potato Early Dying Network (CanPEDNet)



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Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada



CanPEDNet

- Low yields in Atlantic Canada
- Need to increase delivery of processing potato in Manitoba and Alberta
- Goal to reduce the severity of Potato Early Dying (PED), a major yield-limiting factor in all major potato production areas of Canada, by providing potato growers with the knowledge, tools and technologies to manage PED, and increase potato productivity and profitability in Canada
- Project started fall 2019

CanPEDNet Team



Researchers

- Mario Tenuta (PI; Manitoba)
- Dahu Chen (Co-PI), Oscar Molina, Tanya Arseneault, Benjamin Mimee, Judith Nyrianeza (AAFC)
- Dmytro Yevtushenko (Lethbridge)
- Katerina Jordan (Guelph)
- Khalil I. Al-Mughrabi (NB Gov), Vikram Bisht (MB Gov)

Grower Groups

- Ryan Barrett (PEI), Mathuresh Singh (NB)
- Potato Growers of Alberta, Keystone Potato Producers Association, Ontario Potato Board, Potatoes New Brunswick, PEI Potatoes
- Canadian Horticultural Council Potato Cluster

Industry

- Phytodata
- Gaia Consulting
- Cavendish
- McCain
- Simplot
- AMVAC
- Bayer
- Syngenta
- AAFC Science Cluster Program

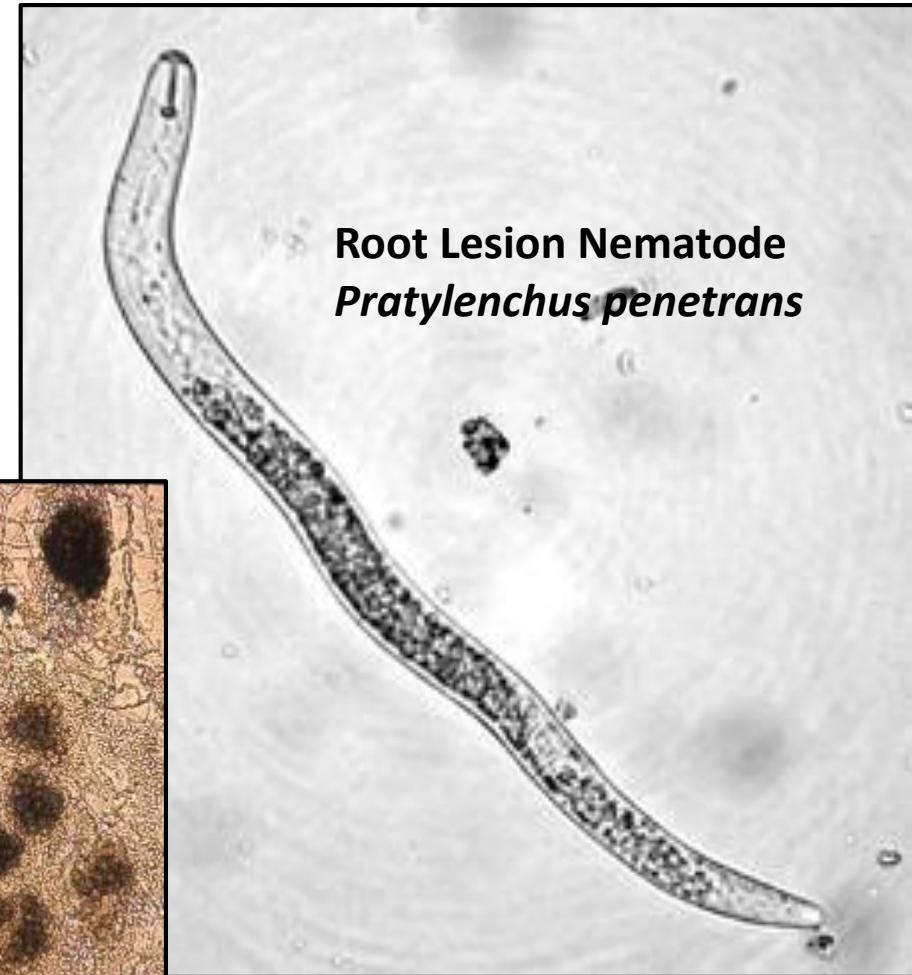
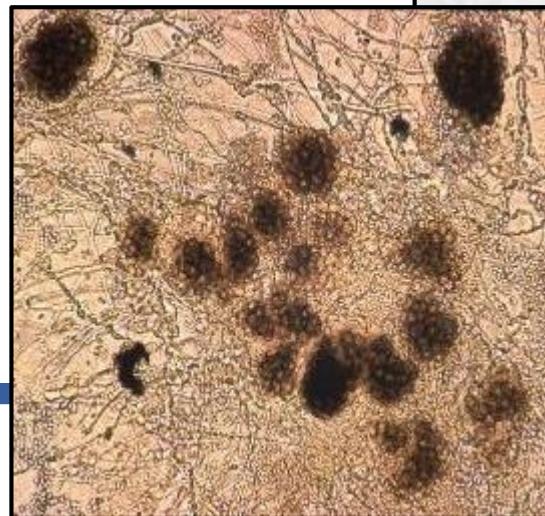
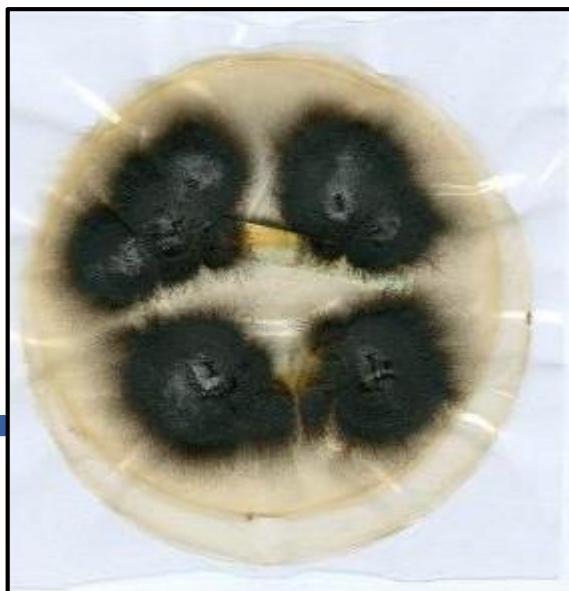
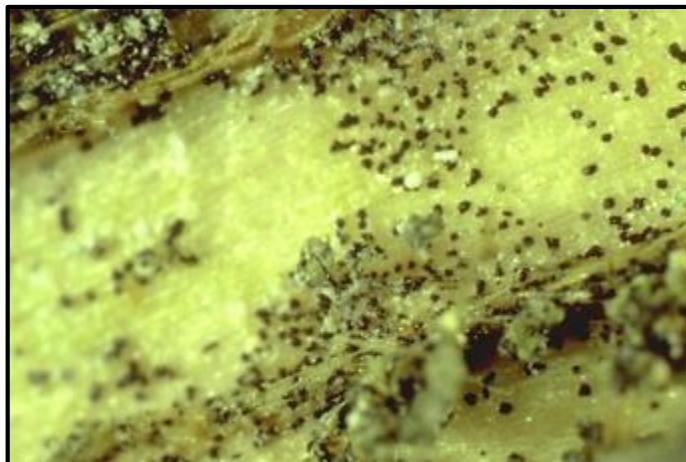
Potato Early Dying

- Essentially: the fungus, *Verticillium*
 - Two species, *V. dahliae*, *V. albo-atrum*
 - Either fungal pathogen alone,
 - or in conjunction with root lesion nematode,
 - *Pratylenchus penetrans*
- Vascular Wilt Disease
- Early death
- Robs yield of large tubers



Causal Pathogen and Pest

Verticillium dahliae



***Verticillium* and Root Lesion Nematode Survey and Relation to PED Disease and Yield**

- This activity aims to determine the species and population levels of the major causal agents of PED (*Verticillium* and root lesion nematode) in commercial potato fields and their impact on PED disease symptoms and yield
- *Verticillium* isolates and root lesion populations will be screened in AAFC Quebec for virulence to Russet Burbank

V. dahliae and *albo-atrum* Across Canada

Mathuresh Singh
ACS-Potatoes NB



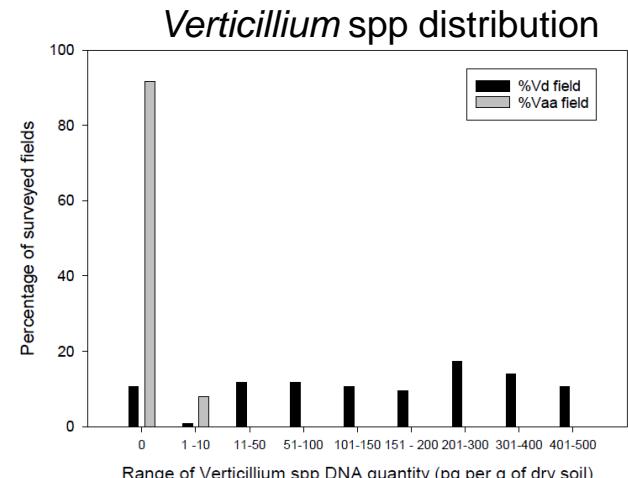
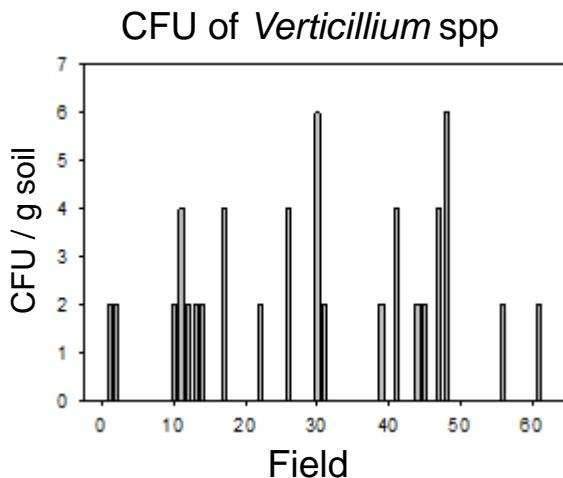
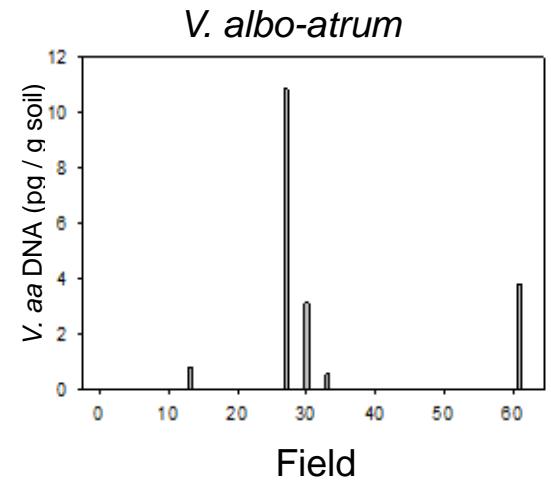
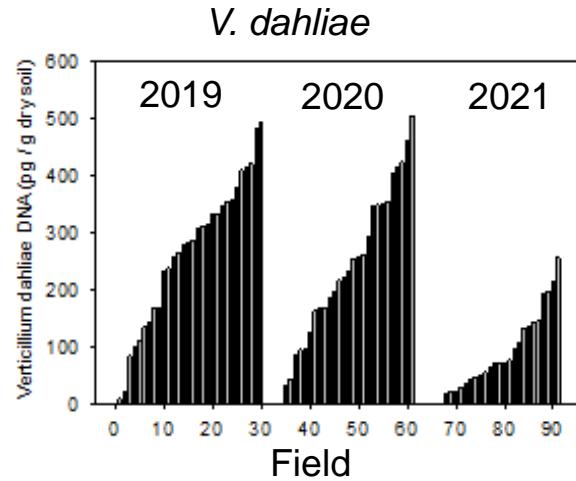
	Mean All Samples		Mean Positive Samples		Frequency Presence	
	<i>dahliae</i>	<i>albo-atrum</i>	<i>dahliae</i>	<i>albo-atrum</i>	<i>dahliae</i>	<i>albo-atrum</i>
	copy/g soil					Frequency
Alberta	235	0	520	-	45%	0%
New Brunswick	1792	152	2103	684	85%	22%
PEI	485	0	607	-	80%	0%
Ontario	1944	36	2222	192	88%	19%
Manitoba	819	15	1016	151	80%	10%
Quebec	816	0	1065	-	77%	0%

Verticillium population density in PEI

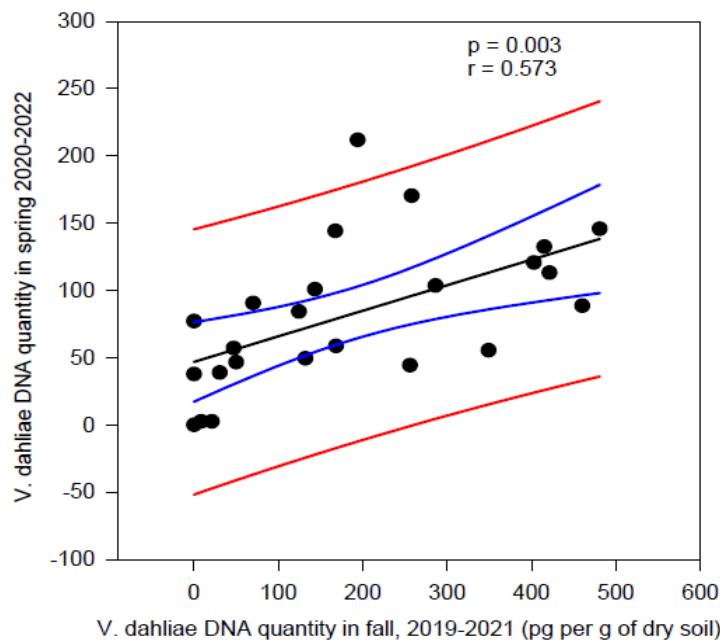
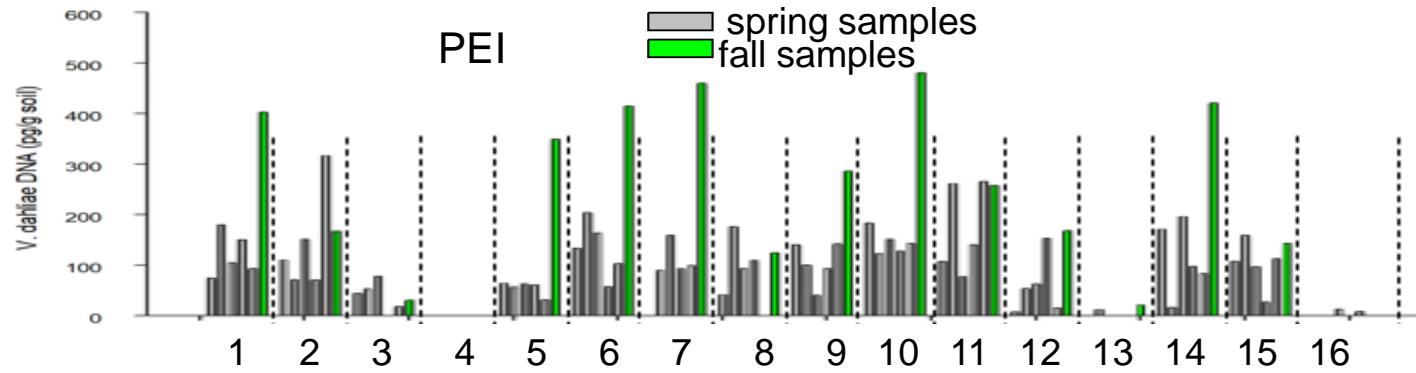


Ryan Barrett/Dahu Chen (AAFC)

- Over 90 % surveyed fields detected with *V. dahliae* using DNA qPCR
- Only 33% surveyed fields detected with *Verticillium* spp using Colony forming Unit method.
- 8% surveyed fields detected with trace amount of *V. albo-atrum* using DNA qPCR
- Most fields having higher level of *V. dahliae*
- DNA qPCR is more sensitive than CFU method



Population density of *V. dahliae* within field and correlation between spring and fall populations



- Verticillium* density varied among samples within field
- Fall population density was significantly correlated with the spring density in the following year
- Population density in fall was higher than that in spring

Effect of pathogen levels on PED severity and tuber yield

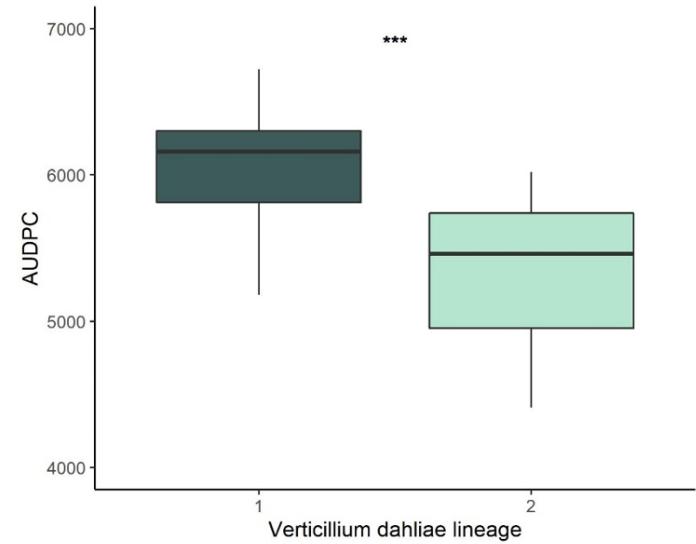
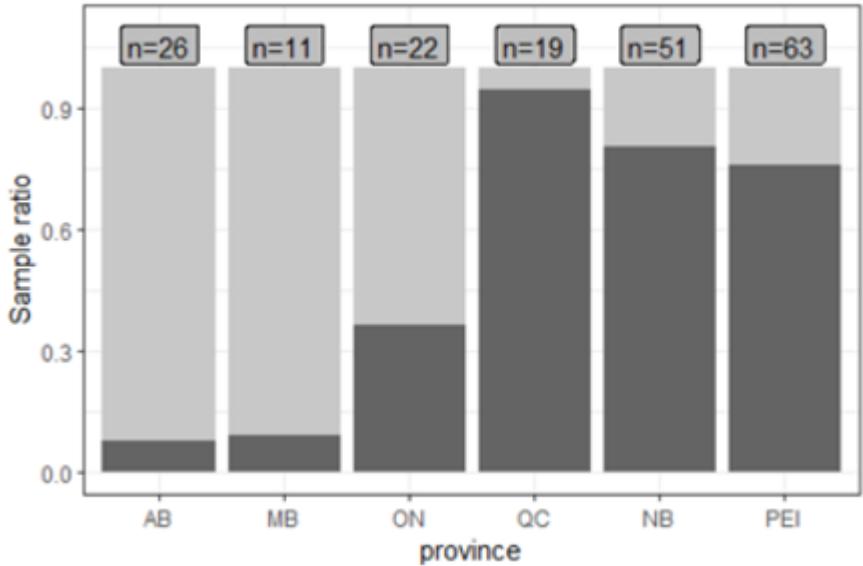
Year	Pathogen level	Number of Fields	RLNs (per kg dry soil)		V. dahliae DNA (pg/g dry soil)		rAUDPC	Total yield (mkg/h)	Marketable yield (mkg/h)
			fall	spring	fall	spring			
2019-2020	Low	3	5917	2715	66	21	18	35	32
	high	2	11928	6341	369	158	32	30	28
	P value		0.36	0.385	0.06	<0.001	<0.001	0.047	0.306
	% change		102	134	460	646	81	-16	-11
2020-2021	Low	3	7416	5298	127	31	18	44	35
	high	5	7452	7084	314	114	16	35	29
	P value		0.571	0.727	0.180	<0.001	0.55	<0.001	0.021
	% change		0	34	148	263	-8	-20	-16
2021-2022	low	4	1128	2231	105	97	31	44	39
	high	3	10404	8159	97	57	37	37	31
	P value		0.030	<0.001	0.929	0.143	0.046	<0.001	<0.001
	% change		822	207	-7	-41	195	-18	-19

- Pathogen levels were grouped based on spring population densities of *V. dahliae* for trials done in 2019-2020 and 2020-2021, and based on RLN counts for trial done in 2021-2022
- Fields with higher pathogen levels significantly reduced tuber yields in three year trials compared to the fields with lower pathogen levels
- Yield reduction ranged from 16 to 20%
- Fields with higher pathogen levels significantly increased PED severity in 2 of the 3 year trials

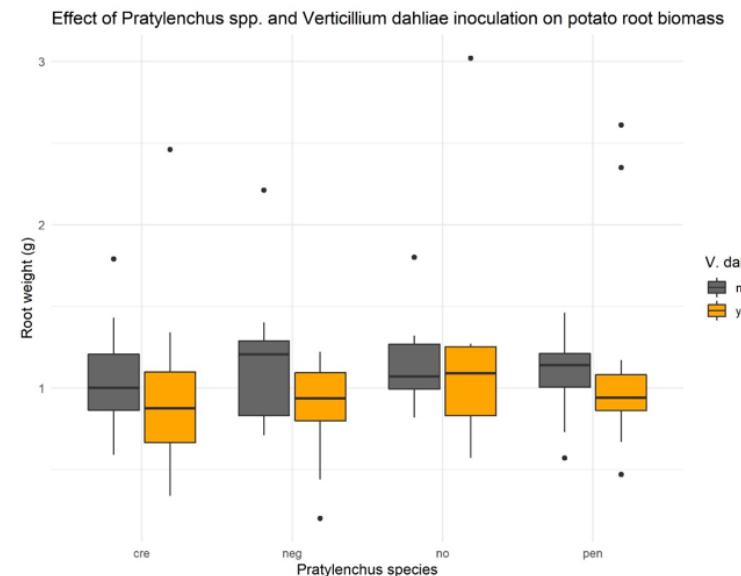
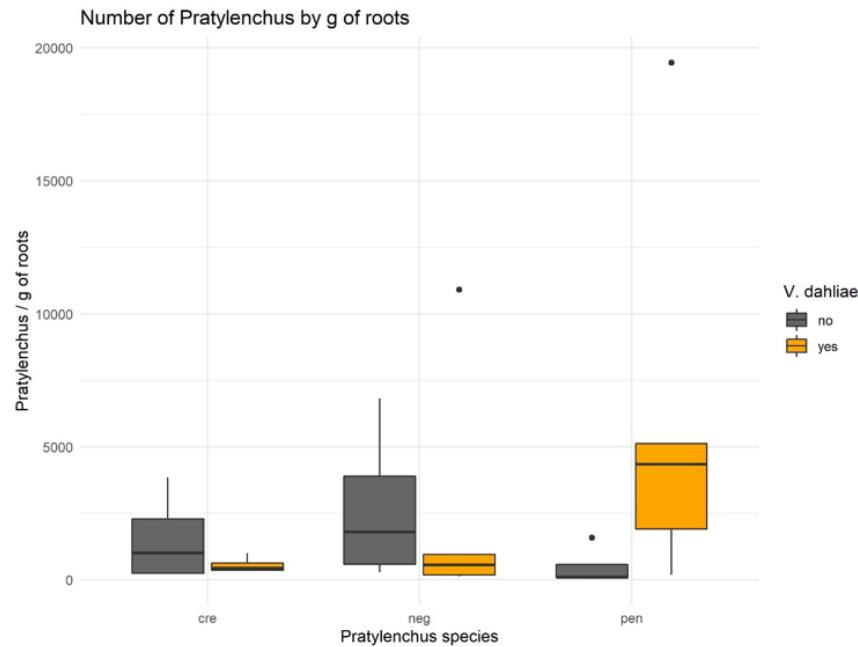
V. dahliae and *albo-atrum* Across Canada



Benjamin Mimee/Tanya Arsenault AAFC

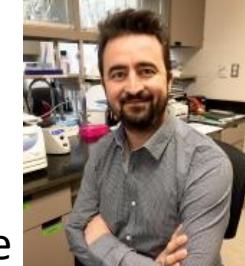


Root Lesion Nematode and *V. dahliae* Interaction



Root Lesion Nematode

Benjamin Mimee



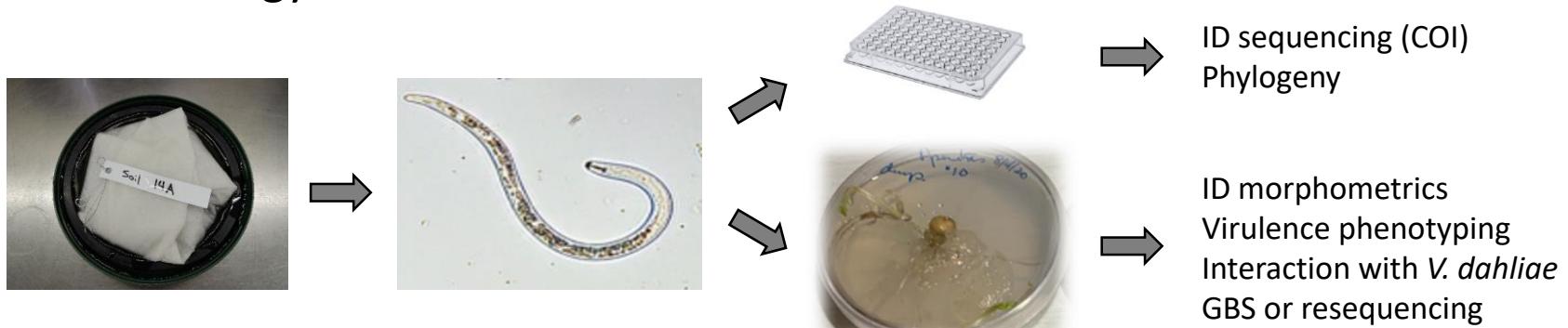
AAFC St-Jean-sur-Richelieu

Root lesion nematode species and interaction with *V. dahliae* isolates

Objectives:

- Identify *Pratylenchus* isolates to the **species level**
- Measure **intraspecific genetic diversity** in *P. penetrans*
- Compare the **virulence** of each taxa and **interaction** with *V. dahliae*

Methodology:

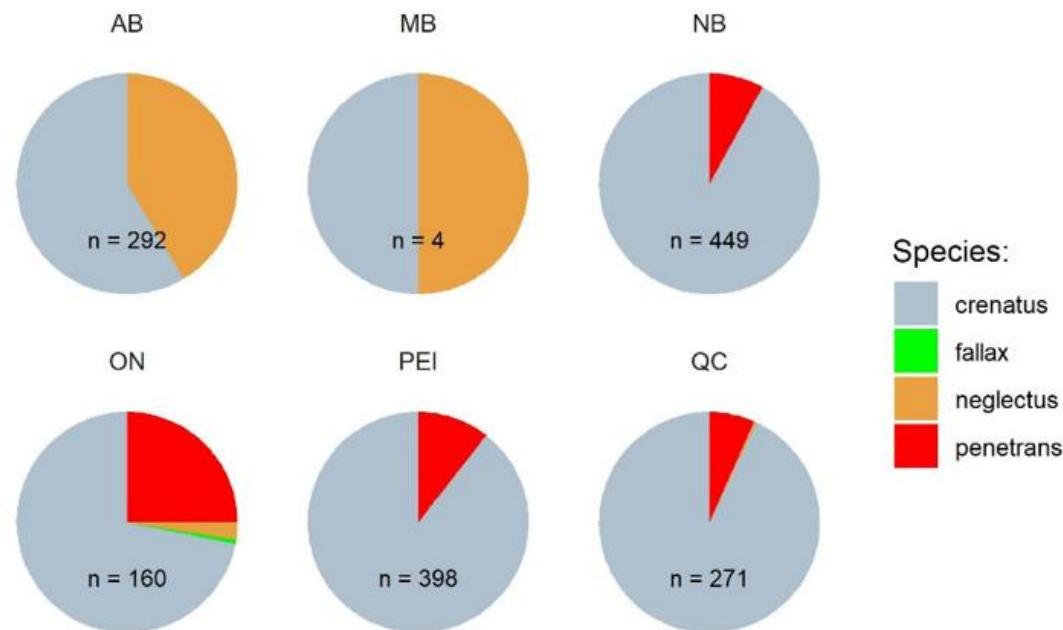


Root Lesion Nematode Species and Interaction with *V. dahliae* Isolates

Results:

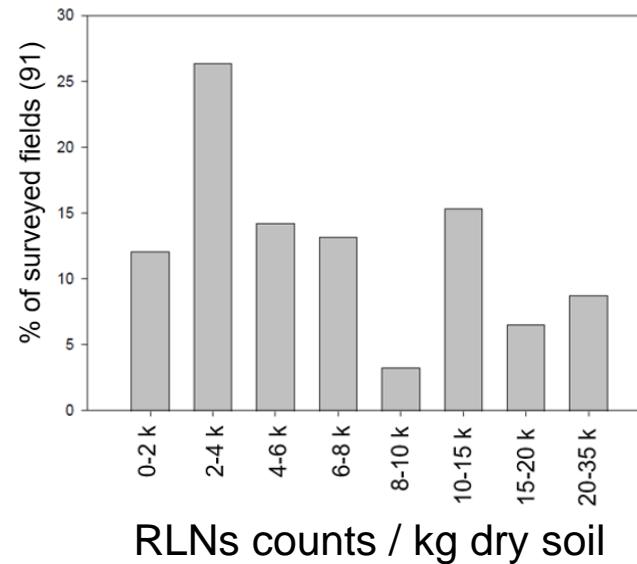
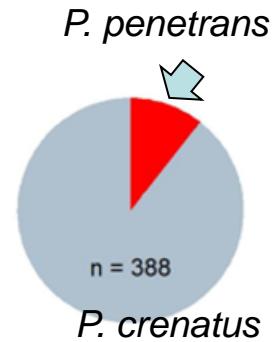
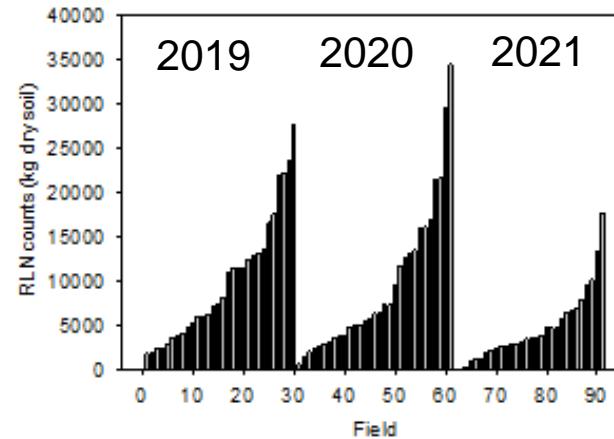
Molecular identification of *Pratylenchus* species and distribution across Canada.

Proportion of *Pratylenchus* species detected in each province
Total number of individual nematodes analyzed is indicated for each province



Root lesion nematodes population density in PEI fields

- All surveyed fields detected with RLN
- Density ranged from <2k to 35K
- 45% fields detected with *P. penetrans*
- P. crenatus* is present in all fields and is predominate

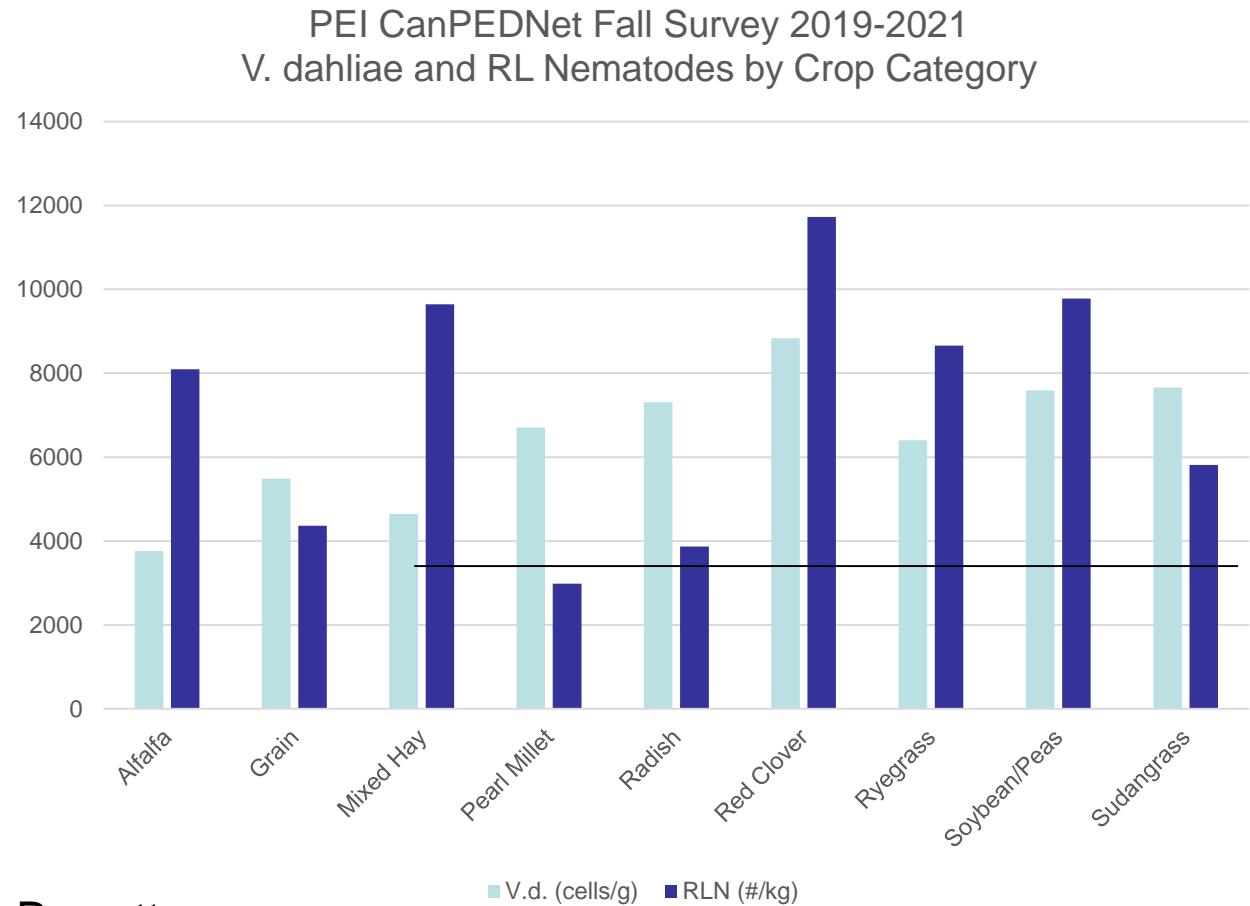


V. dahliae and Root lesion nematodes population density and Previous Crop

- All above threshold for RLN
- Legumes may stimulate RLN
- Pearl Millet lowest for RLN
- Sudangrass didn't reduce *V. dahliae*



Ryan Barrett



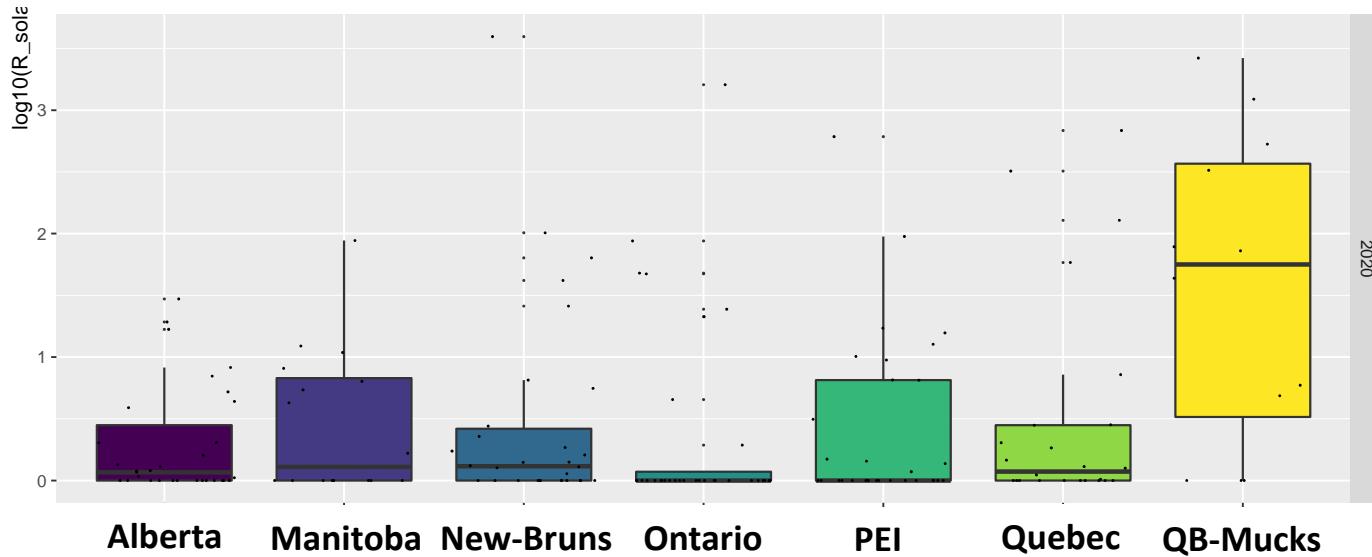
Other Soil-borne Pathogens Associated with the PED Complex

Herve Van der Heyden
Phytodata

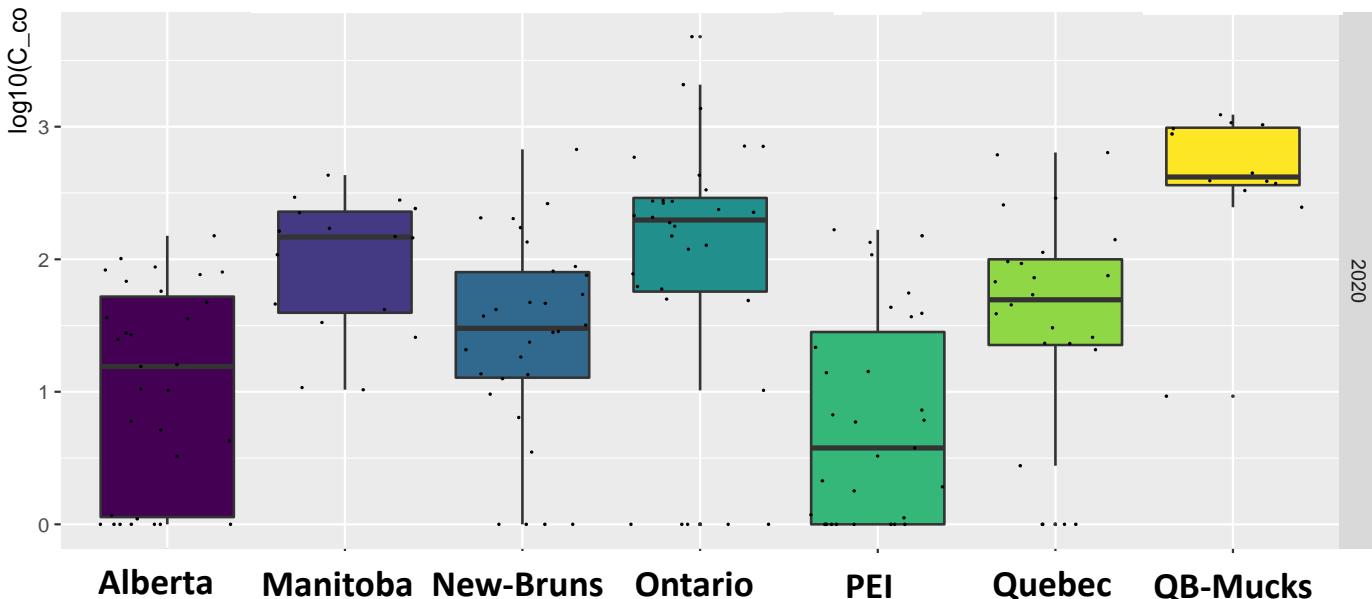


- This activity will determine the population levels, distribution and co-distribution of other soil-borne diseases associated with the PED complex
- Soil from survey in Project 1 will be used by Phytodata in Quebec to screen using PCR levels of other pathogens
- Pathogens include *Colletotrichum coccodes*, *Spongospora subterranea*, *Fusarium* spp., *Pythium ultimum*, *Streptomyces scabies*, *Helminthosporium solani*, *Phytophthora erythroseptica*, and *Rhizoctonia solani*

Other Pathogens

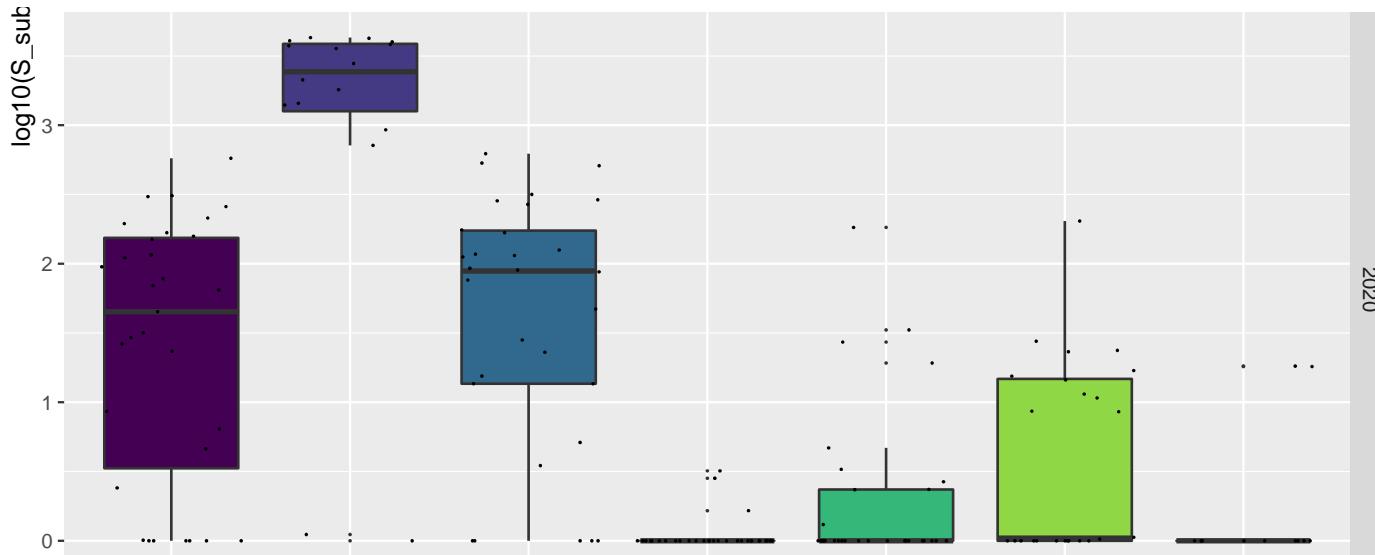


Rhizoctonia solani AG3



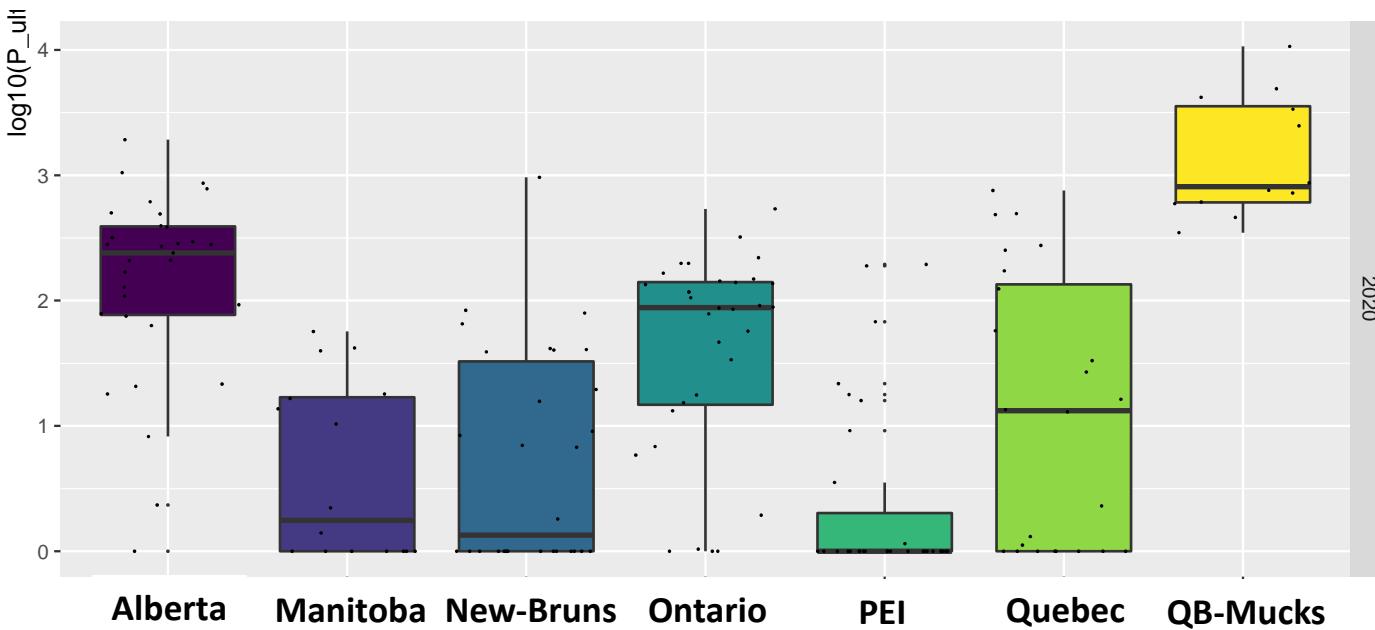
Colletotrichum coccodes
Black Dot

Other Pathogens



*Spongospora
Subterranea
Powdery Scab*

2020



*Pythium ultimum
Pythium Leak*

2020

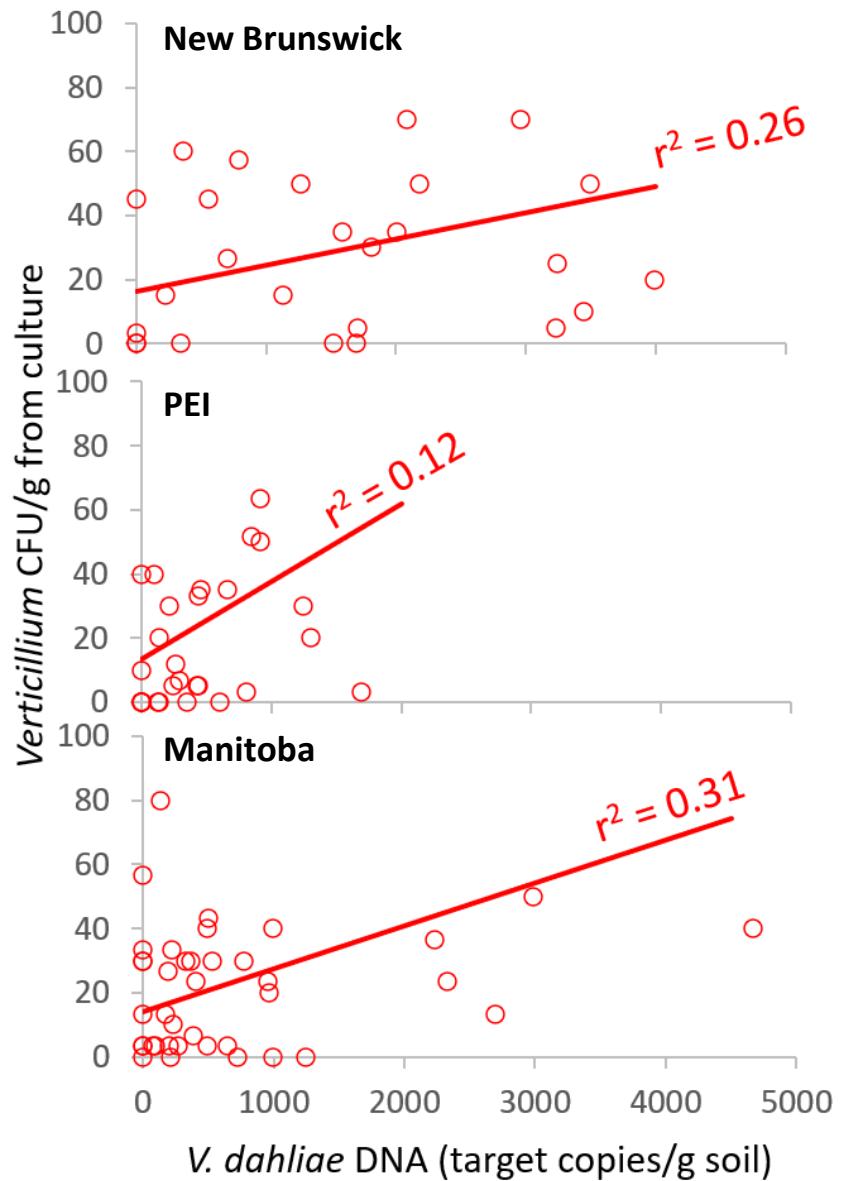
Province

- Alberta
- Manitoba
- New-Brunswick
- Ontario
- PEI
- Québec
- Québec_Mucks

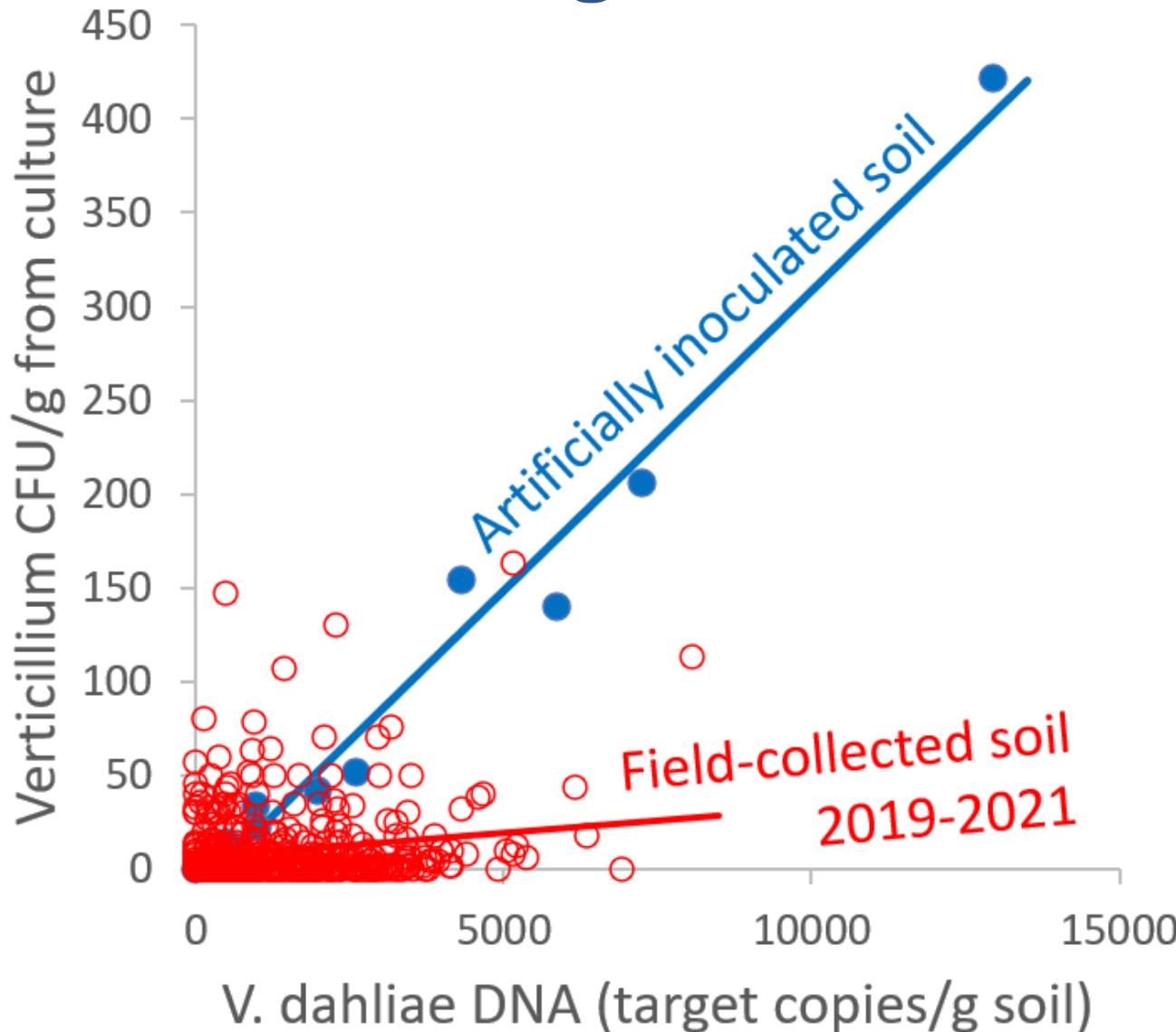
Validation of Real-time PCR Protocol for *Verticillium* Quantification in Soils Across Canada

- This activity will validate a standardized polymerase chain reaction (PCR) protocol for quantification of *Verticillium*'s deoxyribonucleic acid (DNA) in soil
- Agricultural Certification Services (ACS) in New Brunswick has been working with my lab in developing a commercial service for *Verticillium* analysis
- Soils from the survey in Project 1 will be used to calibrate the method to be accurate for potato soils across Canada

Validation of qPCR with soil samples surveyed across Canada for *Verticillium* quantitation



Great Deal of Variation Between Plate Counting and PCR



Sample Submission to ACS

- PCR
 - Quantification of *V. dahliae* and *albo-atrum*
 - \$75 per sample
- Conventional Counting
 - Quantification of microsclerotia producing *Verticillium*
- Shipping
 - 100g air-dried, lightly ground to pass 2mm screen
 - 200-400g fresh soil (not saturated) in an insulated box with cold packs
 - Ship in rigid box not padded envelopes
- Address
 - Agricultural Certification Services (ACS) Inc.
 - 1030 Lincoln Road, Fredericton, NB
 - E3B 8B7
 - Ph: 506-459-0293; Fax: 506-457-0769



PED Control Through Disease Control Products

- This activity will assess the potential to control PED through newly registered fungicide and nematicide disease control products applied alone or in combination
- Being conducted in Manitoba, Ontario, PEI and New Brunswick
- MB Treatments: combinations of Velum (Fluopyram), Elatus (Solatenol and Azoxystrobin), Serenade (*B. subtilis*)

Effect of Treatment on Marketable Yield

New Brunswick 2020

Treatment	Marketable Yield (t/ha)	% Yield of Control
Control	16.40	100
Senator	17.64	108
Elatus	17.78	108
Velum	17.97	110
Serenade Soil	20.55	125
Elatus + Velum	20.75	127
Elatus + Velum + Serenade	20.86	127

Khalil Al-Mughrabi
NB Agric, Aqua & Fisheries



PED Control Through Disease Control Products - Manitoba

PED Control Through Disease Control Products - Manitoba

- Five trials completed in 2020 and 2021
- Metam fumigation completed in falls
- In-furrow treatments



Oscar Molina
AAFC Morden



Darin and Debbie Gibson
Gaia Consulting



Manitoba Site Yield 2020

Treatment		Yield (cwt/ac)					
		< 4 oz	4-6 oz	6-10 oz	10-12 oz	> 12 oz	Total
1 Untreated Check		28.4 a	51.2 a	114.0 a	59.1 a	126.4 a	379.1 a
2 Velum Prime		26.6 a	33.1 a	123.3 a	33.8 a	176.0 a	392.8 a
3 Velum / Serenade		26.0 a	39.7 a	108.8 a	48.5 a	165.0 a	388.0 a
4 Velum / Aprovia / Quadris		31.4 a	43.2 a	112.6 a	44.6 a	155.8 a	387.6 a
5 Velum / Aprovia / Quadris / Serenade		23.9 a	43.2 a	115.5 a	58.6 a	145.1 a	386.3 a
6 Aprovia /Quadris		27.5 a	46.9 a	114.1 a	44.8 a	160.7 a	394.1 a
LSD P=.05		ns	ns	ns	ns	ns	ns
CV		38.3	23.3	16.4	42.1	18.5	5.9
Treatment Prob(F)		0.9421	0.236	0.9295	0.5102	0.2638	0.9503

Treatment		Yield (cwt/ac)					
		< 4 oz	4-6 oz	6-10 oz	10-12 oz	> 12 oz	Total
1 Untreated Check		33.1 a	42.1 a	117.6 a	46.7 a	153.3 a	392.8 a
2 Velum Prime		35.2 a	58.5 a	135.8 a	63.5 a	105.8 a	398.7 a
3 Velum / Serenade		48.4 a	52.1 a	151.5 a	57.7 a	104.7 a	414.3 a
4 Velum / Aprovia / Quadris		36.9 a	60.5 a	128.6 a	57.5 a	142.8 a	426.2 a
5 Velum / Aprovia / Quadris / Serena		37.2 a	58.8 a	164.3 a	51.2 a	113.6 a	425.1 a
6 Aprovia /Quadris		32.3 a	55.4 a	149.2 a	56.0 a	144.4 a	437.3 a
LSD P=.05		ns	ns	ns	ns	ns	ns
CV		49.2	30.4	21.0	33.9	36.4	6.2
Treatment Prob(F)		0.8382	0.651	0.3087	0.8545	0.5171	0.1761

MRK Yield of Check %

Check	100
VP	103
VP Ser	102
VP Apr Quad	105
VP Apr Ser Quad	106
Apr Quad	109

		Yield (cwt/ac)						
Fumigation x In-Furrow Fungicide		< 4 oz	4-6 oz	6-10 oz	10-12 oz	> 12 oz	Total	> 4 oz
1	NF x Quadris	24.0 a	40.1 a	110.9 a	51.7 a	171.8 a	398.5 a	374.5
2	NF x Quadris/Velum	34.4 a	42.8 a	115.4 a	39.6 a	167.4 a	399.6 a	365.2
3	NF x Quadris/Velum/Serenade	27.7 a	31.4 a	90.6 a	59.0 a	197.9 a	406.5 a	378.8
4	NF x Quadris/Velum/Aprovia	27.8 a	32.1 a	91.5 a	45.0 a	179.8 a	376.2 a	348.4
5	NF x Quadris/Velum/Aprov/Ser	21.4 a	37.3 a	110.1 a	50.2 a	172.1 a	391.1 a	369.7
6	NF x Quadris/Aprovia	30.0 a	35.6 a	105.7 a	64.9 a	178.6 a	414.8 a	384.9
7	Fum x Quadris	27.4 a	30.8 a	81.6 a	71.7 a	166.1 a	398.5 a	350.2
8	Fum x Quadris/Velum	21.8 a	39.7 a	130.5 a	39.5 a	176.0 a	399.6 a	385.8
9	Fum x Quadris/Velum/Serenade	28.7 a	37.7 a	86.6 a	47.1 a	204.1 a	406.5 a	375.5
10	Fum x Quadris/Velum/Aprovia	31.1 a	46.0 a	100.4 a	63.0 a	190.7 a	376.2 a	400.1
11	Fum x Quadris/Velum/Aprov/Ser	23.9 a	33.5 a	89.9 a	52.7 a	221.9 a	391.1 a	397.9
12	Fum x Quadris/Aprovia	28.6 a	42.0 a	124.1 a	53.8 a	160.5 a	414.8 a	380.4
LSD P=.05		ns	ns	ns	ns	ns	ns	ns

		Yield (cwt/ac)						
Fumigation x In-Furrow Fungicide		< 4 oz	4-6 oz	6-10 oz	10-12 oz	> 12 oz	Total	> 4 oz
1	NF x Quadris	68.8 a	97.0 a	130.7 a	44.4 a	54.3 a	395.3 a	326.5 a
2	NF x Quadris/Velum	93.8 a	92.1 a	121.5 a	27.8 a	47.4 a	382.6 a	288.8 a
3	NF x Quadris/Velum/Serenade	76.6 a	85.5 a	132.7 a	33.3 a	70.0 a	398.1 a	321.5 a
4	NF x Quadris/Velum/Aprovia	77.5 a	97.1 a	139.4 a	30.2 a	41.8 a	386.0 a	308.4 a
5	NF x Quadris/Velum/Aprov/Ser	97.1 a	88.9 a	113.8 a	30.0 a	50.5 a	380.2 a	283.1 a
6	NF x Quadris/Aprovia	68.0 a	84.3 a	133.9 a	33.8 a	52.3 a	372.4 a	304.3 a
7	Fum x Quadris	71.5 a	99.3 a	192.0 a	53.1 a	71.2 a	487.1 a	415.6 a
8	Fum x Quadris/Velum	64.2 a	111.2 a	168.5 a	37.9 a	85.4 a	467.3 a	403.1 a
9	Fum x Quadris/Velum/Serenade	67.4 a	97.8 a	167.2 a	54.1 a	75.2 a	461.8 a	394.4 a
10	Fum x Quadris/Velum/Aprovia	80.6 a	108.1 a	188.8 a	35.4 a	68.4 a	481.2 a	400.7 a
11	Fum x Quadris/Velum/Aprov/Ser	78.0 a	95.4 a	174.9 a	47.6 a	66.5 a	462.5 a	384.5 a
12	Fum x Quadris/Aprovia	83.9 a	100.4 a	169.4 a	41.1 a	89.6 a	484.4 a	400.5 a
LSD P=.05		ns	ns	ns	ns	ns	ns	ns
Standard Deviation		15.5	14.5	19.2	16.8	24.0	23.8	26.7
Prob(F)		0.1000	0.8687	0.6008	0.9206	0.7113	0.5051	0.7520

		Yield (cwt/ac)						
Treatment		< 4 oz	4-6 oz	6-10 oz	10-12 oz	> 12 oz	Total	> 4 oz
1	Quadrис	42.5 a	43.4 a	92.4 a	57.7 a	209.5 a	445.5 a	403.1 a
2	Quadrис/Velum Prime	34.0 a	24.8 a	101.7 a	64.5 a	230.9 a	456.1 a	422.0 a
3	Quadrис/Velum/Serenade	32.0 a	24.4 a	95.2 a	60.4 a	239.9 a	452.0 a	419.9 a
4	Quadrис/Velum/Aprovia	25.4 a	34.0 a	107.5 a	53.8 a	257.7 a	478.3 a	452.9 a
5	Quadrис/Velum/Aprov/Ser	31.1 a	35.6 a	134.2 a	54.3 a	222.2 a	477.3 a	446.2 a
6	Quadrис/Aprovia	29.3 a	33.2 a	108.0 a	57.5 a	224.0 a	452.0 a	422.7 a
LSD P=.05		ns	ns	ns	ns	ns	ns	ns
CV		45.3	47.4	18.2	35.6	13.1	5.9	6.8
Treatment Prob(F)		0.6919	0.5289	0.0885	0.9763	0.3533	0.4224	0.2207

Shilo

2021 Control Product Results

Portage

Non-Fum
305 cwt

Vapam
400 cwt

Morden

	Non-Fum	Fum
Quad	100	110
Quad VP	97	113
Quad VP Ser	101	111
Quad VP Apr	100	115
Quad VP Apr Ser	99	112
Quad Apr	100	112

2021 Fungicide Products Non-Fumigated Processing Attributes

	Specific Gravity	Hollow Heart	Vasc Discolour	Fry Colour	Sugar Ends
	g/cm3	%	%	0-4	%
Quad	1.0828	8	14	0.08	18
Quad VP	1.0816	16	10	0.02	11
Quad VP Ser	1.0817	6	7	0.06	10
Quad VP Apr	1.0805	8	8	0.03	11
Quad VP Apr Ser	1.0830	8	7	0.04	11
Quad Apr	1.0816	12	7	0.06	10

Thank You

- Many farmers for access to their fields
- CanPEDNet sponsors:
 - Potato Growers of Alberta, Keystone Potato Producers Association, Ontario Potato Board, Potatoes New Brunswick, PEI Potatoes
 - Canadian Horticultural Council Potato Cluster
 - Enabling Agricultural Research and Innovation (EARI) program NB
 - Cavendish, McCain, Simplot, AMVAC, Bayer, Syngenta
 - AAFC Canadian Agricultural Partnership Science Cluster Program
- Gaia Consulting
- The whole CanPEDNet Team
- Amy Argentino