CanPEDNet Summary: PEI activities 2018-2023

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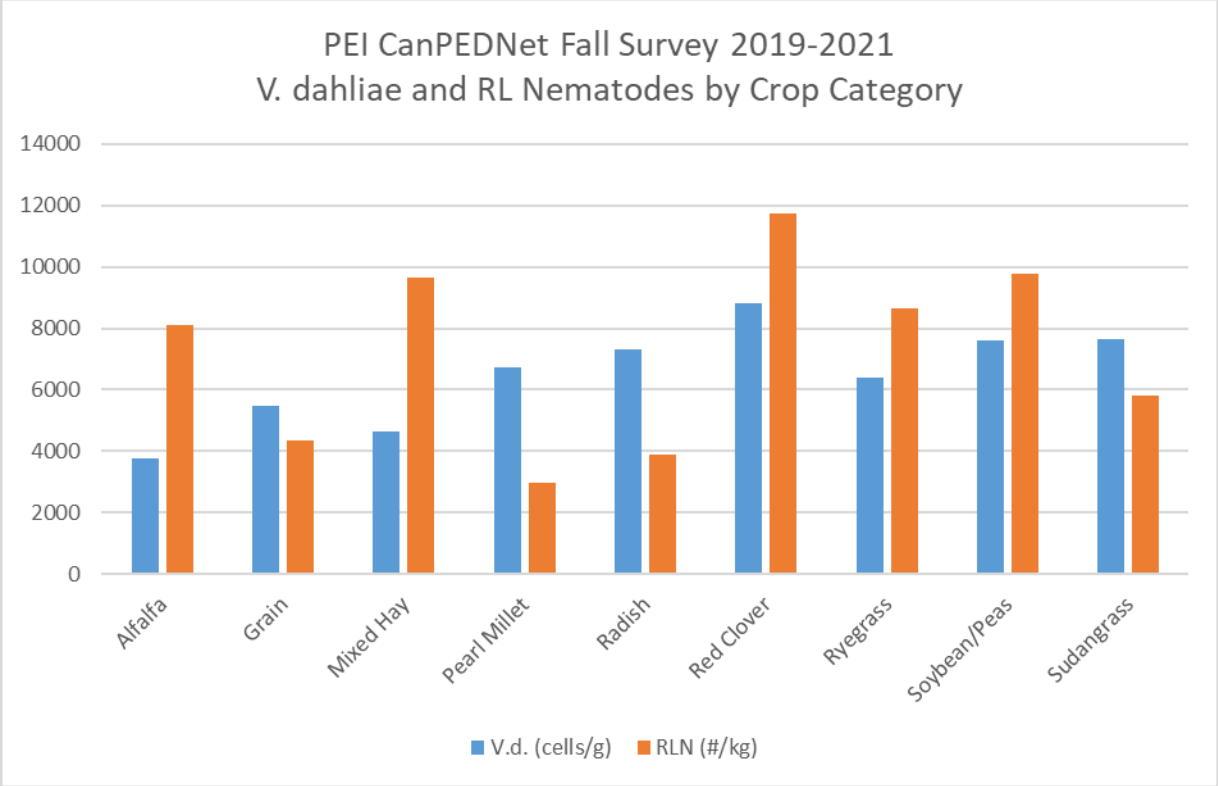
Starting in 2019, the Prince Edward Island Potato Board and the Prince Edward Island Department of Agriculture and Land collaborated to conduct three fall surveys of 30 fields each year (2019, 2020, 2021) for Verticillium and root lesion nematodes. In the following year (2020, 2021, 2022), eight fields were then selected for follow-up soil testing, observation of foliar symptoms, and harvest of yield samples.

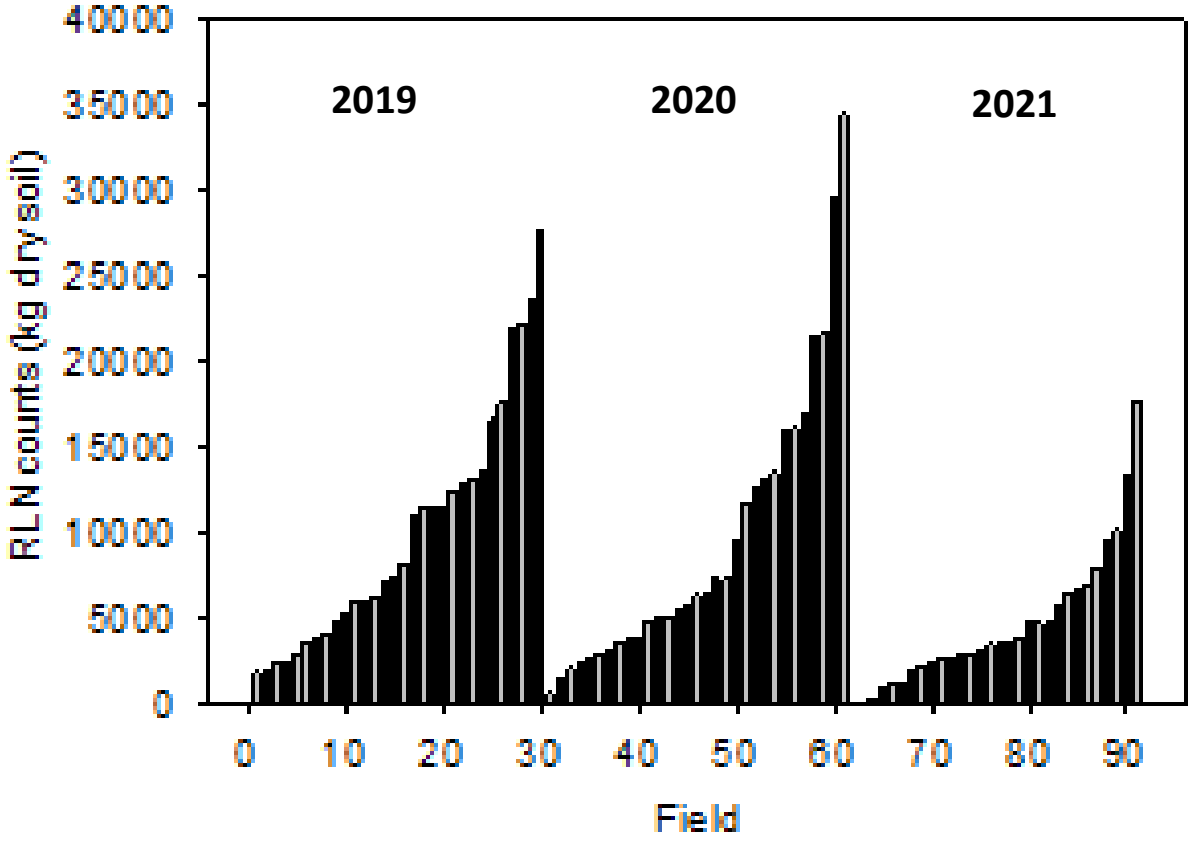
Figure 1: Populations of Verticillium dahliae (in cells/g of soil) and root lesion nematodes (in count per kg of soil) categorized by preceding crop from fall surveys in 2019, 2020 and 2021.



Across the three years of samples, it appears that the highest mean populations of V. dahliae were observed in fields that followed red clover, sorghum sudangrass, soybeans or peas, and oilseed or tillage radish. These results are somewhat surprising for sorghum sudangrass, as it is a crop that has been cited in prior literature as having a role in reducing Verticillium populations. The lowest populations were observed following alfalfa, mixed hay, and small grains (barley, oats, wheat).

For root lesion nematodes, the highest populations were observed following red clover, mixed hay (often including red clover), and soybean or peas. The lowest counts were observed following pearl millet, radish, and small grains. The results for pearl millet are not surprising, as past research has shown forage pearl millet to be a non-host for root lesion nematodes.

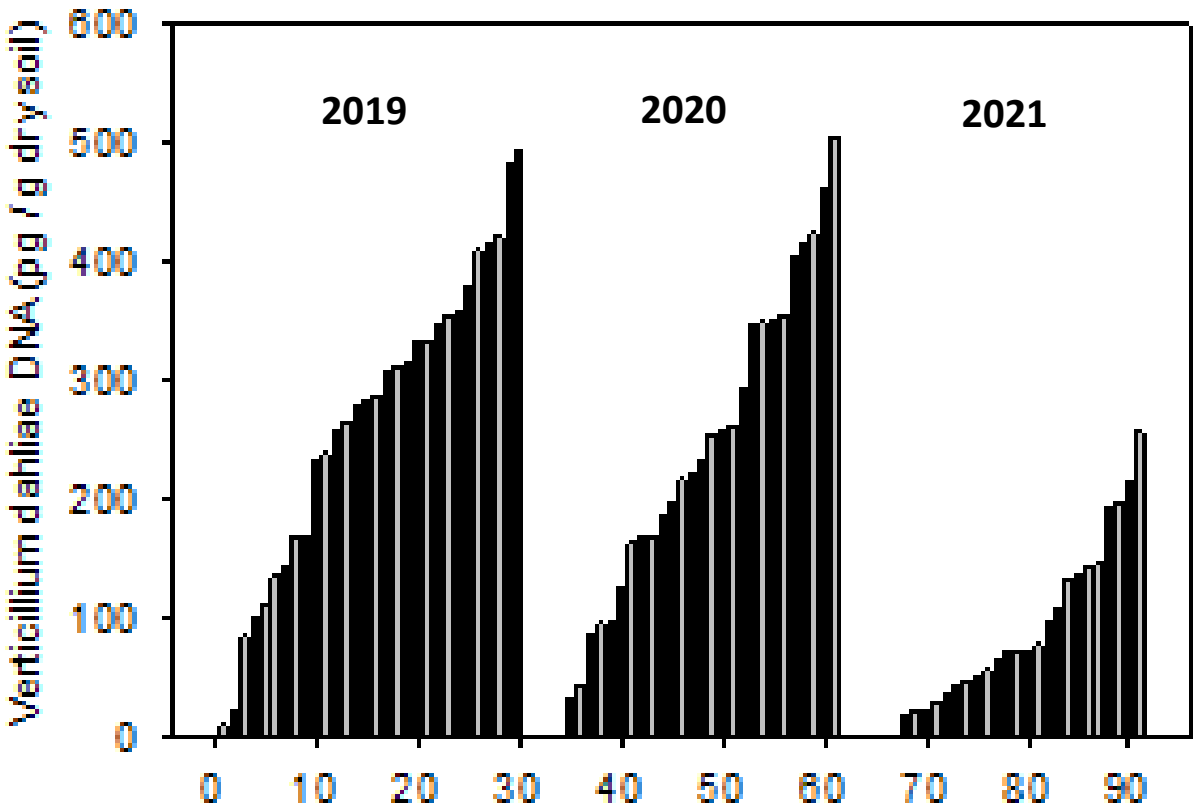
Figure 2: Root lesion nematode counts organized in increasing number by year (2019, 2020, 2021) from Prince Edward Island survey fields.



From Figure 2, you can see that the distribution for root lesion nematodes was quite similar in 2019 and 2020 surveys. In 2021, there appears to be a reduction in counts, particularly at the high end of the scale. It should be noted that the 2019 and 2020 growing seasons were generally dry in PEI, while the 2021 was more of an average growing season, with higher rainfall amounts during the growing season.

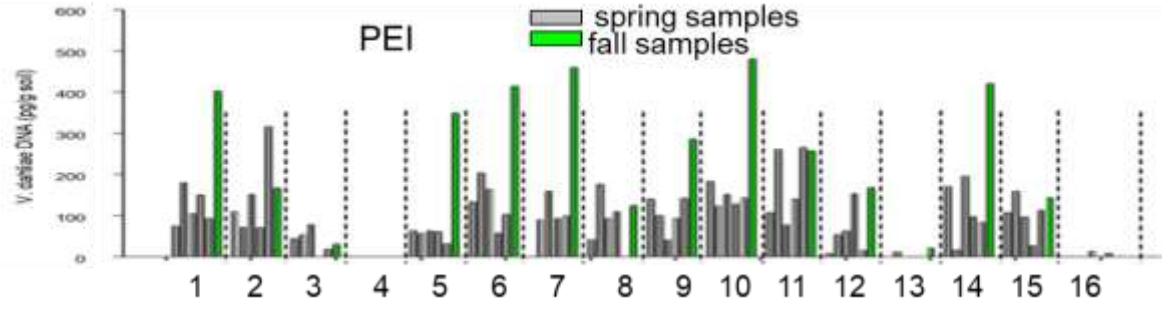
All surveyed fields across the three years had some level of root lesion nematodes detected, ranging from less than 2000 per kg of soil to greater than 35,000. Testing by Benjamin Mimee's lab at AAFC indicated that 45% of surveyed fields had *Pratylenchus penetrans* present, with *Pratylenchus crenatus* being the most commonly found nematode species. *P. penetrans* constituted less than 15% of all root lesion nematodes in PEI soil samples submitted to the AAFC lab.

Figure 3: *Verticillium dahliae* DNA (in pg/g of dry soil) organized in increasing number by year (2019, 2020, 2021) from Prince Edward Island survey fields.



A very similar trend was seen in the levels of *V. dahliae* detected, with the distribution being quite similar in 2019 and 2020 and then being reduced by a considerable margin in 2021. More than 90% of surveyed fields had *V. dahliae* detected using qPCR. Eight percent of surveyed fields had a trace amount of *V. albo-atrum* detected using the same methods. Results from qPCR were not well correlated with counts of colony forming units (CFU) conducted by the same laboratory (ACS in Fredericton, NB).

Figure 4: Comparison of *V. dahliae* between fall survey samples (green) and spring follow-up samples (grey)



There was a noticeable trend toward a reduction in *V. dahliae* levels between fall survey and spring follow-up samples for most fields; however, fall population density was significantly correlated (r^2=0.573) with the spring density the following year. For root lesion nematode populations, the reduction from fall to spring was generally less and the correlation between fall and spring was even more highly correlated (r^2=0.824).

Figure 5: Results from follow-up sampling in 2020, 2021, and 2022 Russet Burbank fields in PEI for early dying symptoms and potato 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

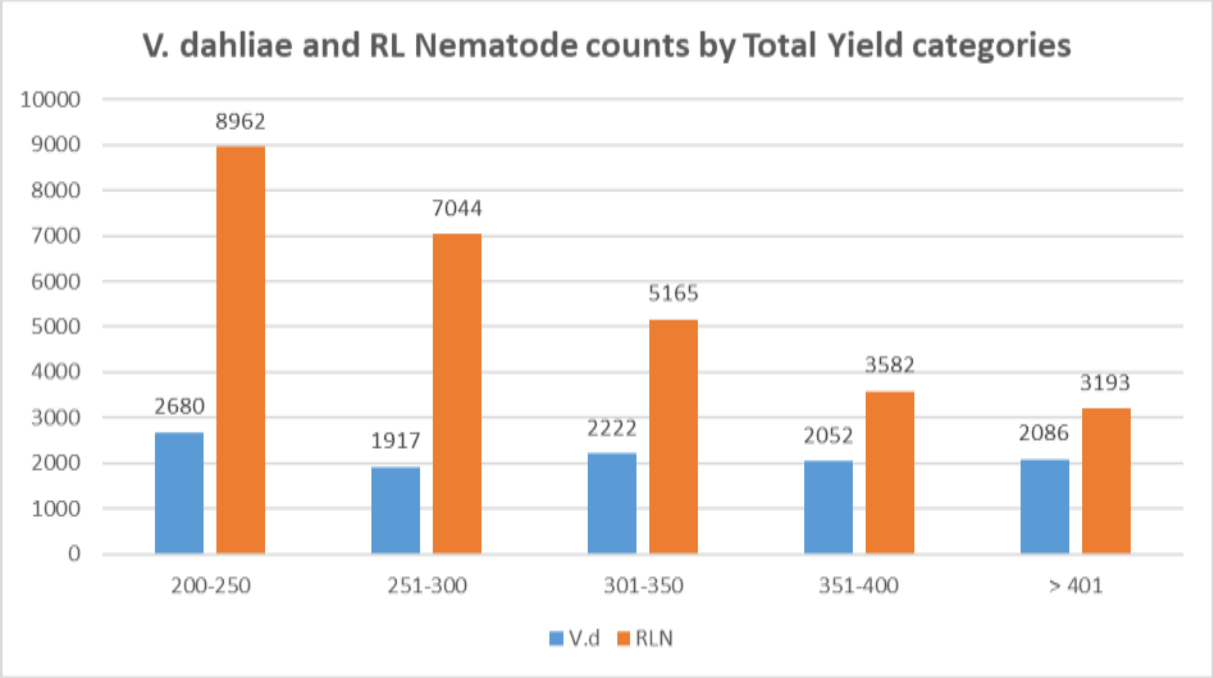
In each year, eight fields were selected for additional follow-up testing based on the results of the fall survey. In 2020, one of the fields had to be excluded due to being planted with a variety other than Russet Burbank. Two fields had to be excluded from analysis due to inconsistent results due to field conditions unrelated to potato early dying. In 2021, all eight fields had useable results; however, one of the fields was reclassified as a high inoculum field based on spring soil test results for V. dahliae and root lesion nematodes. In 2022, one field was lost from analysis due to being planted with a variety other than Russet Burbank.

In all three years, there was a significant different in total yield between the low and high inoculum fields. In two of the three years, there was an observable difference in foliar symptoms. This was not the case in 2021; however, one of the data collectors/observers in 2021 wasn't fully trained to take the required observations and this data may not be reflective of crop conditions.

The level of yield reduction for marketable yield ranged from 11 to 19% across the three years. The largest yield difference was observed in 2022, which was a strong growing season in PEI with provincial average yield hitting an all-time record.

When trying to ascertain what level of inoculum is causing what level of yield reduction, we categorized total yield into a series of groups and then calculated the average counts for both V. dahliae and root lesion nematodes.

Figure 6: Verticillium dahliae counts (cells per gram of soil) and root lesion nematode counts (per kg of soil) averaged by total yield category (in cwt/acre) for the Russet Burbank variety.



From Figure 6, you can see that Verticillium counts trended downward slightly as total yield increased, but the degree of reduction is relatively minor compared to the downward trend observed for root lesion nematodes. Previous research performed by Dr. Joe Kimpinski at AAFC Charlottetown on root lesion nematodes in PEI established an economic threshold of 5000 nematodes per kg of soil, whereby a grower could expect to see yield loss. Using the same testing protocols, average to above average total yields for Russet Burbank (greater than 350 cwt/ac) have root lesion nematode counts below 5000/kg of soil, while below average yields (less than 350 cwt/ac) have counts higher than 5000/kg of soil.

It appears that in this data set, root lesion nematode count is a stronger predictor of yield than V. dahliae. It may be the case that most potato fields in Prince Edward Island have a significant level of Verticillium inoculum and that other mitigating factors, including the presence of root lesion nematodes, may be needed to cause significant yield reductions. Another explanation is that current testing methods are highly variable; as a result, it is difficult to build an accurate response curve of total yield versus Verticillium dahliae levels. Undoubtedly more research will be needed to refine testing as well as build the database necessary to predict yield response.

Take-Home Messages for Producers:

- There is considerable variability within field and between fields for both Verticillium and root lesion nematodes. Proper sampling technique and sampling density is required to get a good estimate of pathogen levels in your fields.

- Root lesion nematode numbers in our fall surveys (90 fields over 3 years) were highest after red clover, mixed legume/grass hay, and soybeans/peas. Nematode numbers were generally lowest following pearl millet, radish (oilseed or daikon), and small grains (barley/oats/wheat).

- *Verticillium dahliae* numbers in our fall surveys were highest after red clover, soybeans/peas, and sorghum sudangrass. It should be noted that the number of sudangrass fields was not large in the survey, and many fields where sudangrass was planted were likely fields that were known to have early dying symptoms in the past. *V. dahliae* numbers were lowest following alfalfa, small grains, and mixed hay crops.

- Only *Verticillium dahliae* was found in significant amounts in PEI. *Verticillium albo-atrum* was only found in trace amounts in a few fields.

- Not all root lesion nematodes play a factor in potato early dying. *Pratylenchus penetrans* is the primary nematode of concern, and it made up less than 15% of identified root lesion nematodes. Approximately half of fields had *P. penetrans* found in soil samples.

- When both *P. penetrans* and *V. dahliae* are present at the same time in significant numbers, early dying symptoms were increased, which is consistent with prior research.

- Improved *Verticillium* detection methods have been developed at the ACS Lab in Fredericton. More work will be needed to refine nematode detection methods, especially those that can specifically identify *P. penetrans.*

- There is a strong correlation between fall and spring samples for *Verticillium* and root lesion nematodes. Sampling in the fall will generally provide producers with a good idea of which of their fields may have more of a potential for potato early dying.

- Across three years of trials, the yield reduction between fields described as “high” and “low” inoculum levels for PED ranged between 16 and 20% for total yield. This level of difference was observed in both fields that were under drought conditions and with sufficient moisture.

- The level of foliar symptoms seen in 2020 and 2022 was a strong predictor of yield reductions.

- From this study, root lesion nematode levels appear to be a great predictor of yield reduction for Russet Burbanks than *Verticillium* levels. The previously established threshold of 5000 nematodes per kg of soil for the testing protocol used by PQI continues to be largely appropriate. More work is needed to establish a response curve or threshold level for qPCR counts of *Verticillium* DNA.

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