Best Management Practices to Minimize the Spread of PVY

based on research by Dr. Mathuresh Singh and research team, Potatoes New Brunswick
report by Ryan Barrett, PEI Potato Board and Dr. Tyler MacKenzie, Potatoes New Brunswick

Summary:

Research by Dr. Mathuresh Singh and his research team in New Brunswick has made significant progress in improving our understanding of PVY spread. From these studies, the key messages for reducing PVY spread include:

- **Plant certified seed with the lowest PVY virus level possible.** Starting with clean seed is associated with significantly lower levels of in-season spread.
- **Weekly application of at least 2 L per acre of mineral oil** from soon after emergence until shortly before top kill, **combined with use of effective insecticides** has been proven to have the lowest rate of PVY spread. Any foliar insecticide spray should be applied tank-mixed with mineral oil to maximize time it is retained in foliage at effective concentrations.
- **Time crop planting, spraying and topkill to maximally protect against aphids.** Spraying should start from 20-30% plant emergence and continue weekly until shortly before top kill. Consider delaying planting into June after mild winters or if spring aphid activity is expected to be high; later planted crops may then emerge after the typical early aphid population peak passes. Fast-maturing crops can reduce the time plants are in the field and available for aphids to transmit PVY among them. Early topkill can reduce late-season infection when the most effective PVY transmitting Green Peach Aphid is prevalent in eastern Canada.
- **Early rogueing**, even in seed plots with a zero virus rating, is important in all seed fields to reduce the risk of virus spread in-season.
- **Weather and regional aphid abundance cannot be controlled by the grower, but vigilant and intense management is sufficient to maintain seed crops below PVY cap**, even in the most challenging years. Spraying intensity and PVY planted in the field – under the grower's control – are statistically stronger at reducing PVY spread than aphids and weather are at increasing it.
- **Growers producing both seed and commercial crops show far higher PVY levels in their seed fields than growers exclusively producing seed crops, especially in high-PVY years.** Growers choosing to mix seed and processing/tablestock production should be extra vigilant to maintain intensive management of their seed crops, and carefully plan where they are grown to isolate them from their potentially higher-PVY fields.

Since 2009, researchers led by Dr. Mathuresh Singh at the Agricultural Certification Services lab of Potatoes New Brunswick have been studying the spread and management of Potato virus Y (PVY). This research has been supported by previous CHC-FVGC National Potato Research Clusters, New Brunswick's Enabling Agricultural Research and Innovation (EARI) programs, and by collaborating scientists from AAFC, NBDAAF, participating industry partners and growers. Dr. Singh's team has published several scientific papers resulting from their PVY research, and frequently presents research results to industry and academic conferences around the world. In this factsheet, we summarize best management practice recommendations for PVY management developed from this research.

Management of PVY requires a two-pronged approach, through: minimizing PVY inoculum in seed, and reducing the spread of PVY in the field.

Planting Clean Seed:

One of the factors with the largest effect on minimizing PVY levels is planting seed with the lowest virus level possible. In New Brunswick research, it was found that **seed lots planted with zero percent PVY had significantly lower PVY levels at the end of the season compared with fields planted with some starting virus level** (Fig. 1). This makes logical sense, as having fewer PVY infected plants for aphids to pick up the virus from dramatically decreases the likelihood of spread to nearby plants within the field. While aphids can bring PVY from other fields, minimizing the initial inoculum in the field is one of the single largest factors in reducing in-season PVY spread. In addition, effective rogueing of seed fields to

remove infected plants early is essential to limiting the spread of PVY as even seed lots with a zero post harvest test may contain some infected plants. This is especially important if planting a seed lot with a virus level higher than zero.

Application of Mineral Oils and Insecticide:

Over several years, Dr. Singh and his team have been able to conclusively show that the regular application of mineral oils in combination with the use of insecticides has consistently shown to be very effective at minimizing the spread of PVY in-season. By examining both grower practices over several years as well as testing on a plot basis over multiple years, the New Brunswick team has identified that **weekly application of at least 2 L per acre of mineral oil is essential to impairing the ability of non-colonizing aphids to transmit PVY (Fig 2).** Growers who maximized their time of protection with mineral oil (starting before 30% emergence and continuing until just before top-kill) showed the greatest control of PVY spread. For frequent or higher-rate oil applications may be necessary during periods of rapid leaf growth.

Foliar spraying with tank-mixed mineral oil and insecticides is effective at reducing PVY spread across a wide range of insecticide types, including biological agents such as LifeGard™. Generally, combined oil-insecticide sprays were shown to be effective; however, certain insecticide types were measurably better than others, including relatively inexpensive pyrethroids (such as lambda-cyhalothrin in Matador™, Silencer™, or alternatively deltamethrin in Decis™) or flonicamid (Beleaf™). Biological/organic plant sensitizers like LifeGard™ also reduced PVY, but with a measurable reduction of harvested yield.

Key to any IPM strategy is alternating chemistries when possible to avoid building insecticide resistance in aphid populations. There is some evidence that Green Peach aphids are showing resistance to lambda-cyhalothrin products; consequently, **growers are encouraged to employ other aphicides late in the growing season when Green Peach aphids arrive**. In addition, rotation of insecticides must be done using not just different products but products from different groups with different modes of action. Rotating products like Matador and Silencer (both with the same active ingredient) is not sufficient.

Foliar sprays with either mineral oil or insecticides alone, by contrast, are not effective at reducing PVY spread. Residue testing has shown that **when tank-mixed and applied together, the insecticide remains longer on or in the leaf tissue**, presumably because it is oil-soluble and retained in the mineral oil sprayed on the plant.

Timing crop management to minimize aphid exposure:

Growers who minimized the time that crops were exposed to aphids consistently have lower PVY levels in their fields. Minimizing exposure can be done by reducing or shifting time in the field to avoid aphids and by maximizing time of protection by foliar sprays.

Potato crops that were grown for a shorter season showed reduced PVY levels compared to crops grown for longer times (Fig. 3). Particularly in 2022, which saw a large number of Green Peach Aphids in September, early topkill (late August to first week of September) showed far lower PVY levels than crops left alive in the

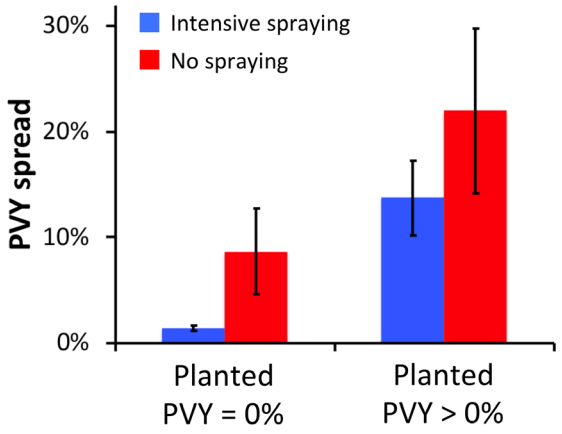

Figure 1: Effect of PVY inoculum planted in the field. Fields planted with no detectable PVY (Planted PVY = 0%) show much less PVY spread even than intensively managed fields (many mineral oil and insecticide sprays) if planted with detectable levels of PVY (Planted PVY > 0%). Data from: MacKenzie, Tyler DB, Xianzhou Nie, and Mathuresh Singh. American Journal of Potato Research 93, no. 6 (2016): 552-563.

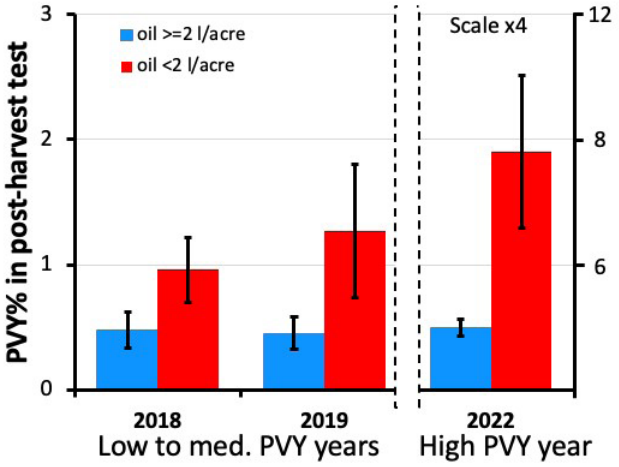

Figure 2: Comparing NB post-harvest test results for PVY for growers applying less than 2L per acre of mineral oil per week (red) with growers applying 2L or more per acre per week (blue). Courtesy M. Singh and T. MacKenzie.

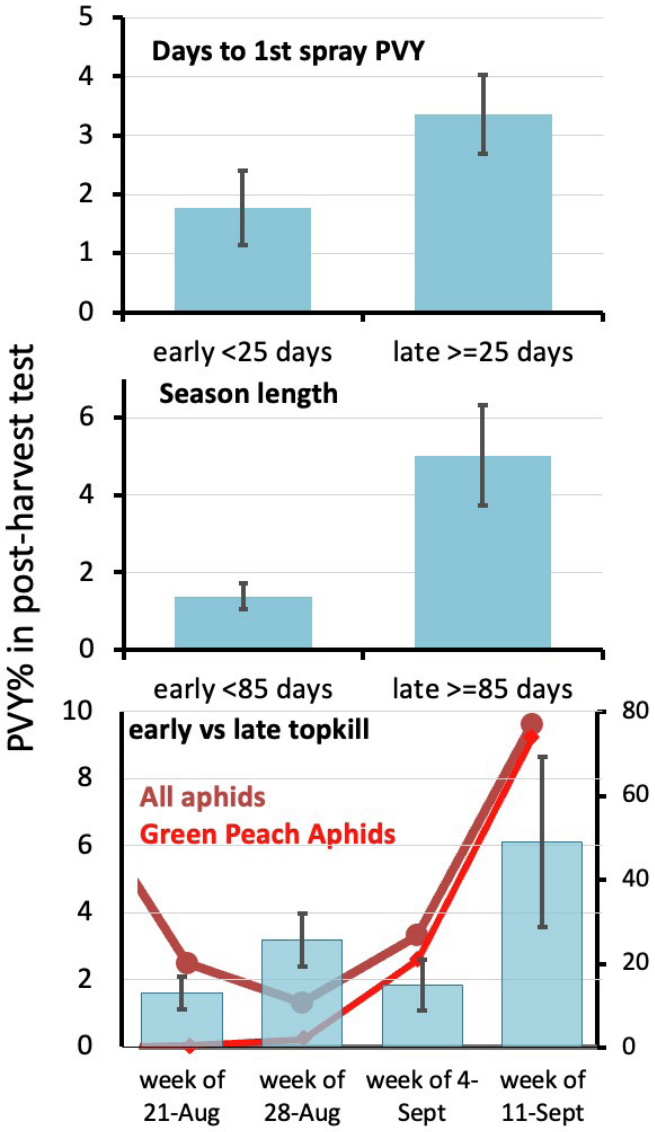

Figure 3: Effects of crop timing in a high-PVY year (2022), in terms of length of the growing season from planting to topkill (season length), interval of time between planting and first foliar spray exposing emerging plants to aphids, date of topkill, and the average PVY in crops topkilled in different weeks alinged with the fall peak of PVY-transmitting Green Peach Aphids.

field later into September. Protecting the crop with foliar sprays while it is actively growing is also important, by commencing spraying early after planting (20 - 30% emergence) and continuing weekly until topkill. Shorter time between planting and first foliar spraying is correlated with reduced PVY at harvest (Fig. 3), and accumulation of PVY in the crop through the season was measured to be much higher in field where spraying commenced two weeks later than otherwise comparable fields sprayed early.

Typically, potato plants are most sensitive to PVY infection when young and actively growing, coincident with a regular early-season peak of aphid abundance in the field. PVY levels at harvest are consistently correlated best with early-season aphid abundance (late June to early July), compared to abundance later in the season, or to the average aphid abundance season-long. Thus, greater vigilance and spraying early in the season, with most frequent tank-mixing of insecticides then as well. This does not mean, however, that spraying is not also important later in the season, only that it is most important early. Slightly delaying planting may also reduce the time when the emerged crop would be exposed to the early-season aphid peak, and the crop is likely to make up much of the time with greater growing degree-days later in the summer.

Changing PVY Strain Populations:

A major shift has occurred in PVY strain populations in eastern Canada, and worldwide, in recent years. PVY is not a singular virus, but a complex of strains with different symptom expression, effects on tuber yield and quality and rate they spread in the field. Traditionally, PVY^{O} has been the dominant strain Canadian growers in past decades were most experienced with. About ten years ago, however, this strain began declining dramatically to be replaced by recombinant, necrotic PVY strains such as $PVY^{N:O}$, $PVY^{N\text{-}Wi}$ and PVY^{NTN} (Fig. 4). PVY^{NTN} is particularly aggressive, spreading much more readily than other strains, and now accounts for >80% of infections. More recently, $PVY^{N\text{-}Wi}$ has also been gaining in population. This aggressive strain has previously been observed to be most prevalent in western North America, and may have arrived here recently from potato seed imports.

In addition, both $PVY^{N:O}$ and PVY^{NTN} tend to display fewer foliar symptoms (mosaic) than traditional PVY^{O}. This impacts the ability to identify infected plants during rogueing. The variation of symptoms on both foliage and tubers has been shown to be variety-dependent, with the NB research team cataloguing the relative severity of symptoms on thirty different varieties. For example, the round white variety Eva has shown to be very resistant to all strains of PVY. On the other hand, varieties such as Envol and Yukon Gold appear to be particularly susceptible to the recombinant strains, with necrotic lesions evident on tubers. Thus far the New Brunswick researchers have not shown severe necrotic effects from PVY in some of the dominant varieties grown in Prince Edward Island, such as Russet Burbank or Goldrush.

While recombinant strains may have a milder impact on yield than PVY^{O} in some potato varieties, the more rapid rate of transmission to more plants in the field and difficulty detecting them visually more than account for any lower yield loss. Growers' variety selection should

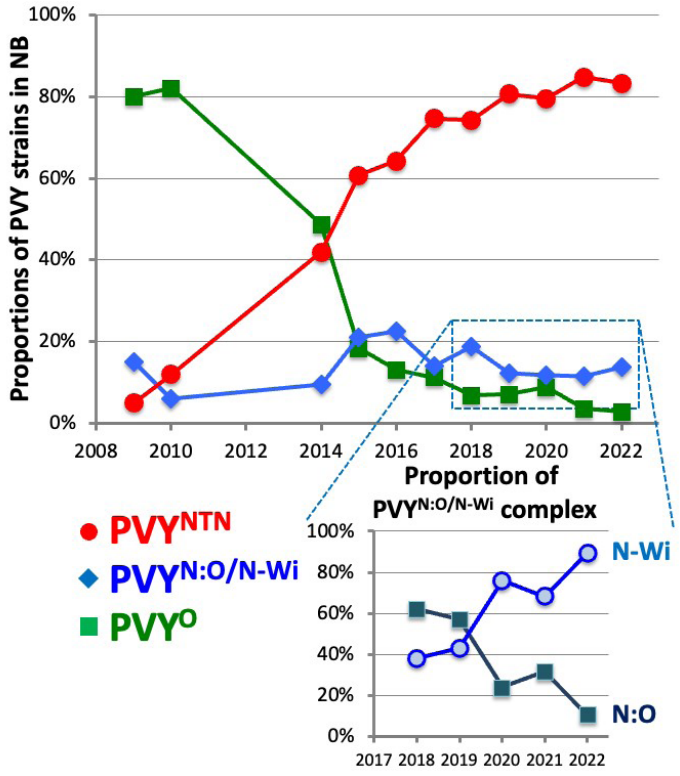

Fig. 4. Changes in PVY strain populations in NB since 2009. The traditionally dominant PVYO strain has dropped twenty-fold, replaced mostly by PVYNTN, though recently the PVYN-Wi component of the PVYN:O/N-Wi complex has also begun to rise. Supplemented data from: MacKenzie, Tyler DB, Jacques Lavoie, Xianzhou Nie, and Mathuresh Singh. American Journal of Potato Research (2018): 1-10

take under consideration PVY strain-specific symptoms, resistance and susceptibility to tuber necrosis. Because of the changed makeup of the strain populations, **PVY is now a very different virus than what growers experienced 15 years ago.**

Recent research results from Dr. Singh's team have shown that, as they are when spread by aphids, these recombinant strains also appear to be more likely to be spread by mechanical damage to foliage. Controlled field experiments have shown that **PVY spread can be several times higher in wheel tracks than in neighbouring, undisturbed rows**, due to the exposure of sap from foliage on wheels travelling down the row and infecting plants through damage to leaves and stems. Further research into the mechanical transmission of PVY is ongoing, but growers of high-generation seed may need to consider changing the management of wheel tracks or using tramlines

Environmental Variables:

Some environmental conditions, notably aphid abundance and weather, are not under a grower's control, but awareness of them can assist in management choices. Aphid abundance early in the growing season most strongly correlates with PVY spread, so any evidence of elevated aphid levels in at crop emergence or during early growth (June to early July), whether from the provincial Aphid Alert program or by field scouting, should trigger intensified foliar spraying of the field.

An early sign that may alert to higher aphid potential later in the year is the temperature of the preceding winter and early spring. Higher-than-average temperatures in February, March and especially April have been correlated with higher aphid abundance and PVY spread during the growing season, likely because it allows greater overwinter survival of aphids as well as volunteer potatoes potentially infected with PVY.

PVY can be spread by aphids between fields, as well as between plants within a field. Awareness of potential sources of PVY in other nearby fields can inform the arrangement of crops to avoid closely neighbouring seed fields. **Working with other neighboring producers to keep higher-inoculum commercial fields away from seed fields is in everyone's best interest!**

A phenomenon that has been observed in NB, which may be related to PVY spread from neighbouring fields, is that **growers who produce both seed and processing crops have on average far higher post-harvest PVY test results than growers who exclusively produce seed potato crops.** It is uncertain how much this is due to seed fields closely situated to high-PVY processing fields, or a level of aphid management of the seed crops that would be of lower intensity, closer to processing field management, than the intense aphid management typical of specialized seed producers. Particularly in high-PVY years, growers mixing seed and processing potato production should be extra cautious of maintaining adequate management and isolation of their seed crops.

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For more information on seed management topics, please visit the PEI Potato Agronomy website at http://peipotatoagronomy.com

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