

## Introduction

Potato virus Y (PVY), type virus of the family Potyviridae, is among the most economically significant pathogens affecting commercial potato producers, with several previous studies demonstrating that the virus reduces yield in many of the cultivar commonly produced in the US (Bonde et al., 1943; Mondjana et al., 1993). Depending on the potato variety and virus strain, infected fields may experience yield losses as high as 80% (Hane & Hamm, 1999). Regarding commercial potato production, the primary PVY reservoir is infected seed potatoes; as such significant effort is expended worldwide to produce seed potatoes with low levels (no more than 2% infection rate) of the virus.

Some varieties, such as 'Russet Norkotah' and 'Shepody', have only mild or latent symptoms as opposed to the typical foliar mosaic symptoms which are readily observed in 'Russet Burbank' and other cultivars (Nolte et al., 2009; Zeng et al., 2018). Symptoms in cultivars may also vary depending on the strain of virus. The emergence of new PVY strain within the US, inconsistent use of suitable diagnostic tools, and the release of asymptomatic cultivars has hampered the efficiency of seed certification inspections and may have led to an increased virus level in seed stocks (Karasev & Gray, 2013).

PVY infection is a persistent problem for seed certification and is responsible for a significant share of seed lot rejections in numerous states (Frost et al., 2013). The presence of non-colonizing cereal aphids such as *R. maidis*, *R. padi*, and *S. graminum* in potato production areas virtually ensures the spread of PVY introduced into a potato field through infected seed potatoes. It has been suggested that non-colonizing aphids are the main cause of poor PVY control (Halbert et al., 2003), leading to seed-borne PVY to persist as a chronic problem for potato growers in the US.



## Objectives

- Model the spread of seed-borne PVY within commercial potato fields over the course of the growing season.
- Use the resulting models and historical price data to create a tool allowing commercial growers to estimate the revenue loss due to seed-borne PVY under various scenarios.
- Calculate an adjusted (indifference) price for seed potatoes based on revenue loss due to seed-borne PVY.

User Input

Potato Variety	Russet Burbank
Seed-Borne PVY %	3.00%
Seed Price (\$/cwt)	\$ 13.00
Planting Density (cwt/acre)	21
Total Acreage Planted	500
Total Seed Cost	\$ 136,500
Model	3 Yr Burbank Quant 50%

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Estimated End of Season PVY Infection Rate and Impact

Estimated EOS PVY %	6.05%
Estimated In-Season PVY Spread %	3.05%
Modeled Yield Impact per % of PVY Infection	1.17
Estimated per Acre Yield Impact of PVY (cwt)	7.07

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Total Economic Impact of Seed Quality

Total Revenue Impact of Seed (Fresh Market)	\$ -5,675.96
Total Revenue Impact of Seed (Process Market)	\$ -4,984.61

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Seed Performance Comparison

	User Input 3.00% PVY	0% PVY	2010 - 2015 Tested Mean 1.63% PVY	Recertification Standard 2% PVY	5% PVY	10% PVY
Seed-Borne PVY Infection %	3.00%	0.00%	1.63%	2.00%	5.00%	10.00%
Estimated EOS PVY Infection %	6.05%	2.50%	4.43%	4.87%	8.41%	14.33%
Estimated In-Season PVY Spread %	3.05%	2.50%	2.80%	2.87%	3.41%	4.33%
Estimated per Acre Yield Impact (cwt)	7.07	2.92	5.18	5.69	9.84	16.75

## Materials and Methods

Data was generated from test plots of both 'Russet Burbank' and 'Russet Norkotah' that were planted in southern Idaho during the 2010, 2011, and 2012 growing seasons. The field trials consisted of five treatment levels with four replications of each except for the 2012 'Russet Burbank' trial, when lower than expected virus levels in the selected seed crop necessitated the use of only four treatment levels (see below).

The field trials used a Randomized Complete Block Design. Enzyme Linked Immunosorbent Assay (ELISA) was used to establish PVY infection status; seed pieces from infected and uninfected tubers were then blended to reach the desired treatment levels just before planting. At harvest, each plant was again evaluated using ELISA to determine PVY prevalence in each plot at the end of the growing season. Using STATA, the data was evaluated using both OLS and quantile regression to model the relationship between seed-borne PVY levels and end-of-season PVY levels.

### Treatment Target and Actual PVY Levels by Cultivar/Year

Variety	Year	Treatment 1 <sup>a</sup>	Treatment 2 <sup>a</sup>	Treatment 3 <sup>a</sup>	Treatment 4 <sup>a</sup>	Treatment 5 <sup>a</sup>
		Target: 0%	Target: 5%	Target: 10% (15%)	Target: 25% (30%)	Target: 50% (NA)
Russet Burbank	2010	4.4%	10.2%	16.3%	30.2%	51.3%
	2011	12.0%	13.8%	13.1%	30.9%	49.7%
	2012	6.9%	10.8%	17.2%	30.5%	NA
Russet Norkotah	2010	1.9%	7.7%	8.1%	26.3%	50%
	2011	8.2%	14.7%	22.0%	31.5%	58.3%
	2012	1.3%	8.2%	14.5%	29.3%	51.3%

<sup>a</sup> The average for the treatment

## Yield Loss Due to PVY

Nolte et al. (2004) reported yield reduction due to PVY infection of 196 kg/ha for each percent of PVY infection in 'Russet Burbank'. Similarly, they found yield reductions of 167 kg/ha and 160 kg/ha per percentage point of PVY infection in 'Russet Norkotah' and 'Shepody', respectively.

More recently, Aryal (2013) has found that the marketable yield of 'Russet Norkotah' potatoes was reduced by 131 kg/ha for each percentage point of PVY infection, resulting in a \$30.32/ha reduction in gross revenues per percentage point of PVY infection (when evaluated using fresh-pack prices). For 'Russet Burbank', marketable yields were found to be reduced by 137 kg/ha per percentage point of PVY infection, and gross revenues, when evaluated using fresh-pack-prices, reduced by \$22.66/ha per percentage point of PVY infection.

## Conclusions

- Seed-borne PVY will be spread to uninfected plants during the growing season, even when the seed-borne level is quite low.
- Adjusting seed potato prices to compensate growers for higher seed-borne PVY level may allow producers of inferior seed potatoes to find buyers.
- Similarly, seed potato producers who produce exceptionally clean seed may be able to demand a price premium from commercial potato growers.

## References & Funding

A complete list of references is available from the authors upon request.

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## Improving Grower Purchasing Decisions

Using the resulting models we created a web application (left) to help commercial growers understand the economic impact of seed potato quality (in terms of seed-borne PVY infection level) and improve their purchasing decisions. This 'PVY Calculator' allows growers to estimate the revenue impact of seed-borne PVY for various infection levels and spread patterns, decreasing the information asymmetry between seed and commercial potato producers.

Try the calculator for yourself at:

<https://www.uidaho.edu/cals/idaho-agbiz/tools/pvy-calculator>



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