The economic impact of PVY, implications for seed certification and commercial production

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Jeremy Rosenman
BROUGHT TO YOU BY:

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- Idaho Agricultural Experiment Station
- Montana Agricultural Experiment Station
Seed Potato Number

THE VALUE OF GOOD SEED POTATOES


During the past decade there has been a constantly increasing demand for good seed potatoes. This demand on the part of the grower has been largely due to the constant raising of the standards of seed certification requirements and the accumulation of indis-
PERCENT OF SEED LOTS WITH PVY, IDAHO

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>&gt;0, &lt;0.5</th>
<th>&gt;0.5, &lt;2.0</th>
<th>&gt;2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>41%</td>
<td>50%</td>
<td>13%</td>
<td>12%</td>
</tr>
<tr>
<td>2009</td>
<td>50%</td>
<td>61%</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td>2010</td>
<td>50%</td>
<td>50%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>2011</td>
<td>50%</td>
<td>62%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>2012</td>
<td>55%</td>
<td>55%</td>
<td>9%</td>
<td>15%</td>
</tr>
<tr>
<td>2013</td>
<td>50%</td>
<td>21%</td>
<td>8%</td>
<td>17%</td>
</tr>
<tr>
<td>2014</td>
<td>21%</td>
<td>21%</td>
<td>11%</td>
<td>21%</td>
</tr>
<tr>
<td>2015</td>
<td>20%</td>
<td>51%</td>
<td>18%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Seed Certification – National Survey of Seed Lots

2006-2012 National average of PVY in seed lots
40% of lots with PVY, 19% of lots rejected at 2% level

Healthy seed lot  PVY detected in seed lot  Rejected seed lot - >2% virus
MONTANA DISEASE TEST DATASET

- 2005–2015
- Several disease tests including PVY
- Summer test and winter test
- Farm ID
- Location (county)
- Generation
- Variety
- Year
PREDICTING WINTER PVY AS A FUNCTION OF SUMMER PVY

Depends on:

What type of model we use
Whether we use some or all of the data
What else we control for

Factor of spread ranges from 2.2 to 9.5 from summer to winter test

Our “preferred” model spread factor: 4.1
% PVY without Screening

Year

0 20 40 60 80 100

1 2 3 4 5 6 7 8 9 10
### Calculating Benefits from Virus Screening

<table>
<thead>
<tr>
<th>Generation</th>
<th>Average for all samples</th>
<th>Under tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PVY Average, Summer</td>
<td>Predicted PVY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average, Winter</td>
</tr>
<tr>
<td>1</td>
<td>0.04</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.07</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>0.15</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td>4</td>
<td>0.36</td>
<td>1.63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.02</td>
</tr>
</tbody>
</table>
FIELD EXPERIMENT

- Seed lots with PVY Identified
- Tubers ELISA tested for PVY + or –
- After ELISA, healthy & PVY + kept separate
- Same storage facility and methods to avoid physiological aging issues
- At planting + and - seed pieces cut
- PVY - and PVY + blended at desired ratios
- Planted in commercial potato field
## Actual Levels at Emergence

Russet Burbank Emergence % PVY
Measured by ELISA

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Target</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>4.4</td>
<td>12.0</td>
<td>6.9</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>10.2</td>
<td>13.8</td>
<td>10.8</td>
</tr>
<tr>
<td>3</td>
<td>10 (15)</td>
<td>16.3</td>
<td>13.1</td>
<td>17.2</td>
</tr>
<tr>
<td>4</td>
<td>25 (30)</td>
<td>30.2</td>
<td>30.9</td>
<td>30.5</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>51.3</td>
<td>49.7</td>
<td></td>
</tr>
</tbody>
</table>
## ACTUAL LEVELS AT EMERGENCE

Russet Norkotah Emergence % PVY
Measured by ELISA

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Target</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1.9</td>
<td>8.2</td>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>7.7</td>
<td>14.7</td>
<td>8.2</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>8.1</td>
<td>22.0</td>
<td>14.5</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>26.3</td>
<td>31.5</td>
<td>29.3</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>50</td>
<td>58.3</td>
<td>51.3</td>
</tr>
</tbody>
</table>
PREDICTING PVY LEVELS AT HARVEST

Quantile regression is used to predict end of season PVY levels in order to reduce overestimation at low virus loads that would result from an ordinary least squares approach.
RUSSET NORKOTAHA
YIELD IMPACTS

Totals for grade and size class were measured from harvested tubers.

Further analysis on the harvested plots was conducted to determine the yield and income impacts of differing disease levels.

All U.S. No. 1 and U.S. No. 2 less than 4 ounces were classified as dry eliminators. All others were sized and valued at both fresh and process market prices.
YIELD IMPACTS

Previous research has indicated that PVY will reduce yields of commercial potatoes, but not how that yield will be reduced.

It is useful to examine how PVY impacts the total yield, grade and size profile of commercial potatoes.

The following slides show that information with the data arbitrarily sorted into categories with less than and greater than 10% PVY
RUSSET NORKOTAH

<table>
<thead>
<tr>
<th>U.S. No.2</th>
<th>&lt; 10% PVY</th>
<th>&gt; 10% PVY</th>
</tr>
</thead>
<tbody>
<tr>
<td>cwt/acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diagram:
- A: > 10% PVY
- B: < 10% PVY
## RUSSET NORKOTAH YIELDS

<table>
<thead>
<tr>
<th></th>
<th>Total Yield</th>
<th>Marketable Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 10% PVY</strong></td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td><strong>&gt; 10% PVY</strong></td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

### Graph

- **Y-axis:** cwt/acre
- **< 10% PVY**
- **> 10% PVY**

### Legend

- Blue: < 10% PVY
- Red: > 10% PVY
RUSSET NORKOTAH U.S. NO. 1 SIZE PROFILE

The chart shows the yield (in cwt/acre) of Russet Norkotah potatoes under different PVY (Potaeto Virus Y) infection levels and size categories. The categories are:

- < 4 oz
- 4-6 oz
- 6-10 oz
- 10-14 oz
- > 14 oz

For each size category, the yields are divided into two infection levels:

- < 10% PVY (in blue)
- > 10% PVY (in red)

The chart indicates that the yields vary significantly between the different size categories and infection levels.
RUSSET NORKOTAH U.S. NO. 2 SIZE PROFILE

- 4-6 oz
- 6-10 oz
- > 10 oz
- Dry elim.

< 10% PVY
> 10% PVY

A
A
A
B
A
B
A

University of Idaho
College of Agricultural and Life Sciences
RUSSET BURBANK

![Graph showing cwt/acre for U.S. No. 1 under different PVY conditions]

- **< 10% PVY**
- **> 10% PVY**

<table>
<thead>
<tr>
<th>cwt/acre</th>
<th>&lt; 10% PVY</th>
<th>&gt; 10% PVY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>50.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>350.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RUSSET BURBANK YIELDS

- Total Yield
- Marketable Yield

- < 10% PVY
- > 10% PVY
RUSSET BURBANK U.S. NO. 1 SIZE PROFILE

![Graph showing cwt/acre vs size classes for different PVY levels.](image-url)
RUSSET BURBANK U.S. NO. 2 SIZE PROFILE

<table>
<thead>
<tr>
<th>Size</th>
<th>&lt; 10% PVY</th>
<th>&gt; 10% PVY</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6 oz</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>6-10 oz</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>&gt;10 oz</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>dry elim.</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

cwt/acre
PVY YIELD IMPACTS - NORKOTAH

- Linear (2010): $y = -1.1687x + 534.89$
- Linear (2011): $y = -1.1687x + 505.36$
- Linear (2012): $y = 1.0806x + 371.81$

Marketable Yield (cwt/acre) vs. EOS PVY (%)
PVY YIELD IMPACTS - BURBANK

\[ y = -1.2196x + 500.02 \]

\[ y = -1.2196x + 437.58 \]

Market Yield vs. EOS % PVY

- 2010
- 2011
- 2012
IMPACTS ON MARKETABLE YIELD

The marginal impact of a 1 percent level of PVY infection:

- Russet Norkotah
  - 1.169 cwt/acre  (based on 2010 and 2012)

- Russet Burbank
  - 1.174 cwt/acre

Note that in both cases these results are statistically significant.
ASSESSING ECONOMIC DAMAGE

The “price” received for potatoes is highly dependent upon the size and grade profile of the harvested tubers.

Important issues:

• “Packout” percent US Number 1
• Size profile
• Amount of washed process grade or dry eliminators
### GROWER RETURNS BY SIZE/GRADE ($/CWT)

**FRESH MARKET PRICES BASED ON 5 YEAR AVERAGES**

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesh 5-lb</td>
<td>$6.32</td>
</tr>
<tr>
<td>Mesh 10-lb</td>
<td>$6.14</td>
</tr>
<tr>
<td>Film 5-lb</td>
<td>$6.79</td>
</tr>
<tr>
<td>Film 10-lb</td>
<td>$6.02</td>
</tr>
<tr>
<td>40-count</td>
<td>$20.41</td>
</tr>
<tr>
<td>50-count</td>
<td>$20.34</td>
</tr>
<tr>
<td>60-count</td>
<td>$20.31</td>
</tr>
<tr>
<td>70-count</td>
<td>$19.81</td>
</tr>
<tr>
<td>80-count</td>
<td>$16.89</td>
</tr>
<tr>
<td>90-count</td>
<td>$13.88</td>
</tr>
<tr>
<td>100-count</td>
<td>$12.55</td>
</tr>
<tr>
<td>U.S. No. 2 (6 oz min.)</td>
<td>$8.33</td>
</tr>
<tr>
<td>U.S. No. 2 (10 oz min.)</td>
<td>$12.69</td>
</tr>
</tbody>
</table>
DOLLAR IMPACTS OF PVY

The potatoes from the field experiments were evaluated using both a fresh-market and process-market in a way that accounts for the specific pack-out characteristics and changes caused by increasing levels of PVY.

Fresh-Market

A net-to-grower price was calculated using a five-year average of shipping point prices for the various sizes and grades of potatoes less estimated packing costs.
DOLLAR IMPACTS OF PVY

Process-Market

The gross returns for processing potatoes were obtained by multiplying the total yield by the processing price computed using potato grade and quality incentives. In calculating the incentive-adjusted processing price, the quality incentives (penalties) are added (subtracted) to (from) the base price as determined at the time of contract between the growers and processors.
DOLLAR IMPACTS OF PVY - NORKOTAH

Fresh-Pack Priced Gross Returns ($/acre) vs. EOS PVY (%)

- 2010
- 2011
- 2012

Linear Regression Models:
- Linear (2010)
- Linear (2011)
- Linear (2012)
DOLLAR IMPACTS OF PVY

Russet Norkotah

Each percent PVY infection = $7.24 to $17.30 per acre loss.

With a 10% level of infection you could expect to lose $122.74 per acre
DOLLAR IMPACTS OF PVY - BURBANK

Fresh-Pack Price Gross Returns ($/acre)

EOS PVY(%)
DOLLAR IMPACTS OF PVY - BURBANK

Processing Priced Gross Returns ($/acre)

EOS PVY (%)

- 2010
- 2011
- 2012

Linear (2010/11)
Linear (2012)
DOLLAR IMPACTS OF PVY

**Russet Burbank – Fresh Market**

Each percent PVY infection = $5.13 to $18.06 per acre loss.

With a 10% level of infection you could expect to lose $115.93 per acre

**Russet Burbank – Processing Market**

Each percent PVY infection = $4.26 to $14.08 per acre loss.

With a 10% level of infection you could expect to lose $91.69 per acre
THE PVY CALCULATOR

We have taken all the information presented here and put together an web-based calculator that we are currently beta testing. For RN and RB potatoes you can enter an assumed level of virus and the calculator will predict:

- Revenue loss per acre
- Total revenue loss
- Adjusted seed price
THE CALCULATOR

Calculator
TAKE HOME POINTS

• PVY spreads in seed from summer test to winter test
• PVY spreads during the growing season
• PVY decreases yields and income
• Always be aware of the winter test results for your seed – the summer results may not accurately predict mosaic levels.
• Buying clean seed is your best defense against problems due to PVY.
QUESTIONS?

Thanks to:

The University of Idaho Potato group

- https://www.uidaho.edu/cals/potatoes
- http://www.potatovirus.com

Each of you for your time and your attention