Influence of Regional Landscapes on Potato virus Y Incidence in Seed Potato

Wisconsin Seed Potato Industry Association

January 28, 2015

“Effects of Cropping System Landscapes on the Ecology and Management of Insect Vectors and Transmitted Pathogens”

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Antigo, WI
Publically Held Data in Agriculture

USGS Pesticide Use Maps

NASS Cropland Data Layer - Cropscape
http://nassgeodata.gmu.edu/CropScape/
Opportunity for eco-informatics in IPM: specifically in plant disease management

➢ Large amounts of pre-existing data are available, from farmers, PCA’s, & other public sources:

   • the labor-intensive job of monitoring pest densities and disease incidence is decentralized → large data sets

   • But, these data are observational, rather than experimental

- Other, significant sources of farmer-held data exist...

The two essentials are, A. Variety purity. B. Freedom from disease.

Wisconsin seed stock is apparently free from those dangers which menace the potato industry in many commercial centers.

This advantage must be maintained by a careful system of inspection in co-operation with this Association.

Wisconsin Seed Potato Certification Program
Seed quality has improved

K. Frost, et al. 2013, Plant Disease 97: 1268-1280
Farmer-held data

Seed potato certification provides a valuable and rare dataset that can be used for decisions on:

- Production
- Trade
- Regulation
- Research
Research goal and objectives

✓ Goal: Increase the efficiency and sustainability of Wisconsin Certified Seed Potato

✓ Specific Objectives:

• Describe the principal sources of variation that explain elevated disease risk (PVY)

• Landscape-scale assessments of factor(s) that contribute to disease risk

• Other sources of variation?
Evaluating variability associated with PVY incidence

- The objective of our analysis is to *estimate variances* - not to detect differences – over a 10 yr interval (2003-2013)

- Factors associated with PVY incidence were considered to be random effects (RE).

<table>
<thead>
<tr>
<th>Response (PVY Incidence)</th>
<th>Variance Estimate (ANOVA)</th>
<th>Variance Estimate (RE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
</tr>
<tr>
<td>Year (Y)</td>
<td>10</td>
<td>212.78</td>
</tr>
<tr>
<td>Producer (P)</td>
<td>22</td>
<td>167.10</td>
</tr>
<tr>
<td>Variety (V)</td>
<td>51</td>
<td>522.11</td>
</tr>
<tr>
<td>Y * P&lt;sup&gt;1&lt;/sup&gt;</td>
<td>180</td>
<td>392.45</td>
</tr>
<tr>
<td>Y * V&lt;sup&gt;1&lt;/sup&gt;</td>
<td>268</td>
<td>422.13</td>
</tr>
<tr>
<td>P * V&lt;sup&gt;1&lt;/sup&gt;</td>
<td>121</td>
<td>123.11</td>
</tr>
<tr>
<td>Y * P * V&lt;sup&gt;1&lt;/sup&gt;</td>
<td>536</td>
<td>370.59</td>
</tr>
<tr>
<td>Residual</td>
<td>2649</td>
<td>943.89</td>
</tr>
</tbody>
</table>

<sup>1</sup> Variance estimates associated with year, producer, and variety for PVY incidence on the scale of the linear predictor. Reported as a standard deviation; Percent of total variance calculated using variances (i.e. \( \sigma^2 \)).

<sup>2</sup> Represents main and interactive random effects
Annual variation in PVY incidence

** denotes above average mean PVY incidence
Producer variation in PVY incidence - management
Producer variation in PVY incidence - management
Varietal variation in PVY incidence – cultivar selection

Table 6. Cross tabulation of the classification of all lots and four selected potato cultivars after summer inspections and subsequent classification following the winter grow-out test (2002–2011)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Summer class</th>
<th>&lt;0.5%</th>
<th>0.5% &lt; x &lt; 5%</th>
<th>≥5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>&lt;0.25%</td>
<td>3166</td>
<td>721</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>0.25% &lt; x &lt; 2%</td>
<td>3</td>
<td>302</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>≥2%</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>3169</td>
<td>1033</td>
<td>131</td>
</tr>
<tr>
<td>Red Norland</td>
<td>&lt;0.25%</td>
<td>208</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.25% &lt; x &lt; 2%</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥2%</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>209</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Superior</td>
<td>&lt;0.25%</td>
<td>246</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0.25% &lt; x &lt; 2%</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥2%</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>246</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>Russet</td>
<td>&lt;0.25%</td>
<td>147</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>0.25% &lt; x &lt; 2%</td>
<td>0</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>≥2%</td>
<td>0</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>147</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td>Norkotah</td>
<td>&lt;0.25%</td>
<td>147</td>
<td>133</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>0.25% &lt; x &lt; 2%</td>
<td>0</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>≥2%</td>
<td>10</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>157</td>
<td>151</td>
<td>20</td>
</tr>
<tr>
<td>Silverton</td>
<td>&lt;0.25%</td>
<td>20</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0.25% &lt; x &lt; 2%</td>
<td>0</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>≥2%</td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>20</td>
<td>23</td>
<td>17</td>
</tr>
</tbody>
</table>

* Percentage of lots calculated based on the total number of lots classified in each category during summer inspections (calculated by row).
Residual variation in PVY incidence – space

** denotes above average, mean annual PVY incidence
NASS CDL – Cropscape: [http://nassgeodata.gmu.edu/CropScape/](http://nassgeodata.gmu.edu/CropScape/)

- 110 agriculture related classes
- 2008-2012 full 48 coverage
CropScape - NASS CDL Program

CropScape - Cropland Data Layer

Layers

Cropland Data Layer:
- Corn
- Cotton
- Rice
- Sorghum
- Soybeans
- Sunflower
- Peanuts
- Tobacco
- Sweet Corn
- Pop or Orn Corn
- Mint
- Barley
- Durum Wheat
- Spring Wheat
- Winter Wheat
- Other Small Grains
- Dbl Crop WinWht/Soybeans
- Rye
- Oats
- Millet
- Speltz
- Canola
- Flaxseed
- Safflower
- Rapeseed
- Mustard
- Alfalfa
- Other Hay/Non Alfalfa
- Canellia
- Buckwheat
- Sugarbeets
- Dry Beans
- Potatoes
- Other Crops
- Sugarcane

Wisconsin

http://nassgeodata.gmu.edu/CropScape/
Langlade County - Field management units
Identified potato fields - 2012
All crops 2012
Distance to nearest forage-2006-2012

\[ Y_{ij} \sim \text{Poisson} (\text{incidence } (\text{mean forage dist}_{ij})) \] – Cross correlation

\( R = 0.05, \ P = 0.901 \)
Distance to nearest small grain-2006-2012

\( Y_{ij} \sim \text{Poisson}(\text{incidence (mean small grain dist}_{ij})) - \)

Cross correlation

\( (R = 0.03, P = 0.840) \)
Distance to nearest soybean-2006-2012

$Y_{ij} \sim \text{Poisson(incidence (mean soybean dist$_{ij}$))}$ – Cross correlation

$(R = 0.04, P = 0.798)$
Distance to nearest potato-2006-2012

$Y_{ij} \sim \text{Poisson(incidence (mean potato dist}_{ij}))$ –

Cross Correlation

$(R = 0.18, P = 0.081)$
Data streams from consultants, farmers, and other public sources can be integrated to create versatile data sets.

An ‘informatics’, posthoc data set exploration has helped to resolve the primary sources of variation (PVY risk) associated with (1) year, (2) producer, (3) variety and (4) space, or landscape that had been recalcitrant to experimentation previously.

Results immediately illustrate values and first principles, associated with non-persistent virus management:

- clean seed and resistant (symptomatic) varieties
- directed contacts with producers (improved management)
- avoidance in space (spatial isolation)
Acknowledgements

People & Associations
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• Wisconsin Potato Industry Board

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