

# Potato Varieties Differ in Current Season Infection of Potato Virus Y (PVY)

D.C. Hane<sup>1</sup>, P.B. Hamm<sup>1</sup>, M.J. Pavek<sup>2</sup>,  
L.D. Leroux<sup>1</sup>, S.L. Gieck<sup>1</sup>, N.L. David<sup>1</sup>

<sup>1</sup>Oregon State University, Hermiston Agricultural Research and Extension Center, P.O. Box 105, Hermiston, OR 97838

<sup>2</sup>Department of Horticulture and Landscape Architecture, Washington State University, P.O. Box 646414, Pullman, WA 99164-6414

## INTRODUCTION

Potato viruses are important production issues regardless of where potatoes are grown in North America. Two specific viruses, PVY (Potato Virus Y) and PLRV (Potato Leaf Roll Virus) have been shown to be of major importance because of either reduced yield or reduced quality. Probably the single most important and differing aspect of PVY from PLRV is its ability to move quickly through a potato field, regardless of normal management inputs including the use of insecticides. This is possible because the virus acts as a contaminant on the stylet of vectoring aphids and is transferred to the potato plant as the aphid probes, even if the aphid is eventually killed by insecticides. Vectoring aphids produce “current season” infections, while tubers from these plants produce “seed-borne” infections the next year. PVY infection is a problem for both seed and commercial growers. Certification standards restrict the allowable level of virus infection and meeting these standards can be problematic to seed growers. Commercial growers seek seed with low levels of PVY to minimize potential yield and quality reductions.

The situation is further complicated by certain cultivars that harbor the virus but express poor or limited symptoms. Two such cultivars, Shepody and Russet Norkotah, are widely grown. Recognizing and rouging PVY infected plants within these cultivars is ineffective for seed producers. And, since plants are not easily recognized as infected, they become reservoirs both in seed and commercial fields from which aphids can spread the disease to healthy plants.

Differing levels of PVY infection have been noted in side by side rows of potatoes in seed-lot trials at Hermiston, Oregon and Othello, Washington. Rows differed only by cultivar. These were not replicated trials, nor was there any virus testing done prior to symptom development, but the indications are that PVY spread differentially with respect to cultivar. With current season infection, it would be expected that all susceptible varieties growing in the same area would become infected at a similar frequency. If differential infection occurs, then knowing the response of a cultivar to PVY acquisition would aid both seed and commercial potato growers in developing strategies to cope with these differences.

This project was initiated to compare current season PVY infection rates of Russet Norkotah, GemStar, Shepody, Gem Russet, Russet Burbank, Ranger Russet, Umatilla Russet, and Alturas. The Washington State Potato Commission, Oregon Potato Commission and Oregon State University’s Agricultural Research Foundation supported this research effort. The main objective was to determine whether or not current season PVY infection differs amongst susceptible potato varieties. Additionally, the potential of environmental effects was investigated. Though multiple PVY strains were identified, no distinctions between strains were made.

## MATERIALS AND METHODS

### *Establishment of Field Plots*

This study utilized experimental plots established at the Oregon State University research station at Hermiston, Oregon during 2004-06 and at the Washington State University research site at Othello, Washington during 2005-06. These sites represent the desert region, center-pivot agriculture of eastern Oregon and Washington. The Othello site is 75 miles north of Hermiston. The experiment consisted of 8 cultivars randomized in a complete block design with four replications. Individual plots were single rows spaced at 34 inches. Each plot contained 50 plants with an in-row spacing of 18 inches in Hermiston and 12 inches in Othello. Wider in-row spacing than is customary for commercial production was utilized to facilitate single plant identity throughout the test period. Planting depth was approximately 8 inches.

After incorporation of organic residue and chiseling to a depth of 18 inches, the trial area at Hermiston was fall fumigated with 170 lbs ai/ac of sodium methylthiocarbamate. Fumigant was applied through the center pivot system with .7 inches of water. The following spring the area received a broadcast application of potassium chloride and boron at the rate of 200 pounds of K<sub>2</sub>O and 2 pounds of boron per acre. Ethoprop at 6 lbs ai/ac per acre was applied with a field sprayer and the area was disked, harrowed, and marked for planting. For initial weed control, S-ethyl dipropylthiocarbamate at 3 lb ai/ac was applied through the center pivot with 0.45 inches of water prior to planting. At planting, 60 pounds of nitrogen, 80 pounds of P<sub>2</sub>O<sub>5</sub>, and 40 pounds of sulfur per acre was banded on either side of the seed piece through the two-row, assist feed planter. Imidacloprid, (R)-2[(2,6-dimethylphenyl)-methoxyacetyl-amino]-propionic acid methyl ester, and azoxystrobin were applied in the furrow with the planter at 0.32, 0.11, and 0.30 oz ai/1000 feet of row, respectively. A dammer/diking tillage operation followed shortly after planting. Near emergence, rimsulfuron plus S-ethyl dipropylthiocarbamate at 0.325 oz/ac and 3 lbs/ac, respectively, was applied through the center pivot with approximately 0.7 inches of water for additional weed control. A late blight fungicide program was maintained throughout the season. Additional pests, including aphids, were confronted as necessary using practices common to potato production in the area.

The trial area at Othello was planted with the mustard cultivar 'Caliente' each fall. When the mustard reached a height of 4-5 feet, it was flailed and soil-incorporated as a green-manure crop; five days later the soil was fumigated with 28 lbs ai/A 1,3-dichloropropene plus chloropicrin at a depth of 18 inches. Nitrogen, phosphorous, and potassium were broadcast and pre-plant incorporated at rates of 75-150-120 lbs/A during 2005 and 100-100-200 lbs/A during 2006; 3 lbs/A of boron, 5 lbs/A of zinc, and 5.3 lbs ai/A of EPTC were incorporated at the same time. Seed tubers were planted using a two-row custom-built assist feed planter and treated in-furrow with azoxystrobin (0.15 oz ai/1000 ft of row) and thiamethoxam (0.125 lbs ai/A). Approximately one week prior to emergence, dimethenamid (0.7 lbs ai/A) and pendimethalin (0.5 lbs ai/A) were applied with 0.5 inches of irrigation water for additional weed control. Approximately one week post-emergence, the furrows were ripped 16 inches deep using a dammer-diker implement. A late blight fungicide program was maintained throughout the season. In-season pest and fertility management was typical for the region.

### *Cultivar Selection and Seed Preparation*

Two broad categories were established for the selection of cultivars in this trial; 1) cultivars that expressed weak symptomology when infected with PVY; and 2) cultivars that readily expressed symptoms when infected with PVY. Cultivars selected for category 1 were Russet Norkotah, Shepody, Gem Russet, and GemStar Russet. Russet Burbank, Ranger Russet, Umatilla Russet, and Alturas were selected for category 2. Seed was obtained through the Oregon State seed production research site in Powell Butte, Oregon in 2004 and 2005. Commercial sources of certified seed were utilized in 2006. Seed was hand cut into 2-2¼ ounce seed pieces, treated with Maxim 4FS at .16 fl. oz./100 lbs. seed, and placed into paper bags of 50 pieces each for planting.

**Field Sampling and Enzyme-Linked Immunosorbent Assay (ELISA) Protocol**

At emergence, plants were individually identified with stakes showing plot and plant numbers. The 1<sup>st</sup> sampling date was established to coincide with early emergence to identify seed-borne infections. Subsequent sampling dates were spaced at approximately 1 month intervals. During subsequent sampling, leaflets were gathered only from those plants that were negative at the previous sampling date. Leaflet samples were collected 3-4 times during the growing season as outlined in Table 1. Leaflets were collected from fully expanded leaves near the top of stems (4<sup>th</sup>-5<sup>th</sup> petiole). Identity was maintained by placing leaflets into bags marked with plot and plant number. Samples were placed in coolers as collected and then transported to the laboratory for ELISA. For ELISA testing, a polyclonal antiserum (Bill Daugherty, OSU, Corvallis, OR) was diluted 1:1000 in standard carbonate coating buffer and used to coat polystyrene microtiter plates. Plates were incubated overnight at 39° F and washed 4 times with phosphate buffered saline containing 0.02% Tween 20 (PBST). Tissue extracts, which were prepared by adding 2 drops of sap from individual leaves into 1 ml PBST containing 2% polyvinylpyrrolidone and 0.2% egg albumin (PEP), were added to duplicate wells for each sample. Plates were incubated overnight at 39° F and washed as stated above. Alkaline phosphatase-conjugated antiserum was diluted 1:1000 in PEP and added to the plates and incubated for 4 hours at room temperature. Plates were washed as above and phosphatase substrate diluted at 1mg/ml in diethanolamine buffer was added. Absorbance readings at 405 nm were taken following 1-2 hours incubation at room temperature. An average of the duplicate wells above a 0.100 reading was considered positive.

Table 1. Planting and Leaf Sampling Dates for 2004-06 Trials at Hermiston, OR and Othello, WA.

	Hermiston, Oregon			Othello, Washington	
Trial year	'04	'05	'06	'05	'06
Planting Date	4/27	4/15	4/13	4/20	4/21
1 <sup>st</sup> sample date	6/1	5/18	5/17	5/25	5/23
(days after planting)	(35)	(33)	(34)	(35)	(32)
2 <sup>nd</sup> sample date	6/28	6/20	6/19	6/27	6/27
(days after planting)	(62)	(66)	(67)	(68)	(67)
3 <sup>rd</sup> sample date	8/02	7/18	7/18	8/02	7/25
(days after planting)	(97)	(94)	(96)	(104)	(95)
4 <sup>th</sup> sample date		8/16	8/16		8/22
(days after planting)		(123)	(125)		(123)

**Data Analysis**

Analysis of variance was conducted on the total percent of plants with current season PVY infection for each cultivar (Proc GLM, SAS 2005). Analysis was restricted to location since years were unequal. A comparison was made for overall infection between Hermiston and Othello for the 2005-06 evaluations. Some analyses did not include the cultivar Russet Norkotah since it died before the final evaluations for current season PVY infections were made.

## RESULTS

### *Current Season PVY Occurrence, Hermiston*

Overall infection levels differed over the 3 test seasons with higher levels of current season PVY infection being measured in 2006 compared to the 2005 season (Table 2), 77.1% and 66.7% of plants becoming infected with current season PVY, respectively.

The cultivar groups established in the protocol also differed significantly in their current season PVY infection levels (Table 3). Russet Norkotah was discarded from the asymptomatic group because of the inability to obtain a sample at the final sampling date in 2005. Higher levels of infection were measured in the cultivar group which expressed poor symptoms (asymptomatic) compared to the more symptom expressive group (symptomatic), 92.1% and 56.1%, respectively.

Cultivar differences interacted with season so results are presented by year in Table 4. In 2004, Gem Russet, GemStar Russet, Russet Norkotah, and Shepody (all asymptomatic cultivars) had the highest percent of plants infected with current season PVY. Russet Burbank was mid-range in comparison, but not different than Umatilla Russet. Alturas had the lowest level of infection but was not different than Ranger Russet. In 2005 the asymptomatic cultivars again had the highest level of current season PVY infection. Alturas was again the lowest and equal to Ranger Russet in current season PVY infection. Russet Burbank and Umatilla Russet had moderate infection levels but Umatilla Russet was less infected than Russet Burbank. Cultivar infection levels were moderate to high in 2006, separating into two groups. Gem Russet, GemStar Russet, and Shepody had the highest levels of infection, while infection levels for Ranger Russet and Umatilla Russet were lowest.

### *Current Season PVY Occurrence, Othello*

Higher levels of current season PVY were measured in 2006 compared to 2005 (Table 5) with 18.2% and 10.2% infection, respectively.

Because of incomplete information due to the early death of Russet Norkotah, ANOVA comparing the asymptomatic group of cultivars with the symptomatic group was done without this cultivar. Table 6 shows that the asymptomatic cultivar group had significantly more current season PVY infection than the symptomatic group.

There was no seasonal interaction with cultivars at Othello and the results are presented as an average of the 2005/06 growing seasons (Table 7). Gem Russet had the highest level of current season PVY infection of the 7 cultivars evaluated. Shepody had fewer plants infected, but was not different from Alturas, GemStar Russet, Umatilla Russet, or Russet Burbank. Ranger Russet had the lowest percent of plants infected but did not differ from Russet Burbank, Umatilla Russet, GemStar Russet, or Alturas.

### *Location Comparison*

Differences between the Hermiston and Othello sites were measured for current season PVY infection (Table 8). Over the two year period, 69.9% of plants at Hermiston were infected with current season PVY while only 13.1% were infected at Othello.

## CONCLUSIONS

There was a very definite environmental (location) effect with respect to current season PVY infection. Though not unexpected, the magnitude of the difference between Hermiston and Othello was surprising. It appears that Othello is much less affected by current season PVY issues than is Hermiston. At the very least, knowing your potential threat from this disease is useful.

Additionally, symptomatic cultivars (Russet Burbank, Ranger Russet, Umatilla Russet, and Alturas) were infected at a much lower level than the asymptomatic cultivars (Shepody, Gem Russet, and Gem-Star Russet). This occurred at both locations even though the overall infection level at Othello was quite low. This is interesting academically and suggests that all things being equal, growers might benefit from selecting cultivars that readily display symptoms of infection with PVY.

Finally, there were strong varietal differences, particularly at Hermiston. Shepody, Gem Russet, and GemStar were highly susceptible to current season PVY infection, while Alturas, Ranger Russet, and Umatilla Russet were significantly less susceptible. Russet Burbank was mid-range in susceptibility to current season PVY infection. As noted, Russet Norkotah died prior to the final sampling date so was not included in the analysis. However, information does suggest that it is likely closer to the asymptomatic cultivars response.

## TABLES

Table 2: Average Current Season PVY Infection for Cultivars Grown in Hermiston, OR 2004-2006.

Year	% Current Season Infection
2004	70.9ab <sup>1</sup>
2005	66.7b
2006	77.1a

<sup>1</sup> Means within a column followed by the same letter are not significantly different at 5% significance level according to LSD.

Table 3: Current Season PVY Infection of Asymptomatic Cultivar Group vs. Symptomatic Cultivar Group, Hermiston, OR 2004-2006.

	Asymptomatic	Symptomatic
Year	percent current season infection	
2004	95.5	52.4
2005	92.2	47.6
2006	88.7	68.4
Average***	92.1	56.1

\*\*\* Means are significant at the .001 level of probability.

Table 4: Total Current Season PVY Infection for 8 Cultivars Grown in Hermiston, OR 2004-2006.

	2004	2005	2006	Overall
Cultivar	percent of plants w/current season PVY infection			
Alturas	36.4d <sup>1</sup>	34.2d	72.3ab	48.1c
Ranger Russet	43.3cd	40.9cd	63.9b	49.6c
Russet Burbank	66.5b	64.0b	75.5ab	68.8b
Umatilla Russet	60.8bc	50.3c	61.3b	58.0c
Gem	97.0a	94.9a	86.8a	92.8a
GemStar	94.5a	86.1a	88.1a	89.8a
Russet Norkotah	91.9a	- -	74.4ab	82.7 <sup>2</sup>
Shepody	94.6a	95.2a	91.5a	93.8a

<sup>1</sup> Means within a column followed by the same letter are not significantly different at 5% significance level according to LSD.

<sup>2</sup> Not included in overall statistical analysis.

Table 5: Average Current Season PVY Infection for Cultivars Grown in Othello, WA 2005-2006.

Year	% Current Season Infection
2005	10.2b
2006	18.2a

<sup>1</sup> Means followed by the same letter are not significantly different at 5% significance level according to LSD.

Table 6: Current Season PVY Infection of Asymptomatic Cultivar Group vs. Symptomatic Cultivar Group, Othello, WA 2005-2006.

Cultivar Group	% Current Season Infection
Asymptomatic	20.3b
Symptomatic	9.6a

<sup>1</sup> Means followed by the same letter are not significantly different at 5% significance level according to LSD.

Table 7: Average Current Season PVY Infection for 8 Cultivars Grown in Othello, WA 2005-2006.

Cultivar	percent of plants w/ current season PVY infection
Alturas	12.7bc <sup>1</sup>
Ranger Russet	4.9c
Russet Burbank	10.0bc
Umatilla Russet	10.8bc
Gem	30.4a
GemStar	11.9bc
Russet Norkotah	--
Shepody	18.7b

<sup>1</sup> Means followed by the same letter are not significantly different at 5% significance level according to LSD.

Table 8: Current Season PVY Infection for Hermiston, OR and Othello, WA 2005-2006.

Location	% Current Season Infection
Hermiston, OR	71.9a
Othello, WA	14.2b

<sup>1</sup> Means followed by the same letter are not significantly different at 5% significance level according to LSD.

#### ACKNOWLEDGEMENTS

This project was accomplished because of financial support from the Oregon State University Agricultural Research Foundation, and the Potato Commissions of Oregon and Washington. Additionally, Oregon State University and Washington State University are thanked for their support through facilities and staff.