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Potato mop-top virus - An Emerging Problem in the Columbia Basin

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A potato pathogen that is increasing in importance in the Columbia Basin is Potato mop-top virus (PMTV). This virus differs from the other major potato viruses in that it is transmitted by the powdery scab "fungus," *Spongospora subterranea*, rather than by insects or nematodes. The classic symptoms of PMTV infection in tubers include various arcs, rings, and blotches that can resemble symptoms caused by Tobacco rattle virus (TRV). PMTV has been a problem in parts of South America and northern Europe for decades. It has been particularly troublesome in parts of Scotland, Scandinavia, and the Baltic countries. In the United States, PMTV was first reported in Maine in 2003. In 2004, a Canadian research team published the results of a survey for PMTV in potato tubers destined for shipment between the U.S. and Canada. They reported that PMTV was found in numerous lots of tubers, although there were no symptoms observed in the tubers. They reported that the virus was found in a total of approximately 4% of tuber lots from the "western," "central," and "eastern" regions of the U.S. and Canada, however a detailed list of the origin of infected samples was not published at that time. Since then, PMTV has been "officially" reported in North Dakota, Idaho, and Washington. In contrast to the symptomless tubers tested by the Canadians, the tubers from ND, ID, and WA showed varying levels of spots, rings, and concentric arcs typical of PMTV infections.

Methods

In 2012, a large test plot in the northern Columbia Basin was established in a field known to harbor *Spongospora* and PMTV in order to determine if there were differences in susceptibility among potato cultivars. Sixty-two cultivars and advanced breeding lines were planted in 5-hill plots with 6 replicates. At the end of the season more than 8,600 tubers were quartered lengthwise and evaluated for the presence of internal symptoms (see Figure 1). Any kind of internal symptom was scored as "symptomatic." Four hundred tubers, both symptomatic and symptomless, were subsequently tested for PMTV serologically (ELISA) using reagents from Neogen, Europe. An additional 280 tubers were tested by molecular methods (RT-PCR) for both TRV and PMTV, to determine if some of the internal symptoms were caused by TRV infections.

Tuber tissue samples ("eye-balls") were removed from several PMTV-infected tubers. These included both symptomatic and symptomless tubers. These were planted in the greenhouse and the resulting daughter plants were tested for the virus by ELISA.

Results

A total of 8,686 tubers from the plot were cut and observed for symptoms. Of these, 13.3% showed internal symptoms. Of the symptomatic tubers tested, 68.5% were positive for PMTV by ELISA or RT-PCR. Of the symptomless tubers tested, 22.0% were similarly positive for PMTV. Only one tuber was found to be infected with TRV. This suggests that the majority of symptoms observed in these tubers were indeed due to PMTV infection. This also supports the observation that tubers infected with PMTV do not always show visible symptoms, as was reported in the Canadian survey.

There was considerable variation among cultivars and lines in the percentage of tubers testing positive for PMTV. Table 1 shows the results on a subset of symptomatic and symptomless tubers that were tested. Alpine Russet showed the highest levels of tubers with internal symptoms and the highest percentage of symptomless tubers that tested positive for PMTV. High levels of virus-positive symptomless tubers were observed in several cultivars and lines.

Figure 2 shows the PMTV infection rate in 28 of the cultivars and lines that were evaluated in 2012. Although this is only one year's data, there appears to be considerable variation in the incidence of PMTV among these materials. Important cultivars, including Russet Burbank, Umatilla Russet, Russet Norkotah, Ranger Russet, Alturas, and Alpine Russet showed high levels of virus infection. In contrast, Shepody and Summit Russet showed no infections in the total of twenty tubers that were tested.

Table 2 shows the results of grow-outs from PMTV infected tubers. Clearly, the virus was transmitted to the daughter plants of many of the cultivars and lines, both from symptomatic and symptomless tubers.

Discussion

A high level of PMTV infection was present in several cultivars and lines indicating that indeed this particular field site was infested with a high level of virus-infected *Spongospora*. Many of the symptomatic tubers showed what would be called "classic" PMTV symptoms consisting of concentric "stacked" arcs. However, other positive tubers showed varying degrees of arcs, spots, and blotches. There appeared to be a gradient of PMTV infection in the lines that were tested, but these results represent only one year of field data. A similar replicated trial has been planted in another infested field this year in order to confirm or refute the first year's findings.

Since most russetted varieties generally do not show high levels of powdery scab lesions on the tuber surface, this cannot be used to estimate the level of PMTV infection. The relatively high level of symptomless infections by PMTV also indicated that tuber symptoms alone cannot be used to determine the level of virus infection.

PMTV was detected in plants grown from both virus infected symptomatic and symptomless tubers. Particularly disturbing is finding tuber transmission of PMTV from symptomless tubers of Russet Burbank, Alpine Russet, and Russet Norkotah. This finding has particular significance for the seed industry, whereby virus could be introduced from seed lots that would appear to be virus-free based on visual observation.

In conclusion, anecdotal reports indicate an increase in the incidence of PMTV infections in potatoes grown in the Columbia Basin. Some fields have been severely affected and significant economic damage was suffered by some growers. Additionally, PMTV infected and symptomatic tubers have been identified by shipping point inspectors and these shipments have been restricted or refused for export to some countries. These results indicate that PMTV is indeed an economically important pathogen in the Basin. Since it is essentially impossible to control the *Spongospora* vector in the soil, development of resistant cultivars appears to offer the best solution to reducing the impact of this virus. The wide range of symptoms and infection levels observed among the lines tested in 2012 suggests that there is resistant germplasm available for incorporation into useful new cultivars.

Additional reading:

Crosslin, J.M. 2011. First report of *Potato mop-top virus* on potatoes in Washington State. Plant Dis. 95:1483.

Crosslin, J.M., P.B. Hamm, K.S. Pike, T.M. Mowry, P. Nolte, and H. Mojtahedi. 2007. Managing diseases caused by viruses, viroids, and phytoplasmas. Pages 161-169 in: Potato Health Management, 2nd edition. D.A. Johnson, editor. APS Press.

David, N., I. Mallik, J.M. Crosslin, and N.C. Gudmestad. 2010. First report of *Potato mop-top virus* on potatoes in North Dakota. Plant Dis. 94:1506.

Johnson, S.B. 2002. Potato mop-top virus (PMTV). University of Maine Cooperative Extension Bulletin #2437.

Lambert, D.H., L. Levy, V.A. Mavrodieva, S.B. Johnson, M.J. Babcock, and M.E. Vayda. 2003. First report of *Potato mop-top virus* on potato from the United States. Plant Dis. 87:872.

On-line info: http://pestsurvey.wi.gov/plantdisease/pdf/potato/PotatoMopTopVirusFactsheet.pdf

Whitworth, J.L. and J.M. Crosslin. 2013. Detection of *Potato mop top virus* (Furovirus) on potato in southeast Idaho. Plant Dis. 97:149.

Xu, H. T.-L. DeHaan, and S.H. De Boer. 2004. Detection and confirmation of *Potato mop-top virus* in potatoes produced in the United States and Canada. Plant Dis. 88:363-367.

Figure 1. Example of internal symptoms observed in tubers from the 2012 PMTV trial in the Columbia Basin. Both of these tubers tested positive for PMTV.

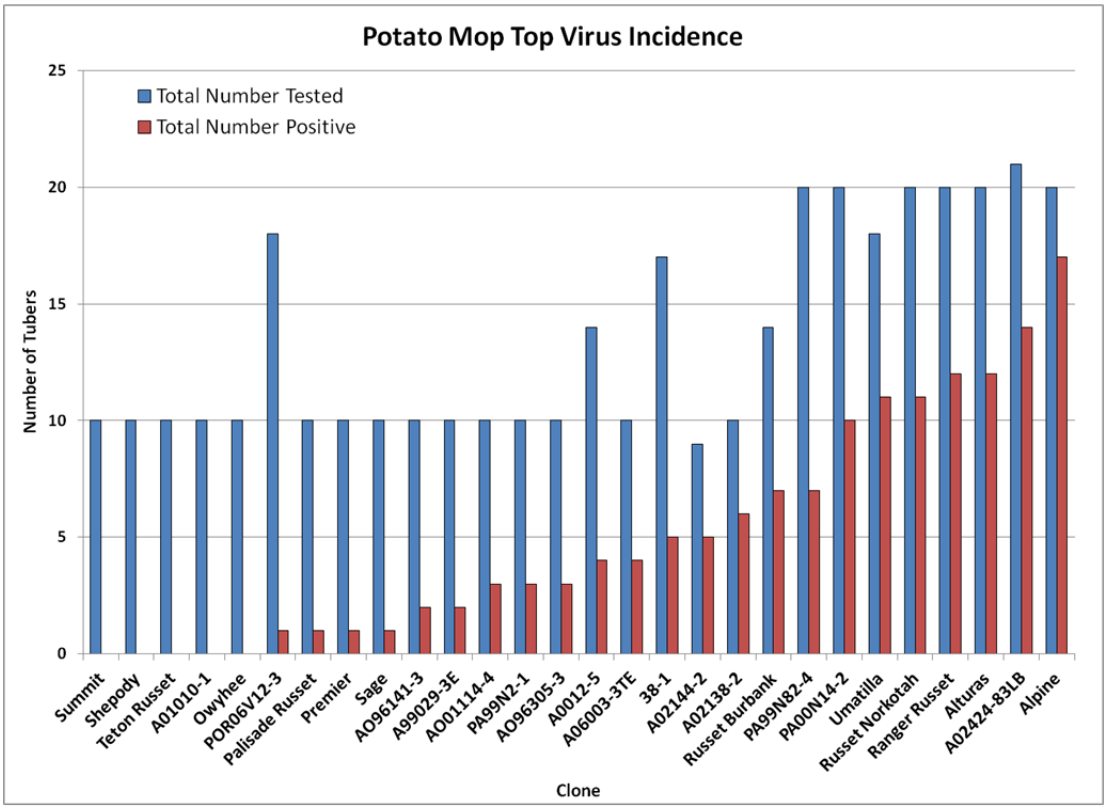

Figure 2. Incidence of PMTV in tubers of select cultivars and lines in Columbia Basin field plots in 2012. Totals represent both PMTV-symptomatic and symptomless tubers.

Table 1. Incidence of PMTV in selected cultivars and lines in trials conducted in the Columbia Basin in 2012.

Cultivar or Line	% symptomatic tubers	% symptomatic tubers positive for PMTV[1]	% symptomless tubers positive for PMTV[1]
PORO6V12-3	3	13	0
OR0436-5	4	70	10
38-1	2	43	20
Ranger Russet	5	70	30
Umatilla Russet	3	88	40
Russet Norkotah	5	70	40
Alturas (field-grown)	22	80	40
AO2424-83LB	20	100	44
Russet Burbank	1	75	60
M7	11	90	60
Alpine Russet	40	80	90

[1] RT-PCR test results.

Table 2. Results of PMTV tests on grow-outs from PMTV-infected tubers, both symptomatic (upper panel) and symptomless (lower panel).

Grown-out from symptomatic tubers:

Cultivar/Line	No. of tubers	Eyes planted	Eyes emerged	No. PMTV positive	Percent PMTV positive
A03921-2	4	16	13	5	38.4
A05013-29	3	12	12	7	58.3
A05015-5TE	2	8	5	0	0
A01325-1	2	8	8	1	12.5
A02424-83LB	5	20	19	2	10.5
A02144-2	1	4	4	0	0

Grown-out from symptomless tubers:

Cultivar/Line	No. of tubers	Eyes planted	Eyes emerged	No. PMTV positive	Percent PMTV positive
Alpine Russet	9	36	32	6	18.7
Sage	1	4	4	0	0
Premier	1	4	4	0	0
Palisade	1	4	4	0	0
Umatilla Russet	4	16	20	0	0
Ranger Russet	5	20	18	0	0
R. Burbank	6	24	24	3	12.5
R. Norkotah	4	16	16	1	6.2

Pest Alerts via Email!

From: www.nwpotatoresearch.com

Potato Insect Pest Survey for the WA Columbia Basin. Get current information about the size and whereabouts of important insect pest populations such as potato psyllid, green peach aphid, beet leafhopper, and tuberworm. Subscribe to receive weekly pest alerts via e-mail by sending an e-mail to Carrie Wohleb (cwohleb@wsu.edu).

Treasure Valley Pest Alerts. For the latest crop pest alerts in the Treasure Valley of southwestern Idaho and eastern Oregon, go to the Treasure Valley Pest Alert website (http://www.tvpestalert.net/) where you can sign up for e-mail alerts and bulletins as well as view the latest on the website itself.

Potato Update from OSU Hermiston. A weekly newsletter on potato insect pests, with news on late blight and other diseases, is produced by Silvia Rondon and Phil Hamm at Oregon State University. To receive this newsletter, contact Silvia Rondon (Silvia.Rondon@oregonstate.edu).

Potato Bytes from OSU Klamath Falls. A weekly newsletter during the growing season with crop- and pest-management information and news. This year's newsletters can be found here: http://oregonstate.edu/dept/kbrec/2013 Brian Charlton produces this newsletter, and can be reached at 541-591-1255.

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