VIRUS MANAGEMENT

Jonathan Whitworth

Many changes have taken place in the last few years regarding potato viruses. Before the year 2000, seed potato producers and, by extension, the commercial potato industry dealt with potato virus X (PVX), virus Y (PVY), and leafroll virus (PLRV) with effective controls that included insecticides and certification tolerances. The virus situation since that time can be listed as follows: 1) PVX - levels have remained low due to standard testing for PVX in certification programs, 2) PLRV - levels have been up and down depending on aphid populations and grower efforts to limit aphids with insecticides, 3) PVY - levels have slowly increased due to new strains of the virus and existence of varieties with latent symptom expression (some introduced before 2000).

In addition, a new virus, potato mop top virus (PMTV) has recently been discovered in both the U.S. and Canada. A survey, in the spring of 2003, of all seed lots in the U.S. and Canada, was conducted on the 2002 seed crop. Results showed that PMTV was detected in Maine and in some Canadian provinces. Canadian officials have not made public the number or name of the affected provinces. Issues with new strains of PVY and the discovery of PMTV have lead the U.S. industry and USDA-APHIS (Animal Plant Health Inspection Service) to work together to develop a plan to standardize seed certification at a national level.

With these changes in viruses, there is critical information that a grower needs to know in order to reduce virus problems. Four things a grower needs to be aware of to reduce virus problems are: 1) seed load - how much virus is in the seed, 2) cultural practices to reduce virus spread, 3) virus biology, i.e. how it spreads, 4) what varieties have resistance to the virus and/or the symptoms caused by the virus.

NECESSARY GROWER INFORMATION

Inoculum refers to virus present in the seed lot. Seed certification systems are based on a graduated scale of disease tolerances. Seed starts at the nuclear level (first year in the field) from disease-tested stock with a zero percent tolerance for viruses. However, each year, a slight increase in the level of virus is allowed. When a seed lot reaches a level higher than the tolerance (usually 1% for PVY) it is rejected from certification. A document available to every seed and commercial grower, called a Plant Health Certificate, lists all of the virus test results on a particular seed lot, plus other diseases of concern that may have been found during routine inspections. It also has the certification number and seed class of that seed lot. This information is important for maintaining lot identity and for knowing what potential disease problems may exist before buying or planting a particular seed lot.

Presented at the Idaho Potato Conference on January 21, 2004.

Cultural practices can be used to help both the seed and commercial grower reduce inoculum and/or the spread of that inoculum. Recent studies from the Red River Valley of Minnesota and North Dakota show the effects of treating the borders of a field with insecticide to control green peach aphid (GPA). In this study by M. Carrol (2003) at the University of Minnesota, 27 seed potato fields were observed for their amount of GPA in the border (18 meters from field edge) and the field interior. The study showed that an average of 1309 GPA was found in the border and 82 were found in the field interior. Three days after an application of methamidophos (Monitor) insecticide, the average population of GPA in the border was 265 and the field interior was 74. One week later, average populations were 475 in the border and 271 in the interior. Therefore a well-timed insecticide spray can reduce the aphid numbers in a field.

Crop borders utilize this edge effect to help protect small acreages in seed fields. Addition of a crop border - that is a non-virus host - can effectively extend the field border beyond the planted potatoes. In this scenario, aphids carrying a stylet-borne virus such as PVY or PVA would land at higher numbers in the border region and any probing by the aphids would help to "clean" any virus particles they may carry by leaving them in the border instead of the potato field. Other cultural practices used by seed growers include rogueing of diseased plants (reducing inoculum) and use of crop oils sprayed on a frequent basis to protect new growth. Crop oils have been show to provide a stylet 'barrier' to protect a plant against aphid probing. No single cultural method reduces virus problems to a manageable level, but several methods used in conjunction can lower virus levels. All of the aforementioned practices utilize certified seed for planting the crop. Certified seed helps manage virus by reducing the inoculum before the crop is even planted.

Problems that can complicate the mosaic virus picture include "symptomless" varieties and new virus strains. Varieties such as Russet Norkotah, Shepody, and Gem Russet, can reasonably fit in a broad category of varieties that have reduced symptom expression of mosaic virus caused by PVY. These varieties are difficult for the seed grower to rogue to remove diseased plants. New virus strains, such as PVY^{N}, tend to have milder mosaic symptoms than PVY^{O}, which is known as the common strain or "ordinary". PVY^{N} is a necrotic strain of PVY. It produces a mild mosaic symptom on potato foliage and necrotic symptoms and plant death in tobacco. A sub-strain of PVY^{N} is known as PVY^{NTN}, which stands for tuber necrotic. PVY^{NTN} can cause necrotic rings and arcs in and on a tuber. Recombination of PVY^{O} and PVY^{N} has been reported, but tests that could be used to rapidly screen large populations (such as seed lot samples) are not yet available. The new necrotic strains introduce a new problem to potato production, because the virus is a quality factor, instead of just causing yield reduction as the regular strain of PVY^{O} is known to do.

One of the factors that will cause the new strains of PVY to be a larger problem than PVY^{O} is how the virus is transmitted. All PVY strains are transmitted in a 'non-persistent' manner. The virus is stylet-borne (present on aphid mouthparts) and when an aphid feeds on a virus plant, the aphid becomes infected within seconds. When the aphid then moves to a healthy plant, the virus particles come into contact with leaf cells during

simple probing behavior and the plant can become infected within seconds. In this case, insecticides may reduce aphid numbers, but do little to reduce virus spread because any aphid that probes potato plants can be a vector. Persistent virus, such as leafroll, must pass through the aphid's circulatory system before the virus can be transmitted. Since this process takes longer, insecticides become an effective tool for leafroll virus control.

As problems with mosaic viruses become more prevalent in the industry, the most permanent methods of virus control become resistant varieties. In field trials at Kimberly, Idaho, Bannock Russet had 4.3% PVY, Ranger Russet had 29.1%, Umatilla Russet had 45.7%, and Russet Burbank had 67.6%. In this same virus study, Russet Norkotah, Gem Russet, and A9014-2 all had PVY levels of 75% or higher. Use of existing resistance would help lower inoculum on a farm, in a region, and in the industry. Conversely, continued use of highly susceptible varieties makes it difficult for the grower or industry to control mosaic virus problems.

STANDARDIZATION AND VIRUS MANAGEMENT PLANS

With new virus strains present in the North American industry, it is important that seed programs work together to standardize the seed industry and help in developing virus management plans. Research needs to be done to characterize the symptom expression in the foliage and especially in the tubers. Necrotic PVY strains have been present in Europe since the 1950's and tuber necrotic strains have been described since 1980. Disease reaction on European varieties is well known, but this information and transmission efficiency is missing for NA varieties.

New virus strains and the need to move seed potatoes between Canada and the U.S. lead to the development of a PVY^N Virus Management Plan in the early 1990's. That effort is an example of efforts to standardize how seed is handled and screened for viruses. Recent efforts to rewrite this plan include other viruses that cause tuber necrosis, including potato mop top virus (PMTV) and tobacco rattle virus (TRV).

The current evolution of the virus management plan for necrosing viruses in North America is that it: 1) includes viruses that cause tuber necrosis ($PVY^{N/NTN}$, PMTV, and TRV), 2) requires testing of all 2^{nd} year field year seed lots for PVY^N, 3) requires sampling at shipping point for tuber necrosis, with follow-up lab tests for confirmation, and 4) any lots found positive for tuber-necrosing viruses cannot be put back into the seed system.

A short history on PVY^N management in Europe and North America should give an understanding of why regional management plans are helpful. In North America, PVY^N was found in Ontario, Canada in 1989 and later in other provinces as well as in California table stock imported into Canada. Initially, it was listed as a quarantine pest and seed lots were destroyed. A management plan was developed that removed the PVY^N from quarantine status and put testing and management of the virus under the plan. Since that time, PVY^N-like viruses have been reported in both countries and the new management plan is being written to address those viruses as well as PMTV and TRV.

In Europe, PVY^{N} was responsible for severe epidemics in 1959 and 1970. Later PVY^{NTN} was described and named potato tuber necrotic ringspot disease (PTNRD) because of its association with necrotic rings and arcs in tubers. A view put forth in a meeting of the UNECE Agricultural Standards Unit (Carnegie and van der Haar, 1999) is that, "The most effective way to control PVY^{NTN} is probably by applying a low overall growing crop tolerance for PVY in certification schemes"; and "It should be realized that necrotic symptoms in tubers can also come from other pathogens (e.g. tobacco rattle virus, potato mop top virus)"

In the U.S. there are 15 states with seed certification programs. Disease tolerances are fairly uniform and reciprocity exists between states so that each state accepts another's certification tag as being equivalent. However, this difference confuses our trading partners who are used to dealing with one government agency when negotiating trade. Currently, the National Potato Council and APHIS have been working together to develop uniform requirements for seed potato certification. The advantages of a national program are the ability to limit movement of uncertified seed between states, increase U.S. export advantage, and provide 'official control' for pests of concern.

SUMMARY

Challenges to the industry have taken place 2000 due to new viruses and strains, and the impact of increased global and interstate trade. Growers must change cultural practices and have a basic understanding of virus management. There are new efforts to standardize the seed system. Results of these efforts should bear fruit that helps the potato industry by making export market efforts more successful and lowering levels of seed borne virus.

Carnegie, S.F. and I.H. van de Haar. 1999. PVY^{NTN} ,threats and possible solutions. UN/ECE rapporteurs, Sept 1999, UNECE Agricultural Standards Unit Meeting. 3 pages. http://www.unece.org/trade/agr/meetings/ge.06/a999_09.r/pvyntn.doc

Carroll, M. 2003. American farmland trust/EPA organophosphate reduction project. 2 pages. IPM World, Aphid Alert, Univ. of Minnesota. http://ipmworld.umn.edu/aphidalert/Alert2003/2003data/EPA_Aphid%20alert.pdf