POTATO MOSAIC VIRUS: YIELD EFFECTS, OTHER CONCERNS

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Important potato mosaic viruses include potato virus Y (PVY) and potato virus A (PVA). Plant viruses are true parasites, in that they are absolutely incapable of existing or reproducing outside of a living host cell. Many plant viruses also require a "vector," an insect, nematode or other independent agent, for movement from plant to plant as well as to gain entrance into the plant. Viruses do their damage by highjacking normal plant biochemical systems and converting these systems to the process of virus manufacturing. Damage results because normal systems within the plant cells are disrupted. Materials and energy required for healthy plant functioning are shunted into virus production, and virus particles may become so numerous that they clog the system.

Over the last ten years or so, the North American potato industry has experienced ever-increasing amounts of mosaic virus, particularly PVY. Why are we seeing so much more PVY lately? Hard information on this subject is lacking but we can do some "informed speculating." One suggestion that always comes forward relates to the steady increase in acreage of potato varieties that do not show good symptoms of PVY like Russet Norkotah, Shepody, Gem Russet, and others. The presence of steadily increasing acreages of these varieties probably means significant sources of virus in our seed production areas that were not present just a few years ago. Seed fields planted to these varieties become reservoirs of virus to infect other varieties. The inability to see PVY-infected plants interferes with one of the classic methods of virus management in seed potatoes: "roguing" or removing the obviously infected plants. In years past and in varieties that show good symptoms, seed producers could easily see the infected plants and remove them. In these "PVY carrier varieties" this task is not so easy anymore.

How does mosaic affect yield? We did a 3-year yield study here at the U of I to determine the effect of differing amounts of seed-borne PVY on the yield of three different varieties (Nolte, et al. 2004). We worked with Russet Burbank, a variety that shows strong, typical virus symptoms and with Shepody and Russet Norkotah, varieties that don't. The end results were somewhat surprising in that the two "symptomless" varieties were affected in exactly the same way as Burbank was. Regression analysis indicated that the impact was a loss of 1.5 cwt/A for each 1% virus. Just as surprising was that this loss occurred independently of yield, meaning that the loss we recorded remained at 1.5 cwt/A for 1% virus whether the total yield was 350 or 500 cwt/A! Applying these numbers to higher percentages of seed-borne virus, our model predicts that 10% seed-borne virus could cause a 15 cwt/A loss, 20% could cause a 30 cwt/A loss, etc.

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How does mosaic affect profits? These stats create the illusion of a nice, neat picture but there are other factors that must be taken into consideration. One of these factors is the confounded variability we always encounter when working with potatoes. Because of this variability, yield differences of 8-10% are typically required before we can confidently say that there is a real difference between treatments. On a 400 cwt/A yield, we need a difference of at least 32 cwt/A (8%) to as much as 40 cwt/A (10%). With these numbers in mind, the predicted loss of 15 cwt/A due to a 10% seed-borne PVY infestation does not rise above the background variability. I personally do not favor planting seed lots with over 10% PVY but even the 30 cwt/A loss predicted with 20% virus would be hard to separate from the background variation. Hard to get varieties or short seed supplies may dictate planting lots with even higher percentages. Based on our data, this practice should not result in an outright disaster, but predicted losses of 45 cwt/A due to 30% PVY could certainly be a problem for many growers.

What about different strains of PVY? The situation with the different strains of PVY that are currently being detected will require a bit of explanation. The original strain of PVY, that we dealt with for decades, is designated as PVYo for “ordinary strain.” The first newcomer, that was recently detected, was a strain designated as PVYn for “necrotic strain.” In this case, however, the necrotic trait refers to the foliar reaction that occurs in tobacco when it is infected with this strain. PVYn actually produces very mild or no symptom at all in our popular North American varieties of potato. The fear and loathing associated with this strain has to do with the potential threat to the tobacco industry. That, and the fact that this strain is on the USDA’s list of regulated pathogens is what makes it newsworthy.

PVYn on its own probably poses little threat to potatoes in North America. However, there have been other developments, particularly when PVYn and PVYo occur together, that could lead to difficulties in the future. One of the consequences of the two strains of virus infecting the same potato plant is that they tend to mix and match genetic information with each other with the result that new and previously unknown strains of PVY begin to appear. Molecular scientists will be the first to admit that we don’t really know what these recombination events mean in the long run, but some of the early information suggests that we had better keep an eye on this situation.

There are two immediate and related problems from strain recombination that have already been identified. One is the appearance of yet another alphabet derivative of PVY called PVYntn. In this case the “ntn” suffix refers to “PVYn ‘tuber necrotic’ strain.” These ntn strains can cause an internal necrosis symptom in the tubers of some varieties under the right conditions. The necrotic symptoms probably most closely resemble the pattern we see with tobacco rattle virus (aka corky ring spot) infection. We don’t know for sure, but it appears as though the ntn strain is one of the first types of recombinants that will be found when there are mixed populations of PVYo and PVYn. The ntn strains are widespread in Europe. More work will be needed to get this sorted out.

The other problem has to do with identifying the strain of virus. We have at our disposal laboratory serological tests (ELISA) to distinguish PVYo from PVYn. At first, we

thought that the PVYntn strains could be sorted out using the PVYn antiserum. Unfortunately some of the recombination that takes place creates PVYn and PVYntn virus particles that consist partially of PVYo genetic material and vice versa. This means we may have strains of PVYn (necrotic on tobacco) and PVYntn (necrotic in potato tubers) that will test positive for PVYo. We also have particles that are mostly PVYo that test positive using PVYn antiserum. Right now using molecular techniques is the only way to be sure just what strain or recombinant we are working with, but even these techniques will need further development. Meanwhile, the virus apparently continues to evolve. More work will be needed to get this sorted out.

Finally, what about PVA? How important is it? PVA belongs to the potyvirus group just like PVY and is similar enough to have once been called PVYa. Research has shown that the two viruses have enough differences to warrant classification as different viruses. PVA is probably spread by aphids in much the same way as PVY but doesn't seem to be as contagious as PVY, at least in our experience. When we performed yield experiments, like the yield studies we did with PVY, we found that PVA had less of an effect on yield than PVY. In the Russet Burbank variety, 1% seed borne PVA led to about 1 cwt/A in yield loss and we could find no effect whatsoever in Russet Norkotah.

References:

Nolte, P, JL Whitworth, MK Thornton and CS McIntosh. 2004. Effect of Seed borne Potato virus Y on Performance of Russet Burbank, Russet Norkotah and Shepody Potato. Plant Disease 88:248-252.