

POTATO EYES



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Potato viruses: Symptoms, vectors and control

Potato viruses reside in the sap inside the vascular tissue (phloem) and arise from seed tubers into the vine and tubers. They can be transmitted between plants by a mechanical or an insect vector. The usual insect vectors for potato are aphids and leafhoppers. Viruses are responsible for generational loss of plant vigor and tuber yield from one year to next, "running out." The best control for all of the viral-induced diseases is through meristem tissue culture, and year-to-year certification inspection and screening. An immunological test, ELISA, is necessary to identify viruses in the sap and is usually done through the state's certification association. Secondary methods of control are roguing, i.e., removing visibly infected plants, insect control and weed control. Viral diseases primarily play a roll by reducing tuber size and number, i.e., yield, and seed tuber performance. Tuber quality is not an issue in the fresh market, but in the case of leaf roll, can be a major issue in processing, fry and chip markets. Tubers grown for seed may be de-certified due to viral content. Viral diseases that have appeared in Nebraska are leaf roll, mild mosaic, rugose mosaic, calico, and spindle tuber.

Simple Mosaic

Symptoms -- Plants mottle in shades of light and dark green which is more evident in cool and cloudy weather as in the spring. There is no leaf wrinkling, no vine stunting, and no



Leaf mottling caused by mosaic.

tuber defects.

Pathogens are Potato Virus M (PVX), Potato Virus M (PVM) and Potato Virus S (PVS) and in combinations.

Spread can be mechanically through brushing and rubbing against by equipment and people. It is also spread by plant- to-plant contact by leaves, roots and seed pieces. Cutting knives can also pick up the viruses and introduce them to uninfected tuber pieces.

Control -- Planting certified seed is a must, and field roguing is helpful. Control of Green Peach Aphid will help reduce spread of PVM.

Mild Mosaic

Symptoms -- Plants are mottled as with Simple Mosaic but more pronounced and obvious. Leaves have light green to yellowish patchiness and there is slight leaf wrinkling. Leaves tend to be smaller. Plants may be slightly dwarfed. There are no tuber defects.

Pathogens are a combination of Potato

Virus A (PVA) with PVX.

Spread can be mechanical but PVA is also spread by aphids.

Control -- Some varieties are resistant to PVA and PVX. Certification and roguing are key. Aphid control may be needed against mid and late season spread.

Rugose and Common Mosaic

Symptoms -- Black streaks appear in leaf veins and on stems. Early-season infection shows shriveled leaves that hang from the stem by a thread of dead tissue. Later in season, the plants become bare with a few leaves on top. Late-season infection does not show any symptoms. Plants from infected seed tubers have mottled and wrinkled leaves that are distorted ("rough") and reduced. Stems are brittle and dwarfing is common. Harvested tuber size is greatly reduced.

The primary pathogen is Potato Virus Y (PVY) which may act alone or in conjunction with PVX. There are many strains of PVY with differing characteristics and behavior.

PVY is spread by both seed and aphids.

Control requires certification, roguing and aphid control. Control of nightshades in and around potato field is necessary as these host PVY. Other crops that are PVY strain hosts are tobacco, tomato and pepper.

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Leaf roll disease is evident in the plant on the right.

Leaf Roll

Symptoms -- The key symptom is an upward leaf roll. In diagnosing this symptom, it is important to realize that several factors can cause it and they need to be ruled out before deciding on leaf roll. Examples: Rule out black leg by looking for the black slime at the base of the plant stem. Rule out European corn borer damage by looking for an entry hole and frass on the affected stem or branch. Associated with leaf roll is that the leaves are stiff and upon shaking the plant a rattle can be heard. The stiffness and rattle are not observed with the other causes of the leaf roll symptom.

The causal pathogen is the Potato Leaf Roll Virus (PLRV).

The disease appears early in the season when PLRV is carried in the seed piece. Then symptoms appear early and young leaves show an upward roll. Leaves become dry, leathery and thick. They turn brittle and give their distinctive rattle when shaken. Plants may also be severely stunted, erect and light green. Tubers are reduced in size and number. With some varieties, a net necrosis develops inside the tuber. This is very evident during frying of strips (french frying) and slices (chips). The appearance is brown spots radiating outwardly from around the center of the tuber. Net necrosis is an elimination factor that can result in a rejected load for fry and chip processing.

PLRV is also transmitted from infected plants throughout the field by aphids. The aphid of greatest concern is the Green Peach Aphid which can transmit PLRV over and over again (persistent) from plant to plant. Aphid transmission of PLRV occurs later in the season and causes upper leaves to roll, turn pale green and become stiff.

Control measures rely heavily on Certification and aphid control. Roguing is helpful as well.

Potato leaf roll is the major viral problem observed. Also refer to descriptions of green peach aphid, its control and its

actions as a vector for PLRV on the web-site Potato Education Guide (<http://www.panhandle.unl.edu/potato/>).

Or see Green Peach Aphid and Potato Leaf Roll Virus in Nebraska. 1997. Nebr. Potato Eyes volume 9, issue 2.



Symptoms of calico disease.

Calico (Alfalfa Mosaic)

Symptoms -- Leaves of infected plants are very noticeable, clearly standing out in a field. They are bright yellow with a smooth surface, often shiny. Tubers may mis-shape and crack.

The pathogen is the Alfalfa Mosaic Virus (AMV) and it is carried by many aphids affecting alfalfa and clover, and sometimes around wheat.

Spread is from nearby alfalfa and clover fields, often just after the time of cutting or harvest as the aphids fly away from these fields into potato fields, where water is present. Aphids become the virus and deposited all in only a few plant visits (non-persistent).

Although the problem is not usually a major concern, sections of fields can be severely affected. Planting more than a mile from an alfalfa or wheat field will eliminate any problem. If planted near these fields, an aphid control program may be needed. Controlling volunteer alfalfa is helpful. The problem appears worst when a circle is planted partially in potato and partially in alfalfa.

Spindle Tuber

Symptoms -- Infected plants are erect and slightly stunted. They are darker green than normal. Leaf tips are pointed upward, best seen in hot weather. Tubers are elongated with pointy ends and may have cracking.

Technically the pathogen is not a virus but a viroid that is a virus without its protective coat.

Spread is through physical contact and by cutting knives.

Microplasmas: Purple Top and Aster Yellows, Haywire, others

Purple Top / Aster Yellows -- Plants have short, vigorous secondary branching. Aerial tubers are common. Young leaves at top will roll at their base, which also may appear pink or purple or yellow. Tubers from infected plants are flabby and produce hair sprouts as might be seen from excess heat (heat sprouting) and psyllid toxin.

Haywire -- Plants are severely stunted and form a rosette. Leaves are rough and stiff, erect and rolled, pointed, and slightly yellow. Seed pieces from infected plants with produce the "little tuber disorder."

The mycoplasmas are spread via leafhoppers.

Control is done through certification, roguing, leafhopper control and control of host weeds.

Witches' Broom

Symptoms -- Plants are severely stunted and appear bushy due to loss of apical dominance on vine. Leaves turn light green with reddish-yellow mar-



Above: Purple top disease. Right: Little tuber disorder.

gins. Seed tubers from infected plants sprout producing a very bushy and erect plant. There are many sprouts per eye. Stolons are long and tuber chaining is seen.

Spread is via various leafhoppers. The mycoplasma is passed on non-persistently by leafhoppers that prefer other hosts than potato. These leafhop-

pers are unable to pick up the mycoplasma from potato so the presence of another infected host is required.

Control involves aphid control, and planting away from perennial legumes such as alfalfa or control of perennial legume weeds.

ELISA test is used to detect potato viruses

Identifying an unknown viral pathogen requires using a transmission electron microscope because they are so small, much smaller than bacteria. But, if a virus is known and can be isolated, an immunological reaction can be induced in an animal such as a mouse or rabbit. Using, then, antibodies from such a reaction can be used to detect the presence of the virus or viroid in infected tissue or liquid. This is the basic principle of the Enzyme-Linked-ImmunoSorbant-Assay, commonly referred to as the ELISA test, a serological test.

ELISA is used in medicine to detect viruses such as HIV in people and is used in agriculture such as to detect potato viruses such as PVX, PVY and PLRV. It is the "state of the art" for seed certification. State seed certification agencies and associations, such as the one in Nebraska, use ELISA to detect viruses in seed tuber lots in the "win-

ter test" conducted in Florida and other warmer climates. ELISA is quick and can detect viruses even in the absence of any plant symptoms of disease.

Some viruses cause diseases with clear symptoms such as leaf roll and calico, and may be readily identified in the field. However, an important virus as PLRV may infect a plants late in the season via transmission by green peach aphids and, although they may not show symptoms, may be enough as to cause a severe problem in the next generation. Therefore, extracting sap from tubers harvested from seed and using ELISA will detect any latent viruses. Identifying PVX, PVY, etc. can not easily be done in the field and ELISA is needed.

How does ELISA work? ELISA plates (having 96 wells) are available for each specific virus. Each well contains the virus-specific antibody bound to its sides. Sap or liquid extracted from tissue or cells is added to the well. In or-

der to minimize possible over-reactions or unwanted reactions, and to titer the virus, the liquid may be diluted several times with a buffer. If the virus is present in the test liquid, it will bind to its anti-body. Wells are rinsed to remove the liquid and its contents that did not bind and therefore not the targeted virus. More of the same anti-body bound to the well is added. This second set of anti-bodies also has an enzyme attached to it which will react with a pigment. These anti-bodies attach to the viruses held by the bound anti-body. After this second reaction, any unattached anti-body is rinsed away. And now, the pigment substrate is added. If the substrate attaches to the enzyme because it is present, it will develop or change color. A color change means the targeted virus is present in the sap or tissue extract and if no change occurs than the virus is absent.

Quick Guide to Viral-type Diseases

Disease	Pathogen	Key Symptoms *	Seriousness	Transmission ^
Simple Mosaic	PVM, PVS, PVX	light leaf mottling	low	aphids (PVM)
Mild Mosaic	PVA + PVX	moderate mottling	mild	aphids
Rogose Mosaic	PVY +/- PVX	shriveled leaves black streaking	severe	aphids
Leaf Roll	PLRV	upward leaf roll plant rattle plant stunting tuber quality	severe	aphids
Calico	AMV	bright yellow leaf	low	aphids
Spindle Tuber	viroid	erect, stunted plants dark green leaves but tuber mis-shaping	severe rare	--
Purple Top	mycoplasma	small leaves	mild	leafhoppers
Witch's Broom and others		bushy, stunted plants		

* These pathogens reduce plant vigor of next generation and reduce yield (tuber number and/or size).

^ Except for AMV, these pathogens are transmitted through seed tubers and mechanically by equipment and people.

More Information on Viruses etc.

- *Potato Field Guide: Insects, Diseases and Defects. 2004. ed. E. Banks. Publ. Ministry of Agriculture and Food, Toronto, Ontario, Canada.*
- *Compendium of Potato Diseases. 2001. 2nd Edition. eds. W.R. Stevenson, R. Loria, G.D. Franc, and D.P. Weingartner. Publ. Amer. Phytopathological Soc., St. Paul, MN, USA.*



The Nebraska Potato Eyes
is on the World Wide Web at:
www.panhandle.unl.edu/peyes.htm

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