What You Need to Know About Viruses©

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Viruses are acellular infectious agents made up of a nucleic acid core and surrounded by a protein coat. Viruses are inert or inactive when not inside a host cell.

HOW LARGE ARE VIRUSES?

Viruses are very small and cannot be seen even with the aide of a light microscope. We measure viruses in units of nanometers, a billionth of a meter.

WHAT DO VIRUSES LOOK LIKE?

Plant viruses are in general very simple. Most are either polyhedrons, spherical in outline but having flat sides like a geodesic dome, or rods, either short and rigid or long and flexuous.

WHAT ARE VIRUSES MADE UP OF?

Plant viruses have nucleic acid, DNA or RNA, in their core and are surrounded by a protein coat. Viruses are not made of cells. Most plant viruses are RNA viruses. If we take a look at a rod-shaped virus such as tobacco mosaic virus, the RNA is arranged in a coil. The proteins are arranged on the outside of the virus providing a protective covering. So, the virus looks somewhat like a corn on the cob.

HOW DO VIRUSES MULTIPLY OR REPRODUCE?

Viruses don't get food like most organisms by using enzymes to digest food. Instead, viruses take over the mechanisms of the host to produce more viruses.

Say that a memory stick is a virus and a computer is a plant cell. I attach the stick to the computer. Plant viruses will enter into the cell. The information from the memory stick moves into the computer and may affect the operations of some of the programs you have put into your computer. These computer viruses can be innocuous and not cause much of a problem, maybe those that simply report back to a company the purchases you have made with the computer. Or the virus could cause a serious problem, send out more viruses to all the addresses in your email address book, and not allow your computer to work.

A virus such as tobacco mosaic virus, after entering a host plant cell, takes over the protein synthesis system in the host and gets the host to produce more viruses. Three types of proteins are produced: (1) enzymes that produce viral RNA, (2) the coat proteins, and (3) enzymes that help viruses move to neighboring cells and eventually throughout the plant. So, new viruses are formed. Just like the computer virus, the plant virus takes over a program in the host cell, that being protein synthesis.

As new viruses are produced, the amino acids and nucleotides, the building blocks for proteins and nucleic acids in the host cell, are used to produce viruses instead of what the host needs. The general symptom produced by viruses is thus a reduction in growth or stunting. Other symptoms, such as color changes, malformations, and sometimes necroses can also be produced. So, viruses use the mechanisms of the

host, mainly protein synthesis, to produce more viruses. This causes the production of symptoms.

HOW DO VIRUSES MOVE THROUGH A PLANT?

In general, viruses are able to infect the entire plant. Viruses are small enough and produce the appropriate enzymes that enable them to move between cells through passageways called plasmodesmata. These passageways also provide paths for viruses to move into the phloem and then throughout the plant. Those of you familiar with meristem culturing realize that the viruses do not become established in the rapidly dividing apical meristems. Phloem sieve tubes and plasmodesmata do not extend into those cells. But that is a very small portion of the plant. So, it is easiest to assume that all tissues within an infected plant contain the virus. Also, some viruses are able to move from the infected plant tissues into the developing seed.

Viruses do not usually kill its host, being obligate parasites that require living hosts to produce new viruses. So, within that living infected plant, a virus is forever.

WHAT ABOUT CONTROLS?

When propagating vegetative materials, obviously if the stock plant is infected, the vegetative propagules will also be infected. These include cuttings, grafting materials, corms, bulbs, tubers, and rhizomes. As mentioned earlier, some viruses will also move into the developing seed. From a disease control perspective, it is very important to start with healthy plants. Since symptoms may not appear on seeds, corms, tubers, rhizomes or may not be obviously indicative of a virus disease, simply looking at the planting materials may not be enough to ensure you are starting with a clean plant. Production of pathogen-free plant stock is very involved and may require organized efforts to test plants or plant parts for viruses. Some examples of plants where such systems have been established by state agencies or commodity groups are potato, citrus, grape, strawberry, carnation, and chrysanthemums, among others.

VECTORS

Specific vectors such as insects, mites, fungi, and nematodes transmit some viruses. A virus has a specific vector and is not transmitted by several different vectors. Mites do not transmit an aphid-transmitted virus, for example. Again, from a disease control perspective, not having the vector would be nice. In a field situation, another possible consideration is not being close to sources of the vector.

MECHANICAL TRANSMISSION

Another way viruses can be transmitted is through mechanical means by having contaminated sap transferred from plant to plant. Usually we assume this happens when pruning or harvesting flowers, for example. Sap containing the virus is picked up on pruning shears when a branch or leaf or flower stalk is cut from a diseased plant. Then on the next cut of a healthy plant, the contaminated sap is placed onto a fresh wound and the virus gets into healthy tissues. Sanitary practices, disinfecting the pruning tools between cuts can reduce this mechanical transmission. Strong detergents and chemical disinfectants will break apart the protective protein coats of the viruses. The nucleic acids in the core can then be degraded and the virus killed.

EXAMPLES

We had an interesting disease occurrence recently at the Ornamental Horticulture greenhouses at Cal Poly. As a plant pathologist I always enjoy seeing disease outbreaks. This involved the Impatiens Necrotic Spot Virus. Being in a teaching institution where we have a rapid turnover of student workers, we never know ahead of time the quality of care the plants and facilities will have. Over a 2- or 3-year span, students received, for their enterprise projects, seedlings infected with the virus. Since this is supposed to be an attempt at making a profit, students are hesitant to get rid of any plants that may survive to be a plant for purchase. Added to the introduction of the virus into the greenhouses, the insect vector, thrips, had become nicely established. Several established plants in the greenhouses were found with s^{Y}mptoms of the virus. Then a group of energetic students decided to clean up the greenhouses of any suspect plants, and serious control of the thrips population was implemented. So the source of the virus, infected plants, was removed and the vector population was reduced. My participation was helping to identify the virus using ELISA kits.

I participated in another interesting project. Do you remember when Pace Picante Sauce was first on the market and the slogan was, "A fresh jalapeno in every jar?" That requires a year-round supply of jalapeno peppers. After Campbell Soup bought Pace, my colleague got me involved in surveying pepper fields for viruses. We know that in the field, trying to control virus diseases by directly controlling insect vectors does not work well. Usually, the vector transmits the virus before the insecticide kills the bug. Our survey was aimed at establishing what fields had a lot of virus. With a large company such as Campbell Soup, it is possible to select fields to grow the crop where and when viruses are not present. One interesting outcome of the survey was that a major source of viruses for cultivated crops was ornamental plants growing in peoples' yards.

CONCLUSIONS

In conclusion, viruses are simply constructed infectious agents made up of a nucleic acid core and protein coat. They use the mechanisms of the host to produce more viruses. Plant viruses are usually distributed throughout the plant. and will reduce the productivity and quality of the plant. As plant propagators, it is important that seeds, cuttings, or transplants are clean; sources of viruses are not located nearby; and large populations of vectors are not present. If virus-infected plants are found, the diseased plants should be destroyed, and hopefully resistant types are available for cultivation.