Manzhos E.O.,

Senior teacher of Ukrainian and

Foreign Languages Department,

VNAU

Kochkina A. O.

Brun U. V.,

Students of Agronomical Faculty,

VNAU

Viral Diseases of Plants

Viruses are intracellular, pathogenic particles that infect other living organisms. Human diseases caused by viruses include chickenpox, herpes, influenza, rabies, smallpox, and AIDS. Although these are the viruses most of us are familiar with, the first virus ever described and from which the term was eventually derived was tobacco mosaic virus or TMV. TMV was discovered by Martinus W. Beijerinck, a Dutch microbiologist, in 1898.

Virus particles are extremely small and can be seen only with an electron microscope. Most plant viruses are either rod-shaped or isometric. TMV, potato virus and cucumber mosaic virus are examples of a short rigid rod-shaped, a long flexuous rod-shaped, and an isometric virus, respectively. Viruses consist of an inner core of nucleic acid (either ribonucleic acid or deoxyribonucleic acid surrounded by an outer sheath or coat of protein. Since the cell membrane in plants is surrounded by a rigid cell wall, plant viruses require a wound for their initial entrance into a plant cell. Wounds in plants can occur naturally, such as in the branching of lateral roots. They may also be the result of agronomic or horticultural practices, or other mechanical means; fungal, nematode, or parasitic plant infections; or by insects. In some cases, the organism creating the wound can also be carrying and can pass or transmit the virus. Organisms that transmit pathogens are called ***vectors***. Mechanical and insect vector transmissions are the two most important means by which plant viruses spread. The activity of humans in propagating plants by budding and grafting or by cuttings is one of the chief ways viral diseases spread. In fact, plant virologists use grafting and budding procedures to transmit and detect viruses in their studies. The seedling offspring of a virus-infected plant is usually, but not always, free of the virus, depending on the plant species and the kind of virus. Insect transmission is perhaps the most important means of virus transmission in the field. Insects in the order Homoptera, such as aphids, plant hoppers, leafhoppers, whiteflies, and mealy bugs—that have piercing sucking mouthparts—are the most common and economically important vectors of plant viruses. Some plant viruses can also be transmitted in pollen grains or by seed.

Symptoms associated with virus infections:

- reduced growth resulting in stunting
- mosaic pattern of light and dark green (or yellow and green) on the leaves.
- malformation of leaves or growing points
- yellow streaking of leaves (especially monocots)
- yellow spotting on leaves
- ring-spots or line patterns on leaves
- cup-shaped leaves
- uniform yellowing, bronzing, or reddening of foliage
- flower color breaking
- distinct yellowing only of veins
- crinkling or curling of margins of leaves.

Some of the above symptoms can also be caused by high temperature, insect feeding, growth regulators, herbicides, mineral deficiencies, and mineral excesses. Virus diseases cannot be diagnosed on the basis of symptoms alone.

Typical leaf symptoms of viral diseases include mosaic patterns, chlorotic or necrotic lesions, yellowing, stripes or streaks, vein clearing, vein banding, and leaf rolling and curling . Flower symptoms include deformation and changes in the color of the flowers including dramatic color mosaics called color breaking. Fruit and vegetable symptoms may include mosaic patterns, stunting, discoloration or malformation (Figure 21), and chlorotic ringspots. Stems of plants may develop stem pitting and grooving or tumors in response to virus infection. The symptoms induced by plant viruses lead to reduced crop quality and yield. The extent of these crop losses is demonstrated by the following three examples. Cacao swollen shoot virus is estimated to cause an annual loss of 50,000 tons of cocoa beans in Africa with an estimated value of $28 million dollars. In southeast Asia, infection of rice with Rice tungro virus leads to an estimated annual economic loss of $1.5 billion dollars annually. Tomato spotted wilt virus infects a wide variety of plants including tomato, peanuts, and tobacco, and the estimated annual losses due to infection by this virus worldwide are estimated to be $1 billion dollars.The end result of virus infection is a reduction in plant growth, lower yield, inferior product quality, and economic loss to individuals who work in the plant industry. Most of the symptoms induced by viruses can also occur due to adverse environmental conditions or diseases caused by other plant pathogens. Because of this, correct diagnosis of viral diseases normally requires laboratory tests.

Although there are virtually no antiviral compounds available to cure plants with viral diseases, efficient control measures can greatly mitigate or prevent disease from occurring. Virus identification is a mandatory first step in the management of a disease caused by a virus. The subsequent strategy for management will depend on the means by which a particular virus enters a crop, how the virus is transmitted between plants within a crop, and how the virus survives when the crop is not being grown. Preventative measures may include use of certified virus-free seed or vegetative stocks, elimination of the virus reservoirs in the surrounding wild vegetation, and modification of planting and harvesting practices. If the virus is known to be transmitted by a particular vector, control or avoidance of this vector is of paramount importance. For instance, insect, nematode or fungal vectors can be controlled by insecticides, nematicides, or fungicides, respectively.

An alternative strategy for virus control is utilization of natural or engineered resistance to virus infection. If available, natural virus resistance genes can be introduced into crop cultivars by conventional breeding. These natural resistance genes are often found among the many cultivars that are available for a particular crop, or the resistance genes are found in related plants that have been identified near the center of origin for that crop plant. Genetic engineering, the transfer of genes between specific organisms using enzymes and laboratory techniques rather than biological hybridization, allows cross-species introduction of such genes. Furthermore, virus resistance can be designed by pre-setting the plant RNA silencing defense system. This is achieved by introduction of fragments of viral nucleic acid into the plant chromosomes. Such transgenic resistance confers immunity to infection by the virus from which the nucleic acid was derived. The effectiveness of this type of transgenic resistance is illustrated by the successful management of Papaya ringspot virus in Hawaii. Although genetic engineering offers unlimited opportunities for generating virus-resistant crop plants, its large-scale application has met some resistance from researchers, supervising agencies, and the public. A better understanding of the potential risks associated with introduction of genetically modified plants into the environment is needed to help assess the safety of plants that have been genetically engineered for virus resistance.

References:

1. Sarah D. Ellis, Michael J. Boehm, and Feng Qu. Fact Sheet journal 2008, The Ohio State University – 1 p http://ohioline.osu.edu/hyg-fact/3000/pdf/PP401_05.pdf
2. Gary Moorman. Pen State journal,College of Agricultural Sciences – 1-2p. http://extension.psu.edu/pests/plant-diseases/all-fact-sheets/viruses
3. Ford, R. and T. Evans. 2003. Tobacco mosaic virus. The Plant Health Instructor. DOI: 10.1094/PHI-K-2003-0528-01. http://www.apsnet.org/edcenter/K-12/TeachersGuide/TobaccoMosaicVirus/Pages/default.aspx
4. Gonsalves, D., C. Gonsalves, S. Ferreira, K. Pitz, M. Fitch, R. Manshardt, and J. Slighton. 2004. Transgenic virus resistant papaya: from hope to reality for controlling Papaya ringspot virus in Hawaii. http://www.apsnet.org/publications/apsnetfeatures/Pages/papayaringspot.aspx
5. Gray, S., and Gildow, F. 2003. Luteovirus-aphid interactions. Annual Review of Phytopathology 41: 539-566.
6. Zaitlin, M. 1998. The discovery of the causal agent of tobacco mosaic disease. Pages 105-110 in: Discoveries in Plant Biology. S.D. Kung and S.F. Yang, eds. World Publishing Co. Ltd. Hong Kong.