

WAYS OF TRANSMISSION OF PHYTOPATHOGENIC VIRUSES

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Annotation. This article reflects the study of the methods of virus transmission in plants, which is becoming increasingly widespread nowadays. Phytopathogenic viruses spread in nature depending on the type of plant and virus. One of the most common modes of virus transmission is through the propagation of vegetative organs. During research, it was found that more than 90 plant viruses can be transmitted through seeds. In addition, viruses can also spread widely without vectors, i.e., through contact, and with the help of various insects. Examples of viruses that spread without vectors in nature include BMV, TMV, CMV, cucumber yellow mosaic virus, and turnip mosaic virus.

Keywords: BMV, TMV, CMV virus, aphids, leafhoppers, thrips, whiteflies, mites, P. Necrovirus, P. Tombusvirus, grapevine A virus, P. Vitivirus, P. Nepovirus, P. Tritimovirus.

Introduction.

The degree of spread of phytopathogenic viruses in nature varies depending on the host plant species and the type of virus. The presence of a rigid cellulose-based cell wall in the cells of flowering plants prevents the direct spread of viral infection. Therefore, virus infections in higher plants are referred to as “wound infections.” The virus can only infect the plant cell through some kind of wound, entering the cytoplasm where it multiplies. A virus-infected plant becomes a permanent reservoir of the virus. Annual plants retain the infection only for one growing season, which explains the temporary persistence and renewal of the virus [4].

The most common mode of virus spread is propagation through vegetative organs. In this way, viruses are preserved in tubers, bulbs, root crops, etc. For example, several viruses of potatoes, lilies, onions, beets, carrots, and others. Viruses can also be transmitted through seeds. To date, more than 90 plant viruses have been identified to spread via seeds. In many cases, viruses of legumes and cucurbits, certain viruses of cereals, grapevine, and citrus fruits have been found to spread through seeds. Viruses may be located in the seed coat, endosperm, embryo, and some resistant viruses on the external surface of the seed. Chemical control is effective against external infection, while thermal methods are more effective against internal infection [1].

Virus transmission by contact has also been observed in nature. This mechanism is based on the fact that virus-containing sap released from an infected plant cell enters a wounded cell of a healthy plant and infects it. Such viruses spread without vectors. Examples include BMV, TMV, CMV, cucumber yellow mosaic virus, and turnip mosaic virus.

Many viruses spread from one plant to another with the help of insects. Currently, there are about 350 species of such insect vectors. Some viruses are transmitted by insects with chewing mouthparts. For example, BMV and CMV are transmitted by the walking legs and chewing mouthparts of insects; the S and M viruses in the Far East are transmitted by the potato tuber moth, and the cucurbit mosaic virus is transmitted by beetles of the *Diabrotica* genus. Insect vectors with piercing-sucking mouthparts, such as aphids, leafhoppers, thrips, whiteflies, and scale insects, play a significant role in the transmission of viruses. Depending on how these viruses are transmitted by insects, they are classified into three groups: nonpersistent, persistent, and semi-persistent. Leafhoppers (Homoptera: Cicadellidae) can also be considered active vectors of phytopathogenic viruses. Leafhoppers transmit viruses that accumulate in the phloem by persistent transmission [3,7].

Analysis of relevant literature:

The initial understanding of viruses was related to viral diseases in humans, such as smallpox. In the Netherlands in 1886 (some sources say 1882) [5], the German scientist Adolf Mayer observed mosaic symptoms in plants. His experiments were later confirmed in Crimea by the Russian scientist D.I. Ivanovsky in 1892, which laid the foundation for the science of virology [2,7].

The transmission of viruses through fungi of the genus *Olpidium* was discovered in 1960 by D. Teakle during studies of tobacco necrosis virus (P. Necrovirus). Zoospores of the fungus *Olpidium brassicae* attach to root hairs and grow inside root cells, introducing the virus into the plant cell. Viruses can survive for some time in their cysts, protecting them from adverse conditions. The virus does not reproduce in the fungal vegetative body. Through zoospores of *Olpidium*, tomato bushy stunt virus (P. Tombrusvirus), and through zoospores of *Polymyxa* and *Spongospora* genera, soil-borne wheat mosaic virus is transmitted. There is also information about the transmission of potato X and S viruses through *Synchitrium endobioticum* and *Spongospora solani* [4].

In special experiments by M.I. Goldin, it was shown that soil-borne viruses are released from infected organisms. A certain amount of virus passes into the solution from the roots of plants infected with TMV.

Several other factors affect virus spread in nature, including the pathogenicity of the virus, the susceptibility of the host plant to infection, and agrotechnical factors [8,4].

I.A. Kartashova, in her book “*Agricultural Phytovirology*,” briefly summarizes Vlasov’s ideas on “natural foci” and classifies viruses into four groups by family, providing short descriptions of viruses in each group. The first group includes cucumber mosaic virus, shining head mosaic virus, chickpea mosaic virus, physalis virus, etc. The second group includes potato Y virus, cauliflower mosaic virus, and tomato yellow leaf curl virus. The third group includes TMV and potato X virus, noting their occurrence in cultivated plants (tobacco, tomato, pepper, potato) and wild plants (nettle, physalis, chicory). The

seed transmission of TMV and tuber transmission of potato X virus demonstrate their stable circulation in agricultural plants [9,4].

The fourth group includes tobamoviruses such as cucumber mosaic virus (a strain called “xol-xolli”) and potyviruses such as soybean mosaic virus. These viruses infect a narrow range of plants and spread through seeds, planting material, contact, or vectors [2].

Research Methodology.

It has been established that viruses in nature can also spread through whiteflies and nematodes. For example, the yellow mosaic virus of bean (R. Begamovirus) is transmitted by the whitefly *Bemisia tabaci* (Homoptera: Aleyrodidae), and the grapevine A-virus (P. Vitivirus) spreads through soil nematodes. Free-living nematodes are also among the vectors of phytoviruses. Viruses transmitted by nematodes include, for example, the ring spot virus of tobacco growing points (P. Nepovirus) [4, 10].

Spiders also play an important role in the spread of phytoviruses. It has been found that they transmit more than 10 types of viruses. For instance, wheat streak mosaic virus (P. Tritimovirus) is transmitted by mites and eriophyid mites such as *Aceria tulipae* and *Aceria tritici*. Mites localize in different parts of the plant at various stages of its development. For example, during the heading phase, mites are found on all leaves [6,10].

Discussion and conclusion.

We know that plants are important both for air purification and for providing food to the population in agriculture. Therefore, it is essential to study more deeply any factor causing changes in plants. Viruses are considered dangerous for humans, animals, and plants. They multiply inside cells and have the ability to completely control the hereditary characteristics of the cell. Based on the presented data and observations of the effect of viruses on the physiological state of plants, it has become clear that each plant requires

individual study. This is of great importance in developing measures to combat the spread of phytopathogenic viruses.

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