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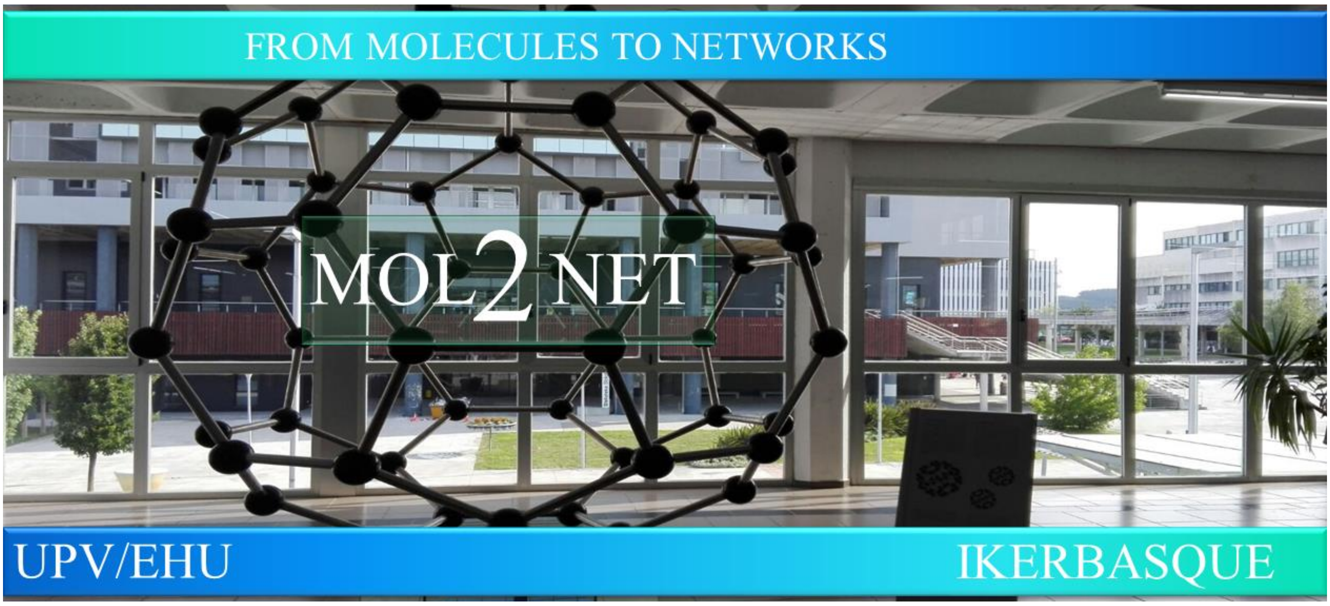

Mini-Review: General aspects of viruses in plants

Estefania Ascencio Medina

IKERDATA S.L., University of Basque Country UPV/EHU, Rectorate Building, Leioa, 48940, Greater Bilbao

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Abstract

Plant viruses are infective particles, considered obligate intracellular parasites. They are generally composed of single-stranded positive ribonucleic acid (RNA) and only in a few cases of single or double-stranded deoxyribonucleic acid (DNA). These are introduced into the plant cell through wounds caused by physical damage due to the environment or by the action of vectors, among the vectors are several species of insects, mites, nematodes and certain fungi, The interaction between viruses and plants adversely affects the morphology and physiology of the host, causing diseases. It has been estimated that plant viruses can cause an annual loss of up to 50 billion euros worldwide, a situation that may be worsened by recent climate change events and associated changes in disease epidemiology. The lack of curative measures for virus infections has prompted the use of risk reduction measures, which have included exclusion, avoidance, and eradication techniques, along with vector management practices. Also, the advent of next-generation sequencing technologies has great potential for detecting unknown viruses.

Keywords: Viruses in plants; Plant defense mechanisms; Viruses in the future

Viruses in plants

The interaction between viruses and plants negatively affects host morphology and physiology, causing disease (Takahashi et al. 2019). Plant viruses are infective particles, considered obligate intracellular parasites. They are generally composed of single-stranded positive ribonucleic acid (RNA) (RNAss) and only in a few cases of single- or double-stranded deoxyribonucleic acid (DNA). These are introduced into the plant cell through wounds caused by physical damage due to the environment or by the action of vectors, vectors include several species of insects, mites, nematodes and certain fungi (Roossinck 2015). The movement and distribution of viruses through plants can take place slowly from the inoculation site from cell to cell, through plasmodesmata modified by the movement proteins of the viral agent or more rapidly (centimeters/hour) from epidermal cells to mesophyll cells, to subsequently reach vascular tissues, generally the phloem or in a massive way towards fast-growing tissues (Stange 2006). The final distribution of viruses in the tissues or organs of a plant may not be uniform and is influenced by the virus, the host and the interaction between the two.

Ways of viruses transmission

One of the ways of transmission is through seeds or by contact. About one seventh of the known plant viruses are transmitted through seed. Some examples are: Hordeivirus, Ilarvirus, Nepovirus, Potyvirus, Cucumovirus, Tobamovirus, Tobravirus (Bhat and Rao, 2020). Similarly, thrips are vectors of plant viruses of the Tospovirus, Ilarvirus, Carmovirus, Sobemovirus and Machlomovirus groups. Transmission occurs when thrips feed on previously infected plants and move to healthy ones (Rotenberg et al. 2015). Thrips lose the ability to acquire TSWV with age; first instar larvae have higher acquisition efficiency than second instar larvae. TSWV is transmitted in a persistent and circulating manner (Zhao and Rosa 2020). Aphids (aphids) are undoubtedly the most frequent and efficient vectors of plant viruses. Three modes of transmission have been defined (Brault et al. 2010): 1) non-persistent mode. With viruses acquired in seconds and retained by their vectors for only a few minutes. 2) Semi-persistent mode. With viruses acquired in minutes or hours and retained for several hours. 3) Persistent mode. With viruses that require minutes to hours to be acquired and can be retained for very long periods, often until the vector dies. Some virus families that are transmitted in this way are Carlaviruses, Alphamoviruses, Cucumoviruses, Potyviruses, Macluraviruses.

Economic losses in agriculture due to viruses.

It has been estimated that plant viruses can cause an annual loss of up to €50 billion worldwide, this situation may be worsened by recent climate change events and associated changes in disease epidemiology (Qiu et al. 2018). In addition, viruses are a significant threat to a wide range of host species, causing substantial losses in agriculture. Since they produce damage within plant cells by intervening in the resources that the plant has produced through photosynthesis.

Mecanismos de defensa para la infección de virus.

- **RNA silencing:** is a plant defense mechanism. A double-stranded RNA (dsRNA)-induced mechanism, it refers to small RNA-mediated regulatory processes that repress endogenous gene expression and defend hosts from offending viruses. Against the host, viruses encode suppressors that can block RNA silencing pathways (Zhang et al. 2006). Viruses possess suppressor proteins that target one or more of the components of RNA silencing, which is an adaptive antiviral mechanism that occurs in plants and many other eukaryotes (Csorba et al. 2009).
- **Autophagy:** The ability of plants to fight pathogenic viruses in order to survive and minimize damage is based on profound cellular reprogramming events. These include the synthesis of new cellular components and the degradation of pre-existing cellular components, which together shift cellular homeostasis towards improved disease tolerance and the strengthening of antiviral defense mechanisms. Autophagy is a prominent and highly conserved cellular degradation pathway that supports plant resistance to stress. The functions of autophagy vary widely and range from fairly nonspecific turnover of the cytoplasm to highly selective degradation of a broad collection of specific substrates. (Csorba et al. 2009).

Future prospects for viruses in plants

The emergence of new viruses or variants through genetic evolution and reservoir host species overflow, changes in agricultural practices, mixed infections with disease synergism, and the impacts of global warming pose continuing challenges to the management of epidemics resulting from emerging plant virus diseases, The lack of curative measures for plant virus infections drives the use of risk reduction measures for the management of plant virus diseases. These measures have included exclusion, avoidance, and eradication techniques, along with vector management practices. The advent of next-generation sequencing technologies has great potential for detecting unknown viruses. In addition, several dominant and recessive resistance genes have been used to control viral diseases in crops. Recently, RNA-based technologies such as dsRNA and siRNA-based RNA interference, microRNA and CRISPR/Cas9 provide transgenic and non-transgenic approaches to develop virus resistant crop plants (Tatineni et al.,2022).

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