



Viruses transmitted by the whitefly *Bemisia tabaci* in organic greenhouse crops *Current situation and risks in Europe*

The silverleaf whitefly, also named the sweetpotato whitefly (*Bemisia tabaci* Gennadius) is an important agricultural pest and is currently considered to be one of the most serious threats to crop cultivation worldwide, predominantly because of the large number of viruses it transmits. Within Europe, *B. tabaci* is present outdoors in coastal areas with a Mediterranean climate, and in many EU countries the pest is present in greenhouses. Viruses transmitted by this insect, especially those affecting tomato and cucurbits, and also beans, pepper and aubergines, are responsible for severe diseases that have a strong negative impact on crop yield. This also affects present ecologic horticulture and because the invasive vector transmits hundreds of plant viruses worldwide, this constitutes a serious threat to future ecologic agro-economics as well.

The vector

Bemisia tabaci adults are up to 0.8mm in length and have a snow-white color, which is attributed by the secretion of wax across its wings and body (Figure 1). They form a complex of at least 28 indistinguishable morphocryptic species, of which four occur in Europe, with two being prevalent: Mediterranean (Med, formerly referred to as biotype Q) and Middle East–Asia Minor 1 (MEAM1, formerly referred to as biotype B) are considered invasive and infest ornamentals, tomato and cucurbits.



Figure 1. Adult of *Bemisia tabaci*.

Viruses transmitted by *B. tabaci*

Bemisia tabaci can transmit an immense diversity of viruses, reflected in numerous species and strains. In general, diseases resulting from these viruses have a serious negative impact on crops. They belong to the genera *Begomovirus*, *Crinivirus*, *Ipomovirus*, *Carlavirus* and *Torradovirus* and have significant differences in the mode of virus transmission. Begomoviruses have single-stranded DNA genomes and are circulative, persistently transmitted plant viruses.

Once the virus is acquired, the insect remains viruliferous to transmit the virus often for the rest of its life. *Crinivirus*, *Ipomovirus*, *Carlavirus* and *Torradovirus* have single-stranded RNA genomes and are non-circulative viruses, thus, whiteflies remain viruliferous only by continuous uptake of the virus from the plant sap.

Viruses present in Europe

The genus *Begomovirus* (family *Geminiviridae*) comprises viruses with either monopartite or bipartite single-stranded DNA genomes. *Tomato yellow leaf curl virus* (TYLCV) and *Tomato yellow leaf curl Sardinia virus* (TYLCSV) are present in most of the European Mediterranean countries and cause tomato yellow leaf curl disease (Figure 2), which is a serious threat to tomato production having a severe impact on crop production and yield. Recently, Europe has been invaded by the first bipartite begomovirus, after its introduction in Spain: *Tomato leaf curl New Delhi virus* (ToLCNDV) infects solanaceous and cucurbitaceous crops, but is especially aggressive in zucchini crops. Since its introduction in 2013 it has caused considerable economic losses in Spain. Members of the genus *Crinivirus* (family *Closteroviridae*) induce symptoms in their corresponding hosts that are often mistaken for nutritional deficiencies: these symptoms consist of interveinal yellowing of leaves from the middle to the lower parts of plants as in the case of cucumber *Cucurbit yellow stunting disorder virus* (CYSDV) (Figure 2) and tomato *Tomato chlorosis virus* (ToCV). The genus *Ipomovirus* (family *Potyviridae*) contains one species which is present in Europe and infects cucurbitaceous crops species: *Cucumber vein yellowing virus* (CVYV) (Figure 2). Infected plants show yellowing and clearing vein on leaves and stunting of the entire plant and sudden plant death as a result of early infections.



Figure 2. Symptoms of TYLCV on tomato, CYSDV on cucumber and CVYV on melon.

Table 1. *Bemisia tabaci*-transmitted viruses in Europe.

Genus	Species	Countries
<i>Begomovirus</i>	<i>Tomato yellow leaf curl virus</i>	Cyprus, France, Greece, Italy, Portugal, Spain, Malta
	<i>Tomato yellow leaf curl Sardinia virus</i>	Greece, Italy, Spain
	<i>Tomato yellow leaf curl Malaga virus</i>	Spain
	<i>Tomato yellow leaf curl Axarqia virus</i>	Spain
	<i>Tomato leaf curl New Delhi virus</i>	Spain, Italy
<i>Crinivirus</i>	<i>Cucurbit yellow stunting disorder virus</i>	France, Portugal, Spain, Greece
	<i>Tomato chlorosis virus</i>	Spain, Portugal, Italy, Greece, France, Cyprus, Hungary
	<i>Sweet potato chlorotic stunt virus</i>	Spain
	<i>Bean yellow disorder virus</i>	Spain
<i>Ipomovirus</i>	<i>Lettuce chlorosis virus</i>	Spain
	<i>Cucumber vein yellowing virus</i>	Spain, Portugal, France, Cyprus
<i>Torradovirus</i>	<i>Tomato torrado virus</i>	Spain, Hungary, Poland, Italy, France

The problem

Many “emerging viruses” have been spread in Mediterranean horticulture areas over the past three decades. Many of these are *B. tabaci*-transmitted and their introduction into Europe is probable a result of global trade and the international exchange of plant material (Figure 3). Of particular importance is the *Begomovirus* genus group which contains to date more than 200 acknowledged species. Moreover, recombination events in begomoviruses are very frequent and this generates novel virus species. Thus, an enormous genetic variation exists, which can lead to potentially a wide range of particular disease phenotypes.

Future research

There is a need of information on the presence and fate of whitefly-transmitted viruses in organic crop systems, because they could be particularly vulnerable. In fact, economic losses due to these viruses might affect significantly the profit margins and jeopardize their future.

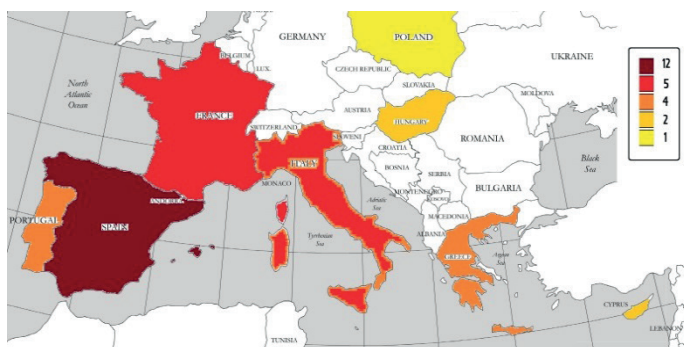


Figure 3. European countries with numbers of virus species transmitted by *Bemisia tabaci*.

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