

SIXTH FRAMEWORK PROGRAMME
THEMATIC PRIORITY 5
FOOD QUALITY AND SAFETY



ResistVir

Co-ordination of Research on genetic resistance to plant Pathogenic Virus,
and their Vectors in European Crops

Project number: FOOD-CT-2005-006961

Co-ordination Action

***Deliverable 6 - Report from Expert Group 1:
Overview of key virus problems in Europe***

Due date of deliverable: **M8**

Actual submission date: **M8**

Start date of the project: **February 1st, 2005**

Duration: **48 months**

Organisation name of lead contractor: **CSL-DEFRA (UK)**

Project co-funded by the European Commission within the sixth Framework programme (2002-2006)	
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PU public	PU
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Overview of key virus problems in Europe

Expert group list

EG1
Overview of key virus problems in Europe
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1. Arable crops (including potatoes)

A. Transmission

While there are many different viruses found infecting arable crops in Europe, there are very few that cause any significant impact. These key problem pathogens fall into two broad categories:

- Aphid-borne viruses
- Soil-borne viruses

B. Control

The use of aphicides has proved extremely effective in control many of the most important diseases of arable crops, to the extent that virus symptoms are rarely seen now well managed crops. This has been partially helped by the use of forecasting schemes which provide risk warnings and aid the targeting of insecticide applications. However the biggest advance in control has come through the use of seed treatments in particular those based on the compound imidacloprid and its successors. These treatments provide systemic protection to young plants for several weeks post emergence; often the highest risk period. Their efficacy has been demonstrated on both cereals and sugar beet.

Given that few of the important arable viruses are seed-borne, the use of certification schemes to ensure virus-free planting material is rare in this area. However the notable exceptions are potatoes and field legumes (pea and beans), where virus control is a vital part of any national seed certification scheme. In most cases this involves a combination of field inspections and post-harvest laboratory virus testing (mostly compulsory). Given the fact that

these schemes set grade-dependant tolerances for permitted virus levels, seed crops often experience very intensive aphid control programs to ensure virus control.

The soil-borne viruses present a particular problem to agriculture, as once land becomes contaminated it is likely to remain in that condition for decades, if not for ever; the actual elimination of soil-borne viruses is virtually impossible. As a result, the first line of defence is often exclusion of the pathogen; using statutory measures to control possible pathways of introduction. However, given that often only relatively small amounts of soil are required to start an infection, this approach can only really help to slow (albeit significantly) any progress, rather than providing a complete protection in the long-term.

It is the use of resistance, that has proved by far and away the most successful strategy for the control of soil-borne viruses of arable crops. With the exception of PMTV, resistance has been identified for all of the soil-borne viruses listed (see below) and in most cases has been incorporated into commercial varieties, which are being grown. Excellent examples include barley mosaic-resistant barley and rhizomania-resistant sugar beet.

2. Vegetable crops

A. Transmission

When looking at vegetable crops the most significant virus problems across Europe as a whole are those transmitted by insect vectors including:

- Aphids
- Thrips
- Whiteflies

B. Control

Given the fact that many vegetables are eaten fresh, vector control using insecticides is often much difficult than with arable or ornamental crops. In addition vectors such as *Frankliniella occidentalis* and *Bemisia tabaci* are notoriously difficult control; being polyphageous and having cryptic life stages. Physical barriers can be used e.g. mesh screens/mulches, especially to protect young plants.

Interestingly, the situation seen for protected vegetable crops grown under glass in Northern Europe, is somewhat different. Here insect-borne diseases are a minor problem, in sharp contrast to the extensive, field production systems of southern Europe. In glasshouse production, it is mainly mechanically transmitted viruses, introduced via contaminated seed or packing crates, that are more of an issue. However, while these viruses can cause significant losses for individual growers, their overall impact on a Europe-wide scale is limited.

Resistance has been effectively deployed in vegetable crops e.g. example in tomato and pepper crops against TSWV. However, this is often not stable and resistance-breaking strains have already appeared in the main production areas e.g. Spain and Italy.

3. Ornamentals

A. Transmission

The situation regarding viruses of ornamentals is complex, given the diversity of hosts and the fact that often the most prevalent virus problem(s) in a particular host are often unique to a particular host or family e.g. *Cymbidium mosaic virus* and *Odontoglossum ringspot virus* are the most important viruses of orchids worldwide but do not infect any non-orchidaceous host. Despite this there are a number of viruses with extremely broad host ranges with ubiquitous vectors that are common on a wide range of different ornamental hosts.

B. Control

With ornamental hosts the provision of virus-free mother stock is the most important means of controlling viruses. So even if potential vectors are present, if there is no initial source of inoculum, then disease cannot establish. However, given that the provision of 'clean' propagation material can often not be guaranteed, there is often a requirement for good insect vector control via chemical or biological means. The precise level of control varies very much on the type of crop involved. For example a bedding plant crop with a short turnaround time requires little or no treatment compared with a continuous (all-year round) flower crop such as chrysanthemum.

4. Fruit

A. Transmission

The most significant and efficient means of long-distance virus spread in fruit crops is via the distribution of infected planting material. Once introduced into orchards localised spread occurs via a range of different means including:

- Aphids
- Mites
- nematodes
- Pollen

B. Control

As with ornamental crops, provision of virus-free planting material has been shown to be highly effective at control fruit virus diseases. Most countries within Europe run centralised National certification schemes for both soft and tree fruit, utilising a combination of field inspection and laboratory testing. The citrus certification scheme in Spain is an excellent example of how effective these campaigns can be.

In order to maintain virus-free status in propagation stocks, vector (especially aphid) control is also important and widely used e.g. strawberry. In trees crops this is often less important (mainly due to the practicalities) but is becoming more important in certain situations e.g. the increased aphid transmissibility of PPV-M strains on peaches/apricots in

southern Europe. Physical barriers (e.g. screen houses) are now widely used for the protection of mother tree stocks.

Future Challenges

1. **Increasing globalisation:** As trade, especially horticulture, becomes more international the threats to the European industry will increase. This is already becoming apparent in the ornamental trade, where many of the plants growing in Europe start life as cuttings or young plants grown in tropical or sub-tropical regions; in particular South/Central America or East Africa. Given the huge size of this trade and the often poor knowledge regarding the status of plant diseases in these regions, the introduction of new, non-European virus diseases is becoming much more likely.
2. **Climate change:** As the weather patterns in Europe alter, it is likely that agricultural practices will also have to change, as will the distribution of pathogens and their vectors. For example, diseases normally restricted to the Mediterranean climates of southern Europe will progressively move north, as temperatures increase
3. **Reductions in pesticide usage:** As concern about environmental impact and food safety issues continues to grow in Europe, pesticide regulations will tighten. As a result the range of compounds available to growers will reduce, as will the number of applications permitted. Examples include the impending ban on the use of methyl bromide: the most widely used soil fumigant in Europe. Further impacts include the reduced use of prophylactic applications of both nematicides and aphicides; both important for the control of virus vectors. As these new measures are introduced, the control of viruses (in particular those with aphid vectors) will become much harder and it is likely that unless alternative control strategies can be developed, many of these diseases will become much more common.
4. **Rapid introduction of new varieties:** Although mainly a problem for the ornamentals industry, the continuous introduction of new varieties is a constant source of new virus diseases. Examples in recent years include trailing petunia, calibrochoa, diascia/nemesia and verbena, where there have been many commercially successful new lines have been introduced that have rapidly become heavily infected with viruses; in most cases a range of different ones, not previously recorded in those hosts.

Significant virus problems

The major virus problems at a European level are discussed below in relation to the sector of agriculture/horticulture. The viruses are those that were indicated by a significant number of the experts responding to the questionnaire as being of economic significance.

Arable crops

Crop	Virus	Vector	Estimated losses	Control
Cereals (wheat, barley and oats)	<i>Barley yellow dwarf virus</i> (BYDV) and <i>Cereal yellow dwarf virus</i> (CYDV)	Aphid	Early infection causes biggest losses, up to 80% ¹	Insecticide, tolerant varieties, delayed planting dates, aphid forecasting
Barley	Barley mosaic disease – either <i>Barley yellow mosaic virus</i> (BaYMV) or <i>Barley mild mosaic virus</i> (BaMMV)	<i>Polymyxa graminis</i>	Susceptible cultivars may suffer 30-50% yield loss ²	Resistant varieties, minimise soil movement to avoid spread.
Wheat/Rye	<i>Soil borne cereal mosaic virus</i> (SBCMV)	<i>Polymyxa graminis</i>	Loss to cereal furovirus have been estimated at 48% and between 30-50% in two recent studies ^{3 4}	Resistant varieties, minimise soil movement to avoid spread.
Potato	<i>Potato virus Y</i> (PVY)	Aphid	Losses dependent on cultivar. Largest losses from infected seed. Data from	Clean planting material and aphid forecasting

			multiple varieties range from 50-85% for 2° infection ⁵ .	
Potato	<i>Potato leaf roll virus</i> (PLRV)	Aphid	Up to 90% can include quality problems due to internal necrosis ⁶	Clean planting material and insecticide, resistant varieties and aphid forecasting
Potato	<i>Potato mop top virus</i> (PMTV)	fungal	Causes quality problems mostly in northern regions ⁷	None
Potato	<i>Tobacco rattle virus</i> (TRV)	nematode	Causes quality problems mostly in northern regions ⁸	Nematicides. Resistance identified but not deployed
Sugar beet	<i>Beet necrotic yellow vein virus</i> (BNYVV)	<i>Polymyxa betae</i>	Yield losses between 53-75% ⁹	Use of resistant / tolerant varieties, active breeding program by seed companies
Sugar beet	Yellows disease – complex of <i>Beet mild yellowing virus</i> (BMYV), <i>Beet yellowing virus</i> (BYV), <i>Beet chlorosis virus</i> (BCV)	Aphids		Insecticides, farm hygiene (removal of groundkeepers), aphid forecasting

Notes:

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Vegetable crops

Crop	Virus	Vector	Estimated losses	Control
Tomato, Peppers	<i>Potato virus Y</i> (PVY)	Aphid	Up to 70% loss in peppers ¹	Insecticide keeps aphid populations down, but doesn't control the virus effectively. Physical barriers and reflective mulches
Tomato, Peppers	<i>Tomato spotted wilt virus</i> (TSWV)	Thrips	In tomato in Georgia losses were estimated at \$8.8 million in 2000 ²	Insecticide. Physical barriers and reflective mulches
Tomato	<i>Tomato yellow leaf curl virus</i> (TYLCV)	Whitefly	Up to 100% loss in Israel ³	Insecticide. Physical barriers and reflective mulches
Tomato, Peppers, Cucumber	<i>Cucumber mosaic virus</i> (CMV)	Aphid	Up to 80% due to quality loss in peppers ¹	Insecticide. Physical barriers and reflective mulches
Cucurbits	<i>Zucchini yellow mosaic virus</i> (ZYMV)	Aphid	Losses ranging from 64-85% in cucumbers ⁴ and up to 94% in Melon ⁵ . Losses higher when infected earlier, and affects yield and quality	Insecticide, aphid repellents only partially effective against aphid population size and establishment. Mild strains. Physical barriers and reflective mulches
Cucumber	<i>Cucumber yellow stunt disorder virus</i> (CYSDV)	Whitefly		Insecticide. Physical barriers and reflective mulches
Brassica	<i>Turnip mosaic virus</i> (TuMV)	Aphid	Up to 10% annually due to leaf necrosis in white	Insecticides used in some crops

			cabbage ⁶	
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Notes:

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Fruit crops

Crop	Virus	Vector	Estimated losses	Control
Stone fruit	<i>Plum pox virus</i> (PPV)	Aphids	More damaging in mixed infections, but the growth of trees can be reduced by 9.2-69.1% ¹	Virus free planting material
Stone fruit	<i>Prunus necrotic ringspot virus</i> (PNRSV)	Pollen and planting material	Yield of infected trees reduced by 8-47% ²	Virus free planting material
Citrus	<i>Citrus tristeza virus</i> (CTV)	Aphids	The most significant disease on citrus. Causes death of trees on susceptible root stocks.	Virus free planting material grafting to resistant rootstocks
Grapevine	<i>Grapevine leaf roll virus complex</i> (GLV)	mealybugs	Reduced quality and sugar accumulation. Yield reduction between 5-8% ^{3 4}	Virus free planting material

Grapevine	Grapevine fan leaf virus (GFLV)	nematodes		Virus free planting material
Currants	<i>Blackcurrant reversion virus</i> (BRV)	mites		Virus free planting material. Effective chemicals that control mite vector being withdrawn, sulphur only chemical available soon. Only one resistant cv.
Raspberries	<i>Raspberry bushy dwarf virus</i> (RBDV)		Most damaging in combination with other viruses, causes quality problems and reduces productive life of fields	Virus free planting material and resistant cultivars
Strawberry	<i>Strawberry crinkle virus</i> (SCV) often in complex with <i>Strawberry mild yellow edge virus</i> (SMYEV) and <i>Strawberry mottle virus</i> (SMoV)	Aphids	Fruit losses in commercial strawberries can range from 30% in single infections to 80% in mixed infections ⁵	Virus free planting material. Insecticide on propagation material

Notes:

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Ornamentals

Crop	Virus	Vector	Estimated losses	Control
Bedding and pot plants, cut flowers	<i>Tomato spotted wilt virus</i> (TSWV)	Thrips	Can cause entire loss due to quality problems above a threshold of affected produce	Insecticides. Virus free planting material
Bedding and pot plants, cut flowers	<i>Cucumber mosaic virus</i> (CMV)	Aphids	Can cause entire loss due to quality problems above a threshold of affected produce	Insecticides. Virus free planting material
Bedding and pot plants, cut flowers	<i>Impatiens necrotic spot virus</i> (INSV)	Thrips	Can cause entire loss due to quality problems above a threshold of affected produce	Insecticides. Virus free planting material