Virus resistance in brassicas

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1. Background

1. Plant viruses are responsible for 45% of emerging plant diseases (fungi 30%, bacteria 16%).

2. Climate change and the withdrawal of insecticide active ingredients will exacerbate plant virus disease problems in the UK.

3. Natural plant resistance is the most environmentally friendly, energy efficient and promising approach to virus control.

4. Little is known about how climate change will impact on natural plant virus resistance (single dominant gene-based resistance often breaks down at temperatures >30^{0}C).

The most important viruses infecting brassicas in the UK

- *Turnip mosaic virus* (TuMV)

- *Cauliflower mosaic virus* (CaMV)

- *Turnip yellows virus* (TuYV)

All are transmitted by aphids.

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2. The importance of *Turnip mosaic virus* (TuMV)

- Member of *Potyviridae*
- Worldwide distribution
- Widest host range of any potyvirus:
  - all brassicas   legumes
  - lettuce   ornamentals
  - radish   rhubarb
- Transmitted by 40-50 aphid species:

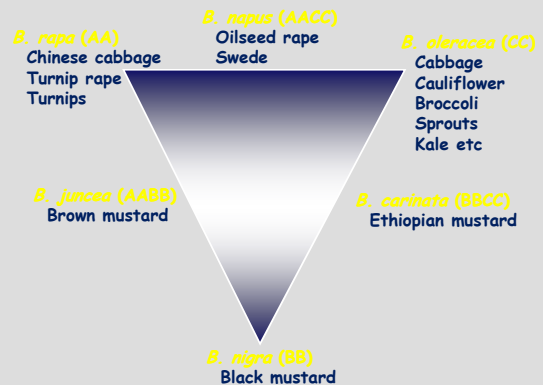 *Myzus persicae*
  Brevicoryne brassicae

Commercial problems and losses in UK *Turnip mosaic virus* (TuMV)

1. We have shown that TuMV reduces the weight yield (tonnage) of most cabbage varieties by over 26%

2. TuMV severely affects the quality of many brassicas including cabbage, cauliflower, Brussels sprouts etc. in the UK such that supermarkets and processors will not accept them and whole consignments have had to be dumped

TuMV in the UK

1. TuMV is non-persistently transmitted by aphids - insecticides are known to be ineffective in controlling non-persistently transmitted viruses

2. Insecticides can exacerbate problems with non-persistently transmitted viruses in that they can cause increased activity of aphids coming in to sprayed crops and thereby increase virus transmission / spread

3. In addition to the losses indicated earlier, cabbage crops that have been stored at ~0°C for up to 9 months have had to be dumped (1200 tonnes in one store alone) resulting in a waste disposal problem and further energy losses in addition to those incurred during cultivation and harvesting

4. Whole sprout crops have had to be abandoned and could only be used to feed sheep

5. Natural plant resistance is the most practically and economically effective and carbon neutral way of controlling TuMV

6. Increasing productivity through natural plant resistance would allow increased production without increasing acreage

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Triangle of U

B. rapa (AA)
Chinese cabbage
Turnip rape
Turnips

B. napus (AACC)
Oilseed rape
Swede

B. oleracea (CC)
Cabbage
Cauliflower
Broccoli
Sprouts
Kale etc

B. juncea (AABB)
Brown mustard

B. carinata (BBCC)
Ethiopian mustard

B. nigra (BB)
Black mustard

TuMV resistance genes we have identified and mapped in brassicas

We have identified and mapped a range of genes for resistance to *Turnip mosaic virus* (TuMV) in brassicas.

These include the single dominant resistance genes *TuRB01, TuRB01b, TuRB03, TuRB04* and *TuRB05* that give strain-specific resistance to TuMV.

We have also identified and mapped two genes (*retr01* and *ConTR01*) which together provide broad-spectrum resistance to all TuMV isolates tested.

Mapping the TuMV genes responsible for overcoming dominant brassica resistances

TuRB03

TuRB04

TuRB01, TuRB01b
TuRB05

| UTR | P1 | HC-Pro | P3 | 6K1 | CI | 6K2 | VPg | NIa | NIb | CP | UTR |
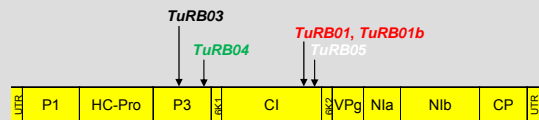
See review on TuMV and resistance etc.:
Walsh, J.A. & Jenner, C.E. (2002). *Turnip mosaic virus* and the quest for durable resistance. Molecular Plant Pathology **3,** 289-300.

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3. *Turnip yellows virus* (TuYV), formerly known as *Beet western yellows virus* (BWYV)

We have shown that TuYV causes tipburn of cabbage.

Commercial problems and losses in UK *Turnip yellows virus* (TuYV) – the virus formerly known as *Beet western yellows virus*

1. We have shown that TuYV reduces the weight yield (tonnage) of most cabbage varieties by up to 28%

2. TuYV severely affects the quality of cabbage in the UK such that supermarkets and processors will not accept them and whole consignments have had to be dumped. Its effect on cauliflower and Brussels sprouts etc. is not known – HDC Project pending.

TuYV is very common in vegetable and arable brassicas in the UK, incidence data from 2006 - 2009

We have found incidences of 100% infection in a range of commercial brassica crops in the UK, including cabbage, cauliflower and calabrese. High incidences were also found in Brussels sprouts.

We have also been surveying rape crops in three regions of the UK (Lincolnshire, Yorkshire and Warwickshire) and have found very high incidences of TuYV.

TuYV in the UK

1. TuYV is persistently transmitted by aphids - insecticides are thought to be to some extent effective in controlling non-persistently transmitted viruses

2. Monitoring 'natural' TuYV infection in commercial crops in the UK in 2006 showed that despite **12** insecticide sprays, cabbage crops became 100% infected by TuYV

3. To date new insecticide seed treatments of vegetable and arable brassicas have not controlled TuYV

4. In addition to the losses indicated earlier, cabbage that have been stored at ~0°C for up to 8 months have had to be dumped (1200 tonnes in one store alone) resulting in a waste disposal problem and further energy losses in addition to those incurred during cultivation and harvesting

5. Natural plant resistance is the most practically and economically effective and carbon neutral way of controlling TuYV

6. Increasing productivity through natural plant resistance would allow increased production without increasing acreage

4. Virus resistance and VeGIN

We have been screening brassicas for resistance to TuYV as part of the VeGIN project at Warwick HRI.

Aims of the virus component of VeGIN

1. Seek host resistance to *Turnip mosaic virus* (TuMV) in brassicas.

2. Seek host resistance to *Turnip yellows virus* (TuYV) in brassicas

3. The brassica resistance gene *TuRB01* to TuMV will be used to mine Warwick HRI's brassica diversity sets - An exercise to evaluate the utility of the diversity sets for gene mining

Acknowledgements