Factsheet 11/14

Field Vegetables

Turnip yellows virus (TuYV)

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Action points

- Early infection of plants by TuYV reduces yield much more than later infections, therefore try to stop aphids feeding on plants, especially early in the growing season. The major aphid vector of TuYV is the peach–potato aphid, *Myzus persicae.*
- Control of aphids which transmit TuYV in vegetable brassicas has been heavily reliant on the use of Gaucho 'dummy pills' due to phytotoxicity issues with seed dressings. Use of Gaucho as a seed treatment or 'dummy pill' is not permitted after 31 December 2014. Alternative control measures are, therefore, urgently needed.
- Chemical control of aphids which transmit TuYV in oilseed rape is reliant on pymetrozine (Plenum) or thiacloprid (Biscaya). Application timing is crucial. AHDB Aphid News at www.hgca.com/pests provides information about aphid numbers and movements and can help identify when to spray.
- In vegetable brassicas, pymetrozine, thiacloprid and other actives are used for aphid control (check current approvals). Application timing is critical, so pest forecasts should be used as a guide to spraying. These are updated once a week on the HDC Pest Bulletin website while more immediate news is available on the HDC Pest Blog, accessible through the HDC website on the Field Vegetables page.
- There is an urgent need to develop brassica varieties with natural plant resistance to TuYV.
- There is also an urgent need to develop an integrated strategy incorporating cultural, chemical and biological approaches for aphid and TuYV control. In vegetable brassicas components of such a strategy could include plant resistance to TuYV, aphid flight and TuYV status monitoring, insecticide seed treatments and foliar sprays.

Background

Turnip yellows virus (TuYV), formerly known as Beet western yellows virus, readily infects brassicas, including broccoli, cabbage, cauliflower, Brussels sprouts, turnips, swede, kale and oilseed rape. It also infects lettuce and a number of other field crops in the UK, including beans. It is spread by aphids, mostly the peach–potato aphid (*Myzus persicae*). Oilseed rape constitutes a massive overwintering reservoir of both the virus and the vector, which then go on to infect vegetable brassicas. In some years, all plants in commercial crops in some areas are infected. However, it often goes unnoticed as the virus rarely causes clear symptoms. The virus can dramatically reduce yields (Figure 1), especially when plants are infected early in the growing season. It is well established in Europe, and is especially common in areas of intensive brassica production in UK.

This Factsheet presents the results from HDC projects FV365 and FV365a, and HGCA project 3498.

1. **An uninfected Brussels sprout plant (bottom) and a plant infected by Turnip yellows virus (top)**

Biology and epidemiology of Turnip yellows virus (TuYV)

TuYV

Turnip yellows virus (TuYV) belongs to the genus *Polerovirus* in the family *Luteoviridae*. The name *Luteoviridae* arises from the Latin 'luteus', meaning yellow. Infections caused by poleroviruses result in substantial economic losses worldwide in a variety of agricultural, horticultural and ornamental crops. There are 13 virus species in this genus, all of which are spread by aphids. Other important members of the *Polerovirus* genus include Potato leafroll virus (PLRV) and the Barley yellow dwarf virus (BYDV) group.

TuYV transmission

TuYV is transmitted by aphid vectors in a circulative, non-propagative manner. The most important vector in the UK is considered to be the peach–potato aphid, *Myzus persicae.* They are green, yellow or light red. Aphids acquire the virus from the phloem of infected plants. The virus enters the haemocoel of the aphids through a receptor-mediated transport process, then passes through the haemolymph and enters the accessory salivary gland through a second receptor-mediated transport event. Infection of plants results from introduction of virus particles in saliva into plant phloem tissues via the salivary duct, during aphid feeding. This intimate relationship between the virus and its aphid vectors means that it takes aphids some time (~5 minutes) to acquire the virus from plants and slightly longer (~10 minutes) to transmit the virus to plants. However, once an aphid has acquired TuYV, it retains the ability to transmit it for the rest of its life, which can be more than 50 days.

TuYV distribution and incidence

TuYV is present throughout the UK with particularly high levels in southern England and other areas where there is intensive brassica production, including Lincolnshire and Suffolk. High incidences of TuYV infection (up to 100%) have been found in oilseed rape crops tested in recent years around UK. In three regions surveyed by the Walsh group at the University of Warwick over a three-year period, the highest incidences were consistently in Lincolnshire, the lowest in Yorkshire with intermediate incidences in Warwickshire.

A survey of TuYV infection of cauliflower and Brussels sprout crops in many areas of UK revealed widespread infection in Lincolnshire, Lancashire, Yorkshire, Kent and Cornwall in a year when few aphid vectors had been recorded. Lower levels of infection were detected in Scotland. The incidences are shown in Tables 1 and 2, however, it should be noted that this is data for one season only and in a year (2010) when there were few aphid vectors flying. The following year (2011), Lincolnshire experienced (or 'saw') 96% TuYV infection in a field of Brussels sprouts five weeks after transplanting and 100% infection after a further two weeks.

Table 1. The incidence of Turnip yellows virus in commercial Brussels sprout crops

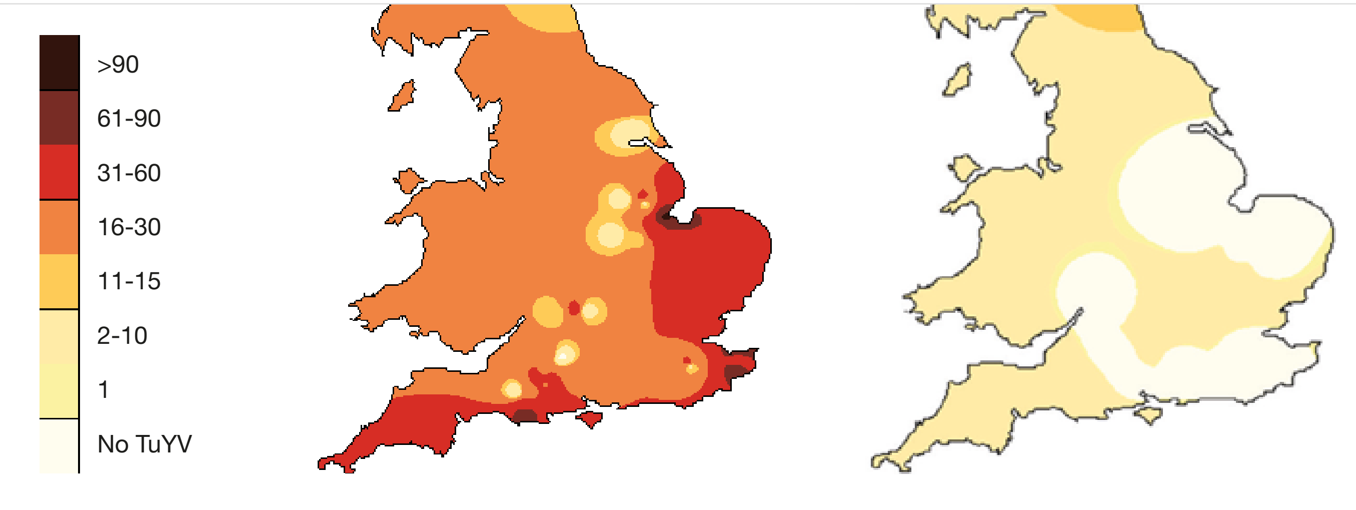
Region	Variety	Date of sampling (2010)	Turnip yellows virus incidence (= % infection) in Brussels sprout crops
Lincolnshire	Cobus	1 November	10%
Lincolnshire	Cobus	1 November	40%
Lincolnshire	Maximus	1 November	55%
Lancashire	Clodius	26 November	20%
Lancashire	Genius	26 November	5%
Lancashire	Doric	26 November	10%
Lancashire	NZ 4021	26 November	15%
Yorkshire	Doric	29 November	25%
Yorkshire	Petrus	29 November	25%
Yorkshire	Batavus	29 November	10%
Scotland	Maximus	1 November	0%
Scotland	Genius	1 November	5%
Scotland	Petrus	1 November	0%
All 13 fields			**17%**

Table 2. The incidence of Turnip yellows virus in commercial cauliflower crops

Region	Variety	Date of sampling	Turnip yellows virus incidence (= % infection) in cauliflower crops
Lincolnshire	Isadora	1 November 2010	20%
Lincolnshire	FT3062	1 November 2010	5%
Lincolnshire	Tintagel	1 November 2010	0%
Lincolnshire	Charif	26 November 2010	25%
Lincolnshire	Jerome	26 November 2010	20%
Lincolnshire	Maginot	13 December 2010	10%
Lincolnshire	Belot	13 December 2010	60%
Lincolnshire	Triomphant	13 December 2010	5%
Kent	Belot	13 December 2010	15%
Kent	Chester	13 December 2010	25%
Kent	Charif	13 December 2010	55%
Cornwall	Jubarte	13 December 2010	40%
Cornwall	Dionis	13 December 2010	50%
Cornwall	Alpen	13 December 2010	30%
Isle of Wight	Keriso	12 January 2011	0%
Isle of Wight	Alpen	12 January 2011	10%
Isle of Wight	Tesminilo	12 January 2011	10%
All 17 fields			**22%**

TuYV surveys, funded by HGCA, have shown that the level of TuYV in spring is largely determined by aphid levels the previous autumn. In 2010 (Figure 2a), a survey was conducted during March and April and included oilseed rape crops on 45 farms in England and Wales. Fifty samples were randomly taken from each field and tested for the presence of virus by ELISA using TuYV-specific antibodies. Virus 'hotspots', of up to 92% plants affected, were identified along the south coast and close to the Wash. TuYV infection in 2011 (Figure 2b) was much less; TuYV was detected at 33% of the sites and infection ranged from 2%–12%. The lower levels of infection may have been due to the reduced numbers of aphids flying in the previous autumn and the very cold temperatures of -13ºC and below, experienced as early as November.

The virus is well established in mainland Europe and has been detected in crops in several European countries, including France, Belgium, Germany, Poland, Ukraine, Denmark, Austria, Czech Republic and Serbia. It is also present in North America, China and Australasia. Although the full extent of its worldwide distribution cannot be confirmed, TuYV is clearly very widespread.



2. The incidence of Turnip yellow virus in oilseed rape crops in a) spring 2010 (left) and b) spring 2011 (right)

Host range

The reported crop host range of TuYV is very wide, including most brassica types (oilseed rape, cabbage, Brussels sprout, broccoli, cauliflower, kale, swede, turnip, Chinese cabbage), radish, lettuce, spinach, peas, and beans. It is also reported to infect a wide range of common weeds including wild brassicas, wild radish, shepherd's purse, chickweed, groundsel, dandelion, dead-nettle, speedwell and nettle. In addition to oilseed rape, weed hosts provide a significant overwintering reservoir of TuYV, threatening vegetable crops.

3. Uninfected Brussels sprouts (left) and Turnip yellows virus-infected plants (right). Note the colour difference between the infected and uninfected plants and the size of the plants

Disease symptoms in plants

Signs of infection on all host plants can be difficult to spot. A wide range of symptoms have been described for infected plants, most of which can be easily confused with symptoms of nutrient deficiency, plant stress, natural ageing, or even frost damage. Reddening or purpling around the edges of leaves, as shown in Figures 3 and 4, is one of the more common symptoms, as well as interveinal yellowing or reddening. Infection can also cause stunting of growth (Figures 1 and 3). However, it is common for many infected plants, including vegetable and arable brassicas, to remain symptomless, meaning that infection can go unnoticed throughout the growth period.

4. Turnip yellows virus symptoms in oilseed rape

Effect on yield and quality

Considerable yield losses and reduced marketability of horticultural produce have been shown to result from TuYV infection. Yield reductions of 22–65%, depending on the variety, have been seen in Brussels sprouts (Figure 1). Weight yield in Dutch white cabbage was reduced by 16–22%, again depending on variety. Further losses in the marketability of infected cabbage have been caused by TuYV induced tipburn (Figure 5). Tipburn in Dutch white cabbage has contributed to significant losses in some years including 1,200 tonnes from one store alone in one year.

TuYV infection causes significant losses in oilseed rape crops. Both seed and oil yields are affected.

TuYV is thought to be one of the main reasons that commercial oilseed rape crops do not reach their yield potential in the UK. The average annual yield loss from TuYV in untreated oilseed rape crops is 15%. This is based on the assumption that 50% infection will cause 12.5% yield loss. TuYV can, however, cause yield losses of up to 30%. The large area of overwintered oilseed rape provides a massive reservoir of TuYV and of vectors, ensuring that the virus persists throughout the year.

5. Tipburn symptoms in cabbage caused by Turnip yellows virus

Control

The reservoir of TuYV in oilseed rape crops means that it is very difficult to control the virus in vegetable brassicas. Currently, the only options are insecticide treatments targeted at preventing aphids transmitting the virus to crops and growing less susceptible brassica varieties.

A number of insecticides have been tested in the glasshouse for their ability to control TuYV in a particularly susceptible Brussels sprout variety (Table 3 – overleaf). The products were applied only once. None of the products prevented the plants from becoming infected, but some did reduce the amount of virus in plants, indicating that they provided a degree of control, possibly by delaying infection and/or reducing the number of aphids transmitting virus to the plants.

Delaying infection of brassica plants by TuYV, has been clearly shown to reduce weight yield losses, and tipburn in cabbage (Table 4 – overleaf).

Table 3. **The mean aphid numbers per Brussels sprout plant at 1, 2 and 4 weeks and the mean plant ELISA value[1].**

Insecticide treatment	Time of application	Mean aphid numbers per plant			Transformed ELISA value (A_{405})[1, 2]
		Week 1	Week 2	Week 4	
Plenum (spray)	transplanting	10	40	91	0.52*
Movento (spray)	transplanting	33	60	94	0.68*
Aphox (spray)	transplanting	8	88	375	0.90
Biscaya (spray)	transplanting	6	56	183	0.68*
HDCI 040 (spray)	transplanting	20	46	92	0.61*
HDCI 041 (spray)	transplanting	11	43	154	0.56*
HDCI 042 (spray)	transplanting	8	40	77	0.57*
Gaucho (dummy seed)	sowing	2	0.8	0.1	0.33*
HDCI 043 (dummy seed)	sowing	0.6	0.6	0.1	0.32*
HDCI 044 (drench)	transplanting	9	27	49	0.55*
Untreated plants		66	450	933	1.17

[1] The higher the ELISA value, the greater the levels of virus in the plant.
[2] The least difference between two mean ELISA values for it to be significant at 5% is 0.29 (33 degrees of freedom).
***The ELISA value is significantly lower than that of the untreated control plants.**

Table 4. **The effect of time of infection by Turnip yellows virus (TuYV) on the severity of tipburn symptoms and the weight yield of the cabbage heads.**

Treatment	Mean weight of cabbage heads (kg)	Mean symptom score[1]
TuYV infection in May	2.870	2.502
TuYV infection in August	3.108	1.038
TuYV infection in October	3.390	0.283
No TuYV infection	3.438	0.273
Least significant difference	0.163	0.333

[1] The higher the symptom score, the greater the severity of the tipburn symptoms.

Control of TuYV in vegetable brassicas has been heavily reliant on the use of Gaucho 'dummy pills'. Use of Gaucho as a seed treatment or 'dummy pill' is not permitted after 31 December 2014. In the immediate term, an alternative approved neonicotinoid seed or 'dummy pill' treatment is needed and, in the longer term, additional alternative control measures are urgently needed.

Ground beetles, soldier beetles, rove beetles and spiders may attack aphids in the autumn and winter and parasitoids can be active in mild weather. In the summer, parasitic wasps, hoverflies, lacewings and ladybirds are attracted to aphid infestations and can provide control of potentially damaging populations.

Natural plant resistance to TuYV has been discovered at the University of Warwick. Further research to exploit this resistance to TuYV by incorporating it into commercial crop varieties is an area identified for further development. Recent HGCA-funded projects have also shown an indication of varietal tolerance to TuYV (see HGCA Project Report 503 and HGCA Student Report 26).

Developing an integrated strategy for controlling TuYV by combining cultural, chemical and biological approaches (including the natural plant resistance) with a decision support mechanism is an urgent need.

Insecticide resistance

There are three different mechanisms of insecticide resistance in peach–potato aphid (*Myzus persicae*) in the UK (Table 5). Neonicotinoid resistance in peach–potato aphids has been discovered in southern mainland Europe but has not been detected in the UK.

The Insecticide Resistance Action Group has issued guidelines for controlling aphids in brassica crops and combating insecticide resistance in the peach–potato aphid, *Myzus persicae*.

Table 5. Insecticide resistance in peach–potato aphids (*Myzus persicae*) in the UK

Chemical group	Actives	Example products	Resistance
Organophosphates	Chlorpyrifos Dimethoate	Dursban WG Danadim Progress	Mechanism: elevated carboxylesterase. Resistance has reduced substanially following a decline in the use of organophosphates against aphids.
Carbamates	Pirimicarb	Aphox	Mechanism: modified acetylcholinesterase (MACE). Resistance is more common and widespread, with more than 80% of peach–potato aphids now resistant.
Pyrethroids	Beta-cyfluthrin Lambda-cyhalothrin Alpha-cypermethrin Cypermethrin Deltamethrin Esfenvalerate Tau-fluvalinate	Gandalf Hallmark with Neon Technology Alert Permasect C Fury 10 EW Decis Clayton Cajole Mavrik	Mechanism: knockdown resistance (kdr). Two forms exist: kdr and a more potent variant termed super-kdr. kdr resistance is currently rare; however, super-kdr resistance is common and widespread. The majority of peach–potato aphids in the UK at present carry both super-kdr resistance to pyrethroids and MACE resistance to primicarb.

Further information

For HDC-funded projects on TuYV infection of cabbage, cauliflower and Brussels sprouts (FV160b, FV365 and FV365a) reports are available from HDC www.hdc.org.uk

HGCA information is freely available at www.hgca.com/pests This includes HGCA Information Sheet 32: Controlling aphids and virus diseases in cereals and oilseed rape.

Encyclopaedia of pests and natural enemies in field crops www.hgca.com/publications

Insecticide Resistance Action Group www.pesticides.gov.uk/guidance/industries/pesticides/advisory-groups/Resistance-Action-Groups/irag

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