British Beet BBRO Research Organisation

Virus Yellows – an increasing threat to future sugar beet production?

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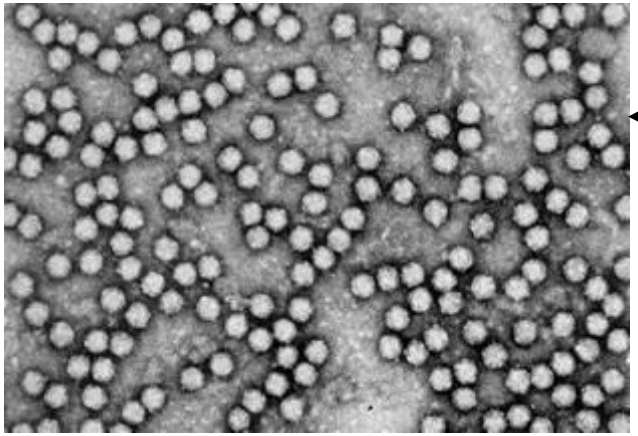
12/10/18

Virus Yellows

Classic Virus-Vector-Host Interaction

HOST



VIRUS

VECTOR

Virus Yellows

Aerial view of symptoms

- At least 3 viruses involved.
- Yield loss = up to 49%
- Worldwide distribution.
- No commercially resistant varieties.

- In 2018, 99% of UK crop protected with neonicotinoid seed treatments

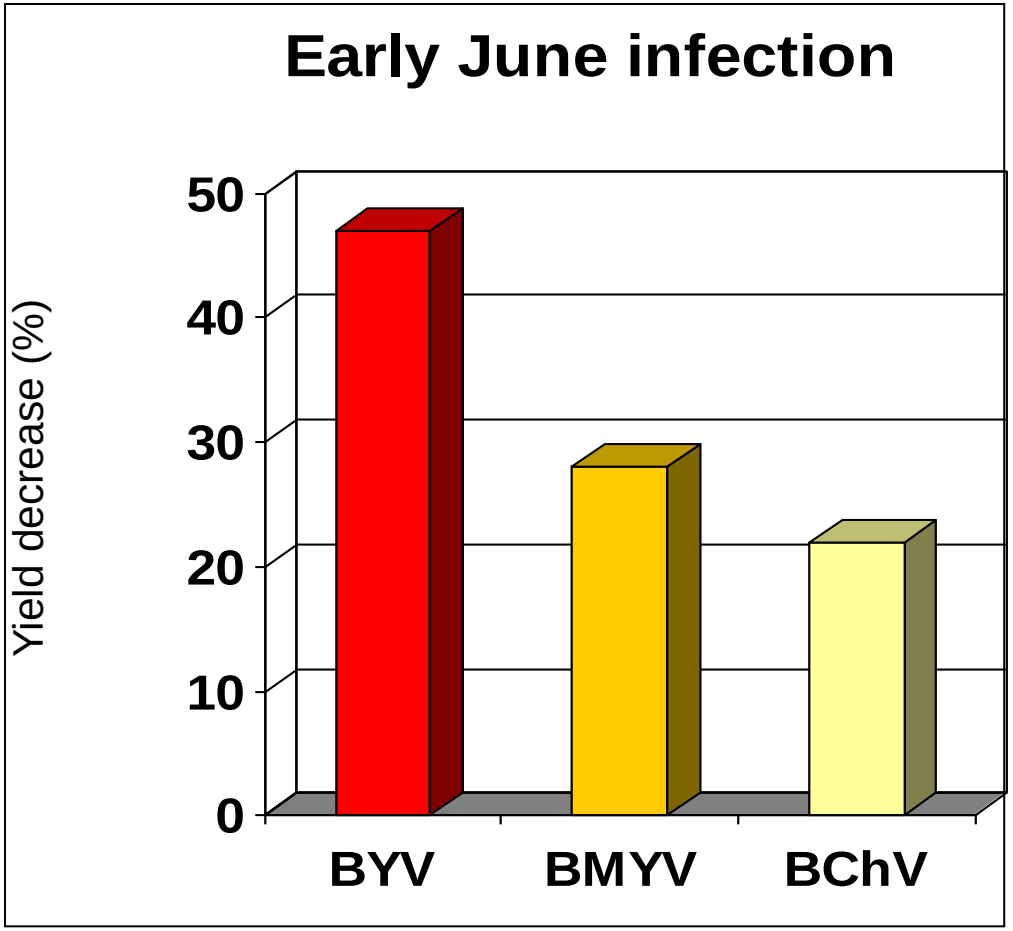
- Preventing yield losses of up to £51M in high risk years.

Impact of yellowing viruses on yield

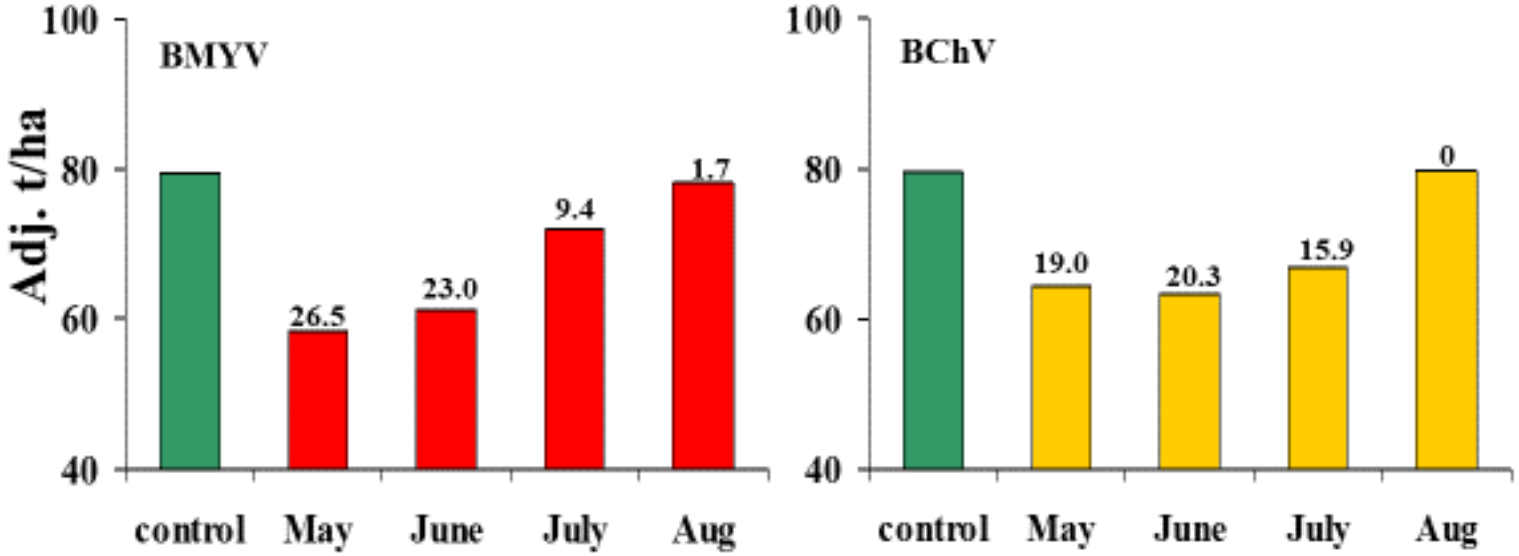
Beet yellows virus

Beet mild yellowing virus

Beet chlorosis virus



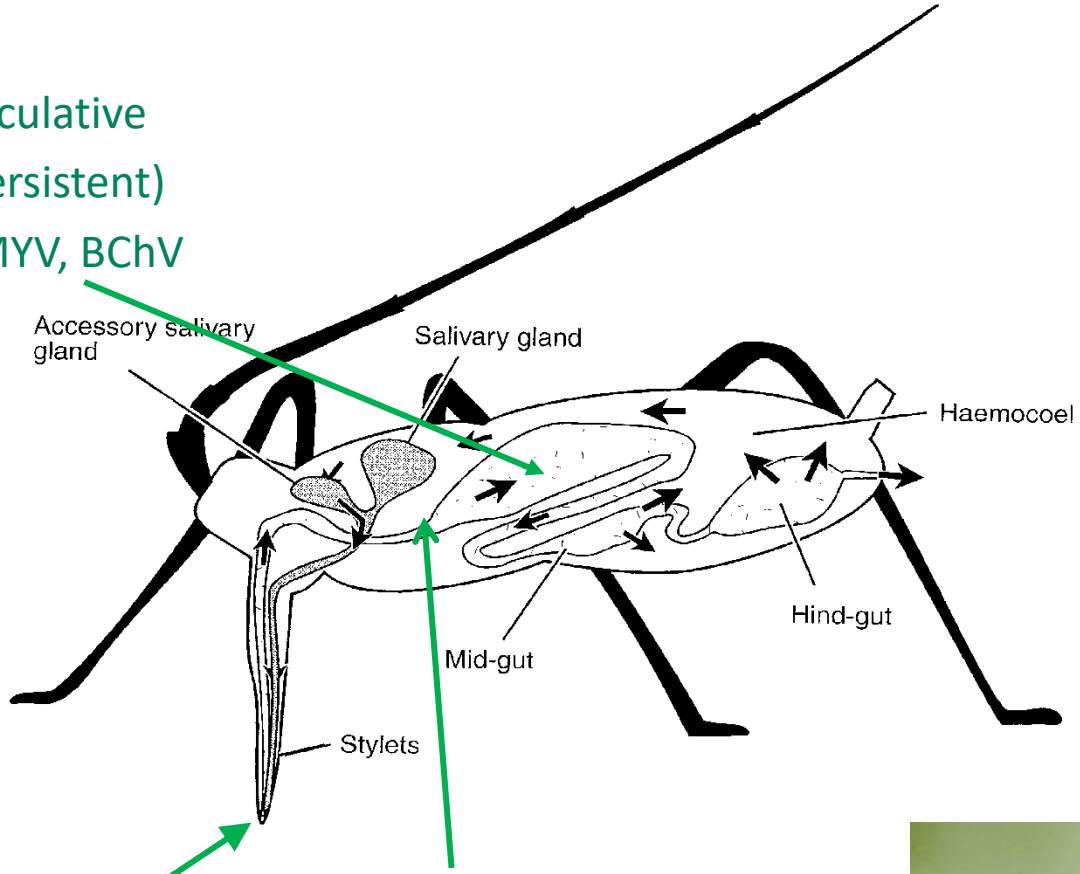
Average effect of BMYV and BChV on root yield at Broom's Barn 1997, 1999, 2000



(numbers above bars indicate % decrease in yield)

Modes of virus transmission by aphids

Circulative
(persistent)
BMYV, BChV

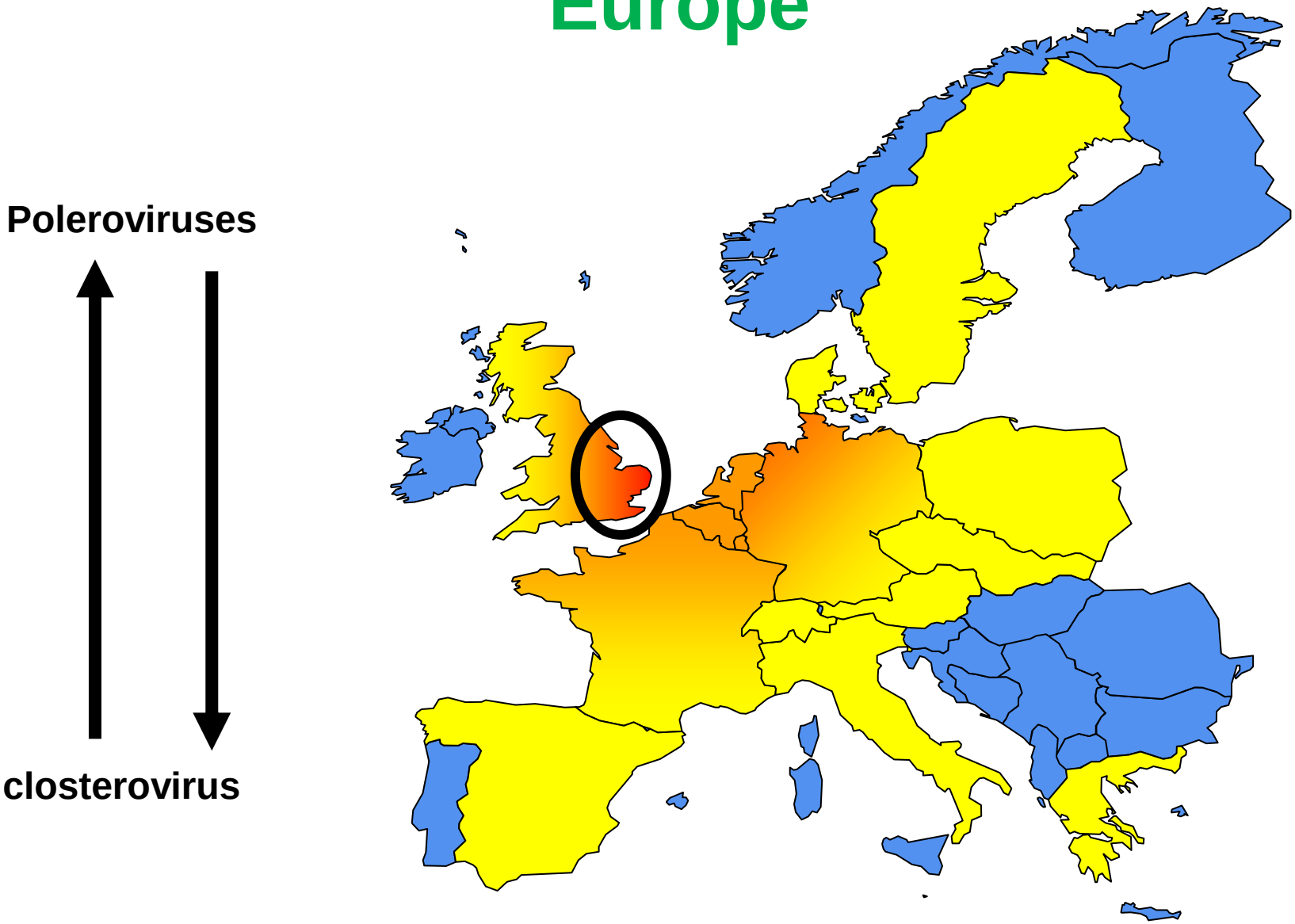


Non-circulative
(non-persistent)

Semi-persistent
BYV
Acquisition hours
Retention a few days

Virus Transmission

Prevalence of yellowing viruses across Europe



Virus Yellows remains a threat:

- Narrow choice of approved products for beet
- Aphid resistance (MACE, kdr, neonicotinoid)
- Lack of new/novel active ingredients
- Changing insecticide use in other arable crops
- Climate change – mild winters?
- Loss of neonicotinoid seed treatments

Options for control

Current		Decision Support
•Removal of sources of infection	←	General farm hygiene
•Chemicals applied as: *Seed treatments*	←	Risk maps
•Chemicals applied as: *Granules at drilling*	←	Risk maps +Forecast
•Chemicals applied as: *Post-emergence sprays*	←	Forecasts + Spray Warning Scheme

Provisos:

Conserve aphid predators

Beware resistant aphids

Options for control

Current

- Removal of sources of infection
- Chemicals applied as:
  - *Seed treatments*
  - *Granules at drilling*
  - *Post-emergence sprays*

Decision Support

- General farm hygiene ←
- Seed treatments: Risk maps ←
- Granules at drilling: Risk maps +Forecast ←
- Post-emergence sprays: Forecasts + Spray Warning Scheme ←

Provisos:

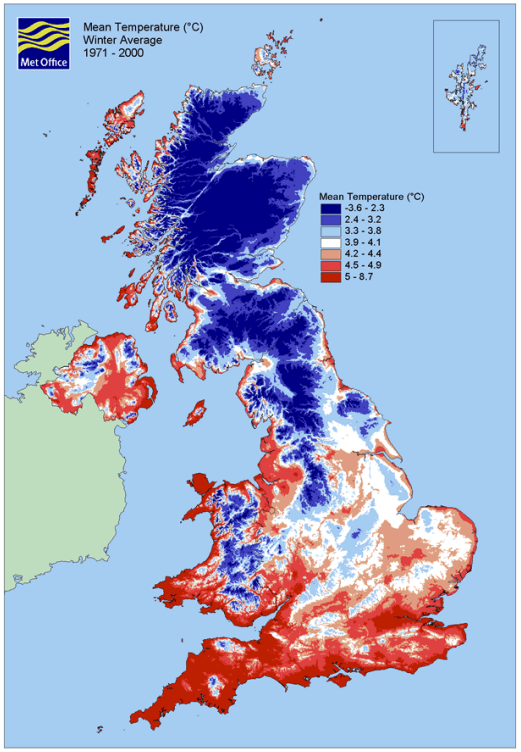
Conserve aphid predators

Beware resistant aphids

Future:

- Resistant varieties ← Performance
- Cost ←
- Risk maps ←

Modelling virus yellows in sugar beet



Winter temperature

Growth stage
(planting date)

Seed treatment

$$\frac{dy}{dt} = (r_p P(1-Y) + r_s Y(1-Y))z(t)Q(x)G(x)$$

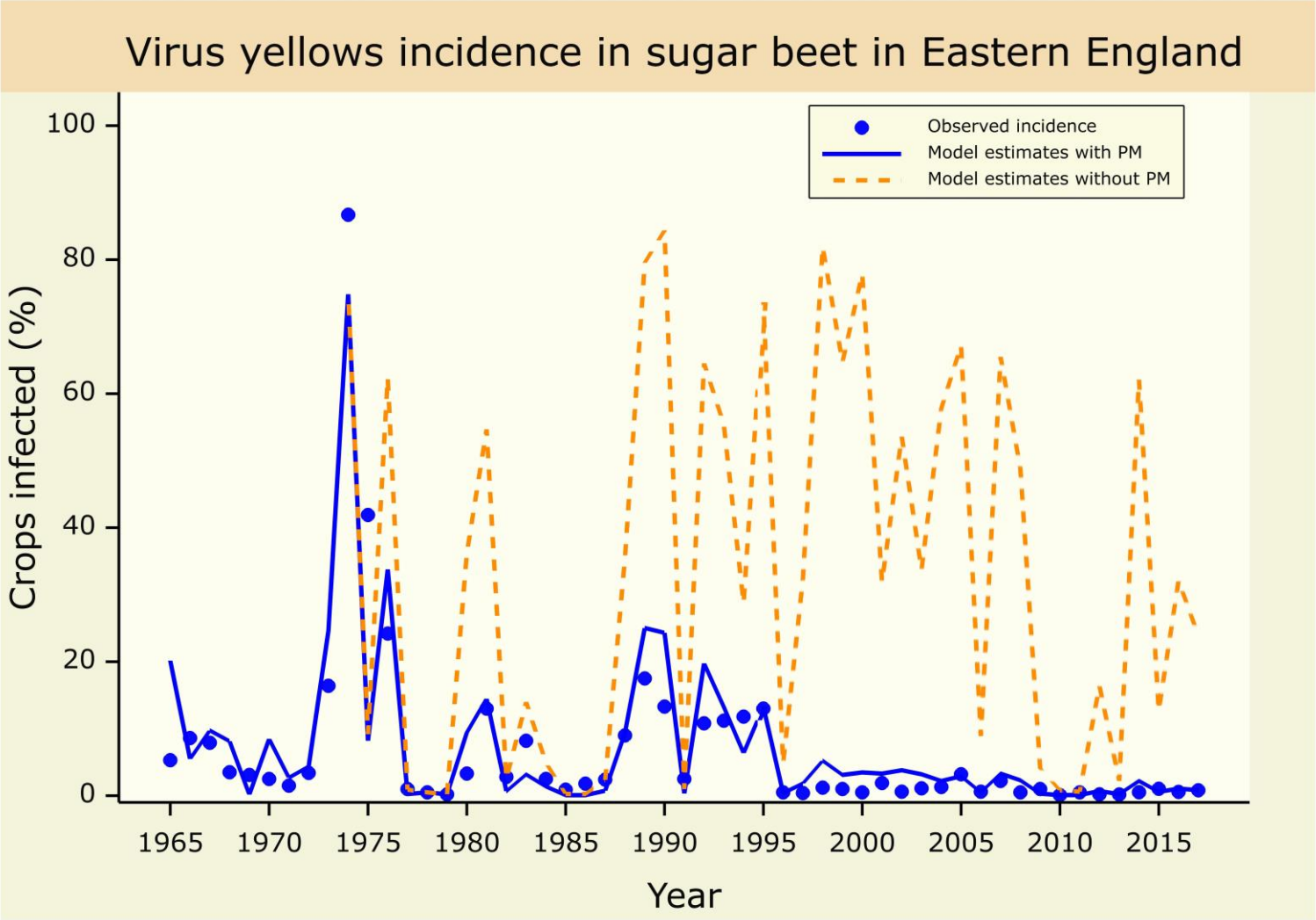
Qi, A., Dewar, A.M. and Harrington, R. (2004) Pest Management Science 60, 727-732

Virus Yellows Forecast for 2017

Factory Area	Option	Virus yellows (%) on Sowing Dates of			Intended use of insecticide treated seed*	Mean Temperature (Jan/Feb)
		15 March	30 March	15 April		
Bury	No Pest Control	17.7	23.9	35.2	-	4.66ºC
	+ Pest Control	0.7	0.8	1.0	99.5%	
Cantley	No Pest Control	14.5	19.8	29.5	-	4.5ºC
	+ Pest Control	0.6	0.7	0.8	99.3%	
Wissington	No Pest Control	17.7	23.9	35.2	-	4.66ºC
	+ Pest Control	0.7	0.8	1.0	98.0%	
Newark	No Pest Control	19.8	28.3	43.3	-	4.46ºC
	+ Pest Control	0.5	0.6	0.7	99.4%	

*source: British Sugar

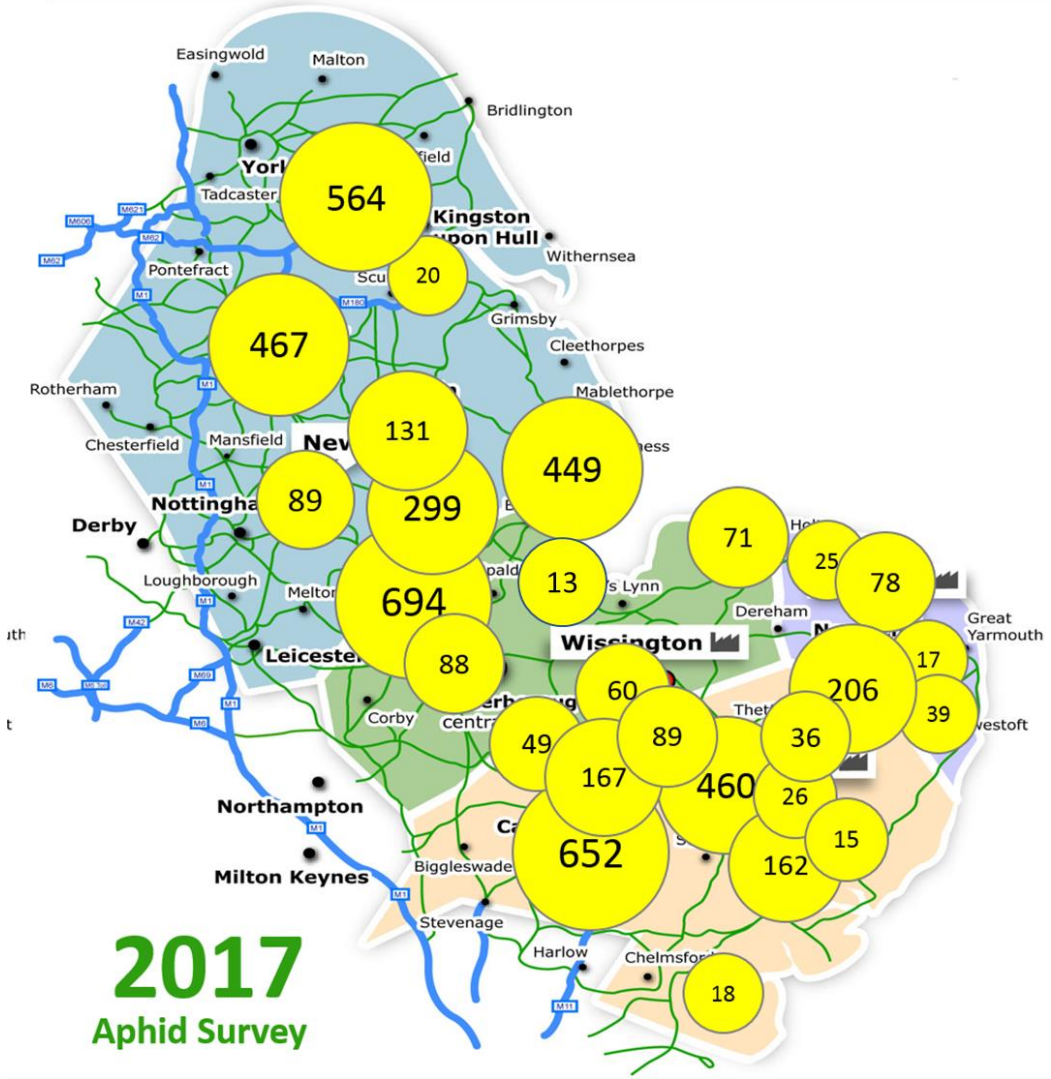
Virus Yellows forecasts



Monitoring

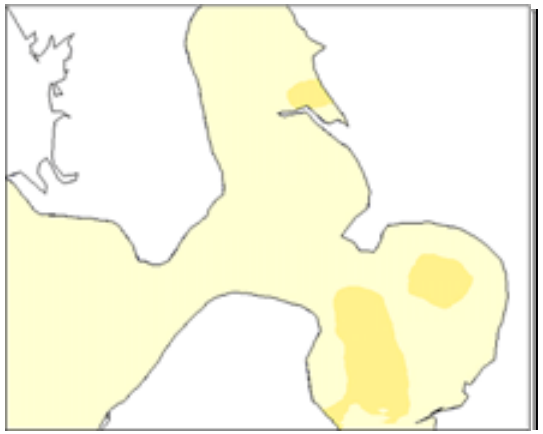
Aphid trapping

2017 aphid monitoring data



Monitoring aphids and their infectivity

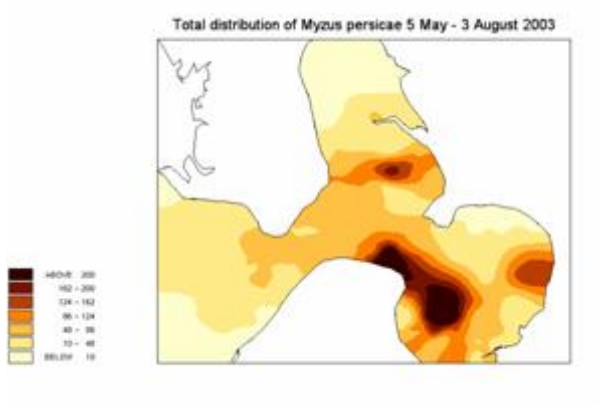
M. persicae distribution
3 May -19 July

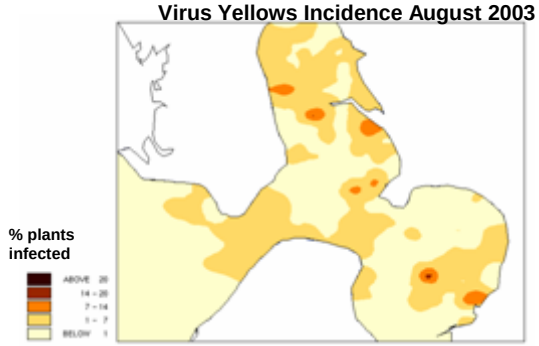


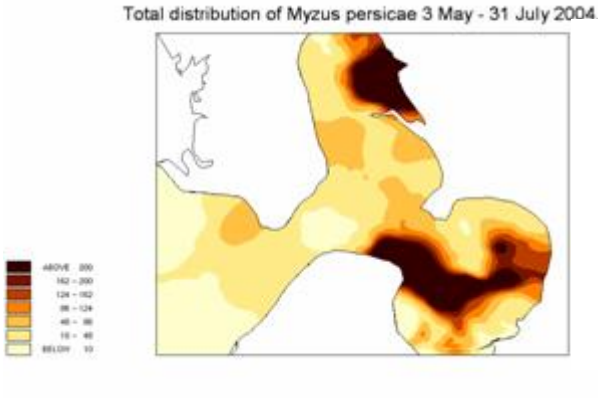
13 - 19 July

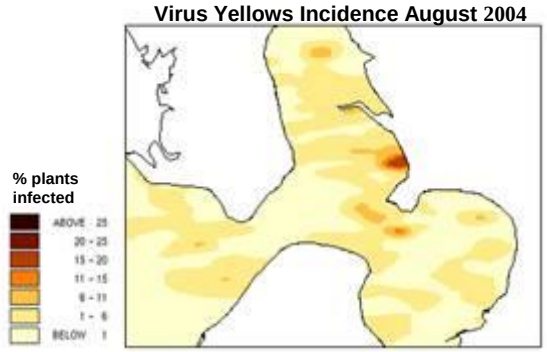
- Used by Industry as warning system
- Adopted in other crops
- Prevents prophylactic insecticide use.

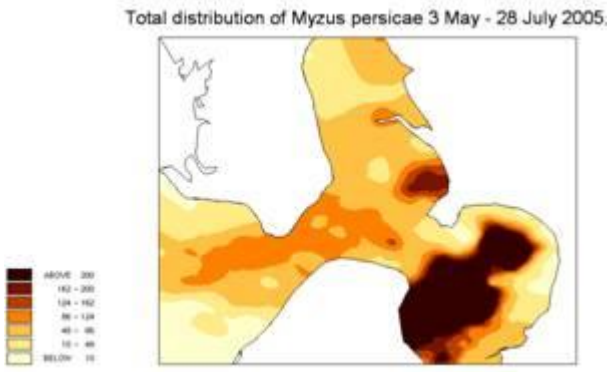
Evaluating *Myzus persicae* distribution and subsequent Virus Yellows incidence.

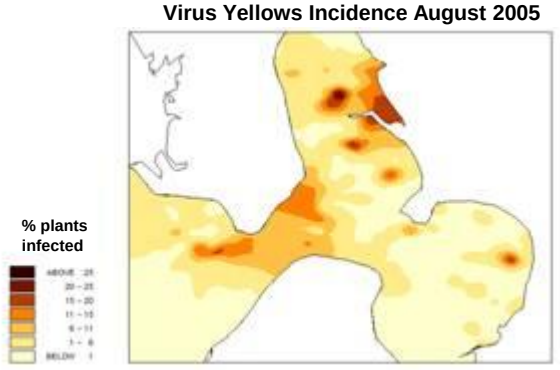




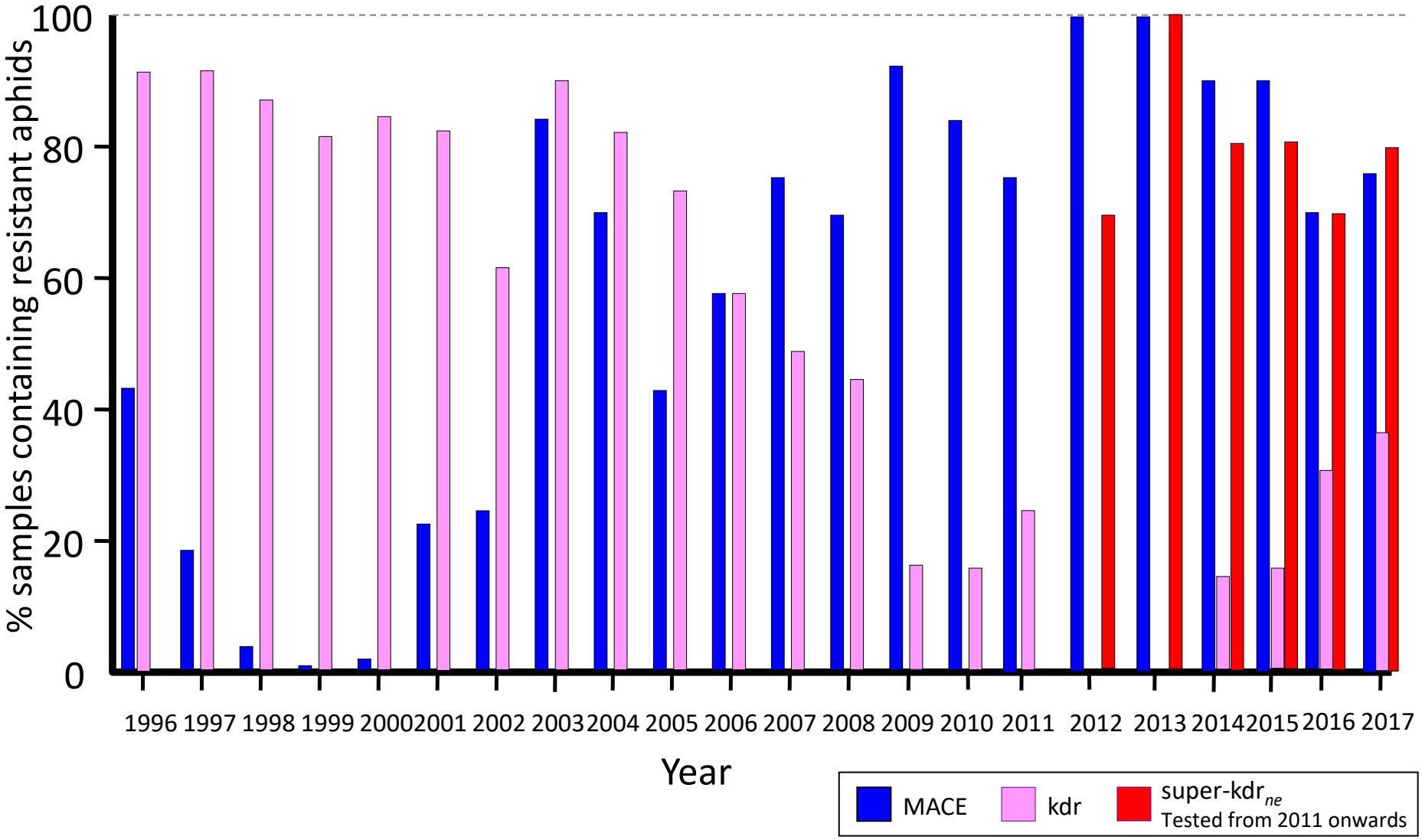








Myzus persicae field samples containing MACE, kdr and super-kdr$_{ne}$ aphids



FUTURE CONTROL

Is it possible?

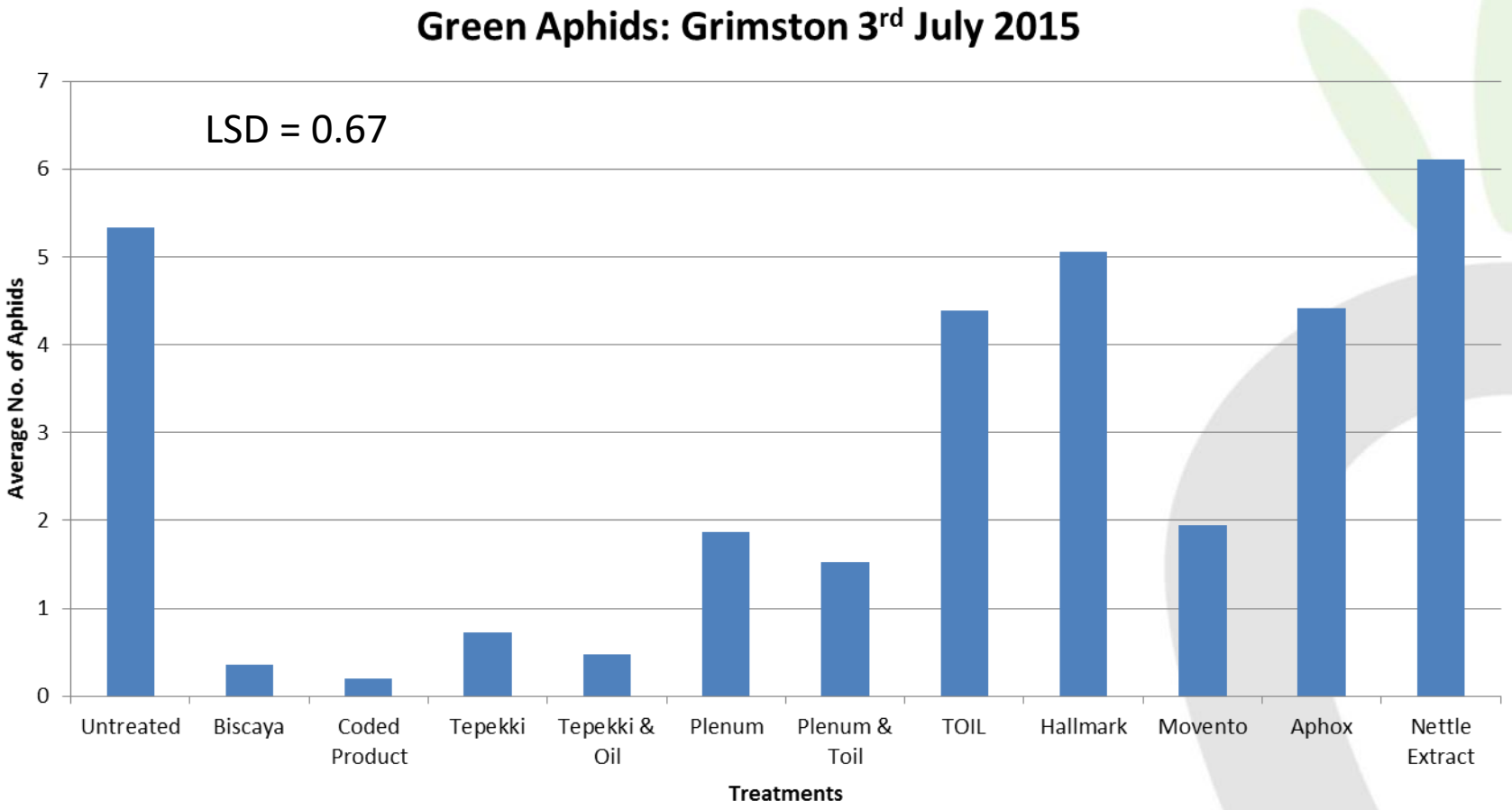
Virus Yellows: current options

- No foliar insecticides currently registered for *Myzus persicae* (one appl. of Teppeki in 2019 permitted)
- Resistance to pyrethroids and carbamates is a major issue (often impacting beneficial insects if applied)
- No resistant varieties currently available
- On farm crop hygiene crucial

Protecting the UK sugar beet crop

- **Importance for alternative strategies:**
  - New/novel insecticides
  - Resistant/tolerant varieties
  - Maximising beneficials
  - Biocontrol

Green aphid control

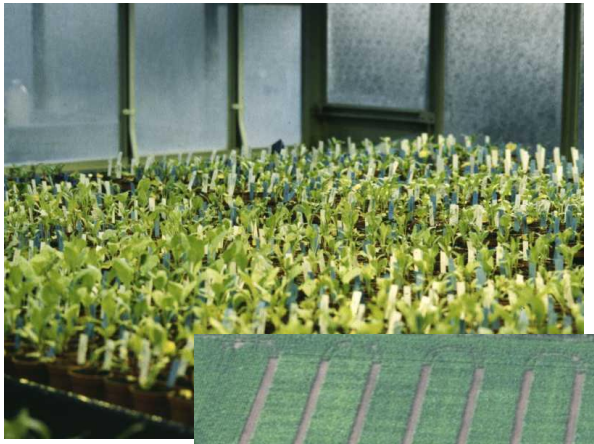


Autumn aphicide trial: Morley 2017

Developing disease resistance strategies

- **Conventional resistance**

  - Beta germplasm evaluation and analysis



- **Alternative resistance**

  - Pathogen-derived using Arabidopsis as model system.

  - CRISPR-cas9

BBRO priorities

- Accelerate virus breeding work
- Enhance pest monitoring network
- Further assess foliar treatments as seed treatments
- Evaluate plant resistance to aphids
- Field trials to study push-pull and aphid barrier strategies
- Real-time data on dedicated BBRO webpage to assist growers.

South Lincolnshire: mid-1970s


Questions?