

# Control of soilborne mosaic viruses of cereals

Kostya Kanyuka

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# Soilborne viral mosaic

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First reported from the USA in the early 1920s

Soil treatments with formaldehyde or steam prevented infection

Disease could be transferred from diseased to healthy wheat in infectious sap by needle-pricking inoculation (virus nature; SBWMV)

Various soil organisms initially considered as vectors

In 1960s a fungal-like root-dwelling plasmodiophorid *Polymyxa graminis* was shown to transmit the virus



# Soilborne wheat mosaic disease distribution





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# Soilborne wheat mosaic disease distribution - England



*"I suspect there is more soilborne mosaic virus in the UK than any of us realise"* NIAB agronomist

# Major soilborne mosaic viruses of temperate cereals

Furovirus

![](_page_6_Picture_2.jpeg)

Soil-borne cereal mosaic virus Soil-borne wheat mosaic virus Oat golden stripe virus Chinese wheat mosaic virus

Bymovirus

![](_page_6_Picture_5.jpeg)

Barley mild mosaic virus Barley yellow mosaic virus Oat mosaic virus Wheat spindle streak mosaic virus Wheat yellow mosaic virus

America Europe E. Asia SBCMV SBWMV OGSV CWMV BaMMV BaYMV OMV WSSMV WYMV

All are transmitted by *Polymyxa graminis* 

# UKCPVS 2024 season results - WYR

Virus species	Acronym	Genus	Natural host species								
			w	В	Т	R	0				
Barley yellow mosaic virus	BaYMV	Bymovirus		х							
Barley mild mosaic virus	BaMMV	Bymovirus		х							
Soil-borne wheat mosaic virus	SBWMV	Furovirus	х	$\mathbf{x}$	$\mathbf{x}$	$\mathbf{x}$					
Soil-borne cereal mosaic virus	SBCMV	Furovirus	х	Ŭ	$\widetilde{\mathbf{x}}$	$\widetilde{\mathbf{x}}$					
Chinese wheat mosaic virus	CWMV	Furovirus	х		Ŭ	Ŭ					
Wheat spindle streak mosaic virus	WSSMV	Bymovirus	х		$\mathbf{x}$	$\mathbf{x}$					
Wheat yellow mosaic virus	WYMV	Bymovirus	х		Ŭ	Ŭ					
Oat golden stripe virus	OGSV	Bymovirus					х				
Oat mosaic virus	OMV	Furovirus					х				

W = wheat, B = barley, T = triticale, R = rye, O = oats.

Affect winter cereals

Crops infected in the autumn, but symptoms appear in spring

Transmitted by a microorganism that infects the roots

Persists in soil for decades (inside *P. graminis* resting spores)

# Disease epidemiology

Autumn	Polymyxa graminis transmits virus to roots
Early spring	Virus detected in stem & foliage
Spring	Yellow or light-green mosaic, stunting

Summer Highly susceptible plants suffer yield loss, others 'recover'

## Additional symptoms:

- Reduced / delayed tillering
- Reduced secondary roots
- Delayed heading
- Shrivelled / aborted seed

Disease is cultivar, virus isolate & environment-dependent

![](_page_9_Picture_9.jpeg)

# Examples of disease symptoms (field and plant scale) **SBCMV**

![](_page_10_Picture_1.jpeg)

![](_page_10_Picture_2.jpeg)

![](_page_10_Picture_3.jpeg)

# Examples of disease symptoms (field and plant scale) **SBCMV**

![](_page_11_Picture_1.jpeg)

# Examples of disease symptoms (field and plant scale) **BaMMV**

![](_page_12_Picture_1.jpeg)

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# Disease is influenced by environmental conditions **SBCMV**

![](_page_13_Figure_1.jpeg)

# Disease is influenced by environmental conditions **SBCMV**

Immediately and a few weeks after seed germination is the most significant transmission period for disease development

A soil temp of >7.5°C and <20 °C and high matric potential is required for transmission

	1-14 weeks after drilling								
	2005-2006	2006-2007	2007-2008						
Number of days with <u>&gt;</u> 1mm rainfall <sup>a</sup>	32	62	42						
Number of days with a soil temperature of <u>&gt;</u> 7ºC <sup>a</sup>	6	41	24						
Number of highly conducive days for <i>P. graminis</i> infection	2	26	12						
Mean soil temperature (ºC)	4.1	6.4	5.3						
Mean daily rainfall (mm)	1.5	2.6	2.7						

# Soilborne wheat mosaic disease vs environment

# GO Infected roots

### Phase 3

Virus in leaves in late spring

![](_page_15_Figure_4.jpeg)

Upward movement is slow Rapidly growing plants could recover

Phase 2

Virus moves into the stem in the late winter-early spring

 $t^{\circ}_{-}$  and moisture ?

#### Phase 1

# Roots are infected with *Polymyxa* in the autumn

![](_page_15_Picture_11.jpeg)

![](_page_15_Picture_12.jpeg)

# Soilborne wheat mosaic disease vs environment

Many reports of soilborne mosaic in wheat and oat in March-April 2023 (March-April)

Many areas in the southern half of the UK had more than double their average March rainfall. The overall UK rainfall total was 155% of average, making it provisionally the sixth wettest March in a series back to 1836.

UK statistical summary											
Mean temperature	Rainfall	Sunshine									
The provisional mean value for	The provisional total for March	The provisional total for March									
March and April is 6.7 °C,	and April is 202 mm, which is	and April is 239 hours, which									
which is 0.1 °C below the	129% of the 1991-2020	is 90% of the 1991-2020									
1991-2020 average.	average.	average.									

**Hypothesis:** A very long, wet and cold spring favoured *Polymyxa graminis* to move and transmit viruses, plus the crop was developing slower than usually, allowing time for the virus to move up the canopy

![](_page_16_Picture_5.jpeg)

# Disease control options

## Crop rotation

*P. graminis* remains dormant in the soil for decades Fungicides

Ineffective against P. graminis

## Chemical fumigants

Environmentally unfriendly

Hygienic cultural practices

Disinfect machinery and tools especially when moving between fields / farms

Virus infected fields are not under statutory control in UK

Delay planting date

## Switch to growing non-cereal crops

## Grow resistant varieties

Excellent resistance against BaMMV / BaYMV in barley, many options Some virus strains could overcome varietal resistance Resistant wheat varieties stop SBCMV spreading to the leaves They could still act as reservoirs of the virus Sometimes resistance can be broken down

# Disease resistance in barley

![](_page_18_Picture_1.jpeg)

- rym4/5 resistance locus cloned
- diagnostic markers for breeders
- broad-spectrum resistance alleles

![](_page_18_Picture_5.jpeg)

KONSTANTIN KANYUKA ⊠, ARNIS DRUKA, DAVID G. CALDWELL, ANNA TYMON, NICOLA MCCALLUM, ROBBIE WAUGH, MICHAEL J. ADAMS

It#

![](_page_18_Picture_7.jpeg)

## Winter barley 2024/25

RECOMMENDED	Buccaneer	Electrum	Craft	LG Caravelle	LG Capitol	Lightning	Bolivia	KWS Tardis	Bolton	Bordeaux	LG Mountain	LG Dazzle	KWS Orwell	Valerie	SY Thunderbo	SY Kingsbarn	SY Kingston <sup>#</sup>	SY Canyon <sup>#</sup>	Belfry <sup>#</sup>	SY Nephin#	Bazooka <sup>#</sup>	SY Buzzard <sup>#</sup>	KWS Feeris
BaYMV1 & BaMMV	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
BaYMV2	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-

# Disease resistance in barley

![](_page_19_Figure_1.jpeg)

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# Disease resistance in wheat

![](_page_20_Figure_1.jpeg)

![](_page_20_Picture_2.jpeg)

mapped *Sbm1* in wheatdiagnostic markers for breeders

collaboration with Limagrain

![](_page_20_Picture_5.jpeg)

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Perovic et al. 2009

# Disease resistance mechanism

![](_page_21_Figure_1.jpeg)

- Root to shoot virus translocation block
- Reduced virus accumulation in roots

Current SBCMV resistant RL wheat varieties: Zulu (not on RL list) Mayflower Bamford Costello

# Thank you

# Any questions?

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