Virus Yellows in sugar beet – biology, occurrence and influence on yield parameters

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Introduction:

The Virus Yellows (VY) disease in sugar beet caused by a complex of different virus species, is mainly transmitted by the aphid *Myzus persicae*. In Europe, *Beet yellows virus* (BYV), *Beet mild yellowing virus* (BMYV) and *Beet chlorosis virus* (BChV) are economically most important (Fig. 1). Representative data on the current natural occurrence of the different virus species in Europe as well as yield losses caused by the disease under natural infection are lacking. Within the framework of this study, the current situation of the occurrence of different virus species was determined by means of a European-wide monitoring in the years 2017, 2018 and 2019 (Tab. 1). The monitoring showed that even the decades-long use of neonicotinoids, which are banned since 2019, has not led to a complete extinction of the virus species. BYV, that was thought to be mainly limited to Southern Europe, has now also been found in Northern and Central Europe. The effect of these virus species on sugar beet yield and quality was studied under field conditions using virus-loaded *M. persicae* for infection by end of May. A severe reduction in root yield and white sugar yield has been observed for all viruses. The experiments will provide new insights into current yield and quality losses in sugar beet following Virus Yellows infection.

Fig. 1: Symptoms of the most important virus species from the Virus Yellows complex on sugar beet leaves.

Fig. 2: Experimental set-up shown for BChV, BYV and BChV/BYV co-infection in a field. Plots with three rows of 100 plants in four repetitions (August 2019).

Materials and methods:

Monitoring: Leaf samples with suspected virus infection were collected from sugar beet fields in ten European countries in a three-year monitoring (2017-2019) in cooperation with European sugar beet breeders and the „Gemeinschaft zur Förderung von Pflanzeninnovation e. V.“ (GFPi). Extracted leaf sap was analyzed by DAS-ELISA using specific antibodies against the viral coat protein.

Field trial for yield and quality studies: Sugar beet seeds (cv. VASCO) were sown in three rows with 100 plants per plot in four biological repetitions (Fig 2). 10% of the plants per plot were inoculated by virus-loaded *M. persicae* at BBCH14 (BYV, BMYV and BChV separate infection and BChV/BYV co-infection). Control plants were protected by insecticides. Plots were scored from July until October to analyse infection rates. Sugar beets were harvested in October and analysed concerning root yield and root quality (e.g. white sugar yield, potassium/sodium, amino-N; not all data shown).

Tab. 1: VY monitoring in ten European countries in 2017, 2018 and 2019.

country	No. of samples			BMYV/BChV [% virus positive]			BYV [% virus positive]		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Germany	586	168	991*	2.6	9.5	11.6	5.4	2.4	4.5
UK	30	67	31	20	4.5	25.8	33.3	35.8	35.5
Netherlands	123	52	76	0	0	40.8	7.3	0	1.3
France	249	208	269	19.3	30.3	67.3	26.1	0	3
Belgium	30	30	30	0	0	26.7	0	0	3.3
Italy	60	60	30	3.3	0	3.3	0	0	6.7
Denmark	31	82	100	0	0	0	3.2	0	0
Hungary	30	-	-	0	-	-	0	-	-
Schweden	30	121	120	0	0	0	0	0	0
Spain	60	30	68	0	0	5.9	63.3	0	91.2
Total	**1229**	**818**	**1715**	**5.8**	**10**	**20**	**12.6**	**3.4**	**7.6**

* Incl. ca. 400 weed samples

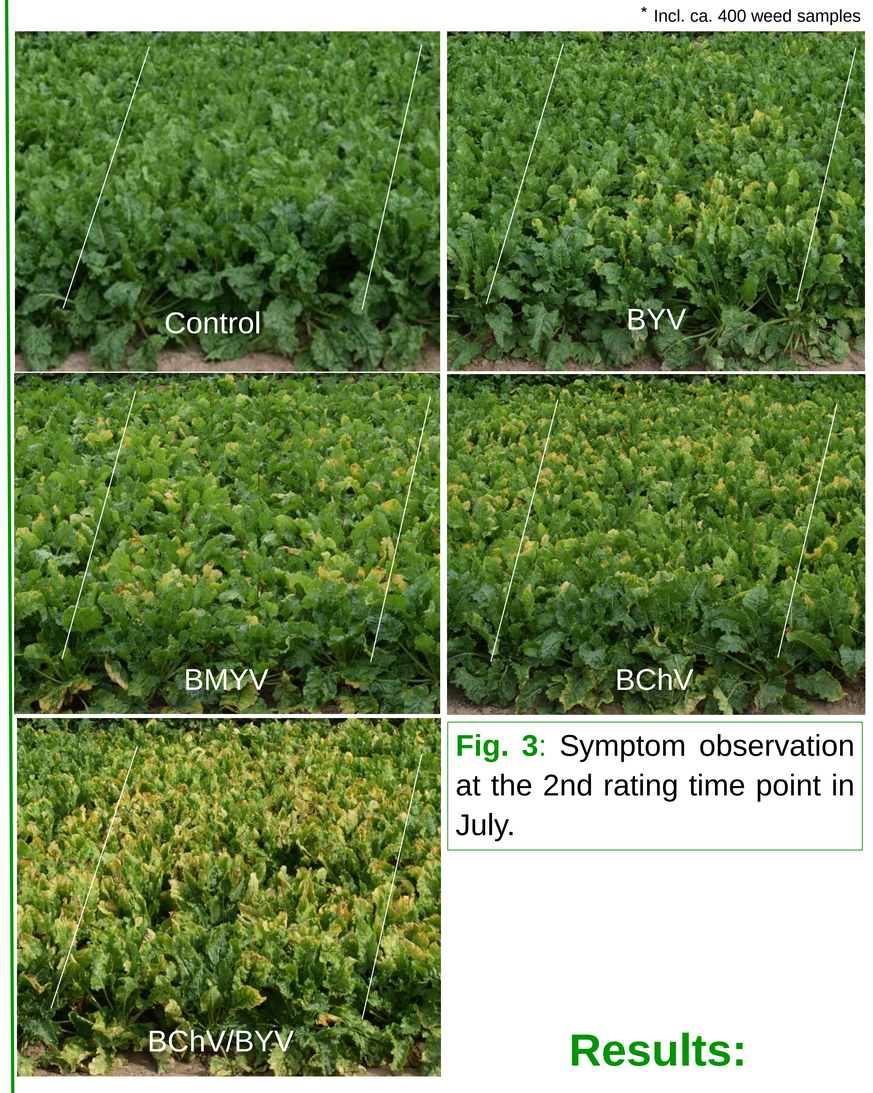

Fig. 3: Symptom observation at the 2nd rating time point in July.

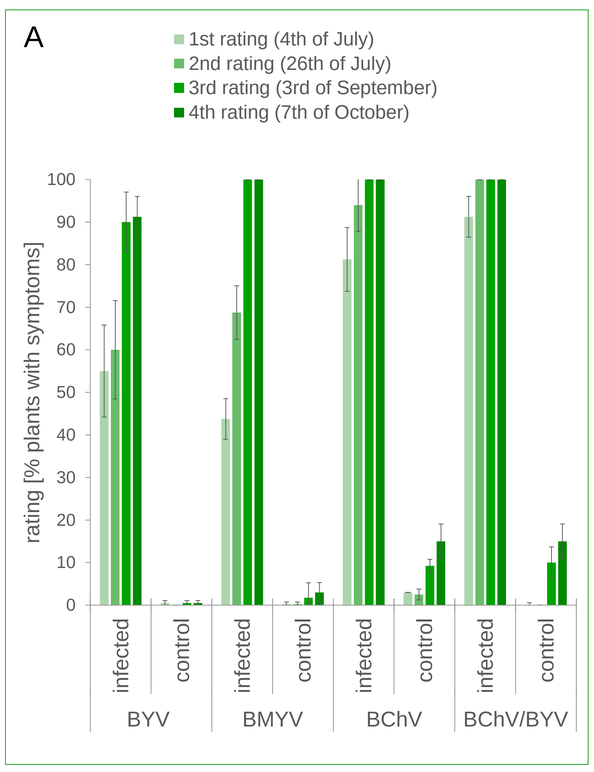

Fig. 4: A) Symptom rating in different months after virus inoculation compared to non-infected control plants.
B) Analysis of yield reduction and reduction of white sugar yield in virus infected sugar beets compared to non-infected control plants.
T-test by p-value < 0.05.

Results:

Species of the VY complex have been identified in eight of ten European countries with year-to-year variations (Tab. 1). All virus species caused symptoms in the susceptible cultivar VASCO (Fig. 3). The BChV/BYV co-infection showed strongest virus symptoms compared to separate infection and reached an infection rate of 100% already by the end of July (Fig. 4A). All virus species reduced beet yield and white sugar yield in the root significantly (Fig. 4B). The highest reduction could be measured for the BChV/BYV co-infection treatment.

Conclusions:

The current situation of the VY distribution in Europe has been presented. As also previously reported, the occurrence of VY is subject to fluctuations in different years. This information is important to design future integrated control strategies. Field trials for the investigation of VY disease progression have been successfully established. Although only 10% of the plants per plot were inoculated, infection rates of 100% were obtained at harvest. Current data for the reduction of sugar beet yield and white sugar yield could be determined. These studies can be used to support breeding companies in the decision-making process to find strategies for resistance selection and resistance breeding programs.

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