



Virus Yellows resistant/tolerant varieties for sustainable sugar beet production, when seed treatments are banned

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OVERVIEW

Breeding against VY within UBS

- **During the 1970's:** evaluation in field for tolerance/resistance to Virus Yellows (VY) Artificial inoculation was applied.
- **End of 1980's:** greenhouse and lab tests were set up to identify resistance to Virus Yellows. Selection and breeding was going on during many years.
- **During the 1990's:** neonicotinoid (NNI) seed treatments against aphids was introduced.
- **During the 2000's:** breeding efforts for resistance/tolerance to Virus Yellows slowed down.
- **From year 2016:** breeding in full speed for resistance/tolerance to Virus Yellows based on strong material already identified, at the same time as new combinations are done.
- **Year 2018:** the neonicotinoids were banned within EU.



Virus Yellows in France 2020



Virus Yellows an issue also in the USA before the NNI came

Observation and Studies of Virus Yellows of Sugar Beet in California

C. W. BENNETT AND A. S. COSTA¹

Virus yellows has been known for many years as a disease of sugar beet in Europe but it was not until 1951 that it was reported by Coons and Kotila (3)² to be present in the United States. In 1952 Coons (1) reported that the disease was present in all of the major sugar beet-producing states of the country.

Surveys in 1952 and again in 1953 indicate that virus yellows occurred in all of the areas in central California where sugar beets were grown, and the disease was found also near Oxnard and Riverside in the southern part of the state. It has not been found in the Imperial Valley or in the Hemet Valley where beets are grown as a seed crop.

In the Imperial Valley beets are planted in the fall and harvested the following spring. There is a period, roughly from July to September, during which few plants are available to serve as potential sources of infection for the fall planting. It is possible that even if the virus were introduced cause tions

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ACADEMIC
PRESS

Aphids As Virus Vectors

1977, Pages 361-383

CHAPTER 15 - APHIDS, VIRUSES, AND THE YELLOW PLAGUE

James E. Duffus

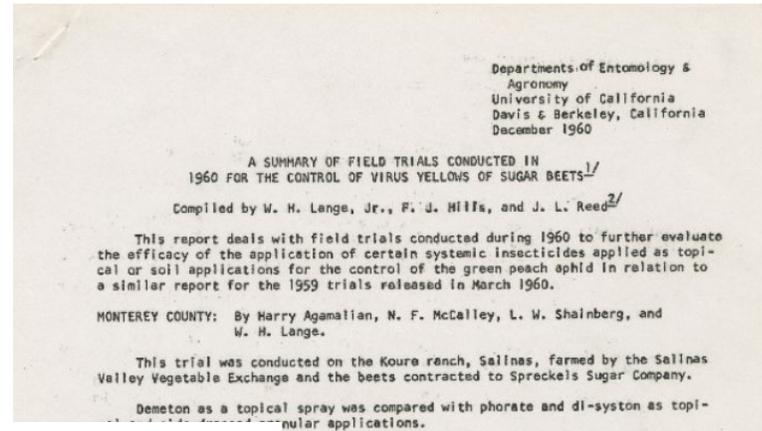
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Publisher Summary



Co-infection of *Beet mosaic virus* with Beet Yellowing Viruses Leads to Increased Symptom Expression on Sugar Beet

William M. Wintermantel, United States Department of Agriculture, Agricultural Research Service, 1636 E. Alisal Street, Salinas, CA 93905

ABSTRACT

Wintermantel, W. M. 2005. Co-infection of *Beet mosaic virus* with beet yellowing viruses leads to increased symptom expression on sugar beet. *Plant Dis.* 89:325-331.

Three distinct aphid-transmitted viruses associated with a yellowing disease on sugar beet were examined in single and mixed infections for the effects of virus interactions on plant weight, rate of symptom development, and virus concentration. Sugar beet lines exhibiting different degrees of susceptibility to the virus yellows complex were inoculated with either one, two, or all three viruses. Severe stunting, as measured by fresh plant biomass, was observed with mixed infections with *Beet yellows virus* (BYV) and *Beet mosaic virus* (BtMV), compared to single infections of these viruses. In addition, the overall rate of appearance of *Beet western yellows virus* (BWYV) symptoms increased during co-infection with BtMV. Synergistic effects on stunting severity, as measured by plant biomass, were more pronounced in susceptible beet lines, but similar patterns also were observed in lines exhibiting tolerance to virus yellows. Relative concentrations of viruses were compared among single and mixed infections using dot-blot hybridization with virus specific probes, and quantified by phosphorimage analysis. Titers of all three viruses increased as a result of co-infection compared with single infections.

Additional keywords: closterovirus, polerovirus, potyvirus, resistance, synergism

Advances in Virus Research

Volume 18, 1973, Pages 347-386



The Yellowing Virus Diseases of Beet

James E. Duffus

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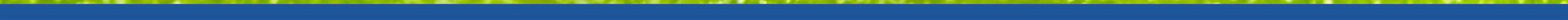
(5,13,32). Seed yields may be decreased by up to 70% as a result of virus yellows infection (6). Each virus in the yellows complex differs in its effect on yield in single infections. BYV infection results in decreased leaf area and losses in both root weight and sugar yield (13). Yield losses associated with BWYV infection are much less than those resulting from infection by BYV (13). BtMV infections result in less than 10% yield loss even when plants are infected early (13).

Members of all three virus genera (represented here by BYV, BWYV, and BtMV) can be present in plants at the same time. Although BtMV is widespread in sugar beet production worldwide, it was not clear what effect interactions between BtMV and yellowing viruses could have on disease development. Furthermore, no studies had been conducted on the effects



Myzus persicae, a vector of Virus Yellows

Myzus persicae





BYV

- ☼ Beet Yellowing Virus
- 🌐 USA, Europe
- 🌱 40% yield loss



BMYV

- ☼ Beet Mild Yellowing Virus
- 🌐 Europe
- 🌱 20-25% yield loss

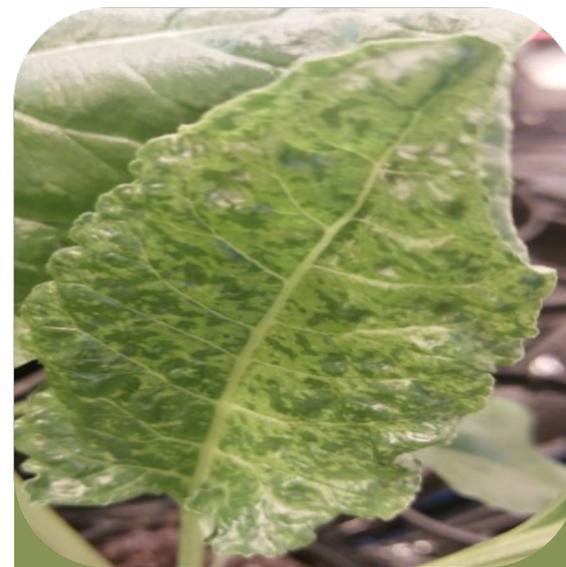
BWYV

- ☼ Beet Western Yellowing Virus
- 🌐 USA
- 🌱 20-25% yield loss



BChV

- ☼ Beet Chlorosis Virus
- 🌐 USA, Europe
- 🌱 20-25 % yield loss



BtMV

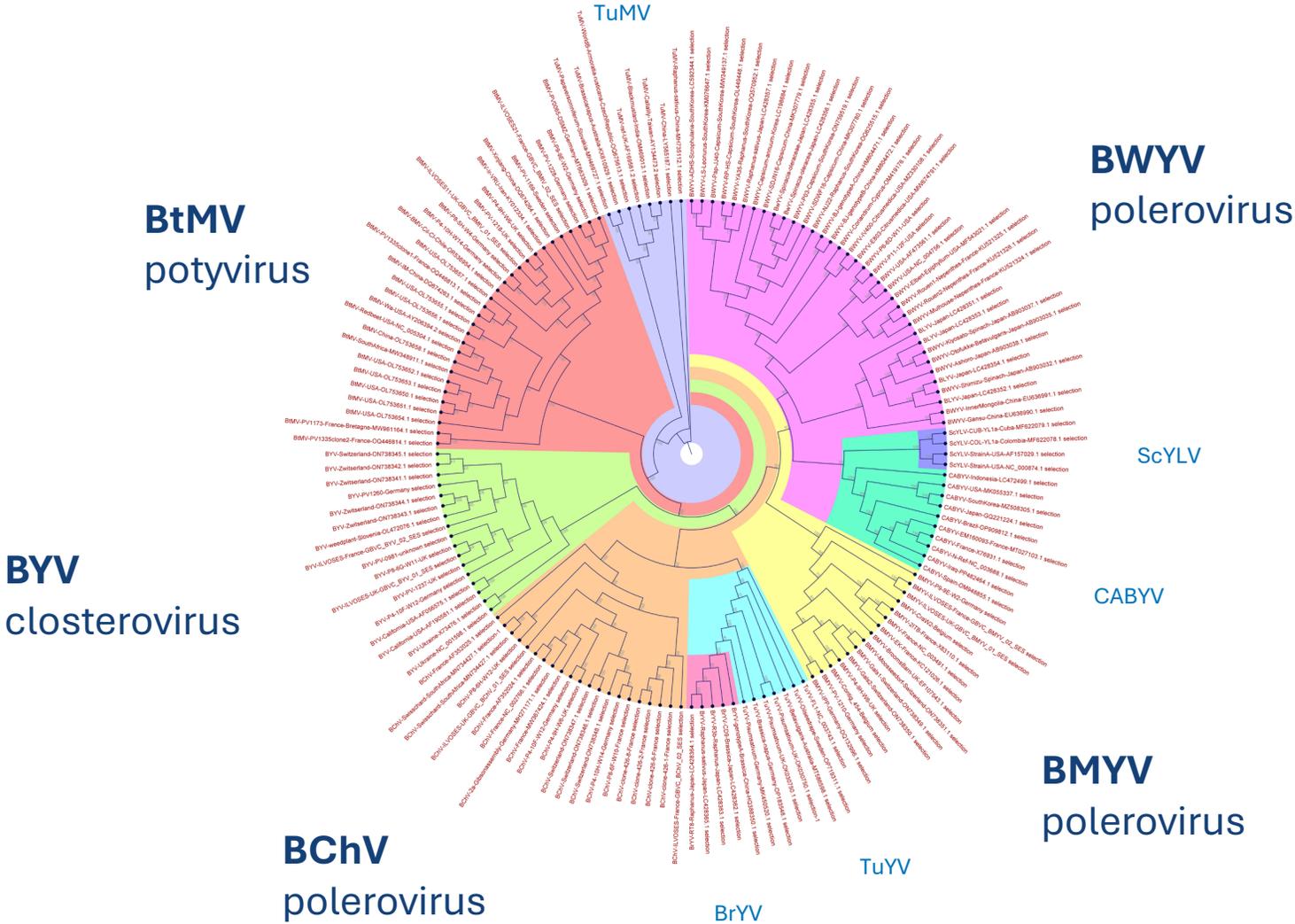
- ☼ Beet Mosaic Virus
- 🌐 USA, Europe
- 🌱 minor yield losses

Mild winters with many overwintering aphids can give an early migration of aphids, followed by early Virus Yellows infection. If sugar beet plants are infected in a young development stage, the yield losses can get high.

VIRUSES



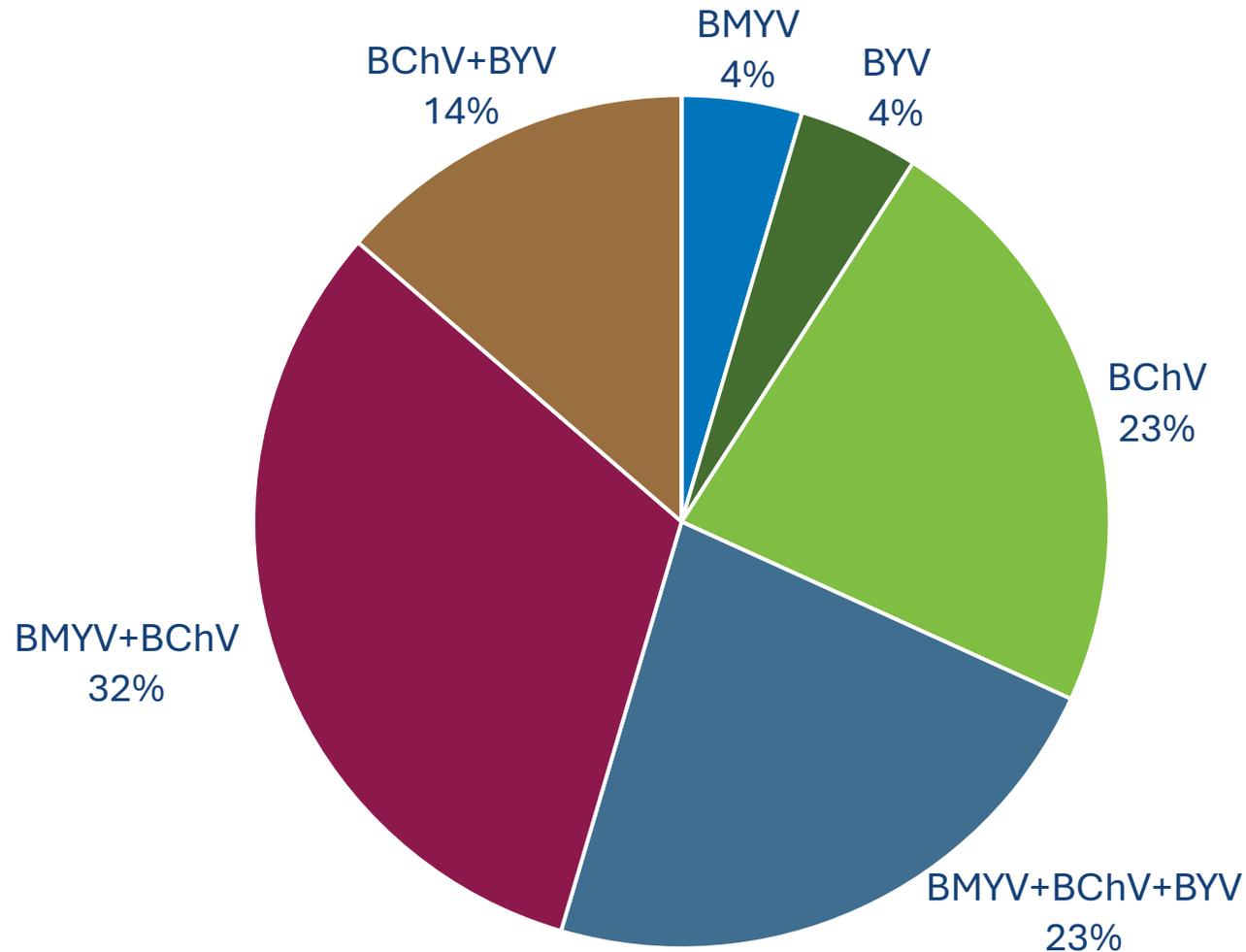
Diversity of viruses based on whole genome sequencing



Ref: NCBI and UBS



Co-infections are common in Europe



Conclusion:

- Internal and external investigations have shown that co-infections are common
- Important to breed for resistance/tolerance to several viruses



Plant defense strategies to VY

	Tolerance	Resistance
Symptoms	Yes, yellow leaves	Few
Virus content	High	Low
Yield noninfected fields	No or small yield loss	Might be lower yield
Yield loss at high infection pressure	Might be high yield loss	Secures yield
Secondary leaf diseases	Yes	Few

UBS uses both strategies to breed against Virus Yellows.



UBS breeding and research

Viruses and vectors	Resistance/tolerance identified
Beet mosaic virus	Yes
Beet chlorosis virus	Yes
Beet yellows virus	Yes
Beet mild yellowing virus	Yes
<i>Myzus persicae</i>	Yes
<i>Aphis fabae</i>	Ongoing



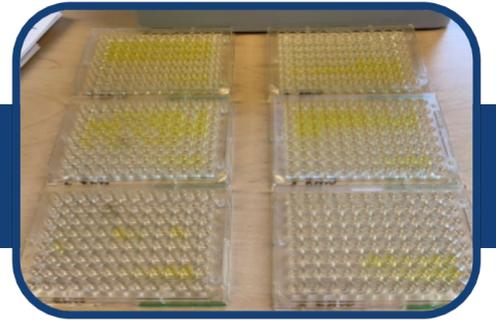
Detection, validation & exploitation of genetic diversity is key



Special thanks to the USDA for providing valuable gene sources over the years to the breeding companies



Field Phenotyping

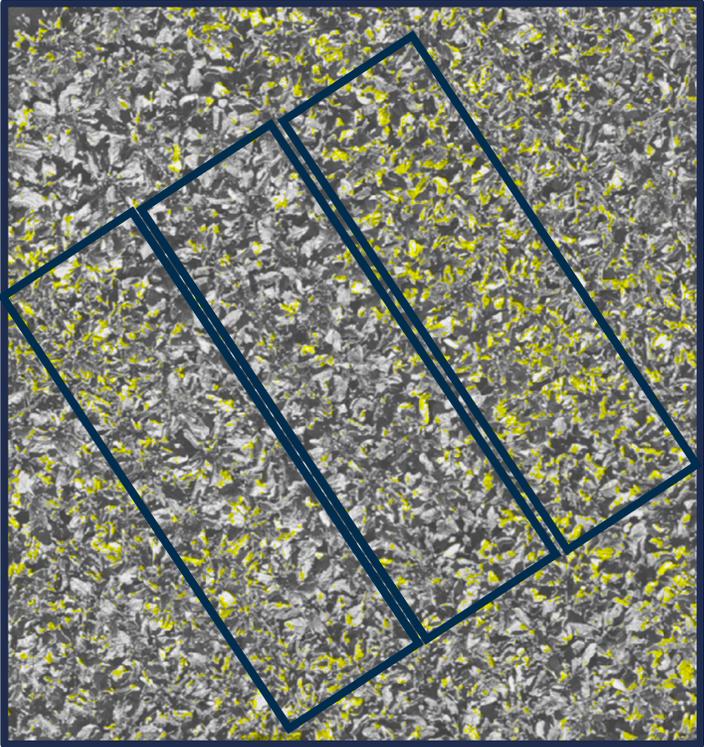


Greenhouse Phenotyping



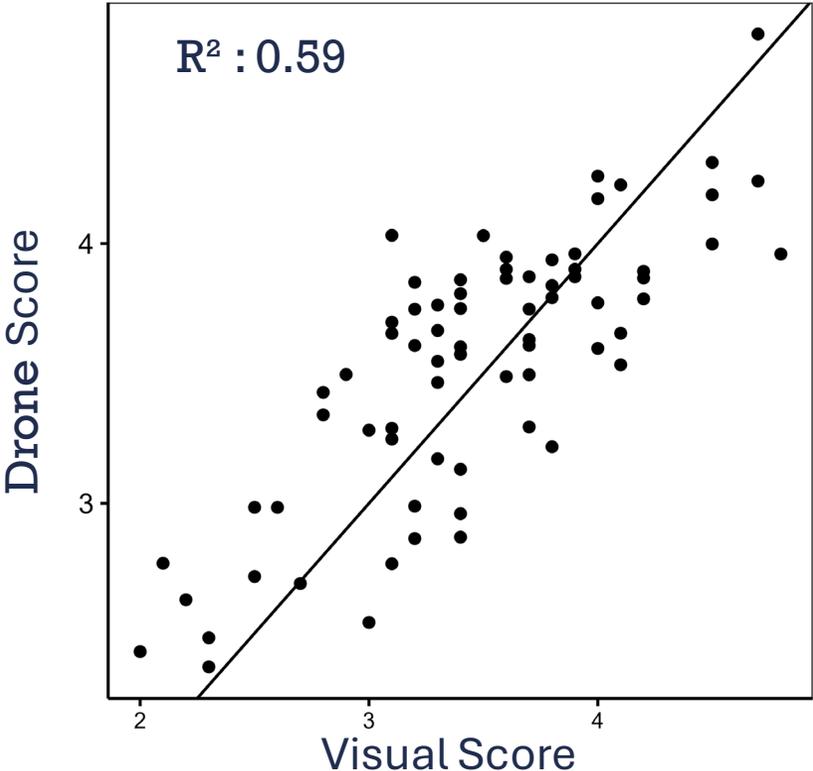
Improved efficiency to score VY trials using drones

Scoring with drones

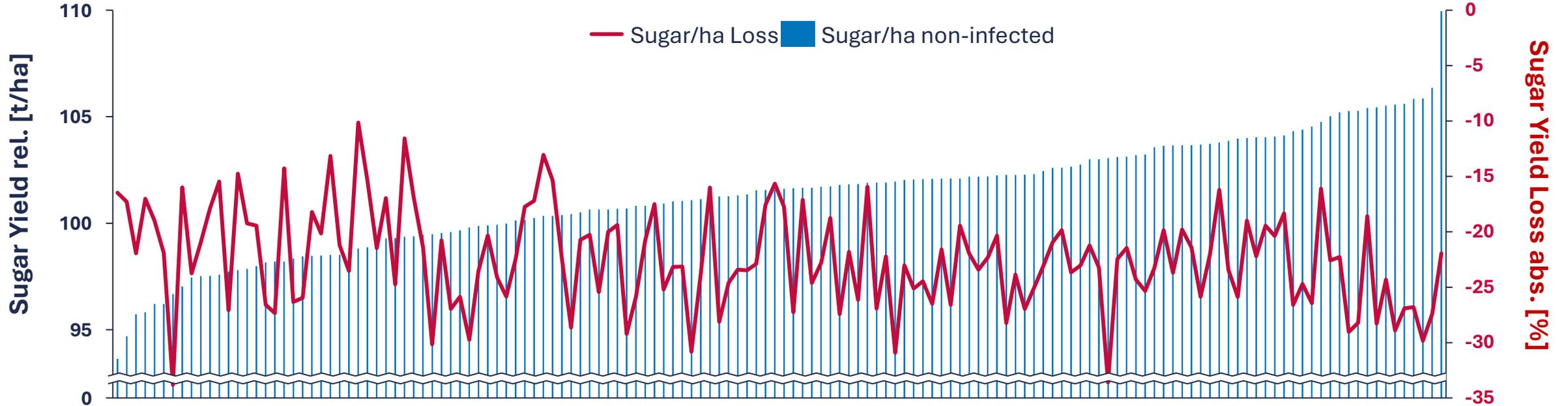


Source: UBS

Drone ~ Visual Scoring



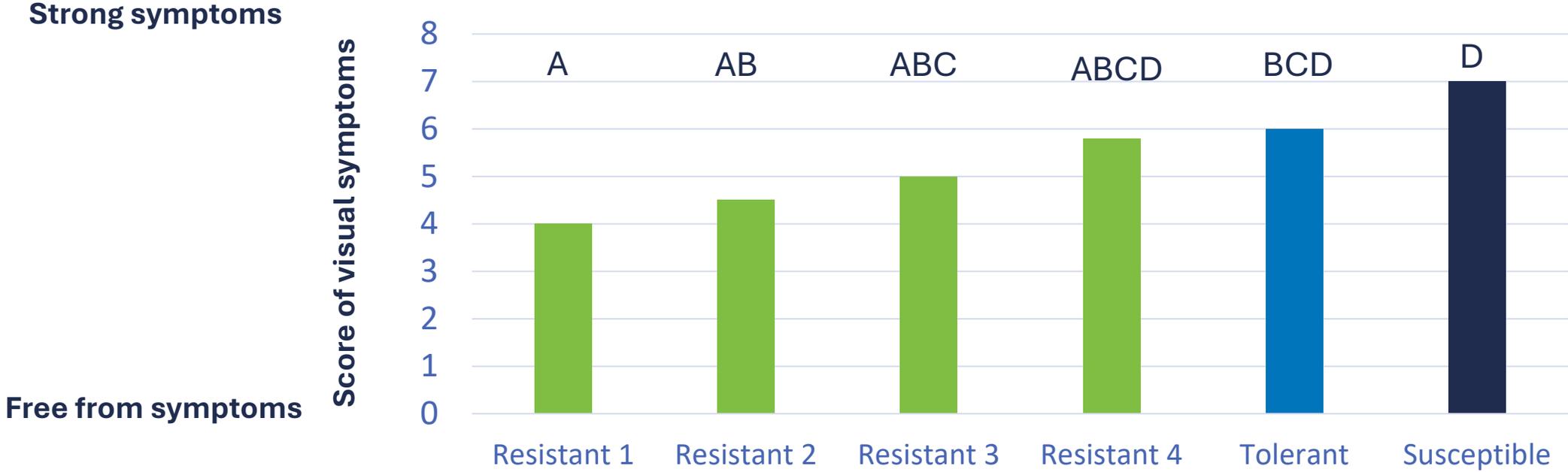
Considerable genetic variation exists after triple infection (BYV, BChV, BMYV).



Source: UBS



Results from field trials with co-infection of BYV, BMYV, BChV



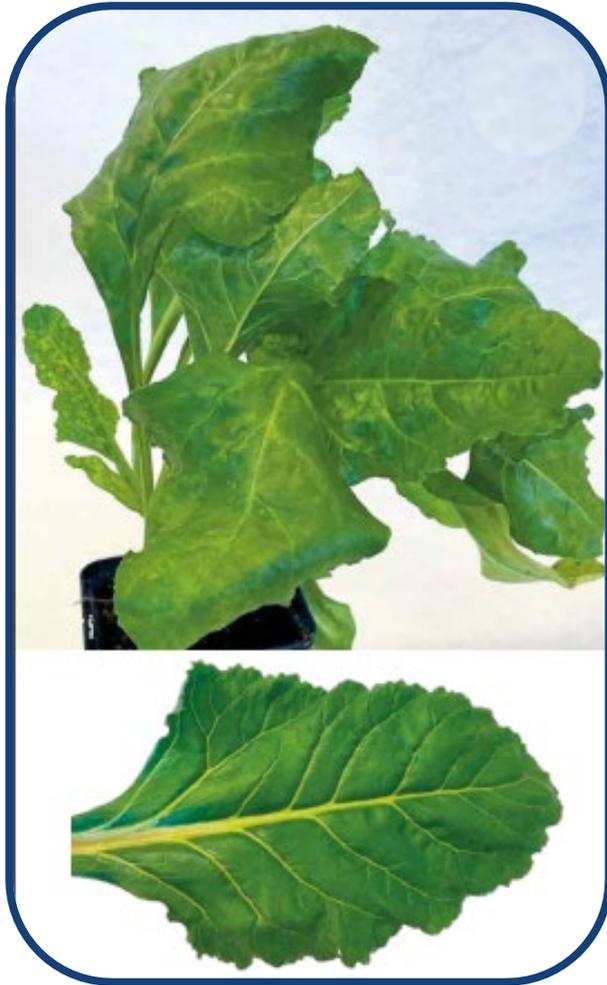
Source: UBS

Conclusion:

BMYV resistant hybrids have less symptoms also in co-infection of BMYV, BYV, BChV.



Results from co-infection in greenhouse tests



Resistant



Susceptible

Co-infection greenhouse trials:

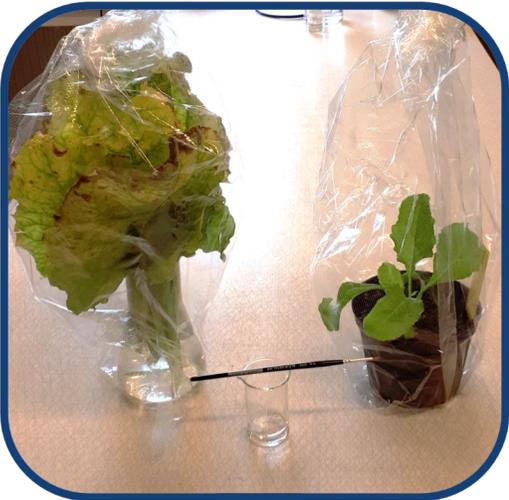
- 10 aphids with BMV
- 10 aphids BYV
- 10 aphids BChV
- BtMV mechanical inoculation

Conclusion:

BMV resistant hybrids have less symptoms also in co-infection of BMV, BYV, BChV, BtMV



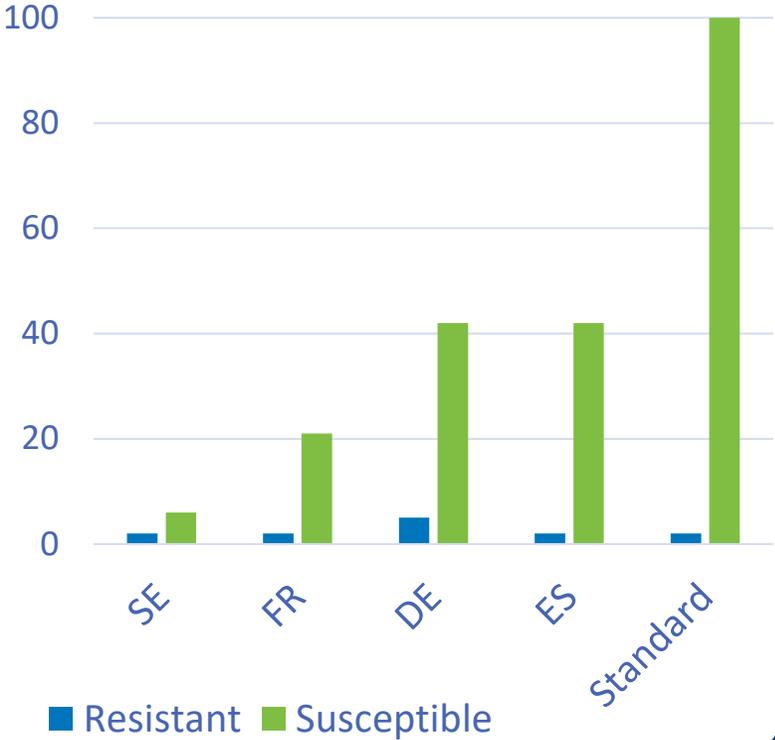
Results from test with field isolates



Symptoms 3w pi in greenhouse

	SE	FR	DE	ES
Resistant				
Susceptible				
	BMVY BChV	BMVY BChV BYV	BMVY BChV BYV	BMVY BChV

% BMVY content in the leaves



Conclusion:

The resistance against BMVY was strong to all tested isolates



Summary

- Resistance and tolerance are identified within UBS to vectors and viruses (BMYV, BYV, BChV, BtMV)
- Breeding is ongoing to combine the Virus Yellows traits with resistance/tolerance to Rhizomania, Cercospora, Erysiphe, Nematodes, Aphanomyces, Rhizoctonia etc.
- With the gene pools from both Group Florimond Deprez and DLF Beet Seeds, and with wild beet materials from the USDA and other gene banks, we can successfully fight against pests and diseases including Virus Yellows.



Thank you for your attention!





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