

Breeding for genetic tolerances against leaf diseases based on a unique, combined gene pool

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Two unique commercial breeding programs with high genetic diversity are combined within UBS

Both programs have a long history of breeding for tolerances against leaf diseases.



- At UBS continuous work since many years on breeding and research on **leaf diseases**
- Over the years UBS has provided the US market with many varieties with good resistance to **Cercospora and other leaf diseases such as Alternaria leaf spot**
- Resistant and tolerant varieties are of importance to tackle the diseases in an **integrated pest management** system

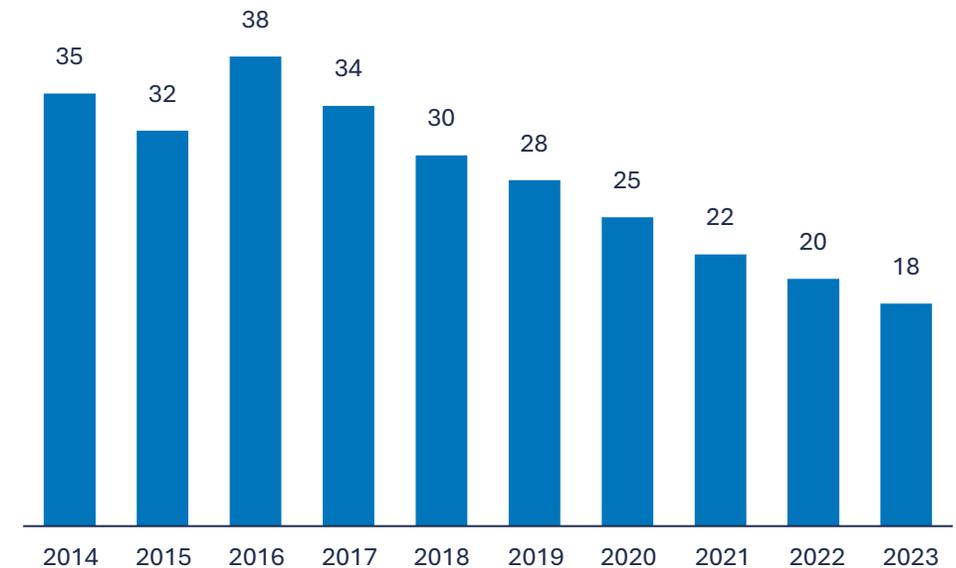


General trends in agriculture

Loss of plant protection products and climate change lead to increased occurrence of pests and diseases.

- **Fungicide resistant isolates** are spread of both *C. beticola* and *Alternaria spp*
- **Climate change** has and will have an impact of the development of fungal diseases
- **Decreasing number of pesticides** are registered in EU during the last ten years

Number of newly registered pesticides in EU



Source: data.europa.eu



Impact of Leaf Diseases in US 2024



Fairgrove, Michigan
Photo: Doug Ruppal



Fairgrove, Michigan
Photo: Doug Ruppal

Cercospora and *Alternaria* leaf spot

Cercospora leaf spot

- Caused by *Cercospora beticola*
- May cause >40% yield loss
- +25-35°C, high humidity
- Mainly *Beta* spp as host
- Spots regular circular shape with sharp dark brown or reddish border
- Dead leaves



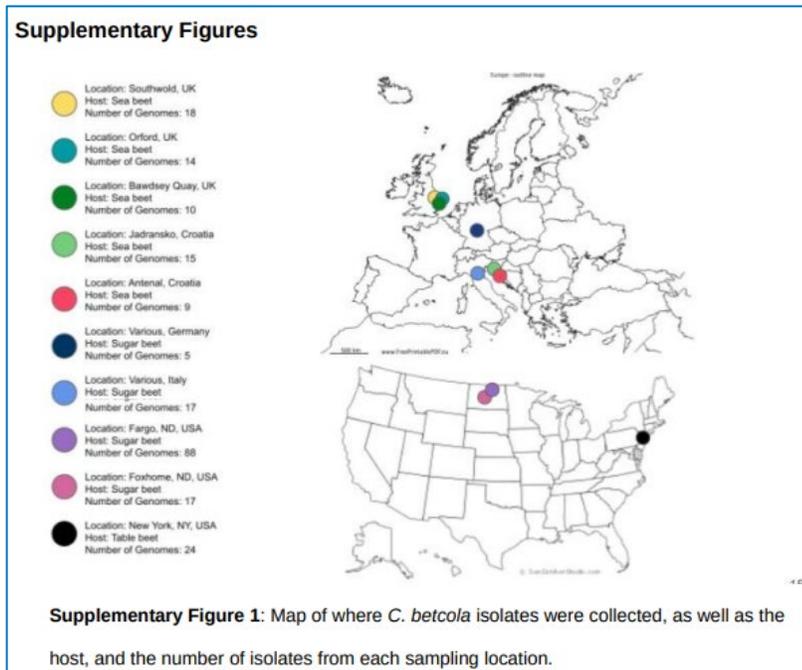
Alternaria leaf spot

- Caused by *Alternaria* spp
- Increase of importance in some regions in US
- +15-21°C, high humidity
- Broad host range
- Circular or irregular necrotic spots that merge
- Dead leaves



Genetic diversity amongst *Cercospora beticola* strains has been extensively studied

High levels of strains admixture in *Cercospora beticola*, while capacity for host specialization remains unclear



- *Cercospora beticola* isolates show a **high levels of admixture**, and that these exist in a global population that experiences substantial gene flow
- Clusters of *Cercospora beticola* exist that are **not strongly associated with either host or location**.
- Genomic regions that indicate some **differentiation between individual genes exist**
- Such genes are likely important in the fungus's biology, and may be regions **involved in future evolution and host specialization**

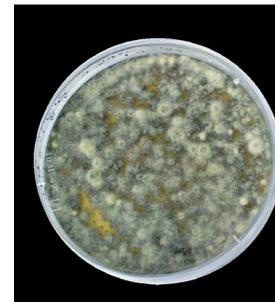
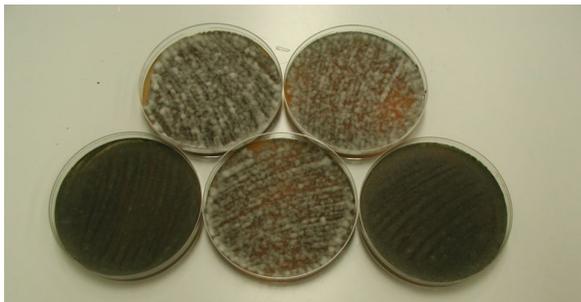
Source: Potgieter *et al.*, 2021



Cercospora beticola isolate analysis to describe genetic and phenotypic diversity

Besides molecular markers/sequence analysis, phenotypic observations such as sporulation, fungicide resistance and aggressiveness test are useful tools to categorize isolates.

- *Cercospora beticola* species isolated from sugar beet leaves checked by **molecular markers** in specific genomic regions
- Whole **genome sequencing**
- **Fungicide resistance** monitored by PCR/qPCR or by plating tests (ref Melvin B's lab).
- Studies of **sporulation** of different isolates
- Analysis of **aggressiveness**
- **Visual** observations

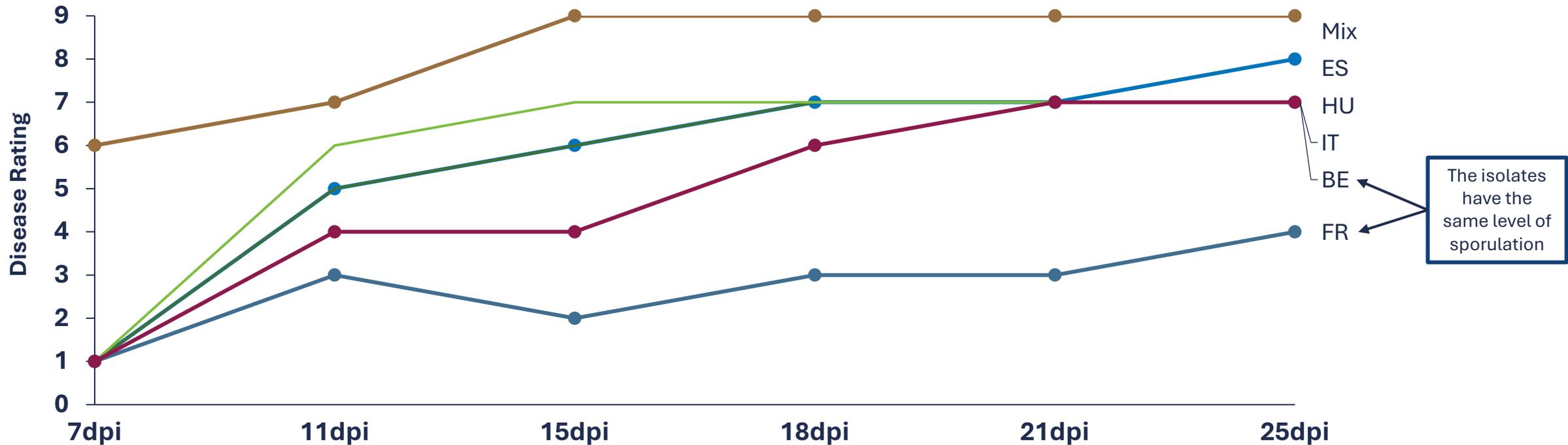


Source: UBS Research



Cercospora beticola aggressiveness study

In a greenhouse study *Cercospora beticola* isolates differ in their aggressiveness depending on the origin of the isolate.

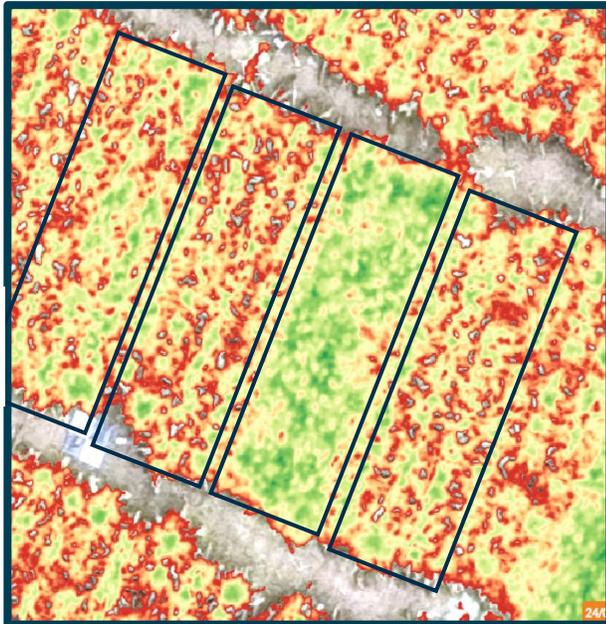


Source: UBS Research



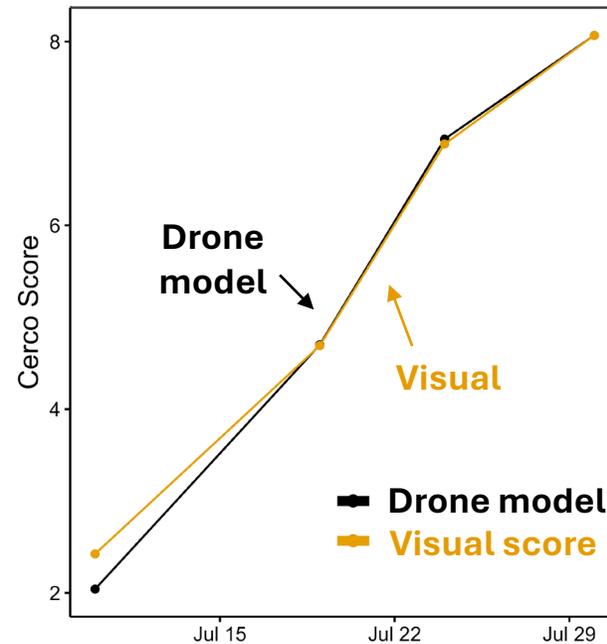
Scoring Cercospora field trials by drone

Cercospora drone model



Source: UBS Research

Disease progression



- **High correlation** between drone and visual scoring.
- By using drones for frequent scoring of field trials, the evaluation is **efficient**, and important differences can be observed between genetics.



Multi- vs monogenic resistance breeding: advantages and disadvantages to be carefully evaluated

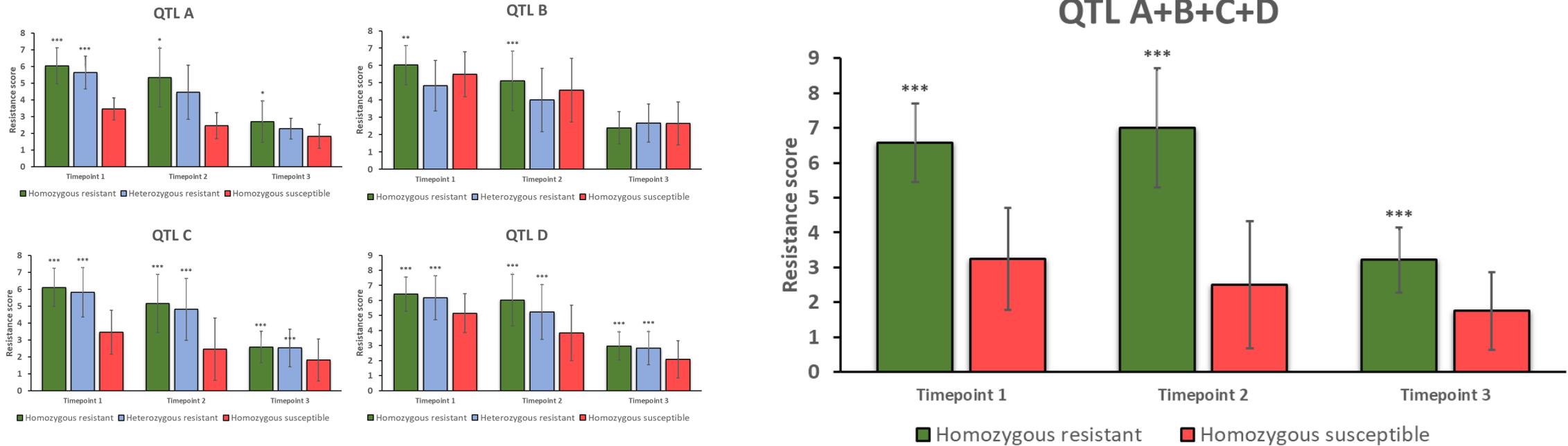
Decreased availability of plant protection products and increased occurrence of pests & diseases favor more durable varietal solutions despite the higher cost and complexity.

	Monogenic	Multigenic	
Effect Size			Full/partial resistance
Type of resistance			Horizontal/vertical resistance
Durability			Time until resistance is overcome
Breeding complexity			Number of genes to be stacked
Cost			Directly related to breeding complexity



Several resistance gene loci have been identified each contributing to the overall resistance

While each single locus has a relatively small contribution, their combination/stacking provides very good and durable field resistance.

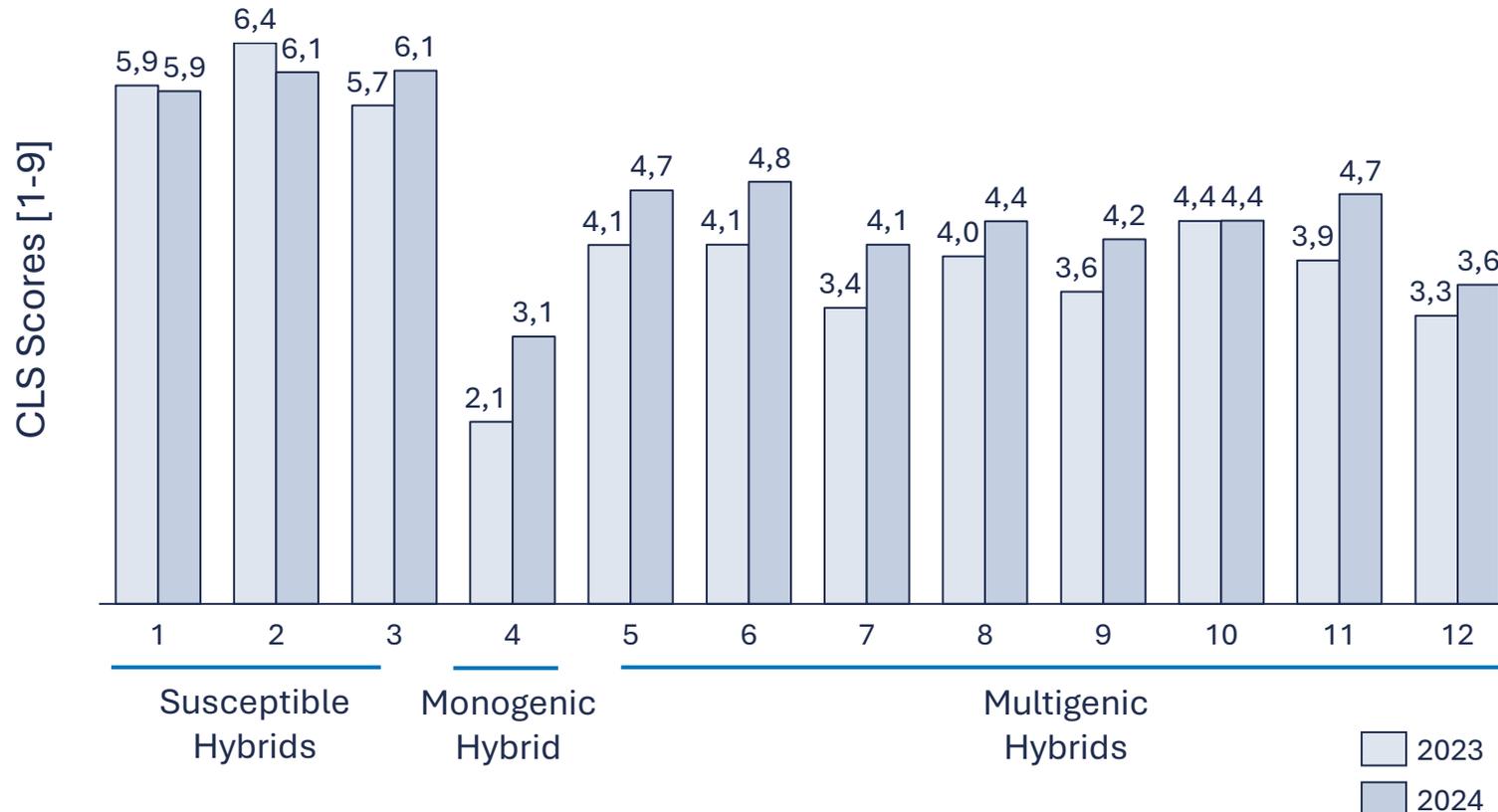


Source: UBS Research (field data)



Varieties with multigenic sources of resistance are less likely to suffer from resistance breaking CLS strains

Cercospora field trials in Central Europe carried out by UBS in 2023 and 2024



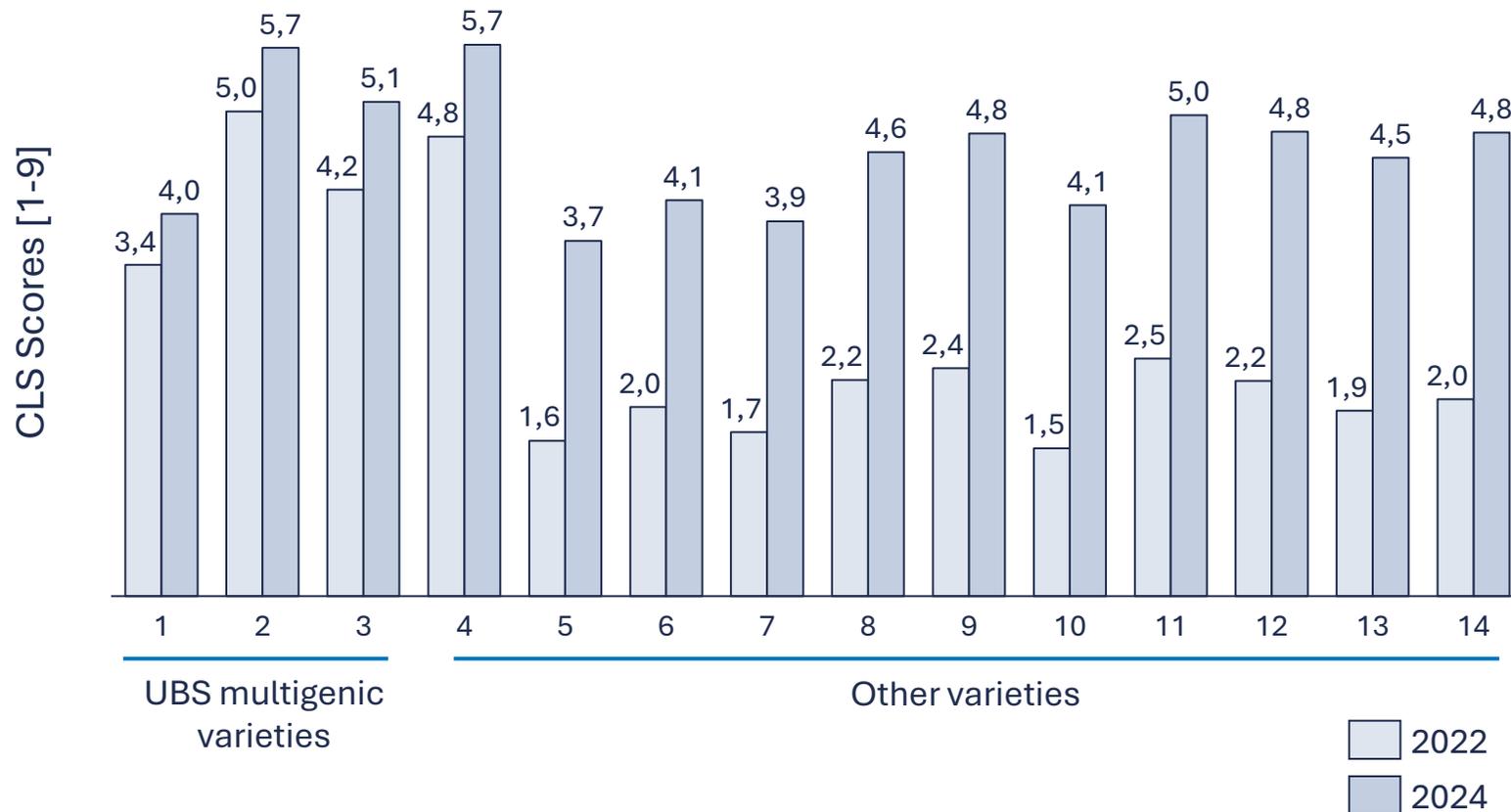
- Generally higher CLS score in 2024 vs 2023
- Susceptible hybrids with stable, but high scores (#1-3)
- Monogenic hybrid (#4) with increased score
- Multigenic hybrids with increased or stable scores

Source: UBS proprietary field trials CE



Varieties with multigenic sources of resistance are less likely to suffer from resistance breaking CLS strains

Cercospora field trials at Michigan Sugar Company in 2022 and 2024



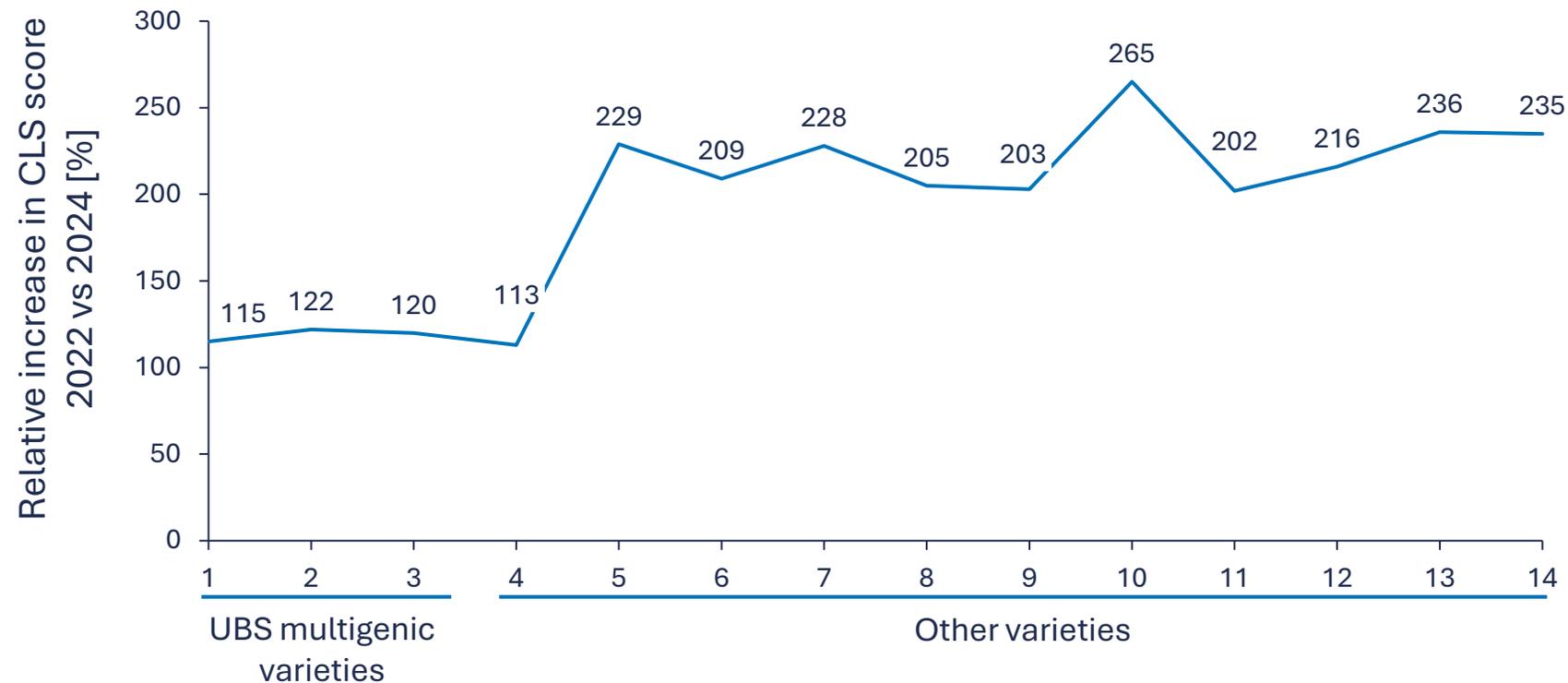
- Generally higher CLS score in 2024 vs 2022
- Strong increase in CLS in formerly very tolerant varieties (#5-14)
- UBS multigenic varieties (#1-3) show only small increase in CLS score

Source: Michigan Sugar Company (2022, 2024)



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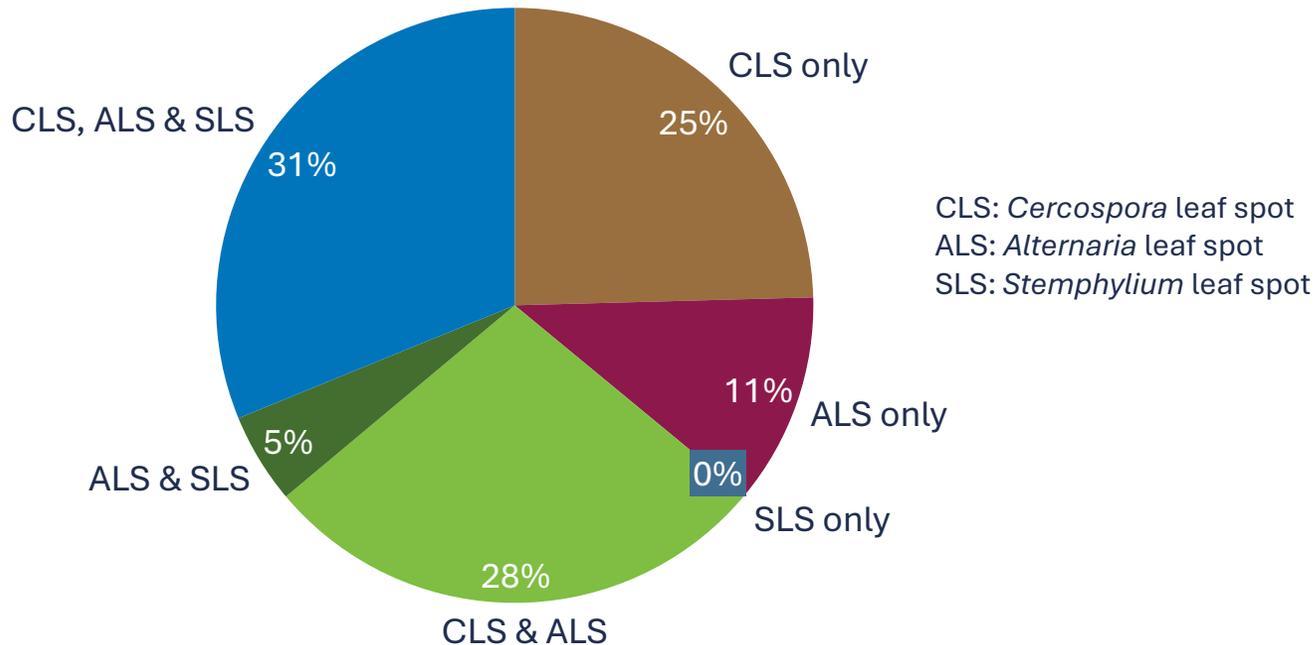
- Strong increase in CLS in formerly very tolerant varieties (#5-14) >200%
- UBS multigenic varieties (#1-3) show only small increase in CLS score <122%

Source: Michigan Sugar Company (2022, 2024)



Increased number of samples show presence of *Alternaria ssp*

Alternaria & Cercospora are difficult to distinguish by visual scores, but molecular analysis reveal an increasing presence of Alternaria in samples collected.

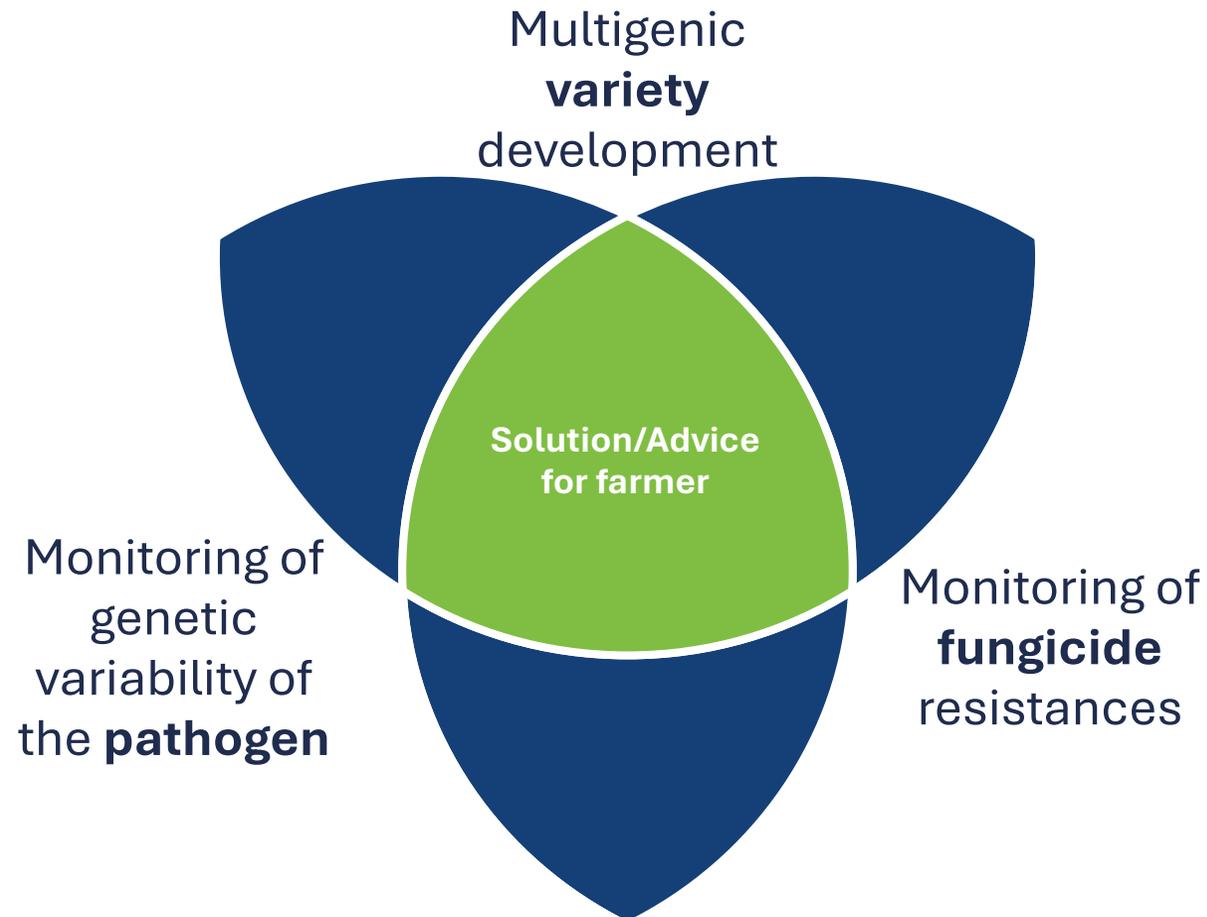


Source: University of Minnesota Sugar Beet Diagnostic lab samples 2024; Ashok Chanda – not representative for MN & ND growing regions.



Integrated pest management requires a combination of targeted monitoring & variety development

Beside the variety, information about fungicide and pathogen are crucial to provide farmers with the most optimal solution.



Conclusion & take-home message

Many factors contribute to successful control of *Cercospora* leaf spot.

- Internal tests have shown that there is considerable **variation between *Cercospora beticola* isolates** and there are differences in aggressiveness
- **Multigenic** *Cercospora* resistance is stable in resistance level over the years
- **UBS germplasm pool** combines a wide range of resistance sources against leaf diseases
- **Integrated pest management** (variety, fungicide and isolate monitoring) required to control *Cercospora* leaf spot in the future





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