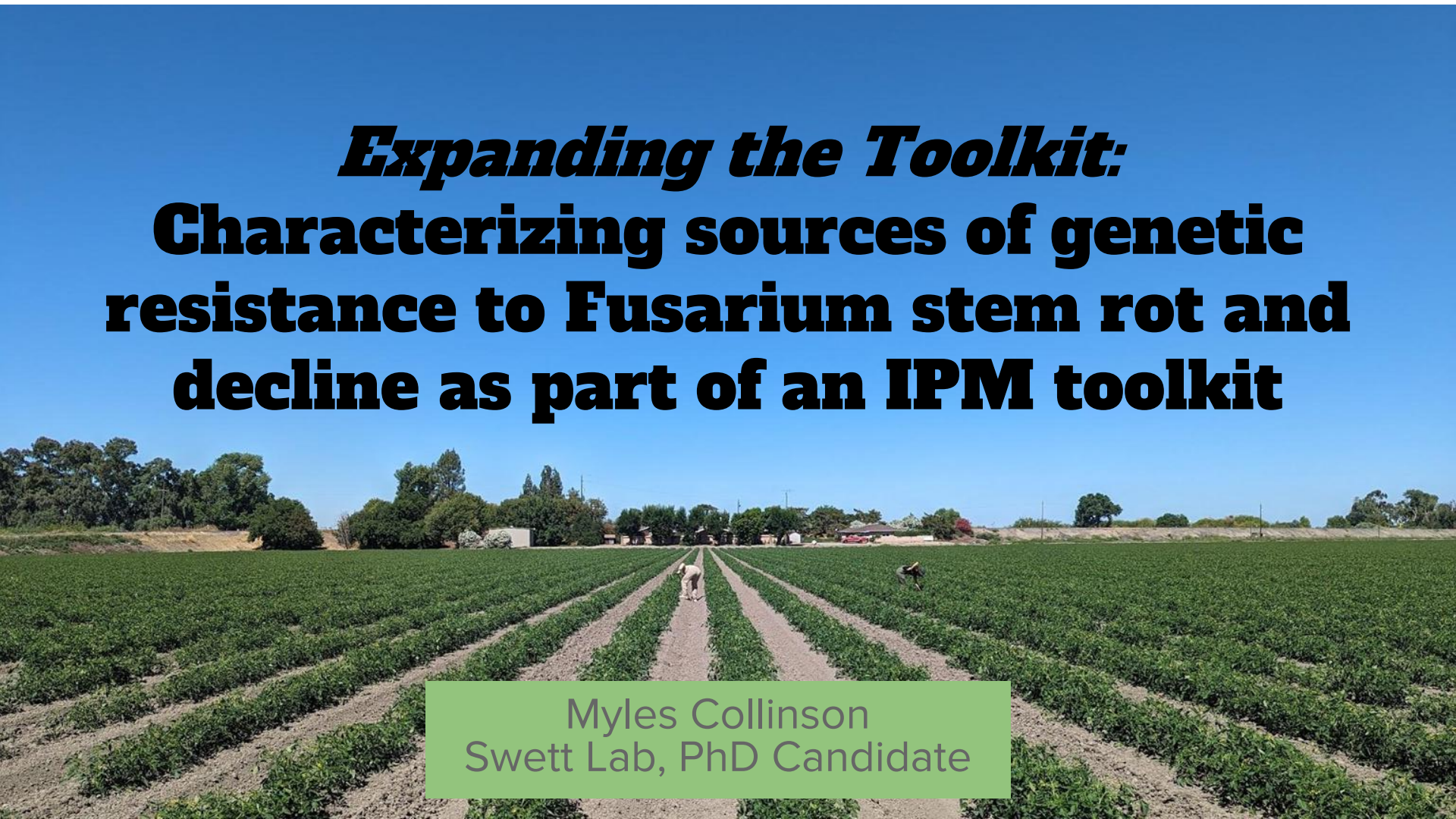
Expanding the Toolkit: Characterizing sources of genetic resistance to Fusarium stem rot and decline as part of an IPM toolkit



Myles Collinson
Swett Lab, PhD Candidate

Fusarium Stem Rot and Decline (FRD) in Processing tomato

>Driven by *F. noneumartii* and *F. martii* (soilborne pathogens)

>Causes foot, crown, and stem rot, and severe canopy chlorosis, necrosis, and collapse

>Premature vine decline leads to fruit exposure and fruit damage

>In controlled trials, up to 90% plant mortality at harvest and over 25% reduction in marketable fruit (depending on cultivar)

>FRD was identified as an issue in ~2017, no established management tools existed

FRD

F. noneumartii

F. martii

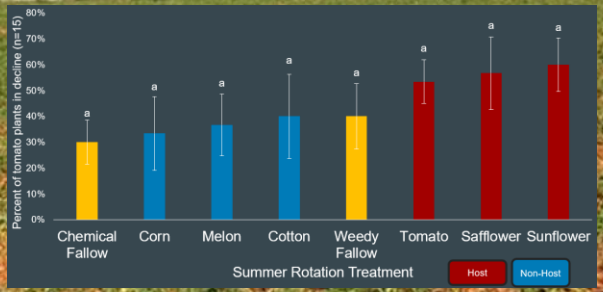
Main Goal: Develop and effective integrated toolkit for FRD in processing tomato

Treatment and rate /A	Total rot incidence (%) [z]	Crown rot incidence (%)	AG stem rot incidence (%) [y]	Total fruit (t/A)	Marketable red fruit (%) [x]	Damaged fruit (%) [w]	Microbial activity (µg/g soil) [v]
K-Pam HL 10 gal	72.5 *a* [u]	40.0 *a*	2.5 *a*	46.6 *ab*	95.2 *a*	2.3 *a*	0.82 *a*
K-Pam HL 15 gal	80.0 *a*	31.3 *a*	10.0 *a*	51.0 *a*	93.7 *a*	2.0 *a*	0.90 *a*
K-Pam HL 20 gal	78.8 *a*	36.3 *a*	10.0 *a*	46.7 *ab*	95.3 *a*	2.7 *a*	0.99 *a*
Untreated control (water)	72.5 *a*	50.0 *a*	1.3 *a*	38.0 *b*	94.4 *a*	1.9 *a*	0.76 *a*

Treatment and amount/A	Total rot incidence (%) [z]	Crown rot incidence (%)	AG stem rot incidence (%) [y]	Total fruit (t/A)	Marketable red fruit (%) [x]	Damaged fruit (%) [w]
Miravis 13.7 fl oz	43.9 *negl* [v]	5.9 *med*	2.2 *small*	46.9 *small*	60.5 *negl*	29.1 *negl*
Propulse 13.7 fl oz	35.1 *small*	6.7 *med*	0.0 *large*	44.9 *negl*	53.8 *large*	29.4 *small*
Velum One 6.84 fl oz [u]	16.2 *large*	5.3 *med*	0.0 *large*	41.8 *small*	60.6 *negl*	29.5 *small*
Untreated control (water) [u]	46.9	23.3	10.0	43.8	61.8	26.8

FRD Integrated Toolkit

- Fungicides
- Cultivar Genetics
- Optimized Rotations
- FRD Outreach



Reduce Yield Losses

Main Goal: Develop and effective integrated toolkit for FRD in processing tomato

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Treatment and amount/A	Total rot incidence (%) [t]	Crown rot incidence (%)	AG stem rot incidence (%) [s]	Total fruit (t/A)	Marketable red fruit (%) [s]	Damaged fruit (%) [w]
Miravis 13.7 fl oz	43.9 *negl* [r]	5.9 *med*	2.2 *small*	46.9 *small*	60.5 *negl*	29.1 *negl*
Propulse 13.7 fl oz	35.1 *small*	6.7 *med*	0.0 *large*	44.9 *negl*	53.8 *large*	29.4 *small*
Velum One 6.84 fl oz [q]	16.2 *large*	5.3 *med*	0.0 *large*	41.8 *small*	60.6 *negl*	29.5 *small*
Untreated control (water) [p]	46.9	23.3	10.0	43.8	61.8	26.8

FRD Integrated Toolkit

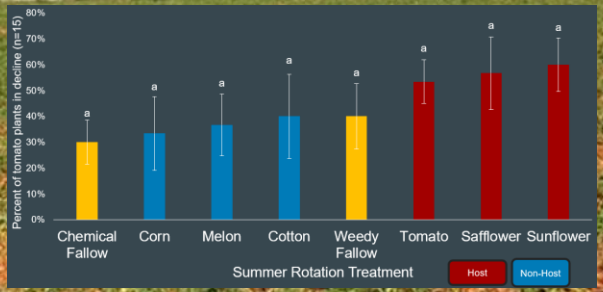
Cultivar Genetics

Fungicides

Optimized Rotations

FRD Outreach

Reduce Yield Losses



Goals for FRD cultivar resistance/tolerance

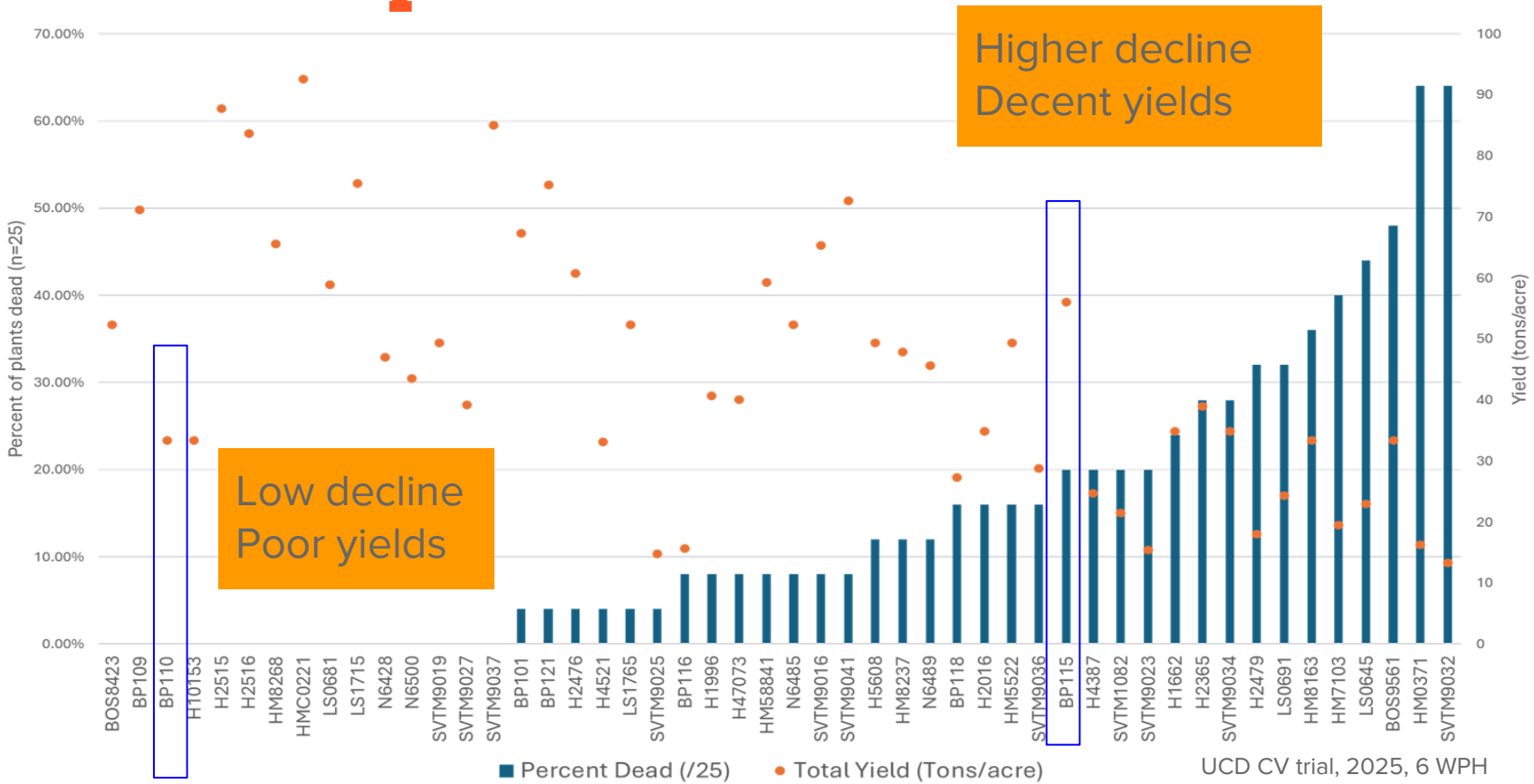
>Managing FRD with existing cultivars already availaible (qualitative resistance): What commerically available traits are connected to:

>Tolerance to fruit impacts

>Reduced suceptiblity to vine decline/stem rot

>New sources of complete resistance (quantitative resistance) or reduced suceptibility

Cultivars vary in FRD susceptibility/tolerance and fruit impacts



UCD CV trial, 2025, 6 WPH

Fruit holding traits (extended field holding) and tolerance to FRD

>Extended field holding (also called extend field storage, EFS) is a fruit trait that slows fruit degradation after ripening

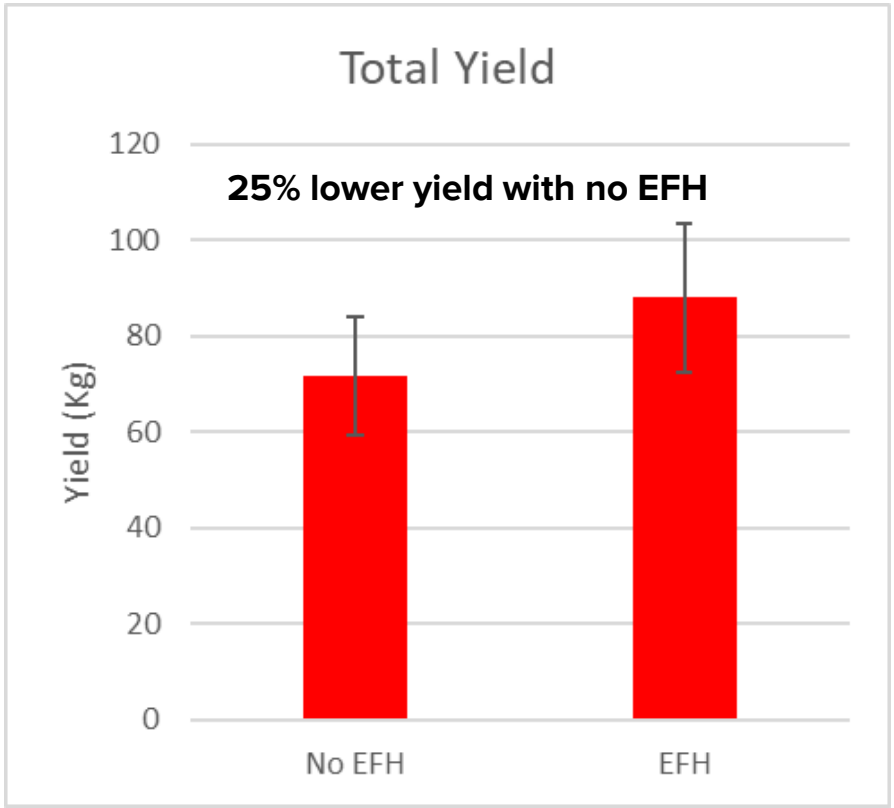
>EFH controls the biosynthesis or action of ethylene gas

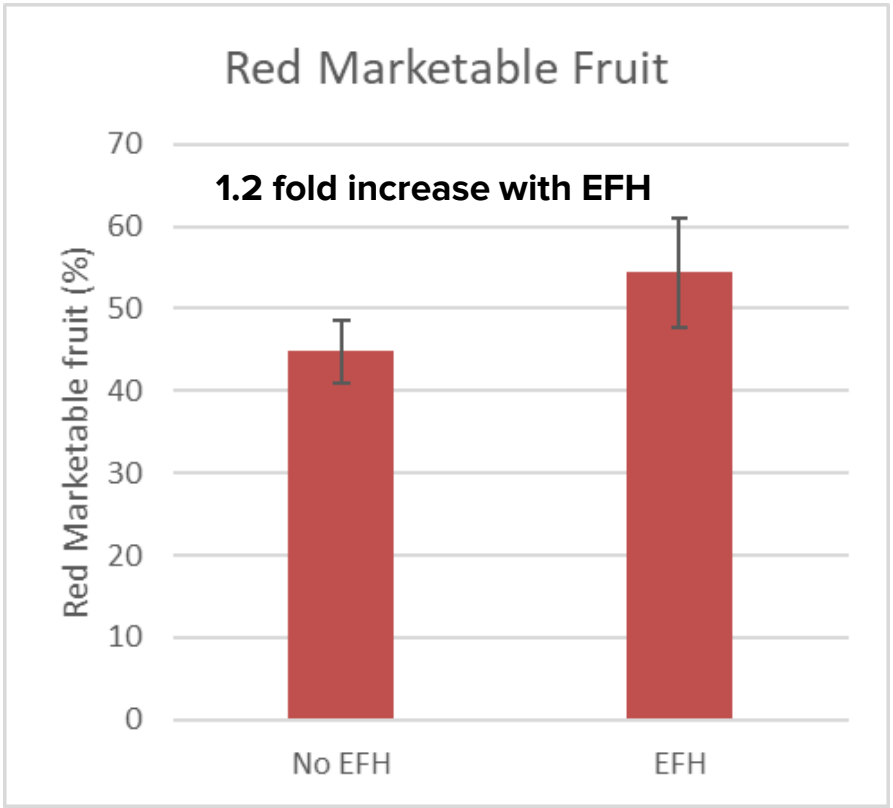
>FRD impacts yield by causing canopy collapse, exposing the fruit to the sun prematurely, leading to fruit damage

>If EFH slows fruit degradation, could it slow fruit damage after premature exposure?

https://www.researchgate.net/profile/Itodo-Adams/publication/330730392_A_Review_on_Postharvest_Storage_Processing_and_Preservation_of_Tomatoes_Lycopersicon_esculentum_Mill/links/62dfa8ec4246456b55e8184b/A-Review-on-Postharvest-Storage-Processing-and-Preservation-of-Tomatoes-Lycopersicon-esculentum-Mill.pdf

Preliminary data: EFH and FRD disease

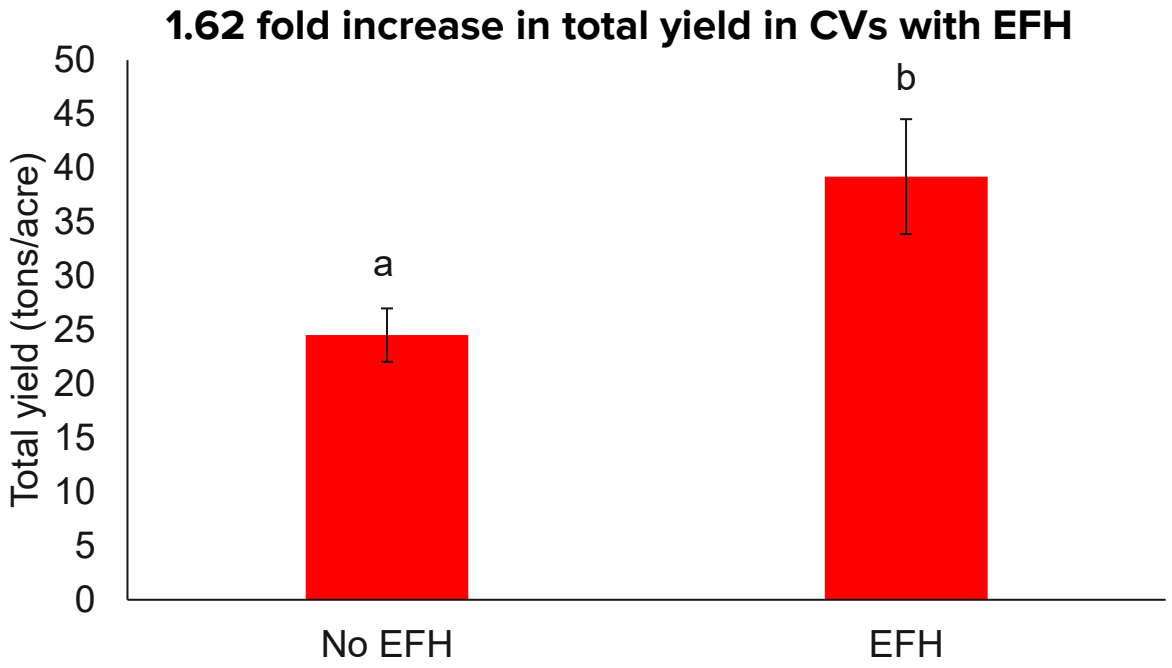




Data from 2021 cultivar trial, Swett

EFH 2024 Trial - Results

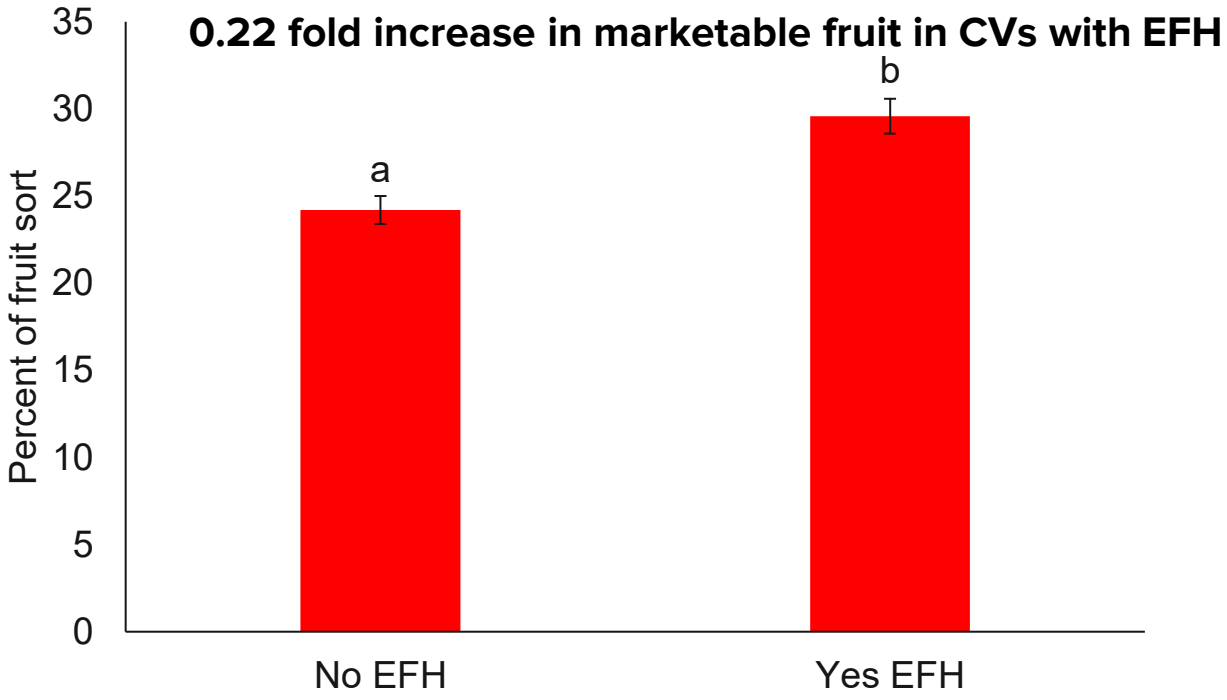
>Total yield data in cultivars grouped by the percent of plants dead and toast (same grouping at time point 1,2)



Fishers, P = 0.028

EFH 2025 Trial - Results

>Marketable red fruit data in cultivars grouped by the percent of plants advanced decline, dead, and toast (time point 2)



Fishers, $P < 0.001$

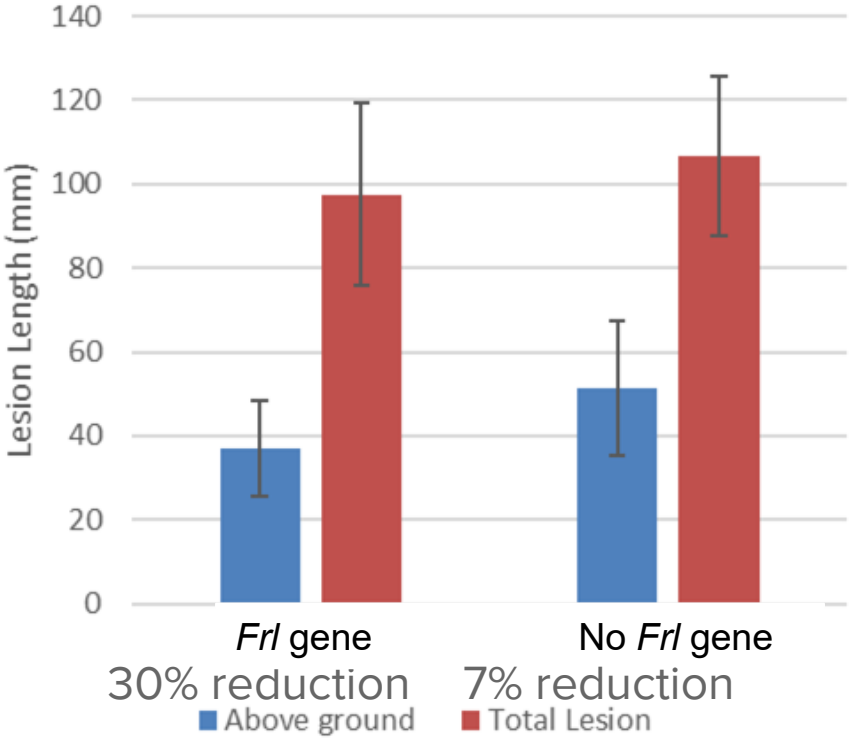
Is there cross resistance from other disease resistance traits?

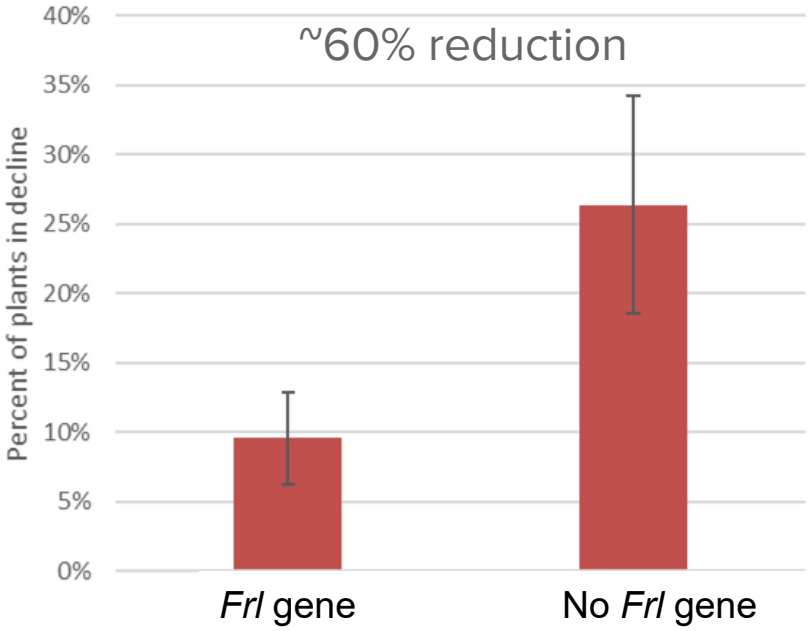
>There are many other traits in processing tomato cultivars, including disease resistance traits

>Could any of these disease resistance traits have cross resistance for FRD?

>Fusarium crown and root rot (FORL) is caused by a Fusarium necrotrophic pathogen that might have similar resistance pathways to FRD → *Frl* gene

Frl gene - Preliminary Data



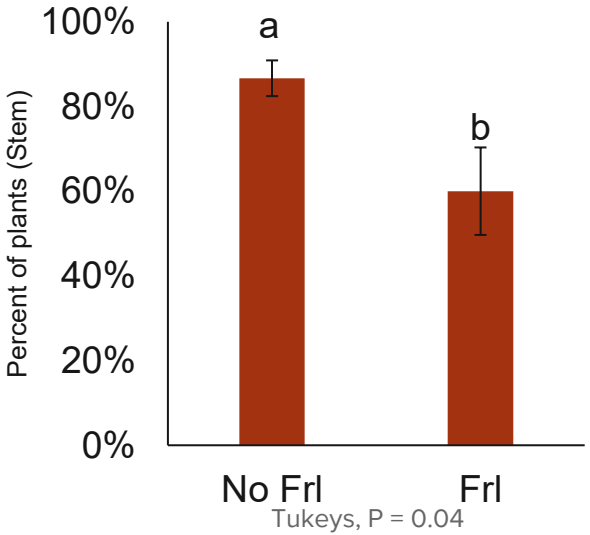


Swett 2021 CV trial

2024 *Frl gene* trial - Results

30% reduction

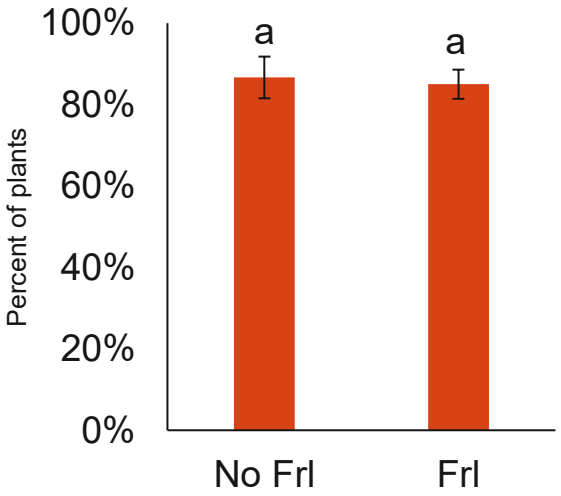
Frl and Stem rot



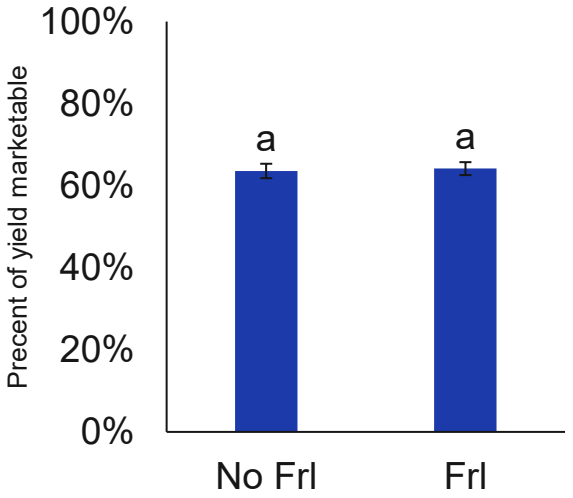
Tukeys, P = 0.04

No differences

Plant death and decline



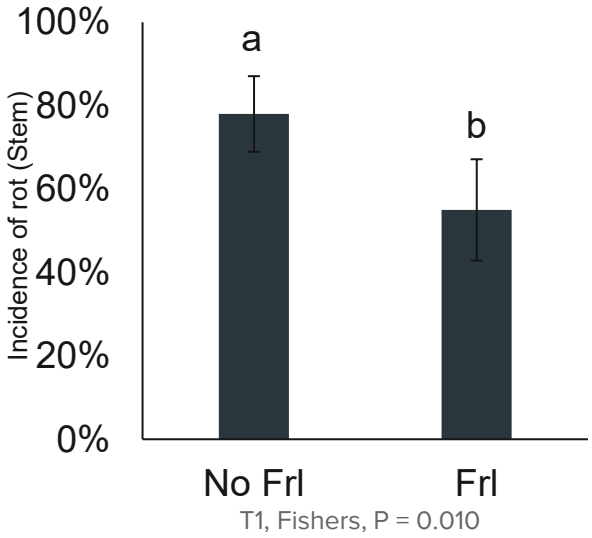
Marketable yield



2025 *Frl gene* trial - Results

42% reduction

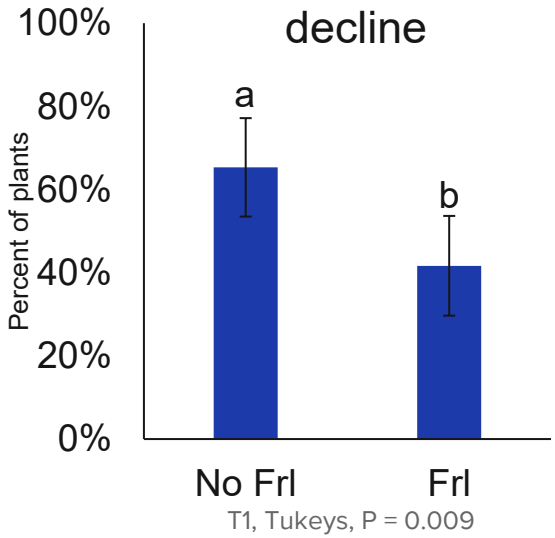
Frl and Stem rot



T1, Fishers, P = 0.010

36% reduction

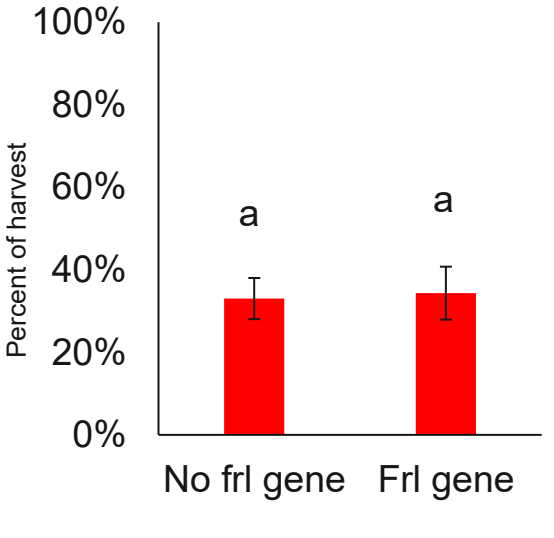
Plant death and decline



T1, Tukeys, P = 0.009

Negligible differences

Marketable red fruit



Summary: Traits correlated with cultivar tolerance

>EFH – Cultivars with EFH had increased marketable fruit levels

>*Frl* gene – Cultivars with the *Frl* gene had lower incidence of stem rot and sometimes vine decline, but not fruit damage

Caveats

>There are two different types of EFH, may have different impacts on FRD associated fruit damage

>There are two *Frl* alleles, one is more effective than the other and may affect FRD stem rot differently

Where can we find novel genetic resistance traits?

>Many genetic resistance traits to tomato diseases originated in tomato wild germplasm

>Both single gene and QTLs

>Might there be novel genetic resistance genes for FRD as well?

S. pennellii LA2719 starting to flower. [photo R.T. Chetelat]

Wild species	R gene	Disease
S. pimpinellifolium	*I, I-2 gene*	Fusarium wilt
S. peruvianum	*Frl gene*	Fusarium crown and root rot
S. pennellii	*I-3, I-y gene*	Fusarium wilt

Wild Germplasm Trials

Goals of this work:

>Ideal goal: Find complete resistance

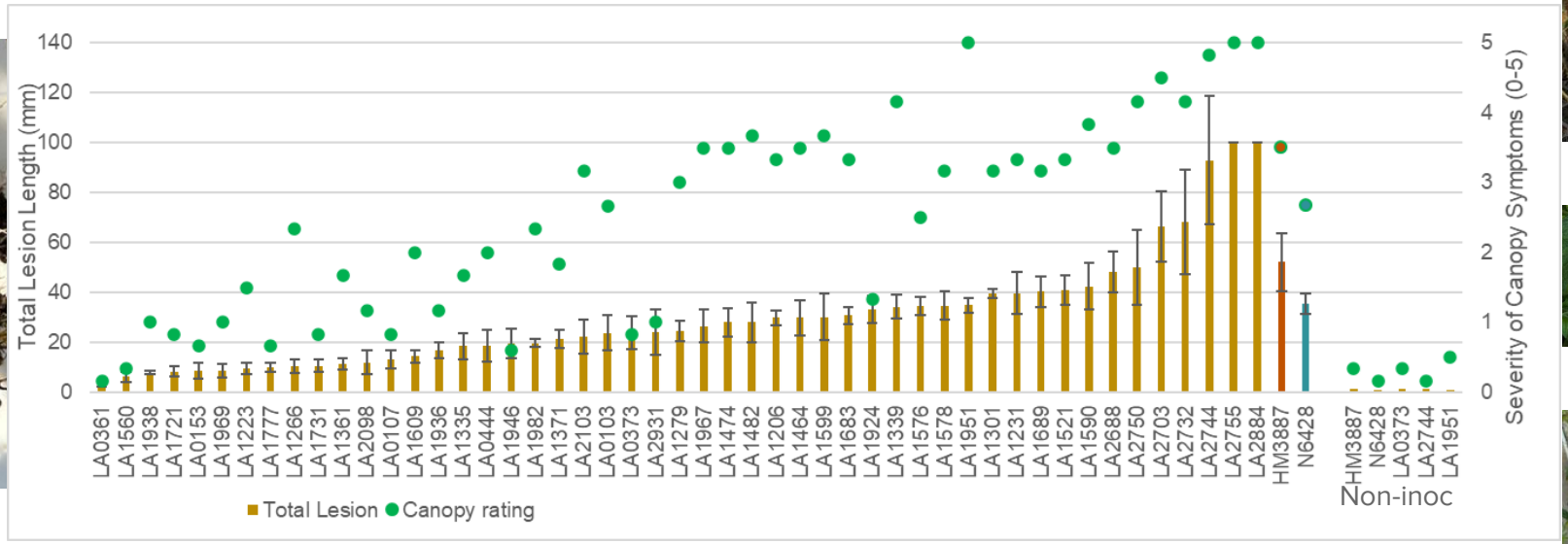
➜ Accession(s) with **no** rot or canopy symptoms

>If this is not possible, minimal goal: find lines that are more resistant

➜ Accession(s) with **less severe** symptoms

Accession: a unique sample of plant material from a single species, collected at a specific time and place, representing a particular gene pool

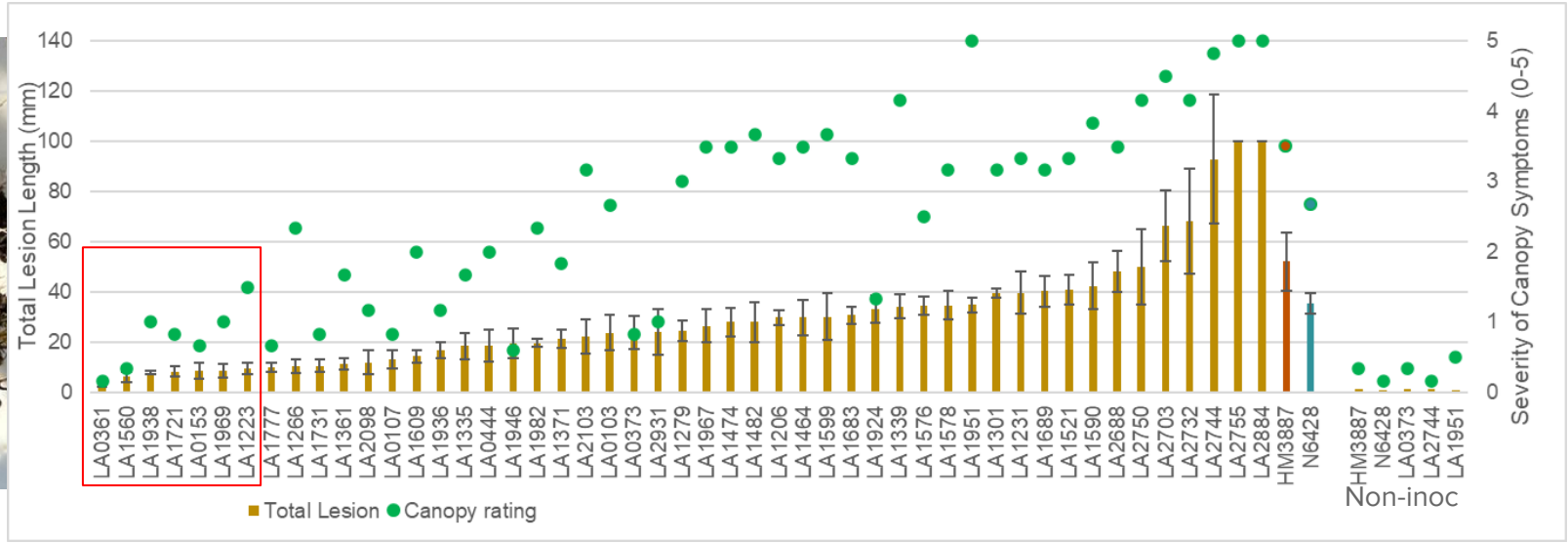
2024-25 Wild Germplasm Trials - Trial 1



Disease scale: 0 = healthy, 1-2 = mild canopy symptoms, 3-4 = decline, 5 = dead

2024-25 Wild Germplasm Trials - Trial 1

Goal 1: Complete resistance?



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2024-25 Wild Germplasm Trials - Trial 1

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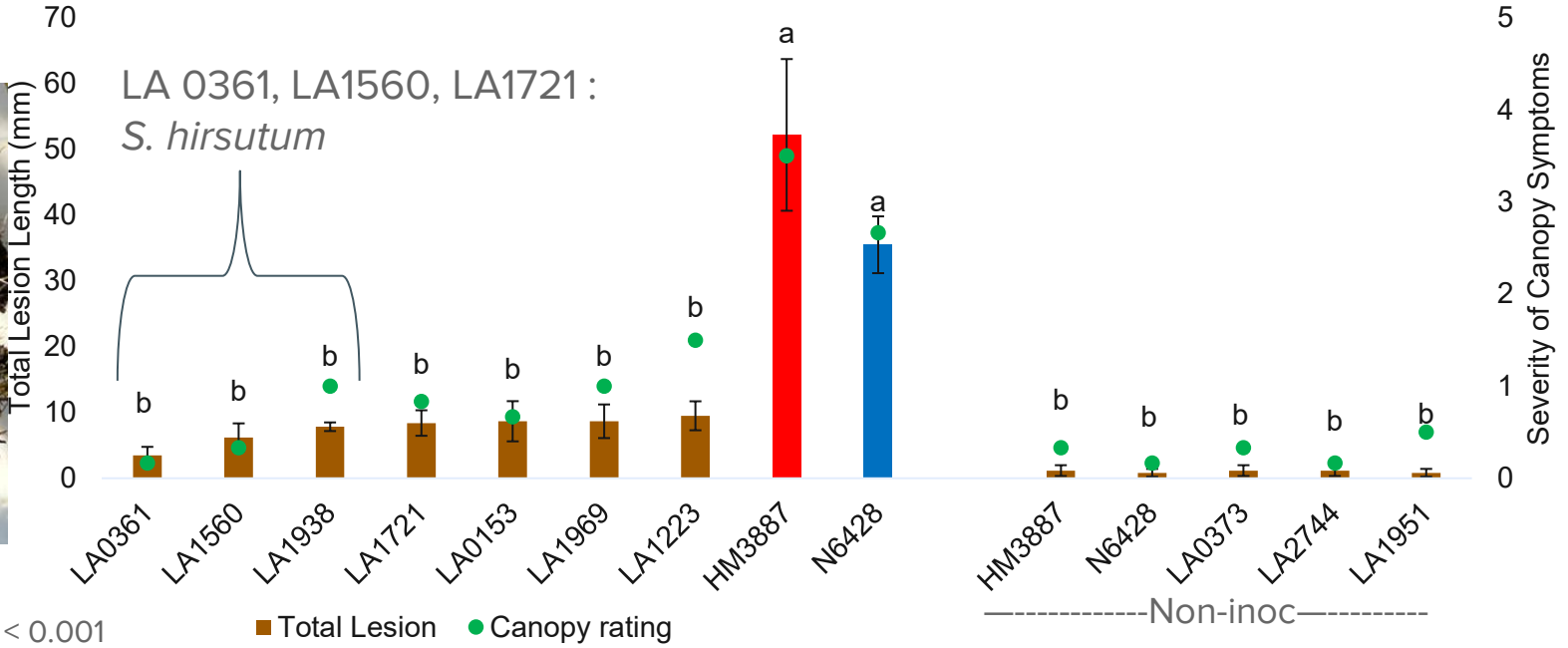
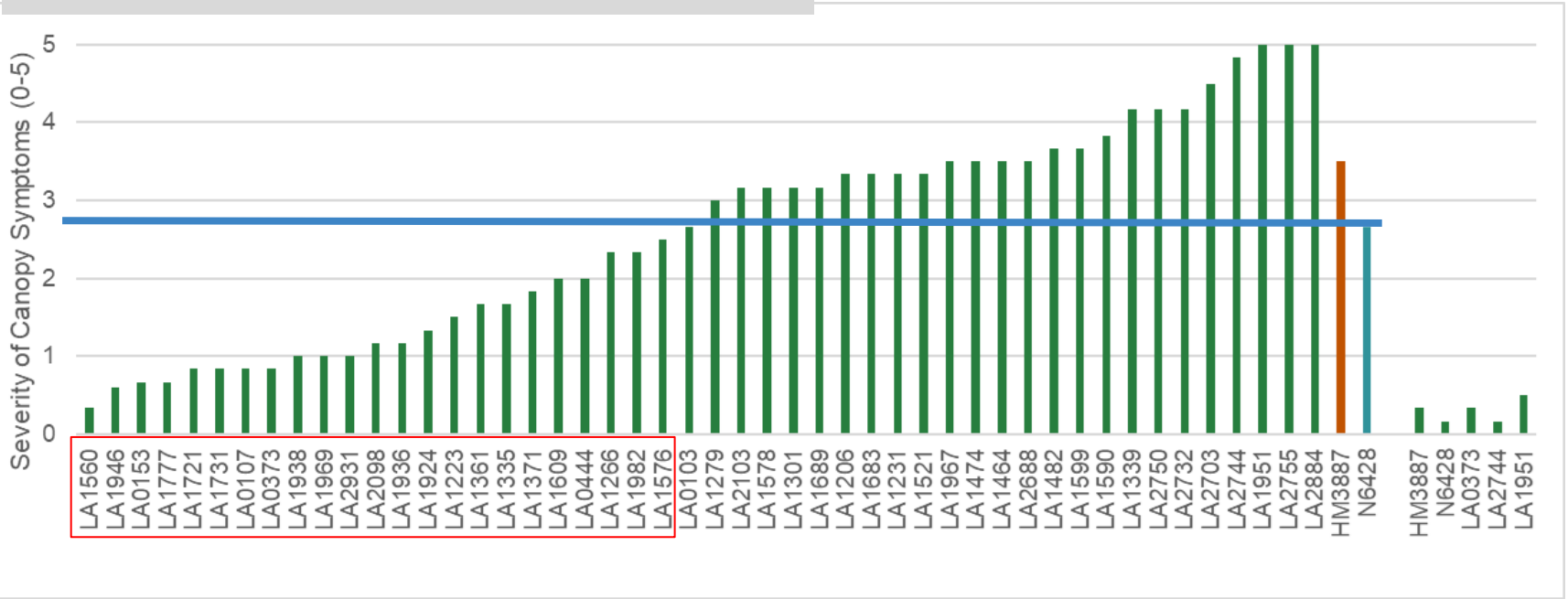


Tukeys, P < 0.001

Disease scale: 0 = healthy, 1-2 = mild canopy symptoms, 3-4 = decline, 5 = dead

2024-25 Wild Germplasm Trials - Trial 1

Goal 2: Reduced susceptibility?



Disease scale: 0 = healthy, 1-2 = mild canopy symptoms, 3-4 = decline, 5 = dead

Wild Germplasm - Next Steps

>Select the best performing acessions for replicated trials with additional commercial checks (better performance than N6428)

>Use initial data to pick the best performing accessions with TGRC isogenic lines

>Screen wild germplasm core collections for FRD resistance

Conclusions

Promising sources of genetic resistance/tolerance to FRD

>EFH - based on current analysis, higher total yields and marketable fruit in cultivars with EFH

>FRL - significant reduction in incidence and severity of foot/stem rot. Inconsistent effect on vine decline, no effect on yield/fruit

>Wild germplasm/novel resistance - LA0361, LA1560 (S. hirsutum) very low disease levels

Thank you! Questions?

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