



VIRUS FREE HOP PLANTS

Plant Health at the Molecular Level – Dr. Ryan Christian



W
S
U

Hops: Botanical Basics



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Dioecious (male and female plants)

Obligate out-crossers, cannot self pollinate.

High level of heterozygosity: Does not come true-to-type from seed!

Must maintain varietal characteristics by vegetative propagation

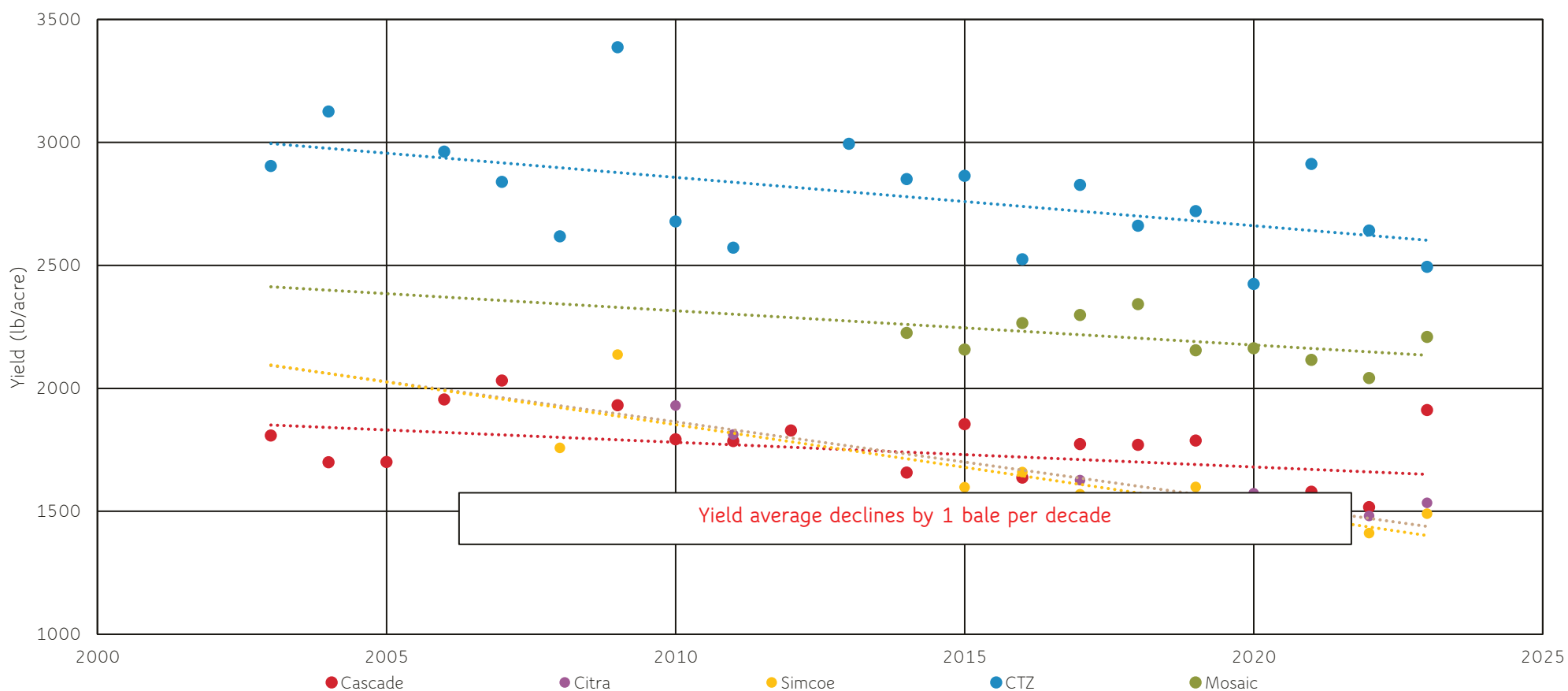


Varieties Decline In Yield as They Expand: Why?



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Yield Decline over Time 2003-2023

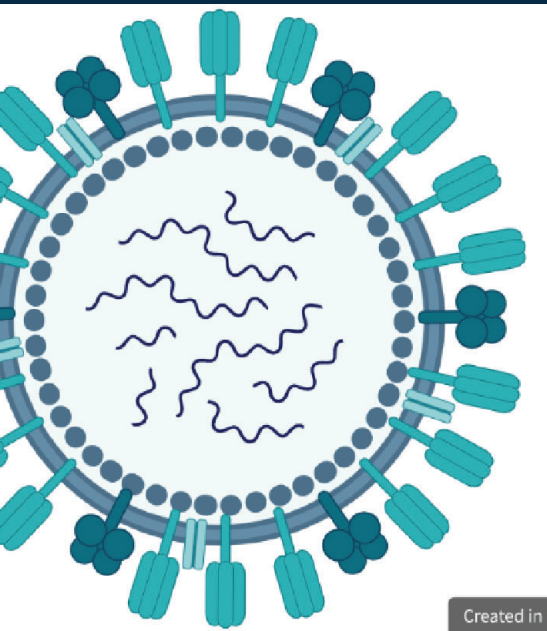


What are Plant Viruses and Viroids?



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SCIENCE

Animal Virus



Created in

Envelope



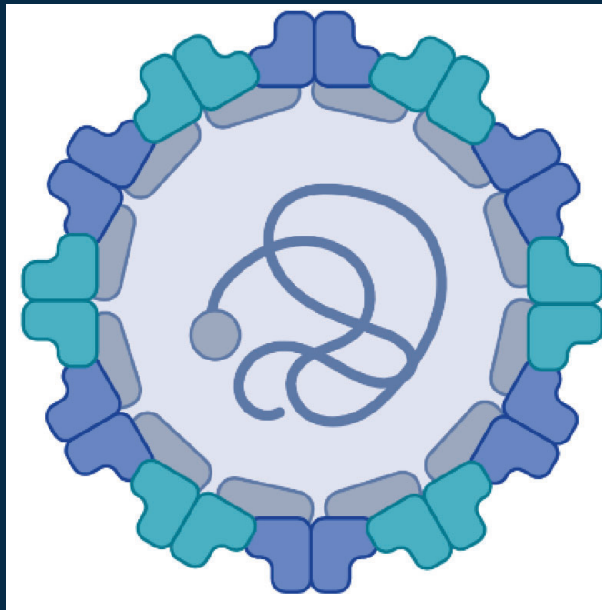
Protein Coat



RNA or DNA



Plant Virus



Lipid Envelope



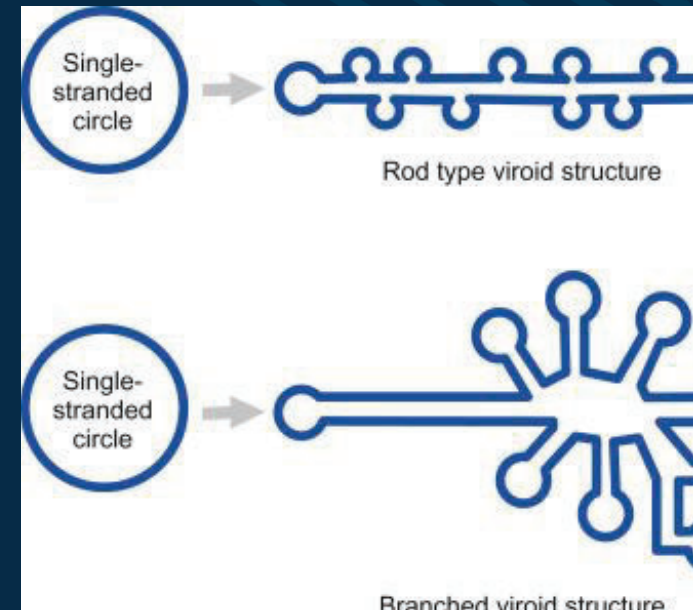
Protein Coat



RNA or DNA



Viroid



Lipid Envelope



Protein Coat



RNA ~~or DNA~~



What are Plant Viruses and Viroids?



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RESEARCH
CENTER



Apple Mosaic Virus on HBC 394 'Citra'

Effects of Virus in 'Cascade'



Negative

ApMV

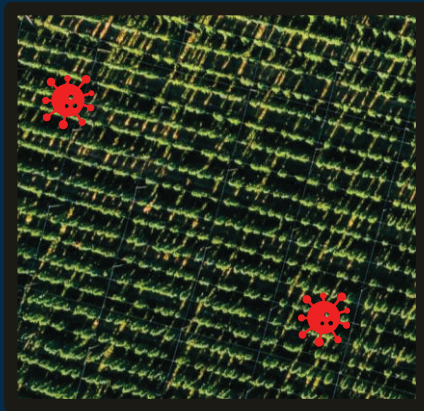
HSVd

Traditional Plant Supply Chain

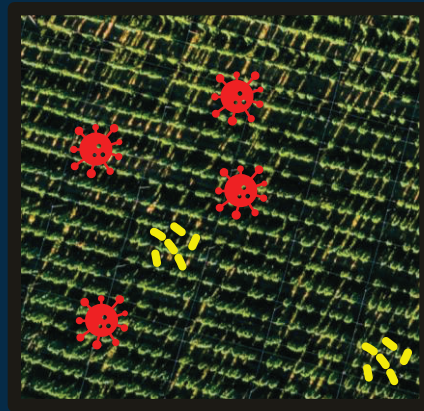
New Variety



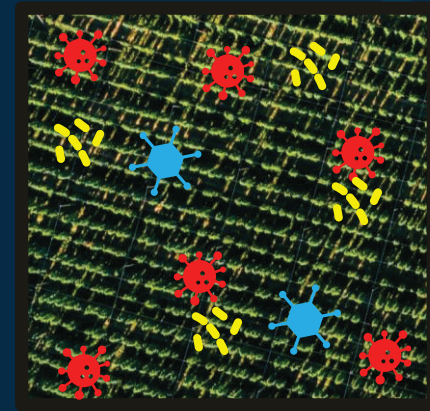
Original Field



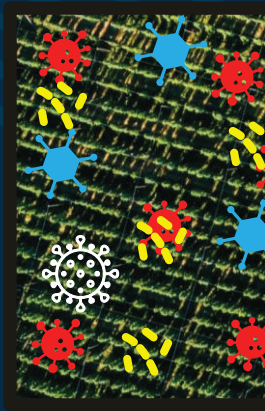
Field A



Field B



Field C

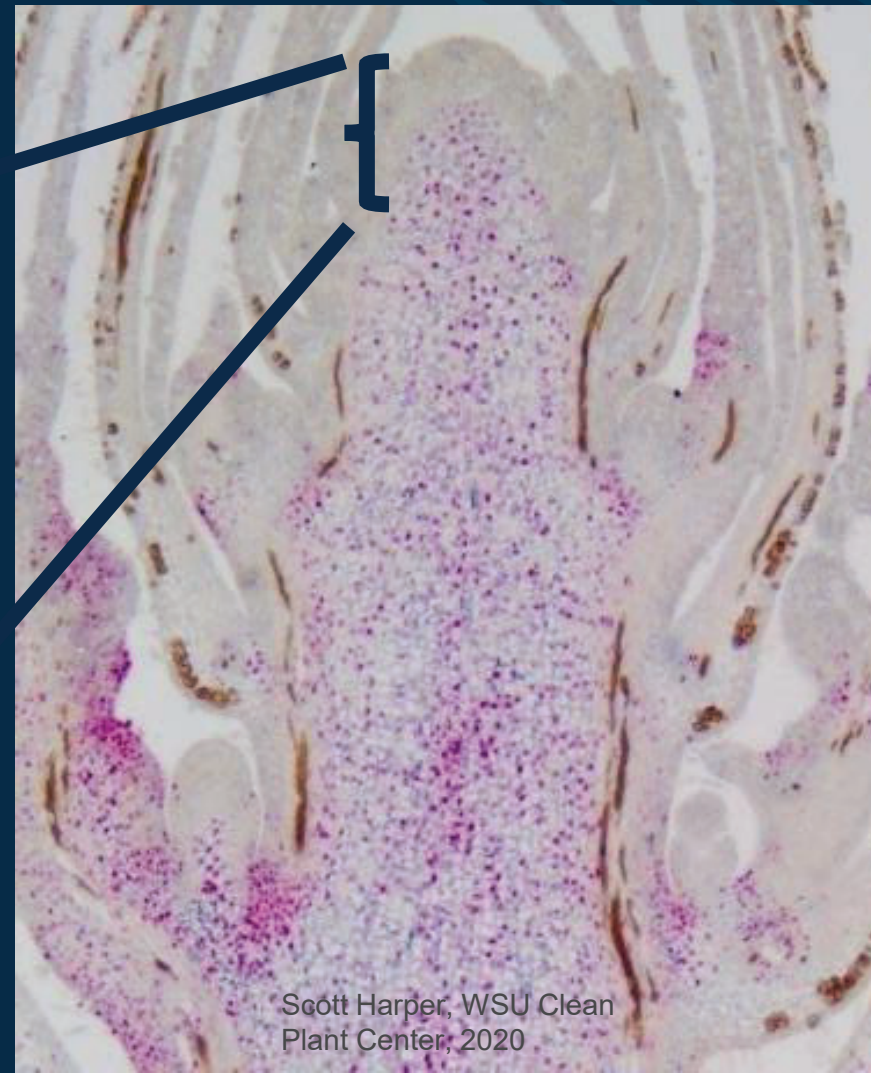
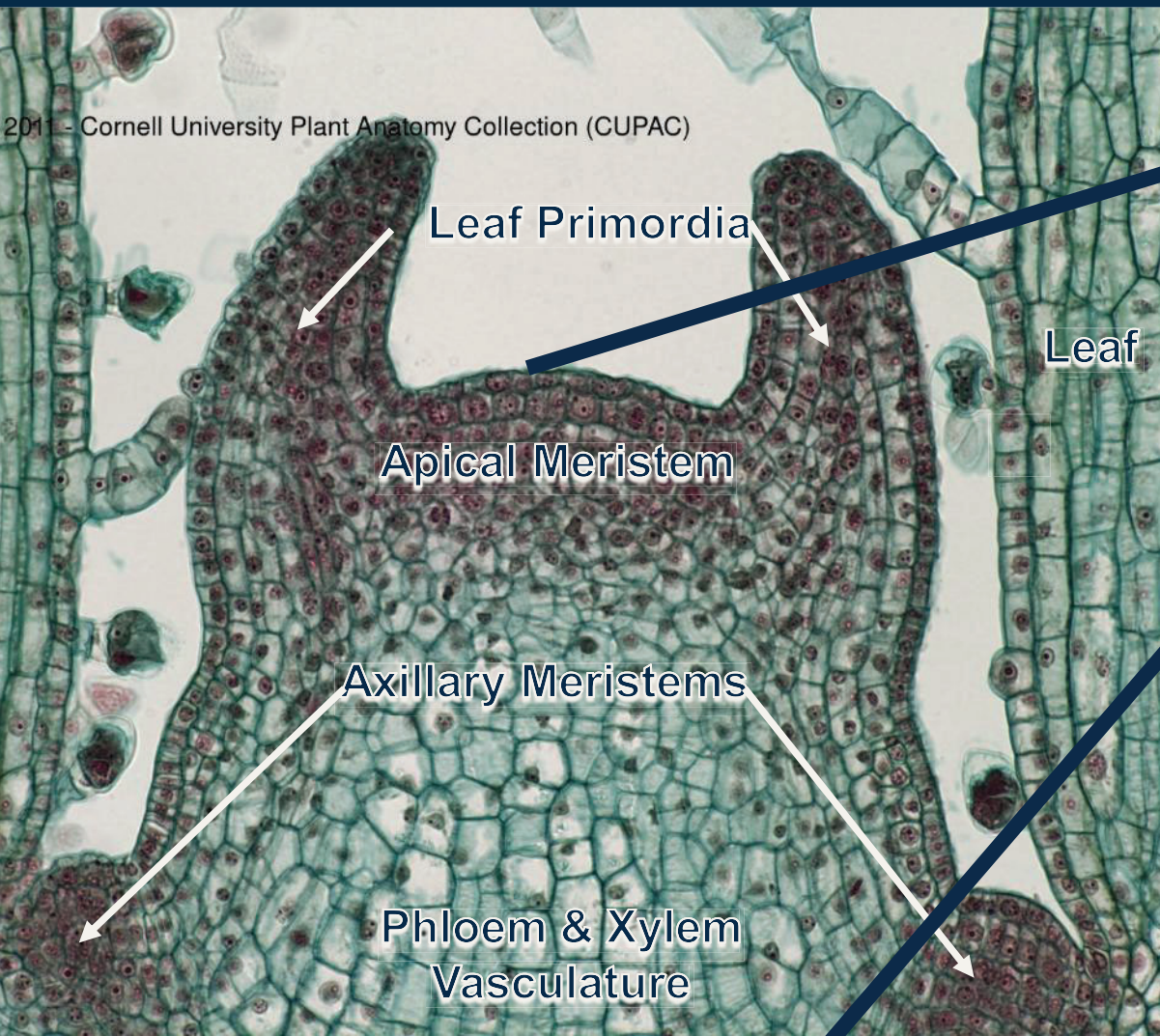


U
S

Meristem Tip Therapy



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Virus-Free Rootstock Timeline

Step 1: Generation of virus free plants (plant therapy), once VF material is produced it is then micropropagated and scaled up. It will then be acclimated to the exterior conditions and sent out to growers.

Step 2: Baby year, planted but little to no production, growth can depend on farm management and location

Step 3: Yield reaches full potential if first year baby plants were planted in the spring, considered "mature".

- If year one plants are planted in the summer or fall, there will be at 75% yield in year two.

Step 4: Late planted material reaches full potential, and OR planted material reaches full production.



Virus Infected
Plant



Generation of
VF Plants



Scaling VF
Material Up



Acclimation of
New Plant
Material



Planted in Fields,
Baby Year



Mature VF
Plants

Step 1: 6 mo-1 yr.

Step 2: 1 yr.

Step 3: 1 yr.

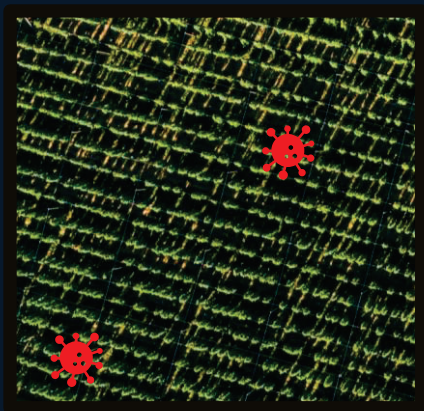
3 Year Process

Modern Plant Supply Chain

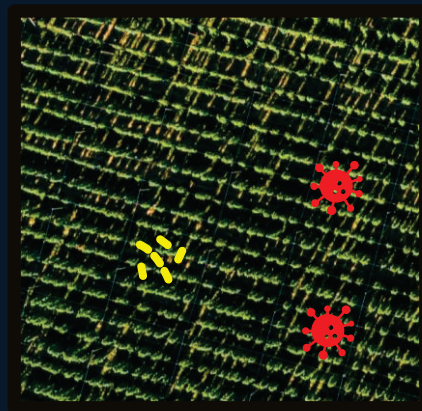
New Variety



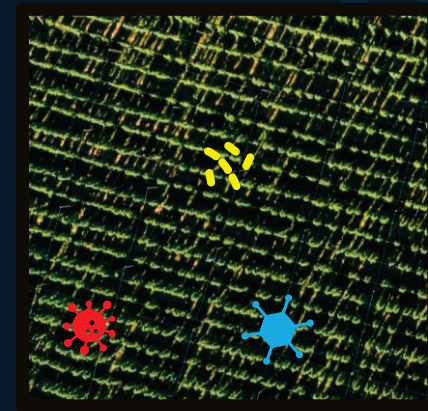
Original Field



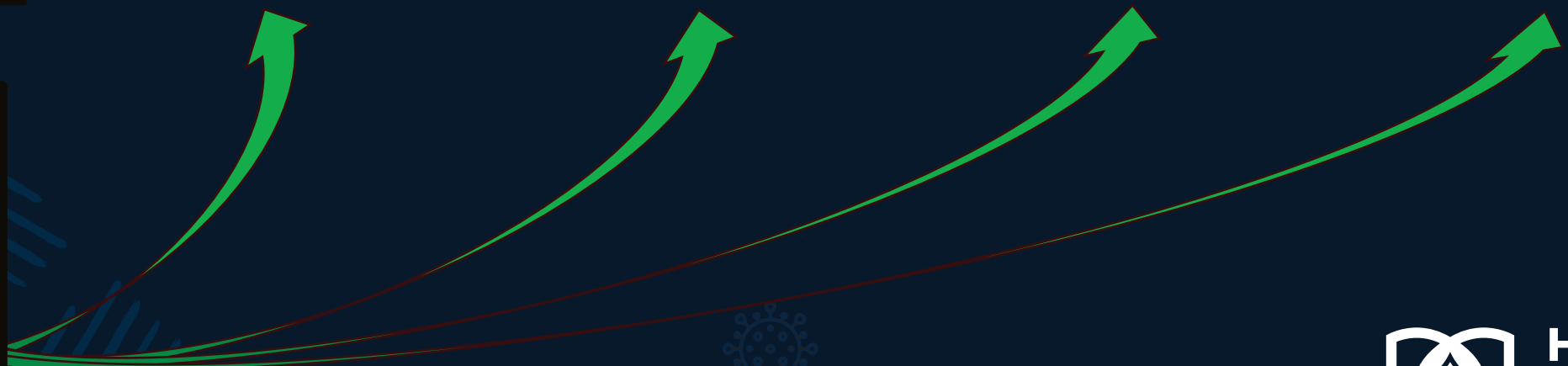
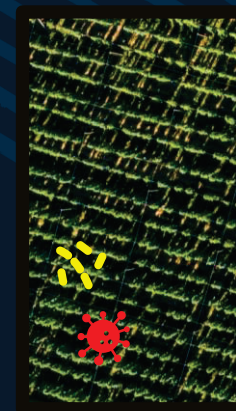
Field A



Field B



Field C



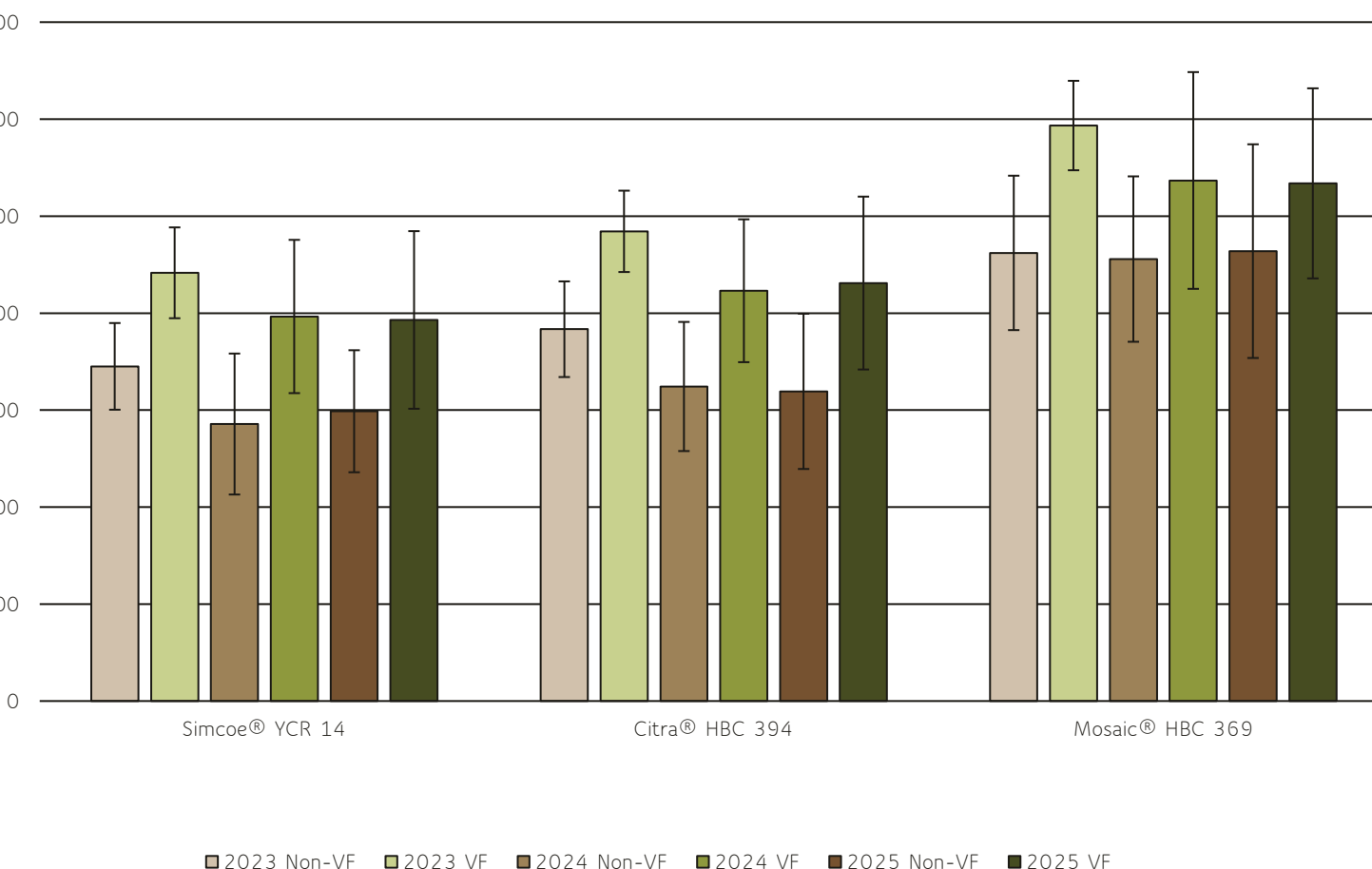
F
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Virus-Free Yield: CY23, CY25



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Yield Variation of Virus-Free and non-VF Fields 2023-2025



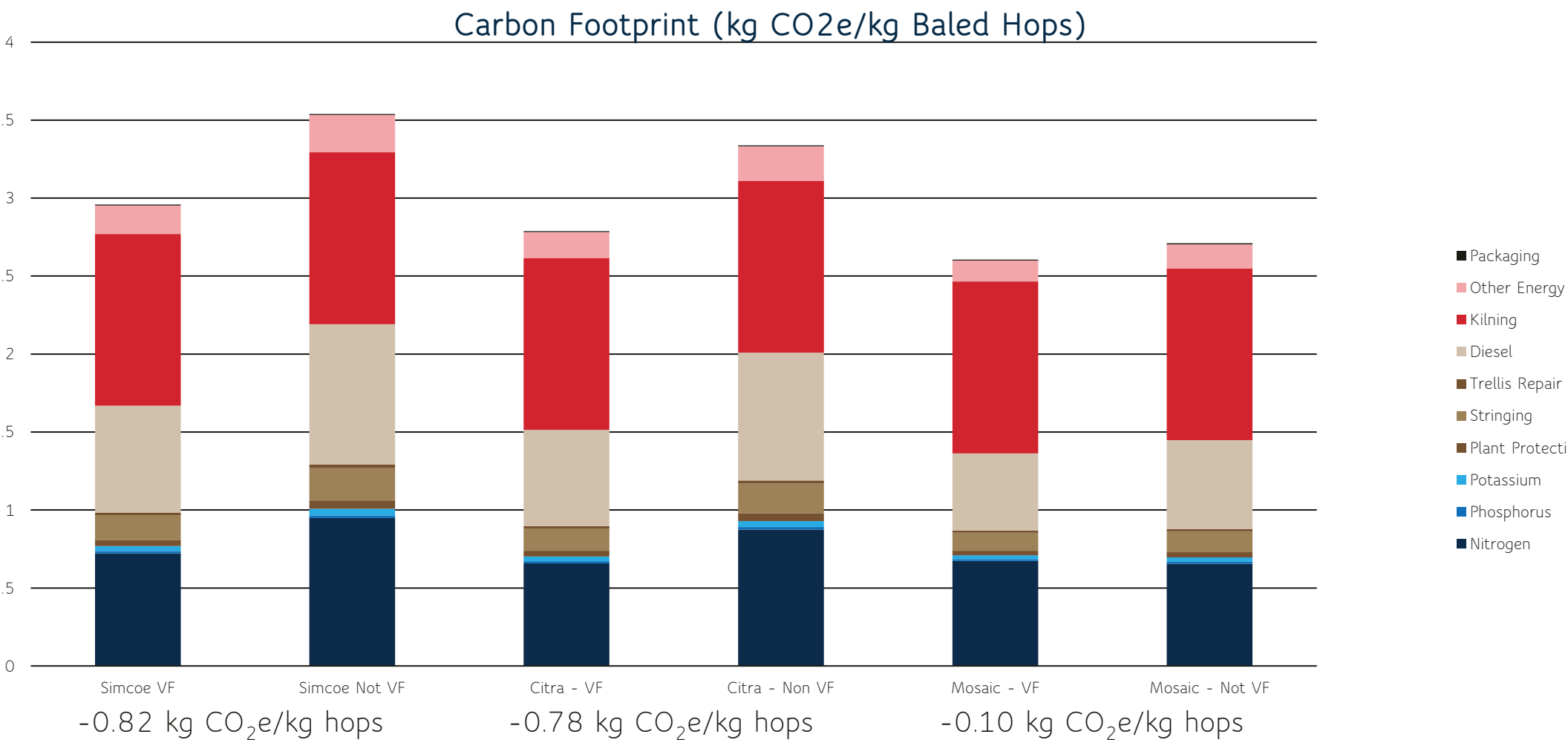
Consistent Yield Improvement

- 25% increase over varietal average each crop year
- Up to 100% yield increase on individual farm/field basis
- Very few virus-free fields underperform relative to the average for non-VF fields

Carbon Footprint – Virus Free



HOHENHEIM
RESEARCH
STATION

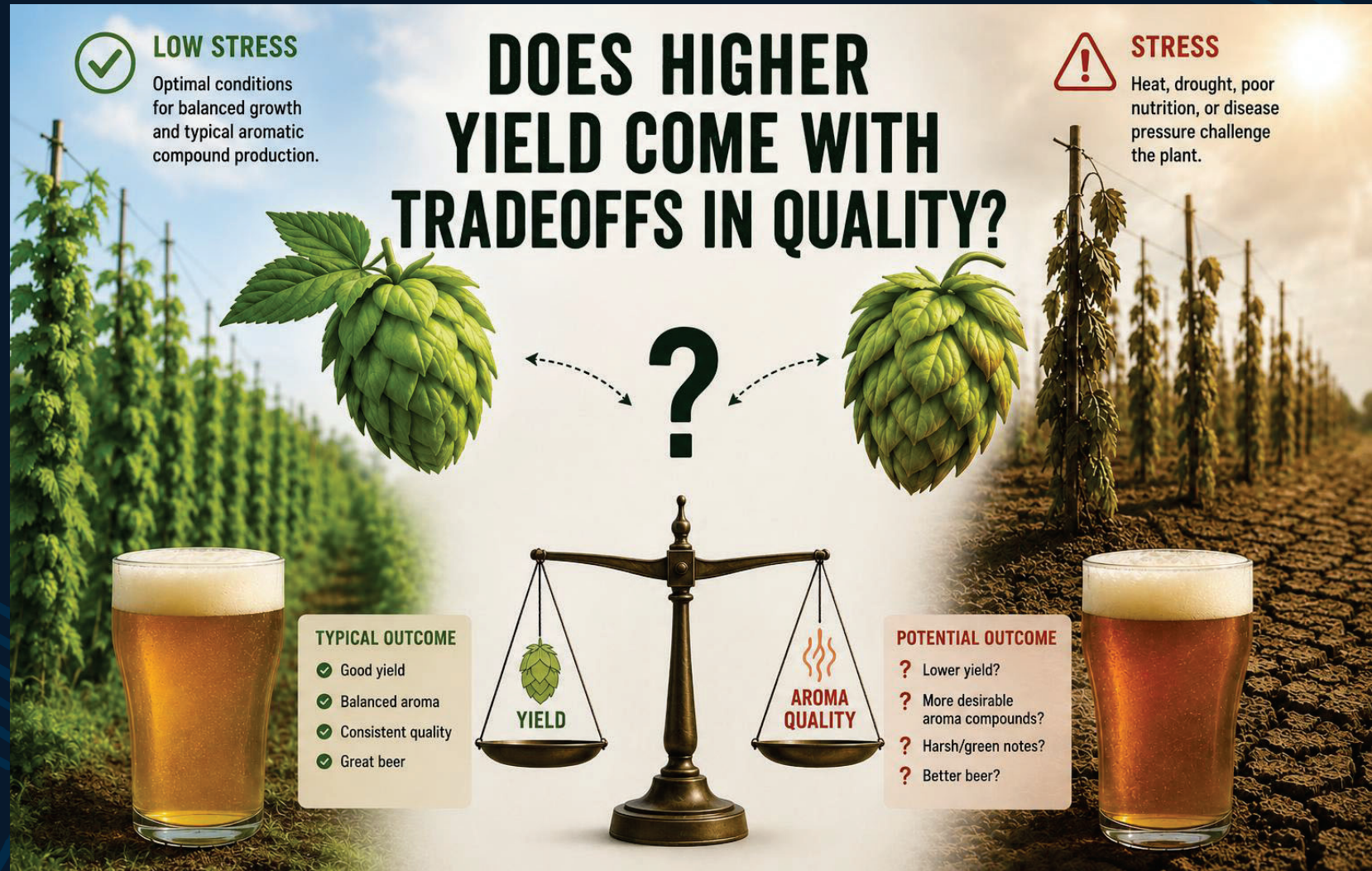


Calculated using a modified version of the Greenhouse Gas Assessment from Bavaria State University, using YCR yield, fertilizer, and plant protection estimates:
<http://www.stmelf.bayern.de/idb/hopfen.html>

What Does This Mean for Quality?



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BREEDING
SCHOOL



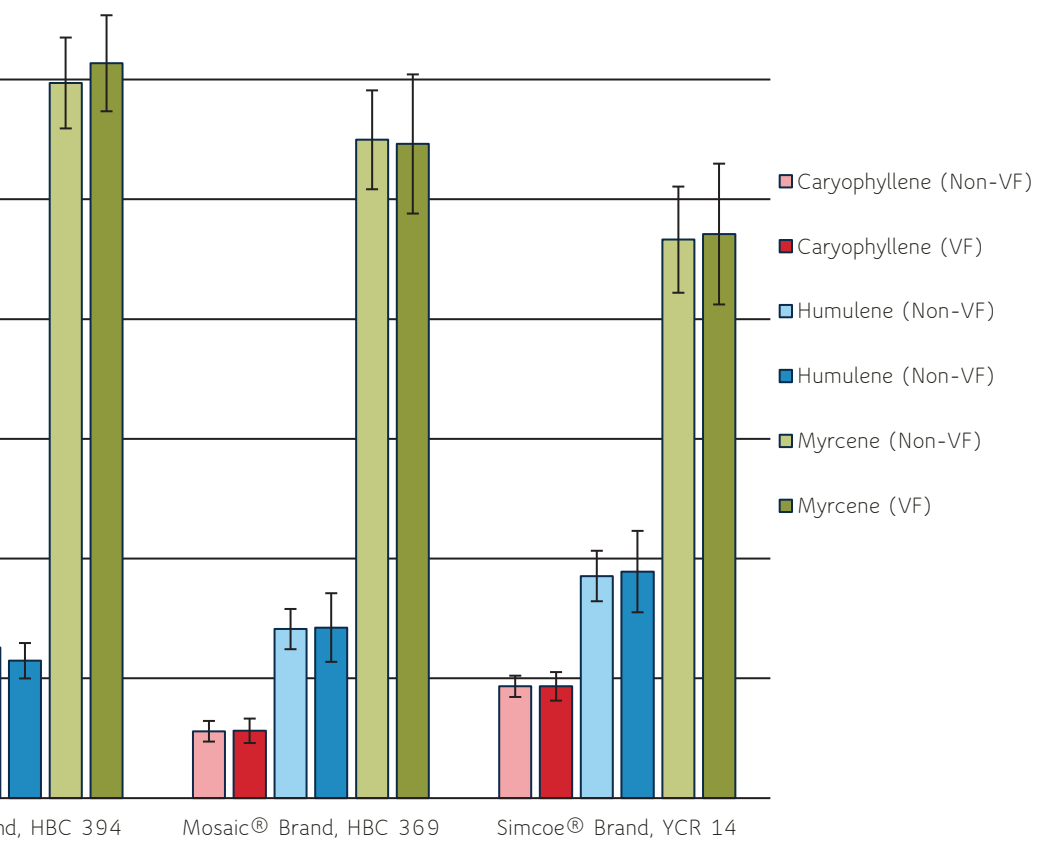
*Image Generated with ChatGPT

Virus-Free Chemical Analysis

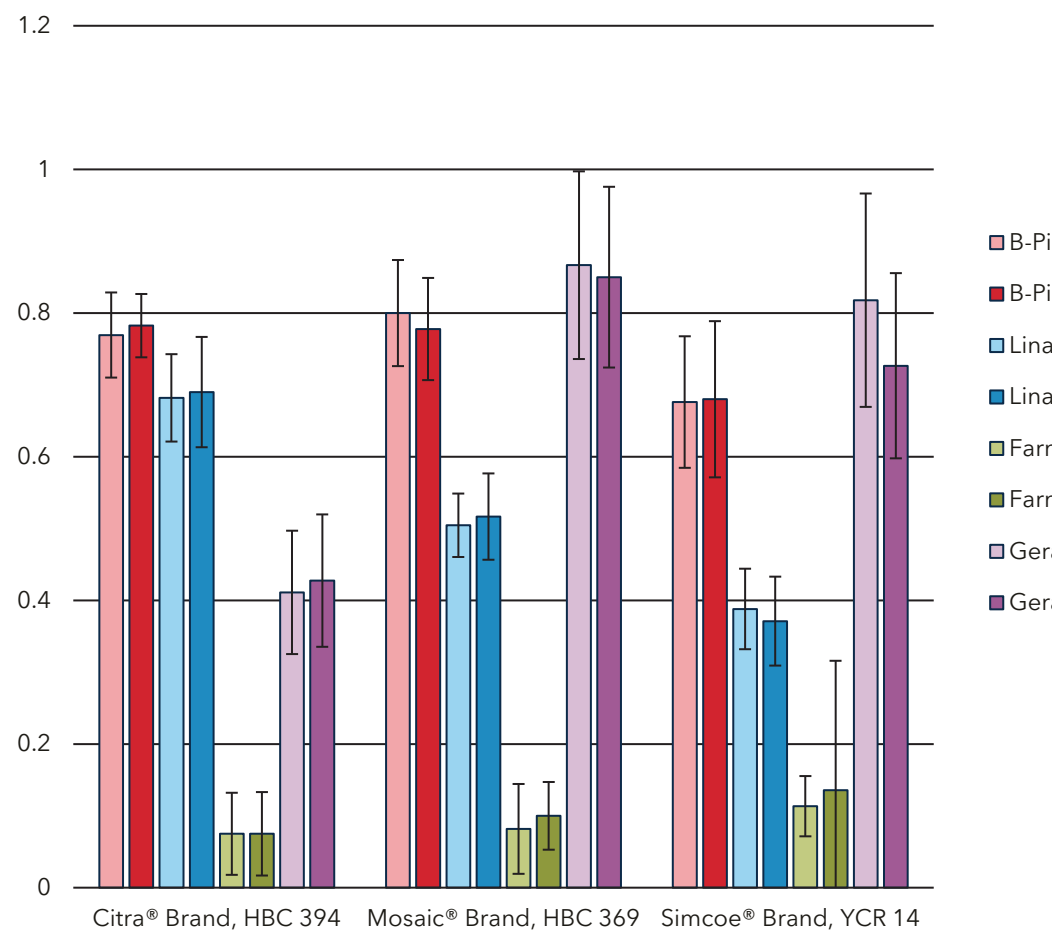


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Major Oil Components



Minor Oil Components

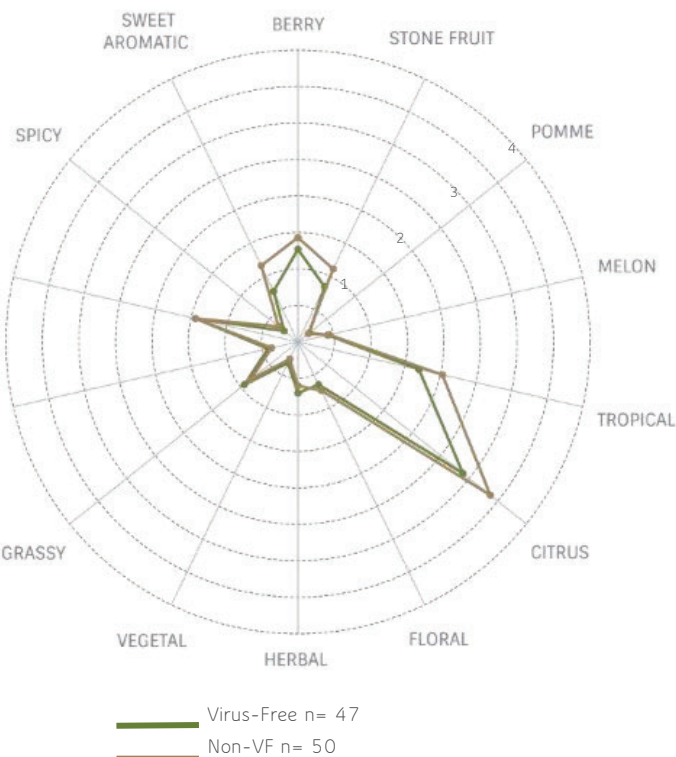


Virus Free VS. Non-VF Simcoe®

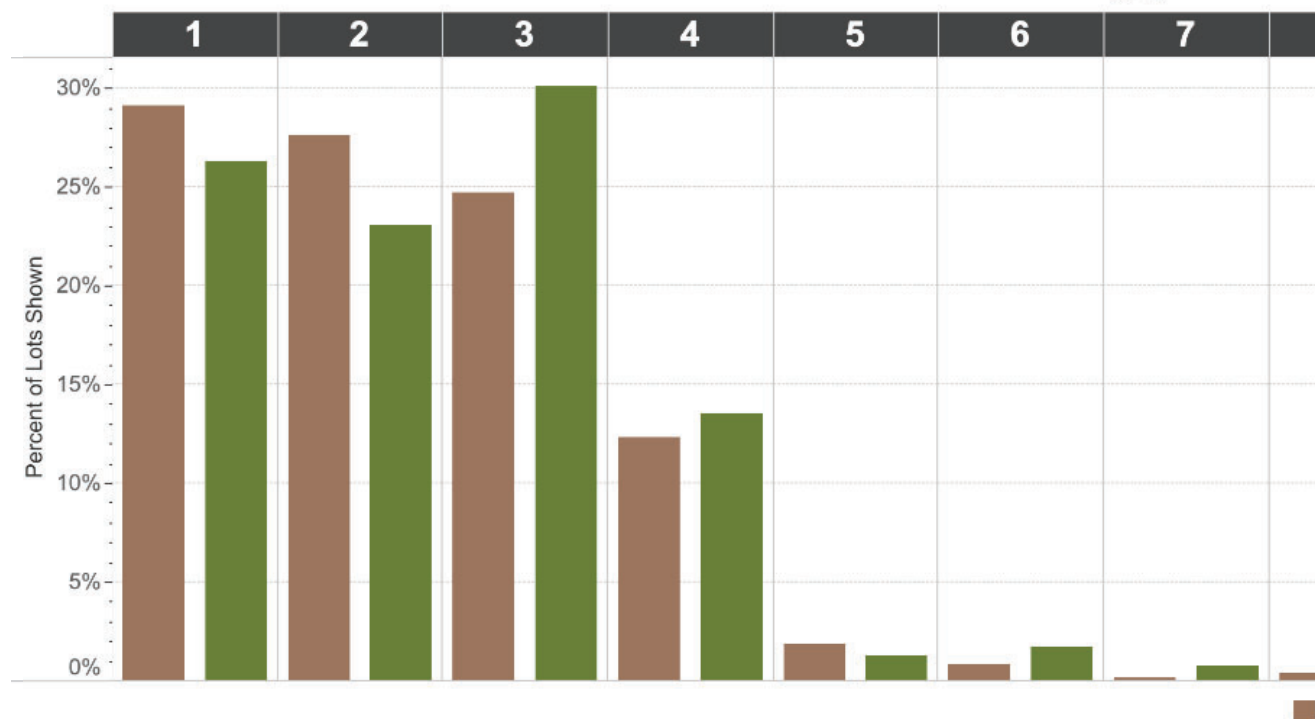


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SCHOOL

Aroma Profile



CY25 Simcoe® c.v. YCR 14 Brewer Selection Ranking (Normalized)

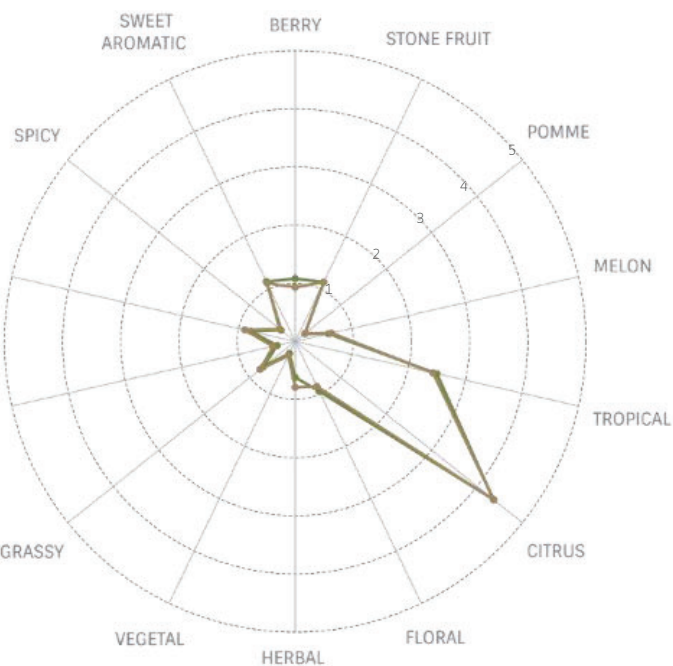


Virus Free VS. Non-VF Citra®

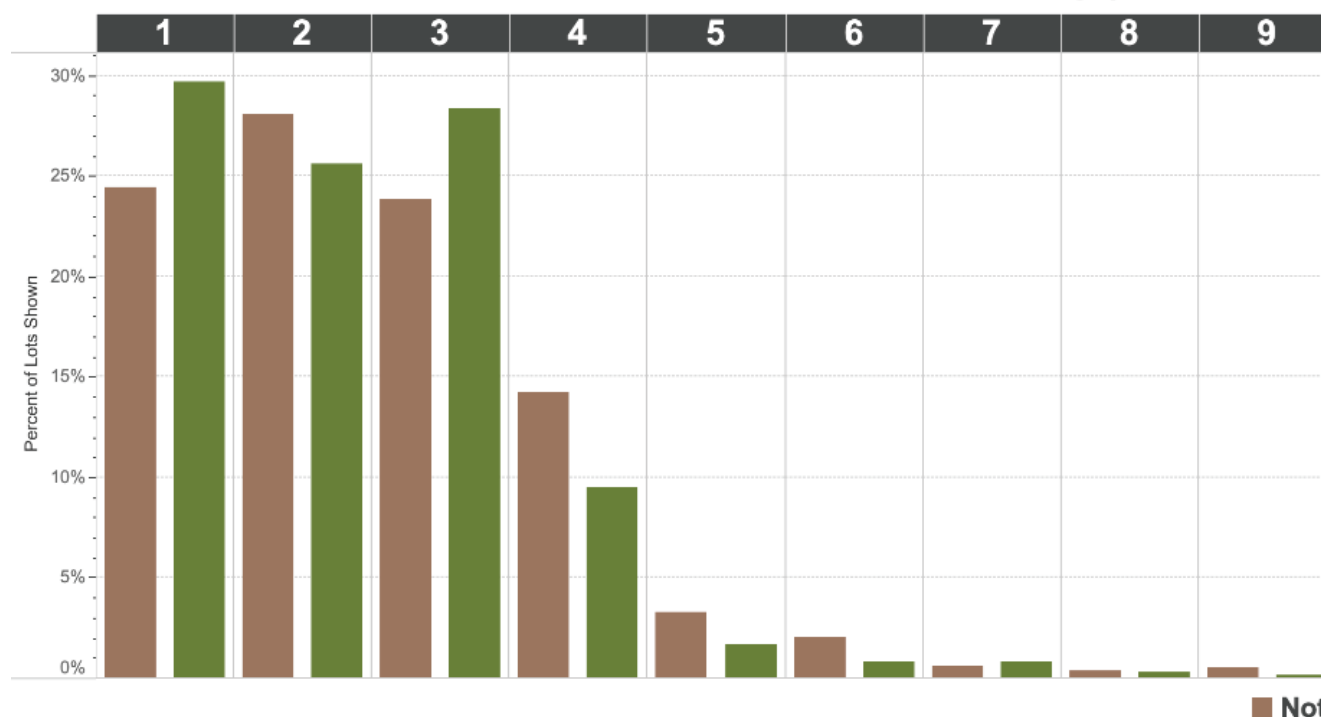


HBC
394
BREWER
SELECTION

Aroma Profile



CY25 Citra® c.v. HBC 394 Brewer Selection Ranking (Normalized)

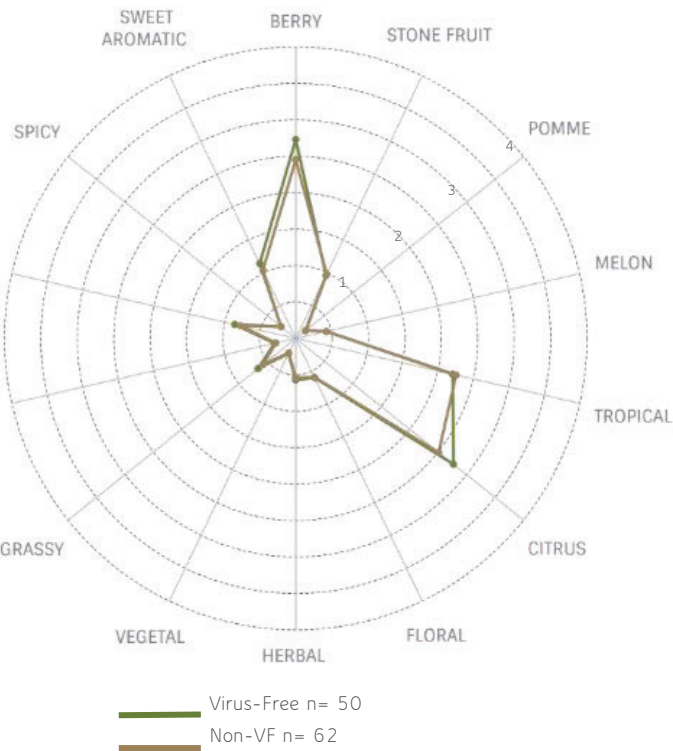


Virus free VS. Non-VF Mosaic®

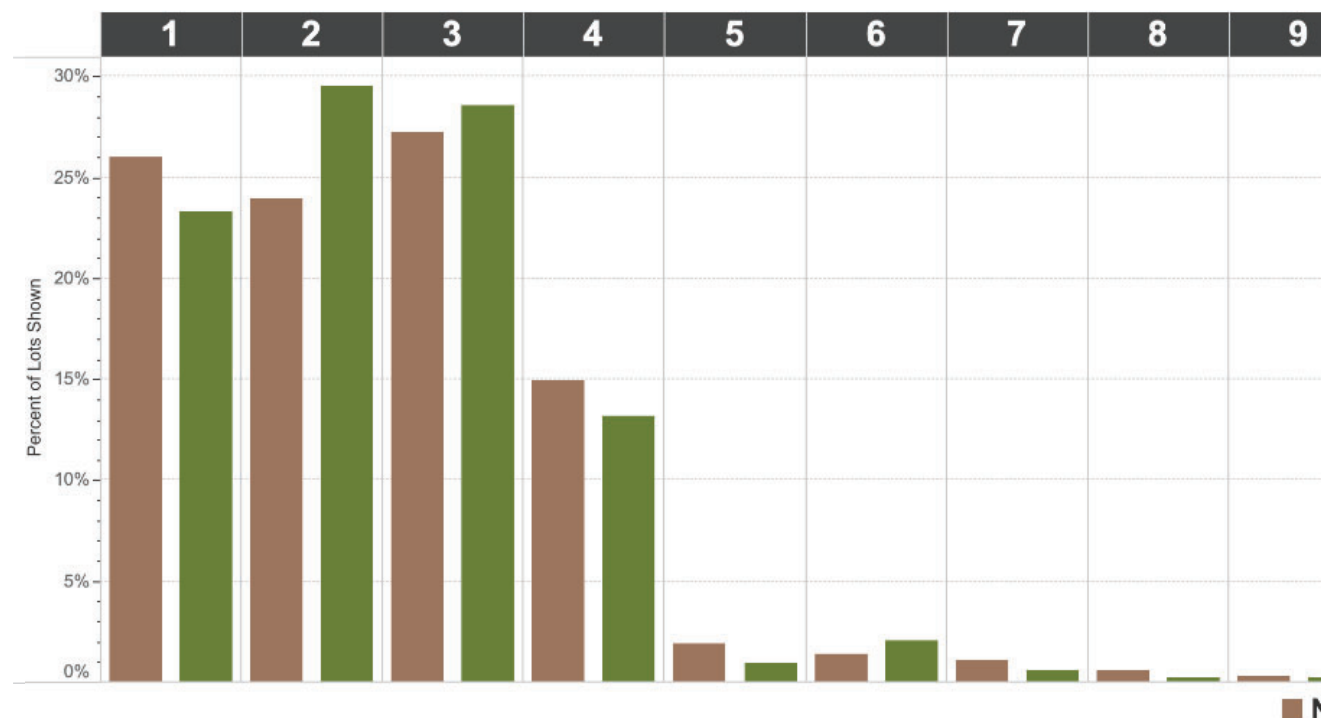


HBC
369
SC

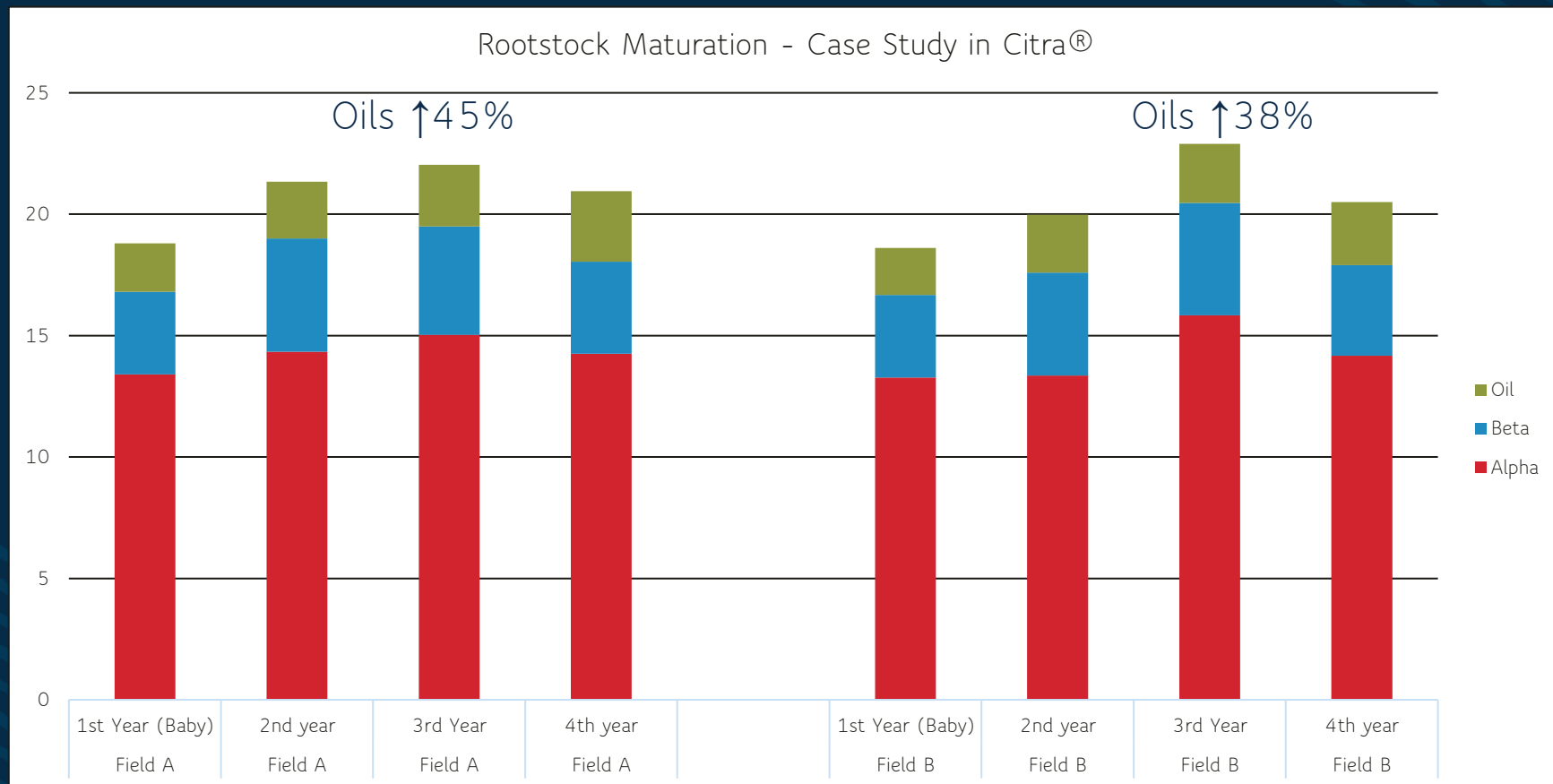
Aroma Profile



CY25 Mosaic® c.v. HBC 369 Brewer Selection Ranking (Normalized)



What Factors Influence Oil Content?

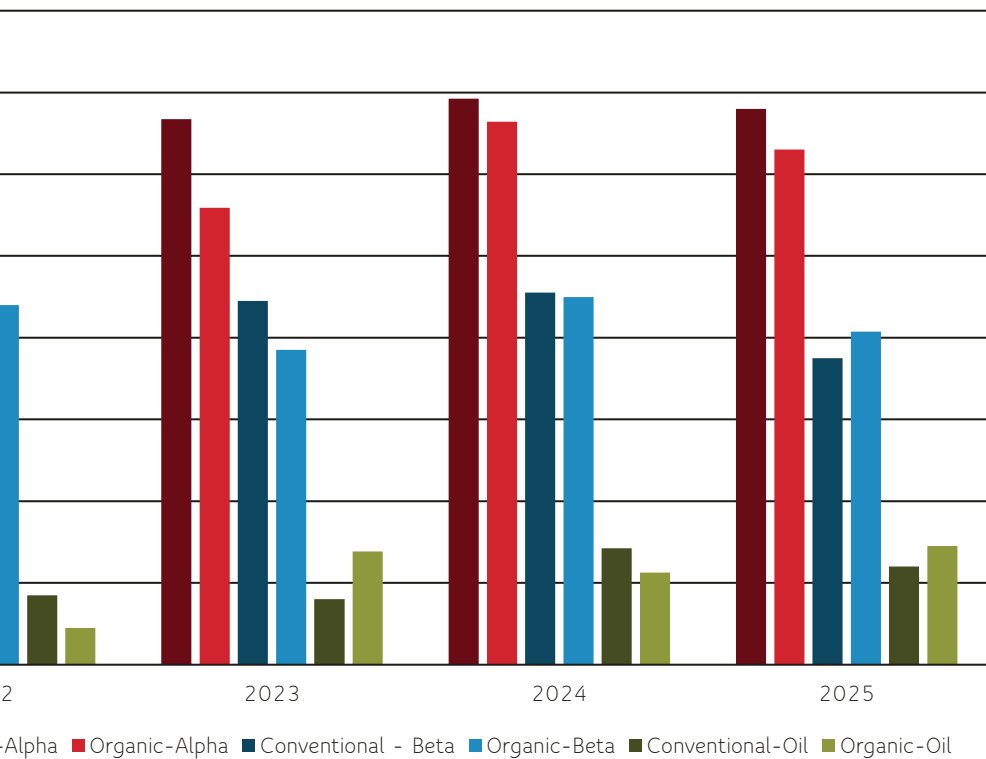


What Factors Influence Oil Content?

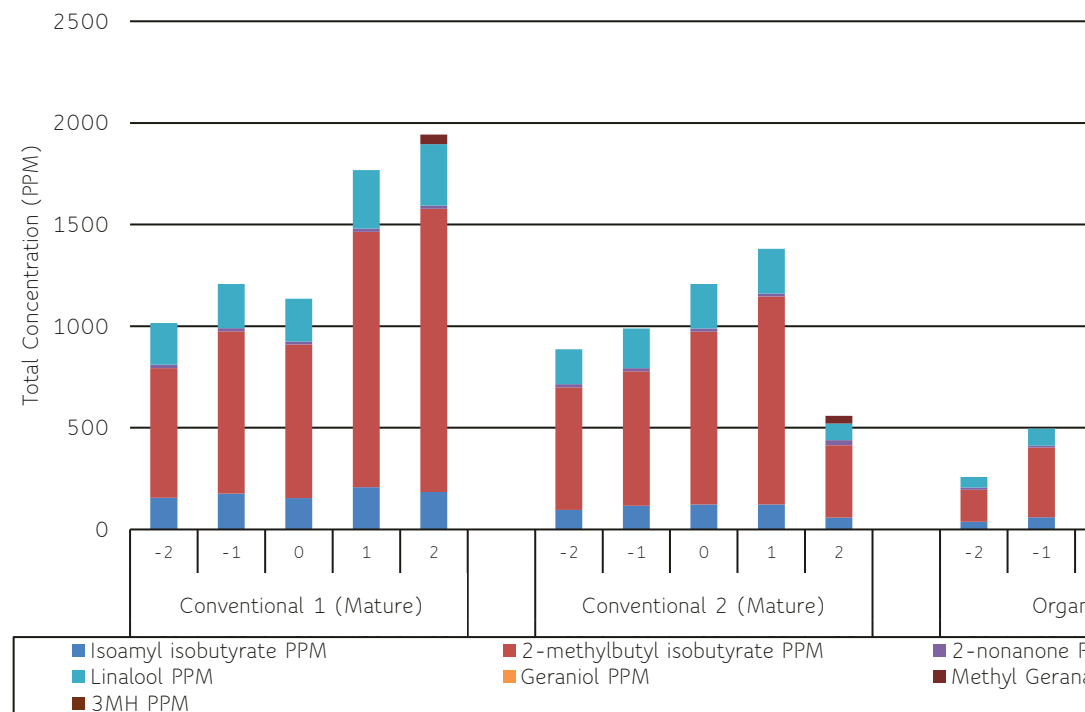


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Organic Production - Case Study in Krush®



CY2022 Krush® HBC 586 c.v. Harvest Window Study
Survivable Compound Absolute Abundance



Virus-Free Summary



HO
BR
SC

