Disease risk management and early detection of decay in table grape vineyards

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Outline

- Introduction
- Materials and methods
- Findings
  - Disease monitoring – Agri-RMS
  - Early detection methods – 100-berry test
  - Early detection methods – qPCR
- Conclusion

Introduction

- High risk for decay - flowering and ripening
- Fruit increase in susceptibility, especially from veraison onwards
- Monitoring and controlling preharvest decay become critical approx. 3 or 4 weeks before harvest
  - Preharvest vs Postharvest pathogens
  - *Botrytis cinerea*, *Rhizopus stolonifer*, *Aspergillus* spp., *Penicillium* spp., *Alternaria* spp. and *Cladosporium* spp.
  - Soft-tissue-breakdown and sour rot:
    Acetic acid bacteria, yeasts, filamentous fungi (*Rhizopus*, *Aspergillus* and *Penicillium*) and vinegar flies (sour rot)

Introduction

- Preharvest infections and inoculum lead to postharvest decay
- Determine the frequency of known and emerging pathogens to identify main pathogens causing decay
- Proactive mitigation actions to reduce pre- and post-harvest losses
- Aim: to develop a disease risk management tool that can be used by producers to assist with disease control

Materials and methods

Vineyard Selection

- Collaborate
- 3 vineyards
- 3 production regions:
  Limpopo, Northern Cape and Western Cape

Monitoring / Scouting

- 3 growth stages x 5 points / vineyard
- Assessment:
  Disease (type and severity)
  Buch/berry condition (amount, size, firmness, sugar, damage)
  Vineyard condition (canopy and floor)
  Indicate risk

Early Detection

- 3 growth stages x 5 points / vineyard (asymptomatic berries)
- Plating method
- ONFIT method
- qPCR (*B. cinerea* from *Vitis vinifera* samples)

Findings - vineyard monitoring

Table 1: Summary of evaluation for Limpopo producer 3 (L3)

Vineyard parameters	Factors measured	Bunch set	Veraison	Harvest
Fruit / bunch condition (Number / % / 0-3 index: none to high)	Total number of bunches	48.4	48.4	48.4
	Touching bunches (% of bunches)	3.3	6.4	3.2
	Compact bunches (% of bunches)	0	0	0
	Remnant within bunch (index)	1.3	1.3	1.3
	Flaccidness (index)	1	1	1
	Sugar (°Brix)	4.2	10.7	.
Injuries / damaged berries (%)	Incidence (% injured bunches)	0	8.1	17.9
	Severity (% injured berries per bunch)	0 - 0	1.2 - 1.5	1.6 - 2
	Type / cause of injury	N/A	Bird	Bird
Diseased berries (%)	Disease incidence (% decay bunches)	0	6.6	19.6
	Decay severity (% decay berries per bunch)	0 - 0	1.1 - 1.3	1.5 - 1.8
	Pathogen / symptom	N/A	Bot / Sour rot / STB	Bot / Sour rot / STB
Vine condition (1-3 index: low to high)	Canopy coverage (index)	1.4	1.4	1.4
	Canopy density (index)	1.8	1.8	1.8
Vineyard floor (0-3 index: none to high)	Canes on floor (index)	1.2	0.9	0.9
	Bunch cuttings on floor (index)	0	0	0
	Leaf litter (index)	1.7	1.1	1.1
	Cover crop density (index)	2.3	2.3	2.3
	Cover crop position (index)	C / B	C / B	C / B
	Cover crop type (index)	G / W	G / W	G / W

Findings - vineyard monitoring

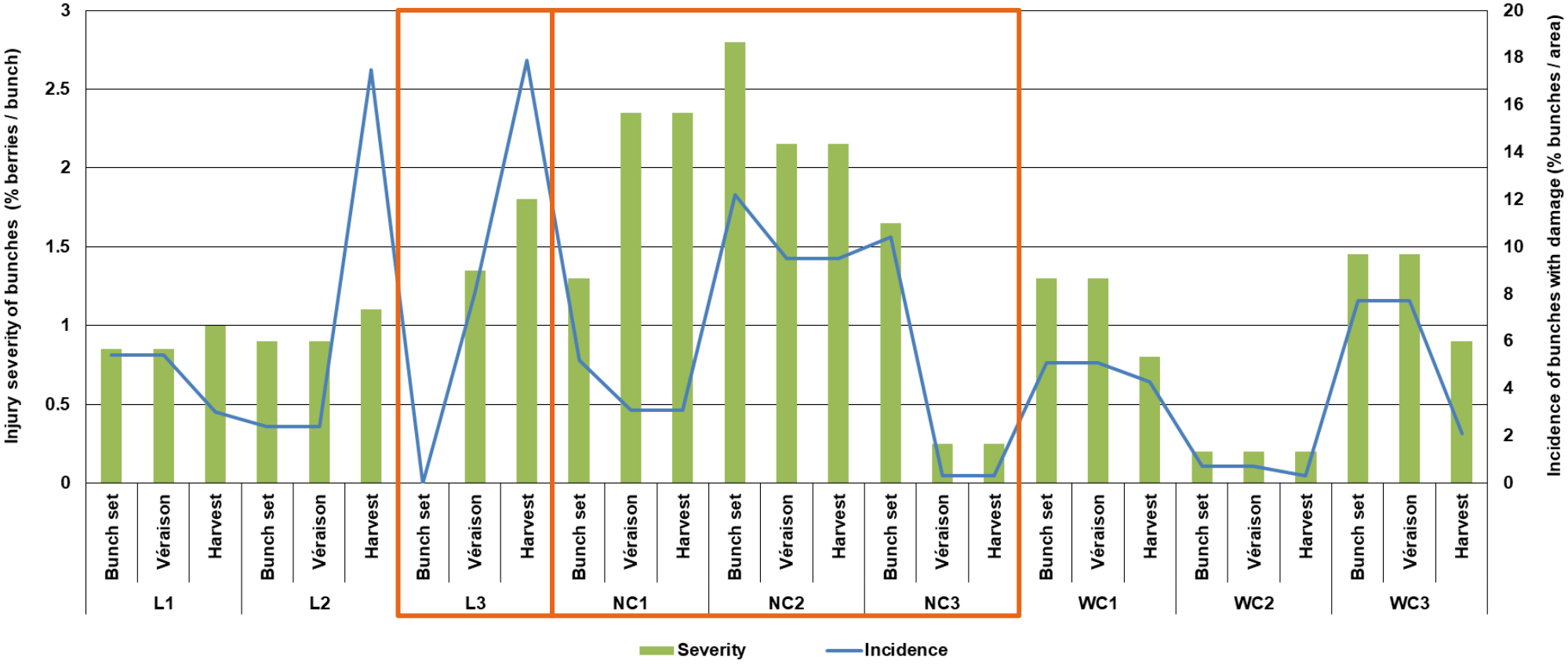

Figure 1: Incidence and severity of damaged / injured table grape bunches. L, Limpopo; NC, Northern Cape; WC, Western Cape

Findings - vineyard monitoring

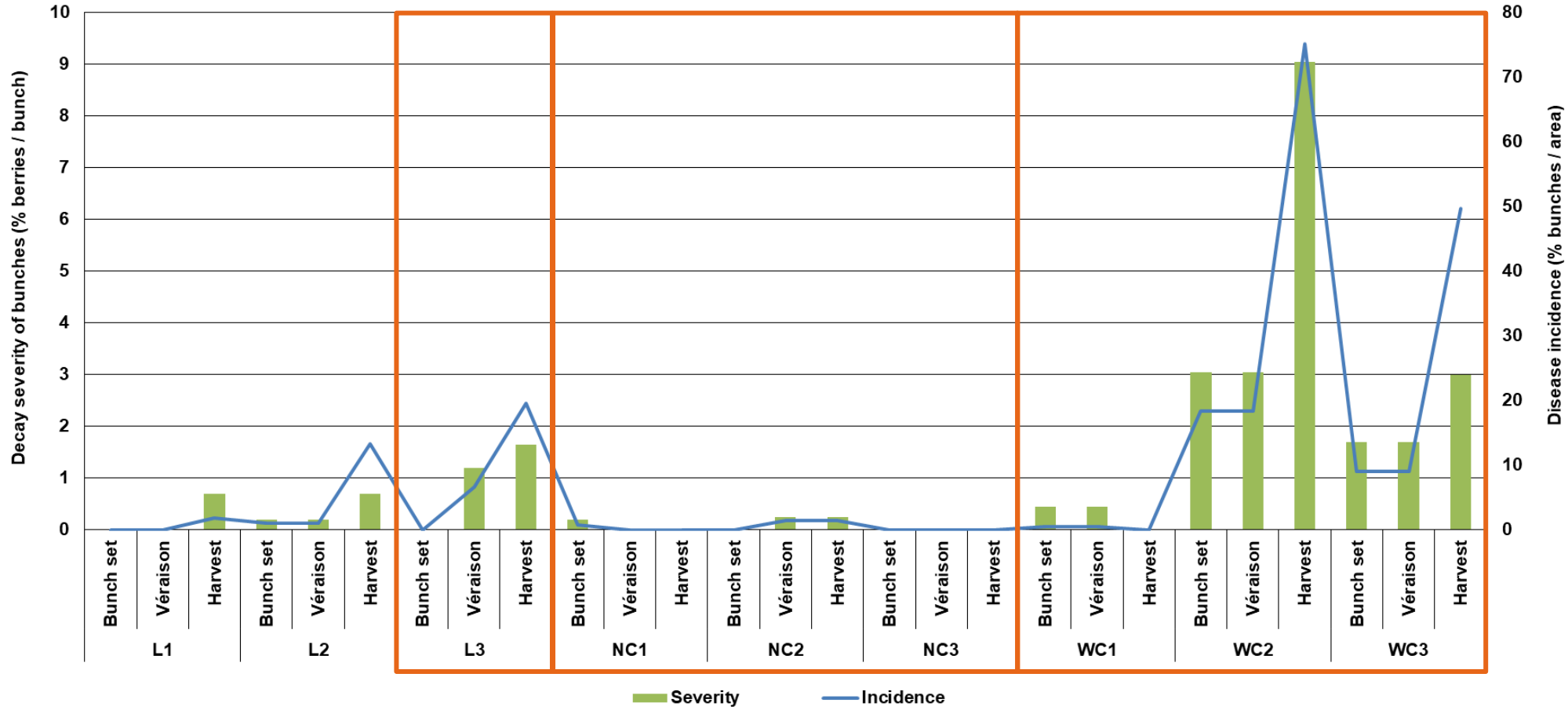

Figure 2: Incidence and severity of diseased / decay table grape bunches. L, Limpopo; NC, Northern Cape; WC, Western Cape

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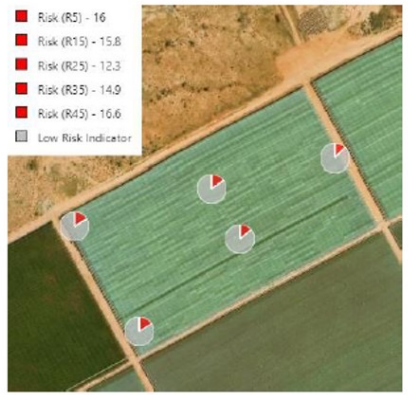
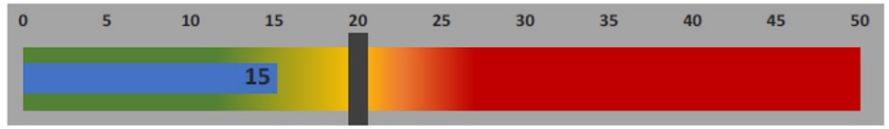
Agri-RMS Report
Producer X - Autumn Crisp (Sugrathirtyfive) - Block D2



Summary of evaluation			2023/01/24
Yield / Condition	Total number of bunches (avg.)		41.8
	Touching bunches (%)		20.1
	Compact bunches (%)		0.0
	Sugar (°Brix)		16.8
Decay*	*Botrytis*	Incidence	1.0
		Severity	0.4
	Alternaria	Incidence	0.0
		Severity	0.0
	Aspergillus	Incidence	0.0
		Severity	0.0
	Rhizopus	Incidence	0.0
		Severity	0.0
	Sourrot	Incidence	0.5
		Severity	0.2
	Total	Incidence	1.9
		Severity	0.8
Injuries*	Split berries	Incidence	0.5
		Severity	0.2
	Bird damage	Incidence	1.0
		Severity	0.4
	Total	Incidence	1.4
		Severity	0.6
Canopy condition	Canopy cover		Acceptable
	Canopy density		Mostly closed
Floor condition	Canes/leaf litter		Moderate
	Bunch cuttings		Little
	Cover crop height		None
	Cover crop density		None

* **Incidence**, % bunches; **Severity**, % berries per bunch
** Values based on the evaluation of one side of three vines



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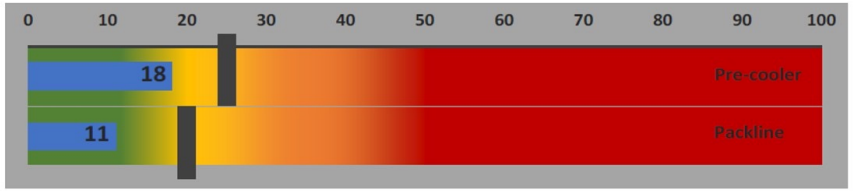
Agri-RMS report for pre-cooler and packhouse of
Producer X - Thompson Seedless

Summary of evaluation		2023/01/25
Pre-cooler operations	Cooling efficiency	Average
	RH (%)	70.0
	Air temp. (°C)	24.0
	Pulp temp. (°C)	22.9
Packline operations	Packline cleanliness	Clean
	Packhouse cleanliness	Clean
	RH (%)	63.0
	Air temp. (°C)	24.6
	Pulp temp. (°C)	19.7
Bunch characteristics	Rachis condition	Green
	Bunch size	XL
	Berry size	L
	Compactness	Acceptable
	Sugar (brix)	19.6
Decay / injured grapes*	Decay at pre-cooler (%)	20.0
	Injuries at pre-cooler (%)	20.0
	Decay after packline (%)	0.0
	Injuries after packline (%)	0.0
Packaging material	SO_2 coverage	Proper
	Bag perf. (% closed)	0.0
Packline efficiency	Decay reduction (%)	100.0
	Injury reduction (%)	100.0
	Risk reduction (%)	38.9

* Percentage bunches / punnets evaluated



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Early detection - plating method

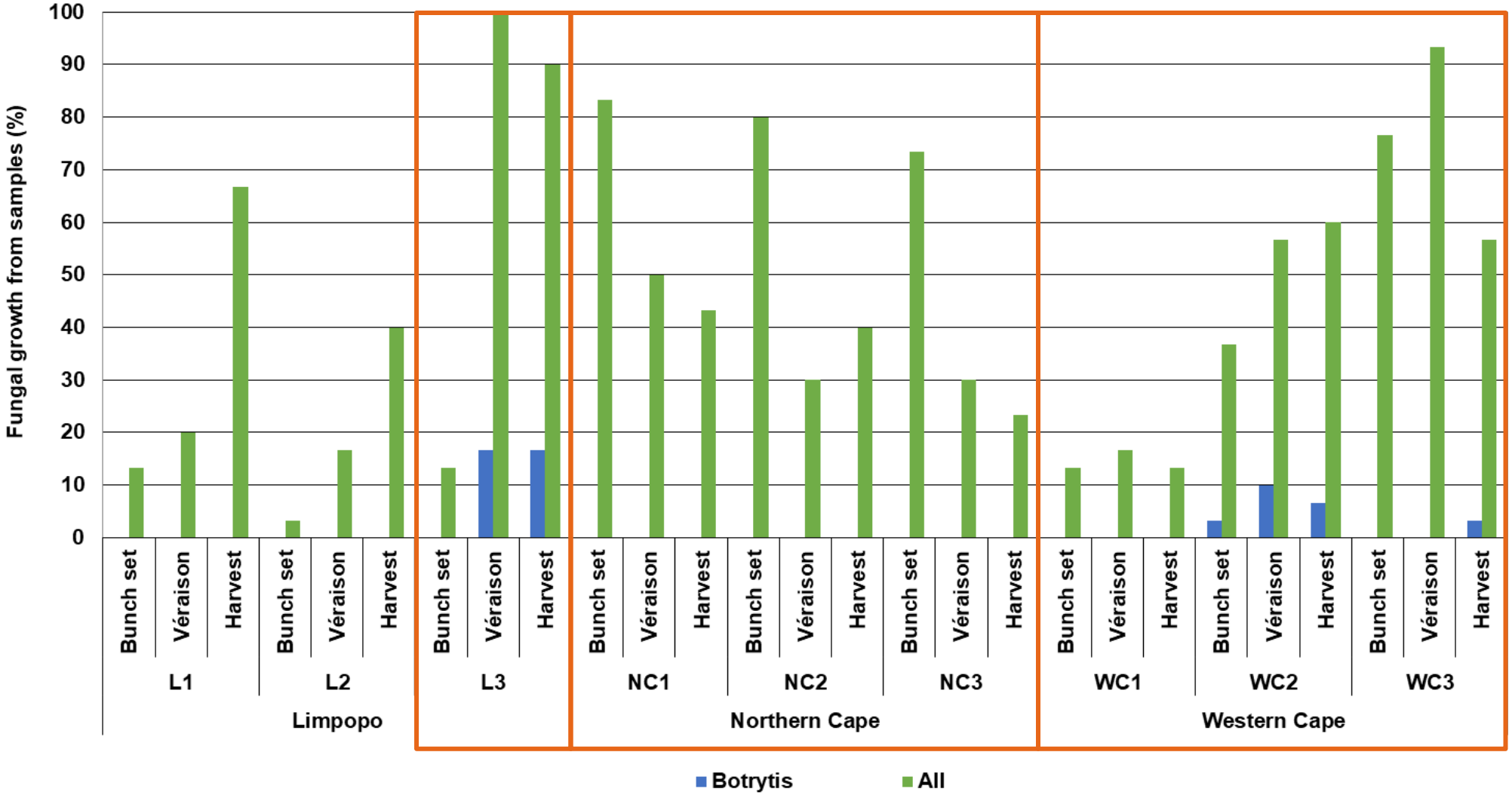
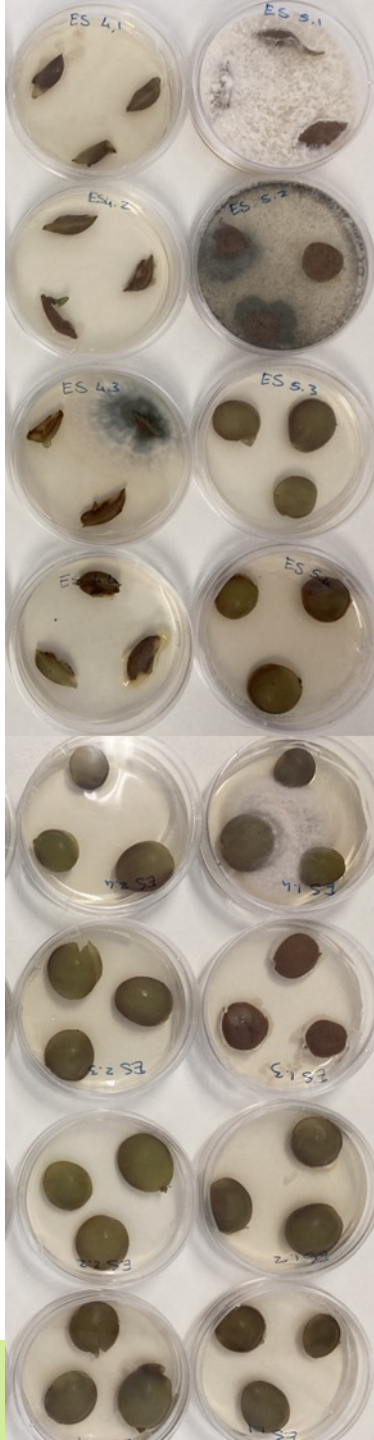


Figure 3: Percentage fungal growth from berry samples plated onto potato dextrose agar plate and incubated at ±22 °C for 9 – 10 days



Early detection - ONFIT

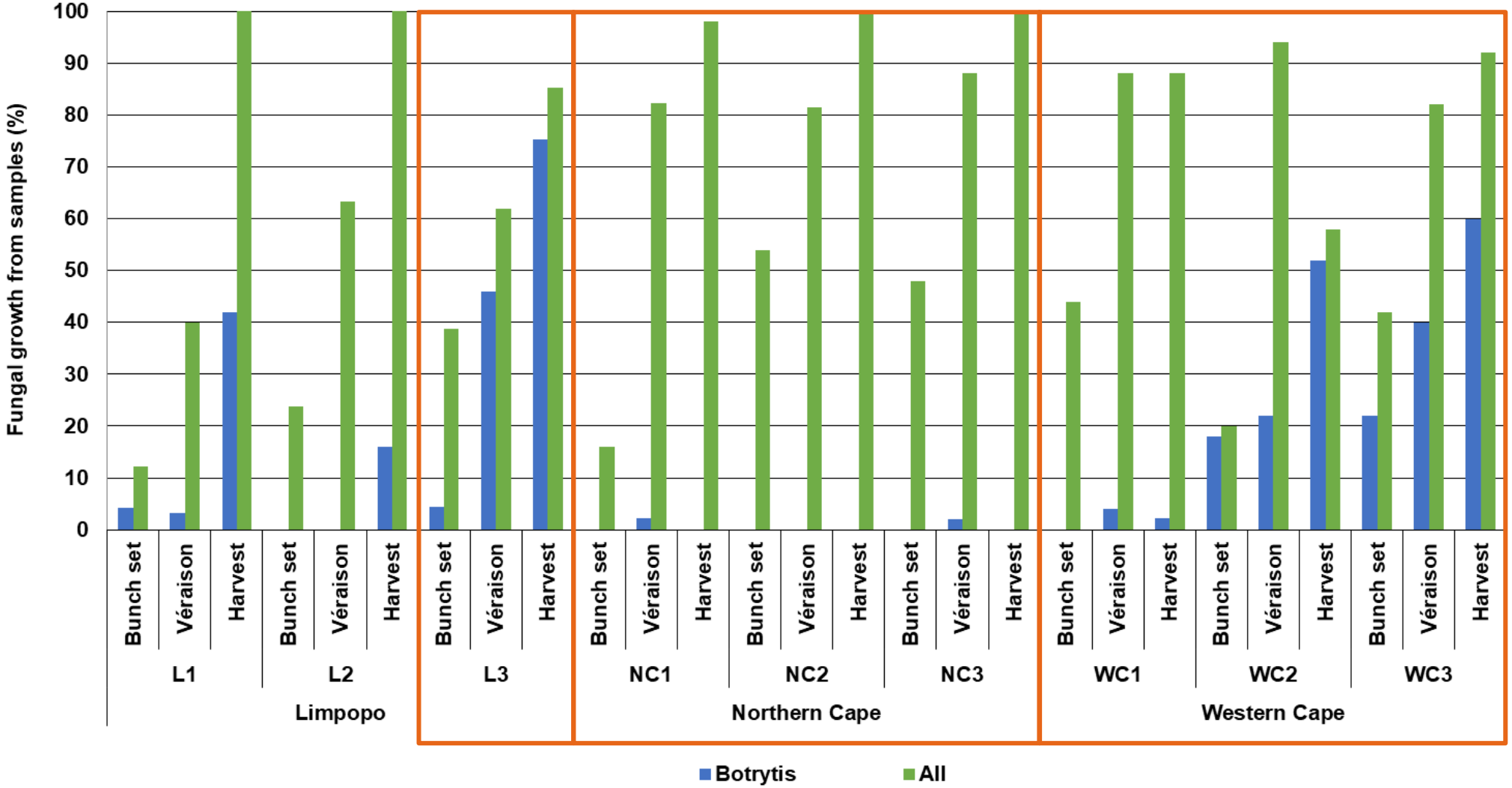


Figure 4: Percentage fungal growth from berry samples frozen (ONFIT method) and placed in humidity chambers at ±22 °C for 9 – 10 days

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100-Berry Test Report
Producer X - Crimson Seedless - Block 1
2022/12/01

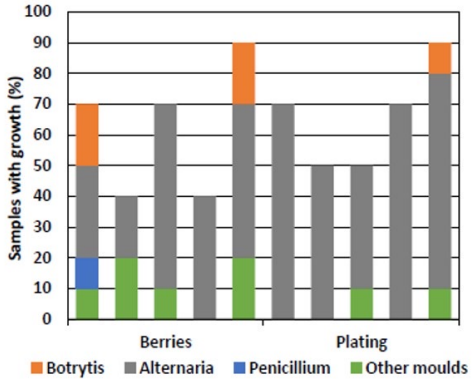

Figure 1: Percentage fungal growth per sampling point

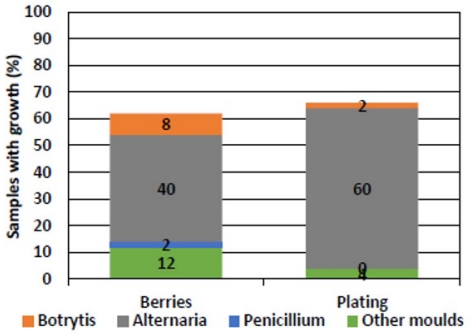

Figure 2: Average fungal growth for the vineyard

- 20% *Botrytis* detected on berries at point 1 and 5, with an avg. of 5% for both methods
- 20% - 70% *Alternaria* detected across all points, with an avg. of 50% for both methods
- 10% *Penicillium* detected on berries at point 1, with an avg. of 1% for both methods
- Other mould growth include *Aspergillus* (avg. 5%) and *Cladosporium* (avg. 3%) for both methods
- Other growth (excl. from graphs) includes yeast (14%) for both methods

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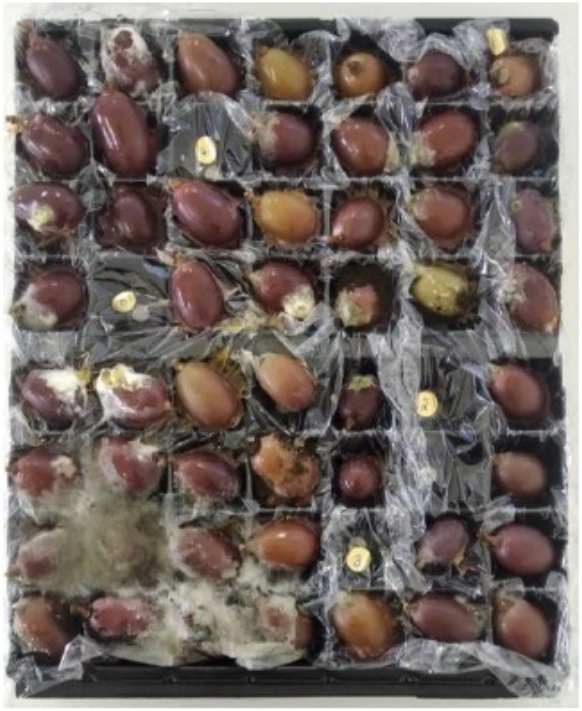

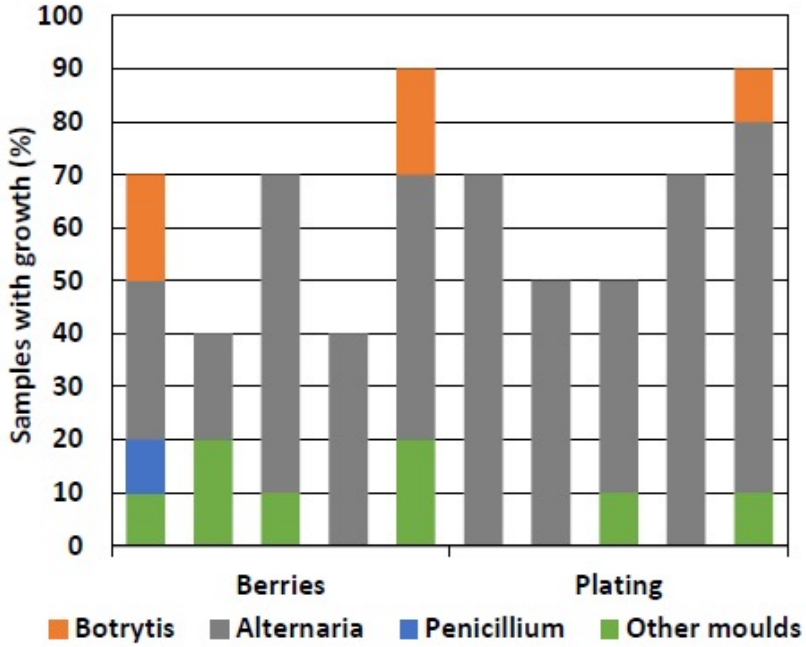

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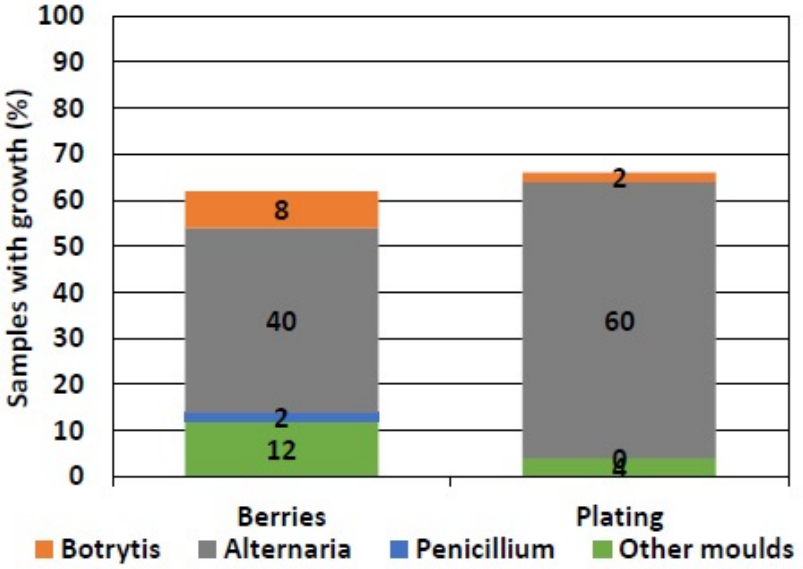
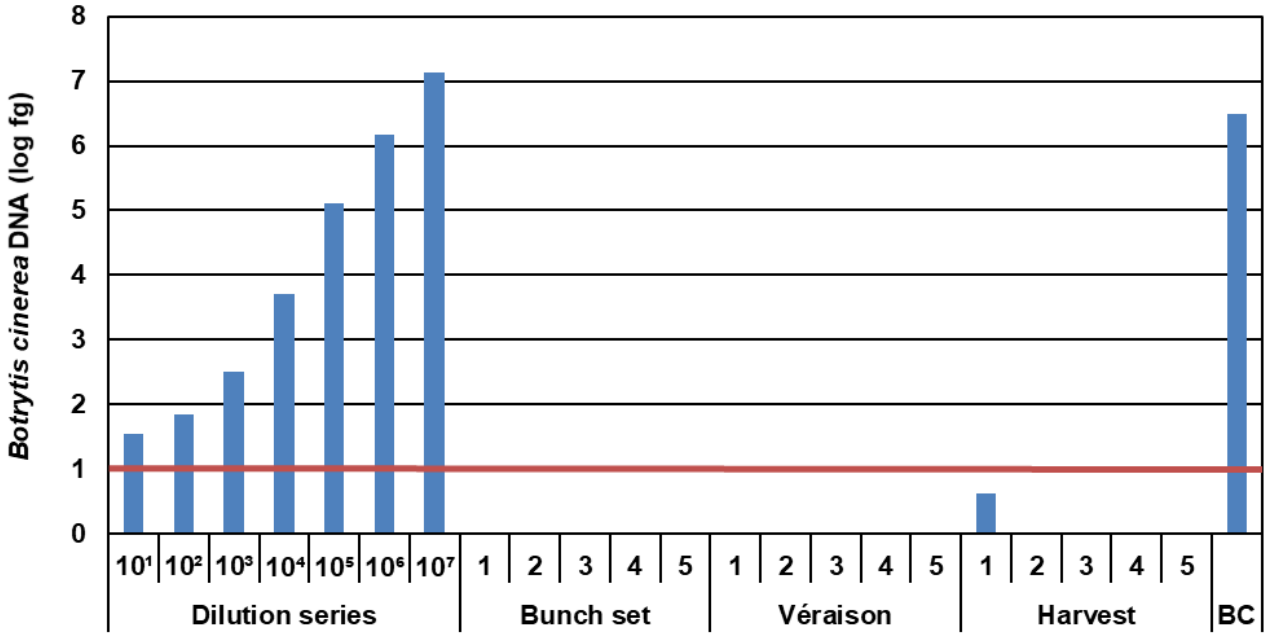


Figure 2: Average fungal growth for the vineyard

Early detection - qPCR



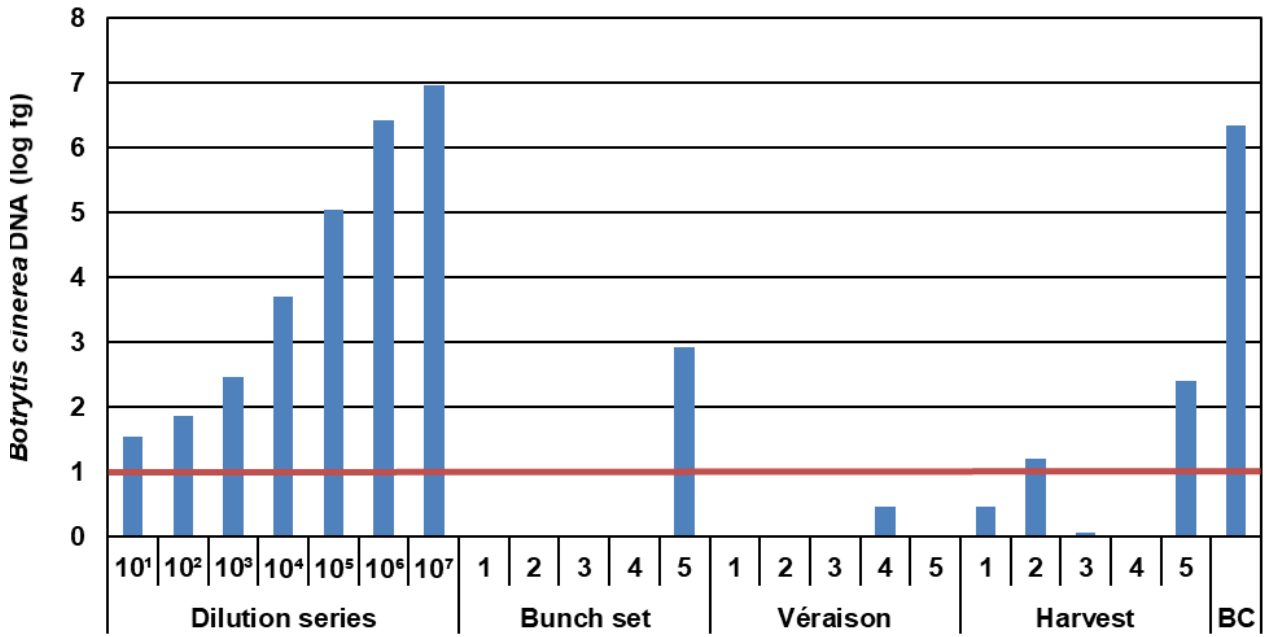


Figure 5: Amount of *B. cinerea* DNA detected at different sample sites (1 – 5) in the vineyard of Norther Cape producer 3 (left) and Western Cape producer 2 (right). Data normalised by multiplying with a correction factor [(average *Vitis vinifera* DNA) / (sample *V. vinifera* DNA)]. The red line represents the minimum detection limit (values below this were too low to confidently detect *B. cinerea*). BC, *B. cinerea* control from a culture

Early detection - qPCR

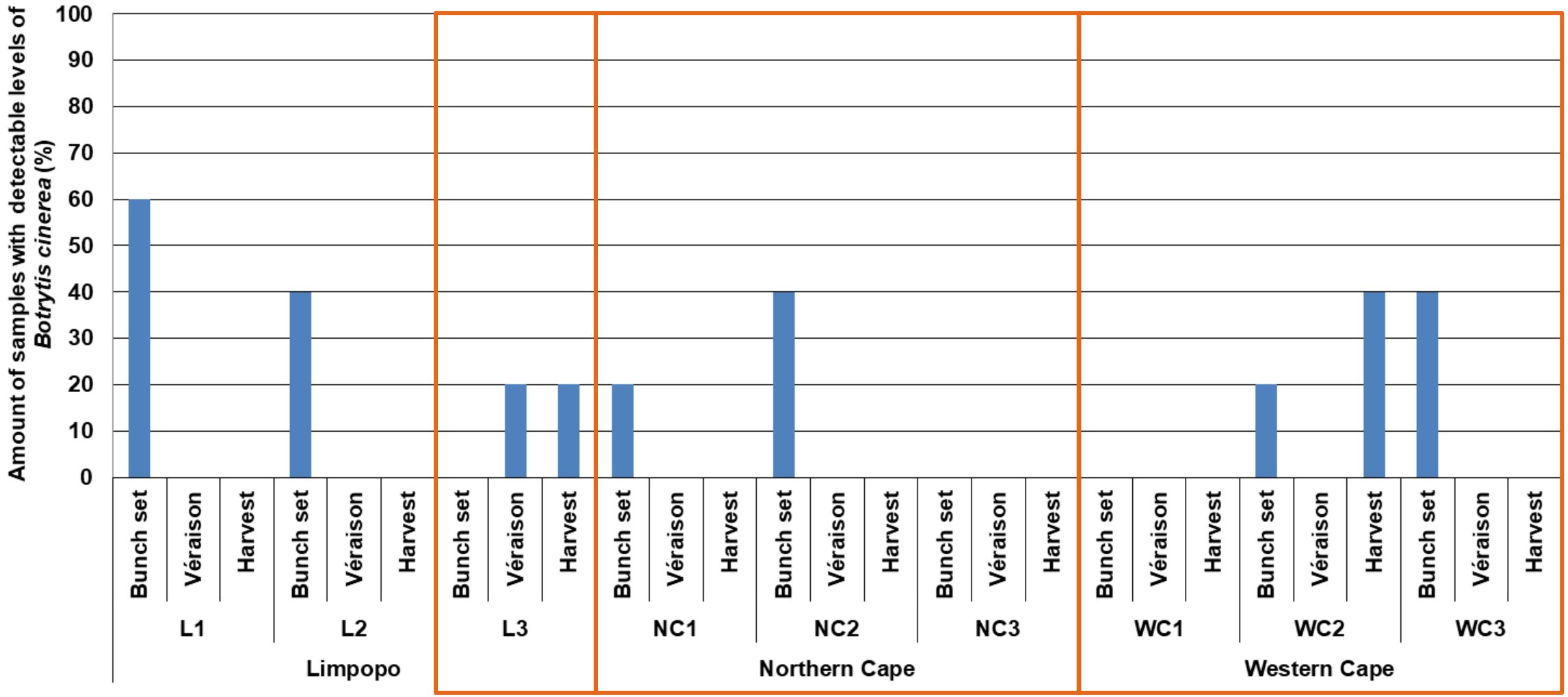


Figure 6: Percentage of samples from vineyards with detectable levels of *B. cinerea* DNA (qPCR)

Conclusion

- Wounds (splits and bird damage), canopy condition, cover crop density and debris on vineyard important factors contributing to decay
- Poor vineyard conditions + Rainfall during fruit ripening = High risk
- Rapid actions + Effective control = Reduce risk (have a strategy)
- ONFIT method - easiest and most effective early detection method
- Plating method - identified vineyards with high risk but low sensitivity

Conclusion

- Duplex qPCR assay detect *B. cinerea* in all of the problem vineyards but didn't correlate as well to vineyard assessments
- Few modifications advised for qPCR:
  - No surface sterilisation required (no incubation)
  - Increase sample sizes or optimise for flowers or leaves
  - Combine ONFIT and qPCR methods with vineyard monitoring to correlate data
- Services for commercial use:
  - Disease risk management system (Agri-RMS)
  - Early detection method (100-berry assay)

Thank You!

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