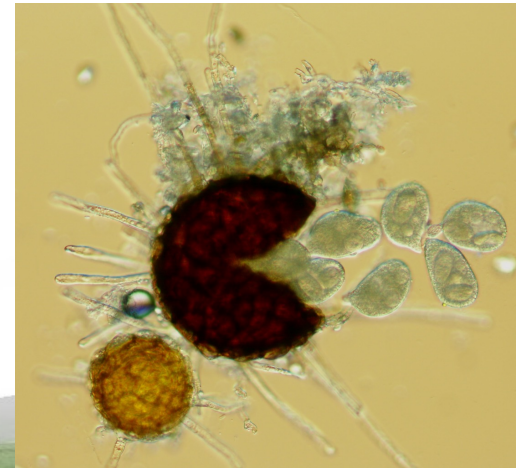




Redefining the epidemiology of grapevine powdery mildew in South Africa

Kara Janse van Rensburg, Francois Halleen, Lizel Mostert and **Minette Havenga**



Grapevine powdery mildew

Erysiphe necator

Huge economic losses

Lower quality and quantity of grapes

Cost associated with fungicides

Obligate biotroph

Require green tissue to survive

Leaves



Canes



Berries



Two phases of reproduction

Asexual



Warmer region: Overwinter in buds

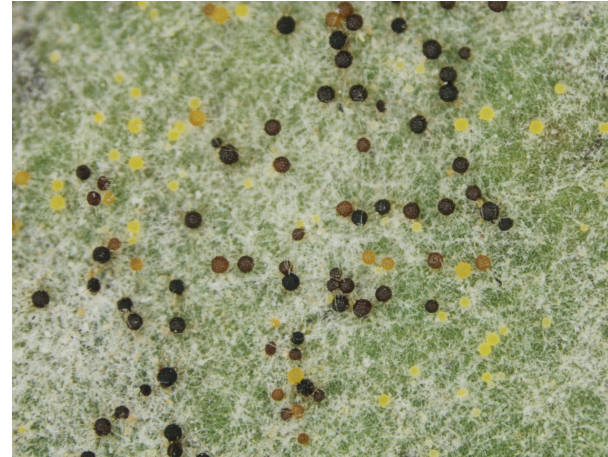
Activated during bud break

Grow with shoots – result in **flag shoot**

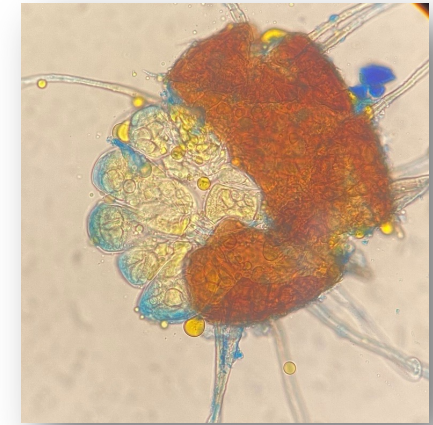
- Deformed
- Stunted: 5-15 cm
- 3-8 weeks after bud break

Sexual

60x



400x



Dormant overwintering structure for survival

Forms late summer/beginning of autumn

Wash down to bark to overwinter in late Autumn

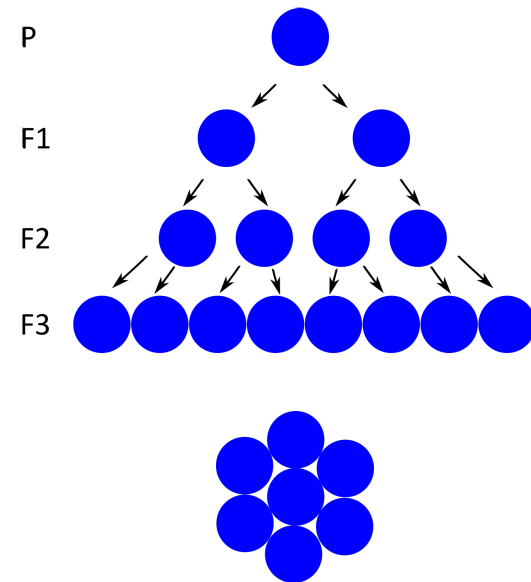
Spore release in Spring

- Temperatures > 4°C
- > 2.5 mm rain
- > 80% RH



Trade-off: Sexual vs Asexual reproduction

Asexual



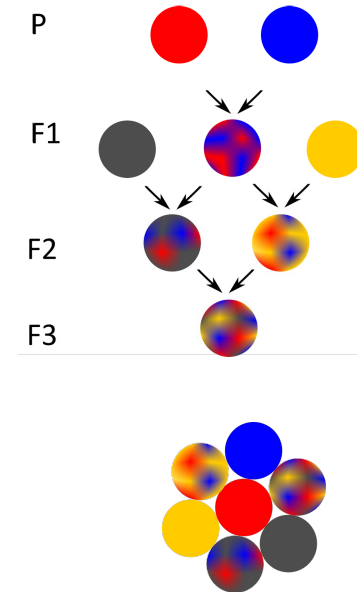
Clonal – retain genetic make-up

New genetic make-up

Could lead to individual that is:

- Less responsive to management
- More adapted to wider climatic conditions

Sexual



Sexual reproduction is concerning!!!

Sexual reproduction: Then vs Now

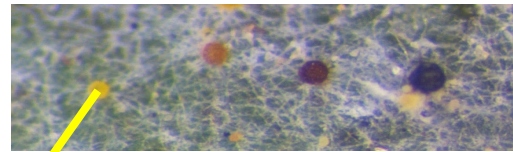
In 1996-1997 (Halleen and Holz, 2000):

Chasmothecia

Western Cape vineyards surveyed (formed in May)

Small numbers (1-10 per leaf), all immature:

- 1 vineyard in Stellenbosch
- 2 vineyards in Simondium



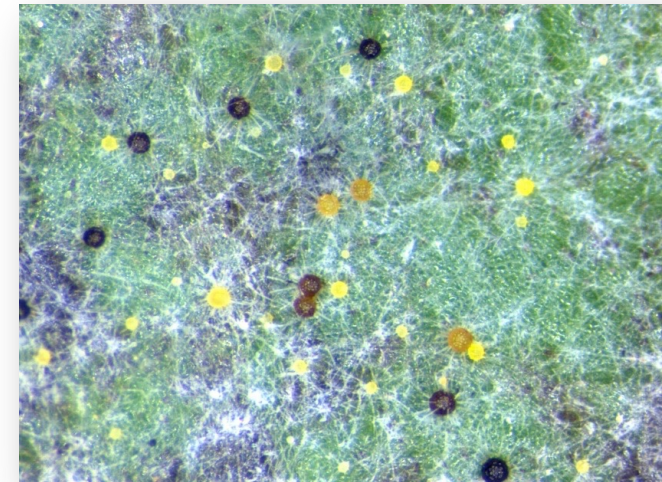
Flag shoots:

Carignane vineyard in Somerset west for two seasons

In 2006 (Halleen et al. 2016)

100s of chasmothecia per leaf

Stellenbosch, Paarl, Somerset West



Shift in fungicide sensitivity against several actives in South Africa are suspected

An urgent and critical re-assessment of primary inoculum in Western Cape vineyards is required



Aim

Re-investigate the epidemiology of powdery mildew in South African vineyards

1. Survey on the wide-spread occurrence of chasmothecia in table, wine and raisin vineyards
2. Monitor the epidemiology bi-weekly in four vineyards in a Mediterranean climate (Csa, Csb)
 - Specific focus on chasmothecia formation, overwintering and spore release

Survey of occurrence of chasmothecia

Occurrence of sexual state in Western Cape and Northern Cape vineyards

End of February 2023 – Winter 2024

Symptomatic plant material sampled:



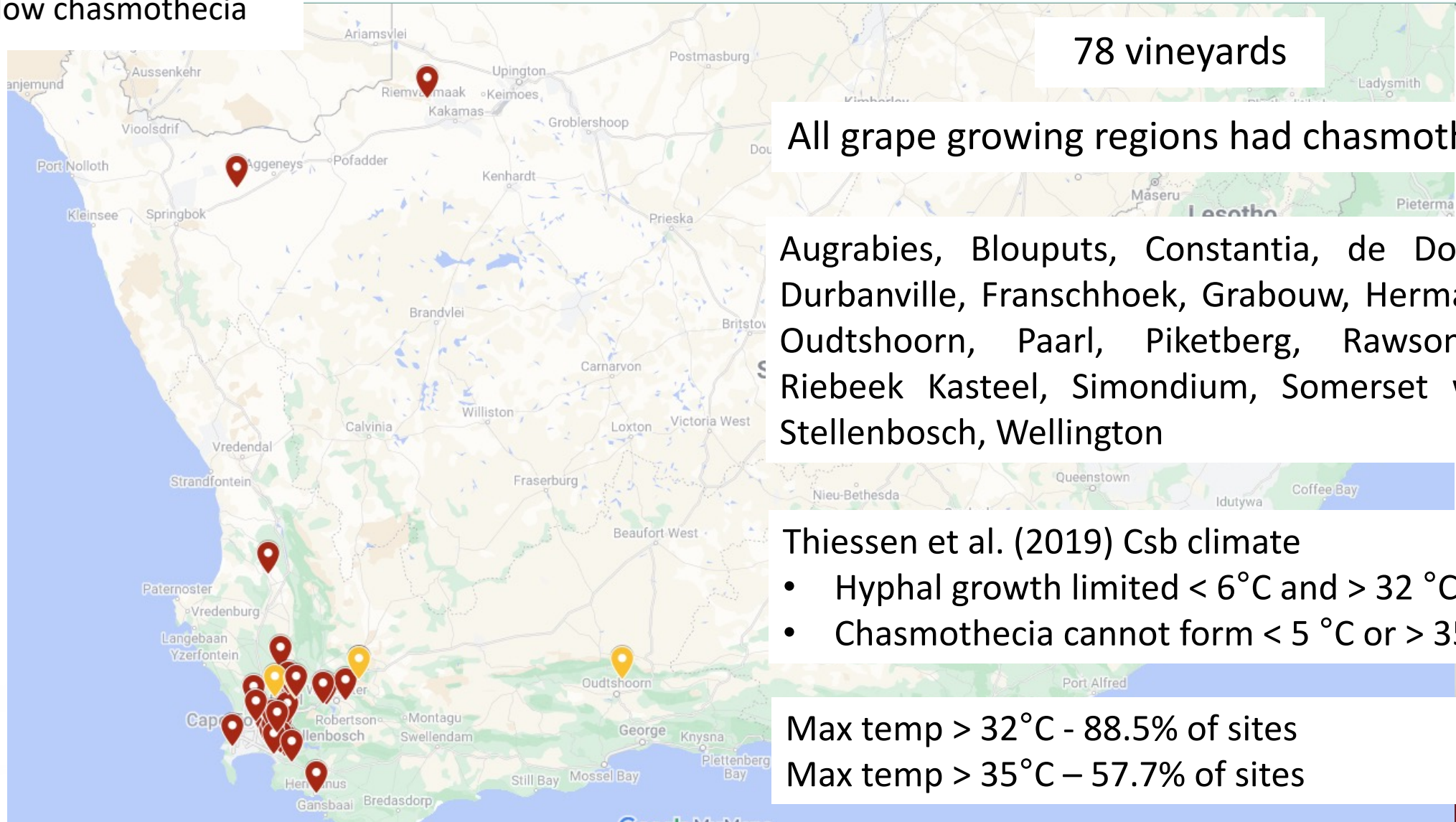


Mature chasmothecia



Yellow chasmothecia

Survey of occurrence of chasmothecia



78 vineyards

All grape growing regions had chasmothecia

Augrabies, Blouputs, Constantia, de Doorns, Durbanville, Franschhoek, Grabouw, Hermanus, Oudtshoorn, Paarl, Piketberg, Rawsonville, Riebeeck Kasteel, Simondium, Somerset west, Stellenbosch, Wellington

Thiessen et al. (2019) Csb climate

- Hyphal growth limited $< 6^{\circ}\text{C}$ and $> 32^{\circ}\text{C}$
- Chasmothecia cannot form $< 5^{\circ}\text{C}$ or $> 35^{\circ}\text{C}$

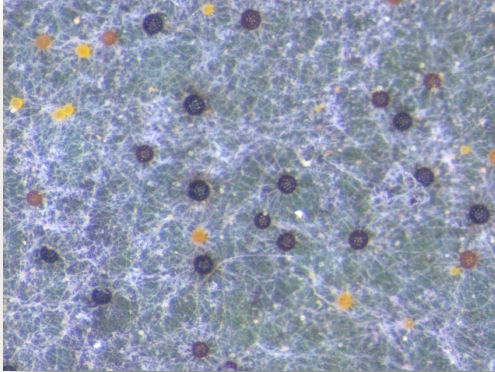
Max temp $> 32^{\circ}\text{C}$ - 88.5% of sites

Max temp $> 35^{\circ}\text{C}$ - 57.7% of sites

Climate of regions: Csa, Csb, Bsk

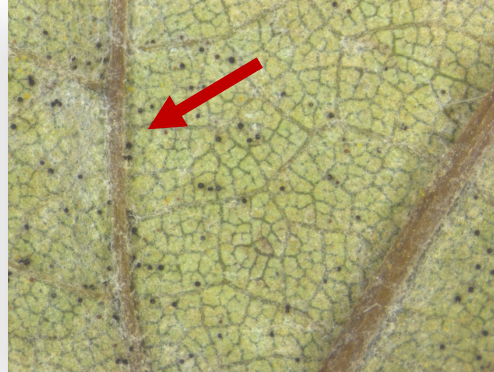
Unexpected observations

Adaxial side of leaf



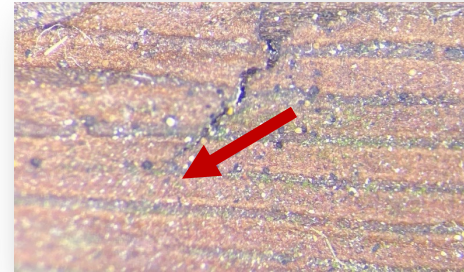
Clusters

Abaxial side of leaf



Concentrated around veins

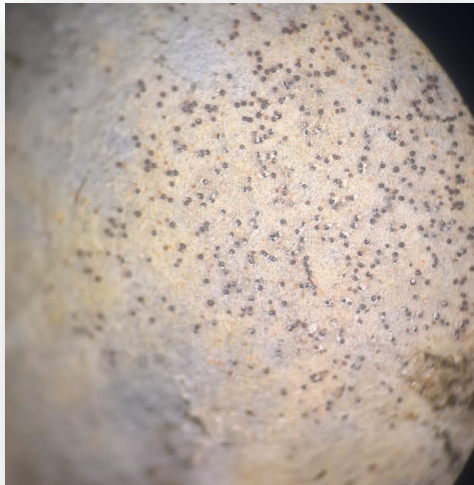
Bark – early February



Post-harvest bunches



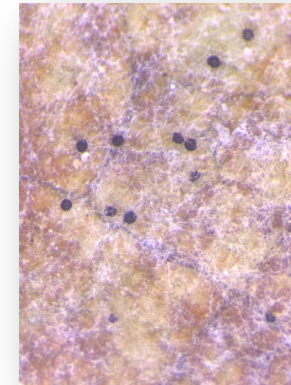
Copious amount on berries



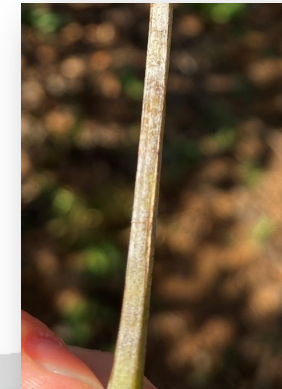
Concentrated around pedicel



Leaf litter



Shoots and petioles



Red and green bunches

First observation on Chardonnay on early January

Ontogenic resistance -> when sugar develop

Mature chasmothecia over time

Four vineyards:

- Simondium (Csa)
- Stellenbosch (Csb)
- Wellington (Csa)
- De doorns (Csb)

Csa - Hot-summer Mediterranean climate
Csb - Cool-summer Mediterranean climate

- Five vines per site
- Every two weeks



5 Symptomatic leaves



14 weeks
March 2023 - June 2023

15 g Leaf litter



8 weeks and 16 weeks
March 2023 - July 2023

5g Bark



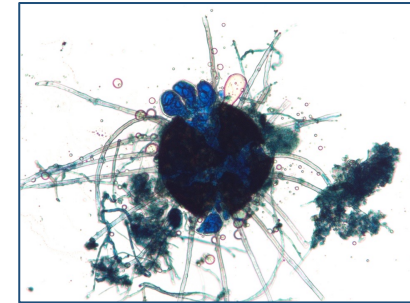
36 weeks
March 2023 - present

Harvesting chasmothecia

1. Plant material into 250mL H₂O
2. Shaken for 5 minutes
3. Plant material removed
4. Filtered through 45uL sieve
5. Backwash with 10 mL ddH₂O
6. Pipette 1mL suspension onto 9mm filter paper
7. Count and calculate mature chasmothecia per 10 mL

Viability of ascospores:
Tryphan Blue

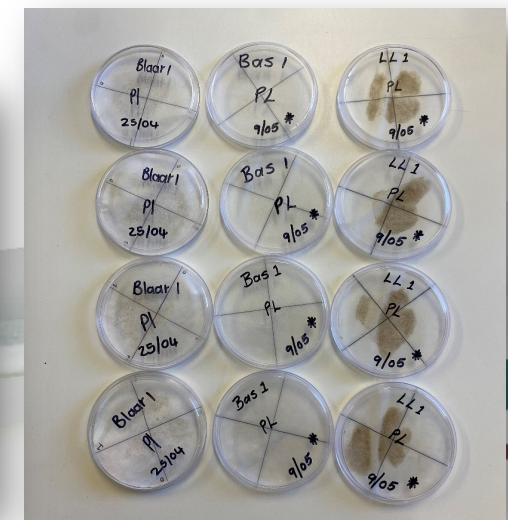
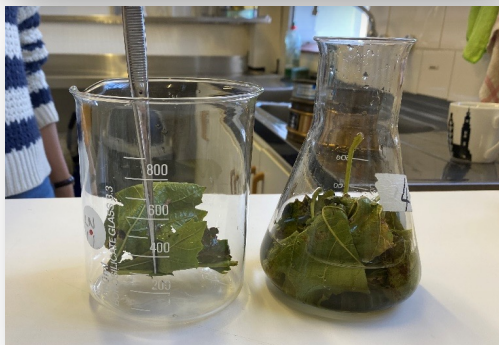
Non - viable



Viable



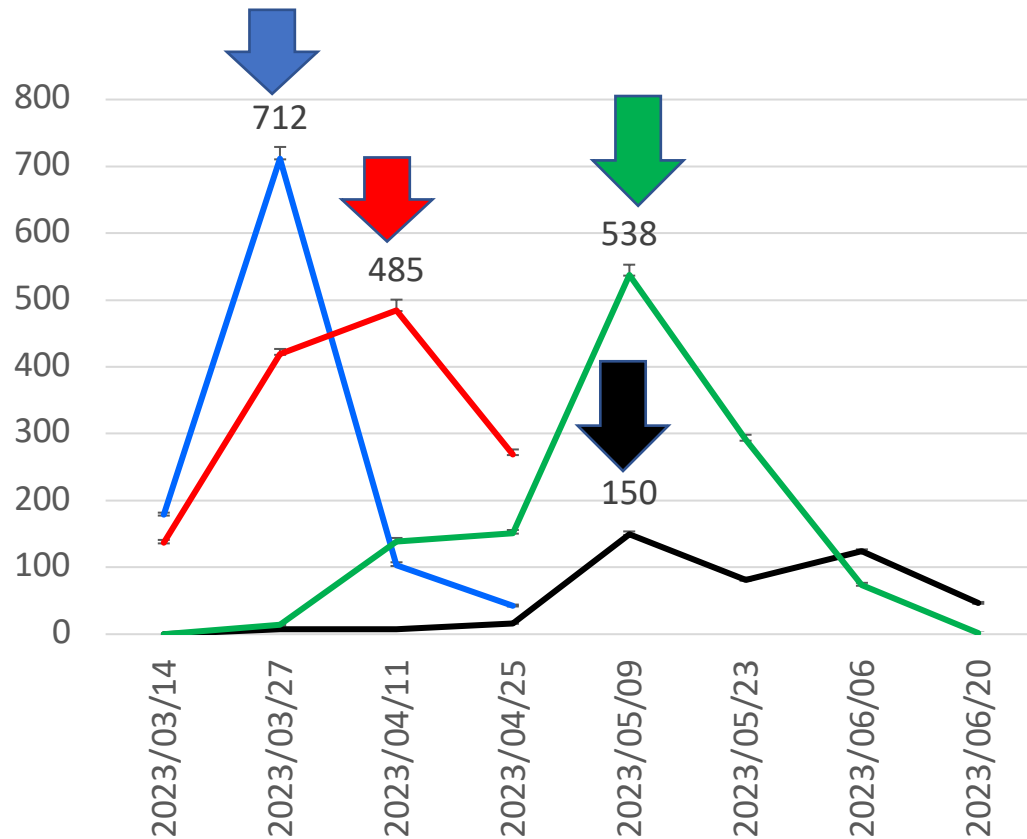
4x



— De Doorns (Csb) — Simondium (Csa)
 — Stellenbosch (Csb) — Wellington (Csa)

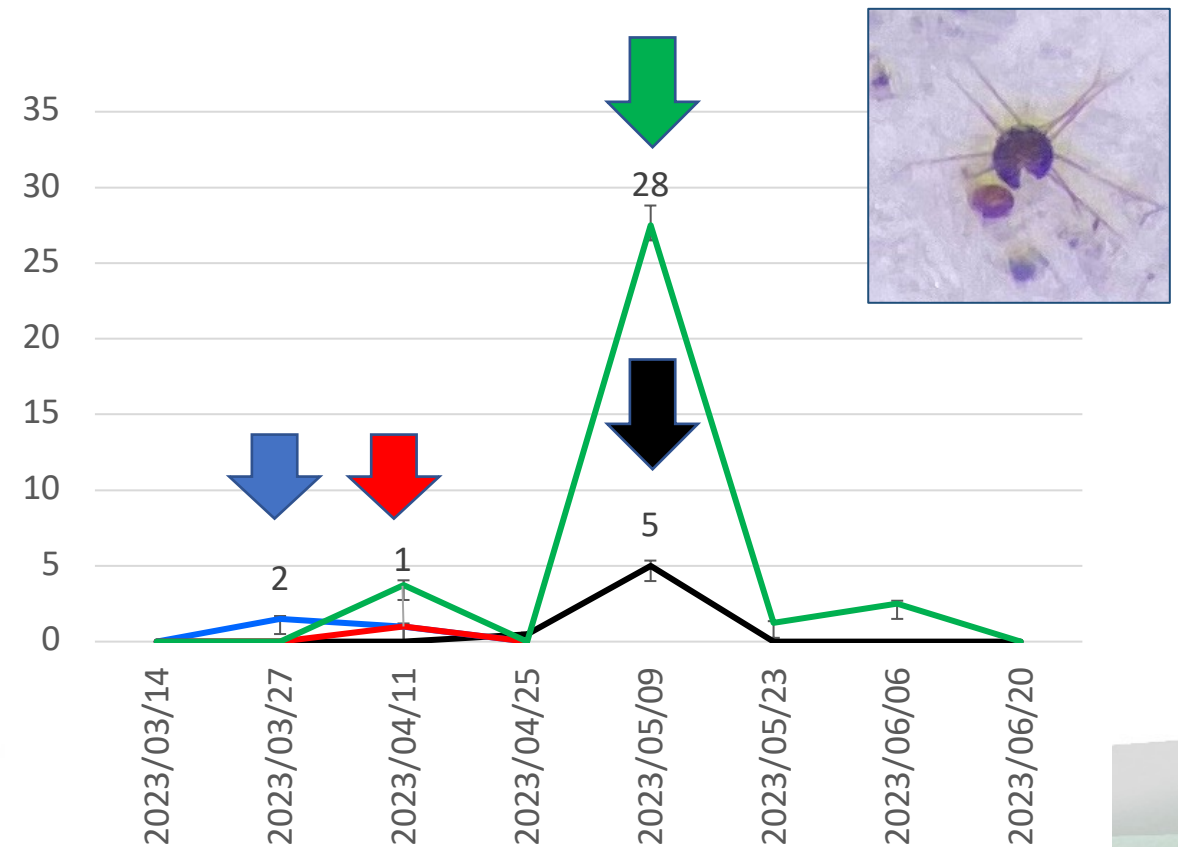
Mature chasmothecia on leaves

Average mature chasmothecia on 5 leaves



Large number of chasmothecia on leaves

Average disseminated chasmothecia



Ascospores released prior to winter?

Ascospore release pattern

Simondium vineyard (Csa)

4 April 2023 – present (33 weeks)

Vaseline-coated microscope slides in 5 vines

- 2 slides per vine
- 10 slides in total
- Replaced weekly

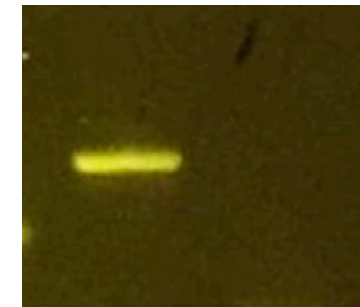


Between leaves



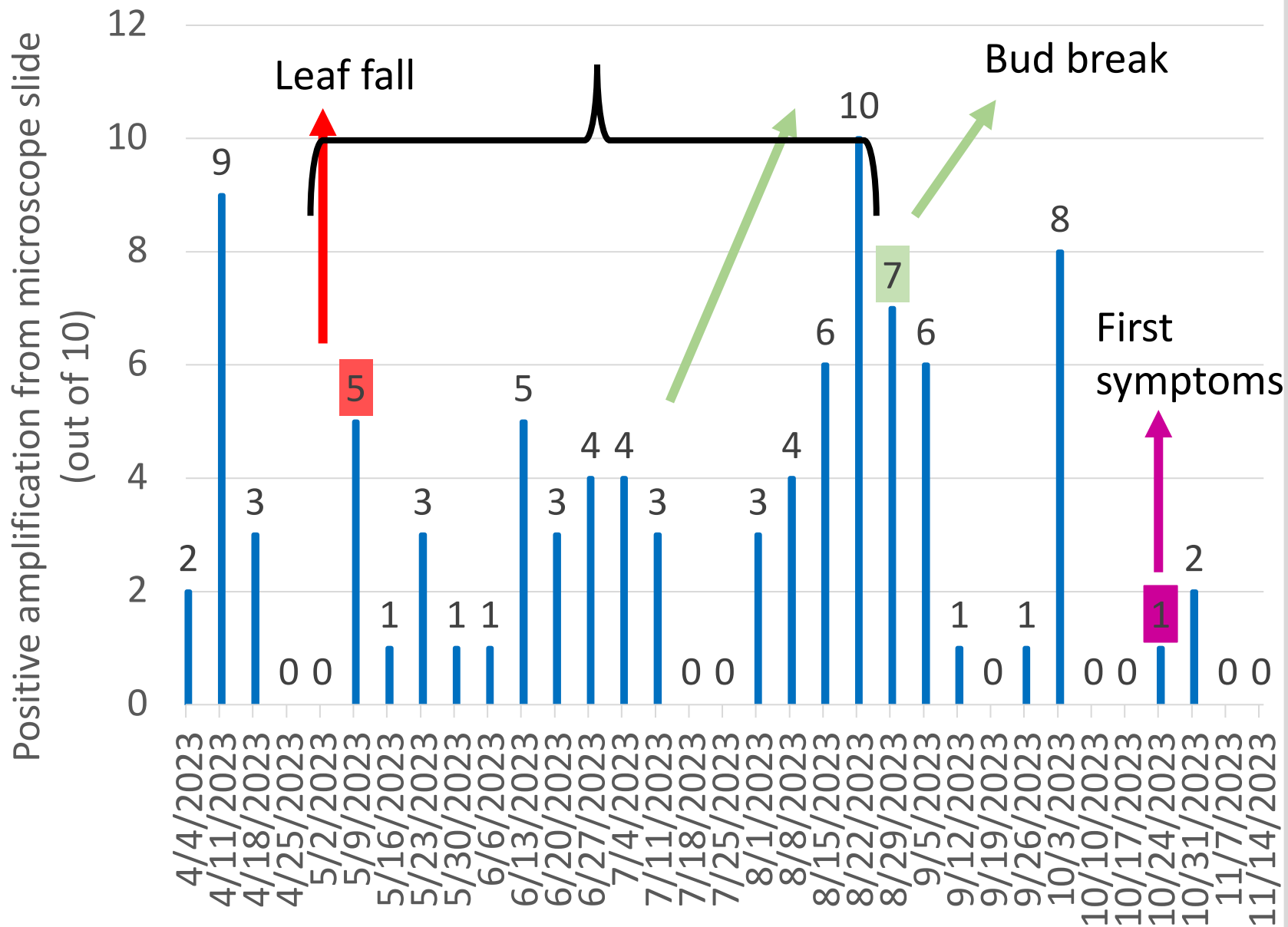
Cordon height

DNA extractions
Species-specific PCRs
(Uncin144 and Uncin511)



Incidence of positive amplification
for 10 slides per week

Ascospore release pattern



Incidence of positive amplification for 10 slides per week

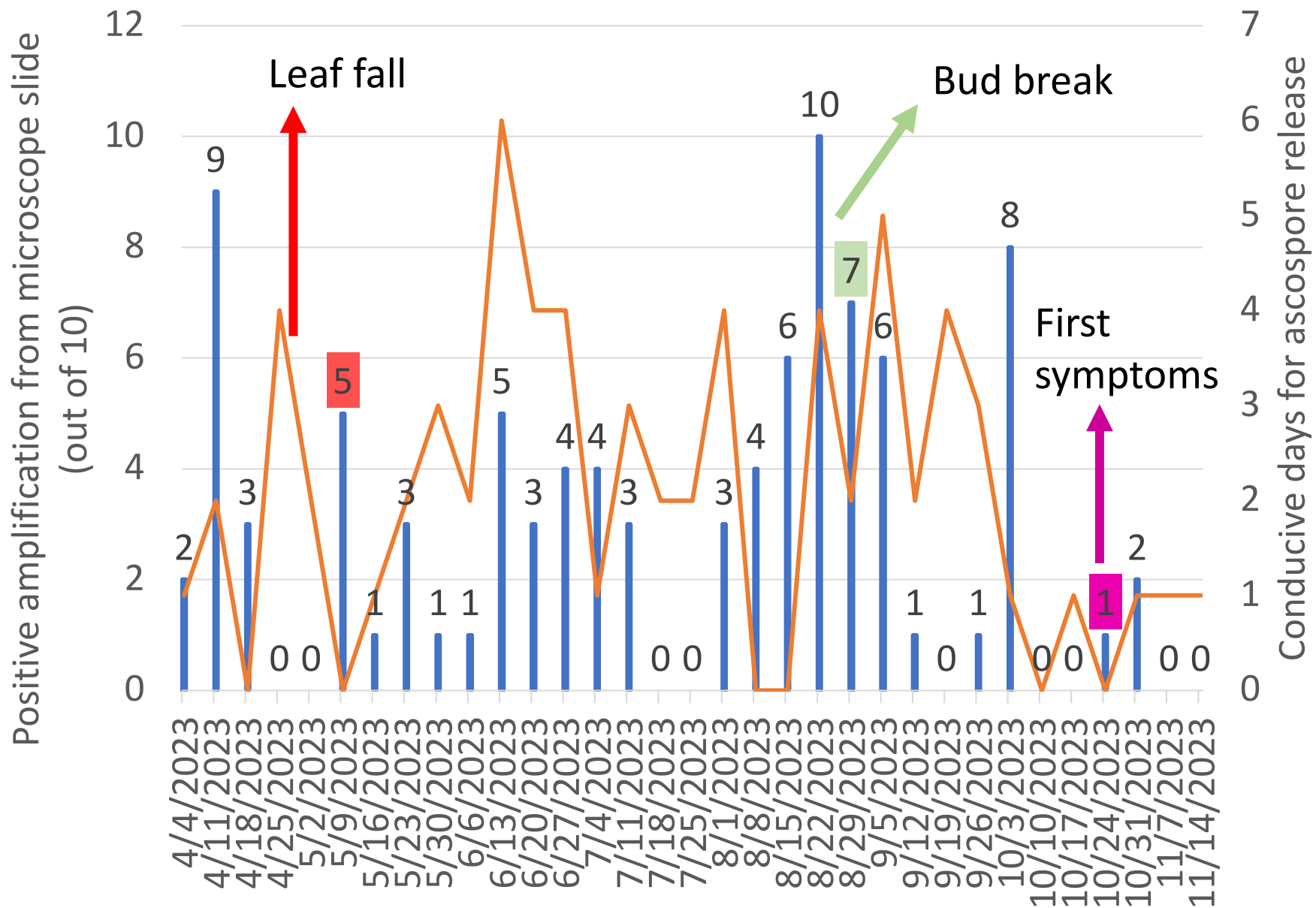
Spore release:

- Before winter
- Throughout winter
- Increase before bud break

Ascospore release in
Within a 24-hour period

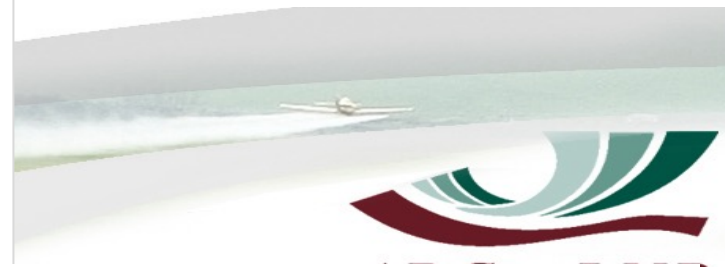
- Temp > 4°C
- Rain > 2.5 mm
- RH > 80%
- Leaf wetness > 6h

Ascospore release pattern



- Ascospore release in Within a 24-hour period
- Temp > 4°C
 - Rain > 2.5 mm
 - RH > 80%
 - Leaf wetness > 6h

Conditions conducive throughout winter for 2023 season in Simondium



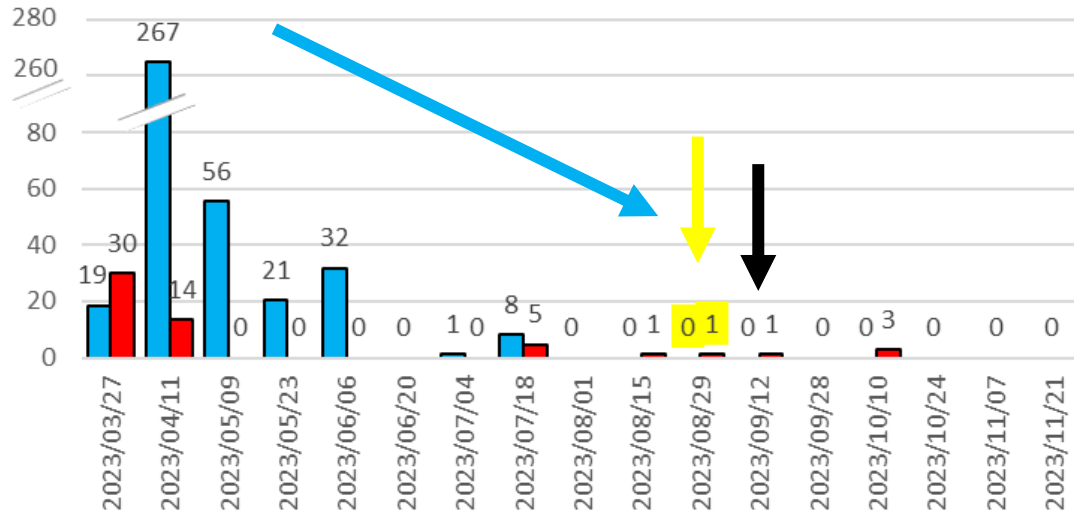
■ Leaf Litter ■ Bark

Bud break

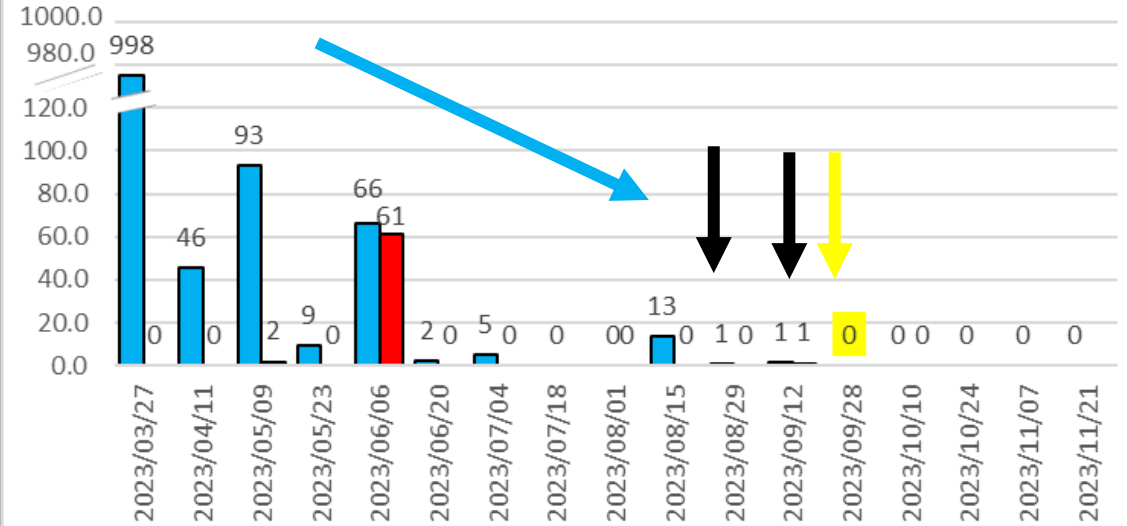
Chasmothecia on leaf litter and bark

Pruning debris

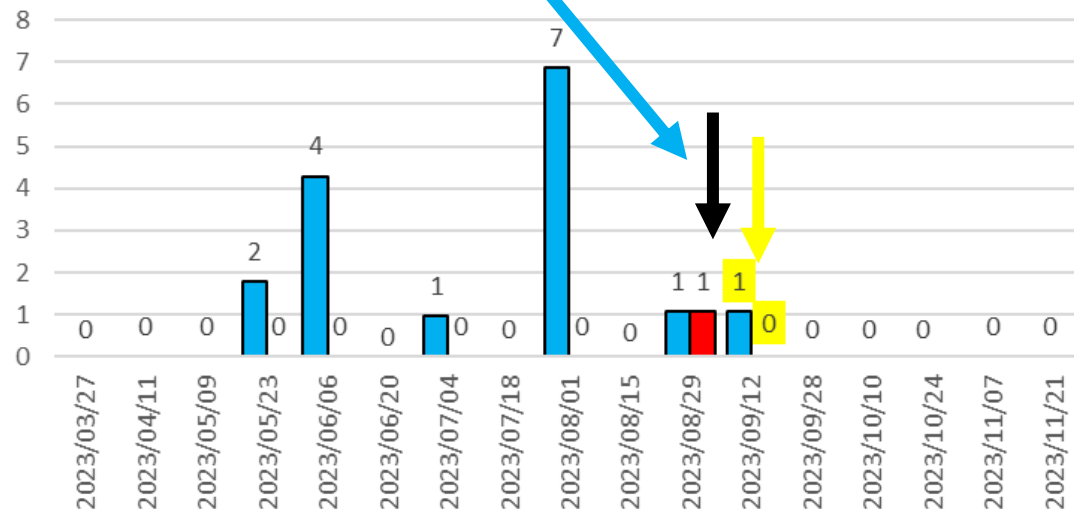
Simondium (Csa)



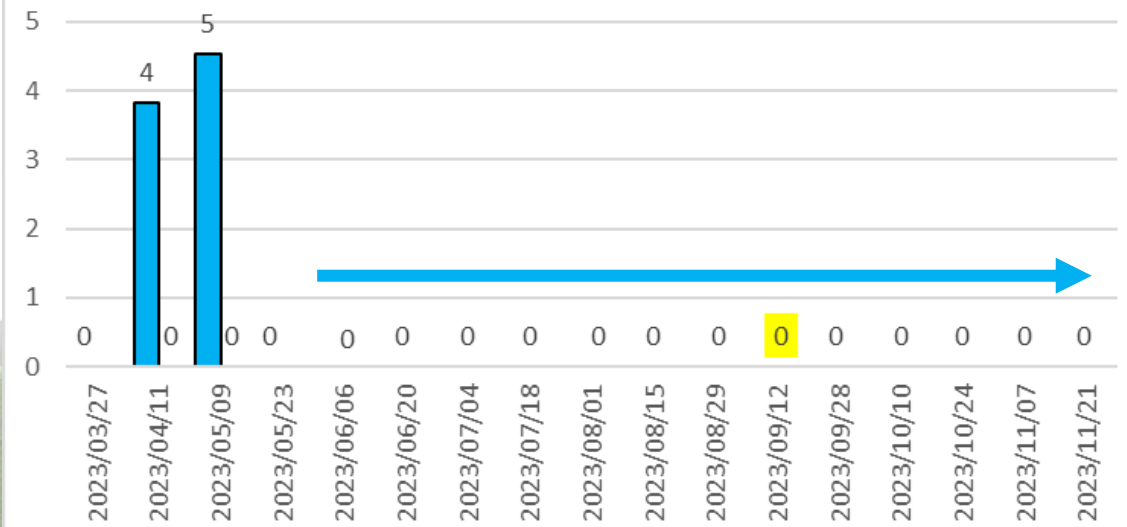
Stellenbosch (Csb)



Wellington (Csa)



De doorns (Csb)



Leaf litter as inoculum source

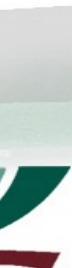
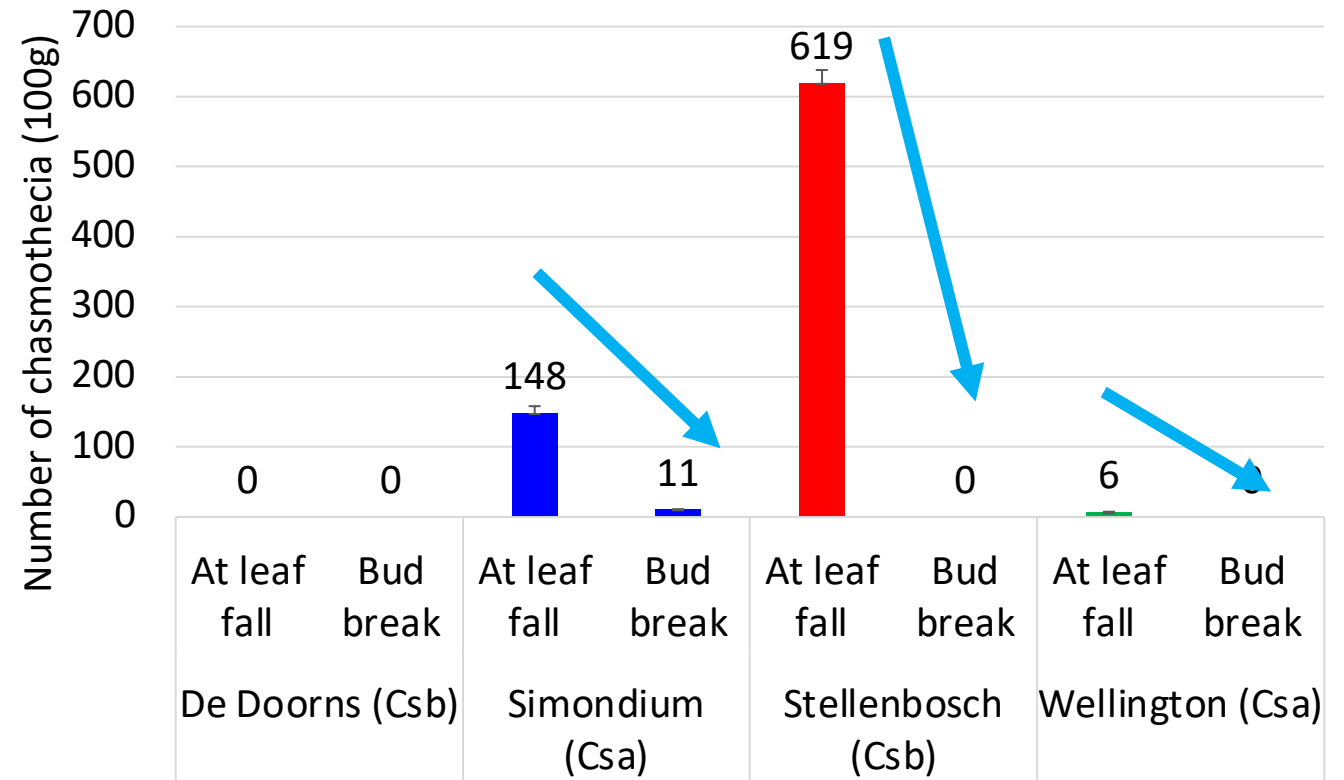
100g of leaf litter
5 vines at leaf fall
Collected at bud break



Very little leaf litter at bud break

Milder climatic regions: Australia, California, Italy:
Leaf litter is an important inoculum source

Colder winter regions: Europe, New York:
Colder region, leaf litter decomposed by bud break



Asexual phase: Flag shoots

Bud break – 10 weeks later

Survey sites for 30 minutes for flag shoots

No flag shoots were observed in any site

One flag shoot in a home garden in Somerset west (18 October 2023)

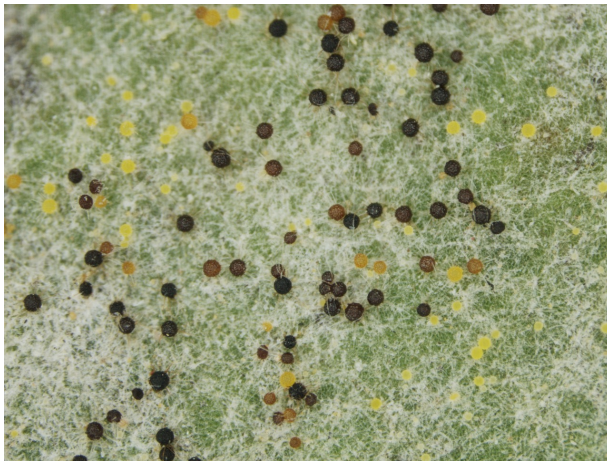
Only area where flag shoots have been reported in large numbers in South Africa



Take home message

Large increase in number of chasmothecia before winter

All grape-growing regions



In Austria similar observation from 1990 – 2021

(Steinkellner, 1998); (Redl et al., 2021)

Possible reasons for increased sexual reproduction:

1. Climate change drives survival and viability of ascospores:
 - Western Cape colder and wetter: creating environment for sexual reproduction
2. Both mating types were not present in South Africa in 2000?
 - Recently introduced
 - Limited to Stellenbosch and Simondium
3. Increase disease incidence:
 - Higher likelihood for compatible partner to find one another
4. Fungicides:
 - Forces survival of pathogen

Take home message

Ascospore release throughout winter and before bud break

Csa, Csb - Mediterranean climate conducive for spore release: South Africa, Oregon, Australia, South America

Possible depletion of inoculum before bud break

No flag shoots were found in sites

Low incidence in Austria, Hungary, Italy

Chasmothecia can over winter on leaf litter and pruning debris

This would only be of concern if leaf litter is still present close to bud break

Sexual reproduction is concerning

- Drives survival of pathogen
- Shift in fungicide sensitivity
- Adapt to wider range of climatic conditions

Management practices to reduce chasmothecia:

Possibly fungicide application after harvest

Acknowledgements



ARC weather stations

