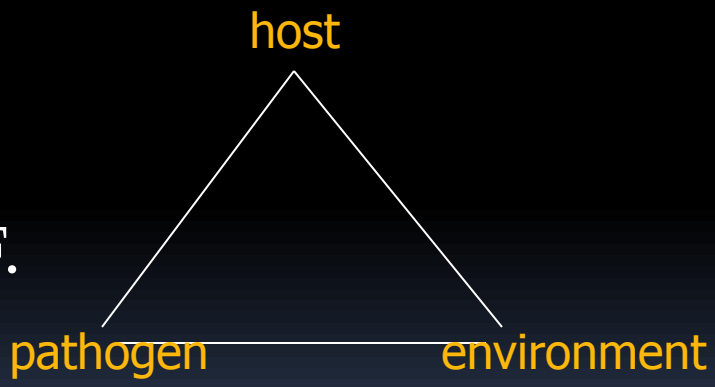
- Botrytis Bunch Rot- *Botrytis cinerea*

  Sour Rot (Summer bunch rot)- *Aspergillus niger, A. carbonarius, Cladosporium spp, Alternaria spp, Penicillium spp., Acetobacter, yeasts*

Disease Triangle

- Pathogen
  - Requires free water for spore germination.
  - Requires free water for infection.
  - Requires >95% RH for sporulation.
- Environmental Conditions
  - Temps between 10-30 C.
  - Optimum temperature is 65 F.
- Host
- Time



Epidemiology

- Sporulation-Requires RH above 95%
- Spore dissemination-Requires water splashing or air movement
- Disease Initiation-Requires certain number of hours of wetness at given temperatures for:
  - Spore germination
  - Infection
    - At 65-75F only 2 hrs are needed

Epidemiology

- Fungus is ubiquitous
- Fungus is a weak pathogen
- Attacks juvenile tissue, highly succulent and senescent tissue such as blossom parts, ripe fruit and injured or dead tissues.
- After infection the fungus can survive as a saprophyte on dead tissue or can produce sclerotia.

Epidemiology

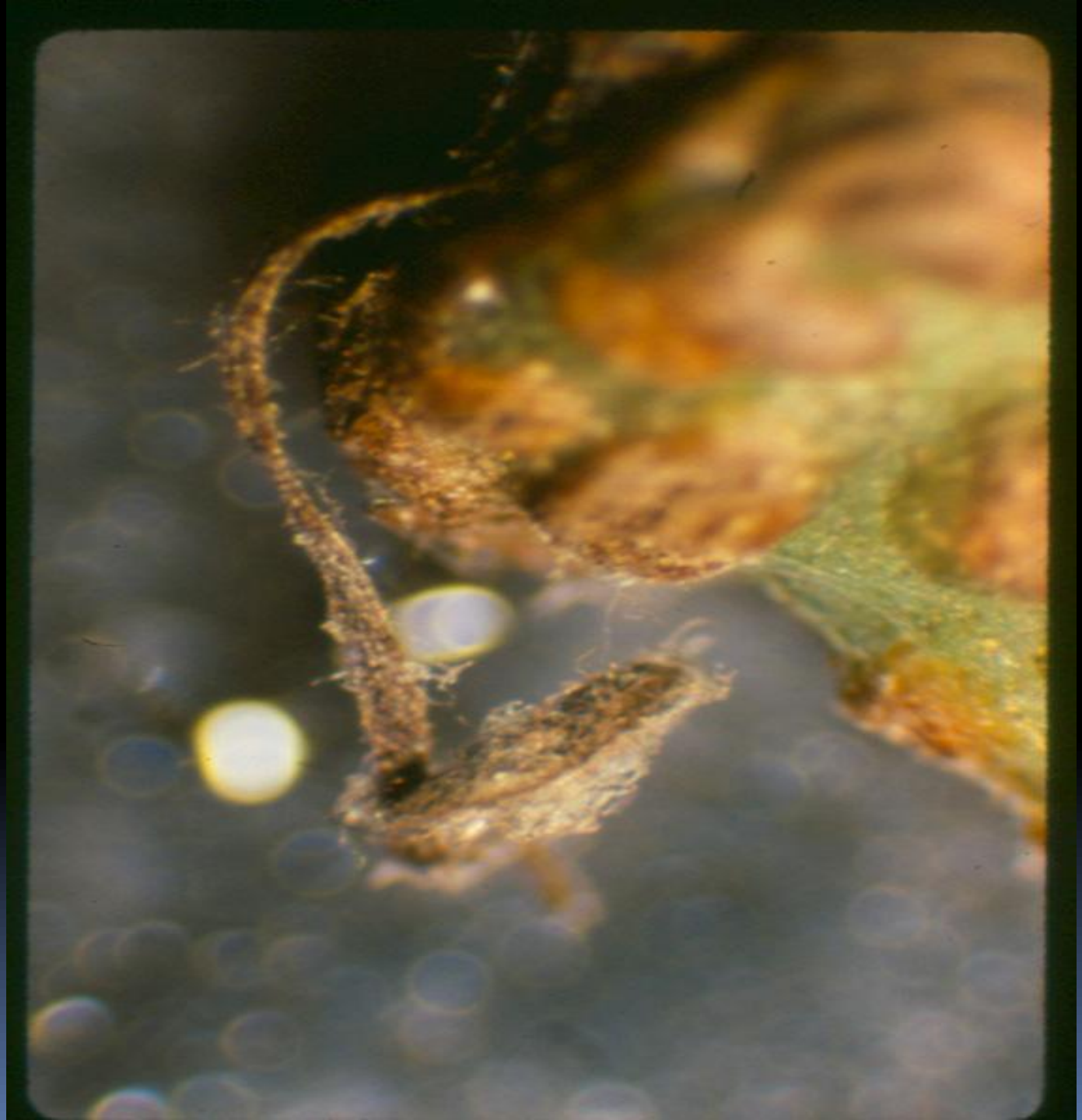
- The fungus can be associated with debris on the vine or on the vineyard floor:
  - sclerotia.
  - blossom
- Sclerotia can survive adverse conditions.
- Sclerotia germinate to produce conidia.
- Conidial production favored by successive interrupted wet periods.
- Conidia are dry and are dispersed by air currents or by water-splashing.

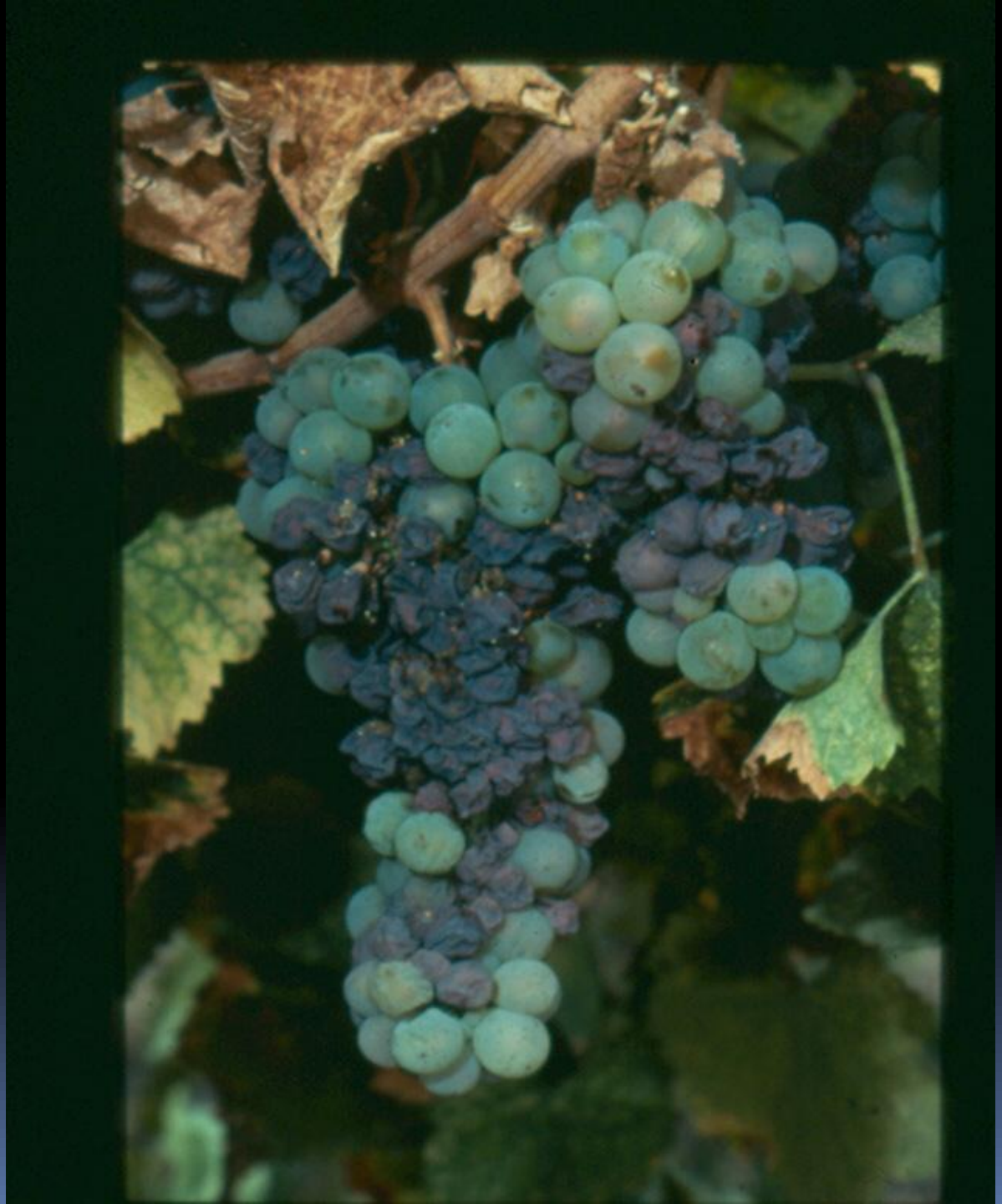
Epidemiology

- Infection occurs in dead and senescing flower parts and invades through the stamens into the receptacle.
- Pathogen can also invade the necrotic areas around the abscission layer of the shredded calyptra on the receptacle.
- Young berries resistant to infection due to epicuticular wax and chemicals in the wax.

Symptoms

- Can occur as 2 epidemics
  - Early mostly asymptomatic and occurring from pre-bloom to fruit set.
    - Brown-reddish lesions develop on leaves. Shoot dieback.
    - Blossoms become latently infected
  - Later from pea-sized berries through harvest
    - Starts as browning of the skin of the fruit and invades other berries through cracks and wounds.
      - Berry leakage
    - Dry weather=lesions cease expansion
    - Wet weather=lesions continue to expand and fungus moves to other berries.





Symptoms

- Poorly hardened shoots may show bleaching in the fall with development of black sclerotia forming in bleached tissue.
- This occurs mostly around nodes and suggests entry of the fungus through the petiole of a diseased leaf or through a leaf scar.
- Sclerotia in mummified berries.

Control

- Fungicides
  - Timing-bloom, preclose, veraison, pre-harvest
- Leaf removal
  - Timing-Cluster set
  - Epicuticular wax
- Blossom Debris Removal
  - Very important to do this early
- Cluster Architecture
  - Prevent berry touch

Botrytis Model

- At conducive temperatures, susceptible tissues typically require only a couple hours of moisture for bunch rot infections to occur, and growers must respond immediately with an eradicative spray because infections flare quickly during bloom or after veraison.

- While the model can accurately predict the risk of infection, the key to using the model successfully for botrytis is being able to respond quickly once that risk threshold is reached.

- This has been a severe limiting factor in the adoption of risk model technology for most grape growers.

The model developed at UC Davis uses a computation of average temperature during leaf wetness events to predict the onset of Botrytis bunch rot infections.

- It then converts those moisture and temperature inputs into an infection index ranging from 0 to 1.0 where :

an index below .5 is a low risk of infection,

0.5 to 1.0 is a moderate risk of infection

1.0 or higher indicates a high risk of infection.

- Growers will then make a decision on when to treat based on that index and their own level of risk tolerance and vineyard history.

▪While the model is a sound predictor of the onset of infections, the catch is in having real time weather data and corresponding botrytis alerts in time to get a fungicide application on in advance of pathogen sporulation.

▪After an infection event, most fungicides only give you about 12 hours of kickback activity to eradicate botrytis.
It's a problem finding out today that yesterday was a bad botrytis day.

▪With the botrytis model, a weather station can forecast the index out for five days, so a grower can use the model as a protectant approach because they know ahead of time when infection is going to occur.

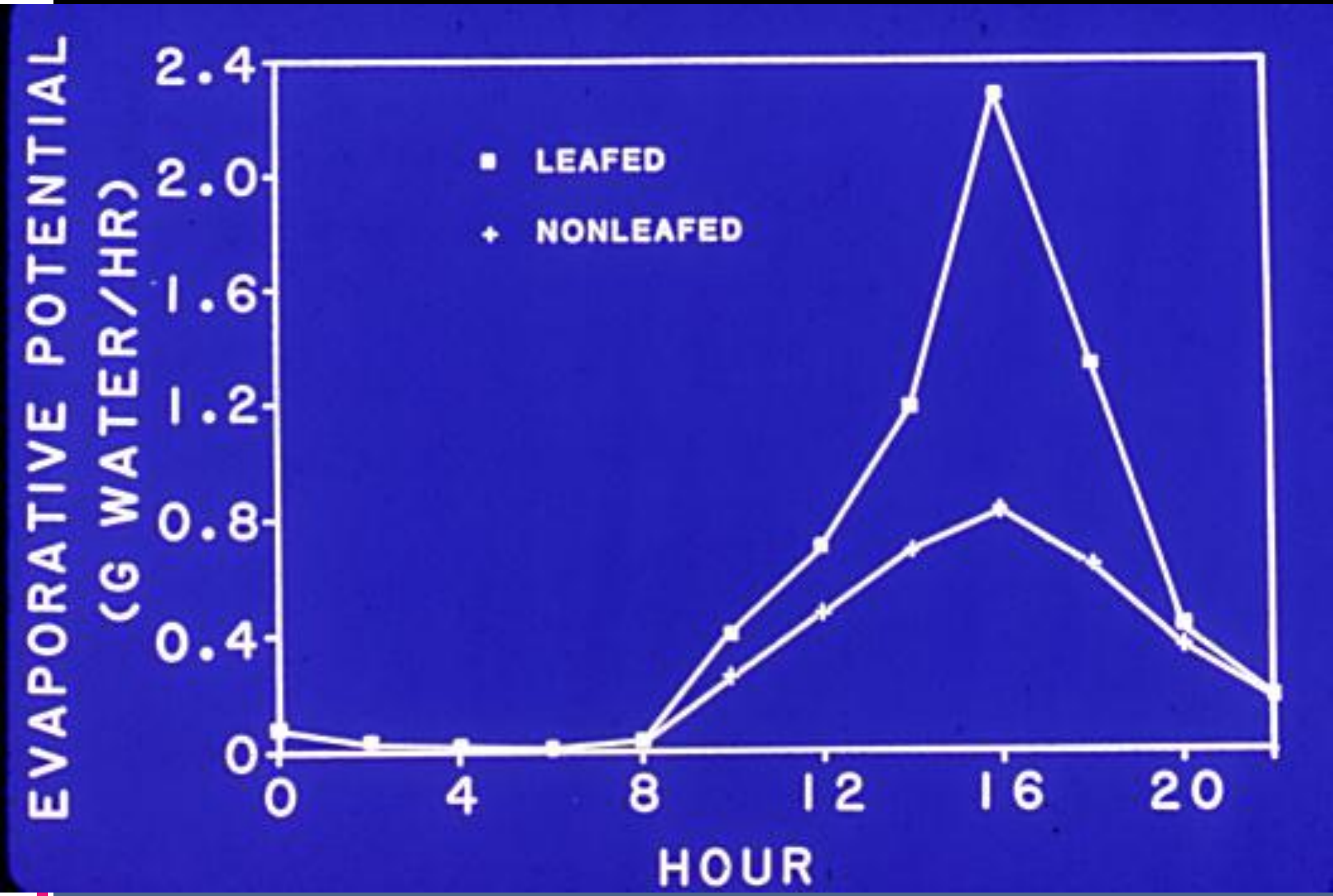
▪The model works in tandem with weather forecasting based on the leaf wetness and temperature conditions expected each day."
Fox says the model allows growers to account for climate variables within a region or vineyard to more accurately forecast the potential for infection

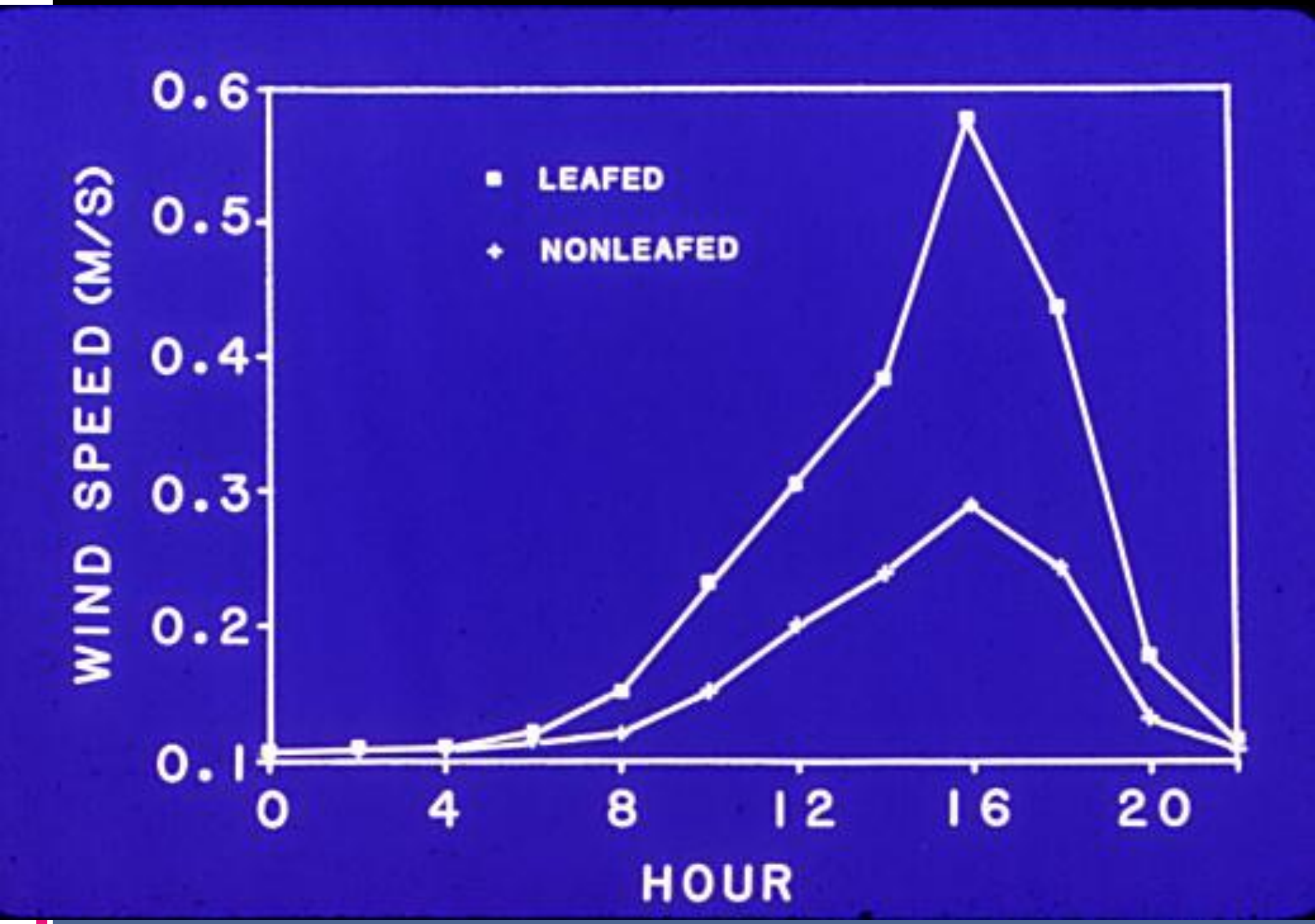
Adcon, Metos, Weather machines have model software for Botrytis model

Control

- Canopy Management
  - Leaf removal

Epicuticular Wax on surface of grape berry


EVAPORATIVE POTENTIAL
(G WATER/HR)
2.4
2.0
1.6
1.2
0.8
0.4
0
LEAFED
NONLEAFED
0
4
8
12
16
20
HOUR


WIND SPEED (M/S)
0.6
0.5
0.4
0.3
0.2
0.1
LEAFED
NONLEAFED
0
4
8
12
16
20
HOUR

Effects of canopy management and fungicide applications on botrytis bunch rot in Chenin blanc, Napa County, 1985

		TIMING OF FUNGICIDE APP.				
		Control	Bloom	Preclose	Bloom+ Preclose	Mean
		Incidence (% diseased clusters)				
Leaf Removal		6.2	7.1	4	5.1	5.6
No removal		30.5	29.2	29.2	20.7	27.4
Mean		18.4	18.1	16.6	12.9	NS
		Severity (% rot per cluster)				
Leaf Removal		0.3	0.4	0.1	0.3	0.3
No removal		3.4	5.1	3.7	3.1	3.8
Mean		1.9	2.3	1.9	1.7	NS
		Yield (tons per acre)				
Leaf Removal		4.7	5.1	4.7	3.8	4.6 NS
No removal		5.8	5.2	5.4	5.4	5.4

Bettiga, Gubler, Marois, Bledsoe. California Agriculture, 1989

Effect of Leaf Removal and fungicide sprays on Botrytis bunch rot in Zinfandel, Lake County, 1986

INCIDENCE: PERCENT CLUSTERS WITH ROT

Rovral at 1.5 lb/acre applied at following timings:

	Unsprayed Control	Bloom	Bloom + Post-bloom	Pre-bloom+ Bloom+ Post-bloom	Mean
No Leaf Removal	28.2	31.1	22.7	18.7	25.2a
Leaf Removal	5.7	5.9	3.4	6.4	5.4b
Mean	16.9	18.5	13	12.6	

Effect of Leaf Removal and fungicide sprays on Botrytis bunch rot in Zinfandel, Lake County, 1986

SEVERITY: PERCENT ROT PER CLUSTER

Rovral at 1.5 lb/acre applied at following timings:

	Unsprayed Control	Bloom	Bloom+ Post-bloom	Pre-bloom+ Bloom+ Post-bloom	Mean
No Leaf Remova	10.7	14.2	11.2	8.2	11.1 a
Leaf Remova	1.2	1.0	1.1	2.9	1.6b

Effect of cluster tightness, by clone, on Incidence and Severity of Botrytis Bunch Rot

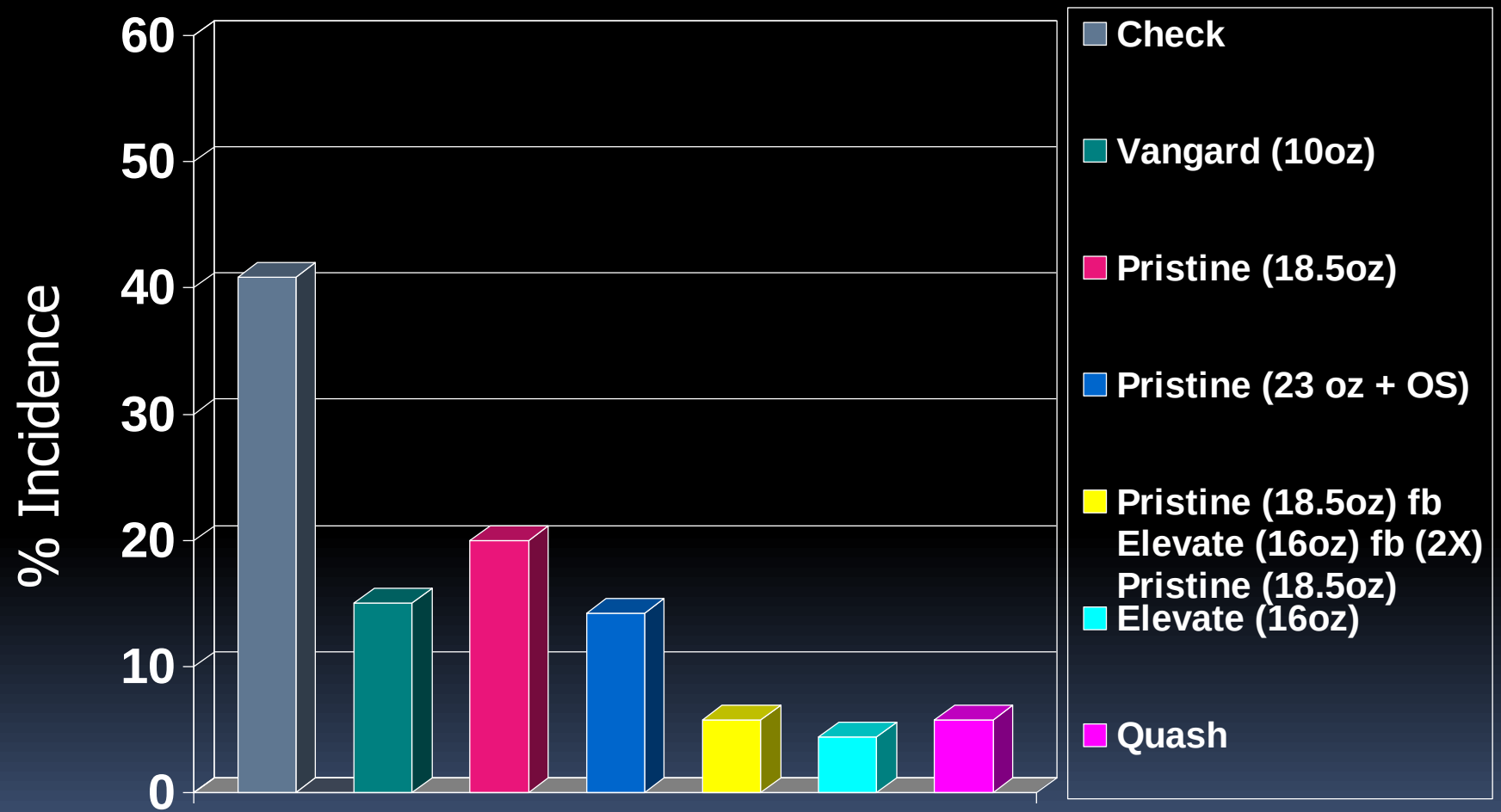
Table 3. Effect of Chardonnay clone on incidence and severity of Botrytis bunch rot in two trials in the Napa Valley, California, 1991

	Incidence (%)		Severity (%)	
Clone	**Cane-pruned**	**Spur-pruned**	**Cane-pruned**	**Spur-pruned**
16	81.5 a[z]	38.5	9.0	8.3
6	61.0 ab	13.5	6.0	7.1
14	60.5 ab	27.5	7.1	9.3
5	60.5 ab	28.0	6.8	13.4
4	56.0 b	26.0	8.9	8.7
15	44.5 b	15.0	3.5	2.4
Standard error	6.1	14.9	3.7	6.7

[z] Numbers in a column followed by the same letter are not significantly different by Duncan's multiple range test ($P < 0.05$).

Vail, Wolpert, Gubler, Rademacher. **Plant Disease** Jan. 1998

Gubler 2010 Grape Botrytis Trial
Carneros - Chardonnay

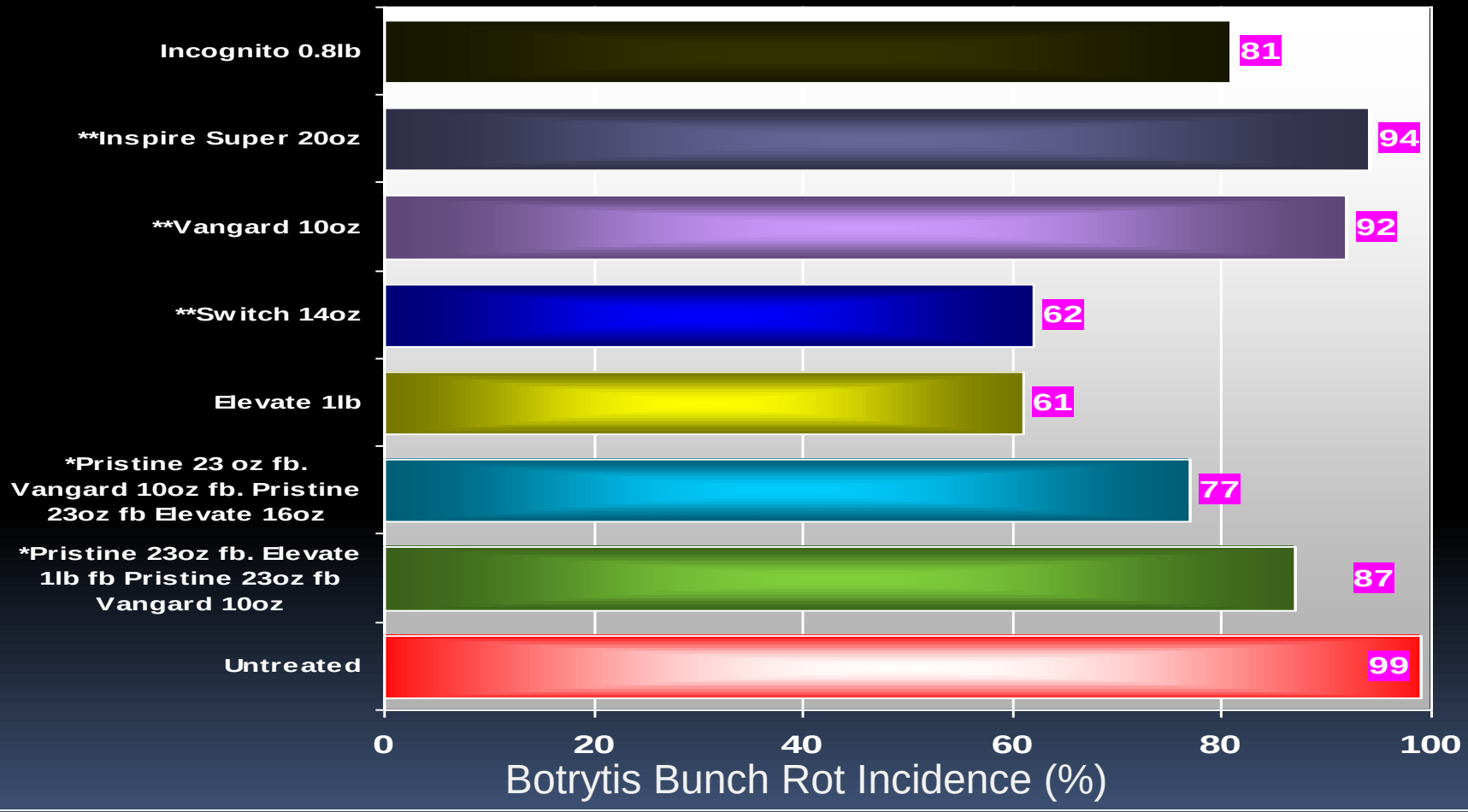


Applications: Bloom, Pre Close, Veraison, & Pre-Harvest – 200 gpa

Ratings taken 21 days after final evaluation

Grape Botrytis Bunch Rot

Doug Gubler, Carneros, CA – 2011 – Final Results



2011 Doug Gubler Carneros, CA - Chardonnay

Four Applications – Bloom (6/15), Pre-Close (7/12) and Veraison (8/25) and Pre-Harvest (9/30) Evaluations – 10/13; 20-30 clusters from each plot

*treatments applied with OS at 3oz/100 gallons - **treatments applied with 0.25% MSO/OS Adjuvant

Sour rot/Summer bunch rot

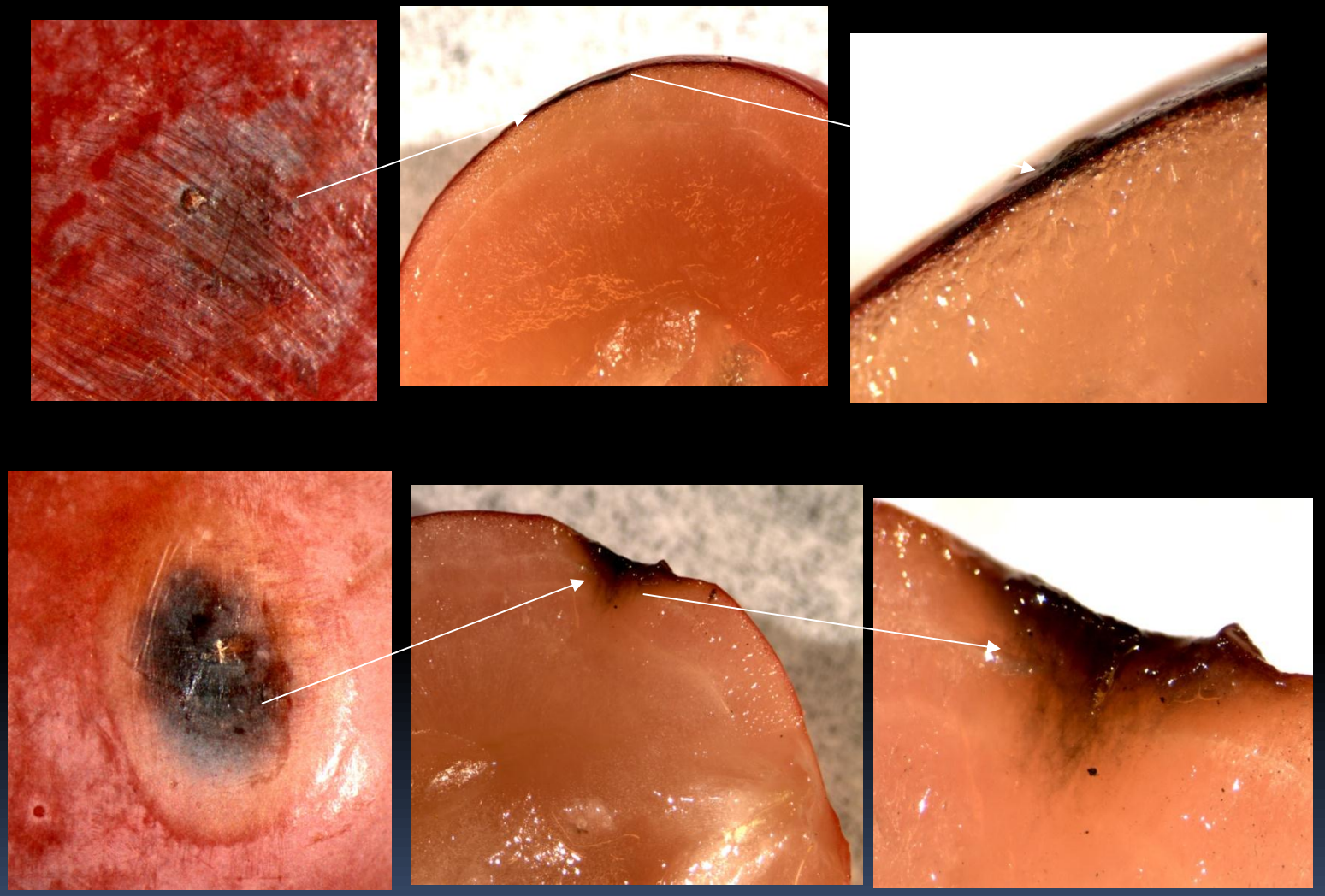
Typical sour rot symptoms in northern vineyards (RG15 and RG31). Grapes are infected with *Aspergillus* and many other fungi/yeasts and are showing leakage

Gubler, UC Davis

Pathogens ??

- *Aspergillus niger*
- *Aspergillus carbonarius*

Skin infection of Red Globe berries (Dec 10, 2008)



It looks like the fungus infected berry skin and expanded gradually into the pulp. It could be the lower temperature that induces the brown spot symptom. Artificial inoculation will be used to re generate the spot symptom.

Seecondary invaders

- *Cladosporium spp*
- *Alternaria spp*
- *Penicillium spp*
- Yeasts
  - *Hanseniospora spp*
- Bacteria
  - *Acetobacter*
  - *Bacillus*

Colonization of berry surface by *Cladosporium* spp.

Aspergillus Biology

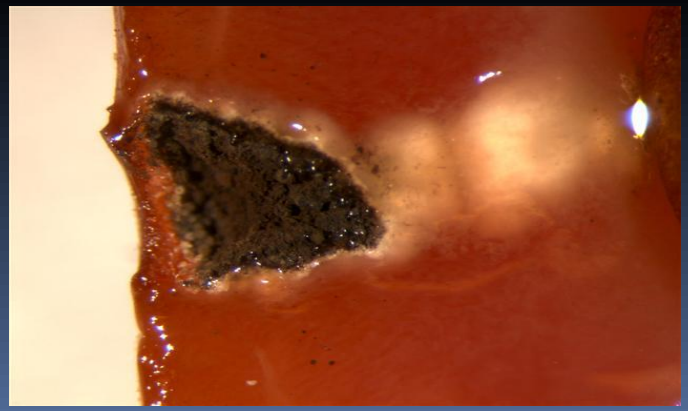
- Soilborne
- Populations of spores increase about veraison
- Aspergillus invades through wounds
- Immediately colonizes pulp
- Produces fruiting body
- Berry falls to ground and fruiting body allows overwintering in soil

Disease epidemiology

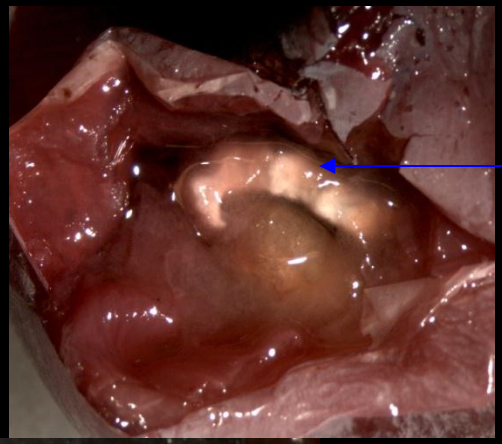
- Disease initiated from veraison until harvest
- Spores released from soil with soil disturbance.
- Wounding occurs from powdery mildew, insects, wind damage, sand blasting.
- No moisture necessary- fungus uses juice leakage
- “Wet” clusters then allow other fungi, yeasts and bacteria to colonize.

- Aspergillus can cause bunch rot without progressing to sour rot.
  - Cabernet sauvignon
  - Zinfandel

- A novel sporulation structure produced by *Aspergillus* spp. has been observed in grape berries affected by sour rot
- *Aspergillus* is a wound pathogen that requires injury for infection to develop typical disease symptoms
- Sporulation occurs at the wounding site with a cranial-like structure of soft fungal tissue inside the berry

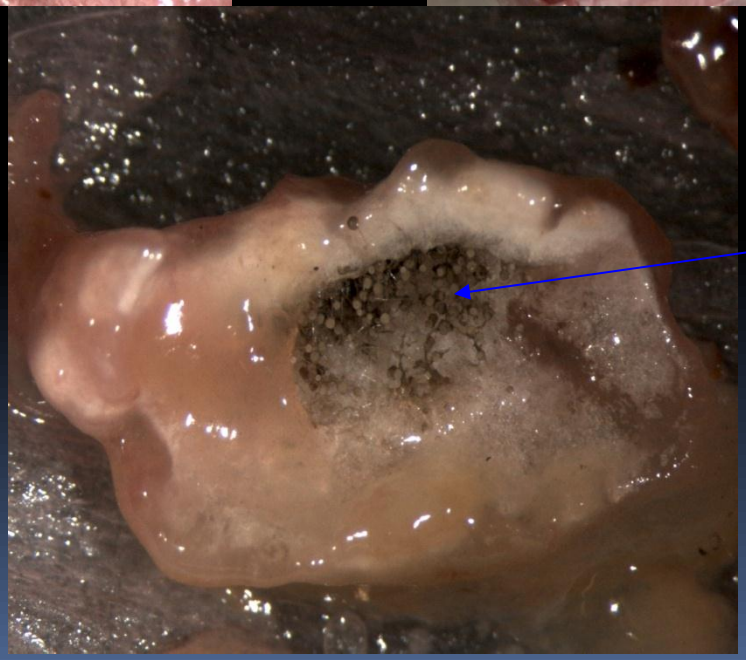


Sporulation/survival structure of Aspergillus in a grape berry (field sample)



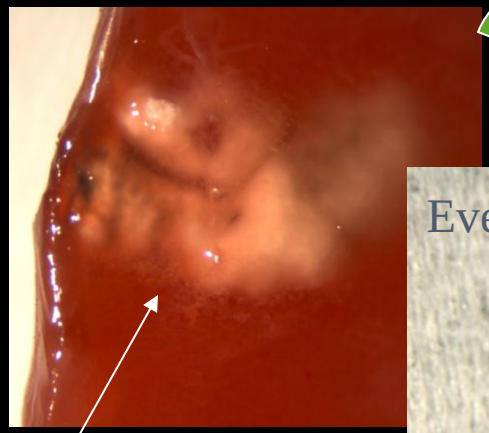
The sac formed inside pulp

Sporulation at the wounded site



Sporulation inside the sac

Development of sporulation/survival structure of Aspergillus in a grape berry (10 days after inoculation)



The sac formed inside pulp

The intact sac

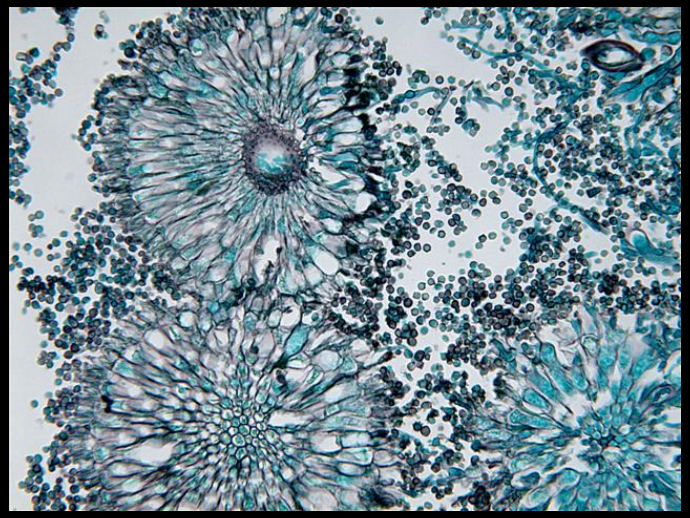
The dissected sac showing

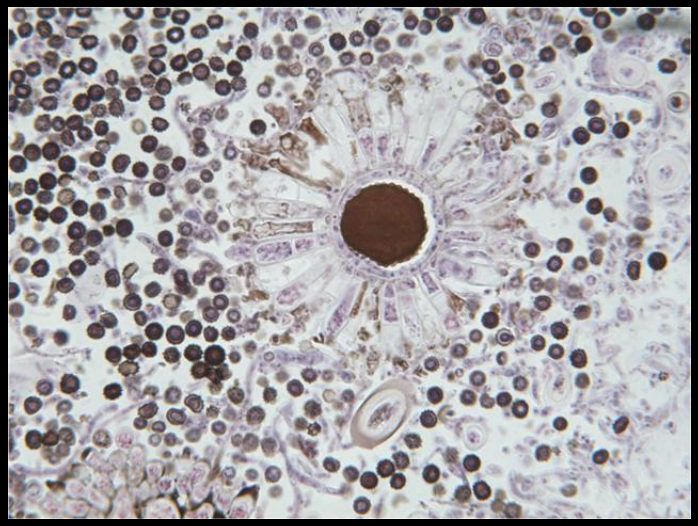
Temperature effects for developing fruiting structures

A. niger at 20^{0}C (left) and *A. carbonarius* at 40^{0}C (right)

A. carbonarius at 40^{0}C 16 dpi (left) and *A. niger* at 40^{0}C 23 dpi

Histology





GMS (left) and H&E stains (right) of *A. carbonarius* on Crimson Seedless 21dpi

GMS (left) and H&E stains (right) of *A. niger* on Crimson Seedless 49dpi

Control

- Leaf removal (early)
- Prevent injury
  - Control insects
  - Control Powdery mildew
  - Control Botrytis bunch rot
- Fungicides
  - Switch
  - Pristine
  - Copper + Rovral

Thank You