

## South American leaf blight (SALB): The symptoms, the spores of *M. ulei*, physiological races and epidemiology of the disease

### CAUSAL PATHOGEN

*Microcyclus ulei* (P. Henn.)  
von Arx

### NOMENCLATURE

- *Dothidella ulei* (P. Henn.)
- *Apospheria ulei* (P. Henn.)
- *Fusicladium macrosporium* (Kuyper)
- *Passalora heveae* (G. Masee)
- *Scolecotrichum ulei* (Griffon and Maublanc)
- *Melanosammopsis ulei* (Stahel)
- *Microcyclus ulei* (P. Henn.) von Arx

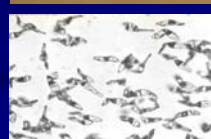
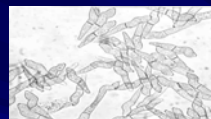
### NOMENCLATURE

- *Dothidella ulei*, *Apospheria ulei* and *Fusicladium macrosporium* are descriptions of the different states of the same fungus.
- *Fusicladium macrosporium* (Kuyper) is the conidial state and *Apospheria ulei* is the pycnidial state.
- *Microcyclus ulei* (P. Henn.) Muller and von Arx is the accepted name with synonyms *Dothidella ulei* (P. Henn.) and *Melanosammopsis ulei*.

### The Pathogen: *Microcyclus ulei*

- *Microcyclus ulei* is a fungus;
- An ascomycete with sexual and asexual stages;
- Produces three types of spores
  - The conidia (asexual)
  - pycnidiospores
  - ascospores (sexual)

### CONIDIA OF *M. ulei*



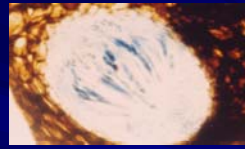
- Either septate (two cells) or aseptate (one cell). Percentage of aseptate conidia increased in drier periods and more common from laboratory cultures.
- Septate conidia are obclavate with broad proximal cell with truncate distal end.
- Possess a characteristic twist.
- Hyaline when young and turn grayish with age.
- Size of septate conidia vary: 23-65 x 5-10 µm (Chee); 23-62 x 5-10 µm (Holliday); 12-30 x 5-8 µm (Langford).
- Size vary with locations and season
- Shrunken conidia are still viable

## PYCNIDIOSPORES



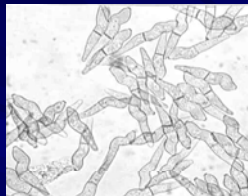
- Dumb bell shaped.
- One end is larger (12-25  $\mu\text{m}$ ) than the other end (2-5  $\mu\text{m}$ ).
- 6 -10  $\mu\text{m}$  in length.
- Borne on hyphal elements.
- Germinate but do not cause infection.

## THE ASCOSPORES OF M. ULEI

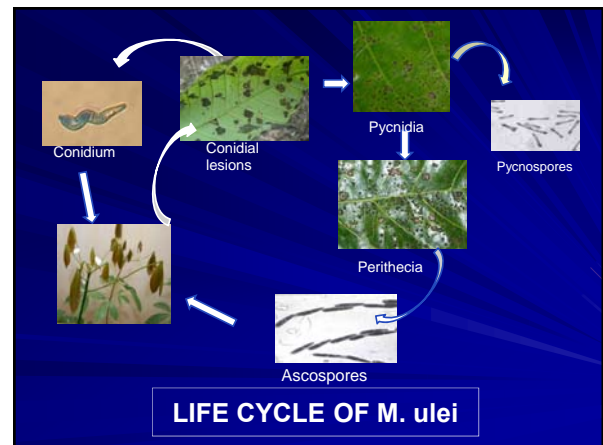


- Septate with constriction at septum;
- Cells unequal in size;
- Various sizes reported: 12-20 x 2-5  $\mu\text{m}$  (Chee); 10-15 x 3-5  $\mu\text{m}$  (Holliday); 3-5 x 10-15  $\mu\text{m}$  (Langford);
- Hyaline and ellipsoidal;

## SPORES OF M. ulei



- Conidia and ascospores are responsible for infection and disease spread



## PLANT PARTS INFECTED

- Young plant parts - leaves, stems, petioles, inflorescence and fruits;
- Leaves at the copper brown stage are most susceptible;
- Leaves are more resistant as they age and mature leaves are immune.

## SYMPTOMS OF SALB

- The symptoms depend on the age of leaves at time of infection;
- The young copper brown leaflets shrivel, curl, turn blackish and drop-off leaving the petioles for several days on the stems;
- The fully expressed conidial lesions are seen on the lower surface of the green leaflets;
- The lesions are covered with powdery masses of conidia giving dark grey to olive green colour.

### SYMPTOMS OF SALB ON COPPER BROWN LEAVES



- The copper brown leaflets are the most susceptible stage;
- The symptoms are visible about 3-4 days after infection starts;
- The leaflets shrivel and crinkle

### SYMPTOMS

- Early symptoms are the distortion of leaves.
- Visible lesions occur 2-3 days after inoculation.
- A few days later irregular shaped lesions developed on lower surface of leaves.
- Lesions appear dark or olive green.
- Size of lesions depends on susceptibility of leaves (age & clone)

### SYMPTOMS OF SALB: SEVERE DISEASE



- The severely infected leaflets turn blackish and drop off
- Petioles remain on the stem for sometimes after the leaflets fall off

### SALB SYMPTOMS ON YOUNG LEAFLETS



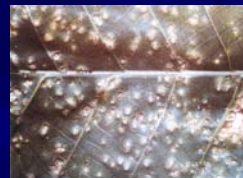
- Lesions appear dark or olive green.
- Size of lesions depends on susceptibility of leaves (age & clone)

### YOUNG LEAVES



- Dark lesions on the undersurface of leaflets covered with conidia (spores)

### SALB SYMPTOMS ON MATURING LEAFLETS



- The pycnidia which appear as dark raised structures are formed on the upper leaf surface forming a ring around the edge of lesion on the lower leaf surface;
- The pycnidia produce the pycnospores;
- The pycnidia are small (120-160  $\mu\text{m}$  diameter).



#### SALB SYMPTOMS ON MATURING LEAFLETS: THE PERITHECIA



- At the site of the pycnidia large (200-400  $\mu$ m diameter) raised black bodies (perithecia) are developed;
- The perithecia produced the ascospores.

#### SALB SYMPTOMS ON OLD LEAVES



- Shot holes appear as the leaf tissues especially at the centre of the stroma die and tear off

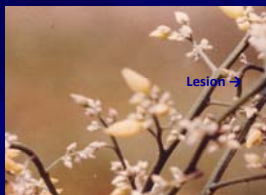
#### OTHER PLANT PARTS INFECTED

- Flower stalks
- Young fruits
- Young shoots
- Young stems

#### OTHER PLANT PARTS INFECTED



#### SALB ON FLOWERS AND FRUITS



- The inflorescence is also infected;
- The young seed pods are infected but it is not known that *M. ulei* is seed-borne

#### SALB CAUSES DEFOLIATION OF MATURE TREES



- Repeated leaf defoliation retards growth of plants and the poor canopy leads to death of branches and even trees.



## PHYSIOLOGICAL RACES OF *M. ulei*

### PHYSIOLOGICAL RACES OF *M. ULEI*

- Many races occur;
- Miller identified four races;
- Chee identified 9 races in Bahia;
- Ismail & Almeida confirmed 4 races (2, 3, 4 & 6) in Bahia ;
- Rivano identified 12 races;
- Carlos Mattos identified 36 races in Ituberá, Bahia;
- Pinheiro stated that large number of strains exist (> 50);
- Strains also differ in virulence.

### Clones to Differentiate Races of *M. ulei* (1)

Race	IAN717	Fx3925	IAN 710	P122
1	HR	HR	HR	R
2	S	S	HR	R
3	S	HR	HR	R
4	HR	HR	S	R

HR – Highly resistant, R – Resistant; MR – Marginally resistant;  
S – Susceptible. Source: Miller, 1966

### Clones to Differentiate Races of *M. ulei* (2)

Race	IAN717	Fx3925	IAN710	Fx2804	Fx2261	Fx985	Fx25
2	S,5	S,5	MR,2-3	S,5	R,0	R,0	HR,1-2
4	R,0	R,0	S,3-4	R,0	S,5	R,0	MR,1-2
5	R,0	R,0	MR,2-3	R,0	HR,0	S,5	MR,2-3
6	R,0	R,0	MR,2-3	R,0	R,0	S,4-5	MR,1-2

R – Very resistant to immune, no symptom or chlorotic flecks or small necrotic lesions with no spores;  
HR – Highly resistant, small necrotic lesions with few spores;  
MR – Marginal resistance, larger lesions with few to medium sporulation;  
S – Susceptible, large lesion with heavy sporulation.  
Sporulation rating: 0 – no sporulation, 5 – very heavy sporulation.

Source: Ismail & Almeida, 1987

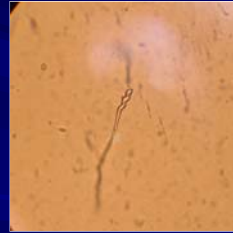
### DIFFERENTIAL CLONES

- RIVANO (1997) used 10 clones (IAN 710, IAN 717, IAN 3087, FX 25, FX 985, FX 2261, FX 2804, FX 3899, FX 3925, FX 4098);
- Disease reaction was scored based on sporulation (0 to 4) and type of lesions (14 categories from 1 + chlorotic lesions <1mm, no spores to 14 = lesions >2.5 mm with abundant sporulation).

## DISEASE INFECTION

**Conidia and ascospores are responsible for infection.**

## CONIDIA GERMINATION

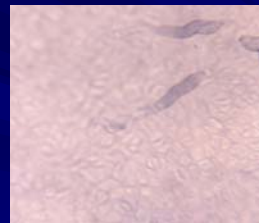


- Distal end of the conidia germinated first followed by the proximal cell;
- One or both cells may germinate.

## GERMINATION OF CONIDIA

- The conidia germinate within two hours;
- Hyphae penetrate directly or by forming appressoria;
- Formation of appressoria is influenced by resistance of leaves;
- Fungus spread intercellularly;
- Germinates between 8 to 36 °C, maximum at 24 °C

## INFECTION PROCESS



## HOST REACTION AND DISEASE DEVELOPMENT



Host cell collapse

## HOST CELL COLLAPSE

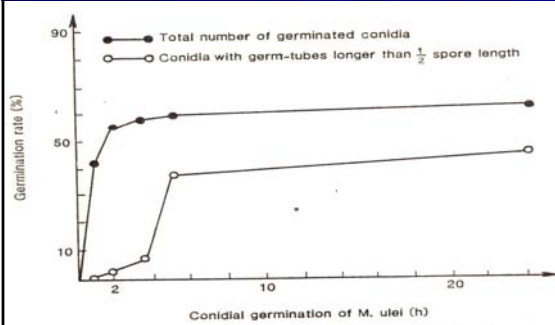


## EPIDEMIOLOGY

## SPORE GERMINATION

Conidia germinate  
between 8 – 36 °C  
(maximum 24 °C);

## RATE OF CONIDIAL GERMINATION



## SEASONAL EFFECT OF CONIDIAL GERMINATION

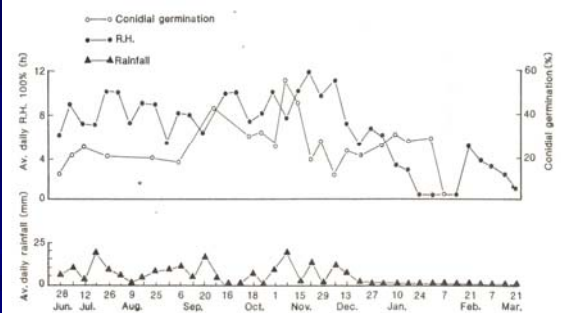


Figure 4. Seasonal effect of conidial germination of M. ulmi.

## DISEASE DEVELOPMENT

- Lesion is visible by two days of infection;
- Host reaction is dependent on resistance of leaves;
- Host cell collapse may occur;
- Age of leaves and clonal resistance determine number and size of lesions

## EPIDEMIOLOGY OF SALB

(Influence of weather on disease)



## EFFECT OF RAINFALL ON SEVERITY

### ■ High Severity

- Annual rainfall > 250 cm, well distributed with no long dry season

### ■ Intermediate Severity

- Annual rainfall > 200- <250 cm, well distributed with no long dry season

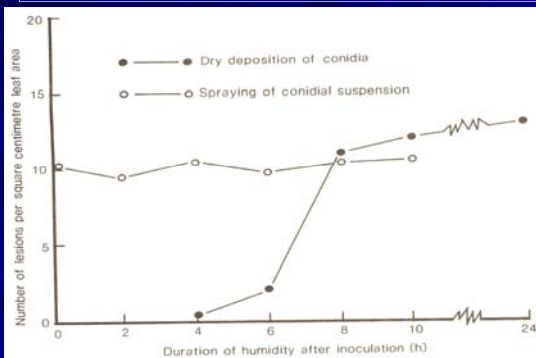
### ■ Low Severity

- Annual rainfall, variable with at least four months dry period with < 7 cm rain per month

## EFFECT OF HUMIDITY ON SALB

- Months with 18+ days with RH exceeding 95% for 10 hrs → severe SALB;
- High RH for 3-6 h is sufficient for infection to take place.

## EFFECT OF HUMIDITY ON INFECTION



## SPORE PRODUCTION

- Spore production vary with weather conditions;
- Optimum temperature for spore production is 24 °C;
- High humidity favors spore production.

## SPORE LIBERATION

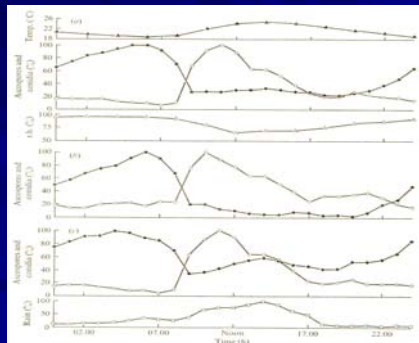
### SPORE LIBERATION

- Spore liberation varies with weather conditions;
- Diurnal periodicity in liberation of spores:
- Conidia liberation:
  - Low at night and rises in the morning;
  - Peak at mid day (10.00 a.m. to 12.00 p. m.) and declines there after;
- Ascospore liberation
  - Ascospore are released at night and peak at 06:00 a.m.
- Liberation of conidia and ascospores is high after a rainfall;

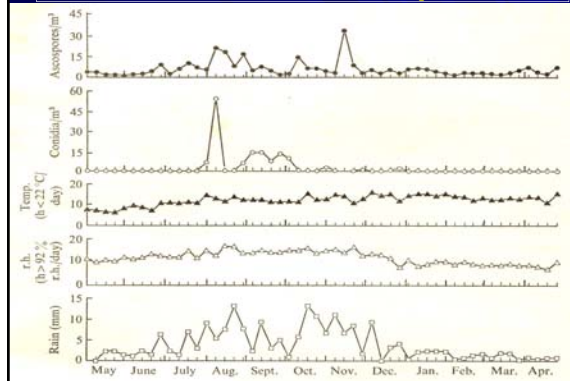


## DIURNAL PERIODICITY OF SPORE RELEASE

Conidia  
(empty dots);  
Ascospores  
(darkened)



## Annual dispersal of spores



## Viability of spores

- Viability of spores depend on weather condition especially moisture and temperature;
- Spores in fruiting bodies remain viable for longer periods than detached spores;
- Several studies were made on viability of spores.

## VIABILITY OF SPORES

- LANGFORD (1945)
  - High germination of conidia and ascospores kept for 3 days at 27 °C and 70% R.H.
  - 80 °F and 70% R.H. - some still germinated after 7 days
  - Conidia sprayed onto young leaves, then kept dry for 7 days still infect when re-moist
- HOLLIDAY (1970)
  - Kept at room condition for 18 days - Ten percent of conidia germinated

## Viability Of Spores Of *M. ulei*

Spores	Storage condition	Viability period
Conidia (detached)	24 °C, 65-95 % R.H.	3-4 weeks
Conidia (intact)	24 °C, 85-100 % R.H.	2 weeks
	24 °C, desiccation	16 weeks
Ascospores	24 °C, 85-100 % R.H.	9 days
Perithecia	24 °C, 65 % R.H.	3 weeks
	24 °C, 100 % R.H.	12 days

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Perithecia	24 °C, 65 % R.H.	3 weeks
	24 °C, 100 % R.H.	12 days

## **VIABILITY**

- Spores stored under cold and dry conditions survived longer;
- Conidia and ascospores obtained from leaves stored for long period in a refrigerator remain viable;
- Ascospores stored under desiccation survived for 15 days;
- Spores stored at -74 °C still survived.

## **DISEASE SPREAD**

- Wind and rain splash;
- Insects and other animals;
- The ascospores initiate new disease cycle and the conidia are responsible for local spread of the disease.

## **THANK YOU**

**The author acknowledges  
other scientists whose  
data or photographs are  
used in this presentation**