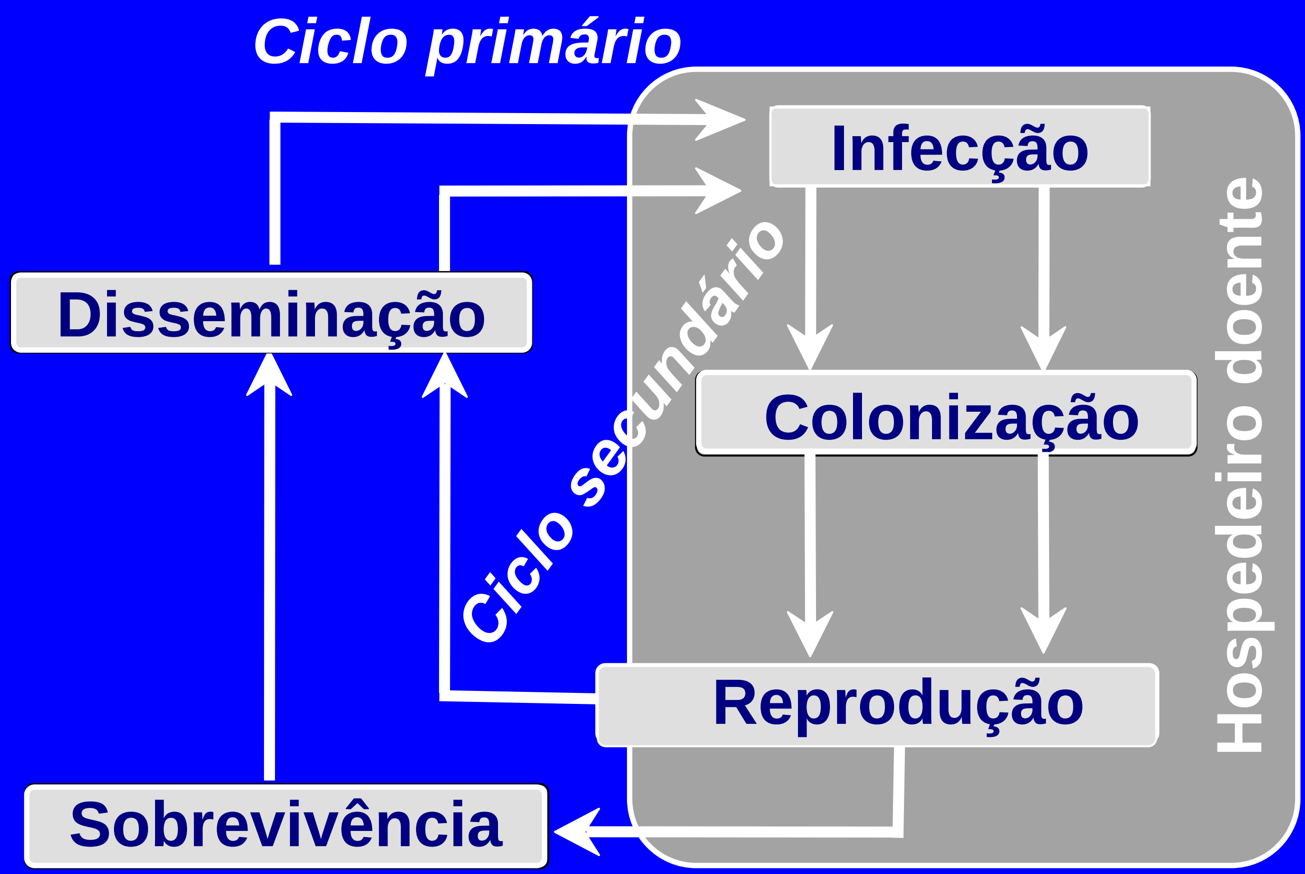
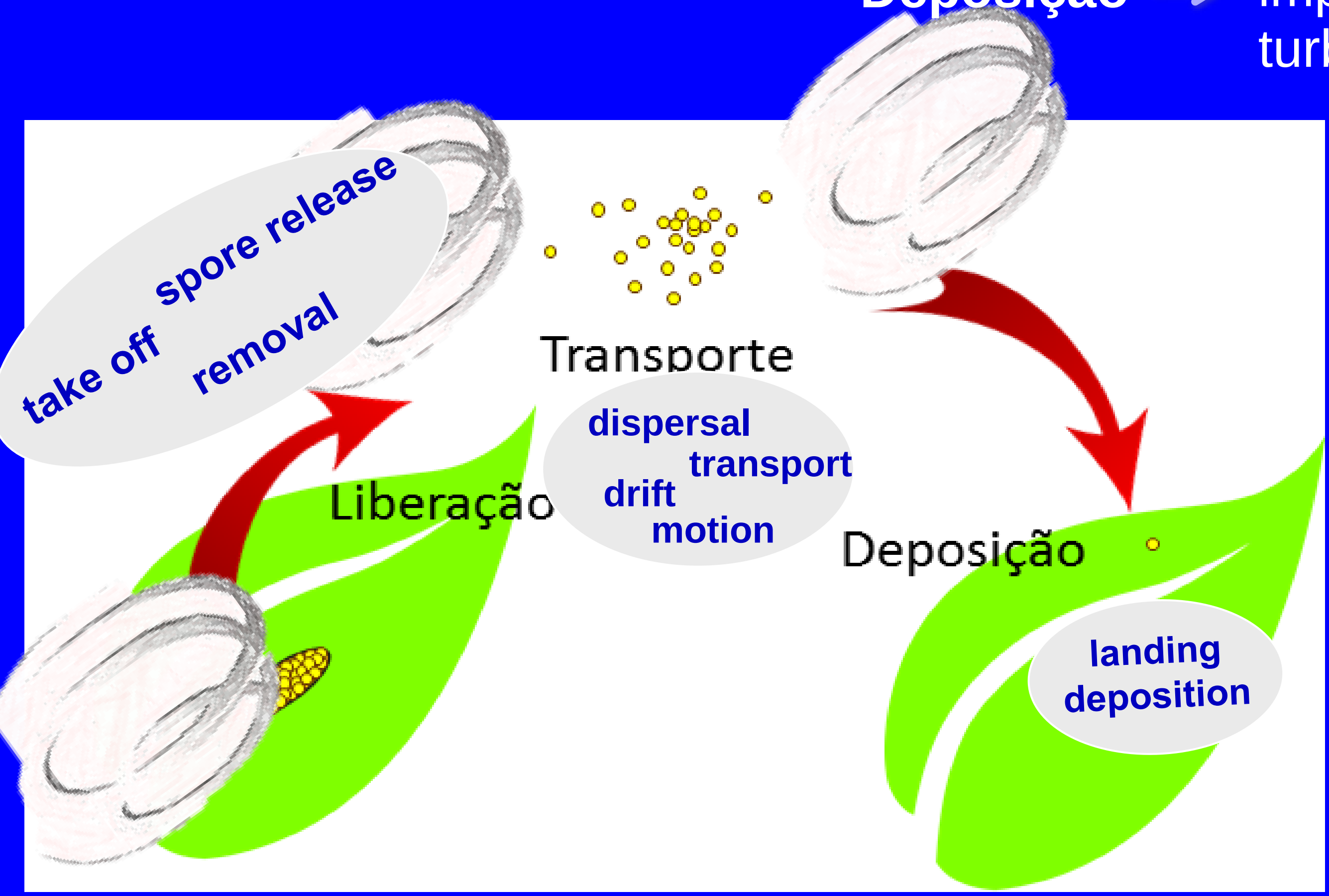
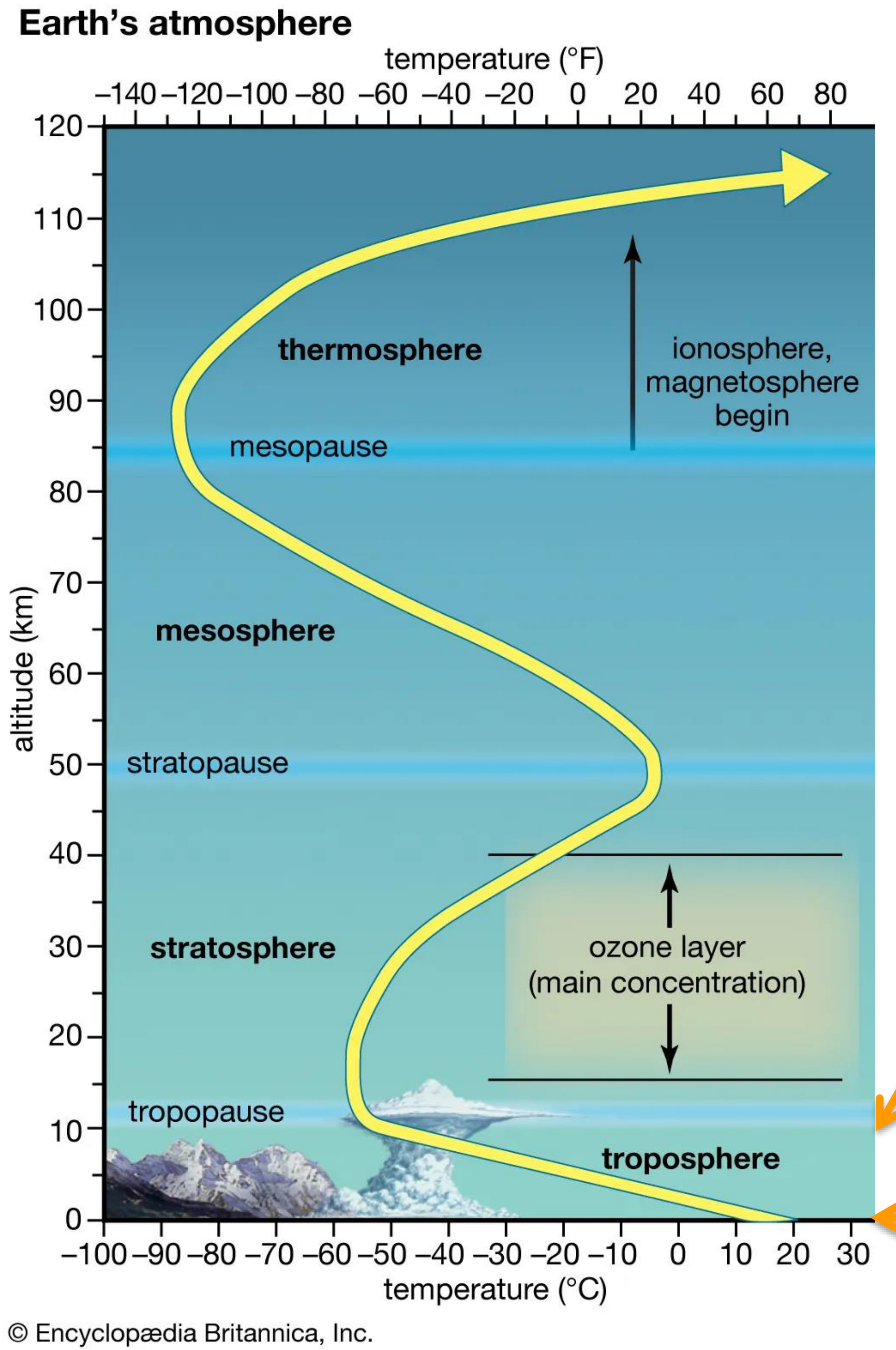
Ciclo das relações patógeno-hospedeiro – Modelo conceitual



Disseminação

- **Liberação** → ativa/passiva
- **Dispersão** → ativa/passiva (ar/água/homem/insetos)
- **Deposição** → sedimentação, impacto, turbulência





Disseminação

- Camada convectiva
- Camada de transição
- Camada de turbulência
- Camada laminar
- Camada estacionária

Liberação - remoção da fonte

até 10 km

Camada convectiva

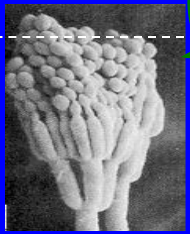
até 1 km

Camada de transição

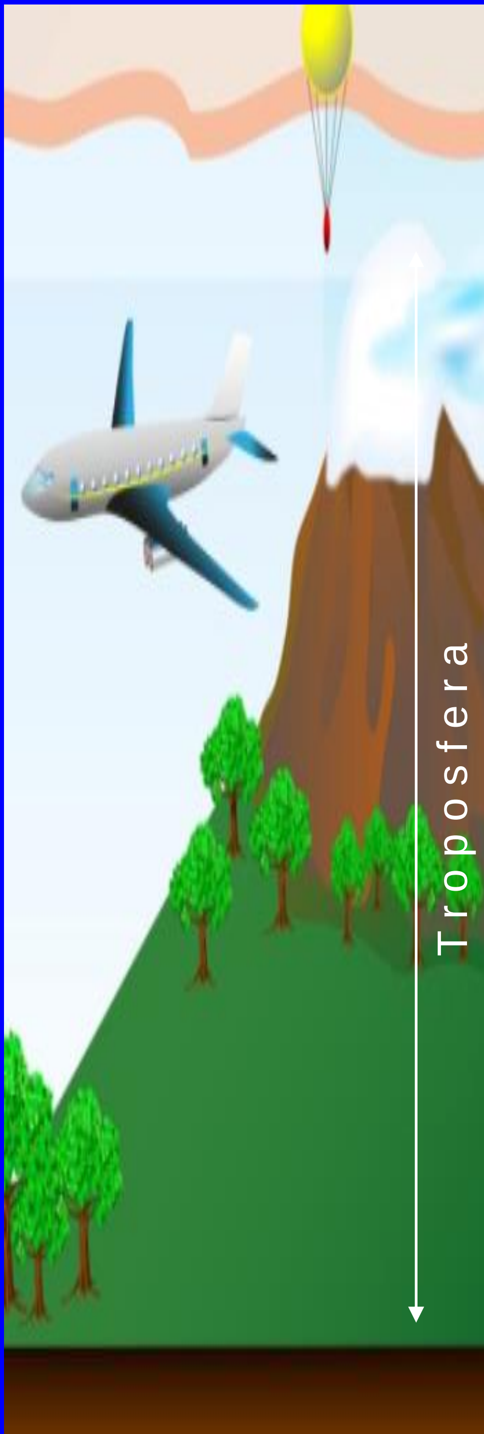
50 a 150 m

Camada de turbulência

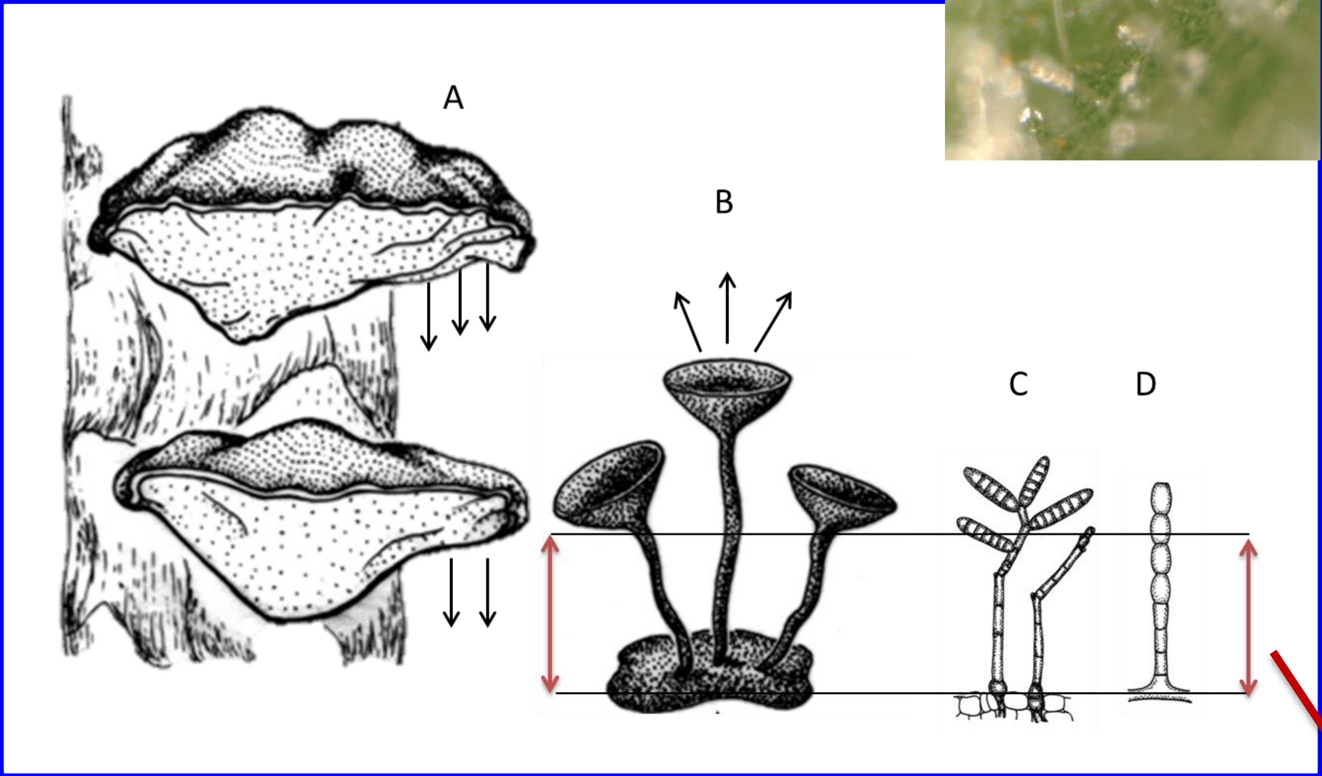
Camada laminar
milímetros



Camada estacionária
micrômetros



Liberação



A - *Ganoderma*
gravidade

B - *Sclerotinia*
ejeção

C - *Dreschlera*
D - *Oidium*
liberação pelo vento ou chuva
cadeia de conídios e conidióforo longos

Camada estacionária

Liberação Passiva
energia externa

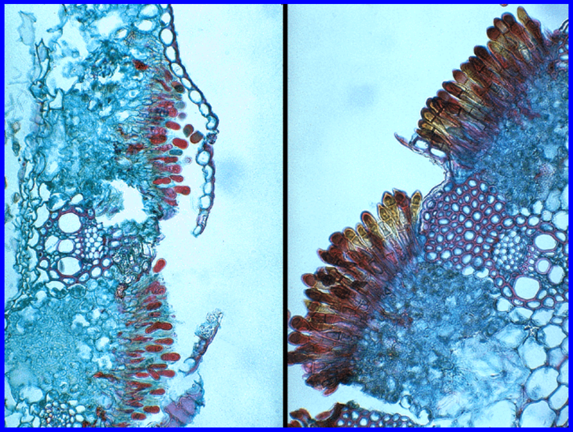
(Inglod, 1971)

Míldios

Plasmopara, Peronospora, Bremia, etc.

Ferrugens

Puccinia, Uromyces, etc.

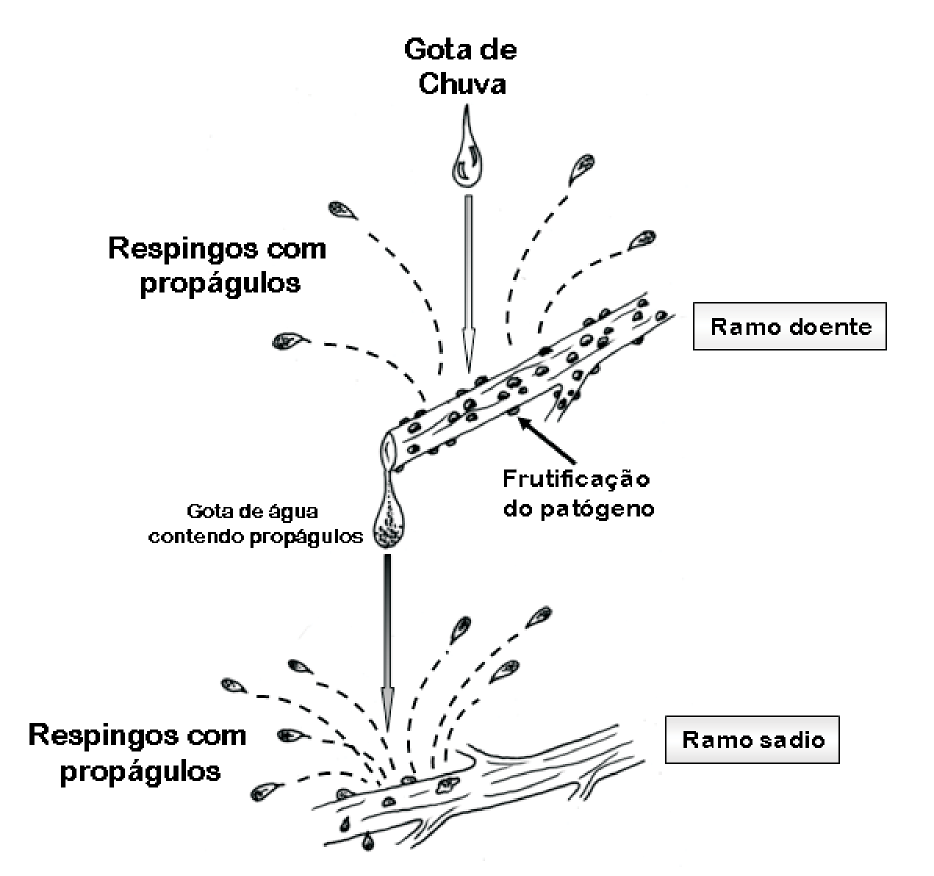


Liberação passiva por impacto

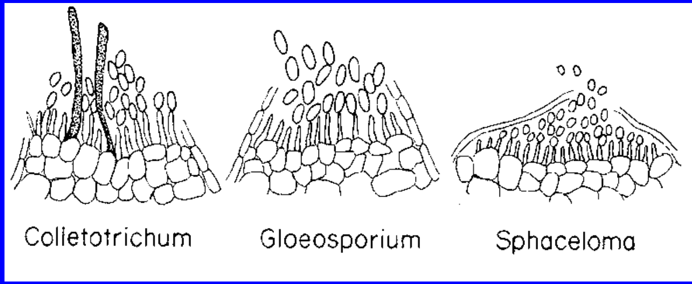
11. Teliospore cloud of *Tilletia controversa* released during harvest of plants affected by dwarf bunt. (Courtesy J. A. Hoffmann)

carvão da cana-de-açúcar

Liberação passiva
Energia externa



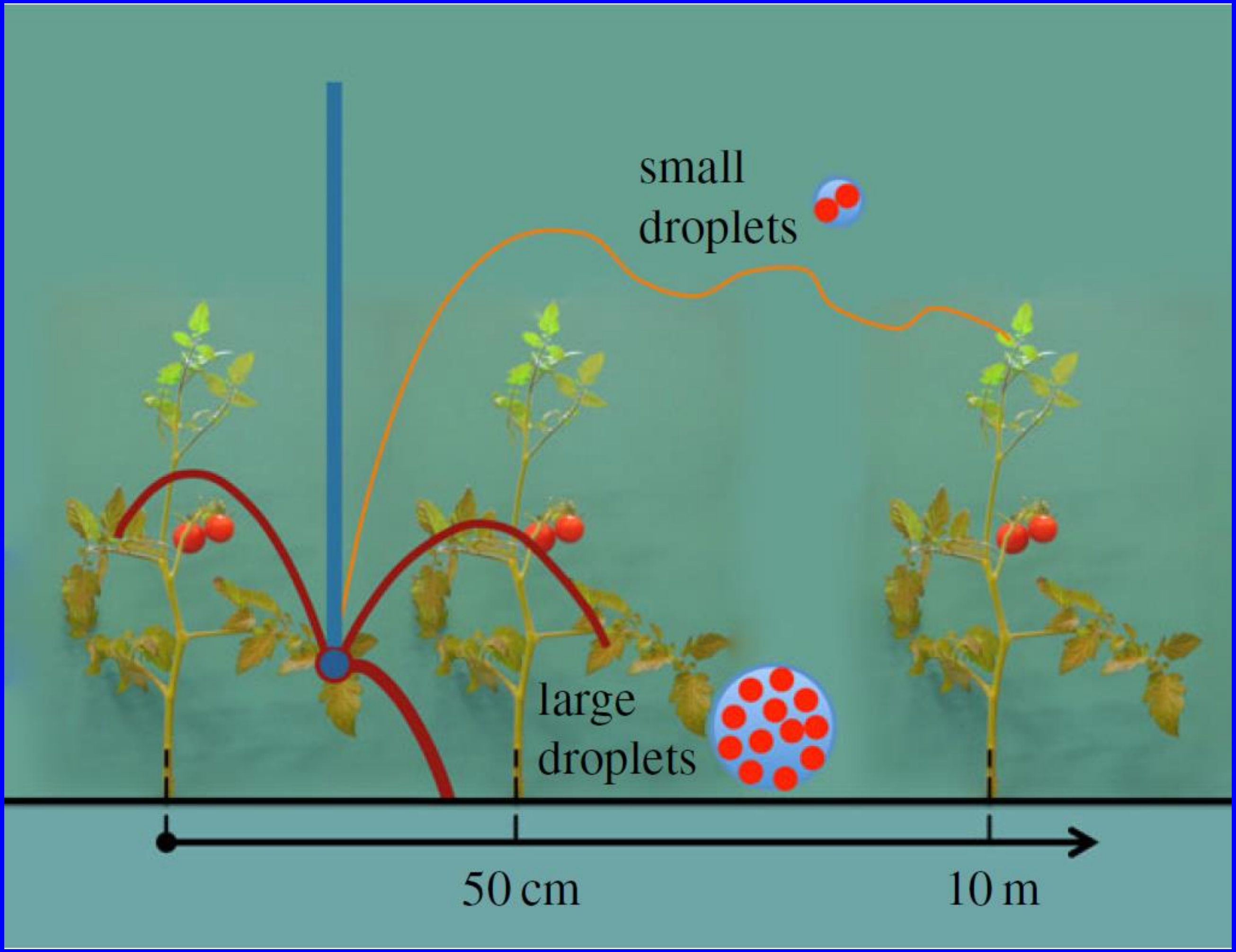
Antracnose
Colletotrichum
Sphaceloma



Manchas - *Septoria*

Manchas bacterianas
Xanthomonas

Liberação passiva



Impacto de uma gota de chuva (azul) numa folha. Grandes gotas contendo vários propágulos do patógeno são arremessadas próximas à fonte, enquanto gotículas menores, contendo menor número de propágulos, podem potencialmente ser levadas pelo vento a locais mais remotos (Gilet & Bourouiba, 2015)

Liberação passiva

https://lbourouiba.mit.edu/research/projects/fluid-fragmentation-shapes-rain-induced-foliar-disease-transmission

Liberação passiva

Effects of Surface Topography and Rain Intensity on Splash Dispersal of *Colletotrichum acutatum*

X. Yang, L. V. Madden, L. L. Wilson, and M. A. Ellis

Postdoctoral research associate, associate professor, research assistant, and professor, respectively, Department of Plant Pathology, The Ohio State University and Ohio Agricultural Research and Development Center, Wooster, Ohio 44691.

Research support and salaries provided by state and federal funds (especially USDA Competitive Grant 87-CRCR-1-2307) appropriated to Ohio Agricultural Research and Development Center, The Ohio State University. Journal Article 105-90.

Use of trade names implies neither endorsement of products by the authors, nor criticism of similar ones not mentioned.

Accepted for publication 31 May 1990 (submitted for electronic processing).

ABSTRACT

Yang, X., Madden, L. V., Wilson, L. L., and Ellis, M. A. 1990. Effects of surface topography and rain intensity on splash dispersal of *Colletotrichum acutatum*. Phytopathology 80:1115-1120.

Effects of ground cover, plant canopy density, and rain intensity on the splash dispersal of *Colletotrichum acutatum* were studied using a rain simulator. In one experiment, three ground covers (soil, straw, and plastic) and two rain intensities (15 and 30 mm/hr) were evaluated by collecting splash droplets with conidia in sheltered gravity samplers consisting of petri plates with a selective medium for *C. acutatum*. Ground covers were characterized by random roughness, the standard deviation of surface elevation. Infected fruits with sporulating lesions were clustered on the ground to serve as the inoculum source. Sampling plates were positioned 20, 40, 60, 80, 100, and 120 cm from the source and were exposed to rain for 1-min periods (every 5 min) for a total duration of 46 min. Ground cover had a major effect on splash dispersal, as measured by colonies growing in selective medium. The estimated total number of colonies over time and space (*N*) was inversely proportional to roughness; i.e., straw had the largest random roughness but the lowest *N*, and plastic the opposite. Differences in *N* among ground covers were due to differences in steepness of the dispersal gradients (i.e., straw had the steepest gradient and plastic the shallowest), not to the release rate of spores at the source. Total number of colonies increased with rain intensity, but the effect was due to the release rate, as measured by the intercept parameter of a gradient model. Rain intensity did not influence gradient steepness. The effect of plant canopy density on splash dispersal of *C. acutatum* was evaluated in a second experiment using a soil ground cover. Leaf area index (LAI) was inversely related to *N*. Cross-row dispersal of spores was reduced by 90% or more for two rows of plants with LAI ≥2.7 compared to no plant rows. Results support the hypothesis that surface topography (including ground cover and plant canopy) is a major factor controlling splash dispersal due to its effect on splash droplet trajectories and loss of inoculum.

Additional keywords: disease spread, *Fragaria* × *ananassa*, quantitative epidemiology.

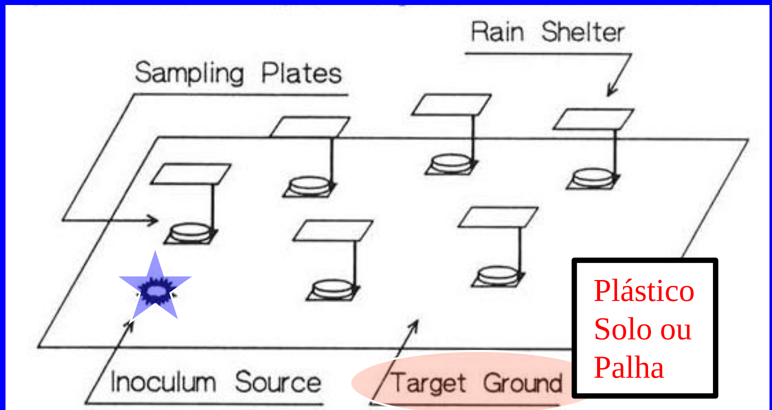


Fig. 1. Overview of the experimental arrangement of source fruit and sampling plates.

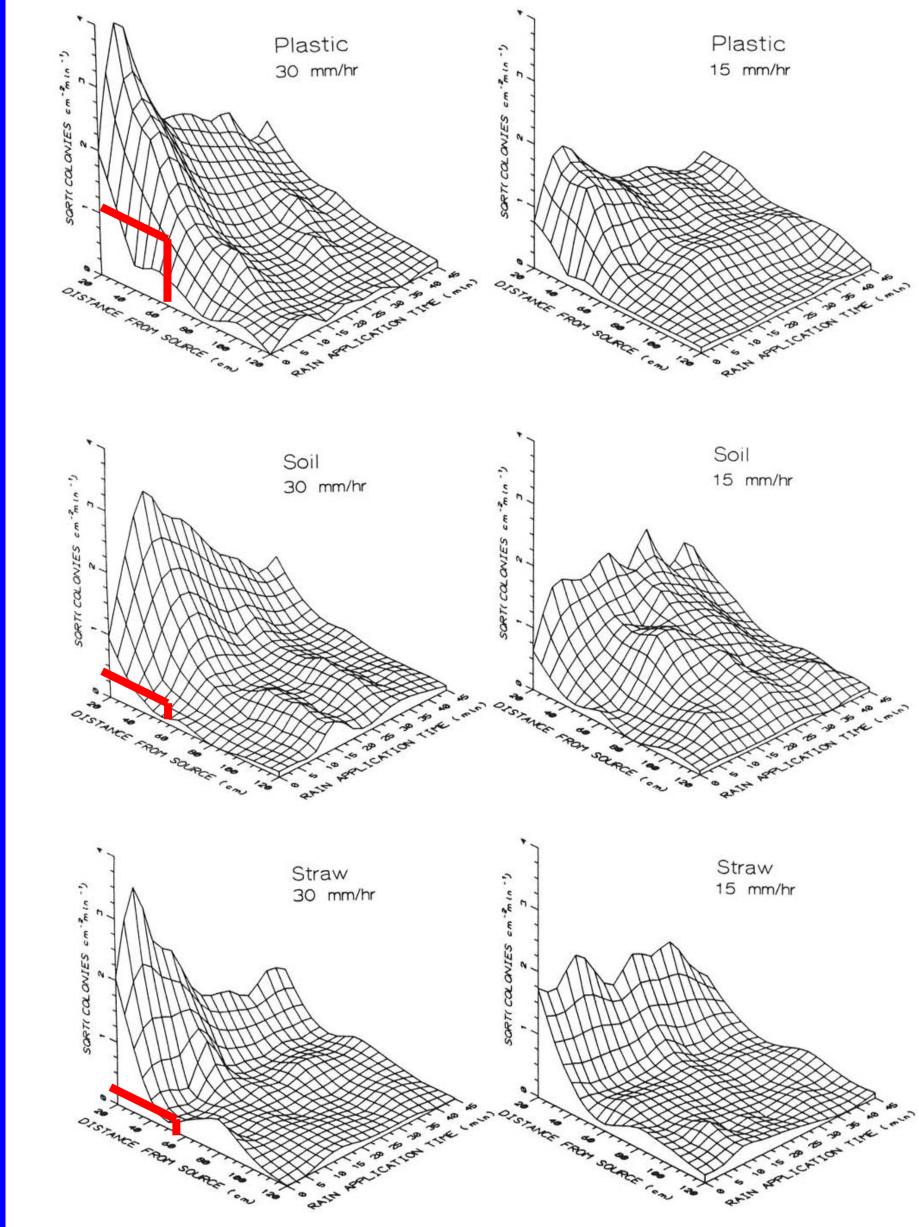
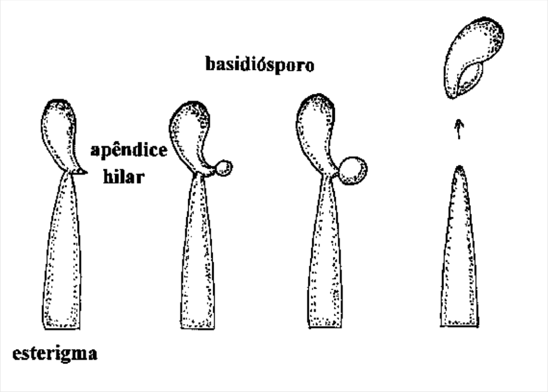
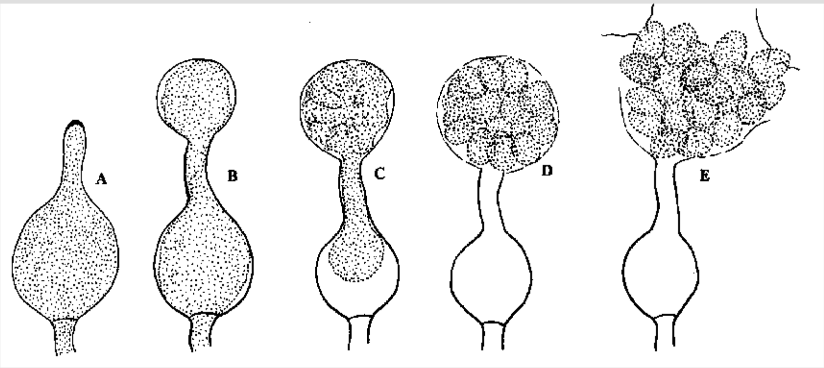


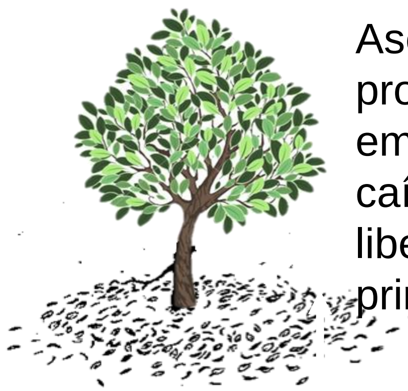
Fig. 2. Spatial and temporal patterns of colonies (n, cm^{-2} min^{-1}) of *Colletotrichum acutatum* due to rain splashing with intensities of 15 and 30 mm/hr for plastic, soil, and straw ground covers. Points represent the means of four replications. The square-root scale was chosen to better illust the data beyond 60 cm from the source, where few colonies were observed.

Liberação ativa
Energia do patógeno





Ascomicetos



Ascósporos produzidos em folhas caídas são liberados na primavera

Basidiomicetos

Pythium sp.

liberação ativa

Monilinia em "blueberry"

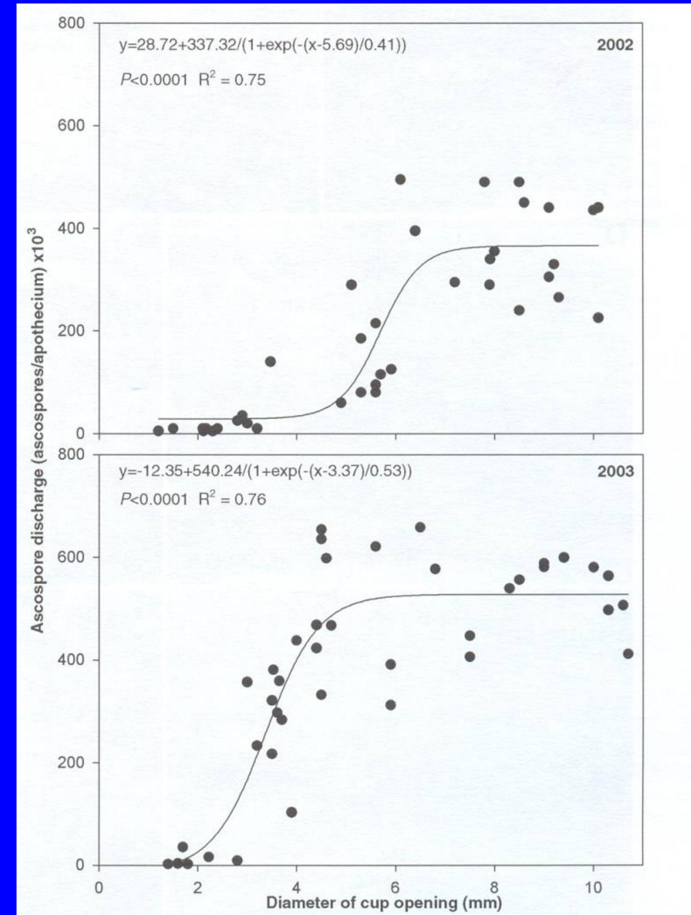
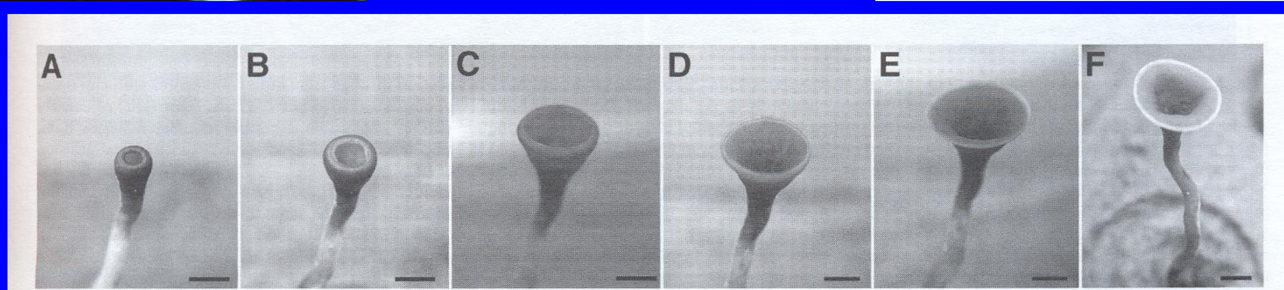
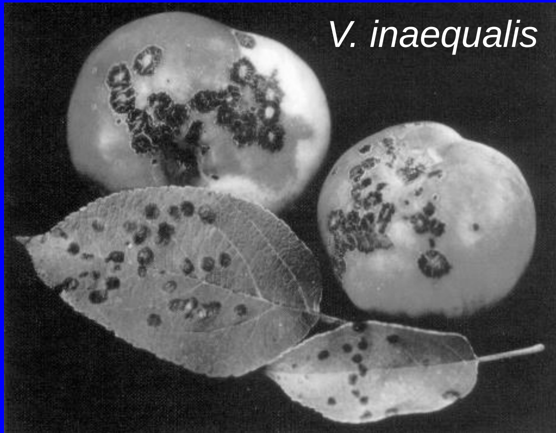


Fig. 2. Relationship between apothecium cup size and total number of ascospores discharged per day by apothecia of *Monilinia vaccinii-corymbosi* in experiments carried out in 2002 and 2003.

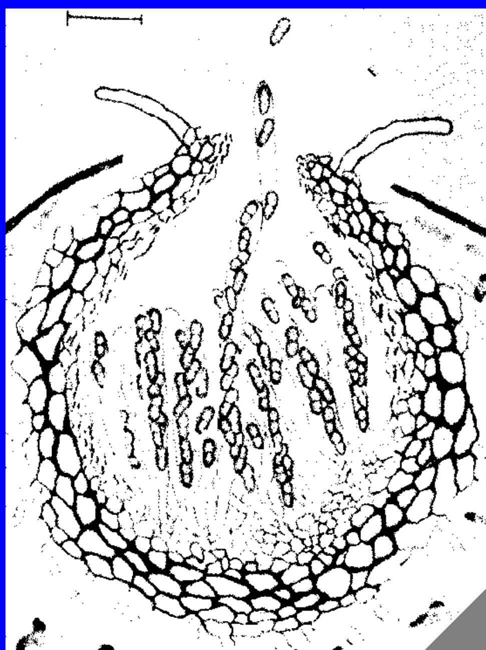


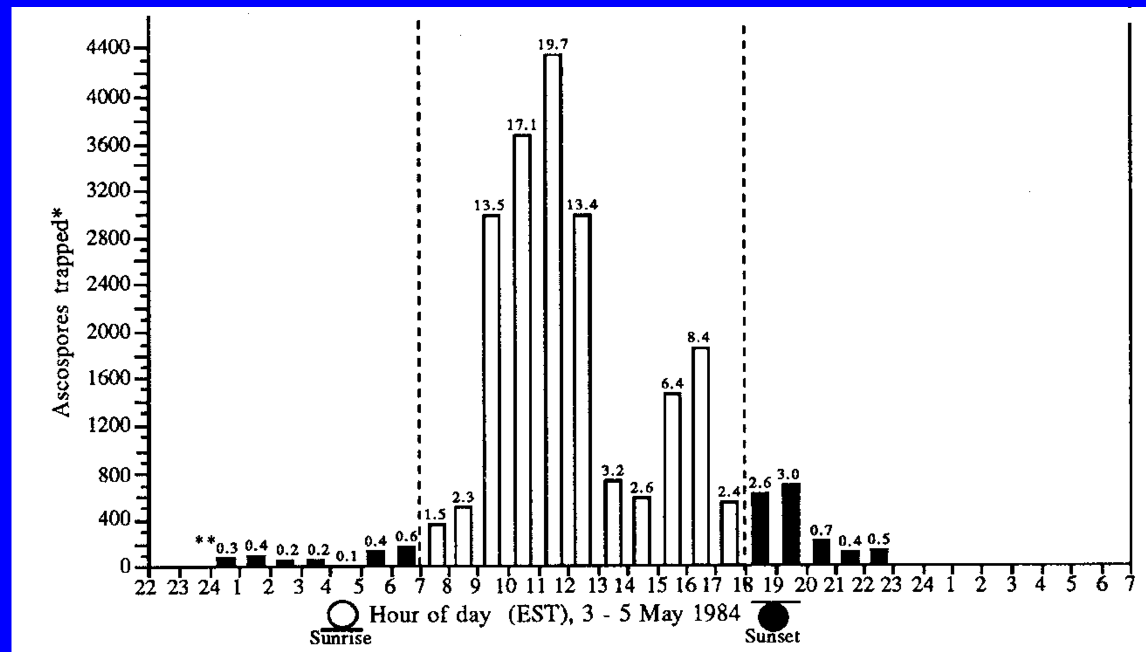
Barras
= 5 mm



liberação ativa

Projeção de ascósporos



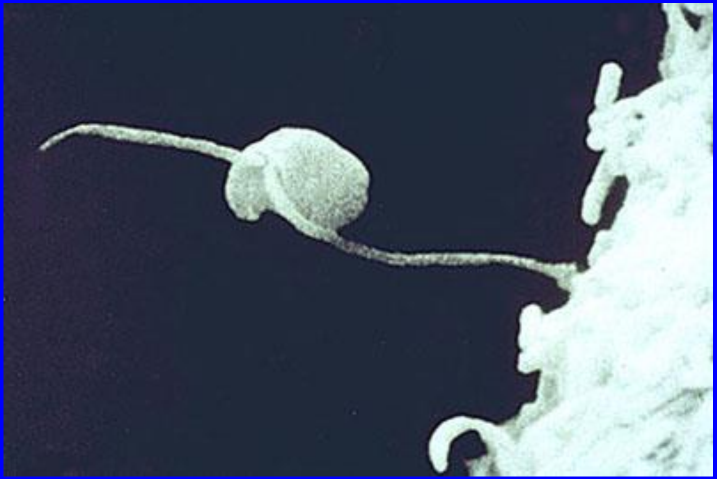


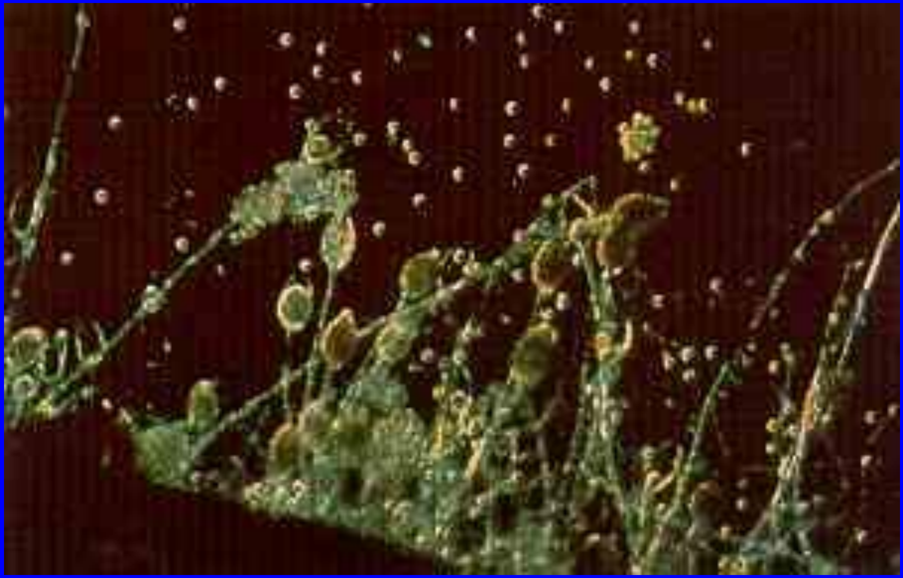
Liberação diária de *Venturia inaequalis*

Ciclo circadiano

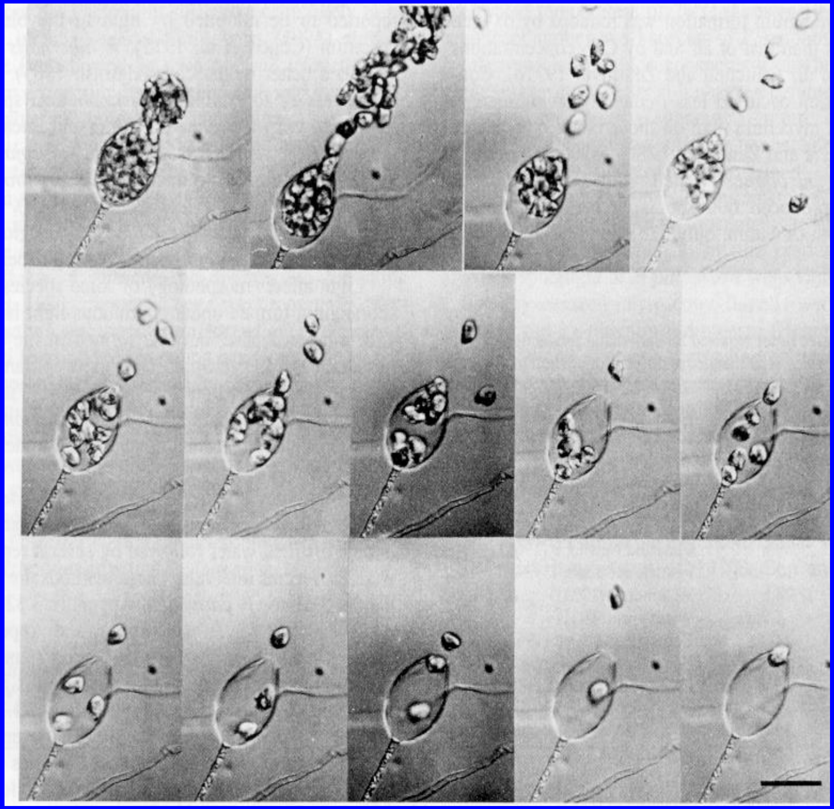
Ciclo próprio de cada espécie manifestado por variações periódicas de acordo com o momento do dia sob condições ambientais constantes

liberação ativa





esporângios e zoósporos de *Phytophthora cinamomi* em água



liberação de zoósporos de *Phytophthora medicaginis*

Dispersão

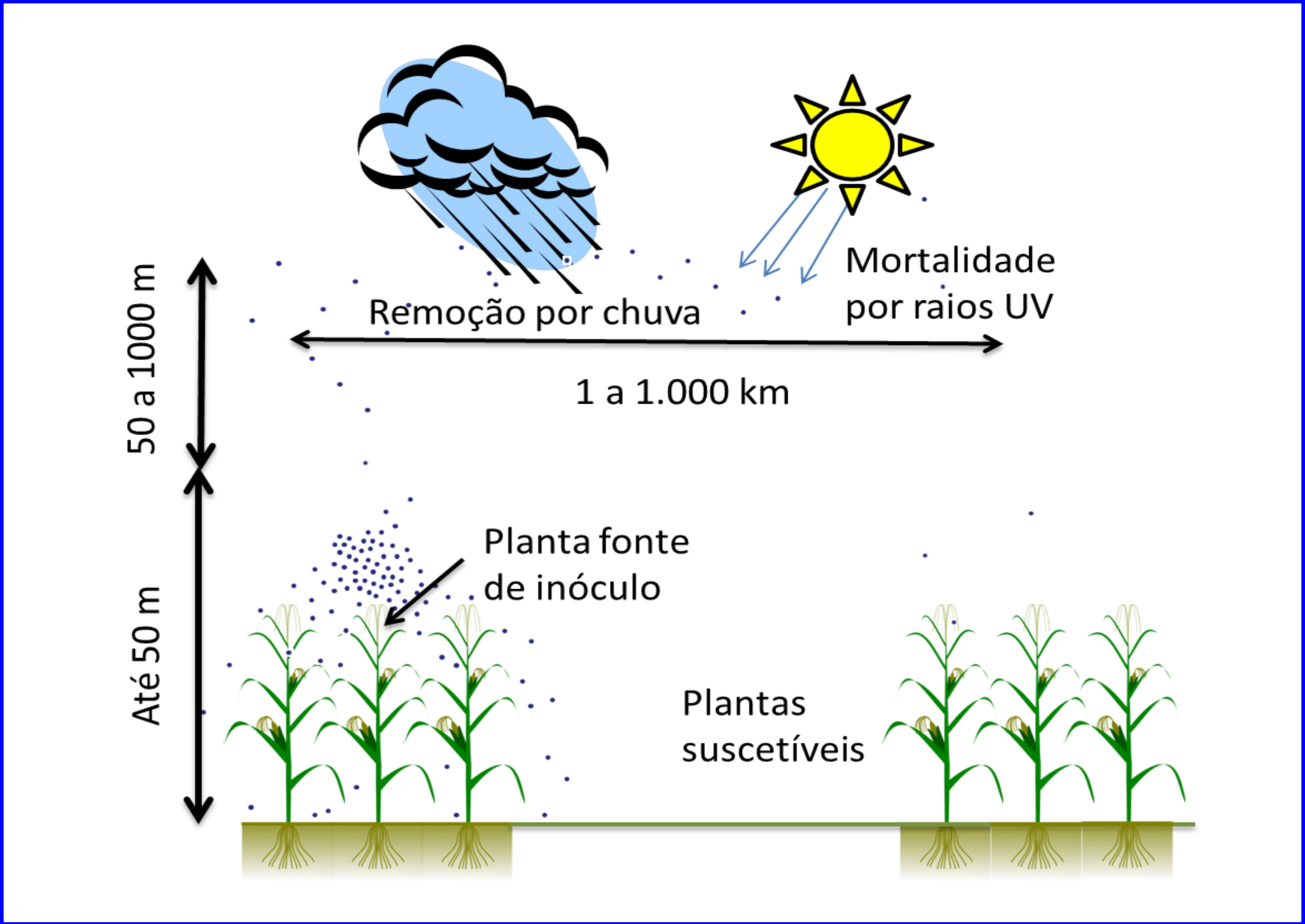
Agentes de Dispersão

Ar

Curtas distâncias (camada de turbulência)
Longas distâncias (camada convectiva)

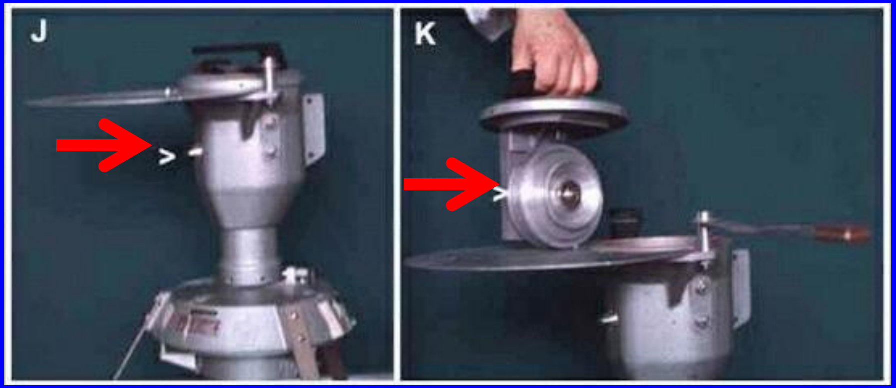
Fungos, Nematoides

Dispersão a curtas e longas distâncias pelo ar



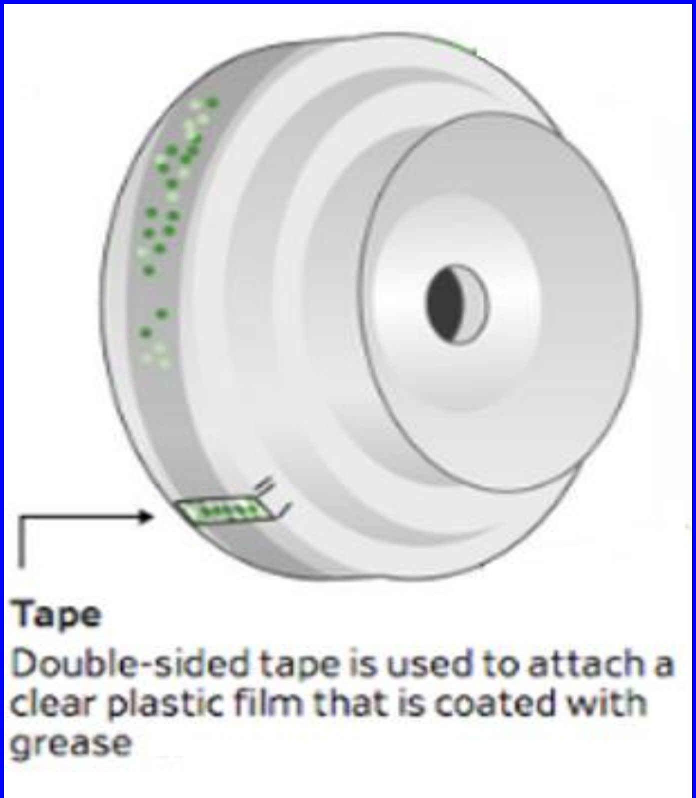
Dispersão pelo ar

Como medir o transporte de esporos?



Dispersão pelo ar

Como medir o transporte de esporos?



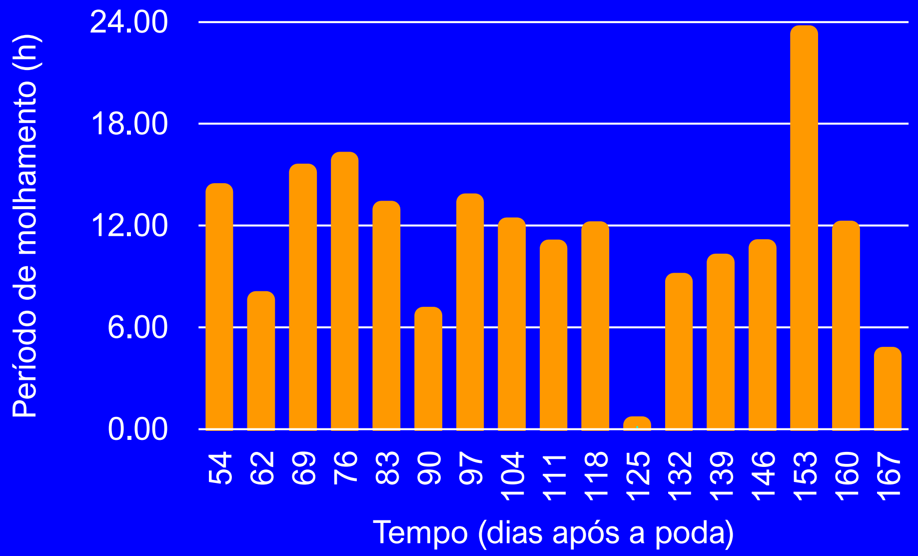
Dispersão pelo ar

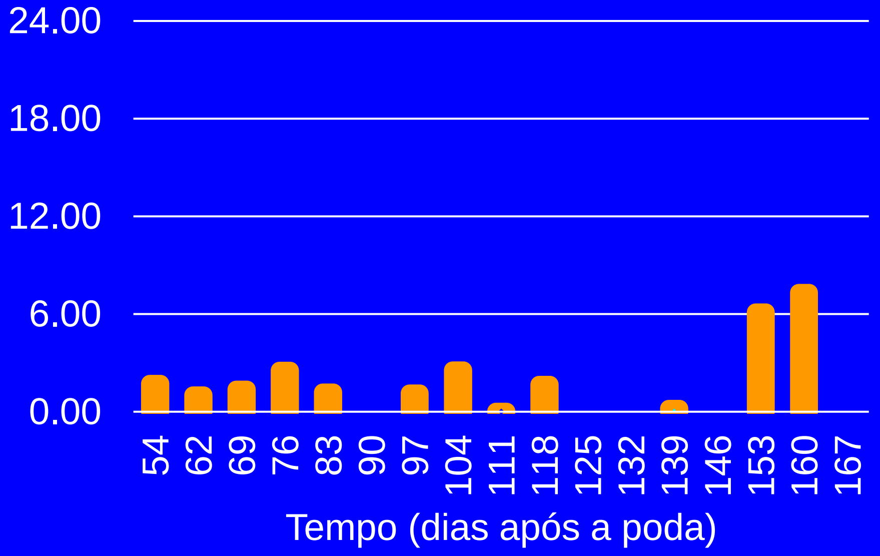
Como medir o transporte de esporos?

Dispersão a curtas distâncias pelo ar

(Simões et al. 2023)

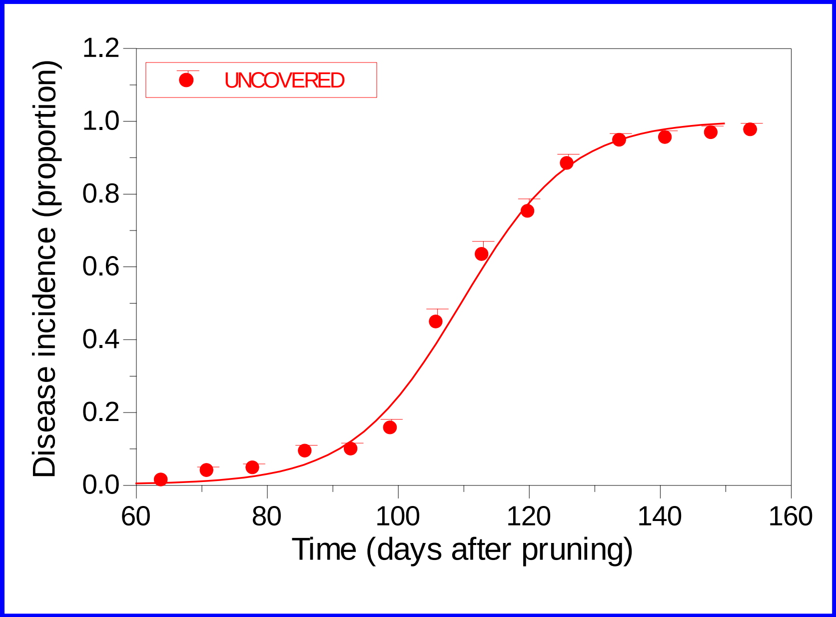
Dispersão a curtas distâncias pelo ar

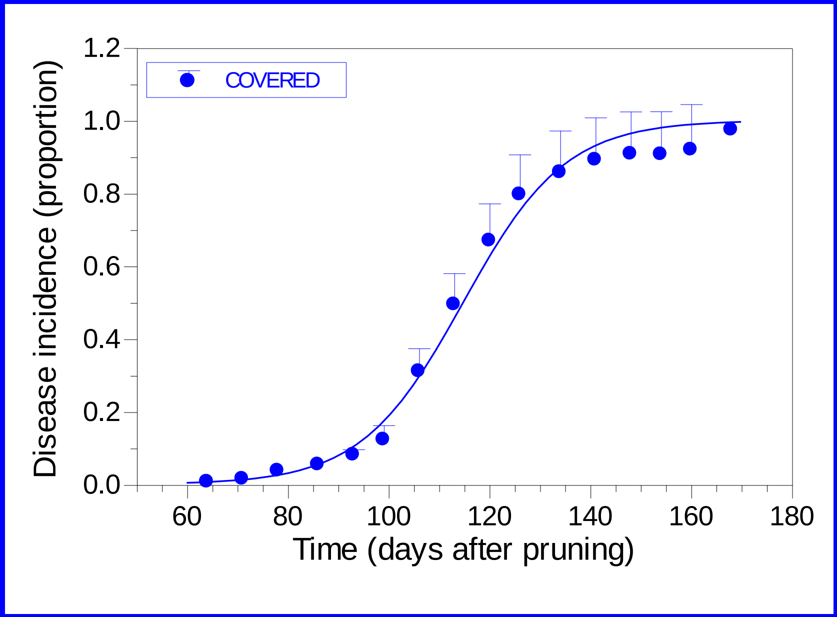




(Simões et al. 2023)

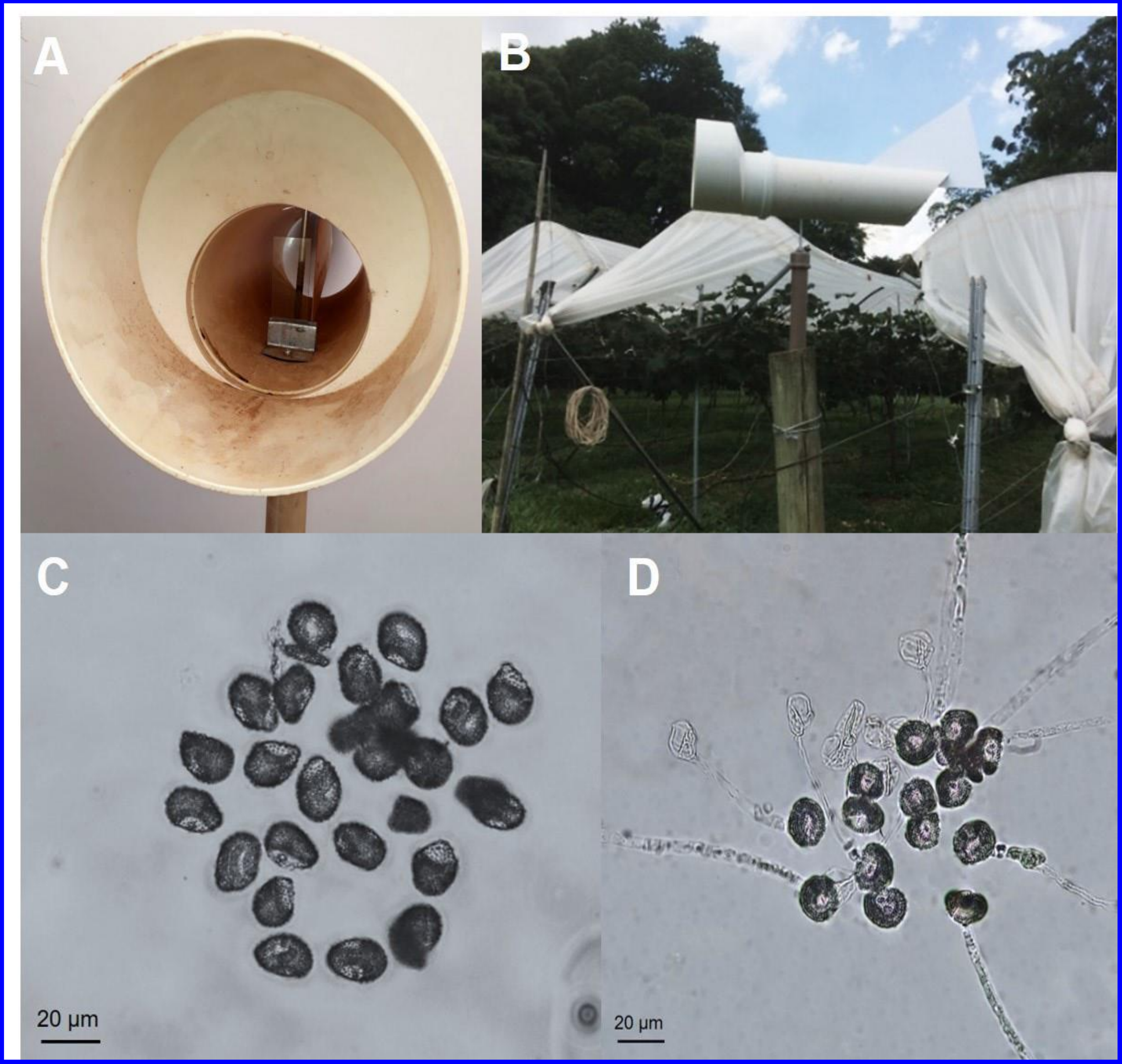
Dispersão a curtas distâncias pelo ar





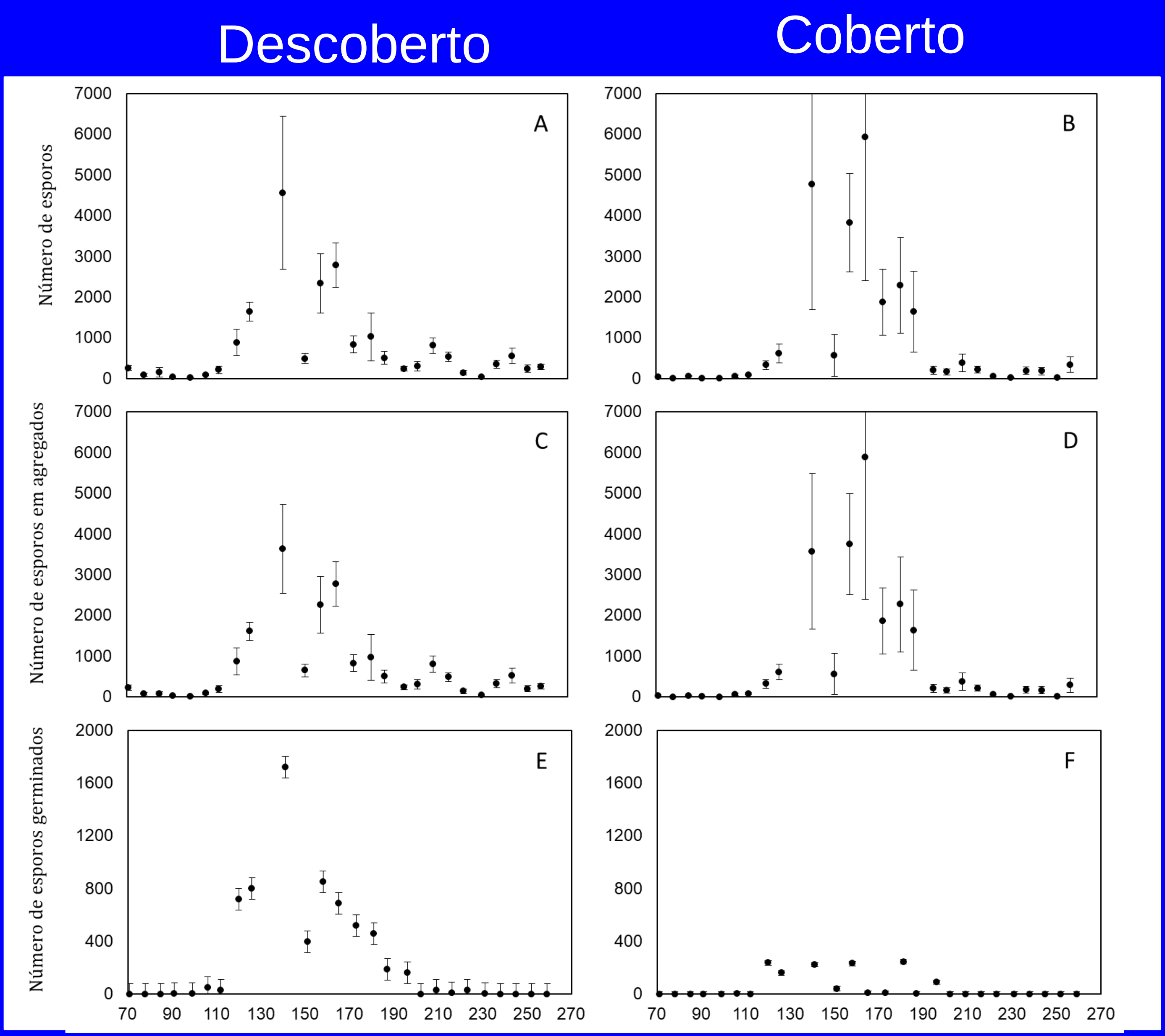
(Simões et al. 2023)

Dispersão a curtas distâncias pelo ar

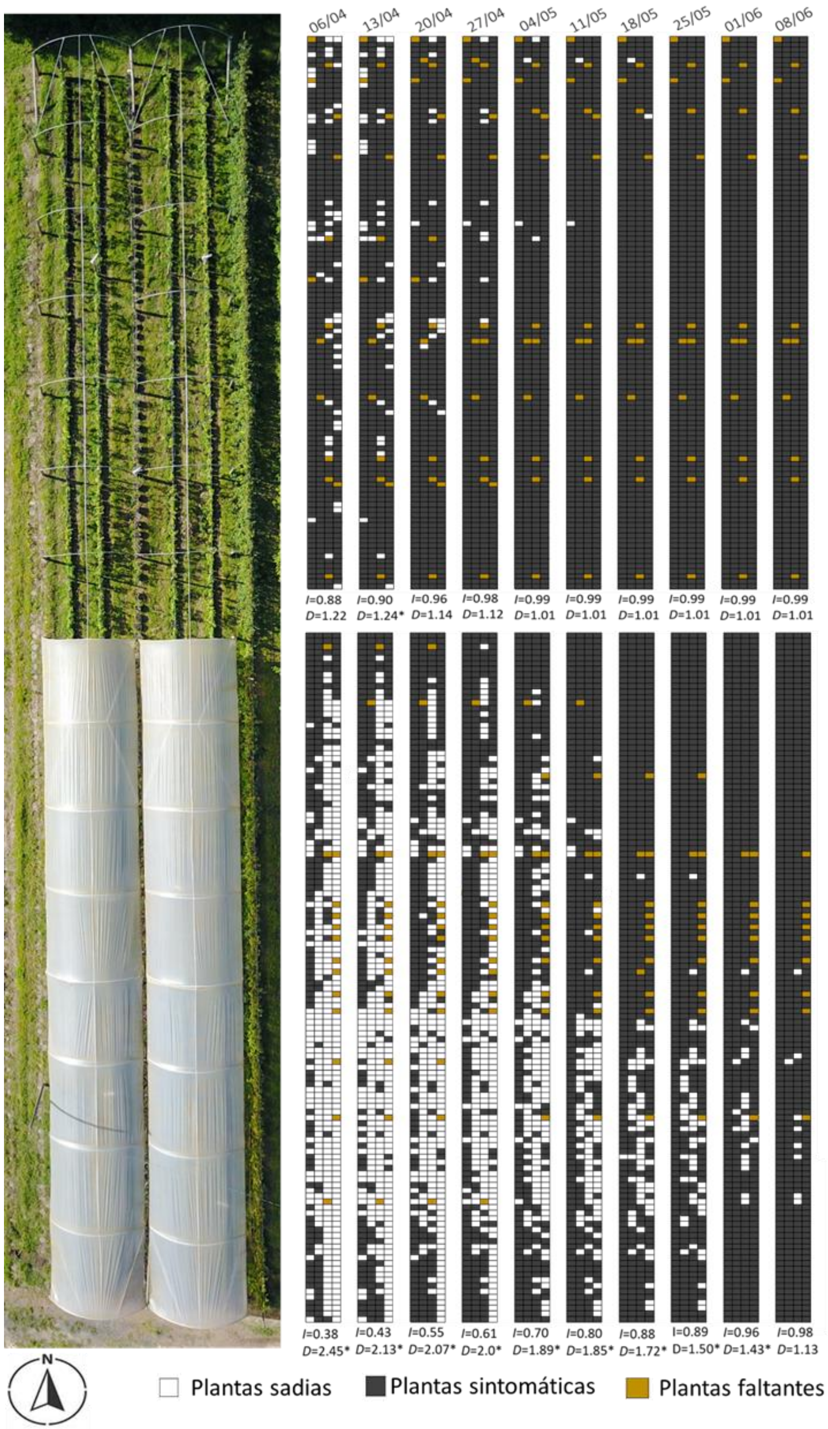


(Simões et al. 2023)

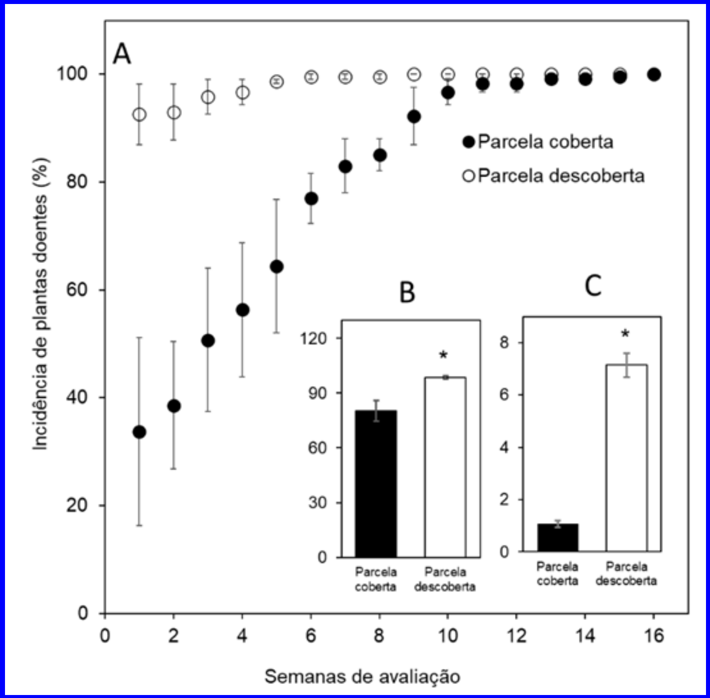
Dispersão a curtas distâncias pelo ar



(Simões et al. 2023)



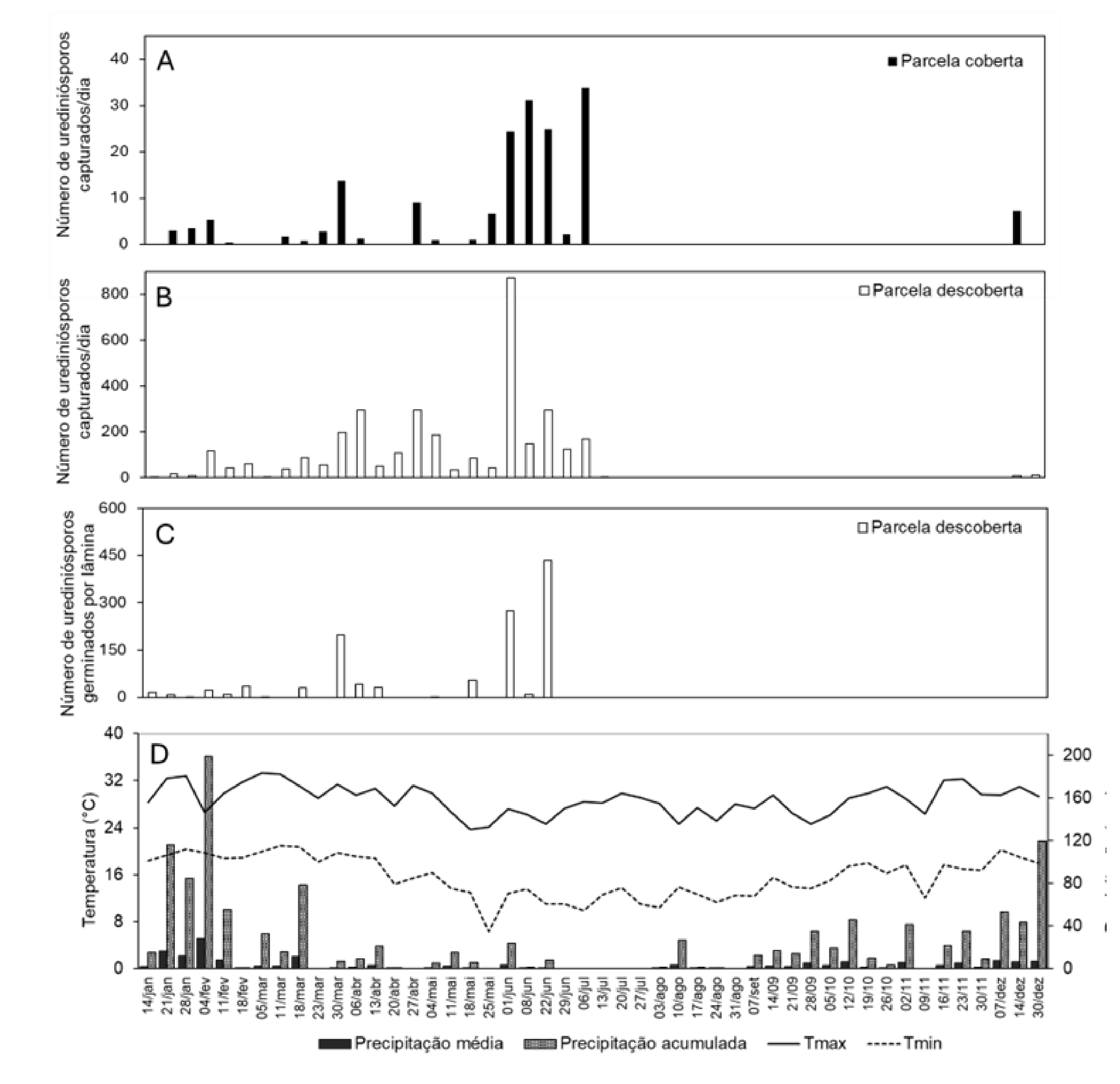
Dispersão a curtas distâncias pelo ar



A- Progresso temporal da doença; B- Área abaixo da curva de progresso da doença (AACPD) calculada para incidência da doença; C- Área abaixo da curva de progresso da doença (AACPD) calculada para severidade nos folíolos

(Azevedo não publicado)

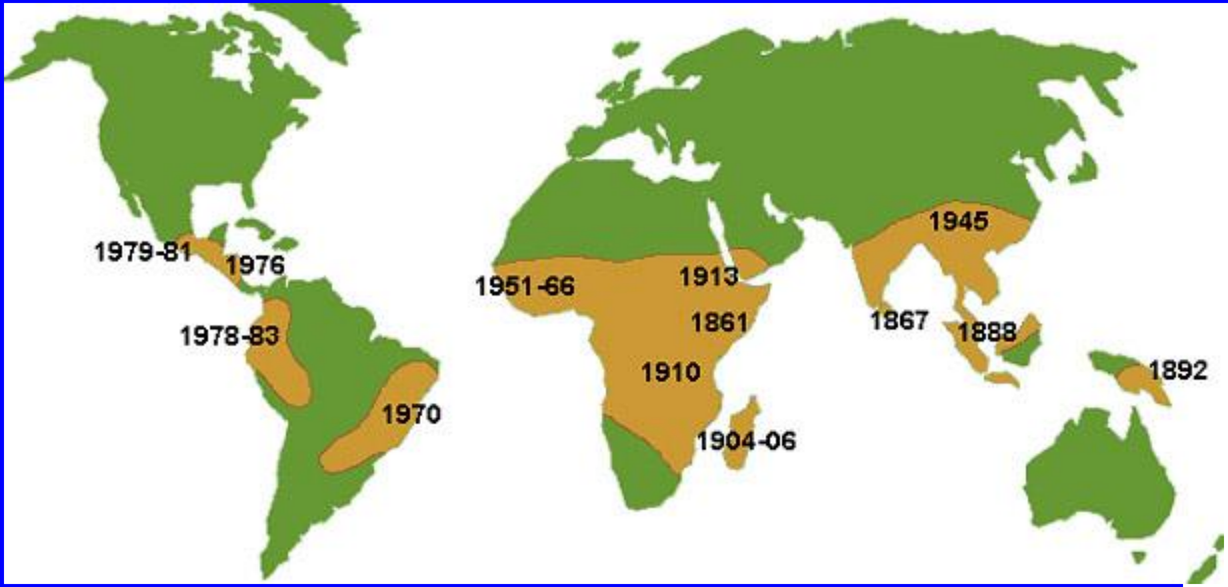
Dispersão a curtas distâncias pelo ar



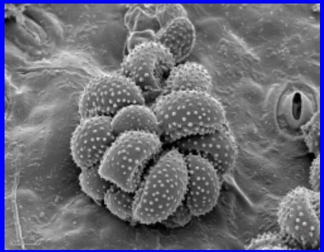
(Azevedo não publicado)

Dispersão a longas distâncias pelo ar

Ferrugem do cafeeiro – *Hemileia vastatrix*



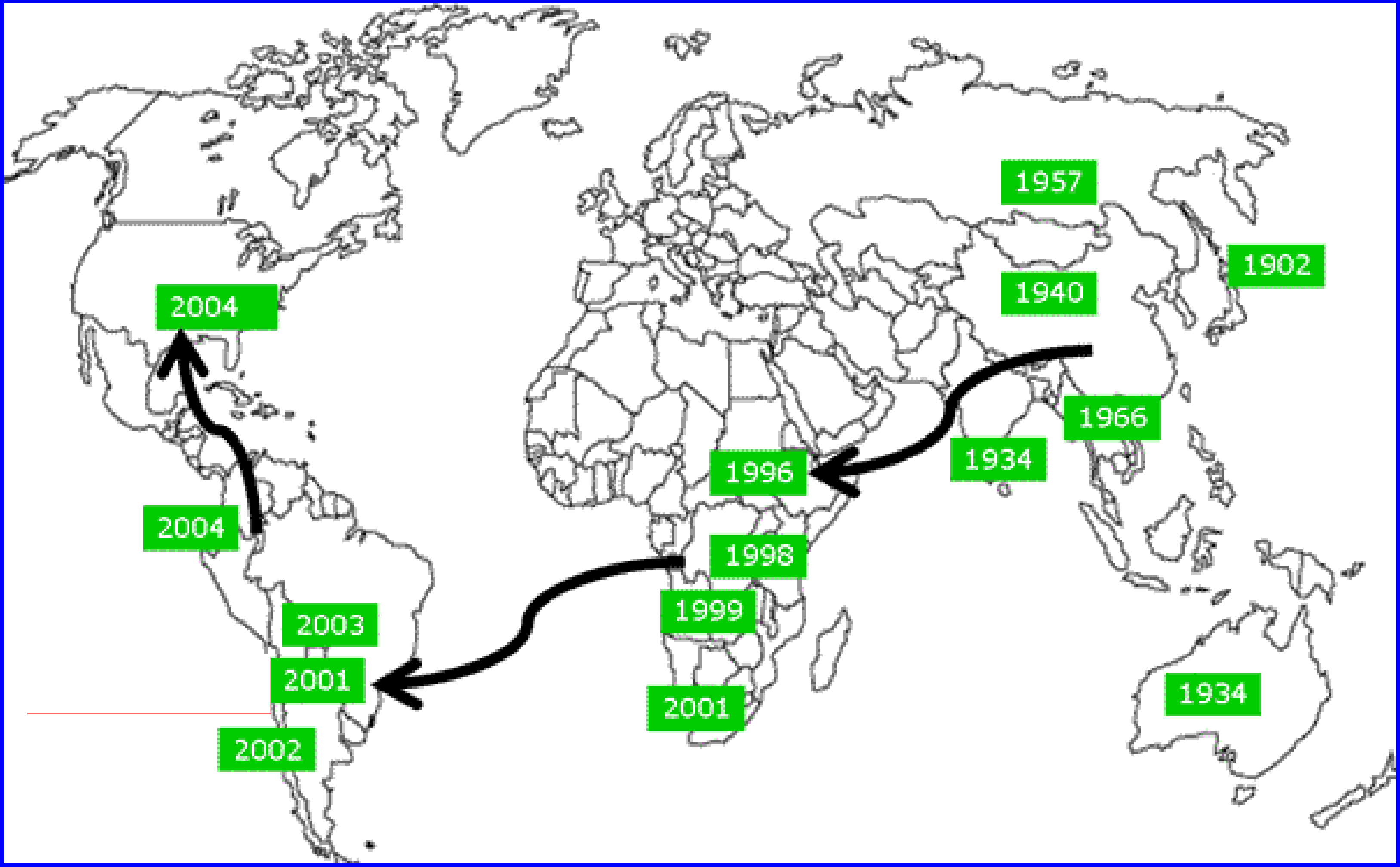
Distribuição de *Hemileia vastatrix* e datas da primeira constatação em cada região



https://www.apsnet.org/edcenter/intropp/lessons/fungi/Basidiomycetes/Pages/CoffeeRust.aspx

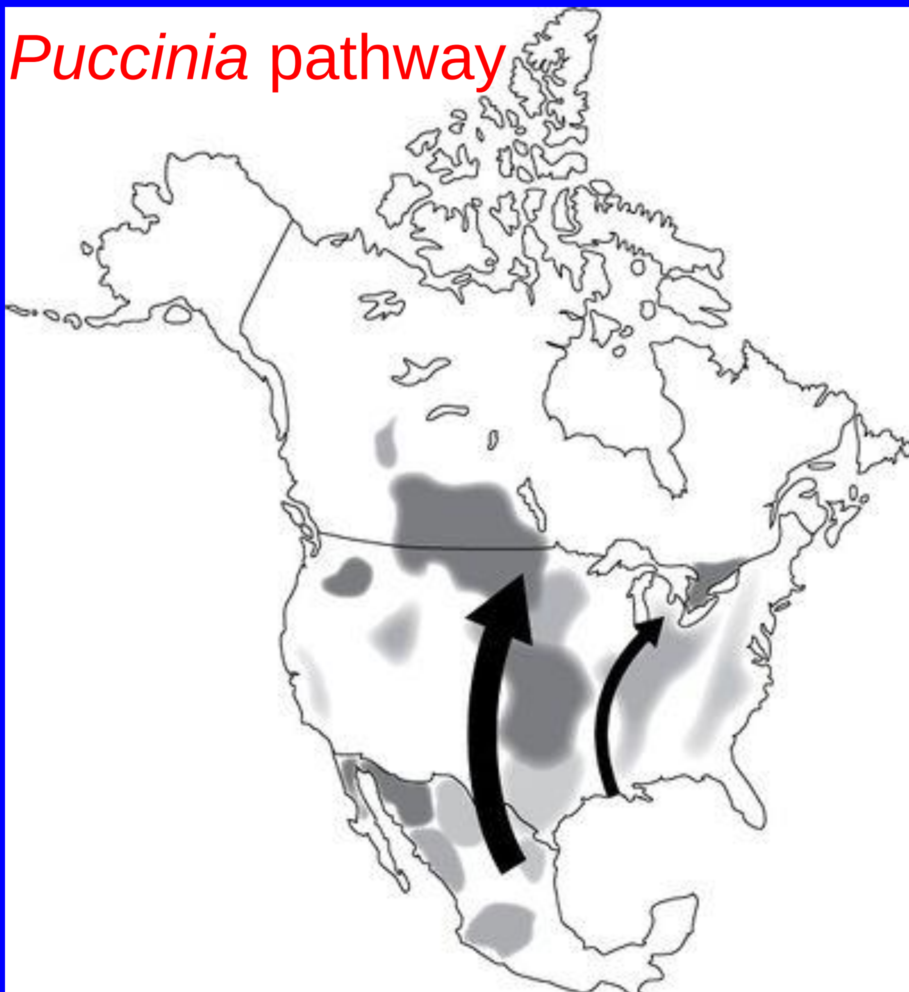
Dispersão a longas distâncias pelo ar

Ferrugem da soja – *Phakopsora pachyrhizi*



Dispersão a longas distâncias pelo ar

Ferrugem do trigo – *Puccinia graminis* f. sp. *tritici*

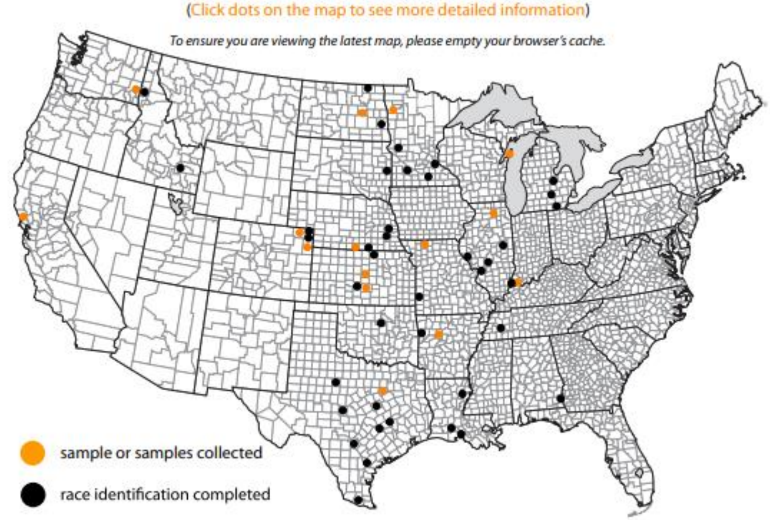


2009 Wheat Stem Rust Observations in the U.S.

Prepared by USDA-ARS Cereal Disease Laboratory, St. Paul, MN

(Click dots on the map to see more detailed information)

To ensure you are viewing the latest map, please empty your browser's cache.



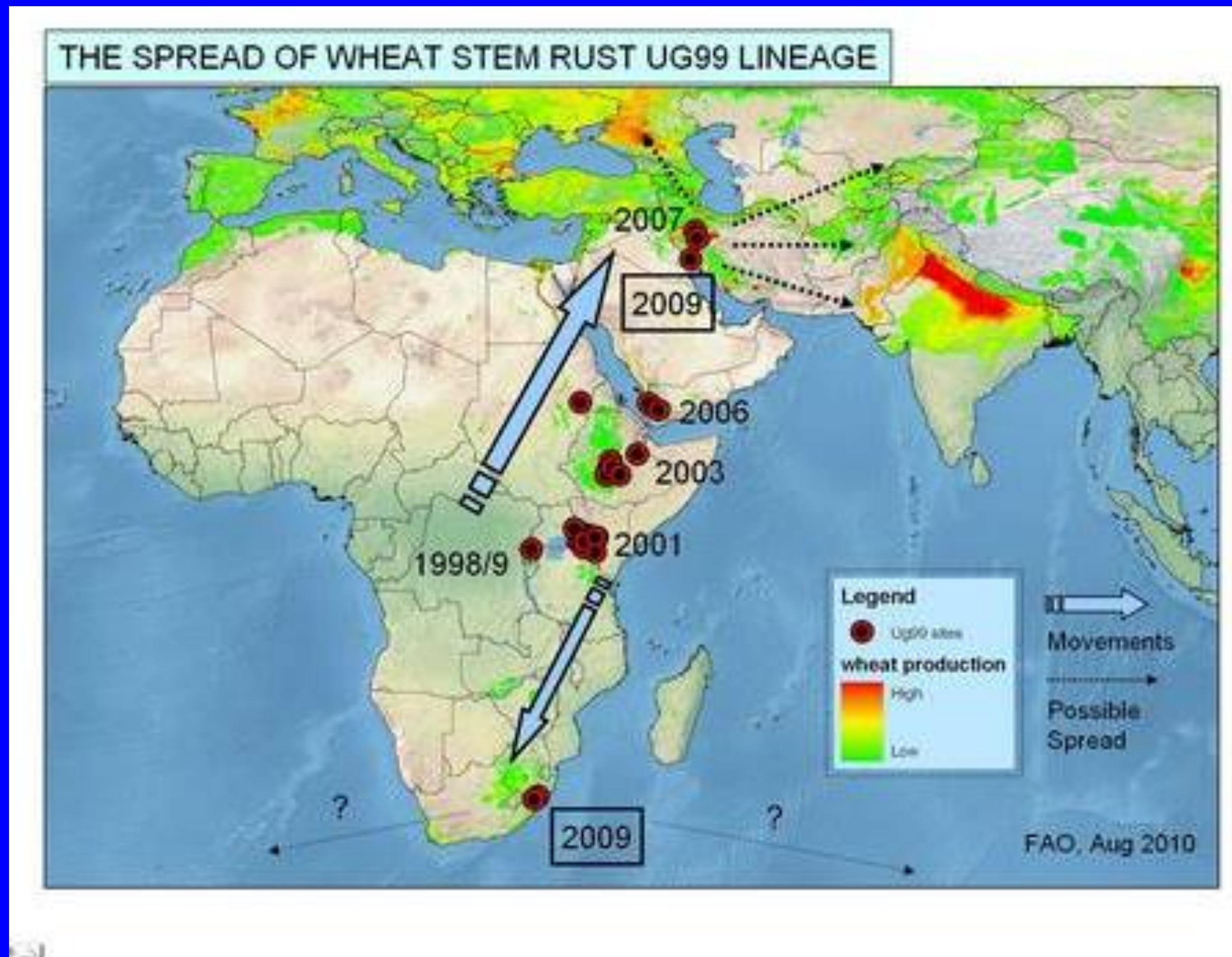
Date*	Location	Field/Plot	Cultivar/line	Race(s) identified
3/23	Weslaco, TX (Hidalgo County)	Field	Spelt wheat, barley	QFCS
4/1	Jeanerette, LA (Iberia Parish)	Plot	Panola	QFCS
4/8	Winnsboro, LA (Franklin Parish)	Plot	4-5 different plots	QFCS
4/9	Beeville, TX (Bee County)	Plot	McNair 701	QFCS
4/9	McGregor, TX (McLennan County)	Plot	McNair 701	QFCS
4/10	near Castroville, TX (Bexar County)	Plot	McNair 701	QFCS
4/20	near Castroville, TX (Bexar County)	Plot	Winter barley plots	QFCS
4/21	Headland, AL (Henry County)	Plot	McNair 701, Panola	QFCS
4/22	Crowley, LA (Acadia Parish)	Plot	CK 9553 and 2 nursery lines	QFCS
4/27	College Station, TX (Brazos County)	Plot	McNair 701	QFCS
5/4	Bardwell, TX (Ellis County)	Plot	Unknown	
5/5	Giddings, TX (Lee County)	Plot	Unknown	QFCS
5/5	Brady, TX (McCulloch County)	Plot	McNair 701	QFCS
5/6	Stamford, TX (Jones County)	Field	Unknown	QFCS
5/8	Kibler, AR (Crawford County)	Plot	Delta King 9577	QFCS
5/11	Russellville, AR (Pope County)	Plot	Panola	
5/22, 5/26	Stillwater, OK (Payne County)	Plot	McNair 701, 09FAWWON #88	QFCS
5/27	Jackson, TN (Madison County)	Field	FFR 510	QFCS
5/30	Hutchinson, KS (Reno County)	Plot	McNair 701, Endurance	
Early June	Spencer and Vanderburgh Counties, IN	Plots	Unknown	
6/1	Ellsworth, KS (Ellsworth County)	Plot	Winterhawk	
6/2	St. John, KS (Stafford County)	Plot	Winterhawk, Turkey	QFCS
6/3	Belleville, KS (Republic County)	Plot	Winterhawk	QFCS
6/4	Lamar, MO (Barton County)	Plot	Several lines	QFCS
6/8	Madison County, IL	Plot	Unknown	QFCS
6/8	Champaign County, IL	Plot	Unknown	QFCS
6/8	Montgomery County, IL	Plot	Unknown	QFCS
6/8	Posey, IN	Plot	Croplan 8868	QFCS
6/9	Lincoln, NE (Lancaster County)	Plot	VA05W-258	QFCS

https://www.apsnet.org/edcenter/disandpath/fungalbasidio/pdlessons/Pages/StemRust.aspx

Dispersão a longas distâncias pelo ar

Ferrugem do colmo do trigo – *Puccinia graminis* f. sp. *Tritici*

Linhagem UG99 quebrou a resistência de *Sr31* e *Sr38*



Agentes de Dispersão

Ar

Curtas distâncias (camada de turbulência)
Longas distâncias (camada convectiva)

Fungos, Nematoides

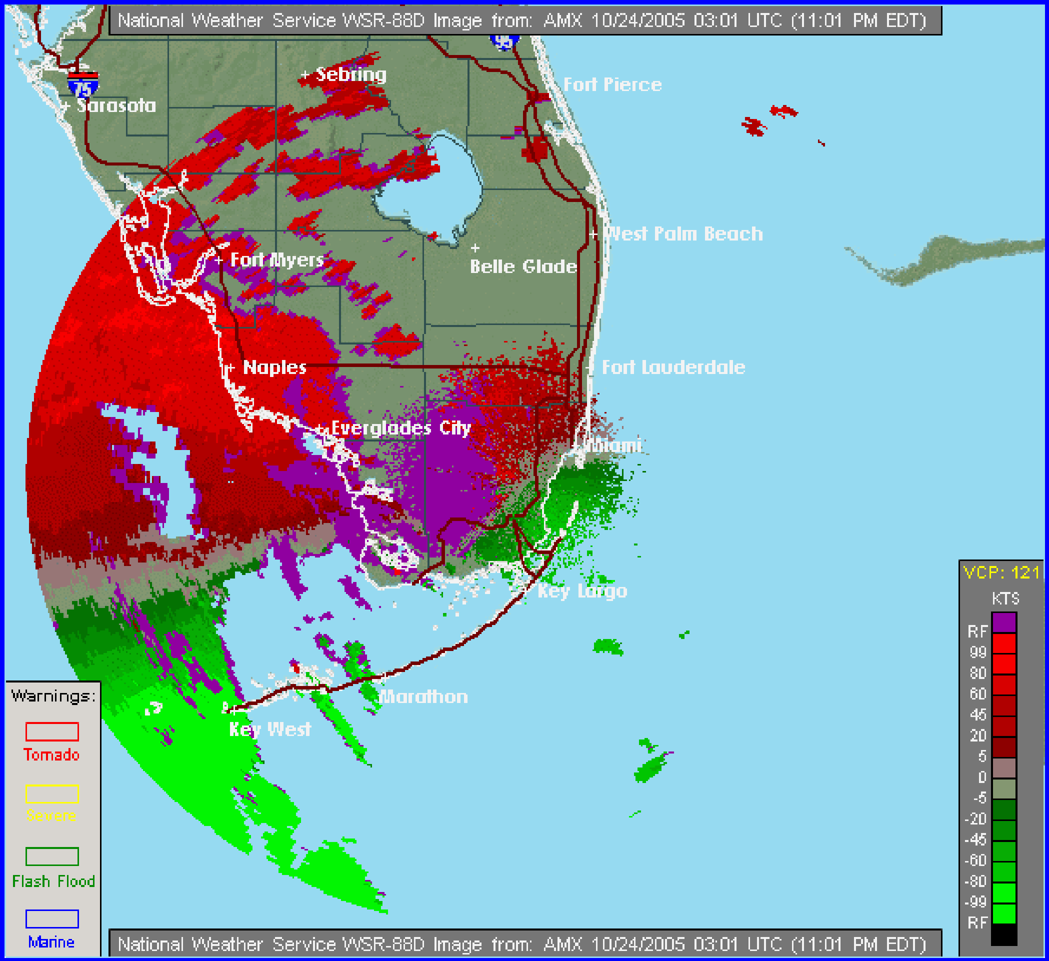
Água

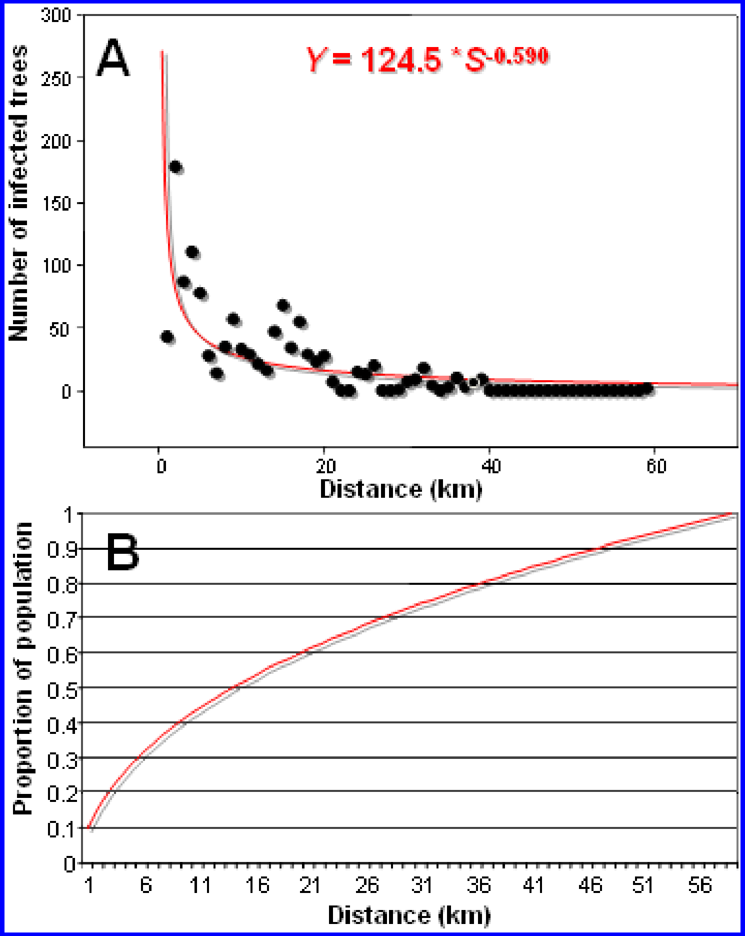
Respingos
Enxurrada
Aerossois

Bactérias
Fungos
Nematoides

Dispersão a longas distâncias

Cancro cítrico na Flórida - efeito de furacões





http://www.apsnet.org/online/feature/hurricane/image/citruscanker16sm.gif

Agentes de Dispersão

Ar

Curtas distâncias (camada de turbulência)
Longas distâncias (camada convectiva)

Fungos, Nematoides

Água

Respingos
Enxurrada
Aerossois

Bactérias
Fungos
Nematoides

Insetos

Vírus
Fitoplasmas
Bactérias
Fungos
Nematoides
Viroides (1)

Pólen

Vírus
Viroides
Fungos

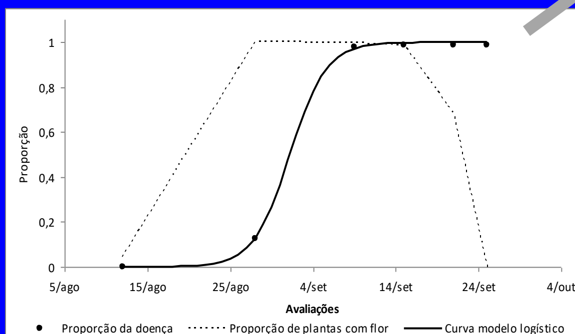
Homem

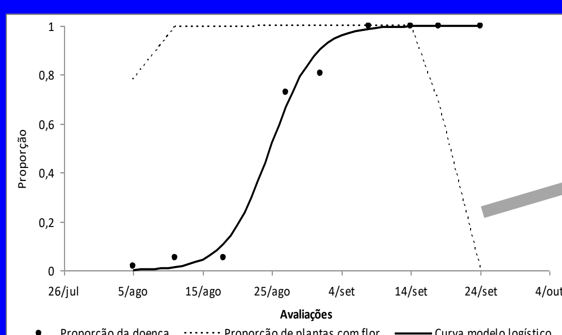
Transporte de material propagativo
Tratos culturais (enxertia, colheita, desbrota)

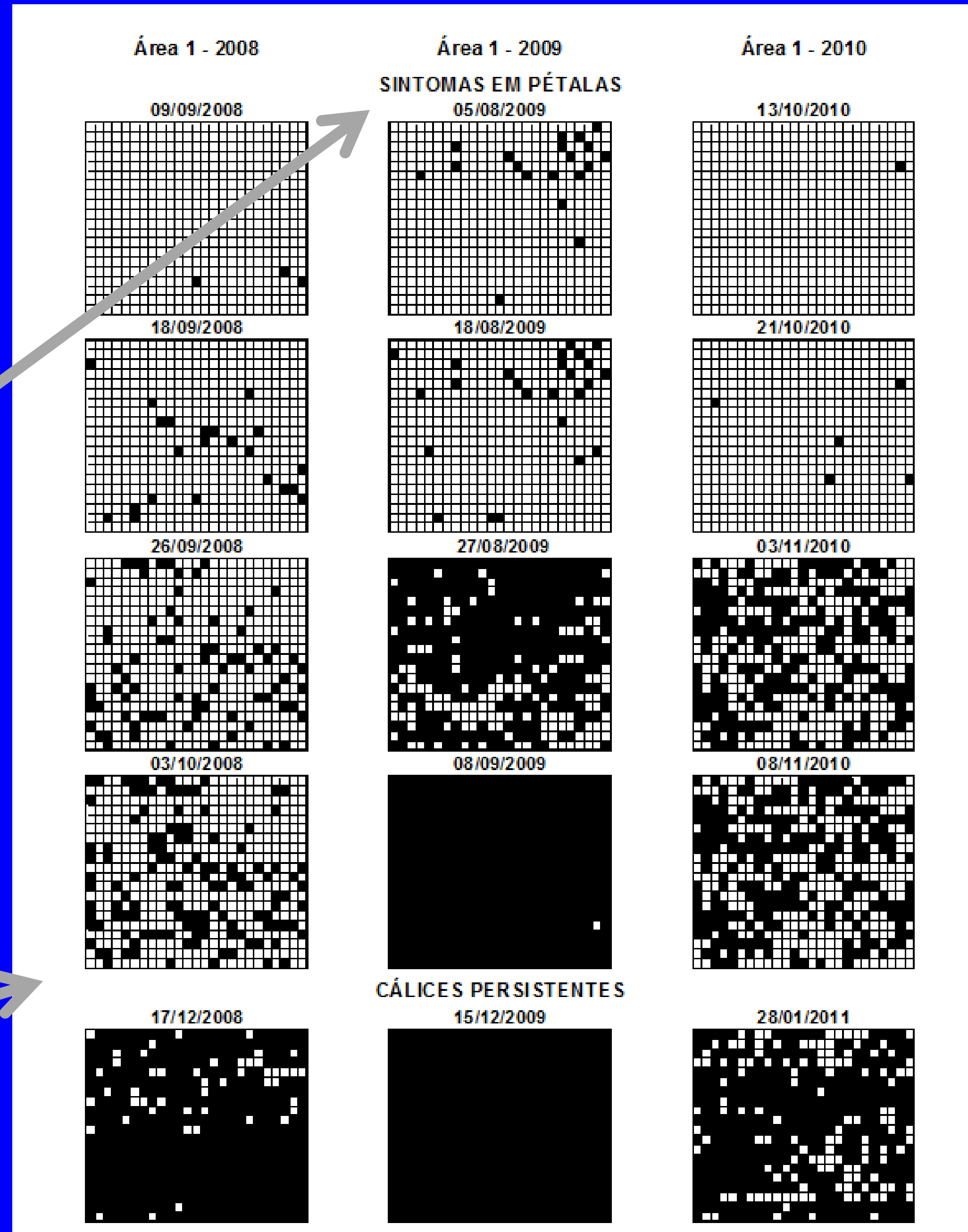
Vírus, Fungos, Bactérias, Viroides, Nematoides, Fitoplasmas ...

Podridão floral dos citros

Colletotrichum acutatum







(Silva et al., 2014)

Transmissão - Liberação, dispersão e deposição

Fonte de inóculo
cv.Valencia

Simulação diária de orvalho

Controle do ambiente dentro e for a das gaiolas

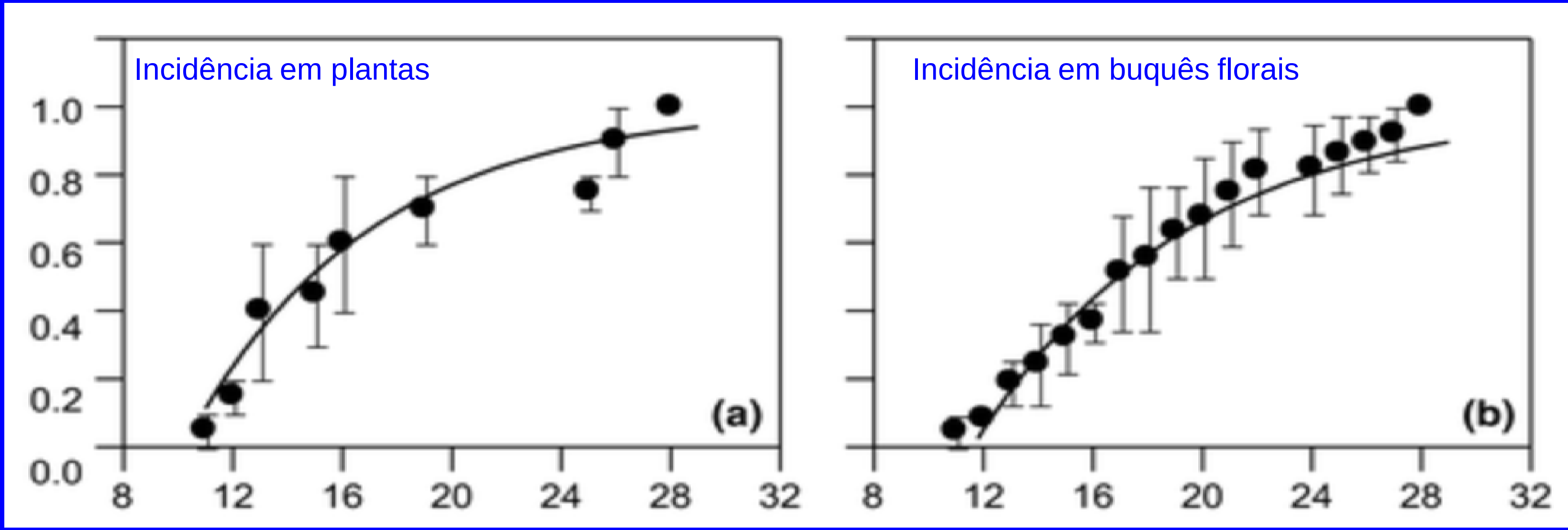
(Gaparoto et al. 2016)

Abelhas podem dispersar *C. acutatum* de plantas inoculadas para sadias

Experimento 1

Experimento 2

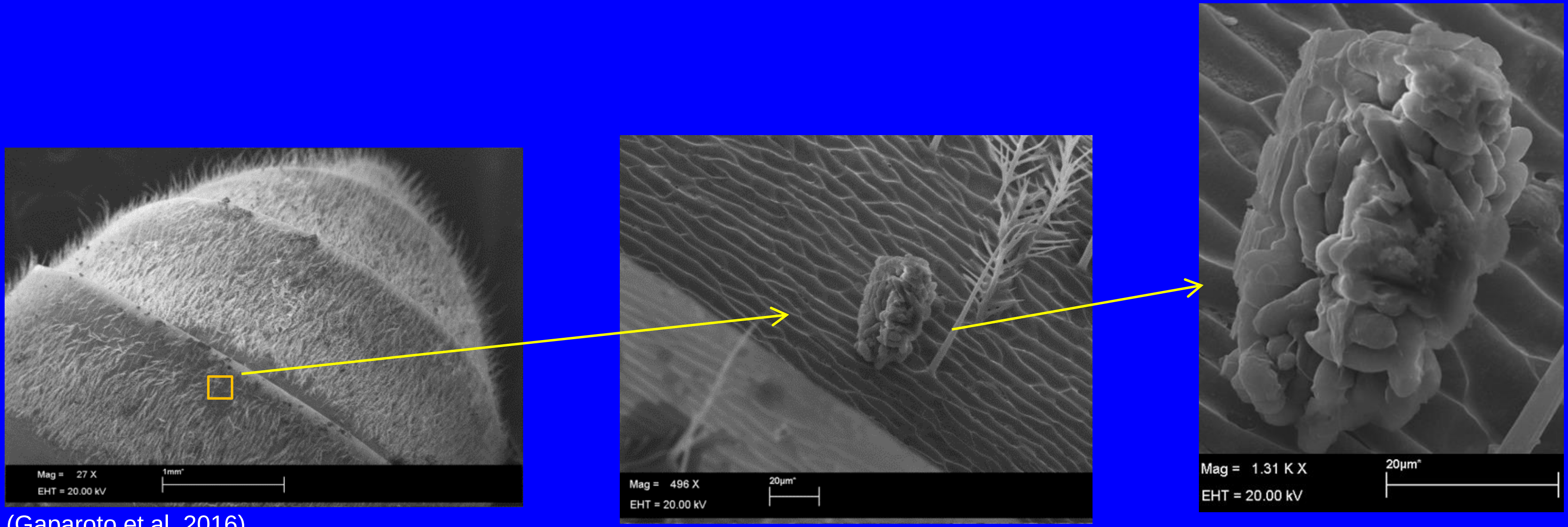
(Gaparoto et al. 2016)



Abelhas podem dispersar *C. acutatum* de plantas inoculadas para sadias

Experimento 1

Experimento 2



(Gaparoto et al. 2016)

Transmissão - Liberação, dispersão e deposição

Vírus, fitoplasmas, fungos e bactérias

Pulgão preto (*Toxoptera citricida*)
Vírus da tristeza dos citros

Parra et al. (2003)

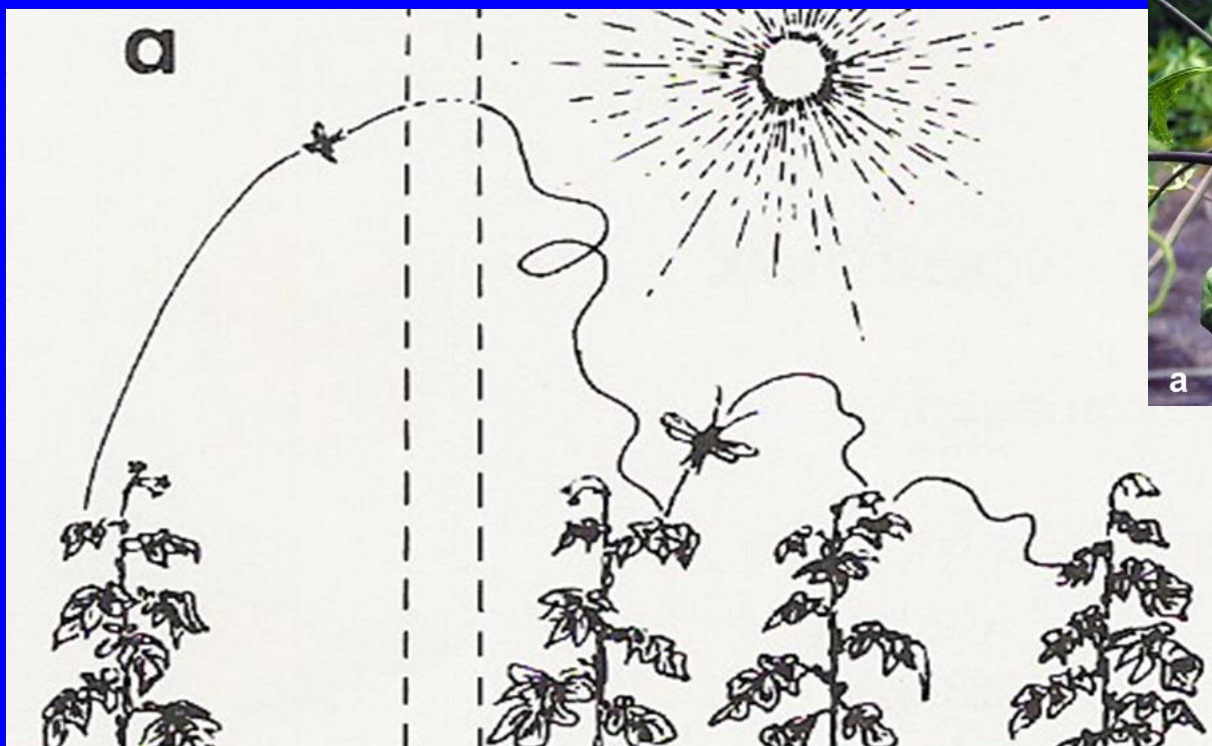
Cigarrinhas
Xylella fastidiosa

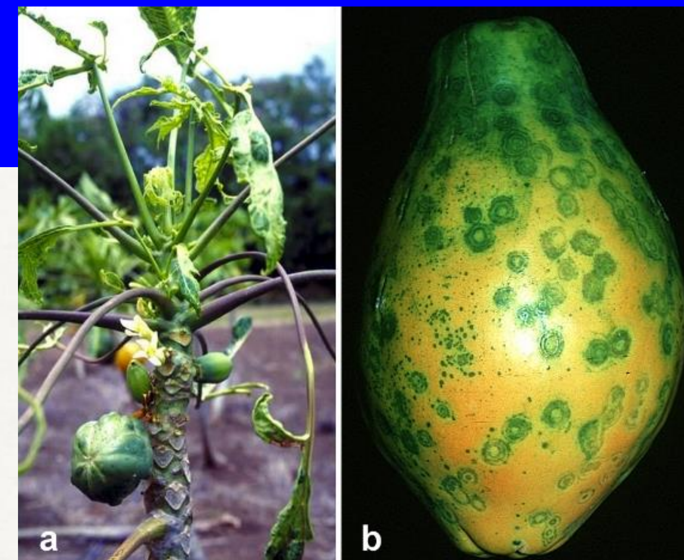
Parathona

Ferrariana

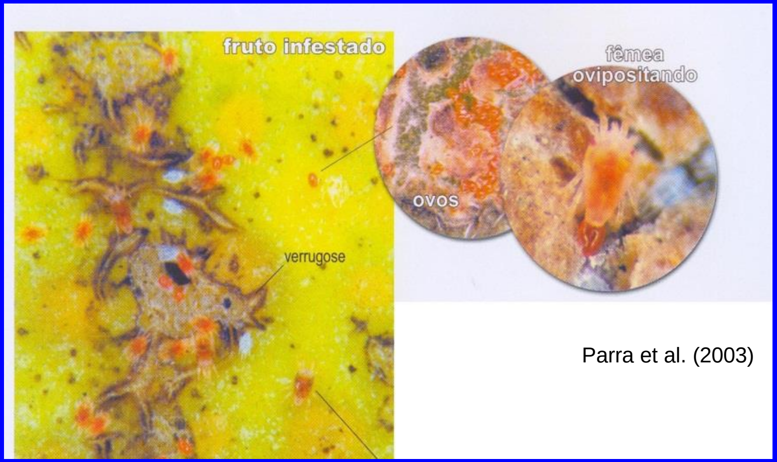
Transmissão - Liberação, dispersão e deposição

Transmissão de vírus por insetos de forma
não persistente





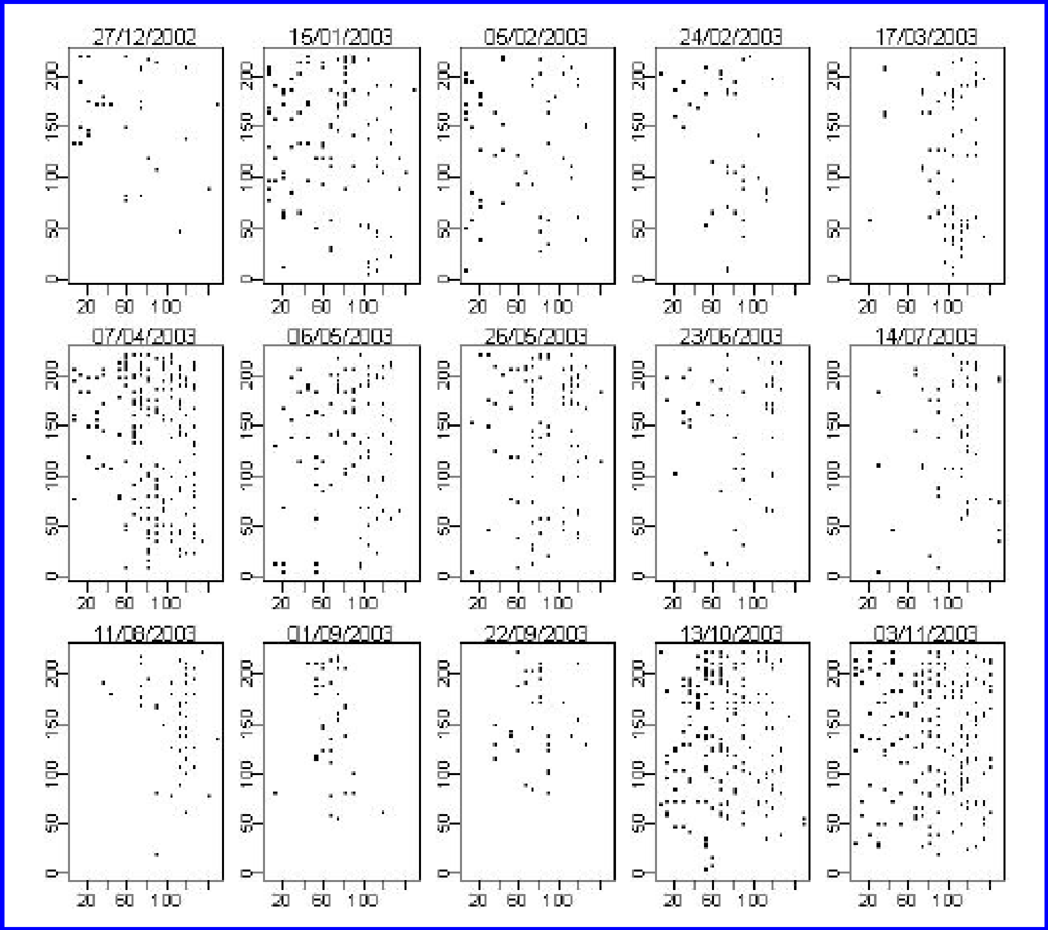
Transmissão - Liberação, dispersão e deposição



Parra et al. (2003)


Bastianel et al. (2006)

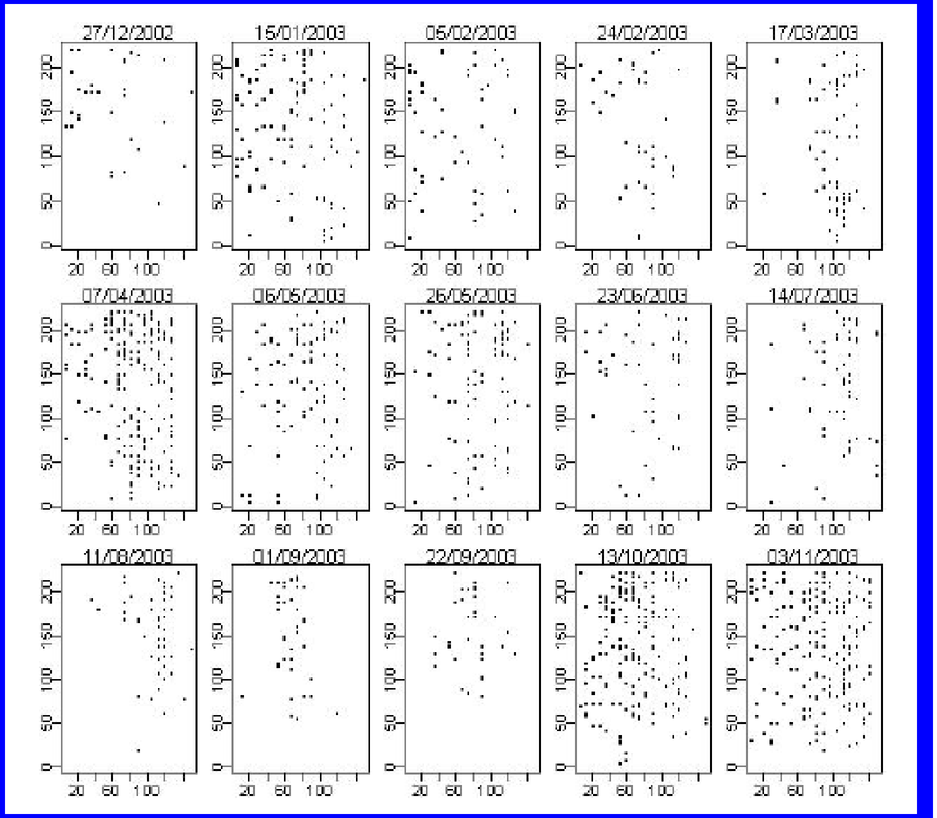
Brevipalpus yothersi



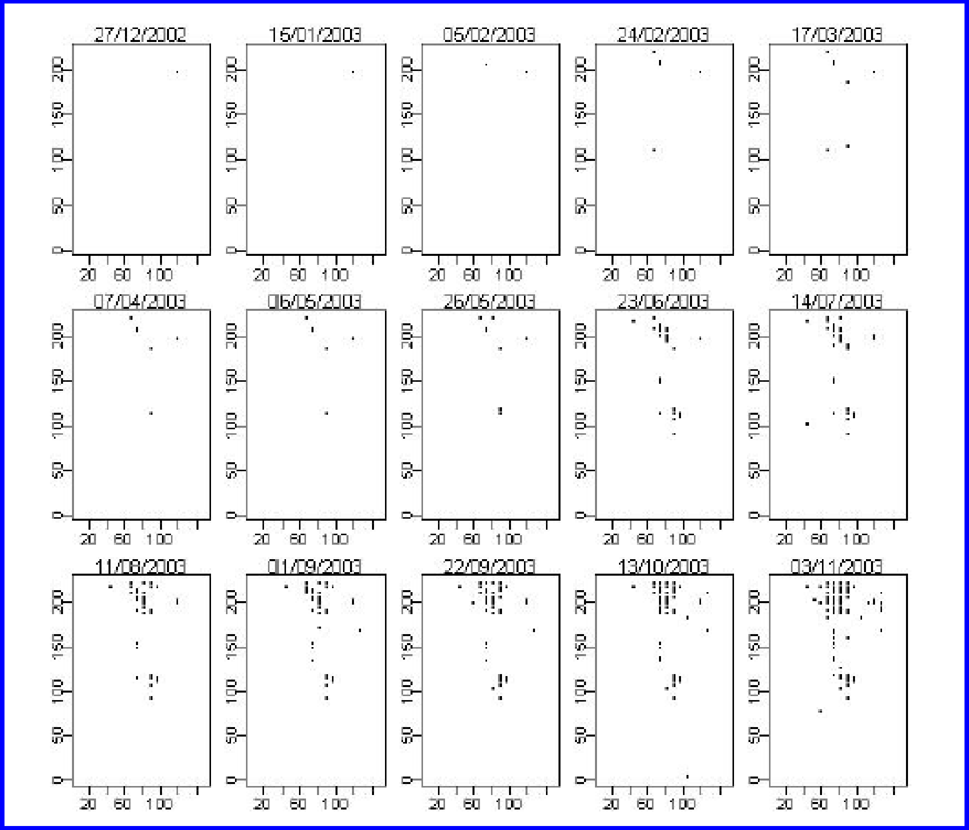
Czermainski (2007)

Transmissão - Liberação, dispersão e deposição

Brevipalpus yothersi



Leprose



Czermainski (2007)

Para a próxima aula:

Trabalho em grupo – definição de infecção e de colonização (procurar definições contrastantes)

Leitura: Aylor, D.E. *Aerial Dispersal of Pollen and Spores* APS Press 2017

Amorim, L. & Pascholati, S.F. Ciclo de relaçãoes patógebo-hospedeiro.