

# BREEDING FOR SCAB RESISTANCE IN PECAN



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# Pecan Scab

- Caused by the fungus *Fusicladium effusum* syn. *Cladosporium caryigenum*.
- Most economically damaging pathogen of pecan in the Southeast.
- Reduces yield and quality and can result in total crop loss if uncontrolled.
- Chemical control requires numerous sprays throughout the growing season.

# Nut and leaf scab symptoms





Desirable + Stuart = 60% Trees in Georgia



Desirable



Stuart

- Nuts from a sprayed orchard in 2005.

# History of Scab Resistance, Albany Ga.

**<1910 - Scab not considered a problem. Mostly seen on seedlings.**

**1910-1920 - ‘Georgia’ and ‘San Saba’ affected.**

**1920 - ‘Delmas’ became affected, spread to entire region by 1923.**

**1920 - ‘Alley’ affected.**

**1923 - ‘Schley’ affected in Baconton.**

**1926 - ‘Schley’ disease epidemic in Albany region.**

**1929 - ‘Pabst’ still unaffected in Albany.**

– From Demaree and Cole, 1929

# History of Scab Resistance

## 1. Cultivars vary in susceptibility over time.

Many cultivars once considered immune to scab can not now be grown due to their susceptibility.

## 2. Cultivars vary in susceptibility over locations.

Orchard to orchard and region to region different cultivars vary in their susceptibility.

Pecan scab is composed of races.

How many races are there?

How specific are they?

- Developed genetically pure scab isolates in the laboratory.
- Inoculated 19 cultivars with 12 different scab isolates.



# Sc-Tif-1

<b>Barton</b>	<b>Resistant</b>
<b>Cape Fear</b>	<b>Resistant</b>
<b>Cheyenne</b>	<b>Resistant</b>
<b>Curtis</b>	<b>Resistant</b>
<b>Desirable</b>	<b>Resistant</b>
<b>Elliot</b>	<b>Resistant</b>
<b>Farley</b>	<b>Resistant</b>
<b>Gloria</b>	<b>Resistant</b>
<b>Kiowa</b>	<b>Resistant</b>
<b>Mahan</b>	<b>Intermediate</b>
<b>Money</b>	<b>Intermediate</b>
<b>Pawnee</b>	<b>Resistant</b>
<b>Schley</b>	<b>Susceptible</b>
<b>Shoshoni</b>	<b>Resistant</b>
<b>Stuart</b>	<b>Resistant</b>
<b>Sumner</b>	<b>Resistant</b>
<b>Wichita</b>	<b>Intermediate</b>



Susceptible



Intermediate



# Cf-Au-2



Susceptible



Intermediate

Barton	Resistant
Cape Fear	Susceptible
Cheyenne	Resistant
Curtis	Resistant
Desirable	Resistant
Elliot	Resistant
Farley	Resistant
Gloria	Resistant
Kiowa	Resistant
Mahan	Intermediate
Money	Intermediate
Pawnee	Intermediate
Schley	Resistant
Shoshoni	Resistant
Stuart	Resistant
Sumner	Resistant
Wichita	Resistant

Table 1. Resistance of 19 pecan cultivars to 12 isolates of *F. effusum*.

	# Cultivars	# Cultivars	# Cultivars
Scab Race	Susceptible	Intermediate	Resistant
Cf-Au-2	1	3	14
De-Tif-3	1	14	3
De-Mo-11	1	13	4
AL-LI-DE	2	10	5
GA-FW-DE	1	6	9
LA-MP-DE	5	2	9
FA-Tif-11	3	6	9
Ma-Tif-11	4	5	9
Pa-OK-11	2	8	8
Sc-Tif-1	1	3	14
St-Tif-13	2	5	11
Wi-Tif-2	2	6	10
Average	2.1	6.8	8.8

# How many races are there?

Many - Most races are virulent on only a few cultivars, so many different races must exist.

# How specific is the virulence of the races?

Very specific - most races are capable of producing a susceptible reaction on only a few cultivars.



Effective resistance system in nature because of the heterozygosity and outbreeding of pecan.



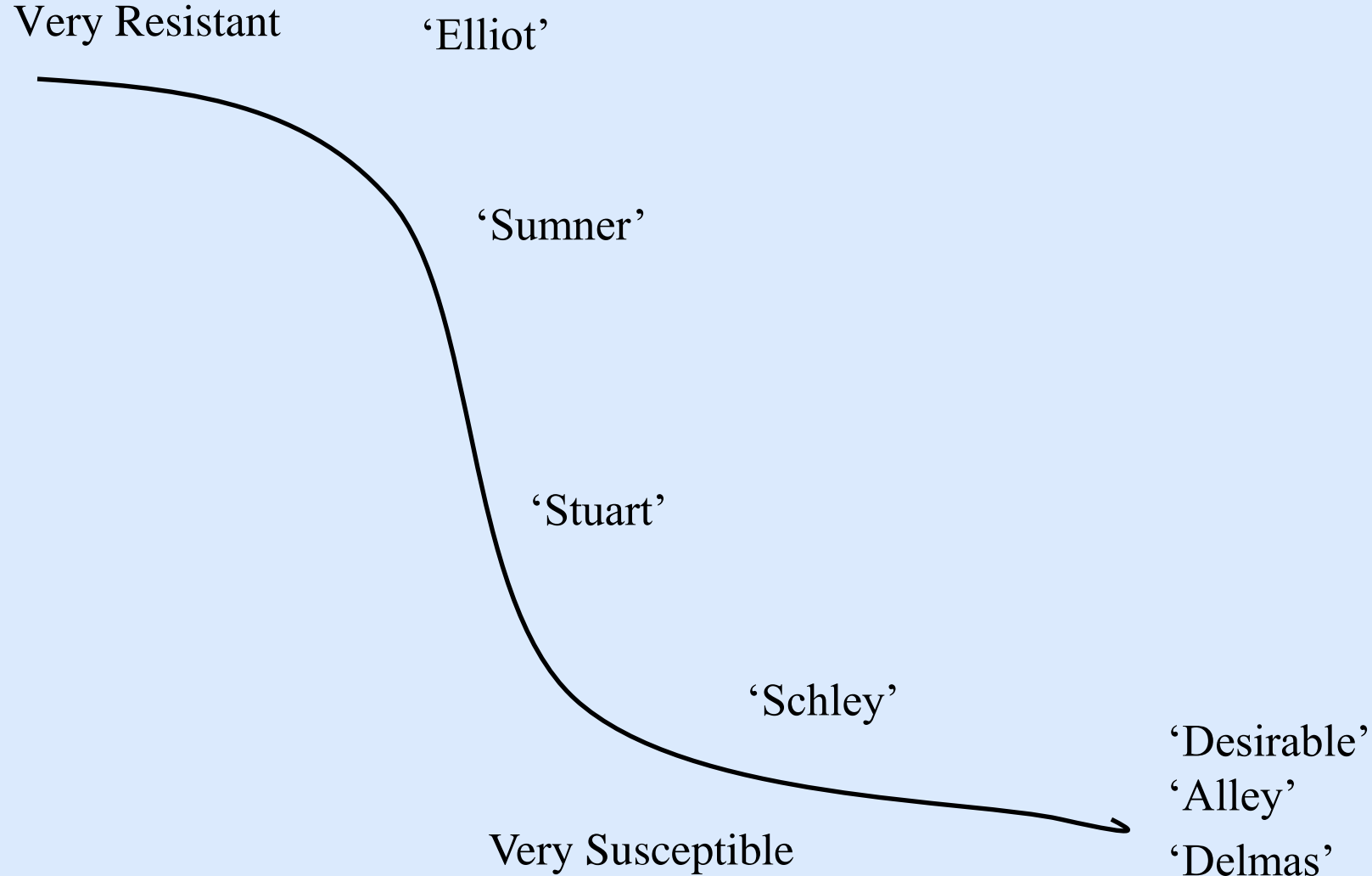


# Ineffective resistance system in long-term monoculture orchards.



8/3/2000

# Resistance tends to decrease over time



# Implications in Breeding for Resistance

- New cultivars may at first appear resistant and then become more susceptible over time.
  - Boom and bust cycle of resistance.
- The more widely a cultivar is planted the more likely resistance will be overcome.
  - A victim of its own success.



# Opportunities in Resistance Breeding

1. Turn over cultivars more frequently, take advantage of the boom cycle.

- Test new cultivars as much as possible to find those most likely to have a longer period of resistance.
- Ensure resistant cultivars have good nut quality so loss of resistance isn't catastrophic.

# Opportunities in Resistance Breeding

## 2. Increase cultivar variability in orchards.

- Plant multiple cultivars in the orchard.
  - Reduces initial amount of inoculum available for disease onset.
  - Spread out the risk by having several cultivars.
  - Slows adaptation by other insect and disease pests.
  - Ensures good pollination.

Breeding program will need to select for cultivars with similar cultural and quality attributes, but with different resistance genes.



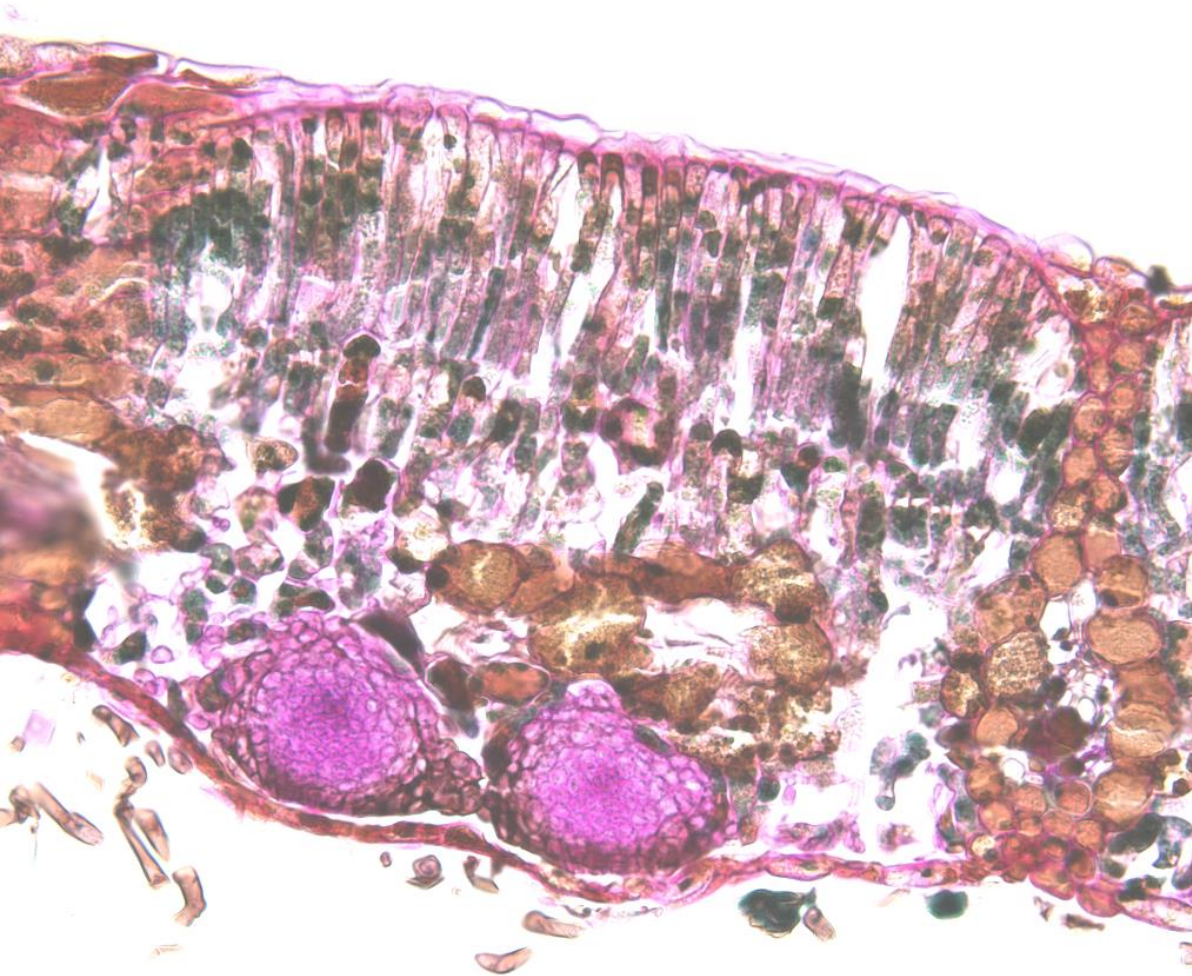
# Opportunities in Resistance Breeding

## 3. Increase durable resistance factors.

- Early leaf maturation.
- Less secondary growth.
- Upright canopies.
- Wide leaflet spacing, open canopies.



# Understanding the physiological basis of scab resistance.



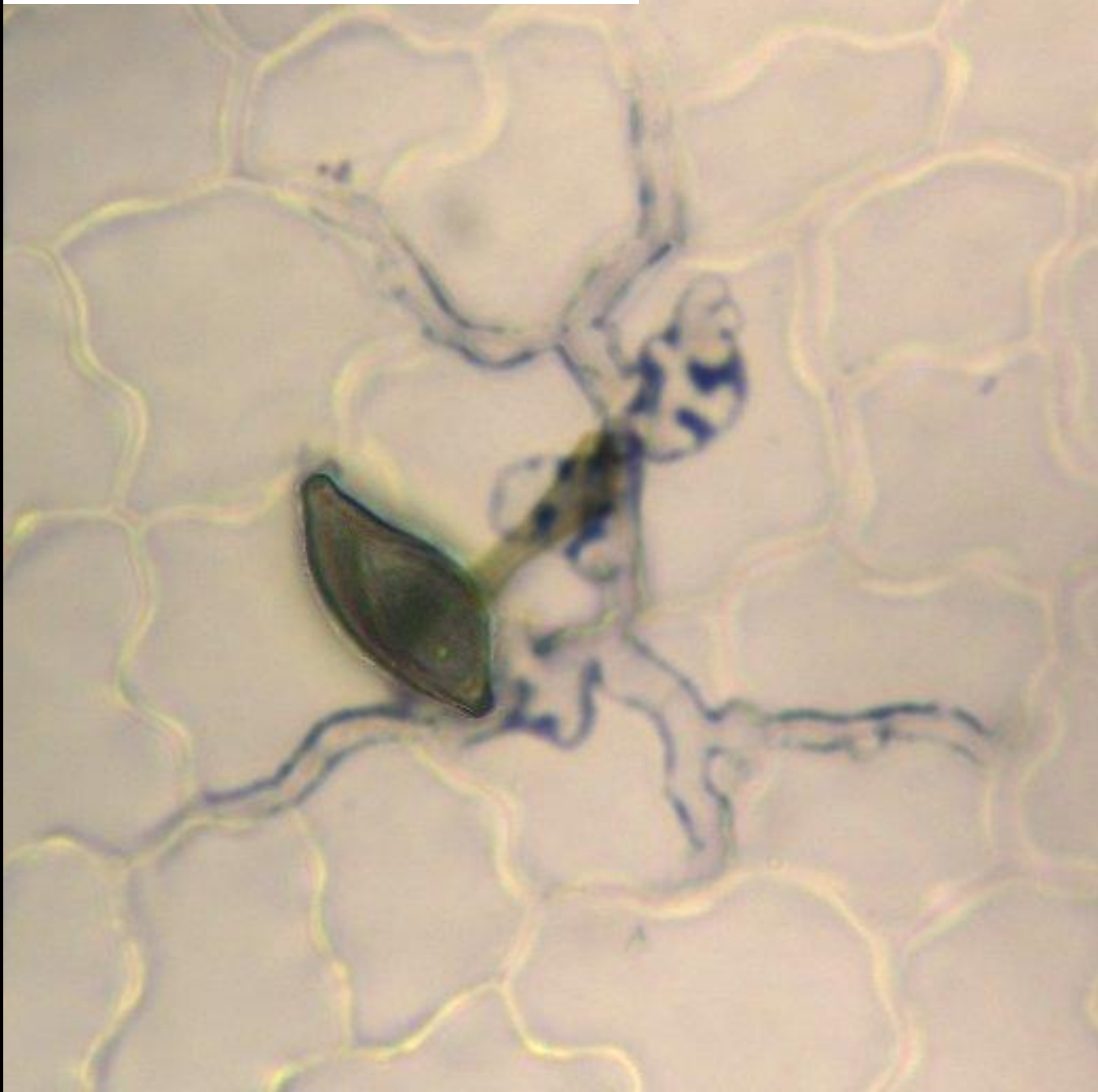
# **Microscopic examination of developing scab lesions.**

**Inoculated 'Farley' leaves with 4 scab isolates.**

- 1. Farley isolate - susceptible reaction**
- 2. Desirable isolate - intermediate reaction**
- 3. Pawnee isolate - intermediate reaction**
- 4. Wichita isolate - resistant reaction**

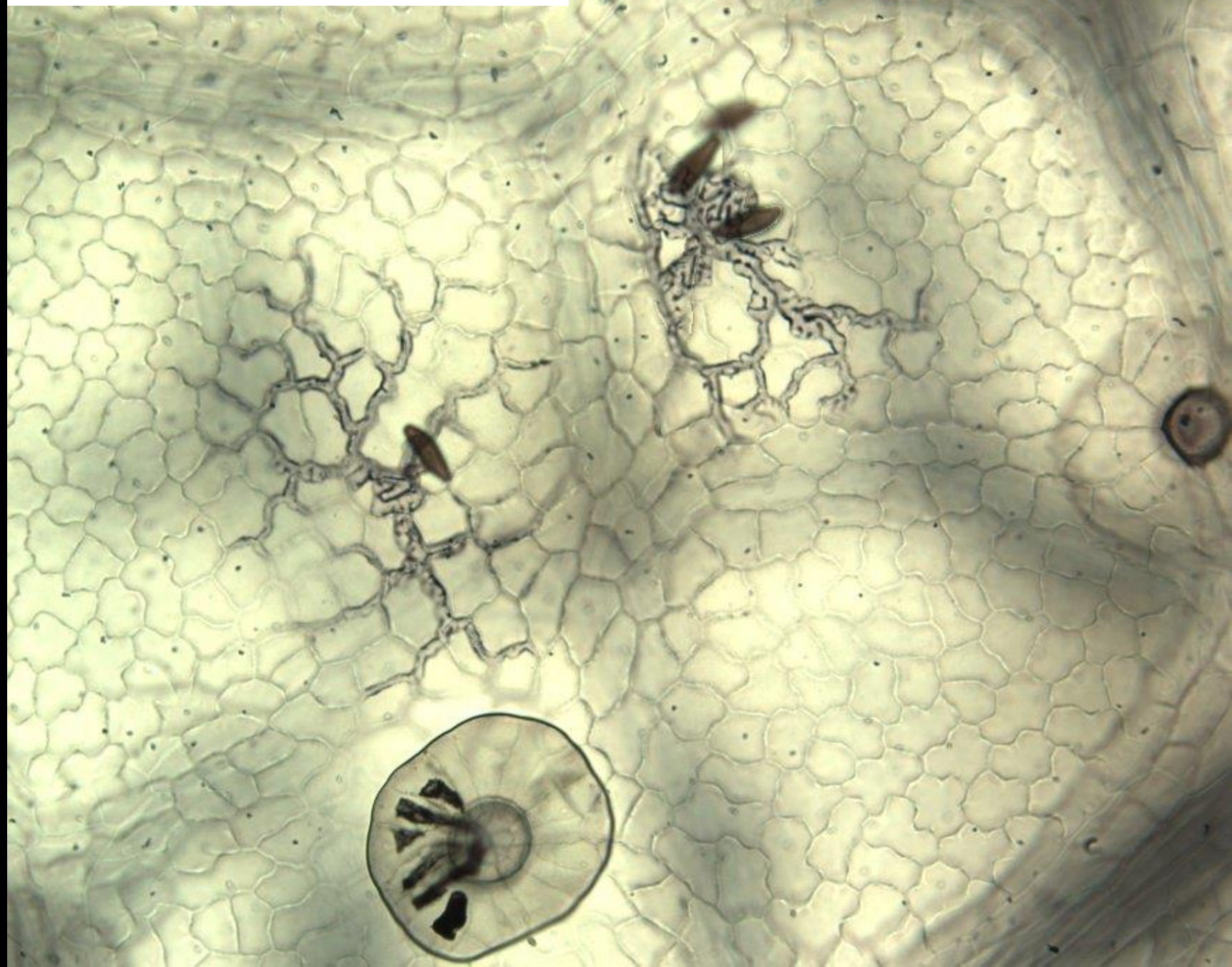
**Leaves were examined at 2, 4, 7, 11, and 15 days post-inoculation.**

## Susceptible Reaction - Day 4





## Susceptible Reaction - Day 8





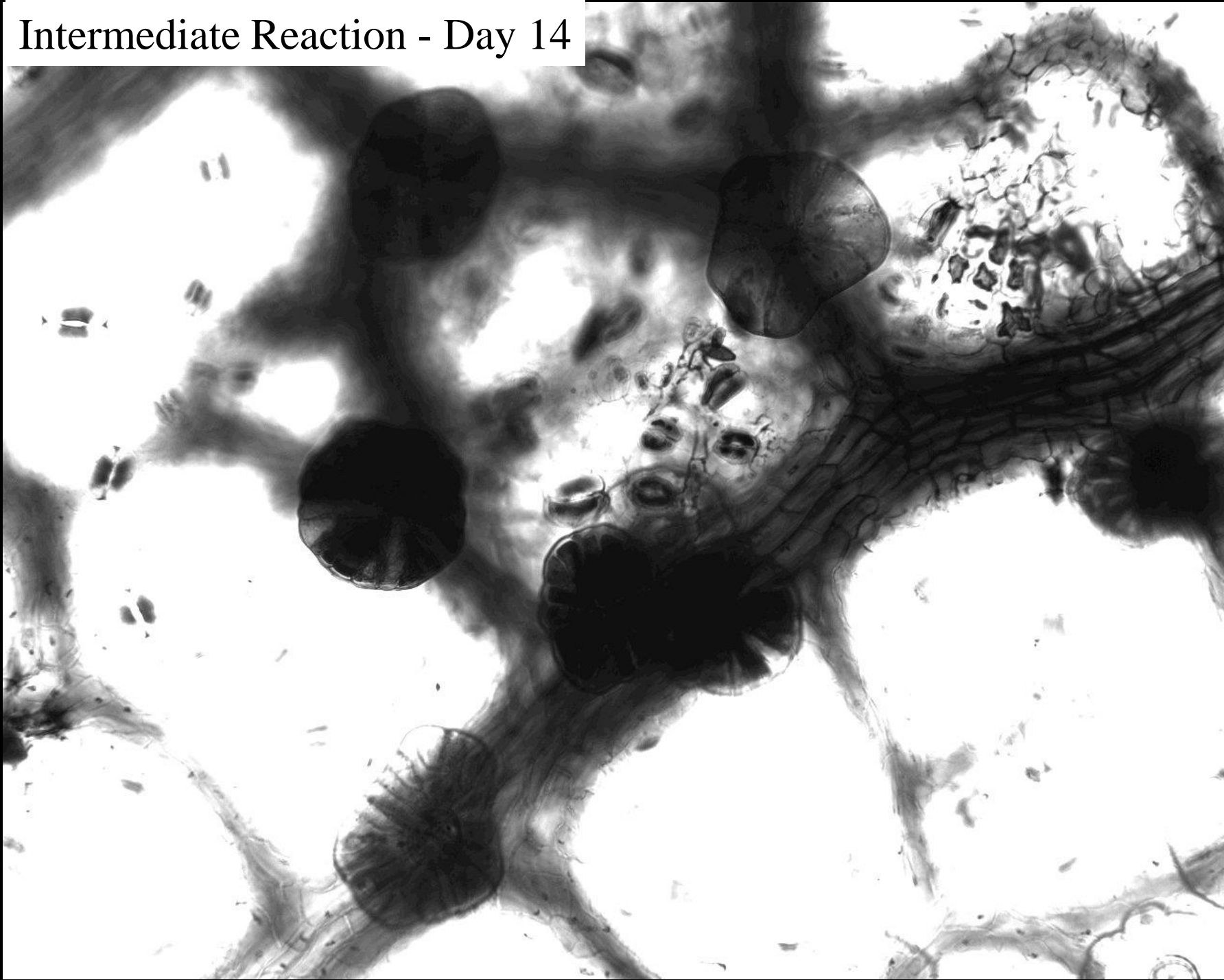
## Susceptible Reaction - Day 14



## Resistant Reaction - Day 2-14

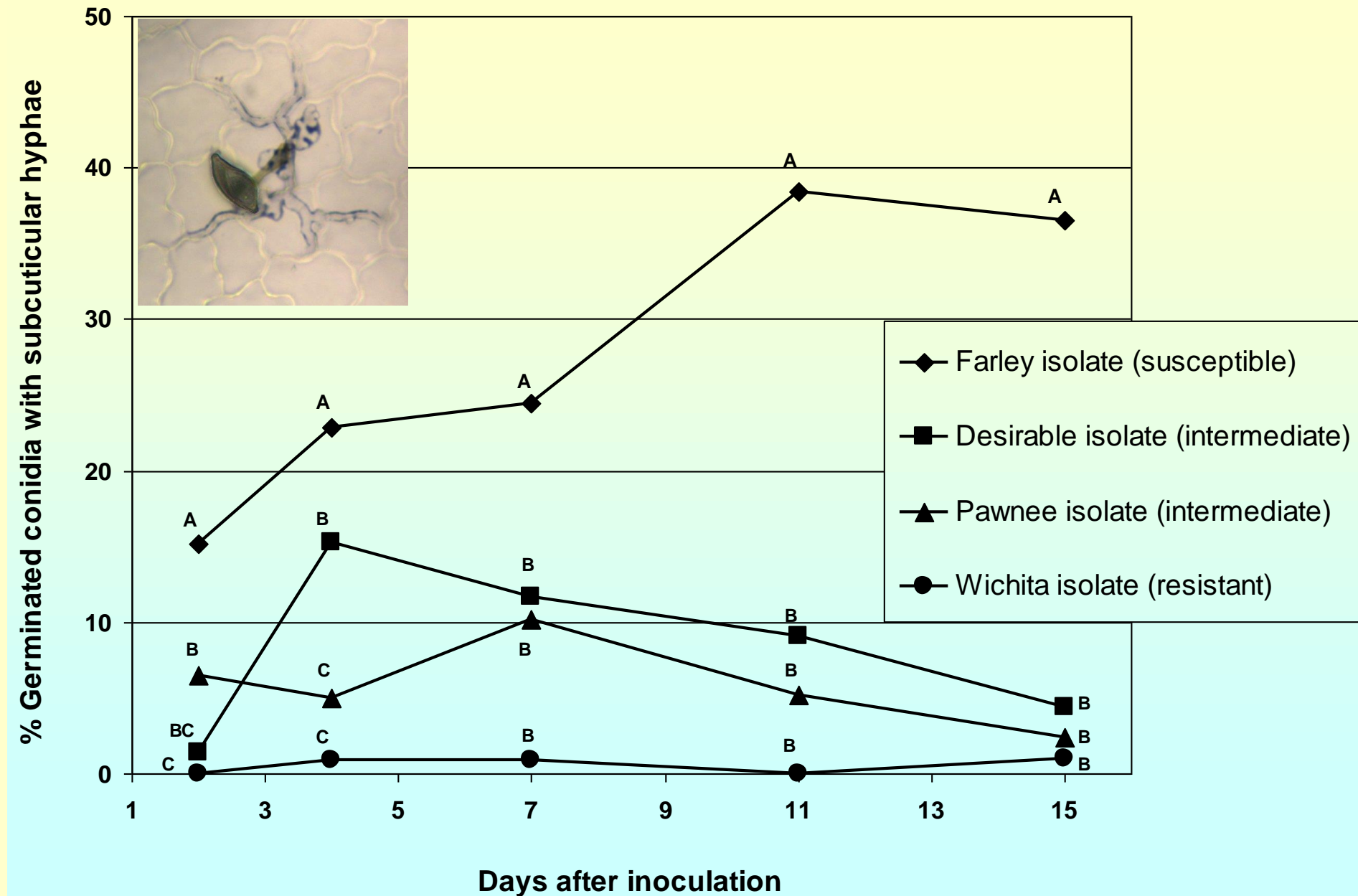


## Intermediate Reaction - Day 14

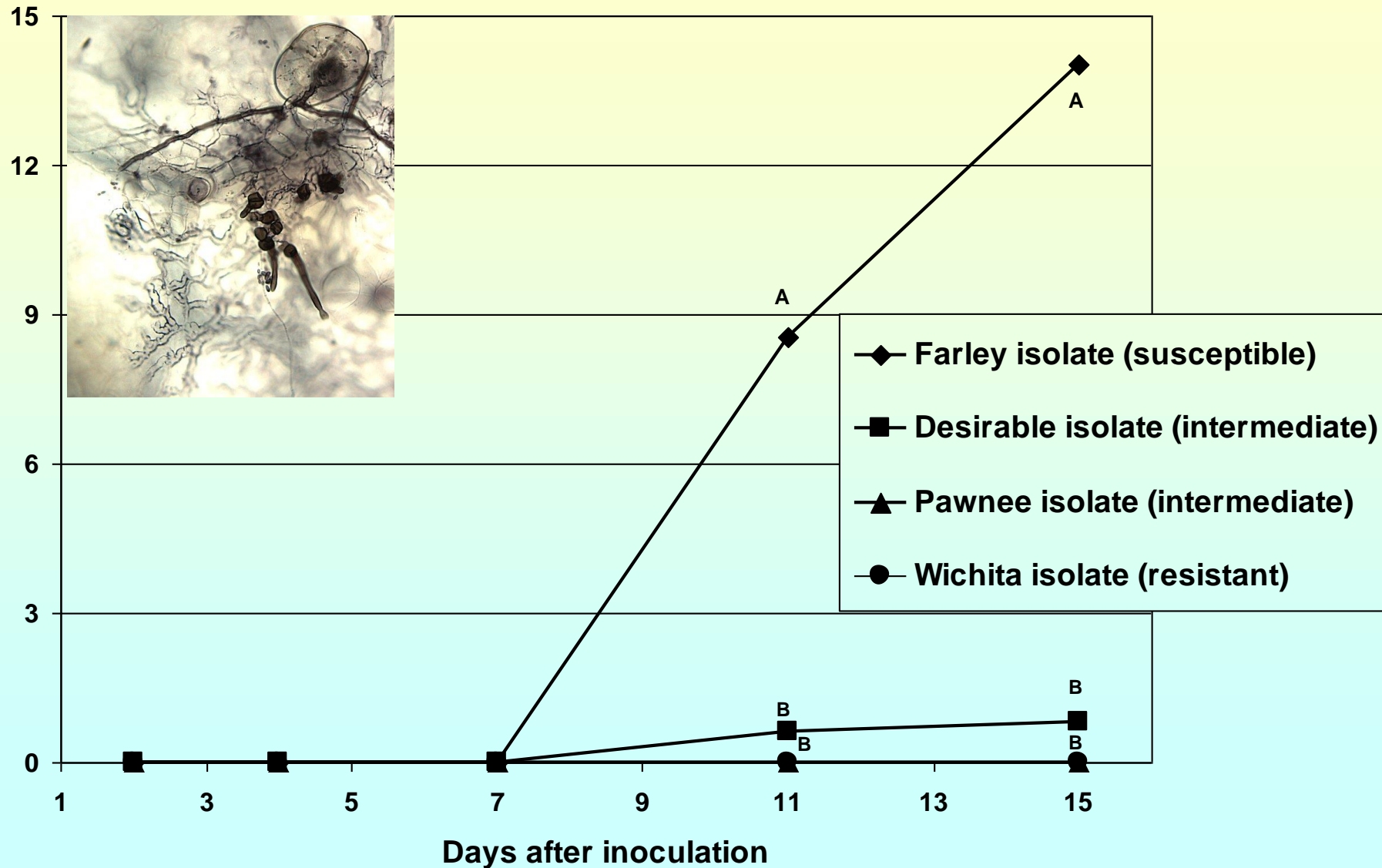




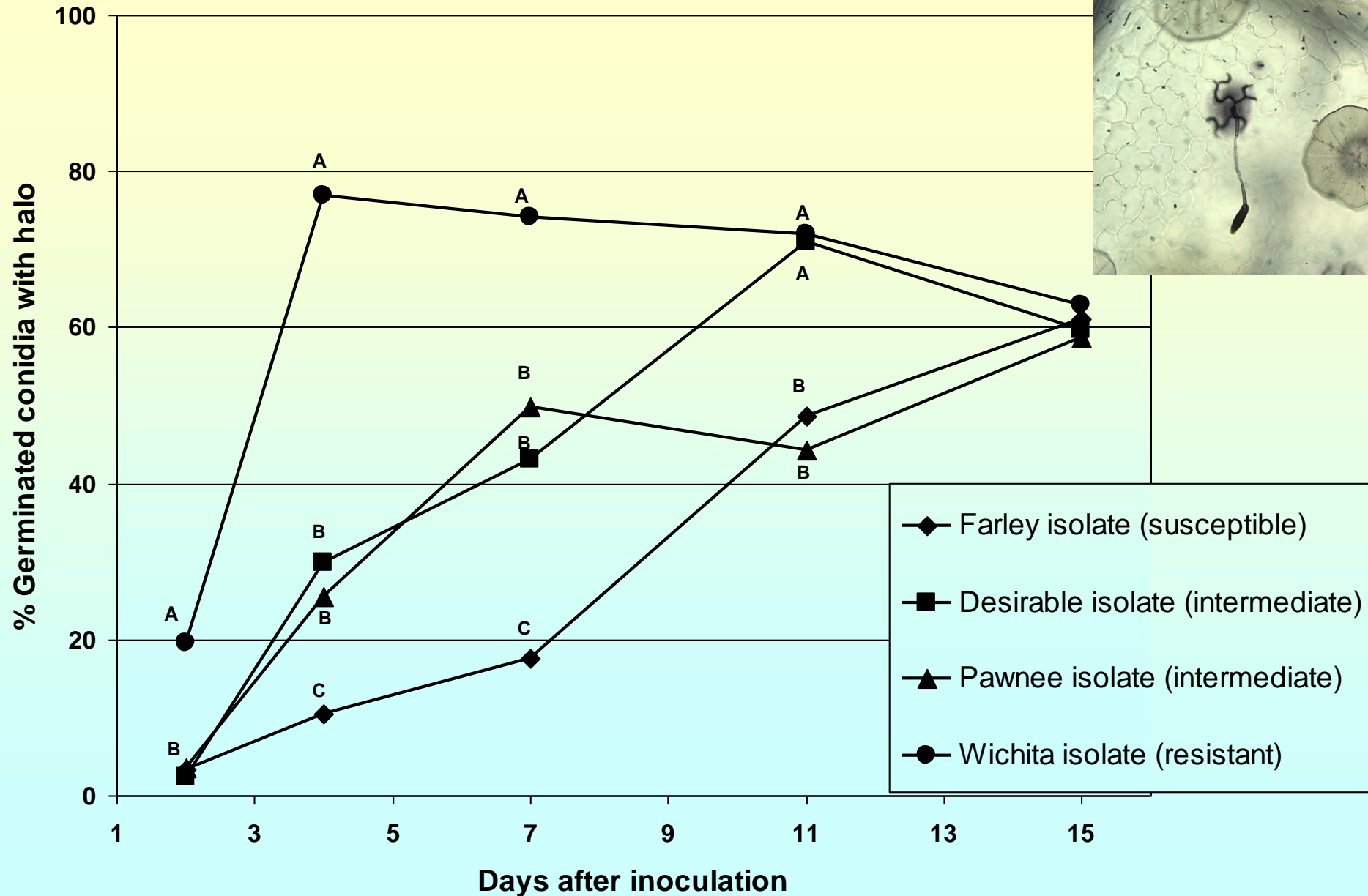
# Development of subcuticular hyphae on 'Farley' leaves.



# Development of reproductive initials on 'Farley' leaves.



# Development of halo staining on 'Farley' leaves.





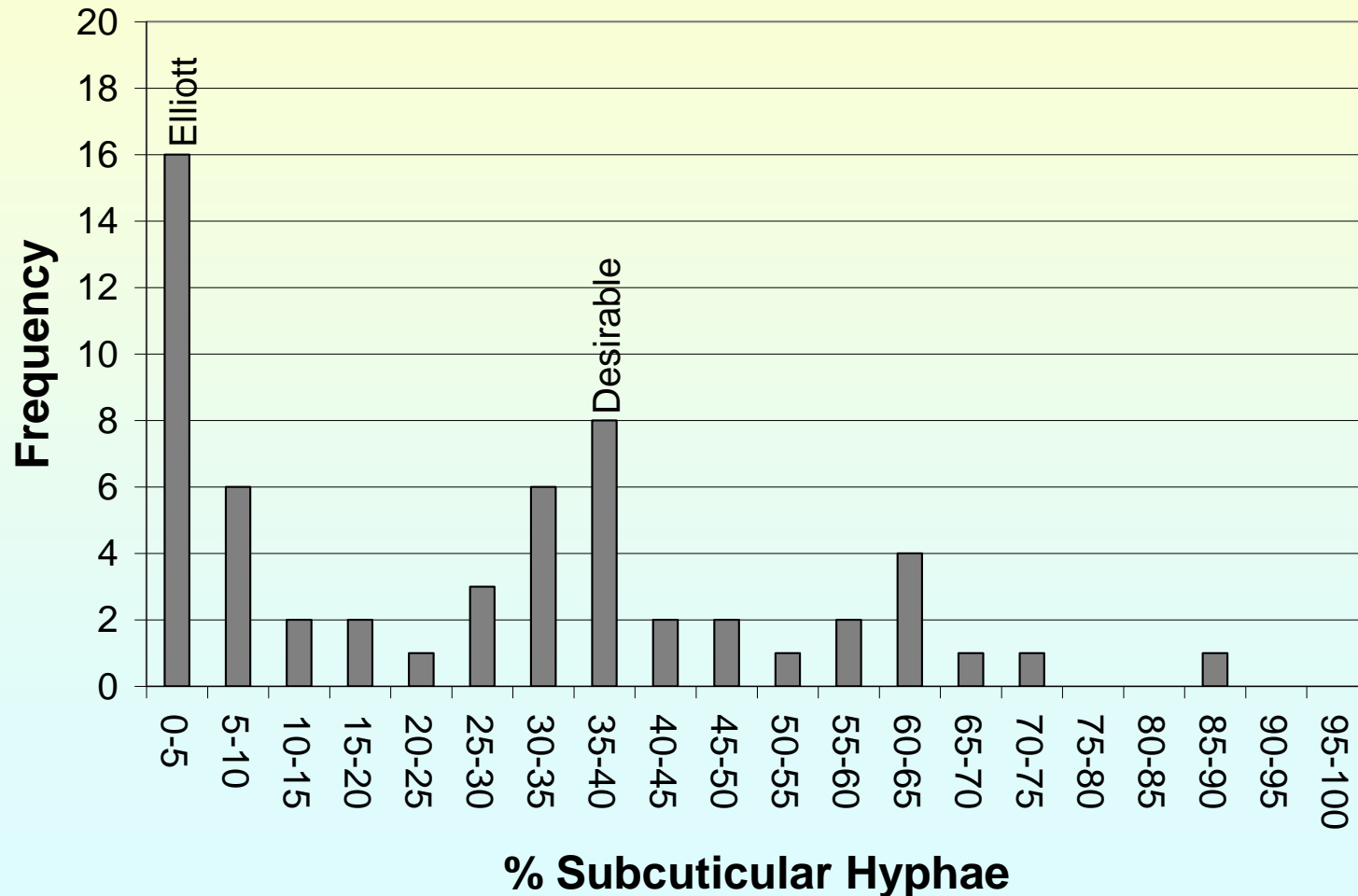
Results: Timing and extent of halo formation is key.

Resistant reactions - Quick formation of halo staining and little or no hyphal growth.

Susceptible reactions - Slow formation of halo staining, usually after sporulation has begun. Halo staining does not contain lesion.

Intermediate reactions - Intermediate speed of halo formation. Halo restricts lesion size and limits sporulation.

Use of % germinated conidia producing subcuticular hyphae to classify a segregating population for scab resistance. 'Desirable' (S)  $\times$  'Elliott' (R) progeny inoculated with a 'Desirable' scab isolate evaluated 14 days post inoculation.



# **Future Directions**

## **SCRI - Coordinated Development of Genetic Tools for Pecan**

Replicated mapping progenies will be evaluated for resistance to specific scab isolates as well as field isolates and resistance genes will be mapped.

The pecan genome will be sequenced.

# Questions?

