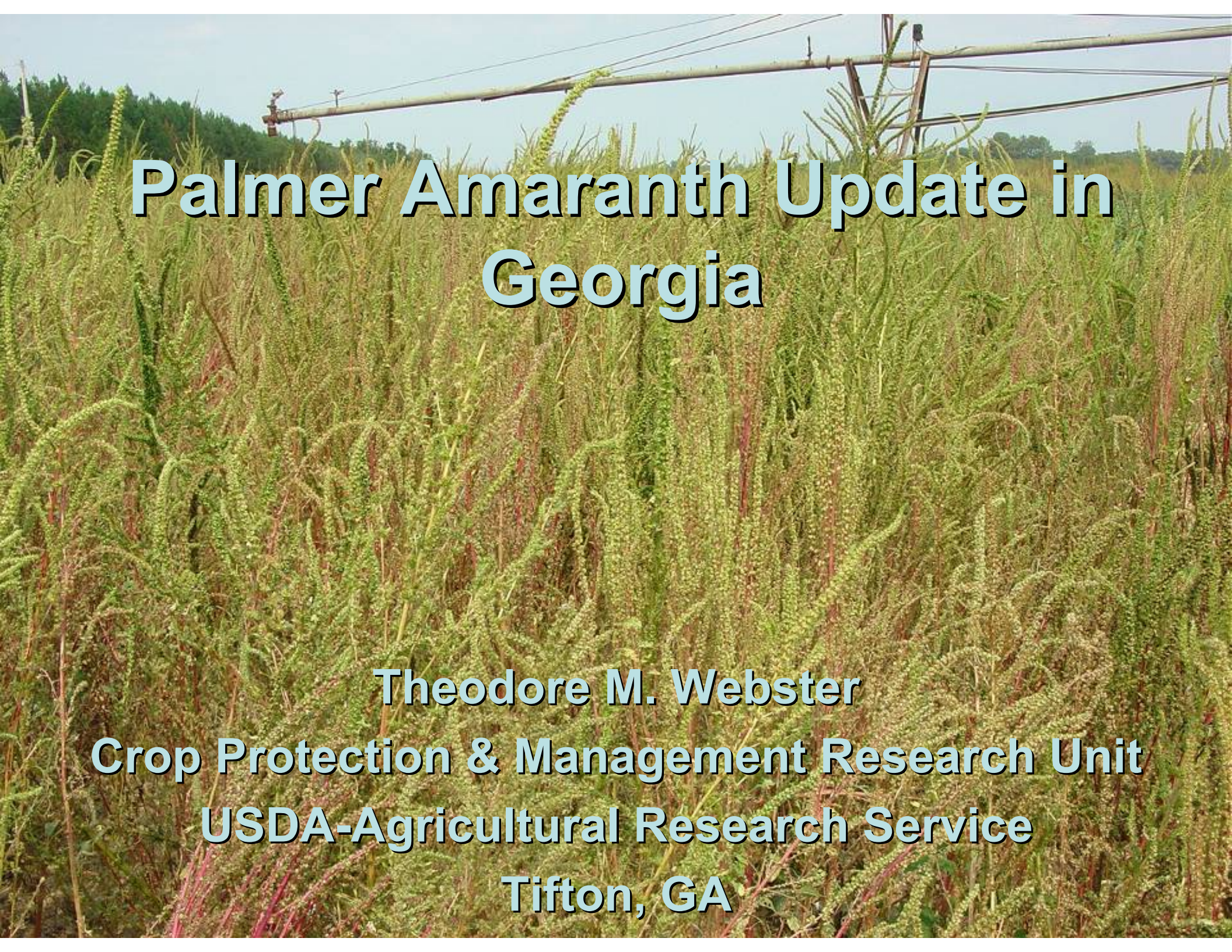
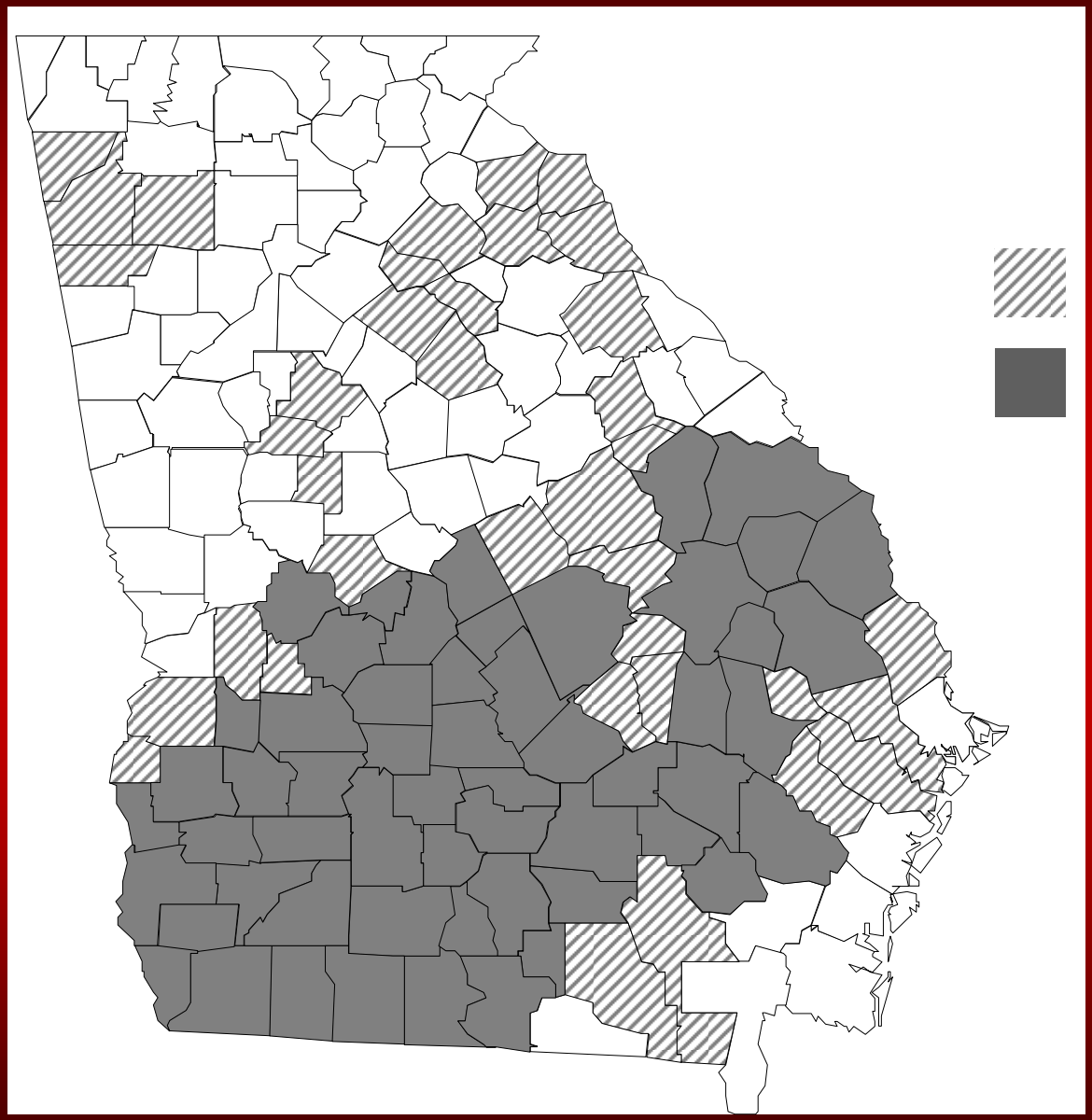


Palmer Amaranth Update in Georgia

Theodore M. Webster
Crop Protection & Management Research Unit
USDA-Agricultural Research Service
Tifton, GA

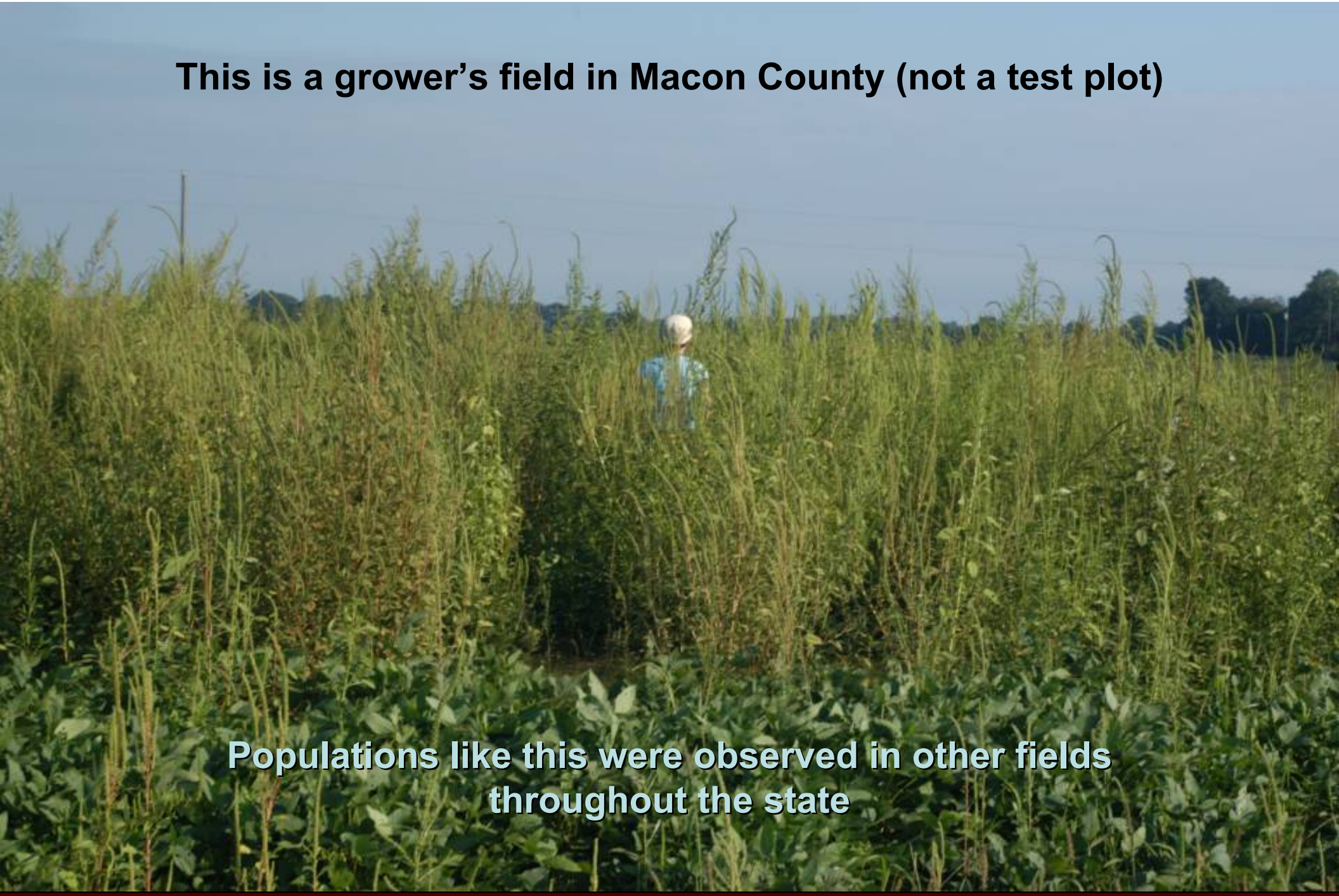
Georgia Cotton Production



Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA


Palmer amaranth is becoming a more
common weed in Georgia cotton

This is a grower's field in Macon County (not a test plot)



Populations like this were observed in other fields throughout the state

Palmer amaranth in unusual areas

Not only is it becoming more common, but it's more troublesome too

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Most Troublesome Weeds in Georgia Cotton

1995	2005
1. Nutsedges	1. Benghal dayflower
2. Sicklepod	2. Palmer amaranth
3. Coffee senna	3. *Ipomoea* morningglories
4. Texas panicum	4. Florida pusley
5. Pigweeds	5. Nutsedges
6. Cocklebur	6. Asiatic dayflower
7. Morningglories	7. Smallflower morningglory
8. Wild poinsettia	8. Texas millet
9. Bristly starbur	9. Wild poinsettia
10. Bermudagrass	10. Bermudagrass

Dowler 1995. Proc. South. Weed Sci. Soc. 48: 290-305

Webster 2005. Proc. South. Weed Sci. Soc. 58: 291-306

Palmer amaranth in cotton

- Other forms of herbicide resistance (DNAs and ALS inhibitors) are present in the species.
  - Possible for multiple resistance genes to become stacked, limiting control options for some growers.

2005 ALS-Resistant Pigweed Survey

61 locations, 21 counties

- 2892 plants treated
- 2442 plants survived (84%)

Wise et al. 2007

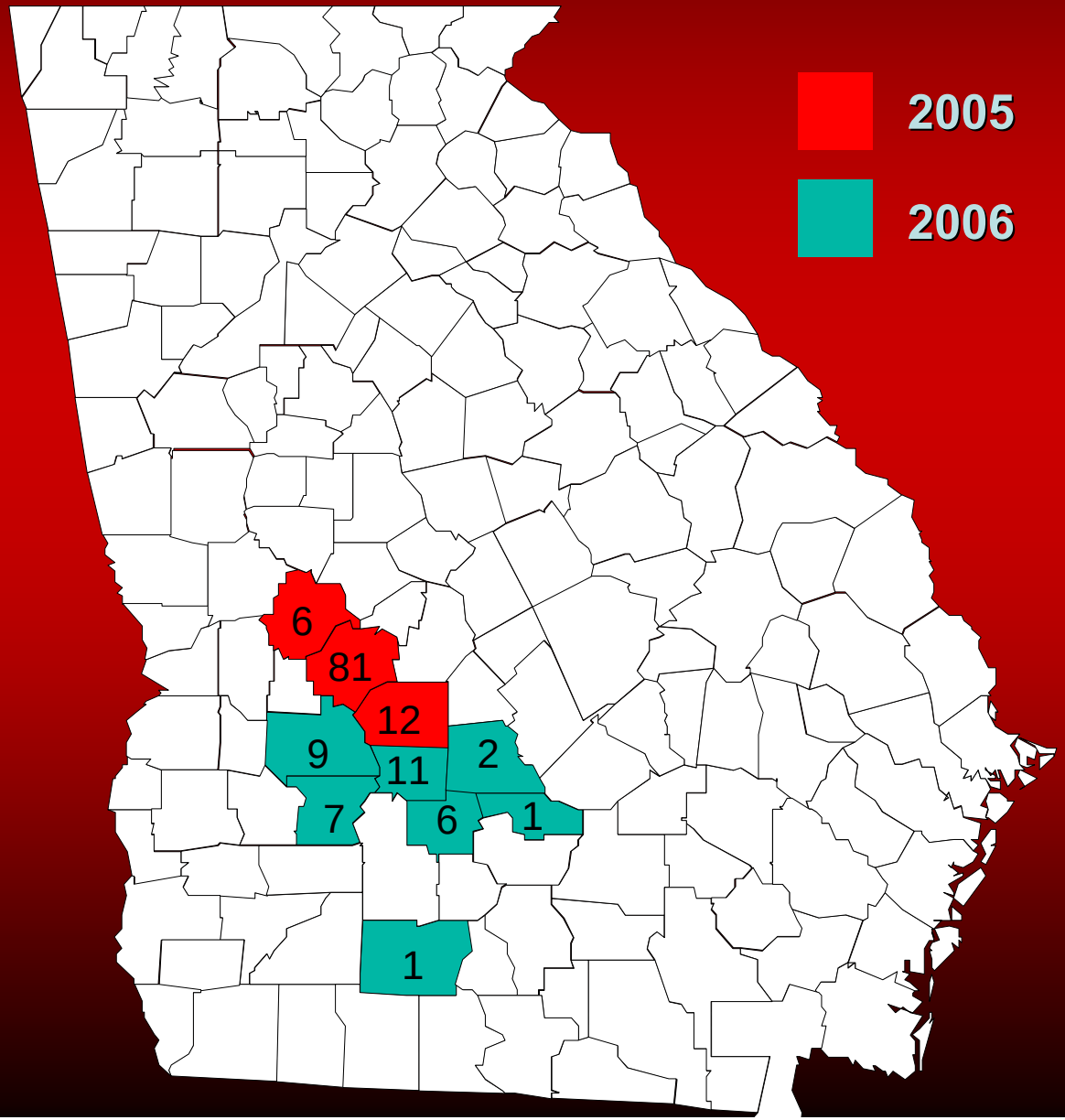
Palmer amaranth in cotton

- Other forms of herbicide resistance (DNAs and ALS inhibitors) are present in the species.
  - Possible for multiple resistance genes to become stacked, limiting control options for some growers.
- The species is dioecious and wind pollinated.
  - A resistance gene may be transferred to susceptible populations via obligate out-crossing.

Georgia counties sampled for glyphosate-resistant Palmer amaranth.

136 fields sampled

30 seedheads per field



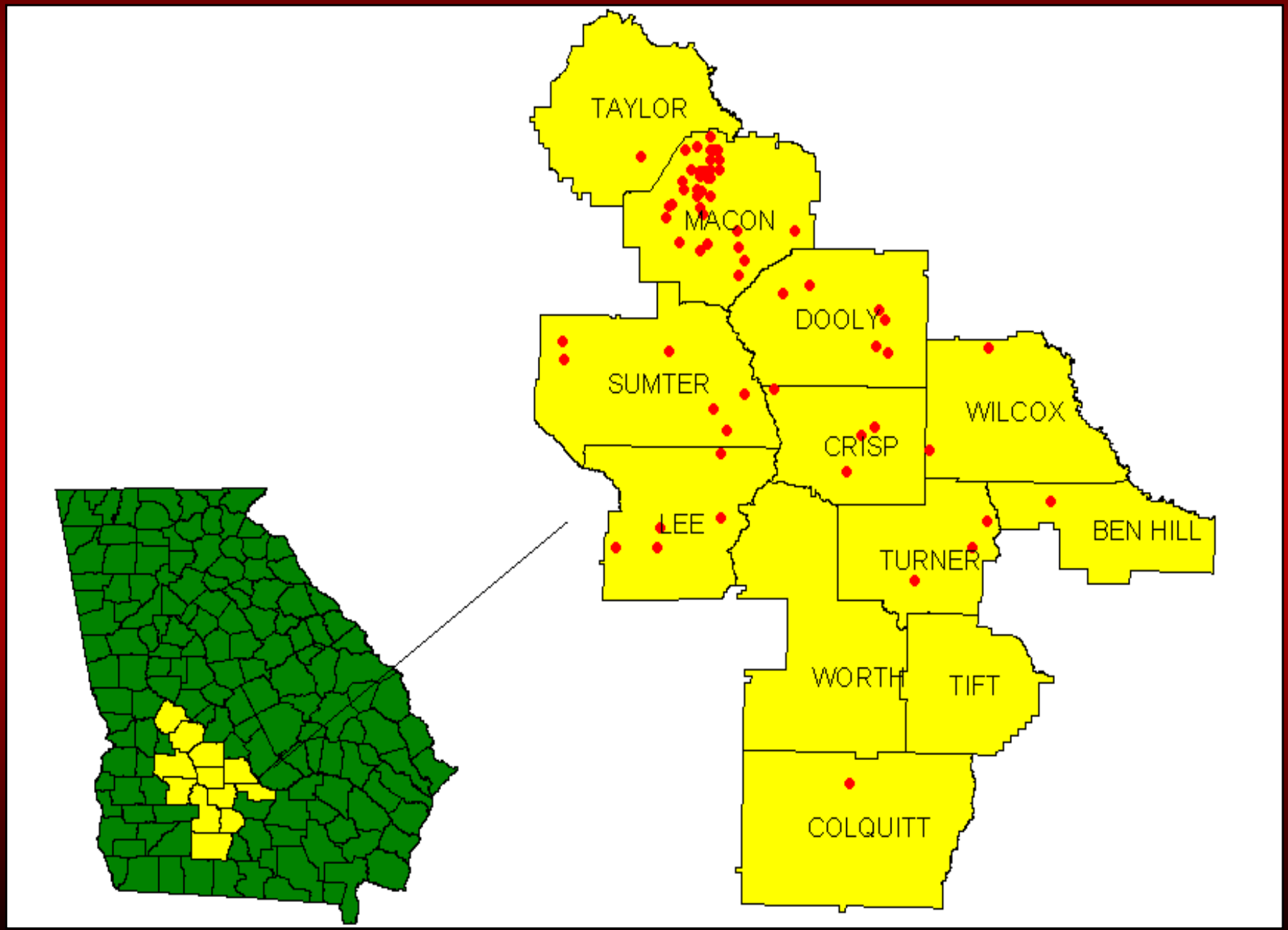
Level of Palmer amaranth resistance to glyphosate in GA

49%	High	Low	Mixed	None
2005	23	20	6	50
2006 62%	10	3	10	14

- < 50% control with 840 g ha = high level
- < 50% control with 280 g ha = low level
- Few plants poorly controlled and rest dead = mixed pop

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Location of 72 fields infested with glyphosate-resistant Palmer amaranth.

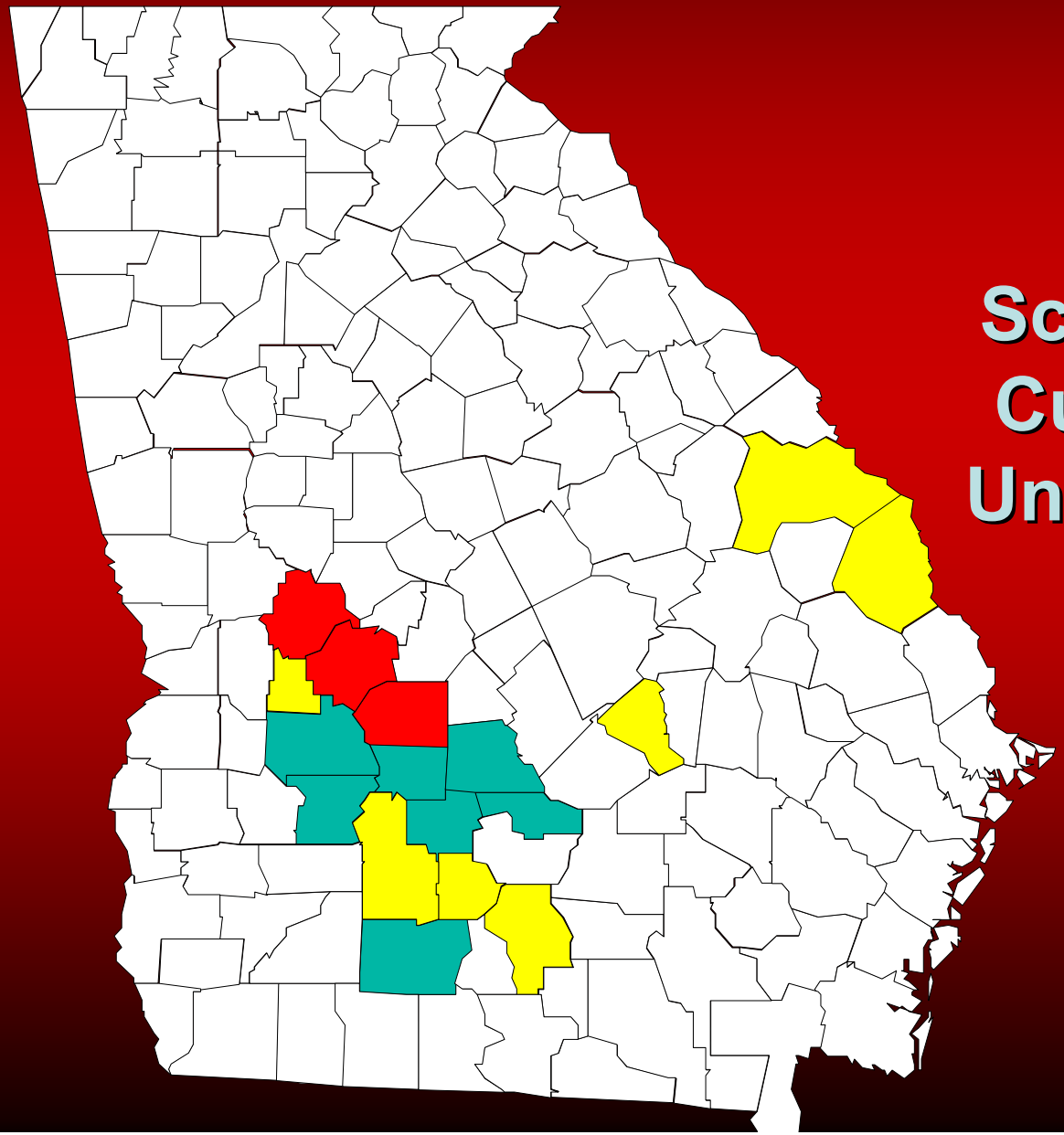


Georgia counties sampled for glyphosate-resistant Palmer amaranth.

2005

2006

2007

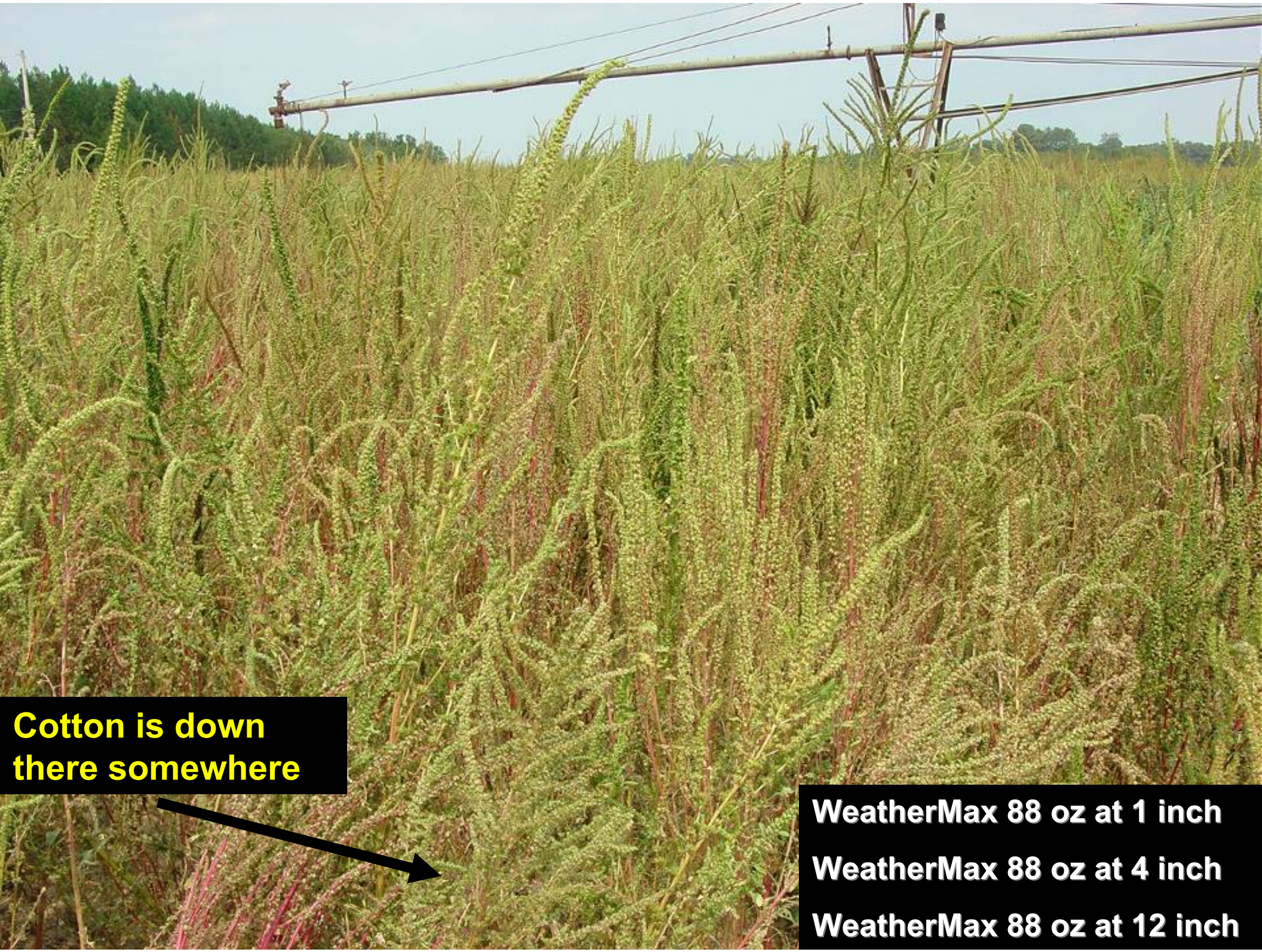


2007 Screening Currently Under Way

Resistant Palmer amaranth response to Glyphosate

WeatherMax 66 oz/A

WeatherMax 264 oz/A


Cotton is down there somewhere
WeatherMax 88 oz at 1 inch
WeatherMax 88 oz at 4 inch
WeatherMax 88 oz at 12 inch

Current Palmer Amaranth Research Directions in Georgia

Theodore M. Webster
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Georgia Weed Science


Stanley Culpepper


Tim Grey


Ted Webster


Andrew MacRae


Tim Murphy


Bill Vencill


Lynn Sosnoskie


Aaron Wise


Carroll Johnson


Eric Prostko

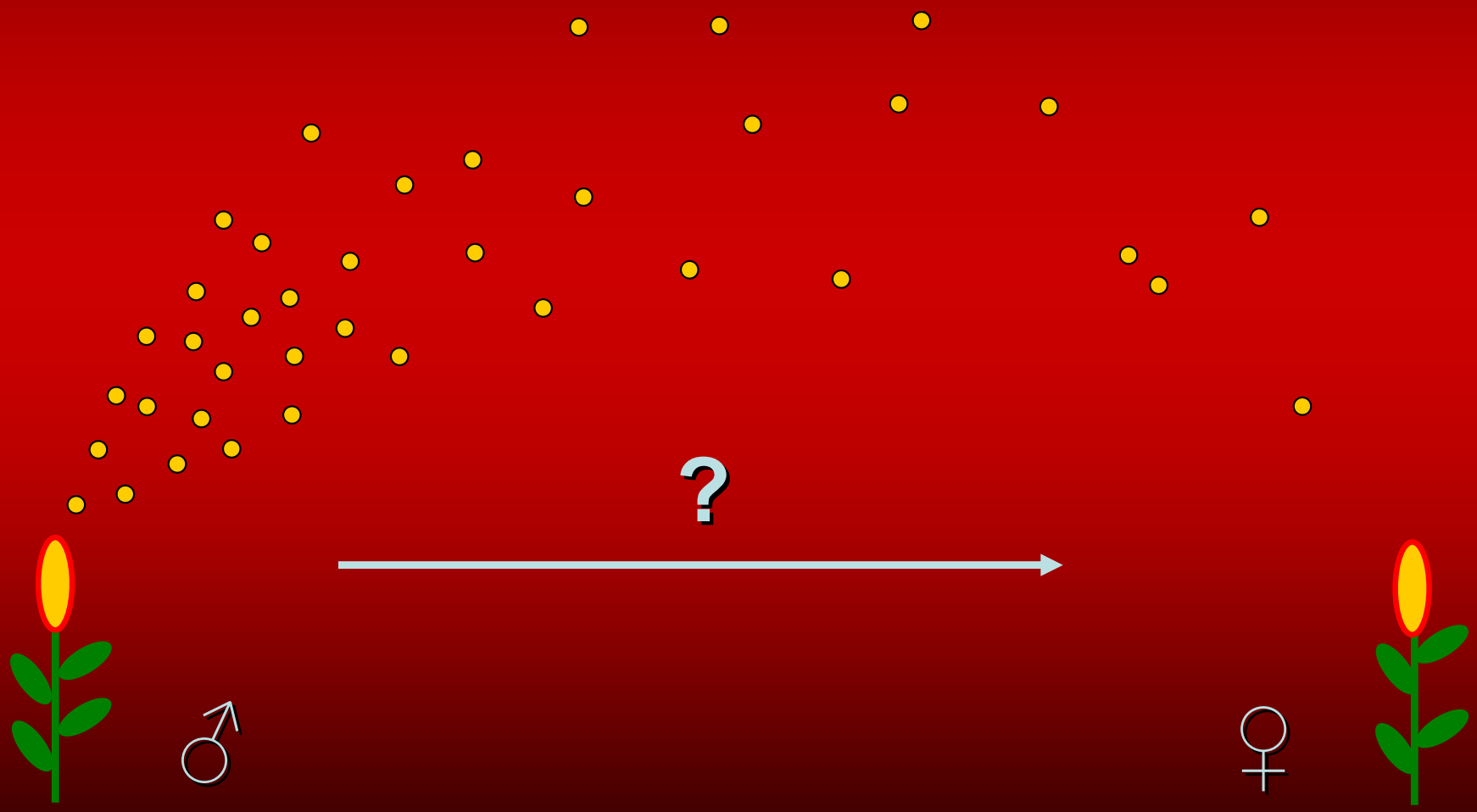
Some of the Georgia Studies

- Potential for movement of the resistance trait in pollen (Sosnoskie)
- Interference of Palmer amaranth in cotton (MacRae)
- Movement of glyphosate in susceptible and resistant populations; where does it go? (Sosnoskie, Grey, Vencill)

Movement of the glyphosate-resistance trait in pollen

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

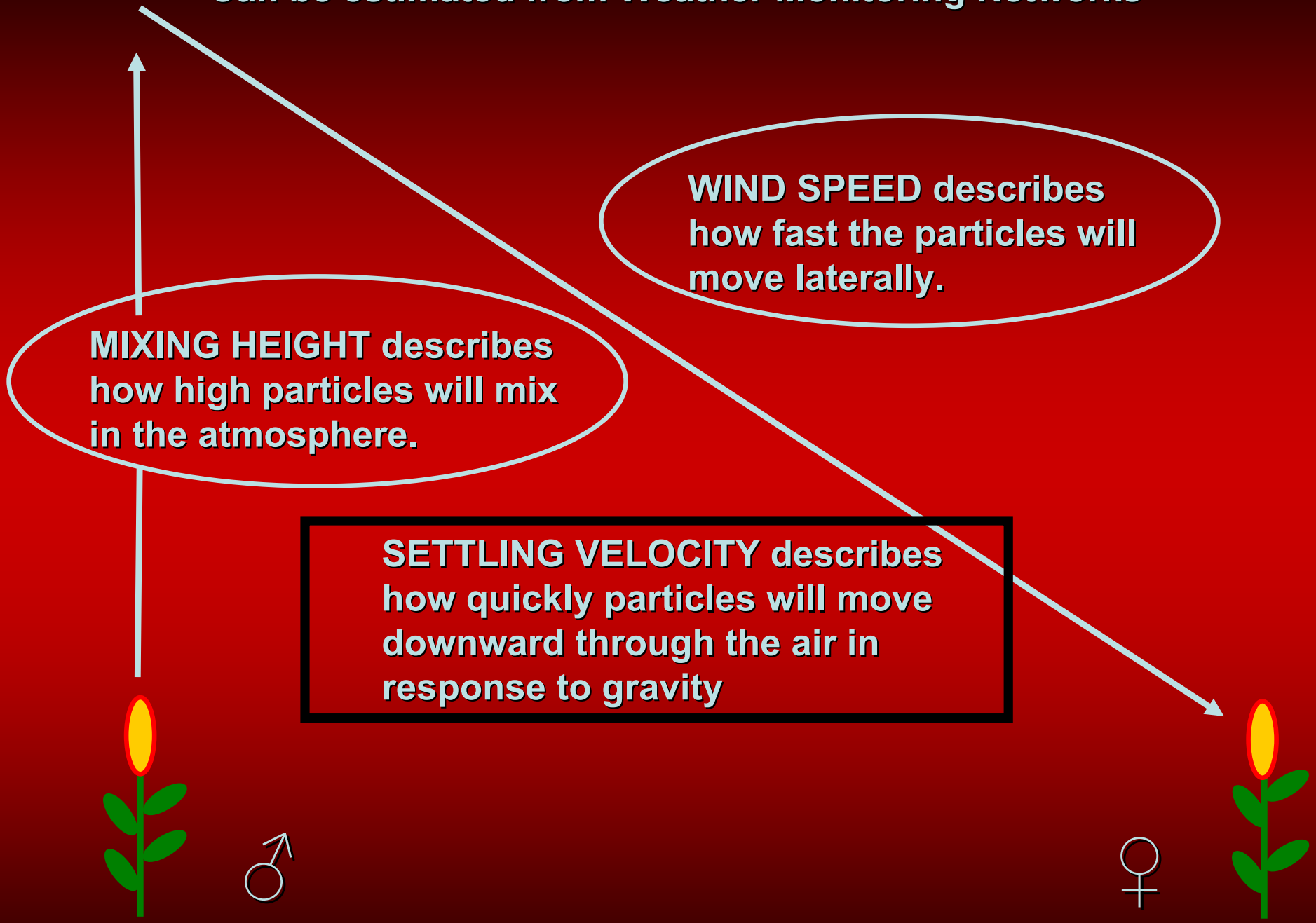
How far (theoretically) can pollen grains travel?



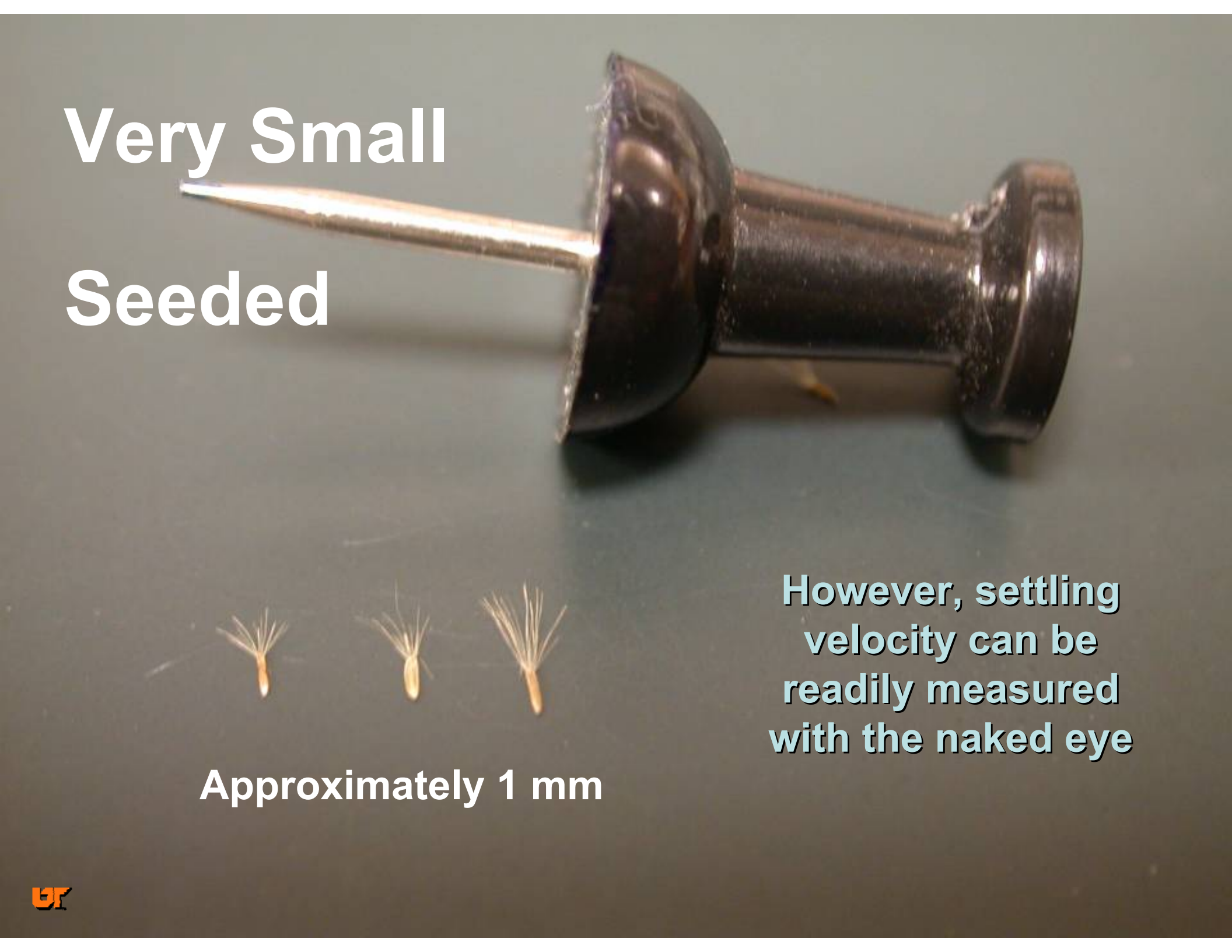
Theoretical maximum flight distance is a function of three factors: mixing height, settling velocity and wind speed

$$\frac{\text{(Mixing height) (Wind speed)}}{\text{Settling velocity}}$$

Can be estimated from Weather Monitoring Networks

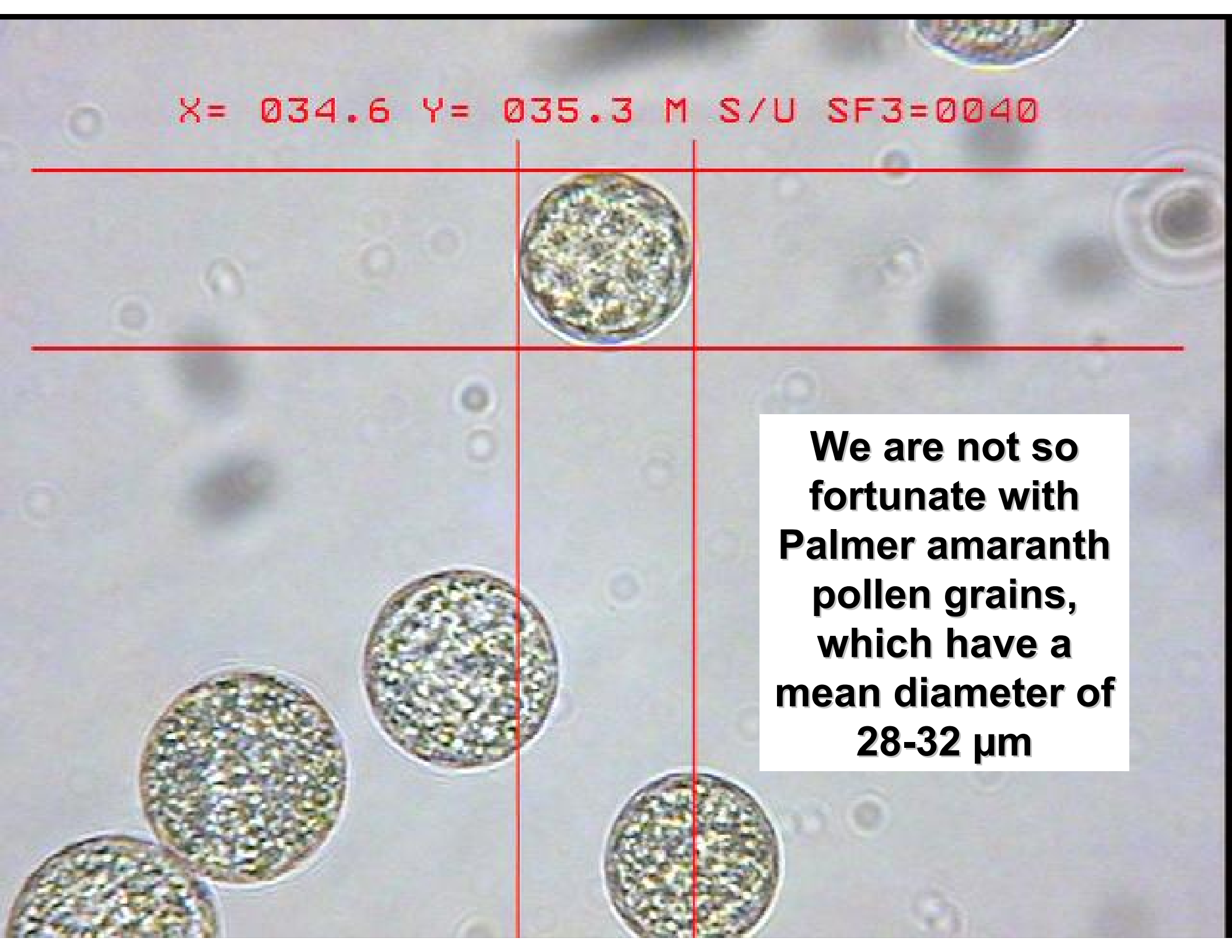


Very Small Seeded



Approximately 1 mm

However, settling velocity can be readily measured with the naked eye


X= 034.6 Y= 035.3 M S/U SF3=0040
We are not so fortunate with Palmer amaranth pollen grains, which have a mean diameter of 28-32 µm

Freshly collected pollen was used in these studies to determine the distribution of pollen settling velocity

Conducted this study in the summer of ’07

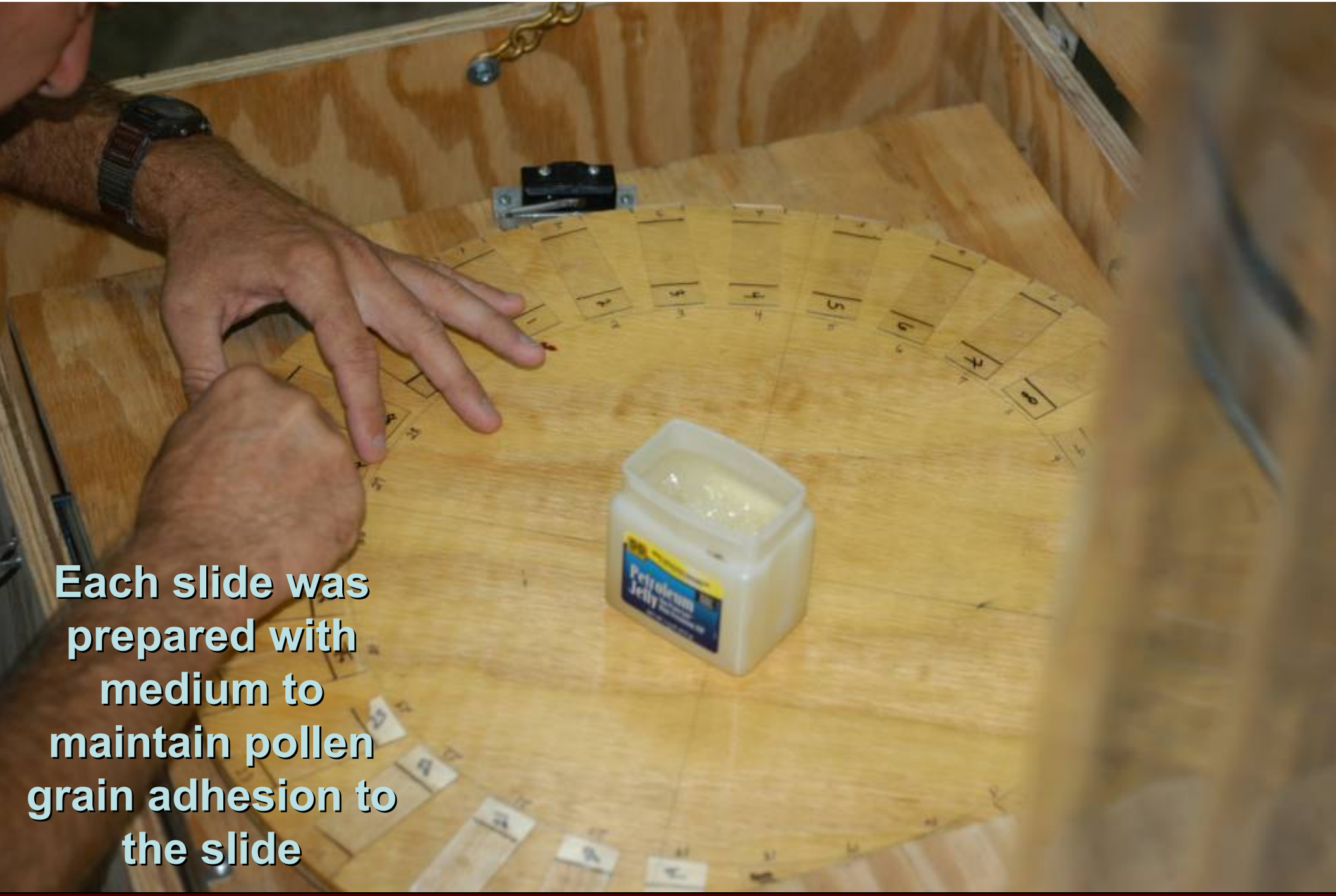
Generated a pollen settling velocity distribution for Palmer amaranth

Also have a pollen size distribution for Palmer amaranth for several locations throughout the pollination season.

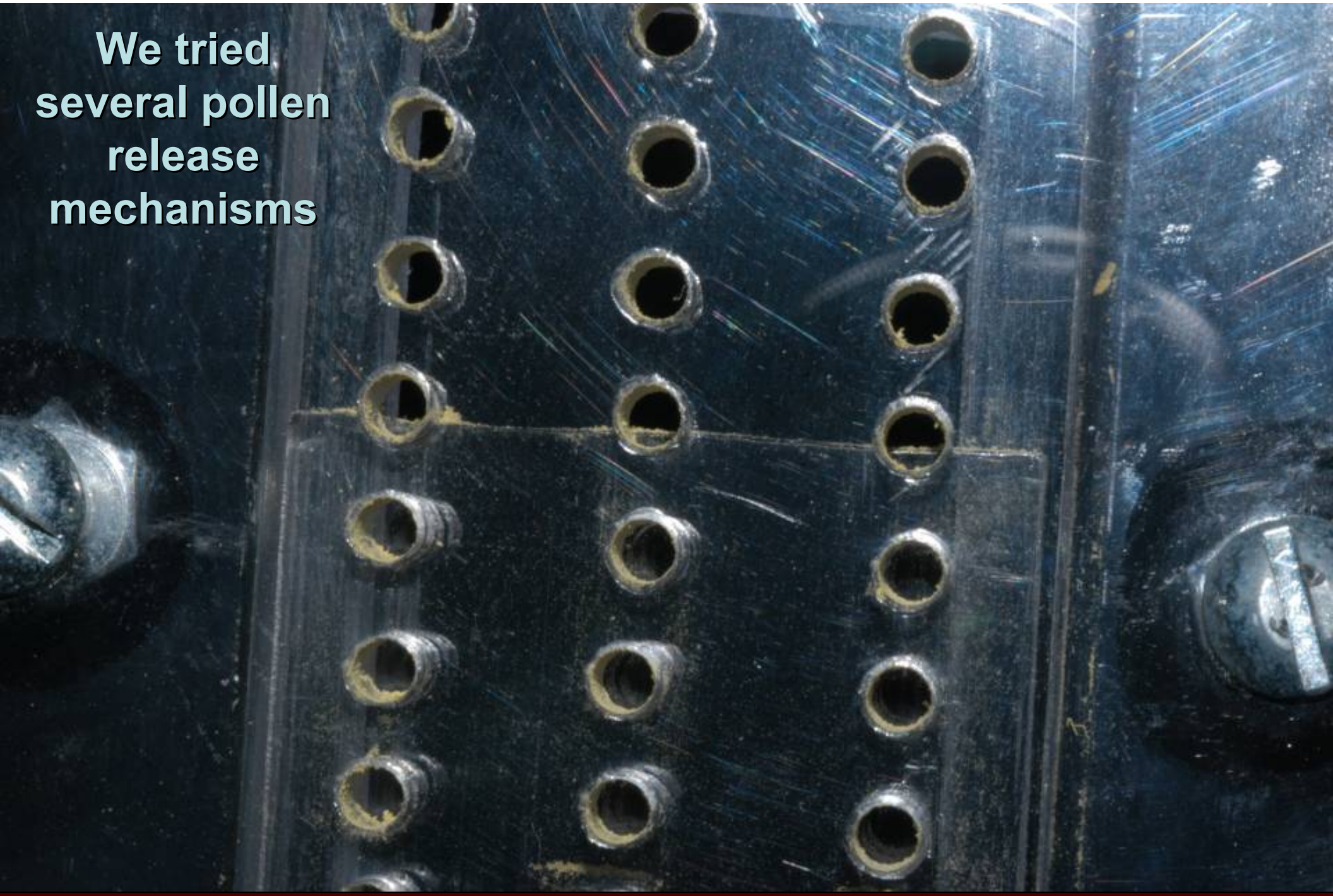
Webster, USDA-ARS; Culpepper,
Sosnoskie, Grey, Vencill, UGA

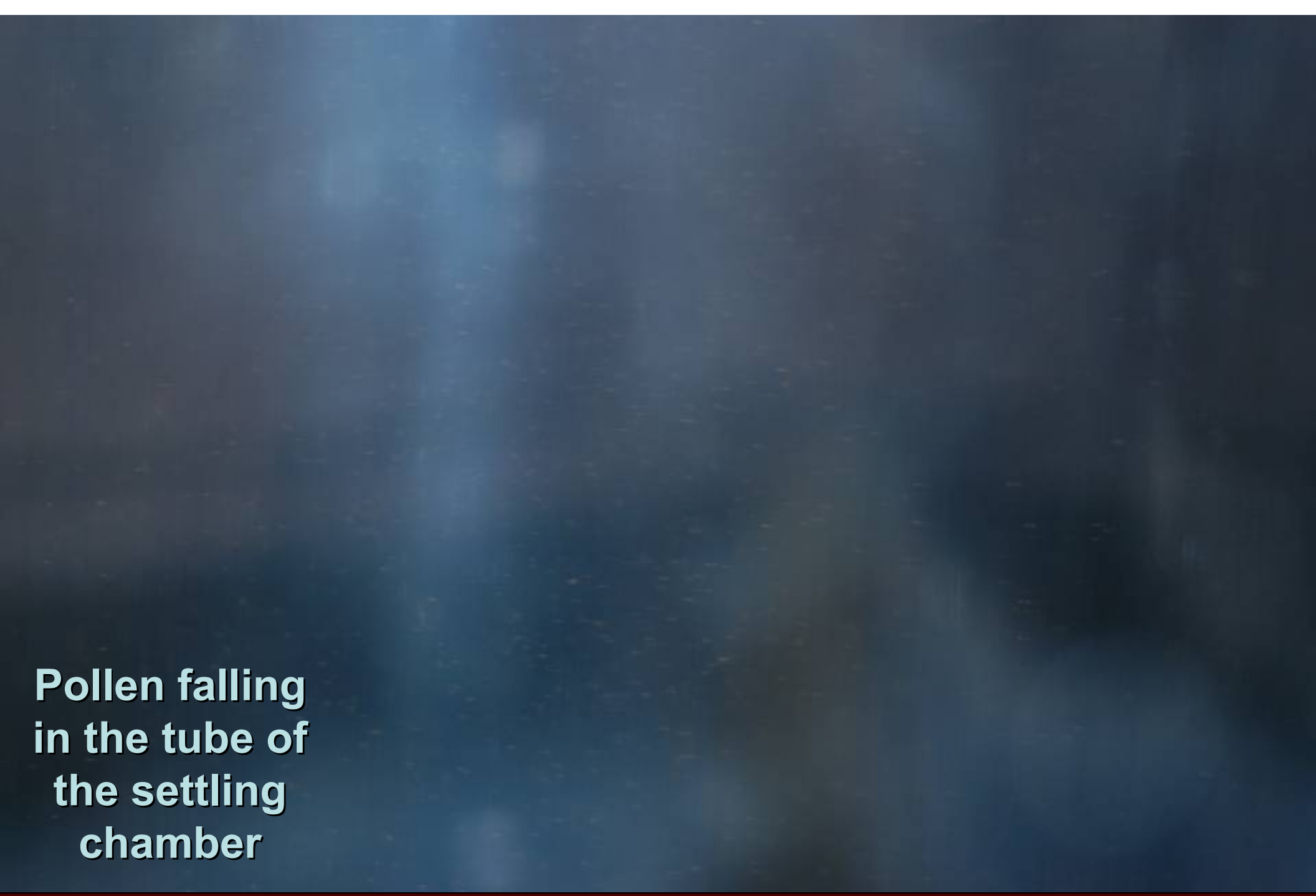

A round table slowly moves so that we have a defined time frame for each slide


The slide is visible at through the hole in the bottom of the settling chamber



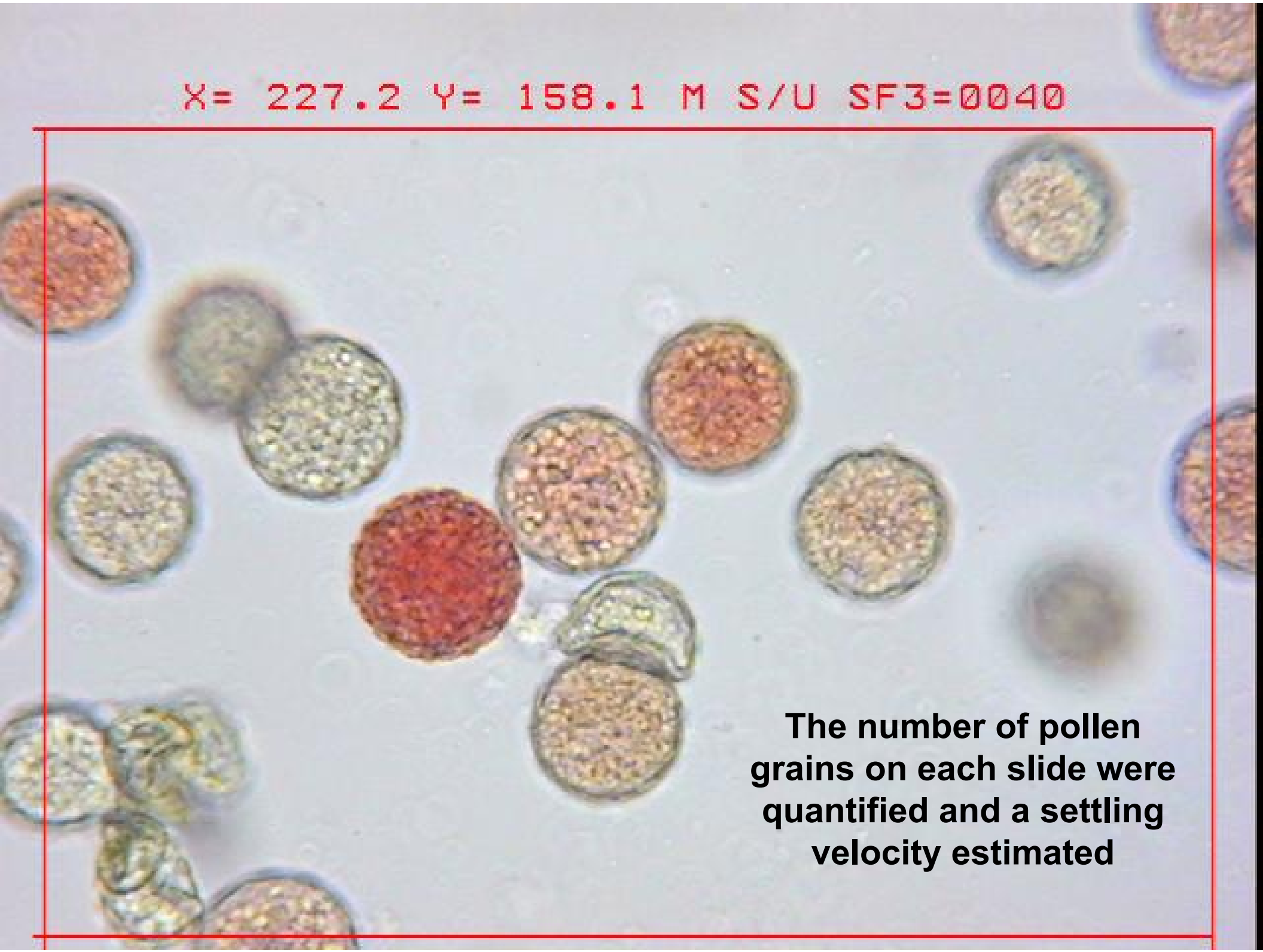
Each slide was prepared with medium to maintain pollen grain adhesion to the slide


We tried several pollen release mechanisms



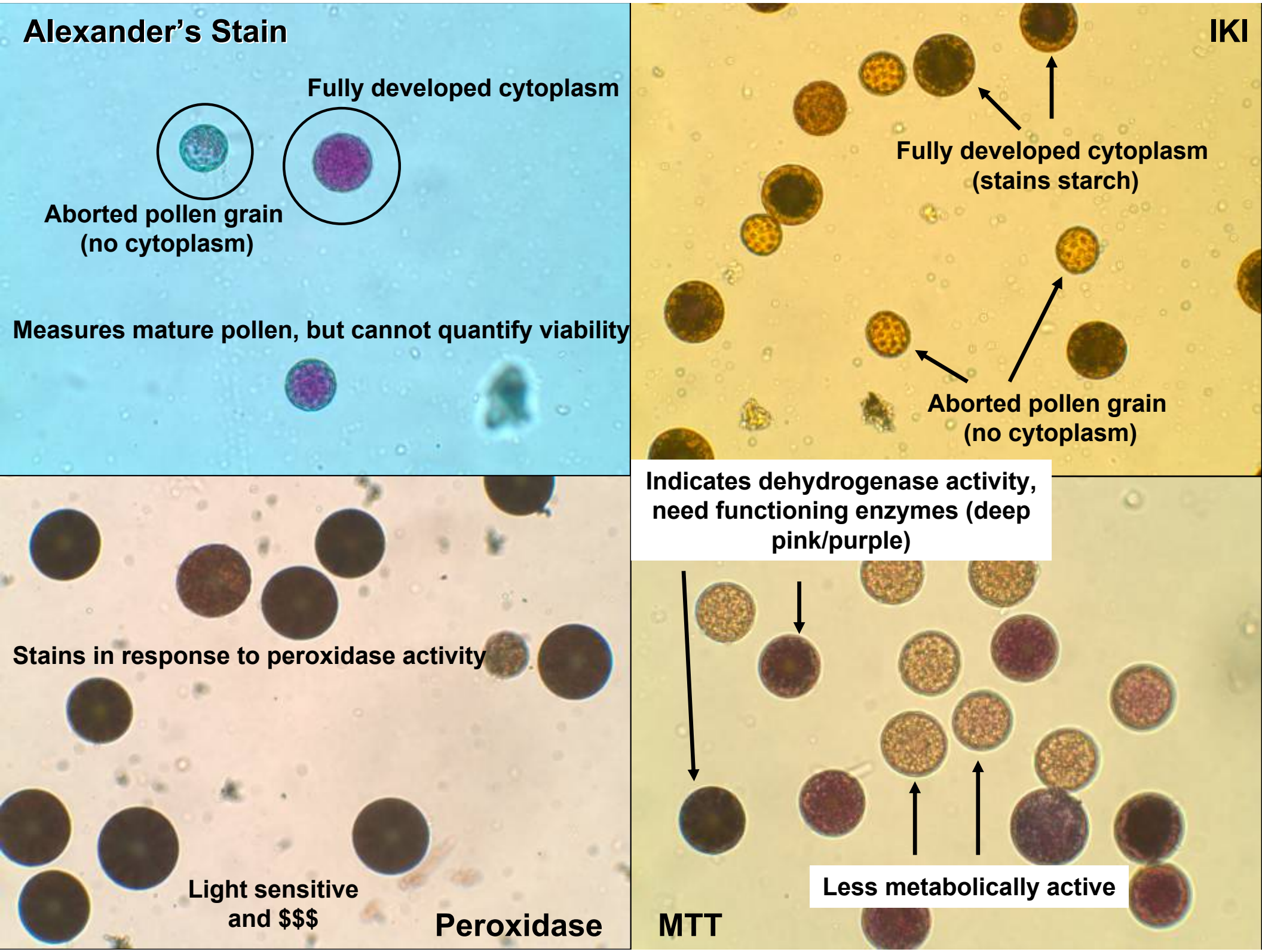
Pollen falling in the tube of the settling chamber


Pollen filled
microscope
slide


X= 227.2 Y= 158.1 M S/U SF3=0040
The number of pollen grains on each slide were quantified and a settling velocity estimated

Also interested in Pollen Longevity

- Pollen movement is necessary in estimating potential dispersal, but…
- Movement of viable pollen is the key factor
- We evaluated longevity of field-grown Palmer amaranth pollen:
  - Time in full sun
  - Temperature
  - Osmotic potential
  - Interactions between these factors


Alexander's Stain
Fully developed cytoplasm
Aborted pollen grain
(no cytoplasm)
Measures mature pollen, but cannot quantify viability
IKI
Fully developed cytoplasm
(stains starch)
Aborted pollen grain
(no cytoplasm)
Stains in response to peroxidase activity
Light sensitive
and $$$
Peroxidase
Indicates dehydrogenase activity, need functioning enzymes (deep pink/purple)
Less metabolically active
MTT

At what distances will resistance be transferred, successfully, to populations derived from susceptible females?

Successful = the production of viable, resistant offspring

Garden Valley, Georgia

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Cotton 2006
Soybean 2007

- Confirmed glyphosate-resistant males were transplanted in the center of the field
- Glyphosate susceptible females were transplanted at 9 distances ranging from 1 to 200 m (’06) and 5 to 300 m in (’07)

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Webster, USDA-ARS; Culpepper,
Sosnoskie, Grey, Vencill, UGA

Webster, USDA-ARS; Culpepper,
Sosnoskie, Grey, Vencill, UGA

Webster, USDA-ARS; Culpepper,
Sosnoskie, Grey, Vencill, UGA

Webster, USDA-ARS; Culpepper,
Sosnoskie, Grey, Vencill, UGA

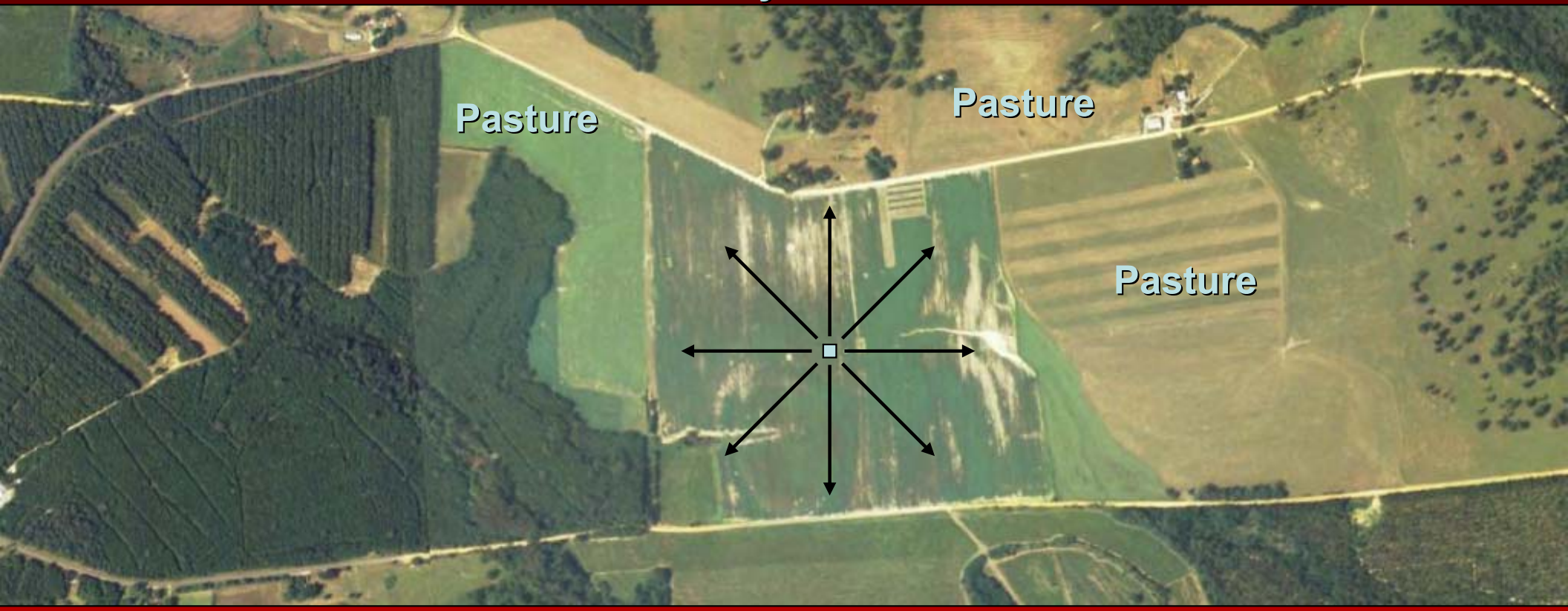
Keeping Palmer amaranth transplants alive in a 75 acre dryland field in the middle of a drought, was a challenge

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

How far can resistance be transferred under field conditions?

- The interior of the field and surrounding acreage (200 m from field edge in each direction) were kept free of *A. palmeri* by chemical and physical means.

Cotton 2006
Soybean 2007



Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

How far can resistance be transferred under field conditions?

- The interior of the field and surrounding acreage (200 m from field edge in each direction) were kept free of *A. palmeri* by chemical and physical means.
- Seed was harvested from over 300 mature, susceptible female *A. palmeri* plants.
- Seed was stored in an unheated greenhouse until the samples could be hand-cleaned.
- Seed from each location was/is being screened for glyphosate resistance in the greenhouse

Palmer amaranth interference in cotton

MacRae, Webster, Sososkie, and Culpepper

Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Treatments

- Density – 0, 2, 3, 5, and 10 / 20ft of row
- Establishment times
  - 3-lf cotton - mimics escape from PRE application of herbicides
  - 8-lf cotton - mimics escape from 4-lf POST application
  - 12-lf cotton - mimics escape from 8-lf POST application
  - 2 wk after layby (17-lf cotton) - mimics escape from layby application

Prowl @ 1qt/A

3-lf Cotton
5 Palmer/row

3-lf Cotton
10 Palmer/row

8-lf Cotton
5 Palmer/row

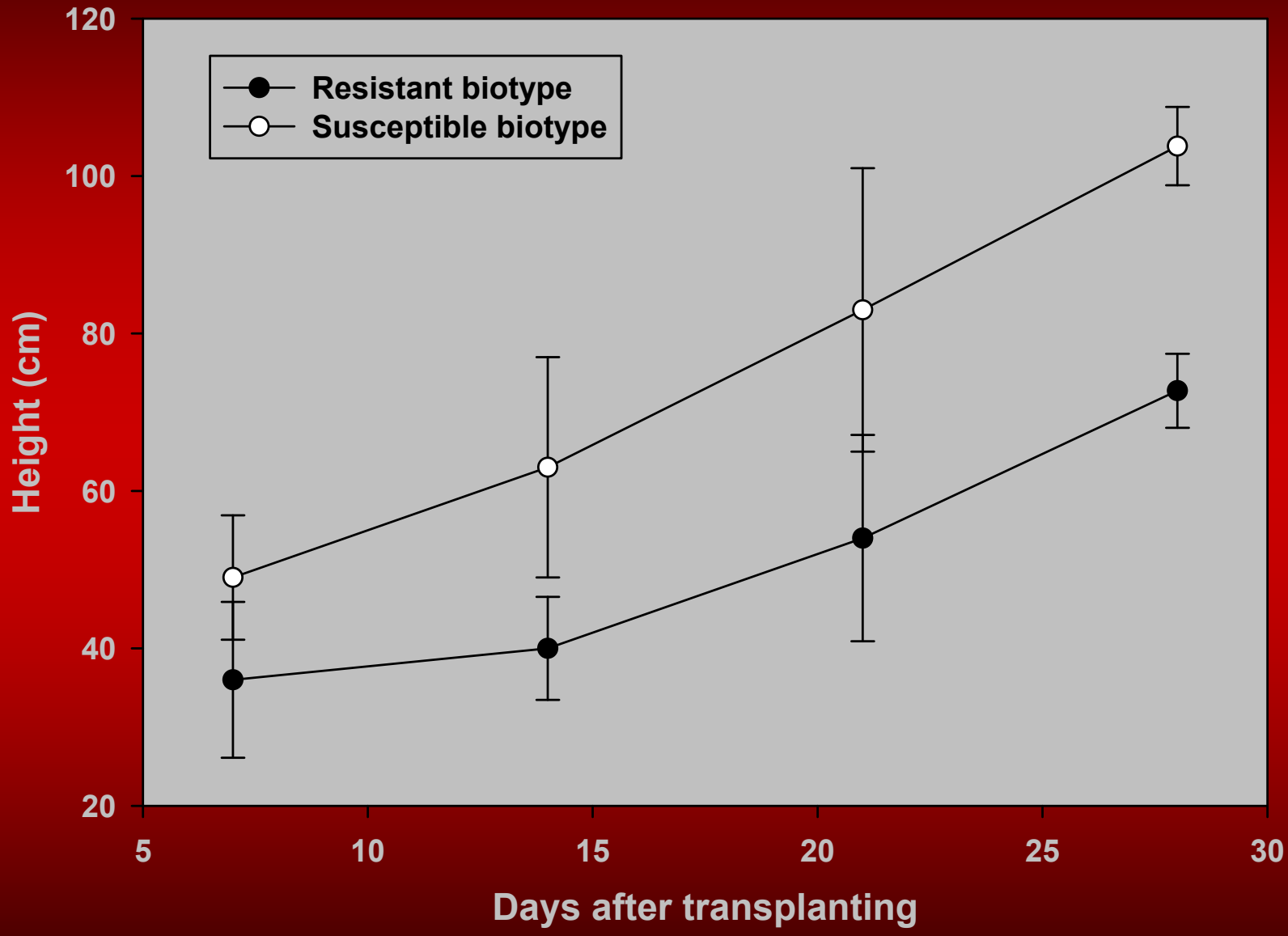
8-lf Cotton
10 Palmer/row

^{14}C-glyphosate: mobility and potential sequestration

Greenhouse Growth Studies

- GR and GS PW seeded in flats and transplanted to 1 L pots at 2 cm high.
- Cecil loam soil
- 2 replications (third to follow), 6 pots/rep with 4 plants in each
- Dose response: R sprayed at 3 cm tall
- Measurements taken at 15 and 30 DAT (1st rep), weekly through 42 DAT

Comparison of R&S Plant Height

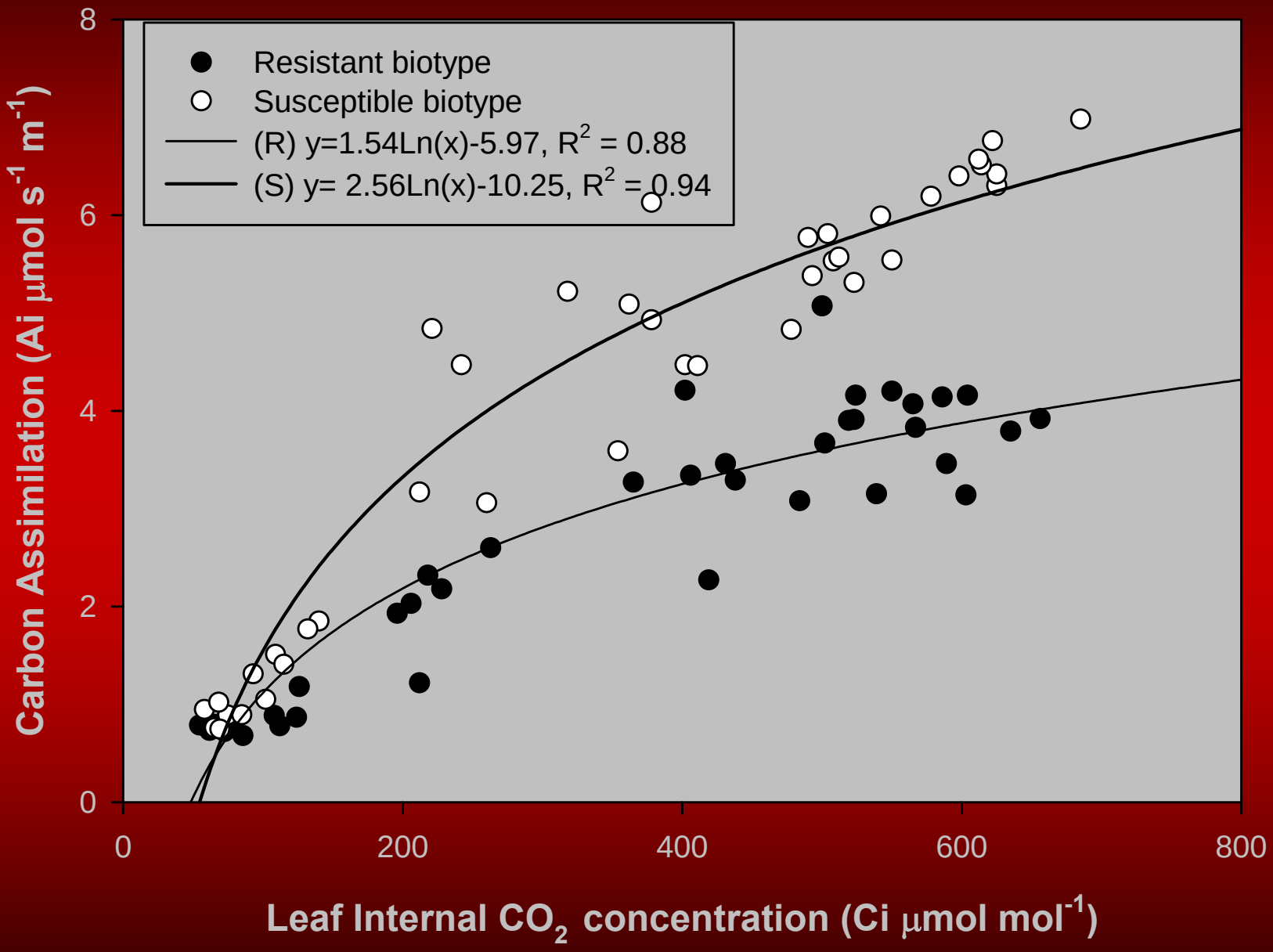


Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Gas Exchange Measurements

- Plants grown as described in greenhouse growth experiment
- Taken using an open gas exchange system (Li-Cor LI-6400)
- Calibration with Li-Cor
- Carbon assimilation measured at seven PAR levels (shown on graph)
- Leaf temperature controlled via thermocouple
- Air flow rate was 500 µmol s^{-1}
- CO_2 concentration held at 400 µmol mol^{-1}

Photosynthetic Carbon Assimilation



Webster, USDA-ARS; Culpepper, Sosnoskie, Grey, Vencill, UGA

Acknowledgements

Staff and Students at USDA-ARS, ABAC and UGA

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