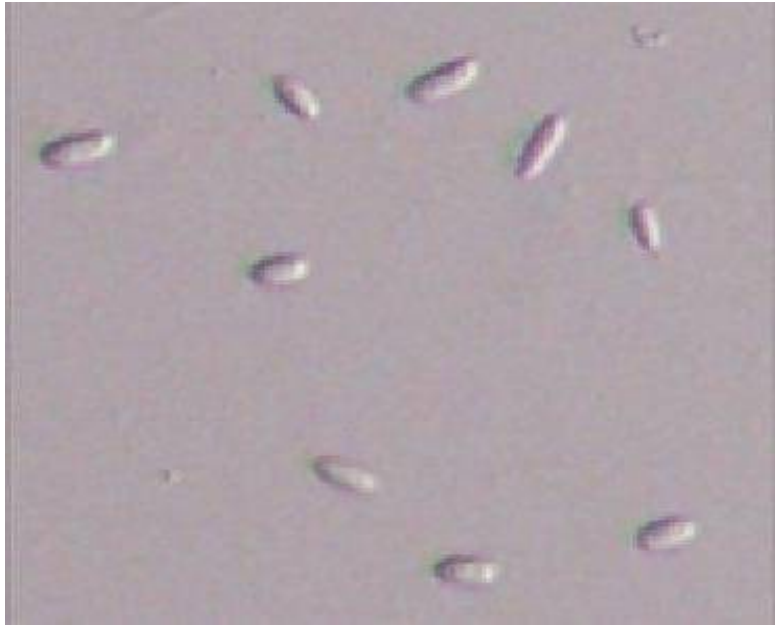


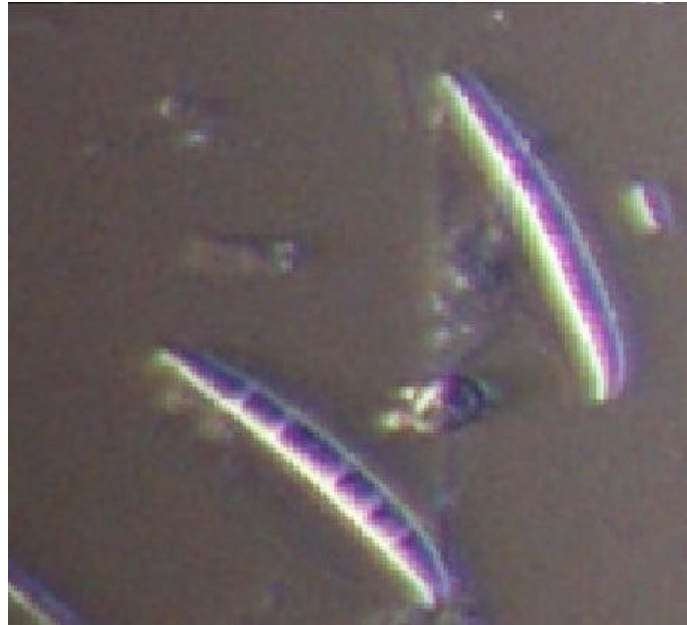
Fusarium Wilt: What to Anticipate from FOV4

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A



B



C



A. Morphology of Microconidia, B. Macroconidia, and C. Chlamydospores of *Fusarium oxysporum* f. sp. *vasinfectum* under compound microscope. Image by Shilpi Chawla.

***Fusarium oxysporum f.sp. vasinfectum* (FOV) = wilt group of Fusarium on cotton.**

Race 1 (FOV1) is in the Southern High Plains of Texas. Root-knot nematode is usually required for symptom expression. Found in sandy soils. Easily isolated from the necrotic area of the stem.

Race 4 (FOV4) was the new race identified in the El Paso valley in 2017. Does not need root-knot nematode to cause symptoms. Is prevalent in the roots (necrotic symptom) and isolated there.



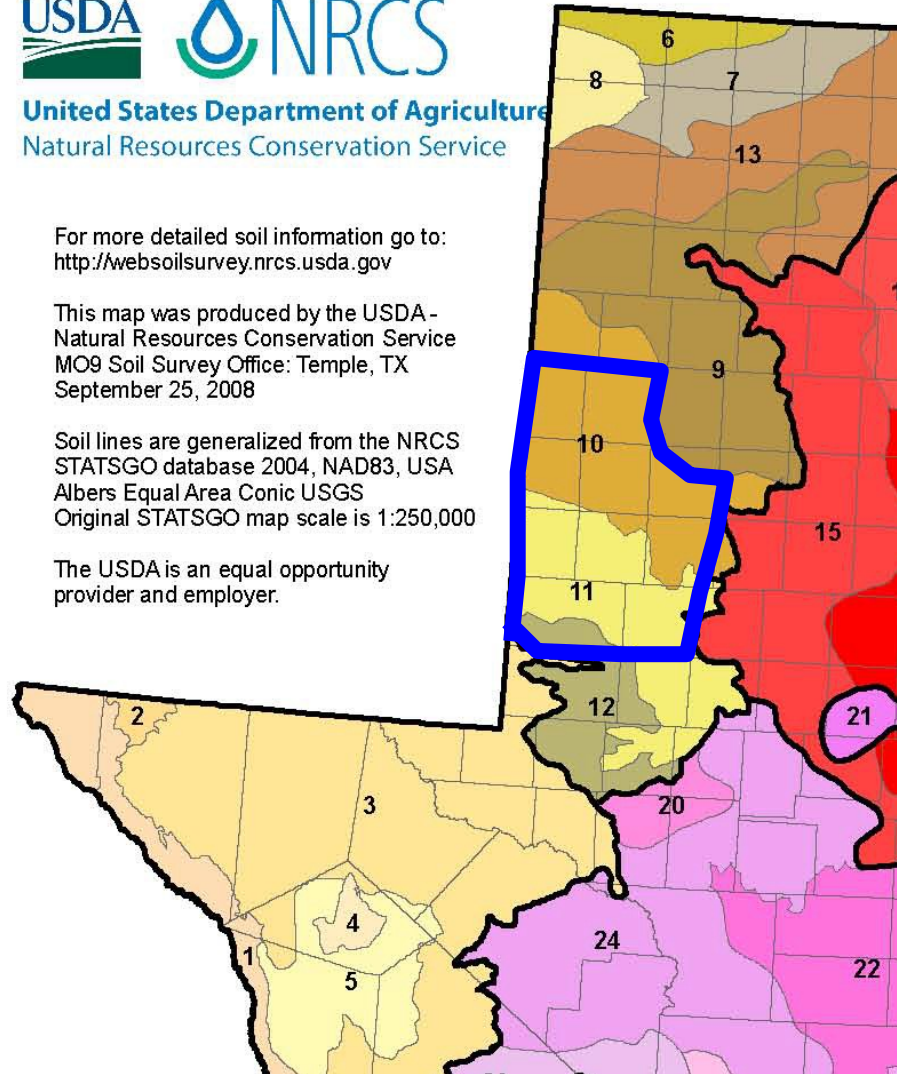
United States Department of Agriculture
Natural Resources Conservation Service

For more detailed soil information go to:
<http://websoilsurvey.nrcs.usda.gov>

This map was produced by the USDA -
Natural Resources Conservation Service
MO9 Soil Survey Office: Temple, TX
September 25, 2008

Soil lines are generalized from the NRCS
STATSGO database 2004, NAD83, USA
Albers Equal Area Conic USGS
Original STATSGO map scale is 1:250,000

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Area where root-knot nematode is common and therefore, Fusarium wilt (FOV1) can cause problems, given a susceptible variety, high fungal density in soil, and sufficient moisture.

FOV1 from Dawson County



FOV1

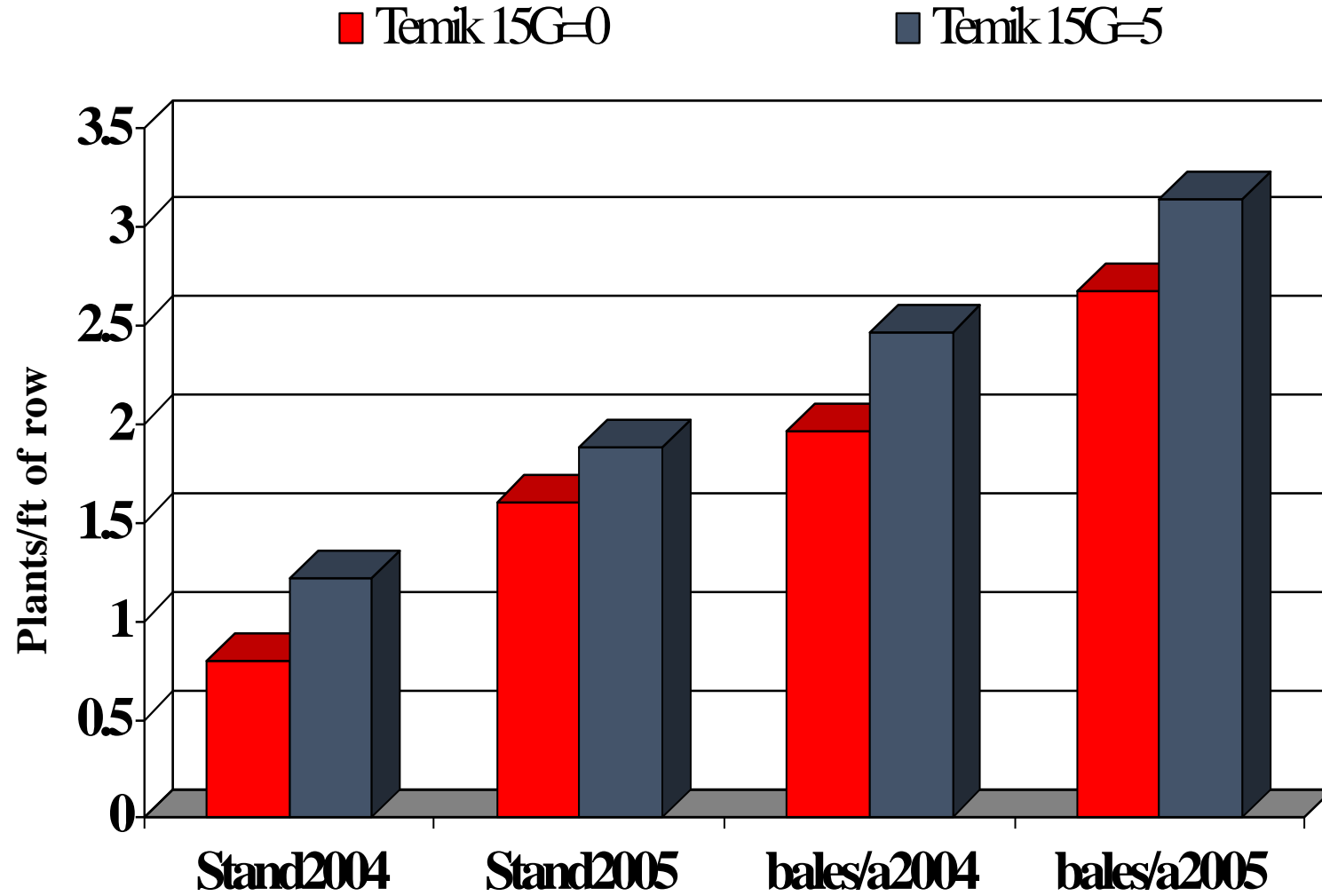


Photographer: Clemson University - USDA Cooperative Extension Slide Series <https://www.forestryimages.org/browse/detail.cfm?imgnum=1234229#collapseseven>

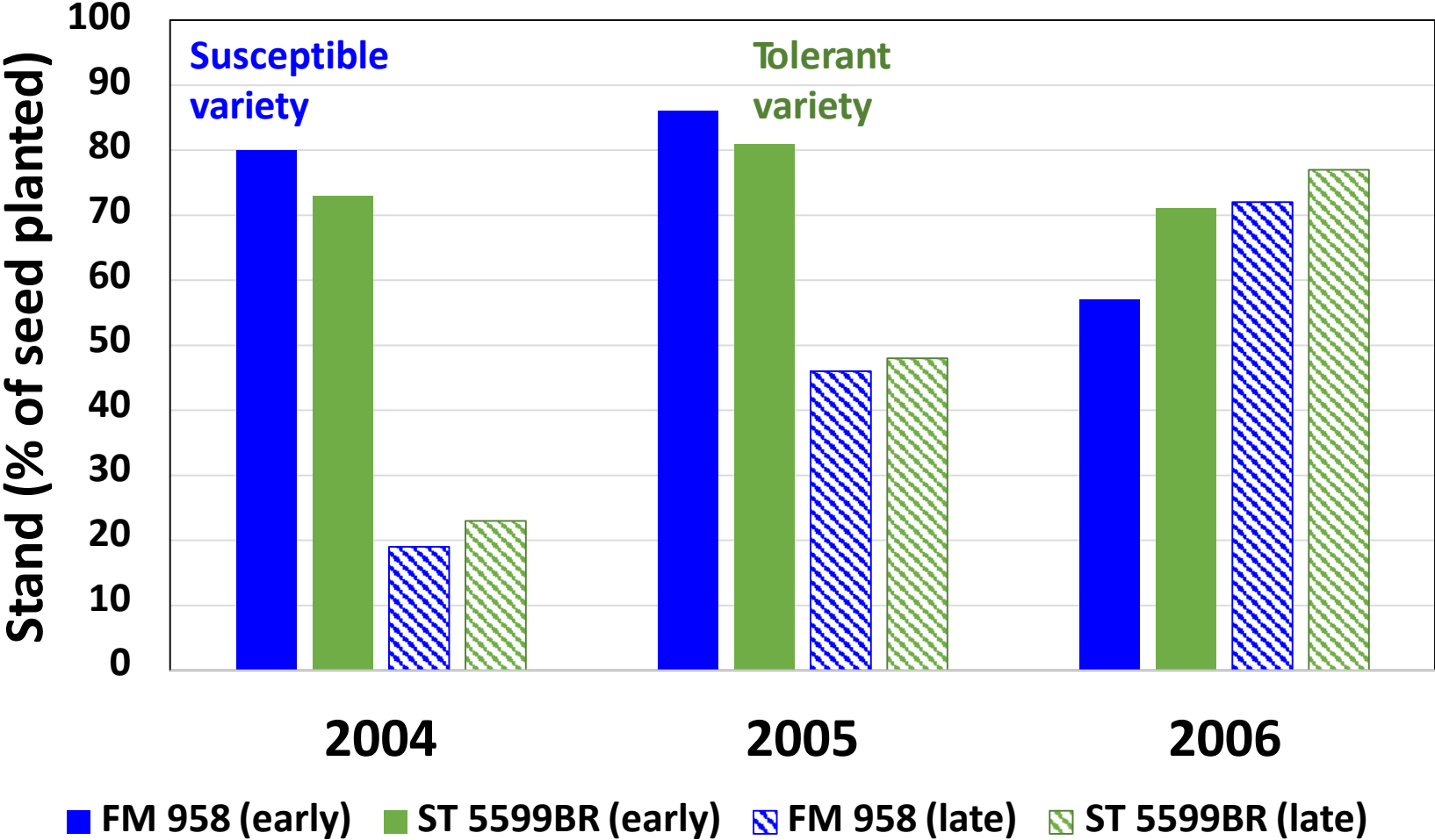
Typical Fusarium wilt (FOV1) symptoms



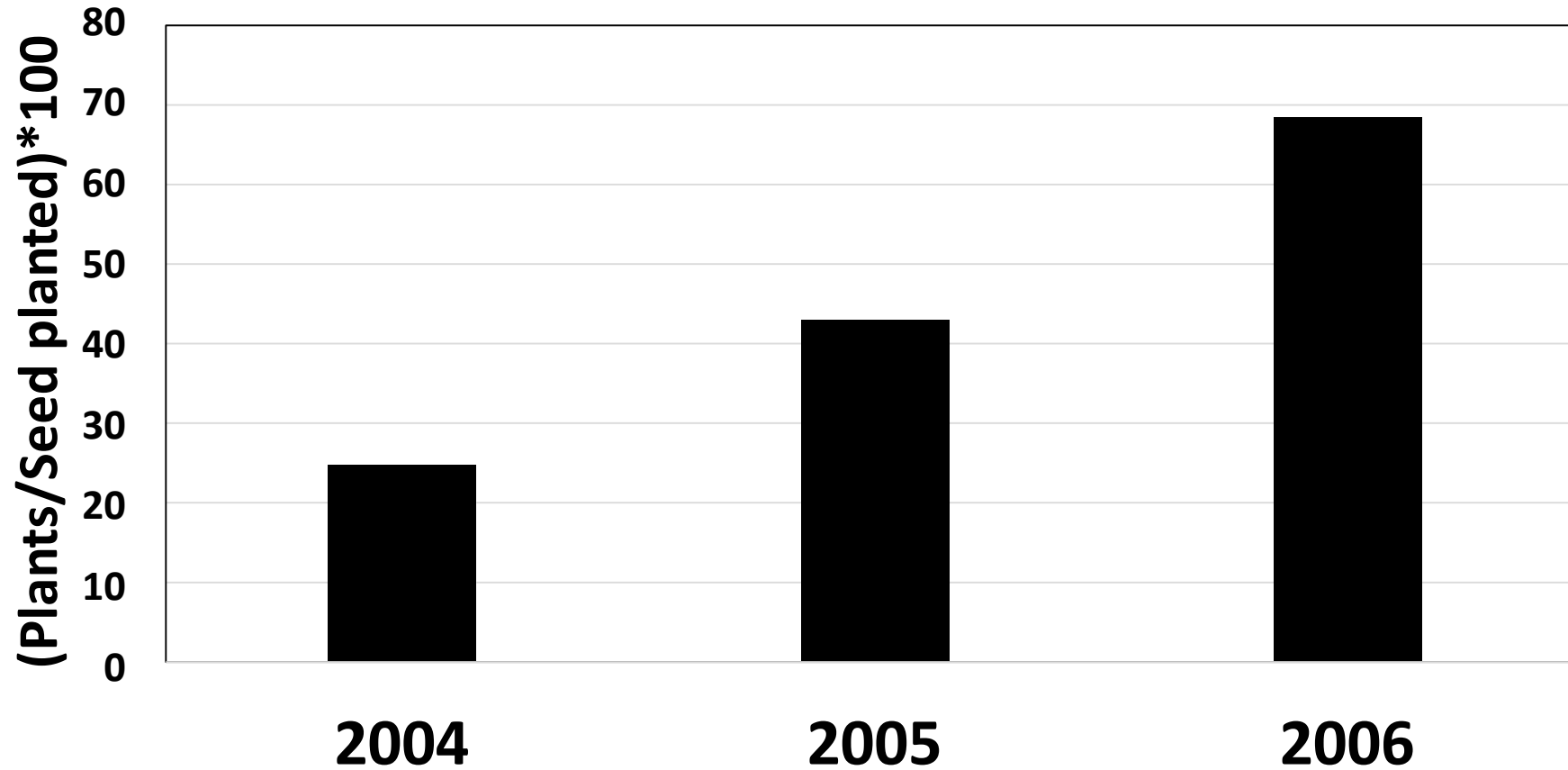
Nematode control impacts Fusarium wilt (FOV1)



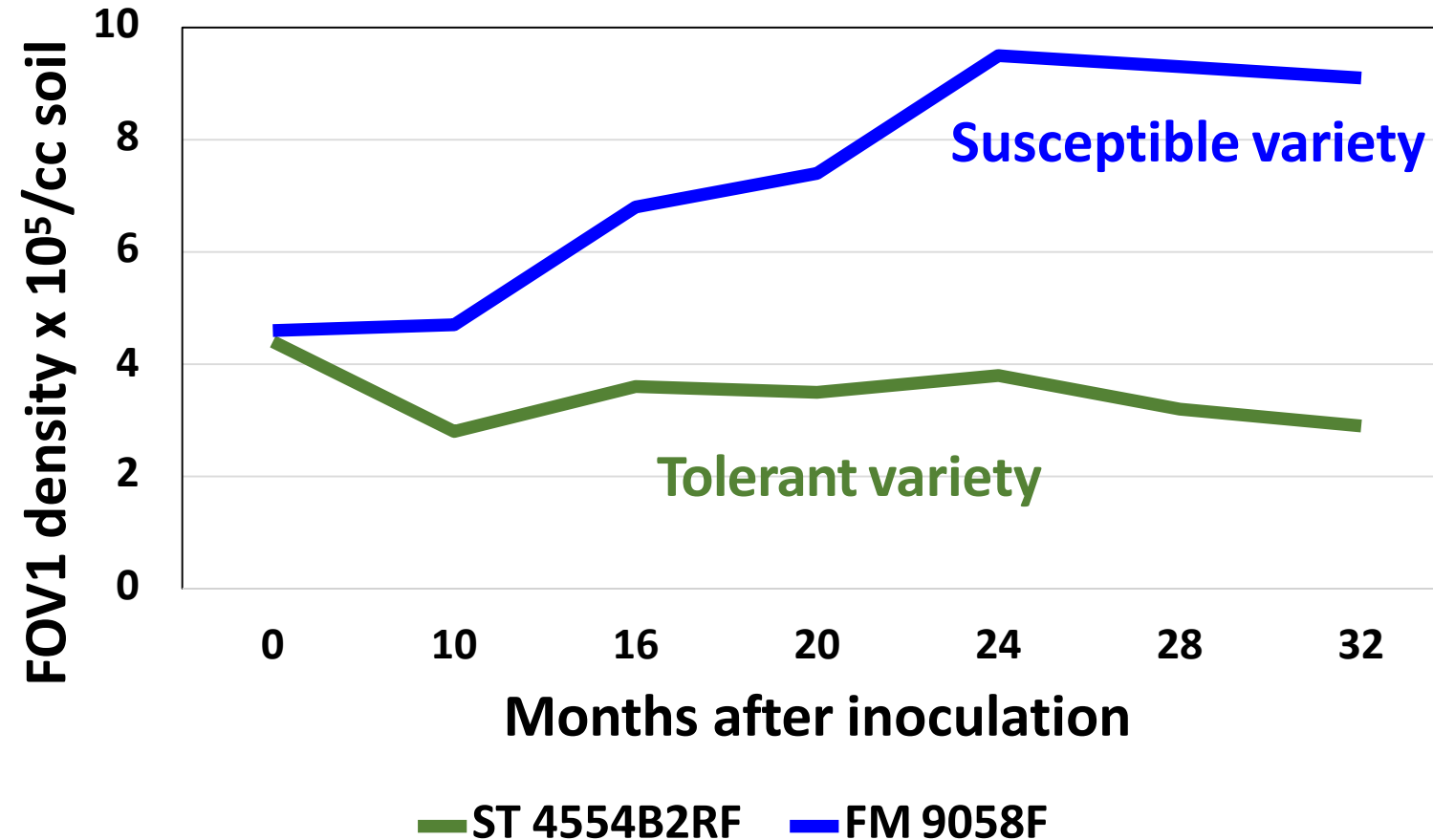
Cotton stands as affected by FOV1



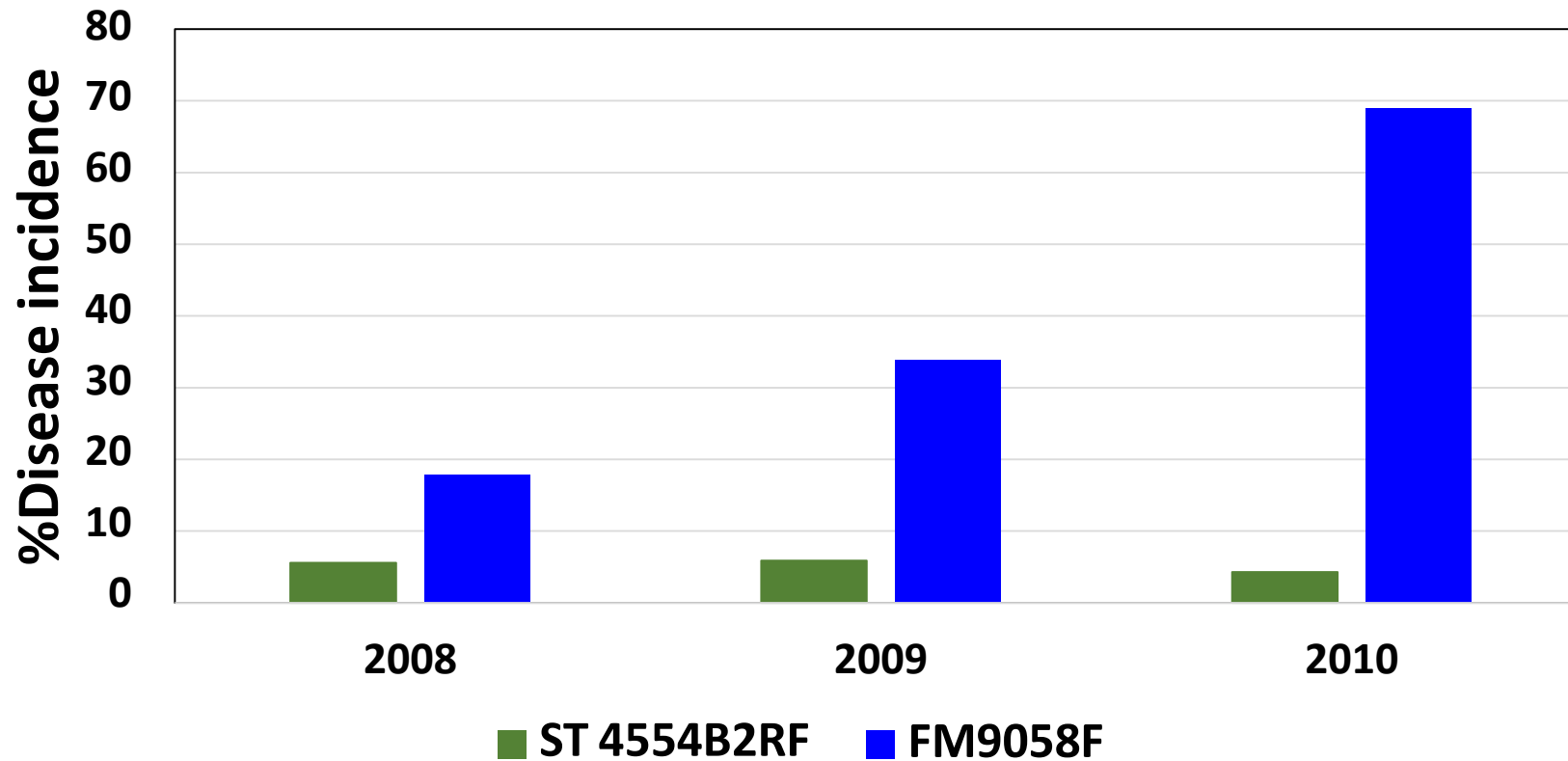
Average stand in FOV1 field when following ST 5599BR (in 2005 and 2006)



FOV1 Population density over Time in an Inoculated Microplot Study by Shilpi Chawla (Ph.D dissertation, Texas Tech University)



Affect of Tolerant and Susceptible varieties on Fusarium wilt over 3 Years (S. Chawla, dissertation, Texas Tech University)



Emergence of FOV4 in the El Paso Valley

In 2016, producers contacted county agent Orlando Flores about severe stand loss problems. Orlando brought samples to Dr. Sanogo at New Mexico State University, who confirmed Fusarium wilt.

In 2017, Jason Woodward (Texas A&M Extension Specialist) and Orlando Flores several months looking at fields and collecting samples. Collectively, they and Dr. Jim Olvey (Pima cotton breeder), and Cotton Incorporated arranged for several different labs to verify whether those samples contained FOV4.

Halpern, H. C., T. A. Wagner, J. Liu, R. L. Nichols, J. Olvey, J. E. Woodward, S. Sanogo, C. A. Jones, C. T. Chan, and M. T. Brewer. 2018. First report of Fusarium wilt of cotton caused by *Fusarium oxysporum* f.sp. *vasinfectum* Race 4 in Texas, U.S.A. Plant Disease 102:446.

Confirmation of Race 4 requires molecular procedures.

Cianchetta et al., 2015. Journal of Cotton Science 19:328.

Utilizes the Translation Elongation Factor (EF-1a) and intergenic spacer (IGS) regions.

Ortiz et al., 2017. Plant Disease 101:34-33. Uses a unique TF01 insertion event in the PHO gene.

Two types of FOV4 isolates were found in the El Paso Valley, suggesting two separate introductions.

Liu et al., 2018. Genetic diversity, pathogenicity, and nematode interactions of U.S. FOV. Beltwide Cotton Conferences.

“About 46% of Texas Race 4 isolates harbor transposable element Tfo1 in the PHO gene. Most California isolates harbor this.

However, 54% of Texas isolates contained a further insertion of a mutator-like element MuDR in this Tfo1 as found in 2 China race 7 isolates”. (China race 7 is considered the same as race 4 in the U.S.).



**FOV4 field from
Google Earth, in
the El Paso
valley, 2017**

**Fusarium Wilt race 4 (FOV4): Picture taken by Tom Isakeit, Texas
A&M AgriLife Extension Service**





**Fusarium Wilt race 4 (FOV4): Picture taken by Tom Isakeit, Texas
A&M AgriLife Extension Service**

**Fusarium Wilt race 4 (FOV4): Picture taken by Tom Isakeit, Texas A&M
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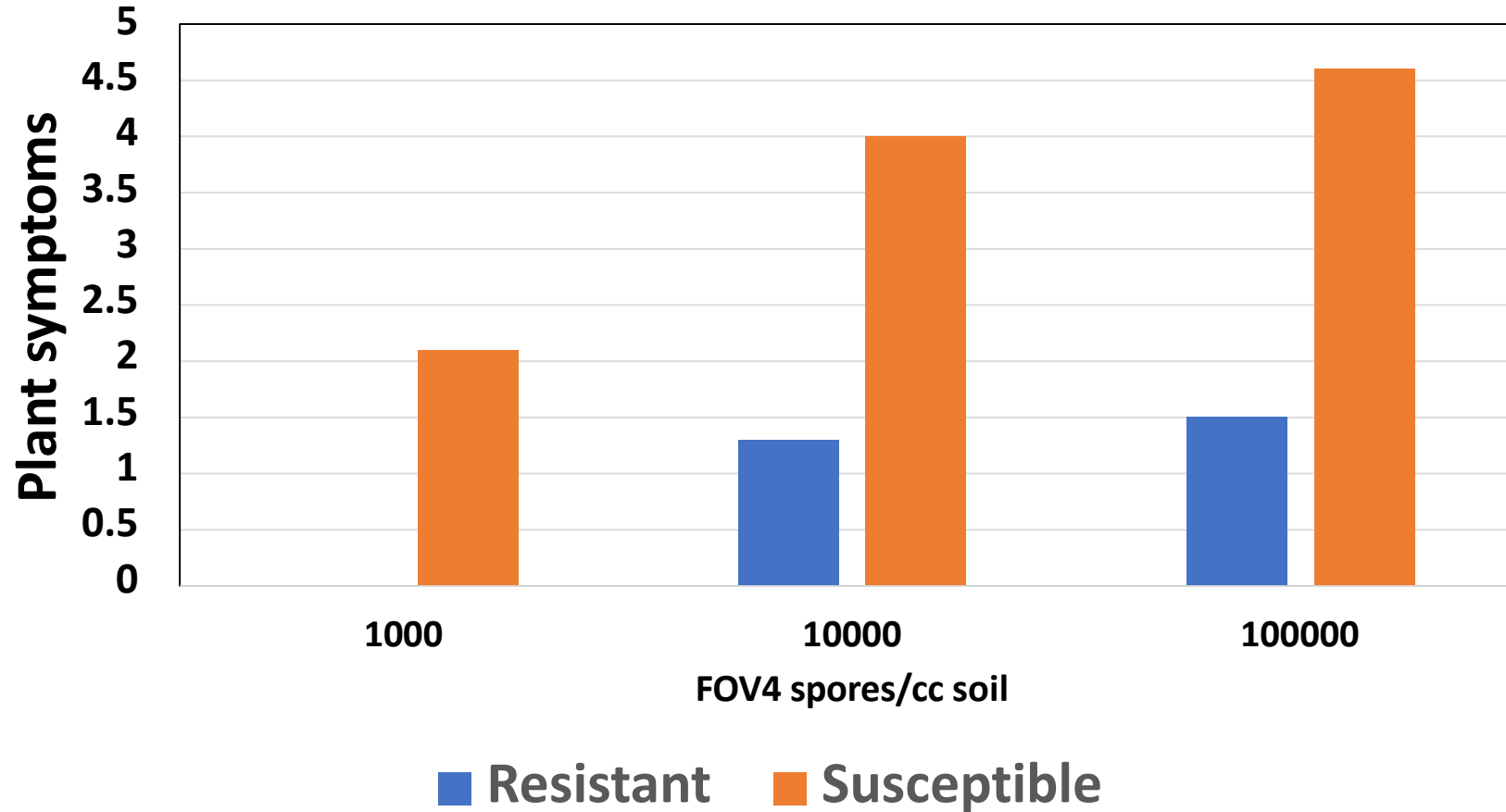


**Fusarium Wilt race 4 (FOV4): Picture taken by Tom Isakeit, Texas
A&M AgriLife Extension Service**



Hao et al., 2009 (Plant Disease)

FOV4 symptoms as related to Inoculum Density



Management for FOV4 will depend on:

Avoidance (don't spread it into new fields)

- a) Avoid seed or using any plant parts in other fields from a known contaminated field**

Minimize spread once in a field

- a) Don't move soil all around a field, once infested; consider turning field into pecan orchard or parking lot when appropriate. Infested soil can still contaminate other cotton fields.**

Movement of disease appears to be down the row, as expected by cultivation and irrigation

Movement of disease appears to be across the rows.



2017 of FOV4 field from Google Earth

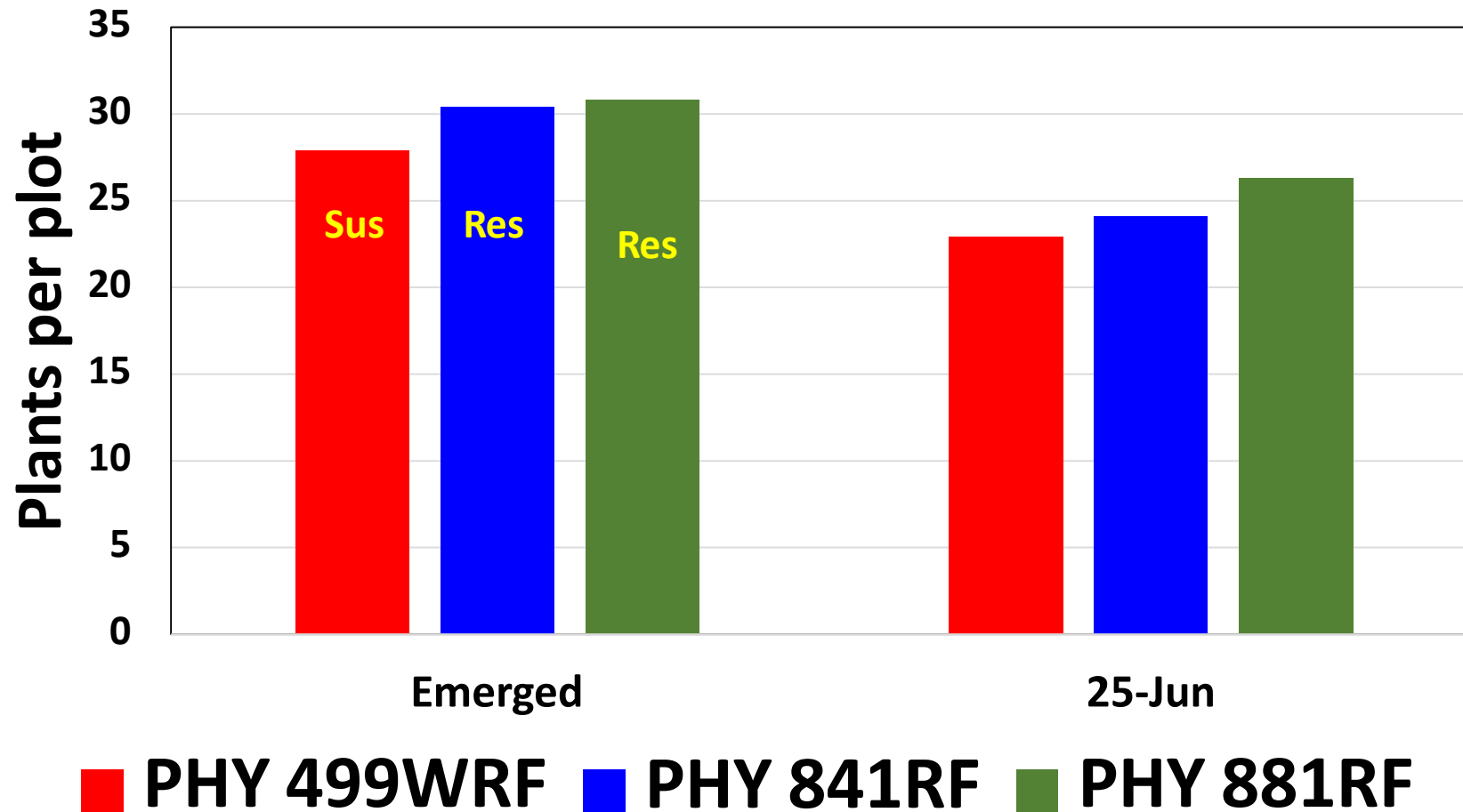
Jim Olvey and Cotton Incorporated had a program in 2018 to screen germplasm from the University and USDA Cotton Breeders in the El Paso valley.

Texas A&M AgriLife Research funded a breeding project in the El Paso Valley

Texas Cotton State Support funded a variety trial in the El Paso Valley with Jason Woodward, which will be expanded in 2019 with Tom Isakeit.

Several seed companies funded fungicide seed treatment trials in FOV4 fields.

Average plant stand/plot (80 seed planted/plot) in El Paso field with FOV4, for upland susceptible variety (PHY 499WRF), and two Pima resistant varieties (PHY 841RF and PHY 881RF).

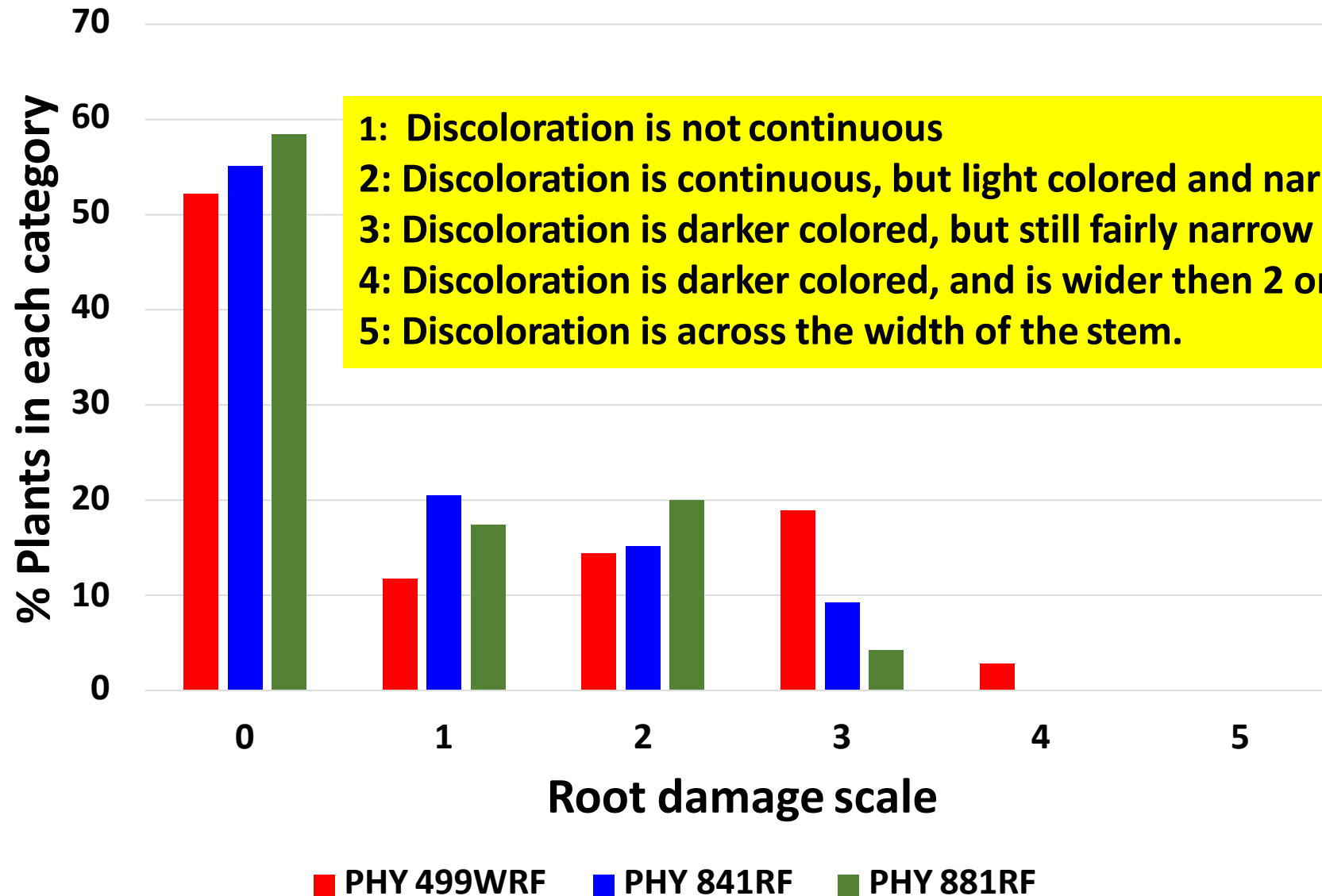


There was initially a poor stand (<50%).

Stands declined by around 17% in both the susceptible and resistant varieties after the initial emergence. Think about FOV1 data, when inoculum levels are high, even tolerant varieties have problems. However, tolerant varieties can reduce inoculum over time.

It will be difficult to diagnose early in areas where the disease is not expected, and spots are small.

Root symptoms in FOV4 field in El Paso with susceptible and resistant varieties (approx. 150 plants rated/variety).



1: Discoloration is not continuous
2: Discoloration is continuous, but light colored and narrow around center of stem.
3: Discoloration is darker colored, but still fairly narrow around center of stem.
4: Discoloration is darker colored, and is wider than 2 or 3, but not across entire stem.
5: Discoloration is across the width of the stem.

60% of plots rated on 3-6 July and 40% made on 22-24 July)

Root Discoloration is a Function of

- 1) Susceptibility or Resistance of Germplasm**
- 2) Inoculum Density of FOV4**
- 3) Time in the Season that Rating Occurs (more severe symptoms as season progresses)**

Remember while we know that Upland Cotton can be Affected by FOV4, it is Generally not as susceptible as Pima cotton (lacking the resistance gene).

We do not yet know how serious FOV4 will be in Upland Cotton, if it Spreads to Other Cotton Growing Regions. The Potential YIELD LOSS, Can Probably Be Managed with Tolerant or Resistant Cotton Varieties, once those varieties are developed or discovered.

Thanks to Texas A&M AgriLife Research, Cropping Systems Program and PhytoGen Cottonseed for Providing Seed of PHY 499WRF, PHY 841RF, and PHY 881RF.