

Status of Race 4 *Fusarium oxysporum* var *infectum* and screening efforts in California cotton

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Thanks to:

- *Grower and PCA Cooperators*
- *CA Cotton Growers Association Research Fund*
- *CA Cotton Alliance*
- *Cotton Incorporated State Support Committee ; Cotton Incorporated CORE*
- *CA Department Food and Agriculture*
- *seed companies and private breeders (Bayer, Dow/Phytogen, Monsanto/DPL, Olvey and Associates, Dynagro/CPS, Hazera, others)*

Fusarium wilt (FOV) Symptoms



Disease introduced to field in small individual locations, progression to larger impacted areas takes place as inoculum produced in infected plants, then spread / dispersed to larger areas



Farm calls often to fields where early symptoms look like this



Screening trials done in fields more like this



Evaluation Methods – Fusarium Assessments

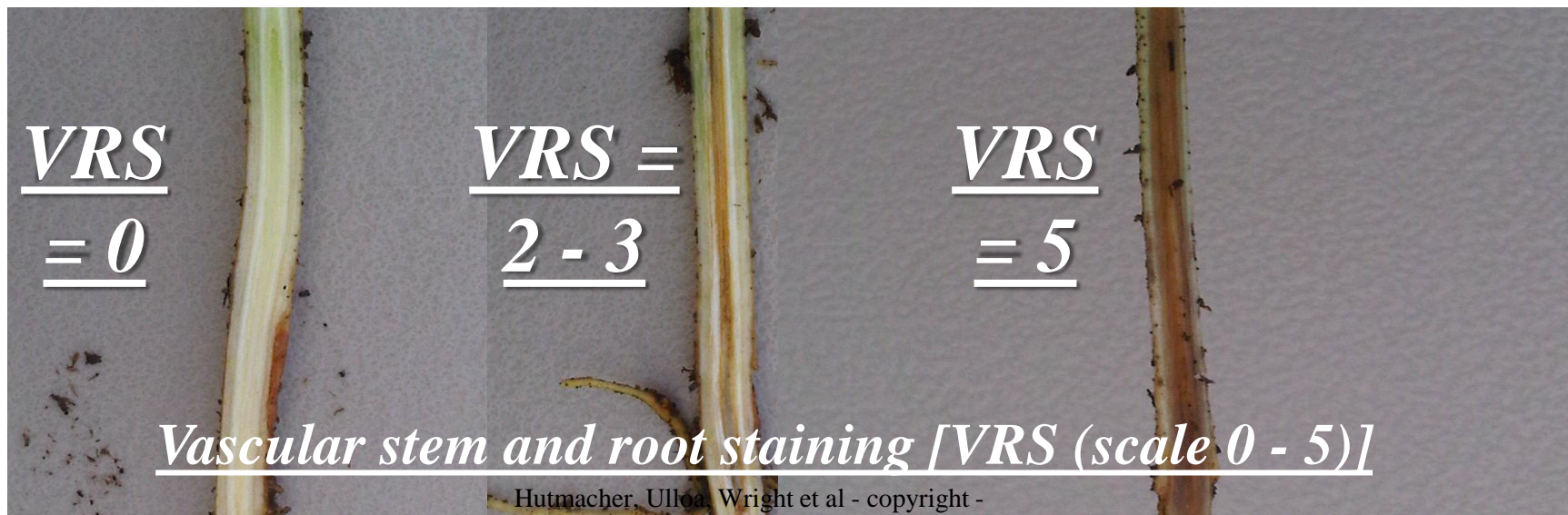
FUSARIUM evaluations include:

- Root vascular stain rating
- Whole plot foliar symptom and single plant foliar symptoms
- Plant height and main stem total node # (used as a relative indicator of impacts on vigor, growth)
- Plant survival % at about 7-8 weeks post emergence (calculated as a % of plants that emerge within first 2 weeks after planting)

Plant Infection

Resistant < 2.0 & Susceptible > 2.0

Disease severity index (DSI) of leaves, (scale 0 – 5)



Recommendations for Field Scouting for Fusarium – race 4 or others?

- Scouting needed EARLY in crop development....
- Differentiate between seedling disease losses and potential FOV by looking for dark, continuous vascular staining in tap roots, which is symptomatic of FOV (Fusarium)
- evaluations of fields best done from seedling stage if possible, but could start mid-squaring to no later than early bloom to look for race 4 Fusarium symptoms (much easier to see than in late season or when Verticillium could be evident)
- **Make sure to scout seed production fields with extra efforts and care**

Fields with FOV Race 4 confirmed by plant sample collection & pathology tests (Mike Davis lab, Bob Hutmacher or Ag Dia quick test)

• Fresno County

- Farm #1 (1 in 2001, 4 in 2003, 3 in 2006, 2 in 2010)
- Farm #2 (3 in 2003)
- Farm #3 (3 in 2004, 2 in 2009, 2 in 2010)
- Farm #4 (2 in 2004, 3 in 2005, 1 in 2006; 3 in 2010)
- 80 addt'l 2005-2015 (+31)

• Kings County

- 55 fields 2004-2015 (+ 23)

- **TOTAL confirmed fields about 400 between 2003 & 2015 – plus about 70+ more through mid-2017**

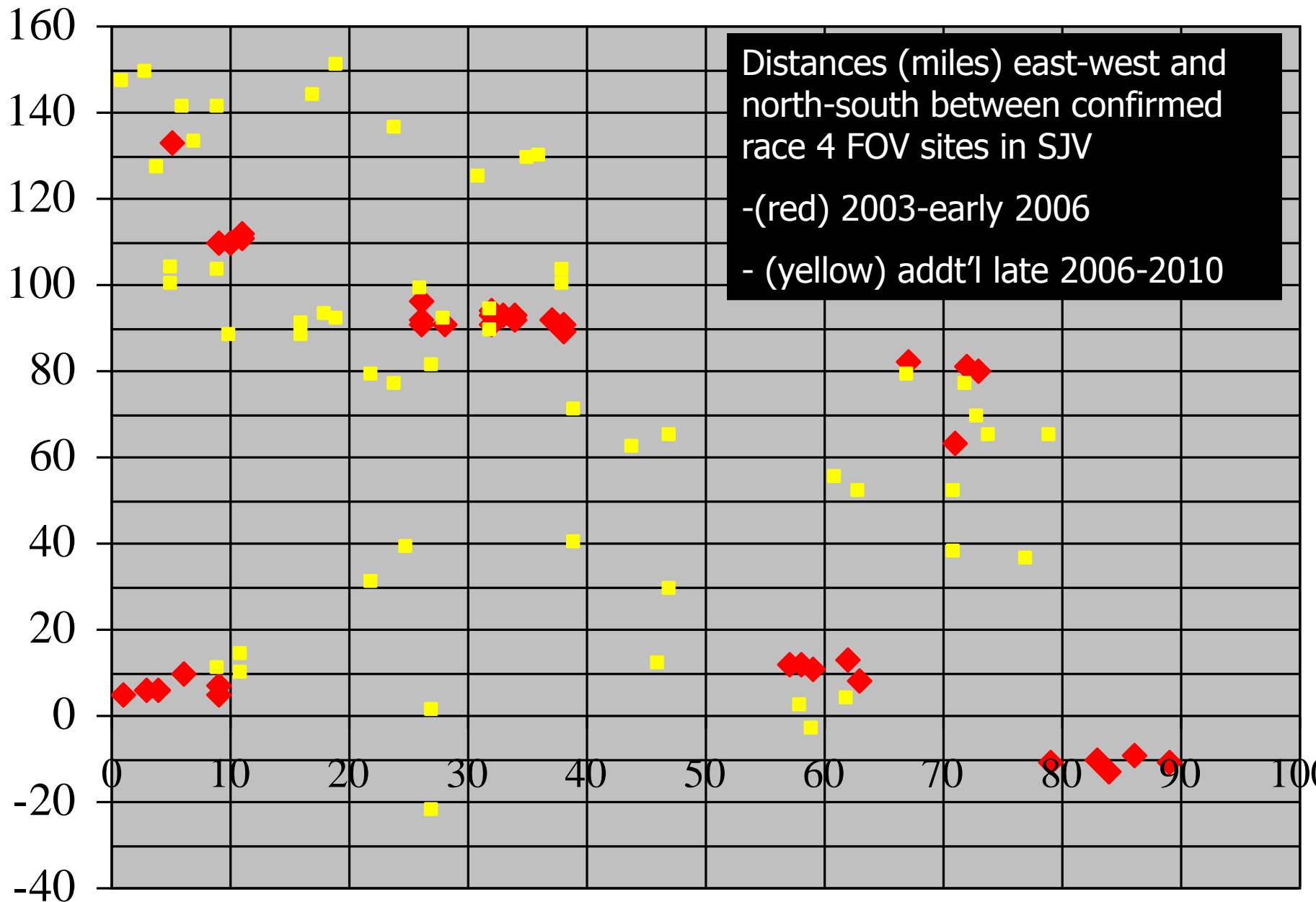
• Tulare County

- Farm #5 (1 in 2003, 1 in 2004, 2 in 2007; 2 in 2010)
- Farm #6 (2 in 2005; 2 in 2010)
- Farm #7 (1 in 2006; 2 in 2009)
- 37 addt'l 2006-2015 (+19)

• Kern County

- Farm #8 (1 in 2004)
- Farm #9 (3 2005-6)
- Farm #10 (2 in 2004, 1 in 2005, 2 in 2006-7)
- 39 addt'l flds. 2006-2015 (+17)

- **Madera & Merced Co. – 31 sites identified thru 2015 (+15)**





Phytogen – 72 Acala field (race 4 FOV stand losses)

*Is FOV-4 a Pima-only disease? **No.***

evidence of more field injury to Acala plants in some 2004, 2005, 2006 and later fields – continued to increase as inoculum levels increased

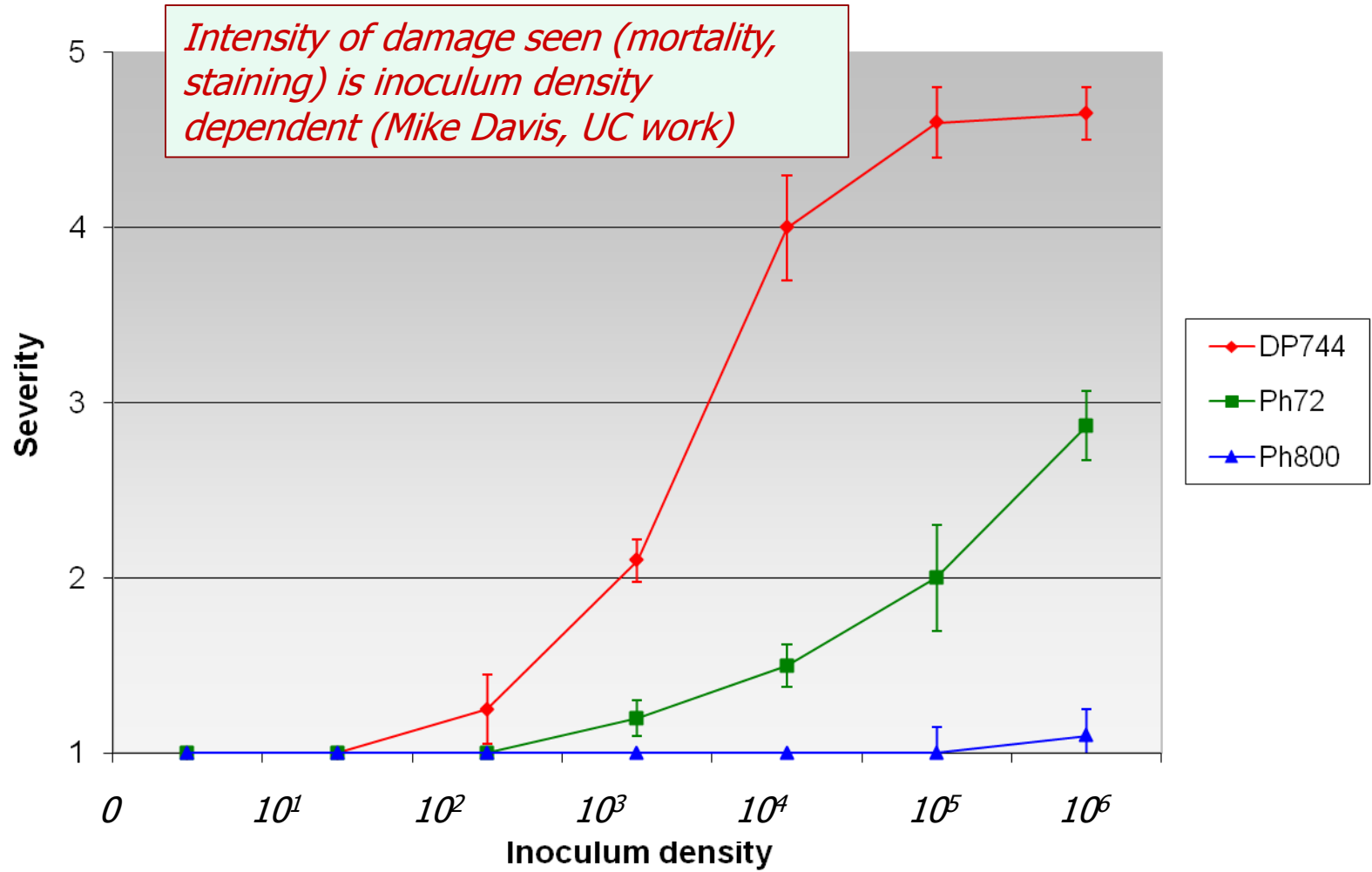
*Phy-800
race 4 FOV
tolerant*

*DP-744 Race 4
FOV
susceptible*

V
531
05
R

V
531
05
S

Symptoms



Inoculum density is part of explanation – other issues and situations with potential impacts ...

- Some year-to-year & location differences in responses related to:
 - (1) higher soil inoculum levels – inoculum levels building in repeat test sites if susceptible varieties grown (checked with indicator susceptible varieties)
 - (2) differences in multiple stresses to which plants exposed in different sites and years
- For example: colder, difficult weather at and after planting results in greater cumulative stresses on seedlings in earlier plantings – matches strategy in Australia where have found less injury in FOV-infested sites with later plantings (**planting date effects**)

Bottom line: multi-site or multiple year data helps assess environmental condition impacts, potential for other pathogen impacts, and FOV inoculum level differences when assessing cultivar tolerance / resistance potential.

Impacts of different years & conditions on stand survival % of select varieties – FOV race 4 sites

VARIETY	Year 1 Fresno	Year 2 Kern	Year 3 Kern	Year 4 Fresno	Year 4 Kern	Year 5 Fresno	Year 5 Kern	Year 6 Fresno	Year 6 Kern
Phy-72	80	77	33	72	60	61	22	41	38
Ultima RF	91	83	71	76	70	88	39	43	48
Phy- 725RF			52	79	68	78	34	36	53
Phy-800	93	95	90	88	87	96	78	85	84
Phy-830			27	43	21	22	6	20	14
DP-744	27	8	5	17	12	16	4	4	10

Once you know FOV-4 is there ... management options?



Containment issues for growers as sites with FOV are identified ?

- *Remember that spores of this organism can be very long-lived so limit practices that expand movement*
- *What rotation crops will reduce inoculum / pop'ns ? most non-cotton crops will reduce inoculum levels in a relatively slow manner, but unlikely any crop will eradicate it*
- *Transmissible via infected seed? Yes – Rebecca Bennett, USDA-ARS) & Mike Davis (Univ CA) confirmed*
- *Can this strain influence other crop spp? Highly unlikely, but can impact susceptible cotton, both Uplands and Pimas*
- *Can inoculum be spread in fields with soil transport or movement of plant parts (leaves, flowers, squares?) ...yes.. By irrigation? ...yes... cultivation ...yes*



**KEEP THIS FARM
FUSARIUM
WILT FREE**



WARNING
COME CLEAN GO CLEAN
AUTHORISED ACCESS ONLY
RESTRICTED AREA
for
DISEASE CONTROL
FOR ACCESS AUTHORISATION PLEASE CONTACT
ANTHONY McALARY on 68 47 9197
or REPORT TO THE OFFICE UHF 4
AFTER HOURS CONTACT NUMBER
FARM MANAGER 0408 410 228
AGRONOMIST 0407.479 197

Roadblocks or at least limits in long-term efficacy of sanitation efforts to limit spread

- crop rotation (careful attention to avoiding wet soil operations and movement – must carry on through crop rotations when you rotate out of cotton)
 - examples of problems: rotations to winter vegetables, such as lettuce, broccoli; harvest operations in tomatoes, etc. tend to include wet-soil operations
- dust control measures / road watering sticks soil to equipment and personnel, aiding movement
- efficient water use efforts – tailwater reuse and recovery methods can move infested soil, residues
- everyday movement of equipment, people, transportation, consultants/scouts where FOV-4 spread is not their primary concern

Field Variety Screens – FOV race 4 sites



*Susceptible varieties
severely affected –*

*others grow through it
to varying extents even
if infected*

Multiple Screening-Related Efforts (UC (Hutmacher) & USDA-ARS (Ulloa) – *related in some ways (field screening sites, some personnel) but different in objectives and scope:*

- 1) Commercial Cultivar Screening for Fusarium Wilt Race 4 resistance – RBTN and commercial seed company connections**
- 2) Identification and Development of Cotton Germplasm with Potential Breeding Lines with Improved Fusarium Race 4 Wilt Resistance, Fiber Quality and Yield**



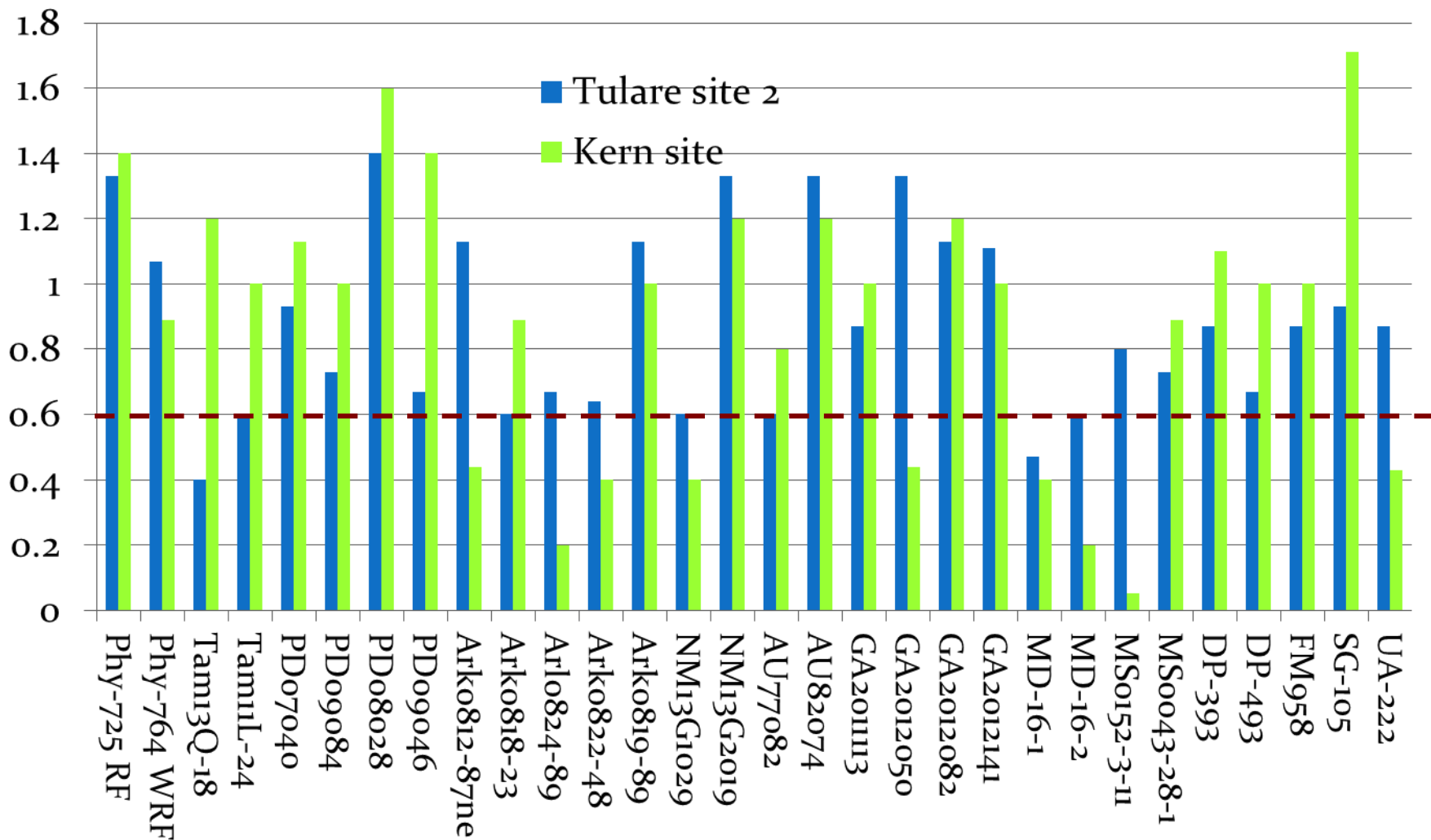
Commercial Entries, RBTN Screening Efforts – in Uplands

(project not involving USDA/UC breeding efforts)

- Commercial entries (seed company releases & experimentals) have been tested for many years*
- Entries tested have been those in Univ. CA variety trials + those experimentals chosen & submitted by seed company reps + RBTN (more recent years)*
- Data provided to RBTN community & those submitting entries*

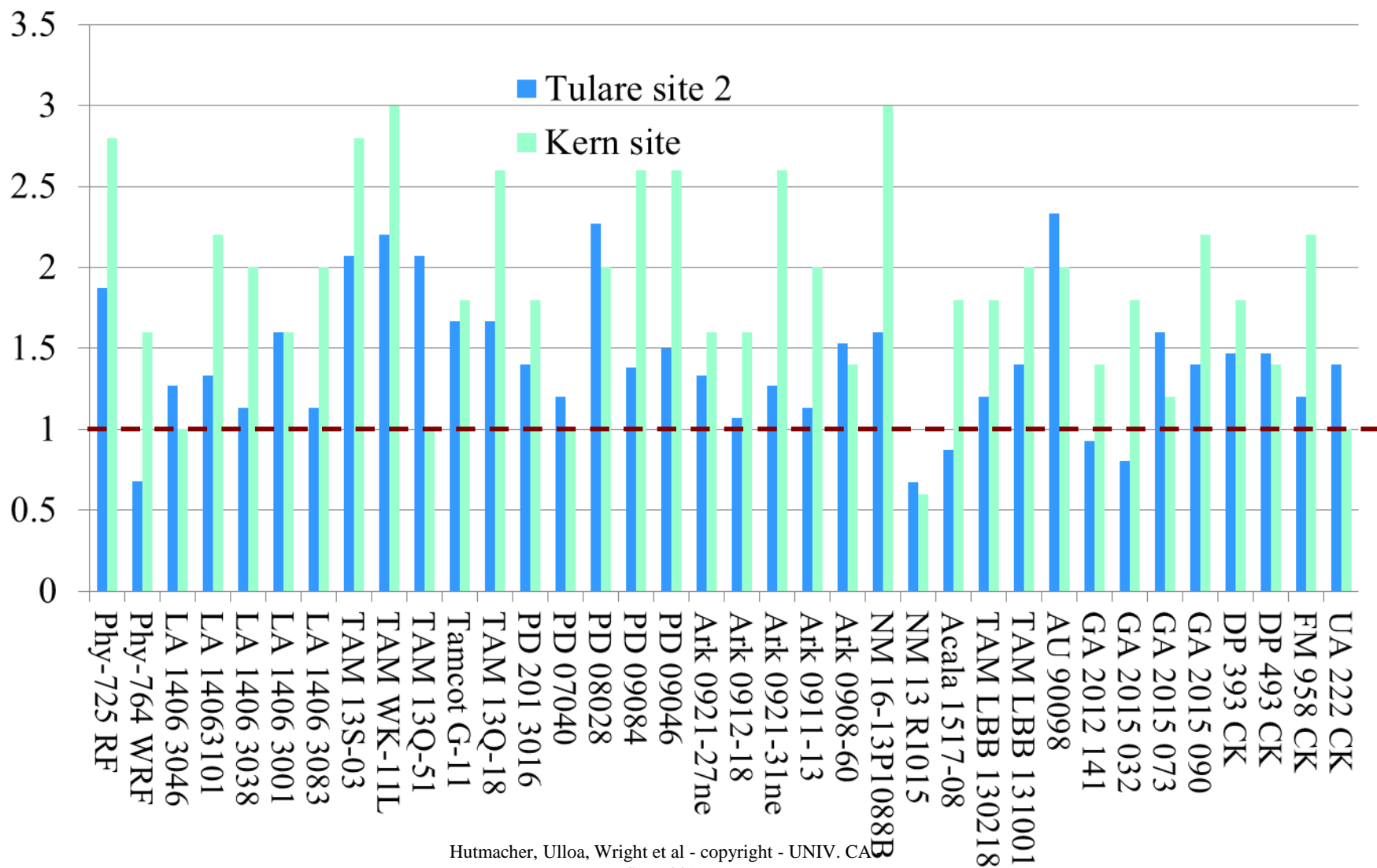
Experimental Uplands (**RBTN program** – Wallace et al) - 2016

Root vascular staining index - evaluations at two sites



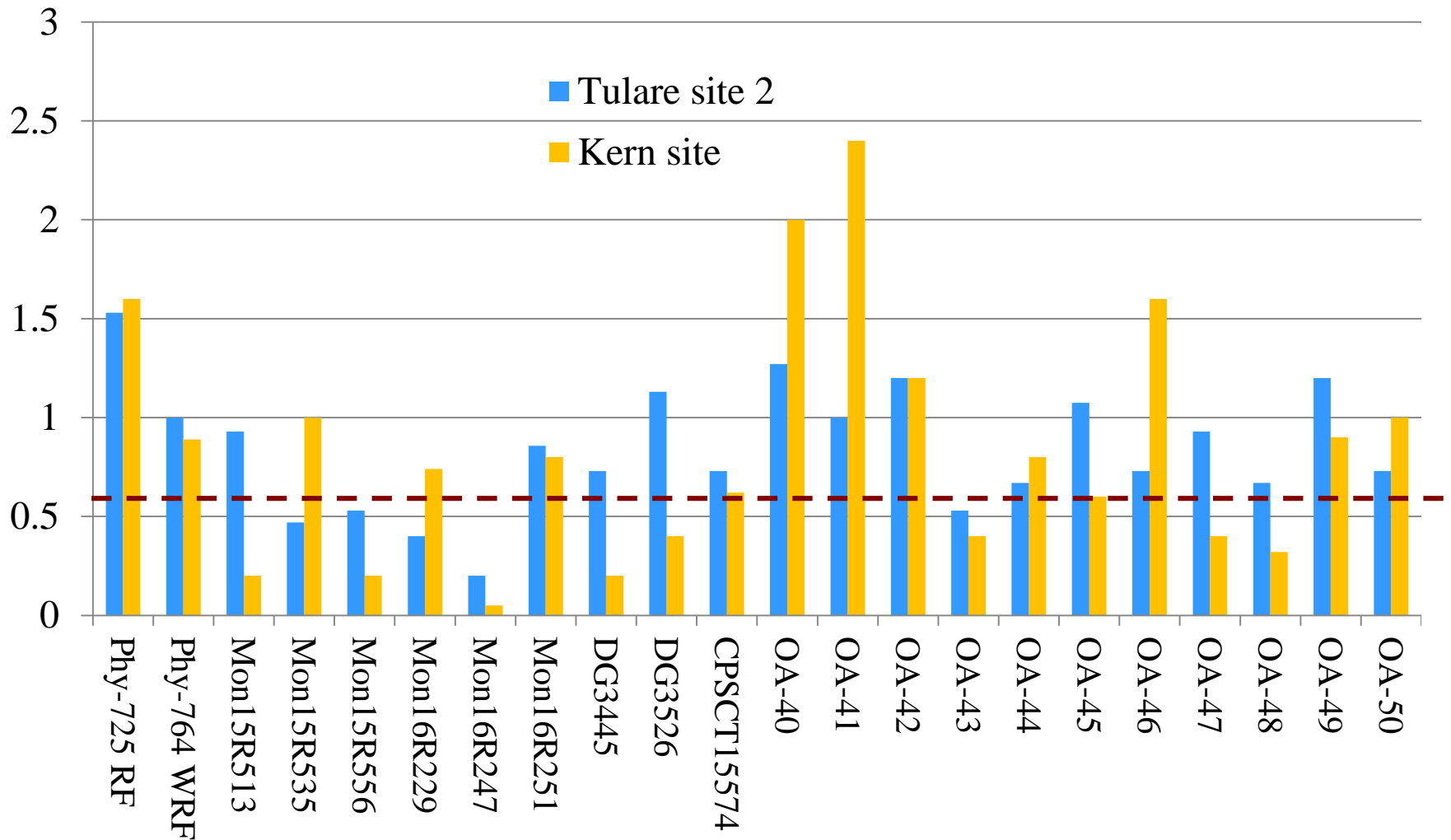
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Root vascular staining index - evaluations at two sites



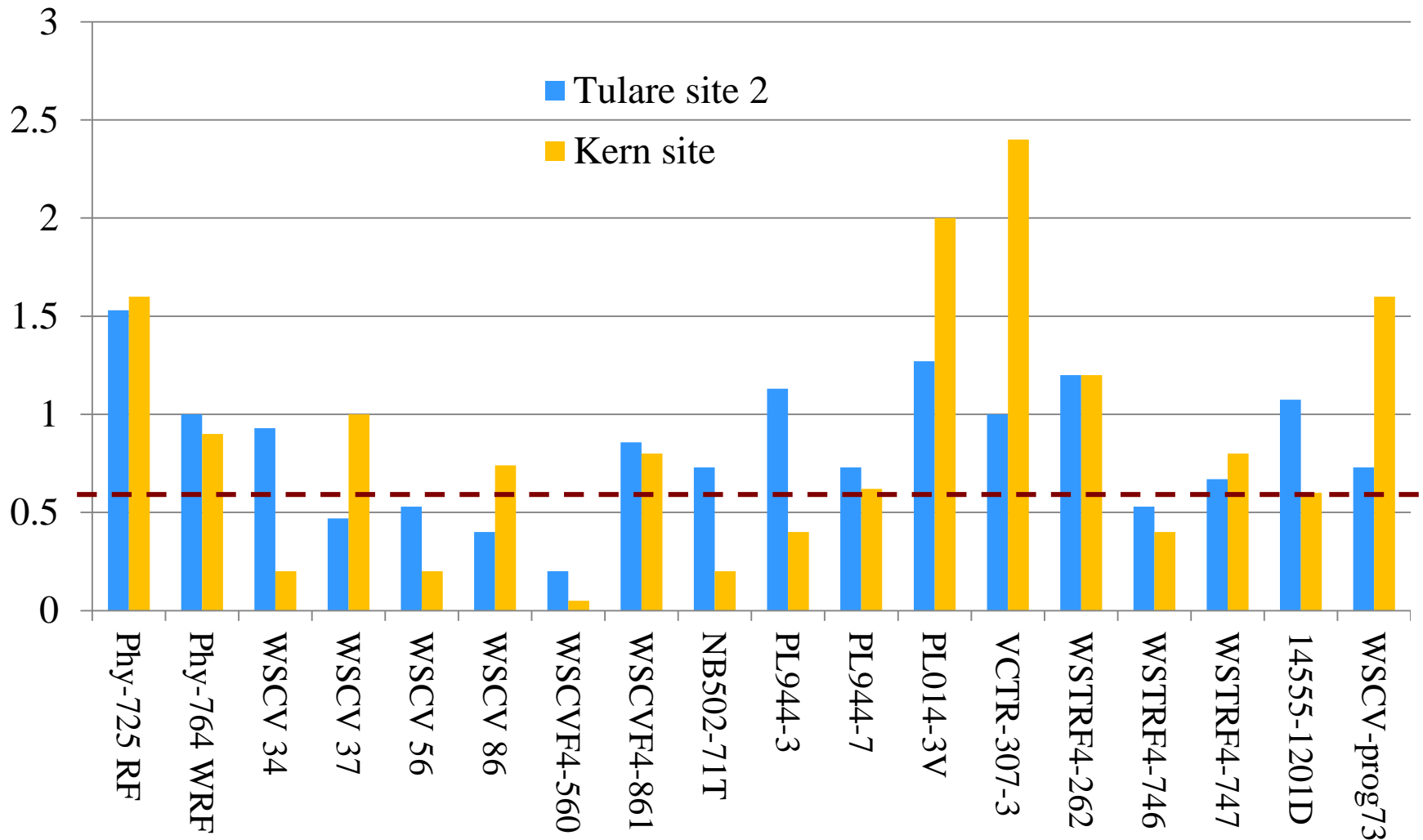
Experimental Uplands (*multiple companies*) – 2016 – *group #1*

Root vascular staining index - evaluations at two sites



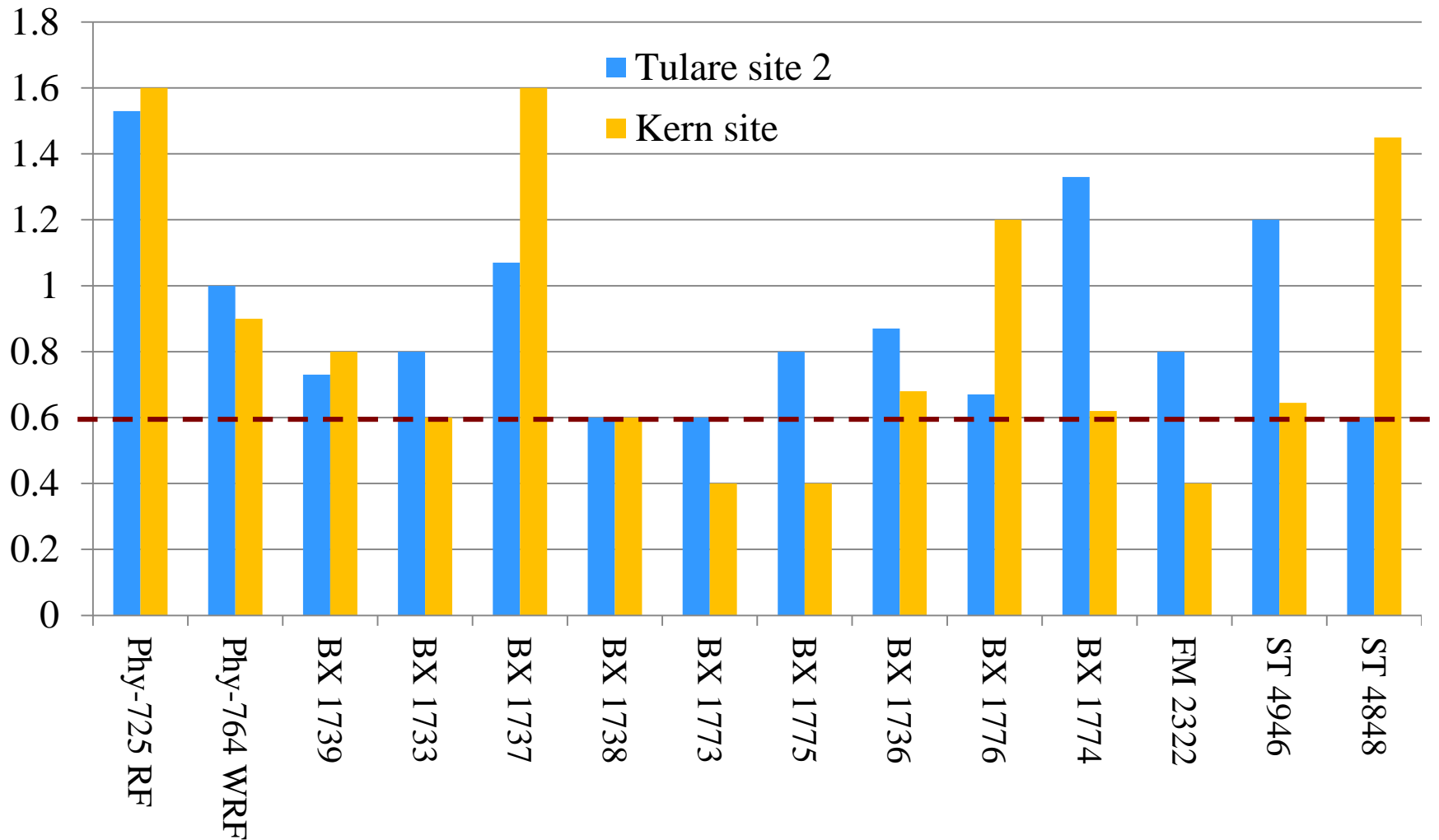
Experimental Uplands (*multiple companies*) – 2016 – *group #2*

Root vascular staining index - evaluations at two sites



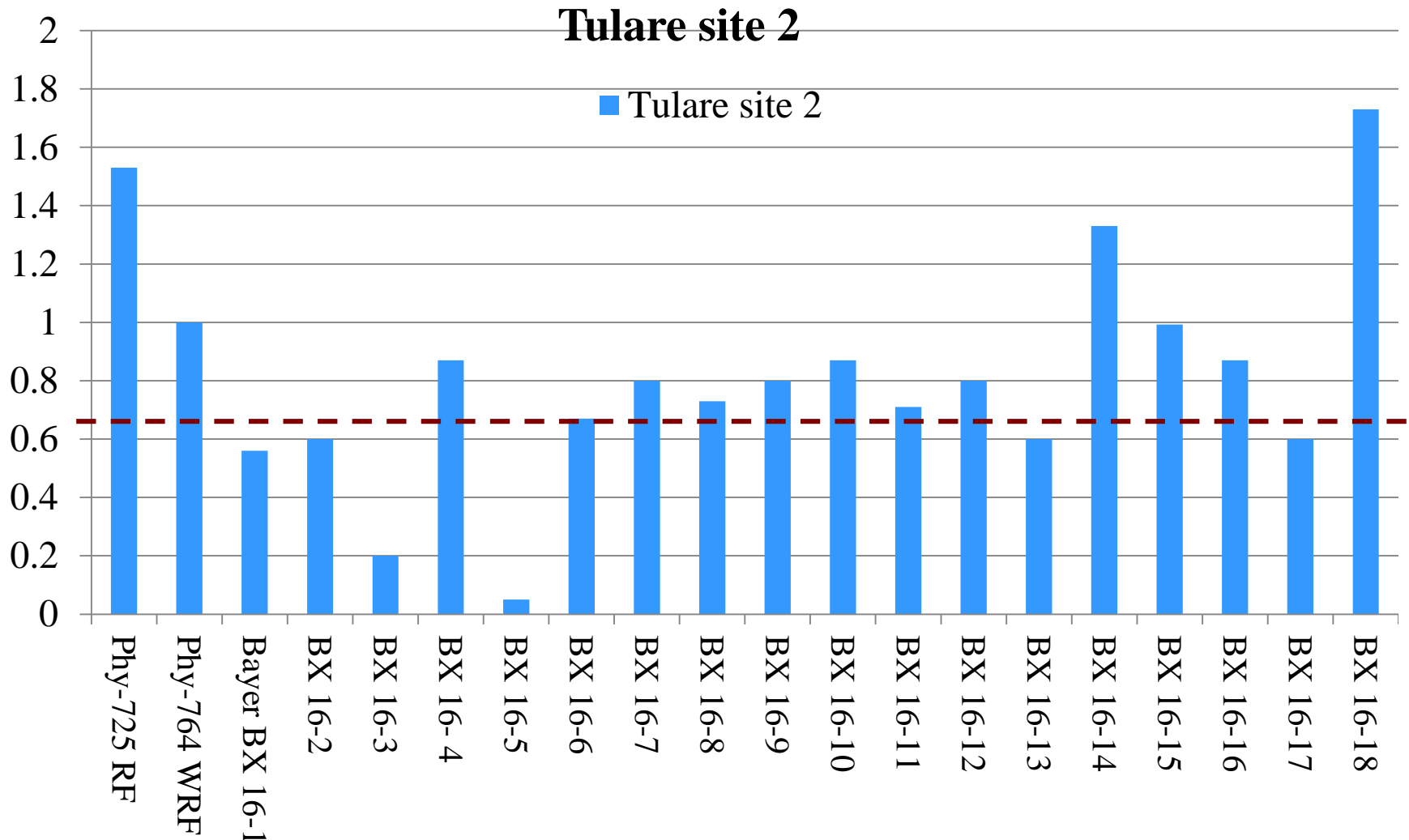
Experimental Uplands (*Bayer Crop Sci.*) – 2016 – group #1

Root vascular staining index - evaluations at two sites



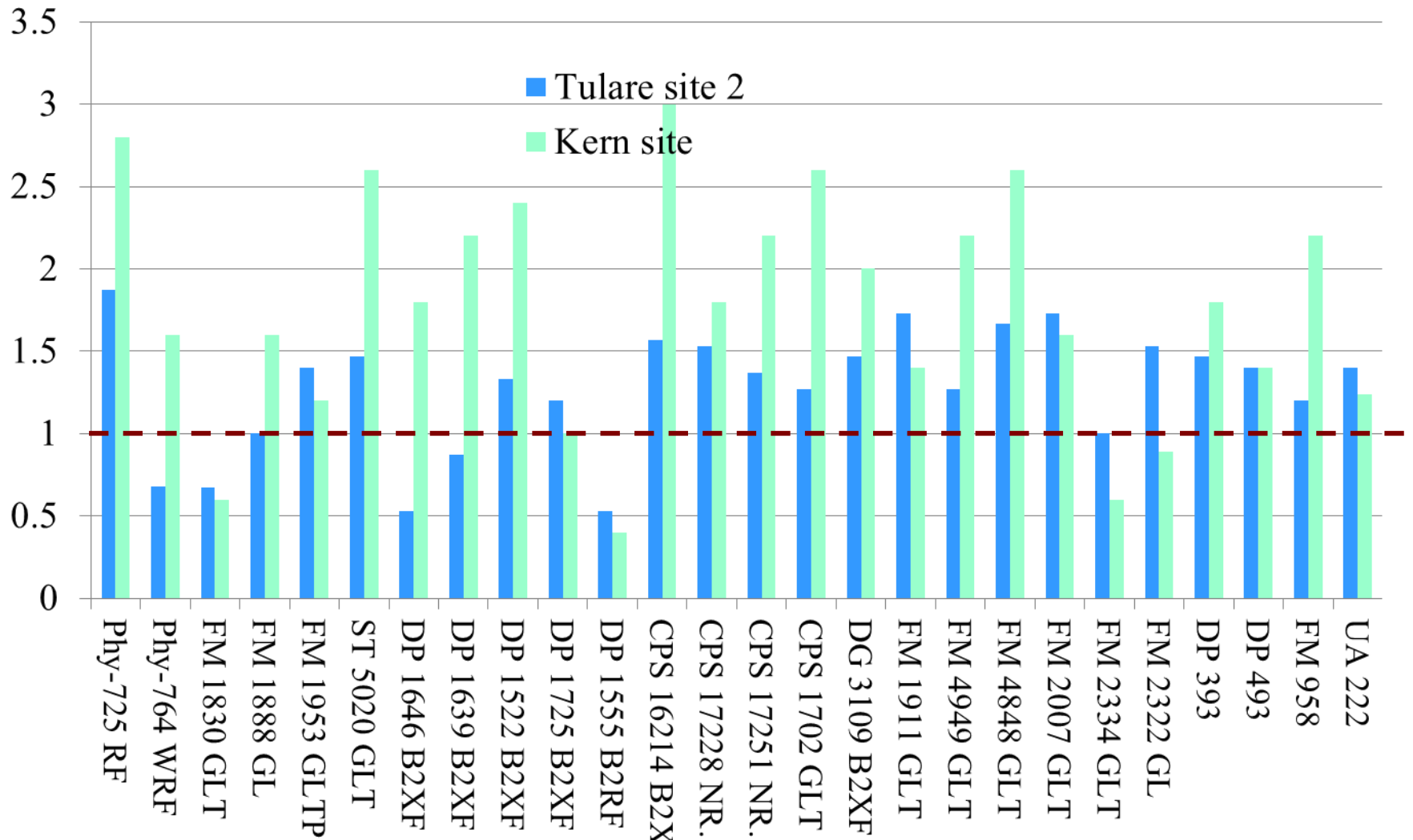
Experimental Uplands (*Bayer Crop Sci.*) – 2016 – group #2

Root vascular staining index - evaluations at two sites



Commercial Uplands (various companies) – 2017

Root vascular staining index - evaluations at two sites



SUMMARY

- Fusarium race 4 recognized for about 14 years now in CA
- Commercially-available cultivars, company experimentals, and public breeder program entries (RBTN) continue to be field screened in highly FOV-4 infested fields as part of our overall efforts.
- Over the years, the cross-section of Pima varieties tested have represented some of the most susceptible & damaged cultivars, while other Pimas have typically been the most tolerant and least damaged (**status**: *addt'l Pimas with improved tolerance identified each year*).
- Uplands (*G. hirsutum*s) tested to date have been consistently and broadly infected and susceptible to FOV-4 in highly-infested fields, and capable of reproducing inoculum and expanding the problems. (**status**: *some cultivars submitted for testing have shown lower vascular staining ratings and higher survival %, particularly past 3 years*).
- This screening data has been made available to companies and public breeders for their use in advancing germplasm in their programs.

**Further information on cultivar screening results
(plus symptoms, containment recommendations)
available on UC cotton web site:**

<http://cottoninfo.ucdavis.edu>

Thank you

*University of California Cooperative Extension
& UC Davis Plant Science Dept.*



Hutmacher, Ulloa, Wright et al -
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