

# Phenotypic and Molecular Variation in 44 Vintage Tomato Varieties

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## Heirloom tomatoes:

- appealing through their diverse range of color, size, shape, texture and flavor
- largely unimproved for traits such as yield or disease resistance
- as such they have attracted efforts of breeding for niche markets



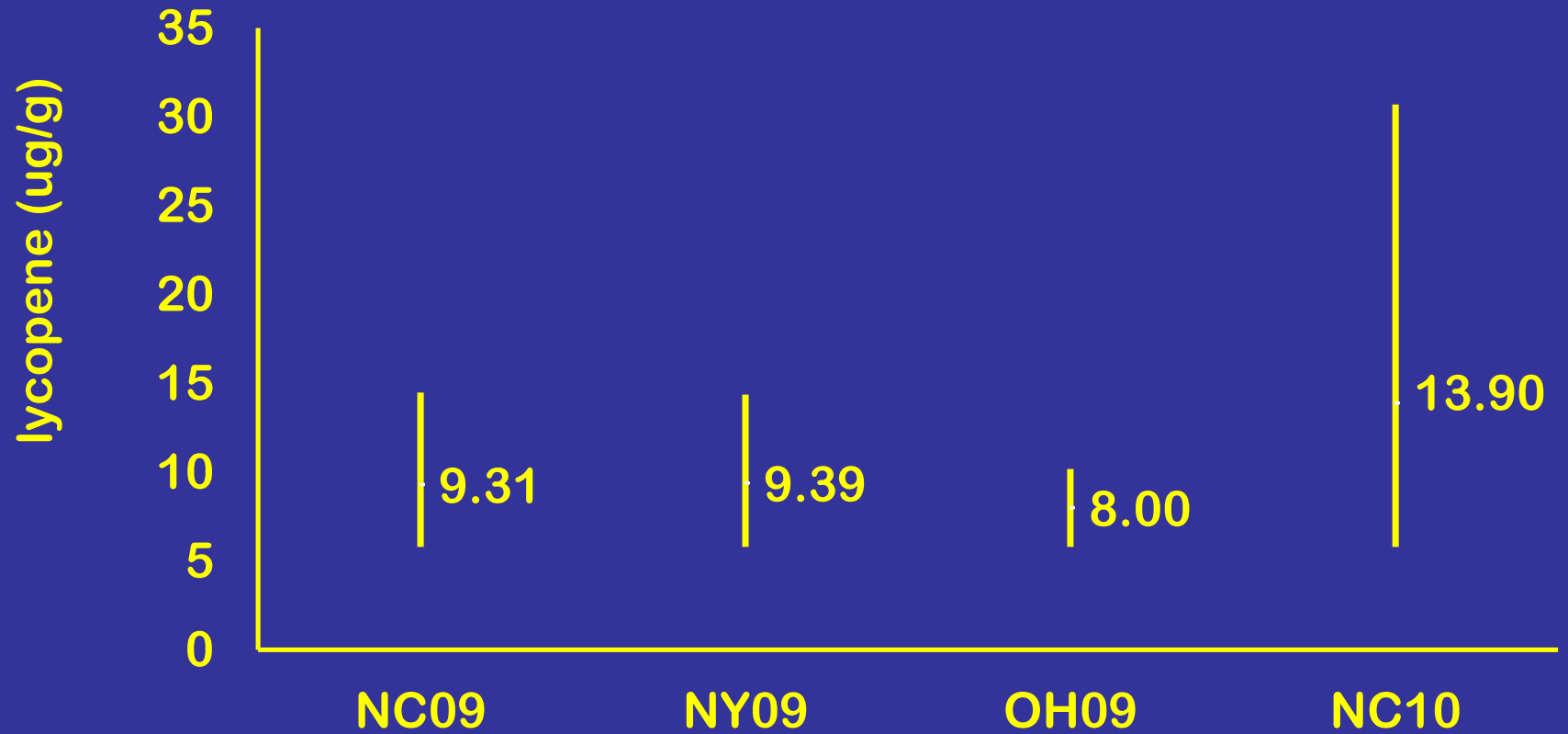
The National Plant Germplasm System (NPGS) Plant Genetic Resources Unit (PGRU) holds the largest public tomato (*Solanum lycopersicum* L.) collection in the U.S., many of which are heirlooms. Characterization of the collection will increase its efficiency of use.



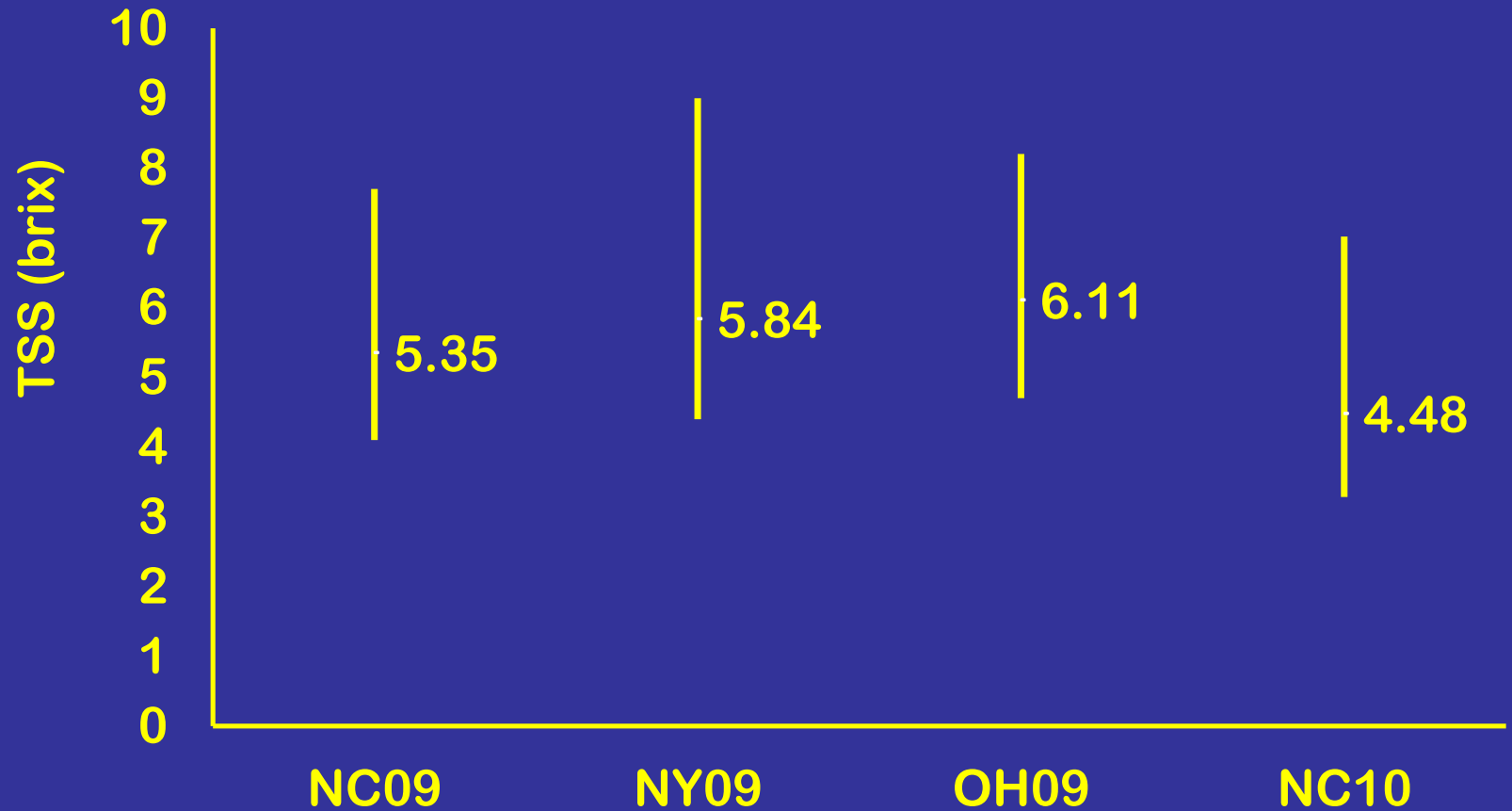
- 44 heirloom varieties (SolCAP panel), replicate plots in OH, NC, NY (2009), NC (2010)
- scored highly heritable horticultural traits
- scanned fruit for Tomato Analyzer
- fruit quality traits: lycopene, total soluble solids, ascorbic acid (Vit C), titratable acid



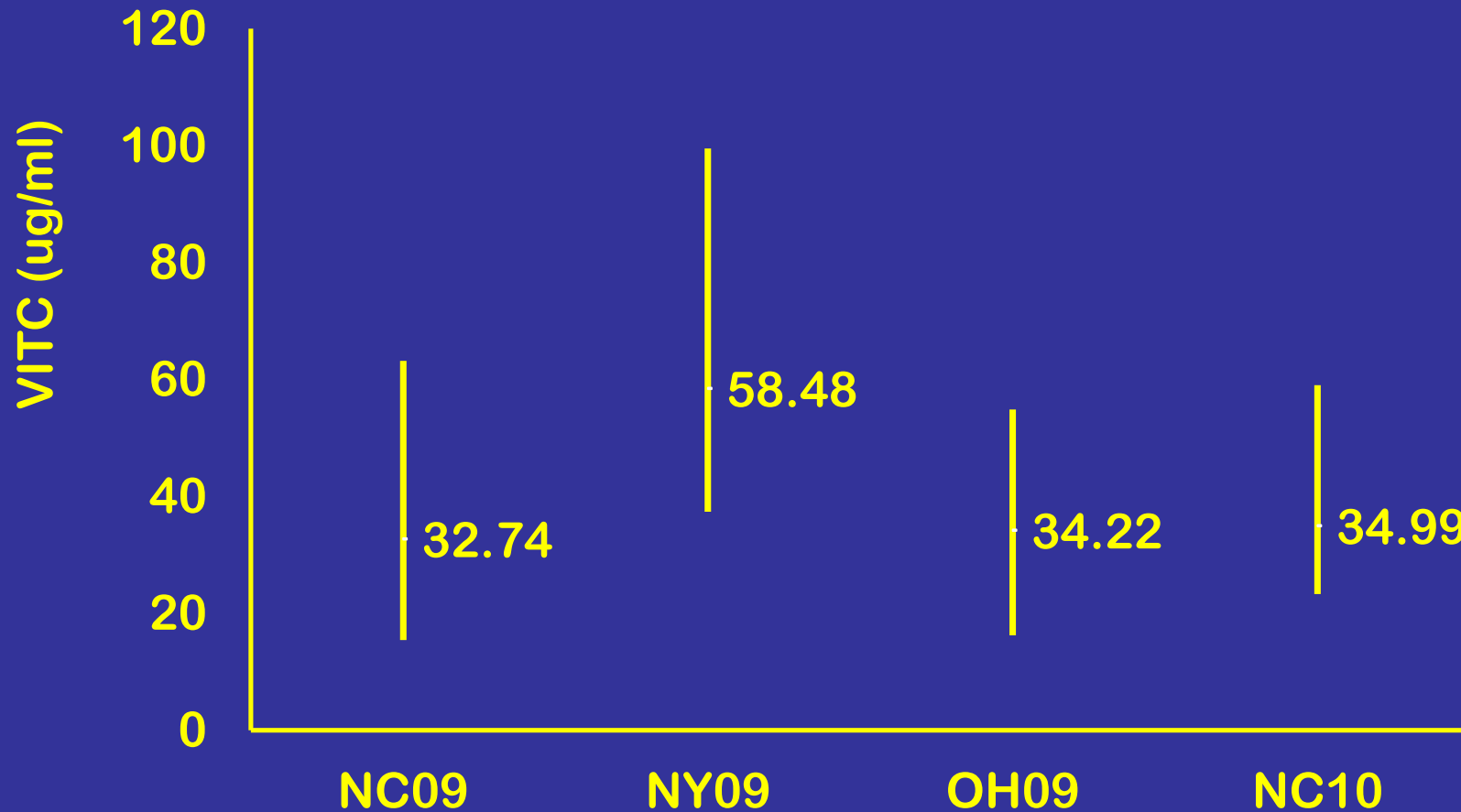
# trait values across 4 environments • LSmean (min, max)



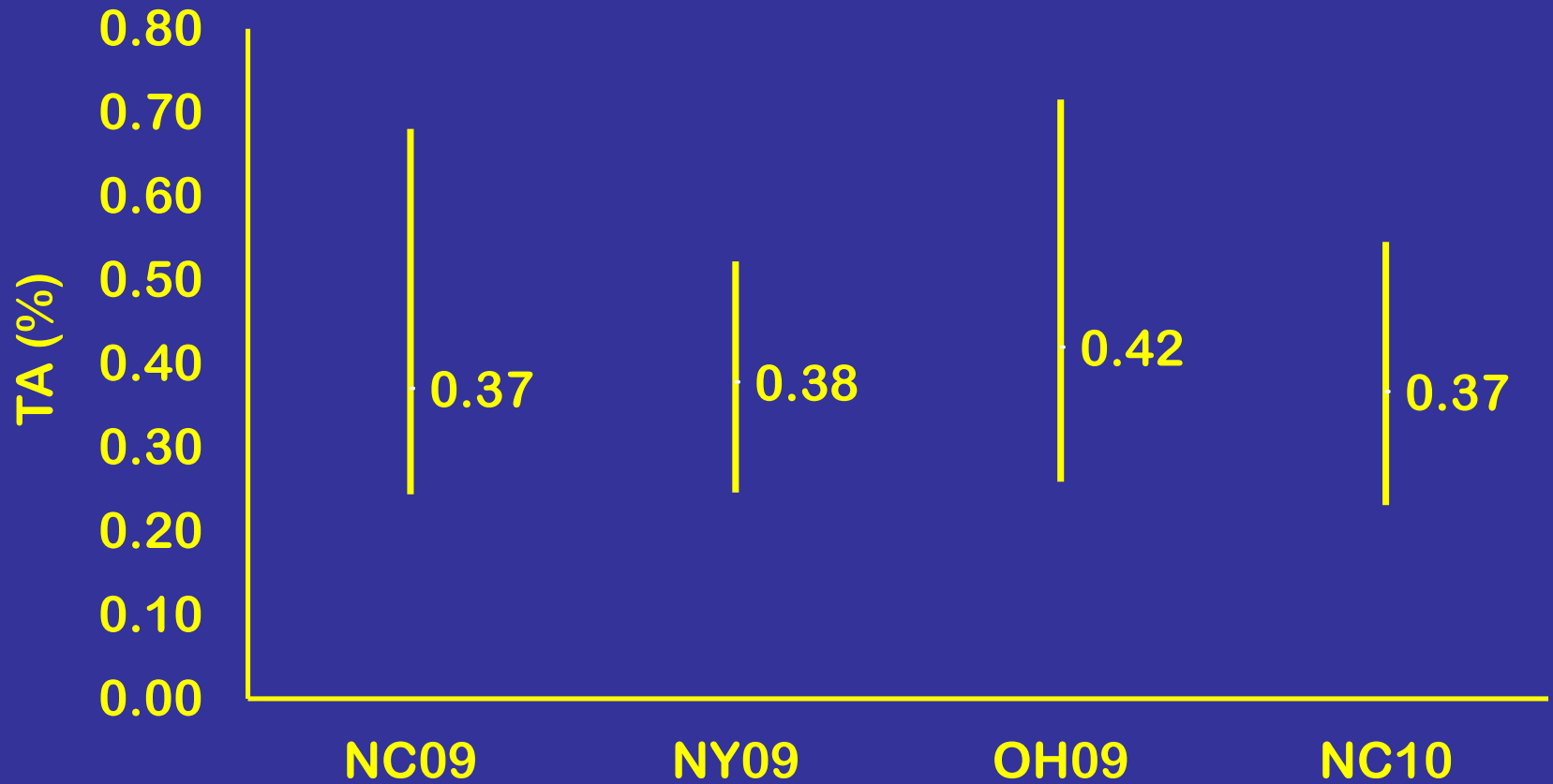
# trait values across 4 environments • LSmean (min, max)



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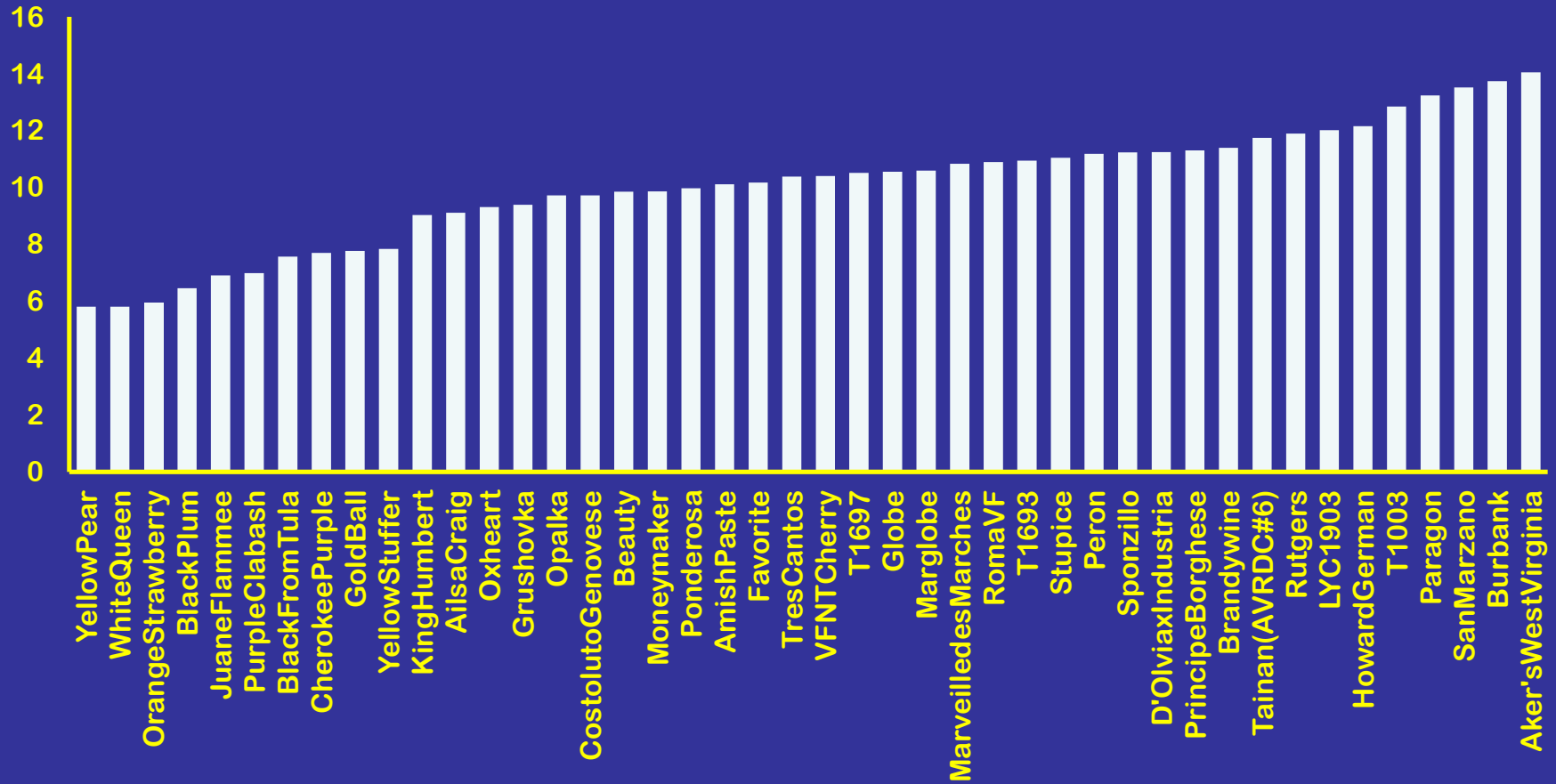
# trait values across 4 environments • LSmean (min, max)



# Mean trait values

## 44 entries across 4 environments

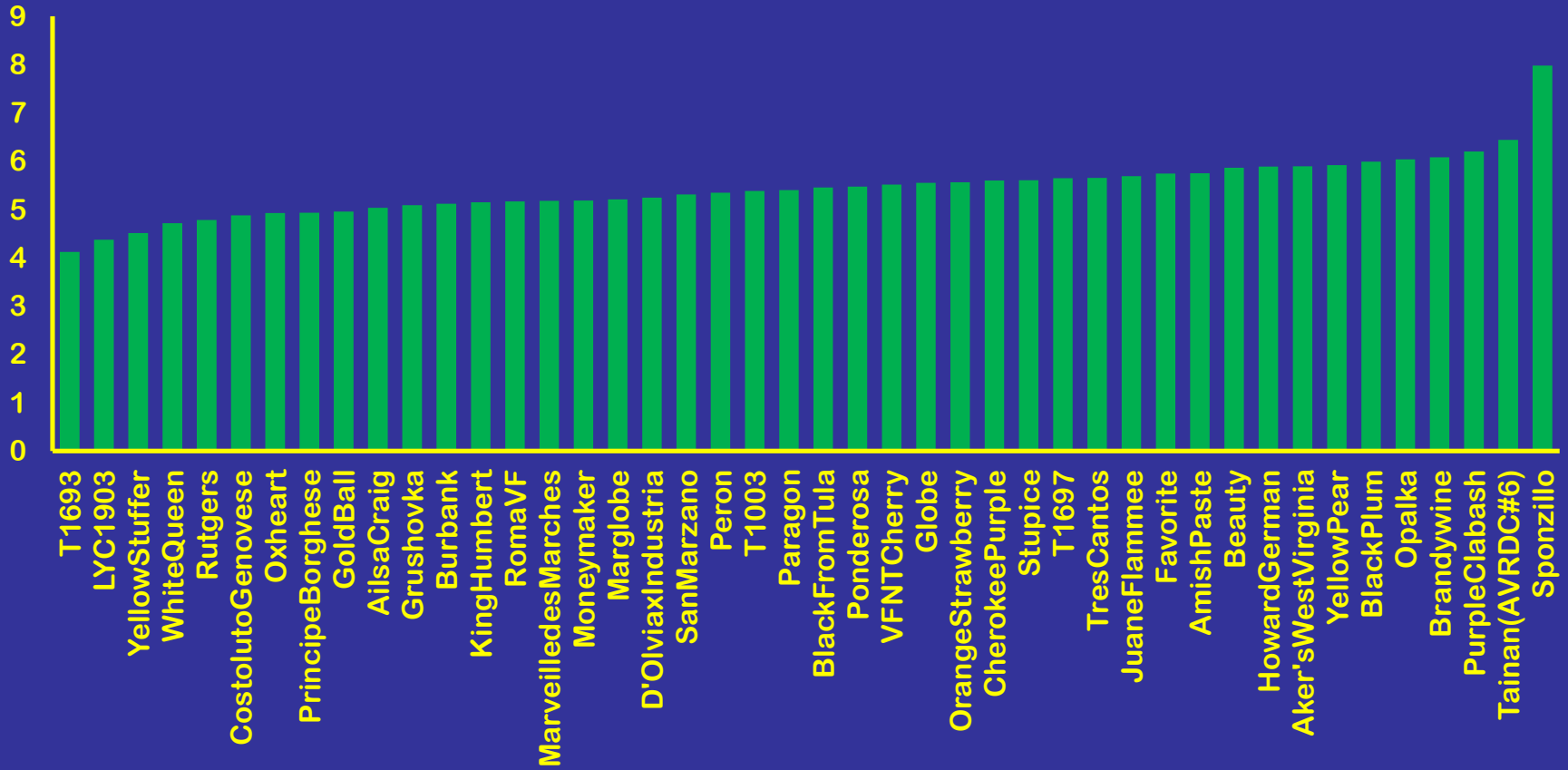
### Lycopene (ug/g)



# Mean trait values

44 entries across 4 environments

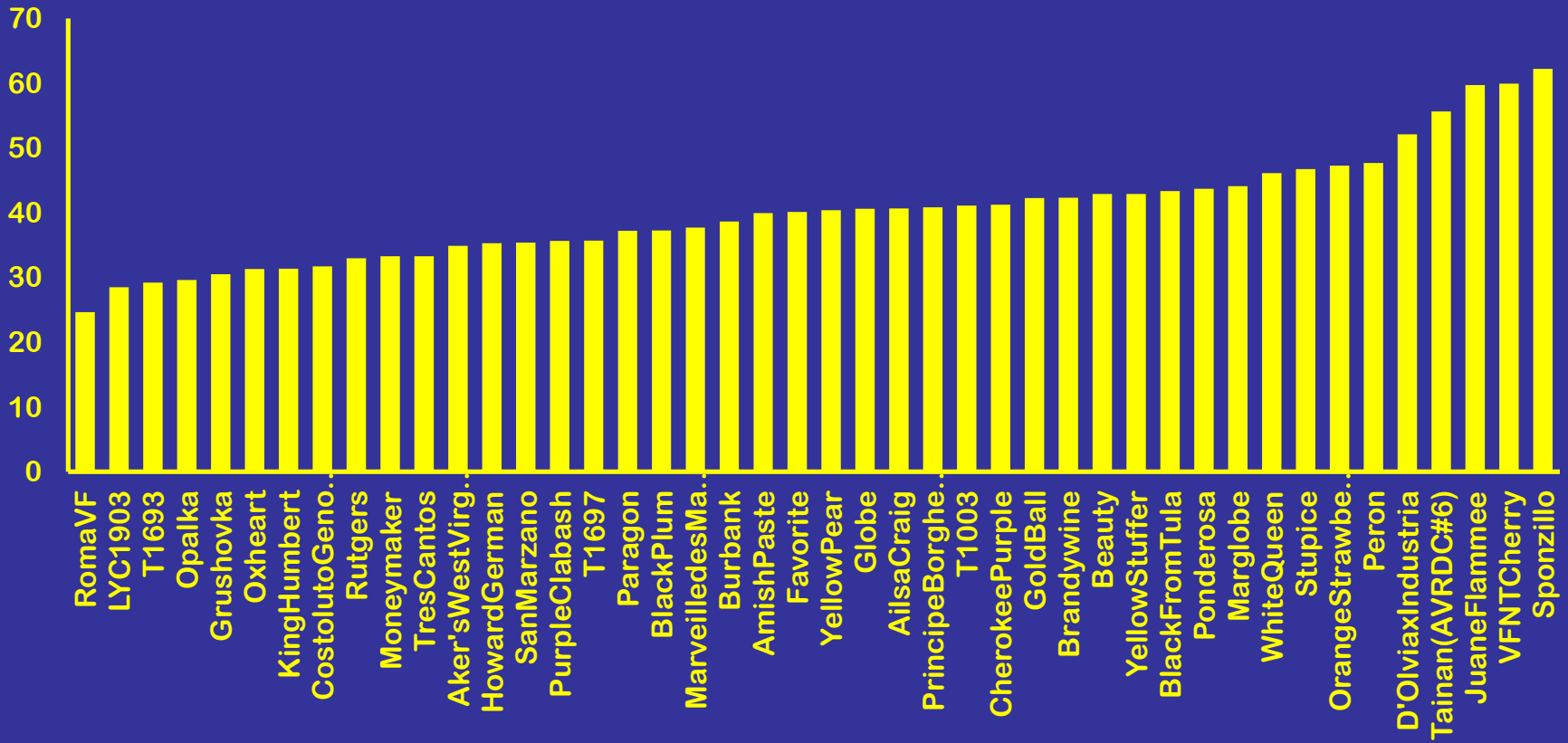
## TSS (brix)



# Mean trait values

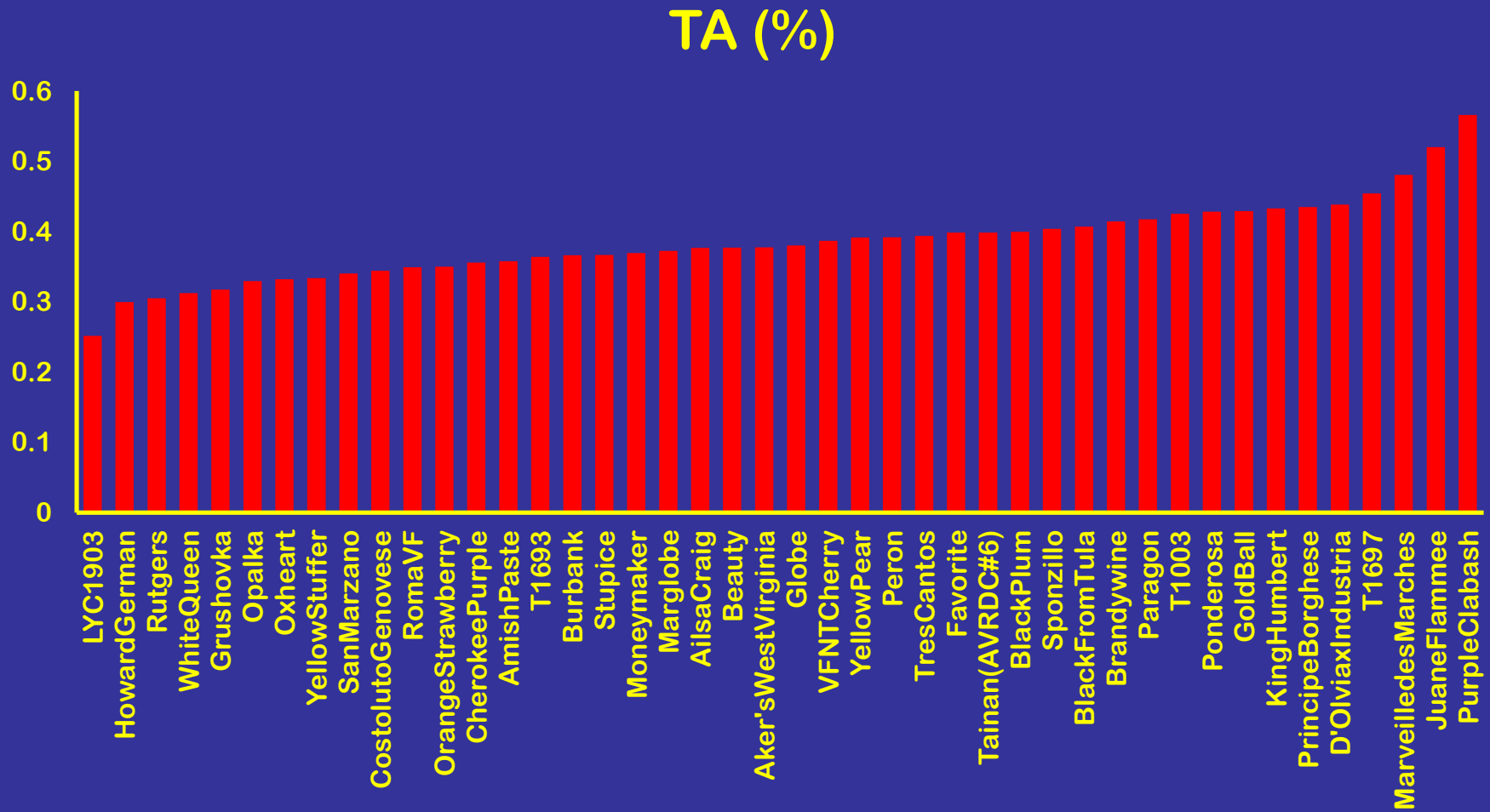
44 entries across 4 environments

VITC (ug/ml)

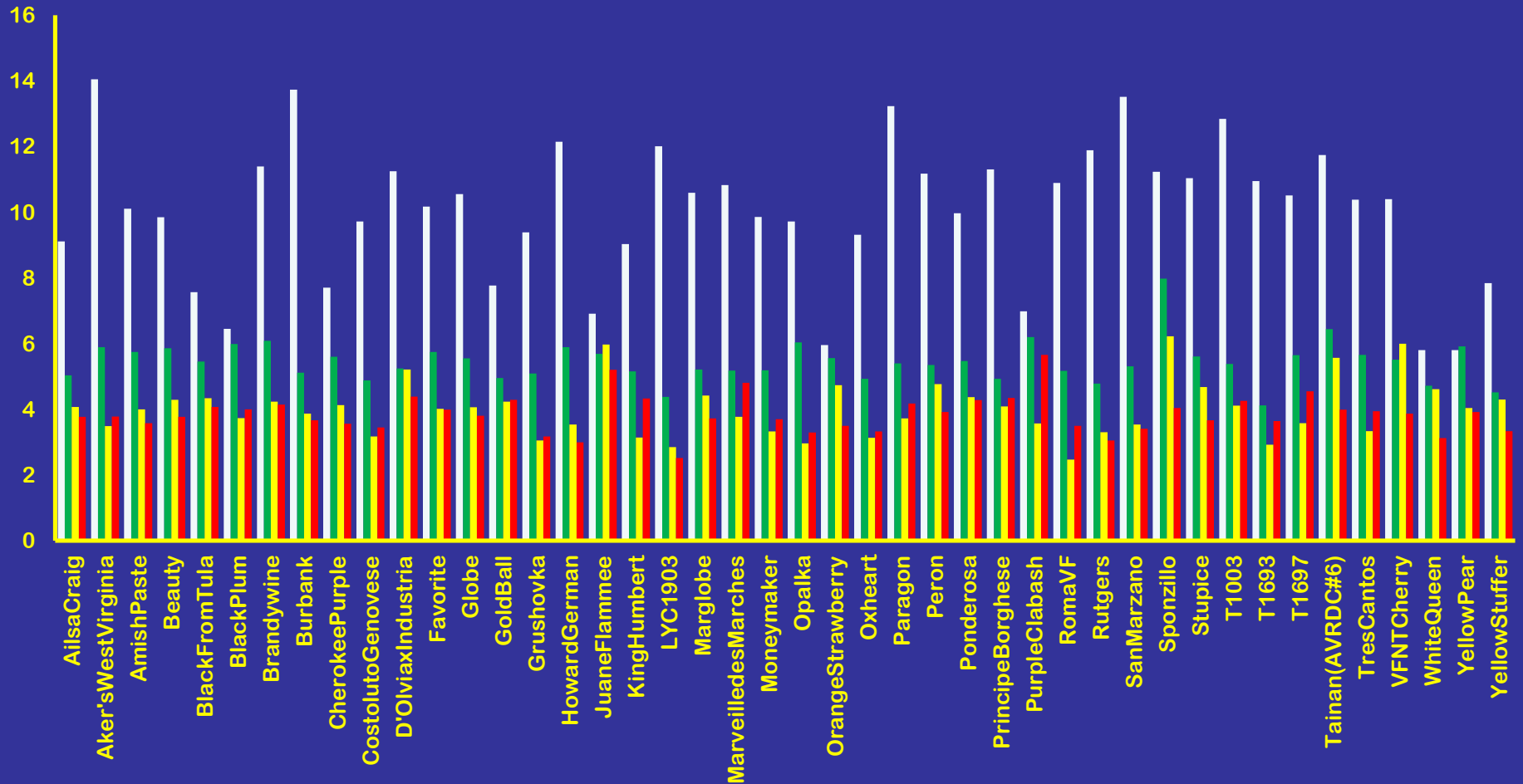
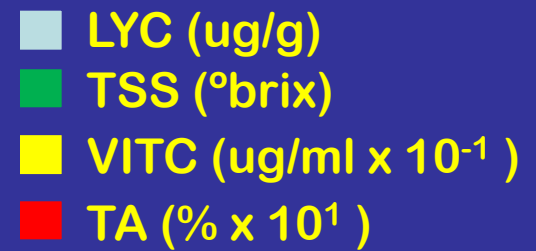


# Mean trait values

## 44 entries across 4 environments



# Mean trait values 44 entries over 4 environments



## ANOVA, 44 entries x 4 locations

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Source	df <sup>a</sup>	VITC	LYC	TA	TSS
Genotype	43, 164	8.07***	2.05***	8.89***	10.96***
G x E	127, 164	6.18***	1.84***	2.63***	5.03***

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<sup>a</sup> numerator, denominator degrees of freedom

## Descriptive statistics and heritability estimates for fruit quality traits in 44 vintage varieties of tomato

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Trait	Mean	Min	Max	StDev	Heritability (%)
LYC (ug/g)	10.2	5.8	50.9	4.9	49.8
TSS (%)	5.5	2.9	9.0	1.0	88.7
VITC (ug/ml)	40.4	8.9	104.6	16.2	79.9
TA (%)	0.4	0.2	0.8	0.1	73.9

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**Genetic (below diagonal) and phenotypic (above diagonal) correlation coefficients of 44 entries across 4 environments**

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	<b>LYC</b>	<b>TSS</b>	<b>VITC</b>	<b>TA</b>
<b>LYC</b>		<b>0.01</b>	<b>-0.15</b>	<b>-0.11</b>
<b>TSS</b>	<b>-0.02</b>		<b>0.49</b>	<b>0.29</b>
<b>VITC</b>	<b>-0.28</b>	<b>0.53</b>		<b>0.37</b>
<b>TA</b>	<b>-0.16</b>	<b>0.27</b>	<b>0.52</b>	

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## Diversity estimates of tomato germplasm based on SNP markers

Germplasm sample <sup>a</sup>	<i>n</i>	No. SNP markers	$H_e$	$F$	Freq of major allele
1) Vintage	44	18	0.110	0.827	0.895
2) Vintage	20	86	0.076	0.798	0.835
3) Geodiversity	50	68	0.199	0.717	0.848
4) Geodiversity	30	49	0.171	0.965	0.852

<sup>a</sup> 1) current study, 2) Sim et al. 2011, 3) Baldo et al. 2011, 4) Labate et al. 2011

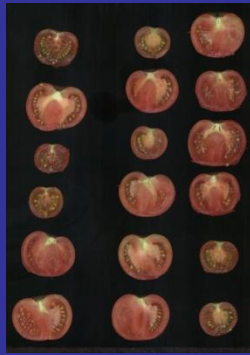
# High resolution scans for Tomato Analyzer



Sponzillo



Purple Clabash



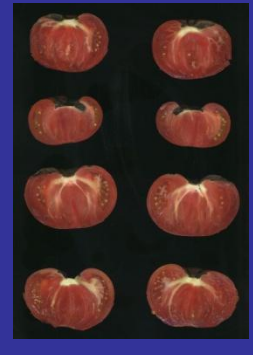
Marveille des Marches



Howard German



Juane Flammee



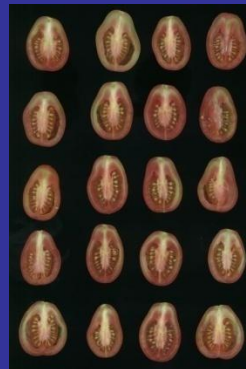
Brandywine



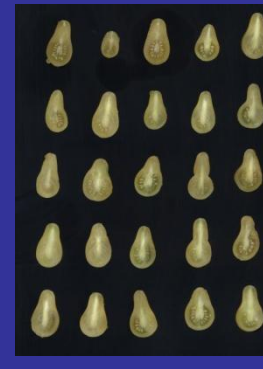
Opalka



Aker's West Virginia



King Humbert

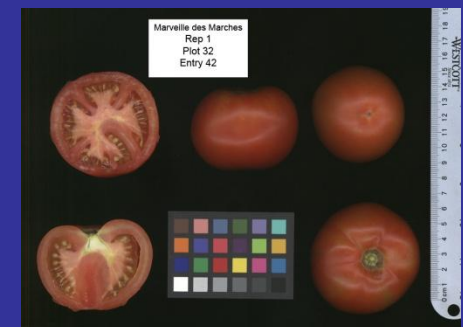
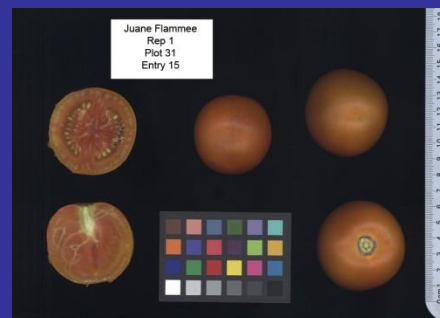
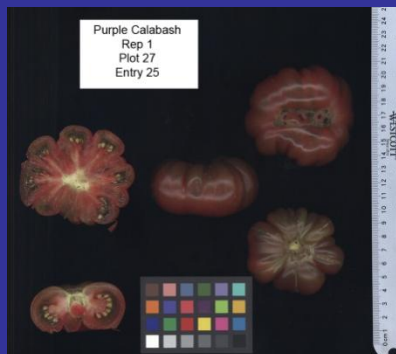
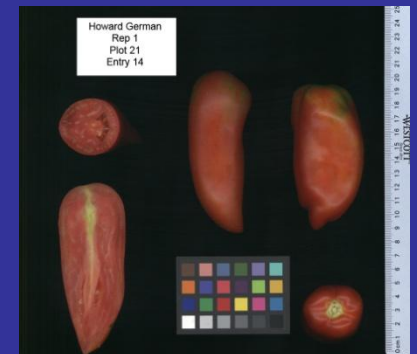
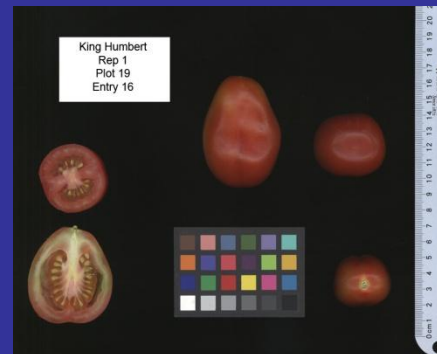
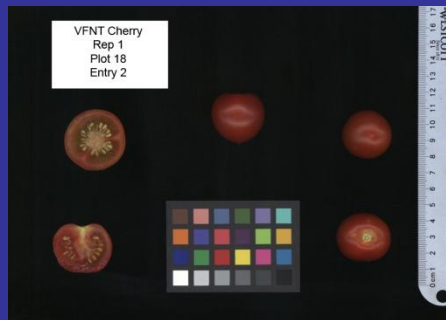
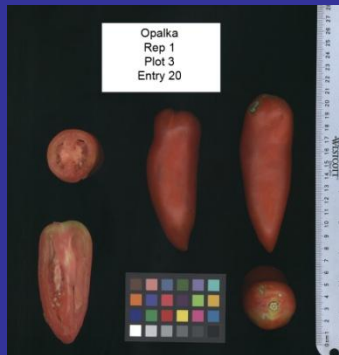


Yellow Pear

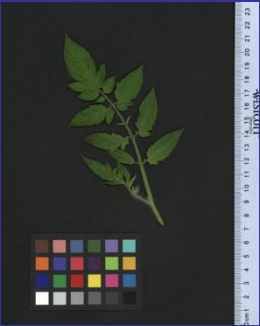


VFNT Cherry

# Digital images for GRIN database



# Digital images for GRIN database



**Marveille des Marches**



**Yellow Pear**



**Juane Flamme**



**VFNT Cherry**



**King Humbert**



**Brandywine**



**Howard German**



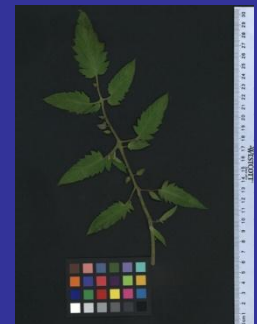
**Aker's West Virginia**



**Purple Clabash**



**Sponzillo**



**Opalka**

## Summary

- Four fruit quality traits were assayed for 44 heirloom tomato varieties in replicate plots, 4 environments
- Extensive variation among entries, significant Genotype and GxE effects for all traits
- All traits showed high heritability (50-89%)
- Traits were positively correlated with the exception of lycopene
- Molecular genetic diversity estimates were similar to tomato geodiversity samples
- Phenotypic characterization data of 44 tomato heirloom varieties will be available in GRIN <http://www.ars-grin.gov/>
- Accessions have been regenerated and are listed in PGRU Tomato Core Set  
<http://www.ars.usda.gov/SP2UserFiles/Place/19100500/TomatoCoreListing.pdf>

*Thank you!*

PGRU

T. Balch  
S. Tennies  
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PFRU

B. Cain



Cornell Univ  
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NC State Univ  
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