

Genetic variation in heirloom versus modern tomato (*Lycopersicon esculentum*) cultivars
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The genetic base of commercial U.S. cultivars for certain crops is believed to be relatively narrow because of decades of intense selection, and oftentimes breeding for phenotypic uniformity. The National Plant Germplasm System provides food security by conserving genetic diversity within species, from which novel traits and resistances to biotic and abiotic stresses can be sought out as needed. Cultivated tomato (*Lycopersicon esculentum*) is known to be highly monomorphic at the molecular level although it is phenotypically very diverse. We will compare molecular genetic and phenotypic variation of 13 American Heirloom cultivars versus 12 modern commercial hybrid cultivars. One to two plants per cultivar were genotyped at 8 microsatellite loci and phenotypic data were collected on traits such as growth habit, leaf type, flowers per inflorescence, days to maturity, fruit appearance, fruit weight, and fruit set number. Results from this pilot study will be used to design a more comprehensive study to characterize our collection of tomato accessions. We wish to determine how much diversity resides within the tomato collection at PGRU, and how it is organized within and among accessions.

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Rationale

- The genetic base of commercial U.S. cultivars for certain crops is believed to be relatively narrow because of decades of intense selection, and oftentimes breeding for phenotypic uniformity.

- We compared molecular genetic and phenotypic variation of 13 American Heirloom versus 12 modern commercial hybrid tomato cultivars (Table 1). We obtained preliminary data addressing the question of whether there is less genetic variation in modern tomato cultivars compared to what U.S. farmers were growing in the late nineteenth and early twentieth centuries.

- Decreases in genetic variation can lead to monoculture and increased vulnerability to biotic and abiotic stresses. Also, there may be favorable alleles for improvement that have been unintentionally excluded from the modern commercial tomato gene pool.

Table 1. Tomato cultivars genotyped and phenotyped in this study.

Entry	Name	ID	type
1	San Marzano	G14594	heirloom
2	Earliana	P1212421	"
3	Break O'Day	P1212437	"
4	Hoffman Globe A	P1254659	"
5	Baltimore	P1270171	"
6	Bonnie Best	P1270172	"
7	Ailsa Craig	P1286251	"
8	Golden Glow	P1303736	"
9	Immuna	P1347239	"
10	Mini Red Current	P1368168	"
11	Mini Red Plum	P1368170	"
12	Santa Cruz	P1429835	"
13	Ace	P1433066	"
14	Better Boy	commercial	modern
15	Pink Girl	"	"
16	Husky Gold	"	"
17	Husky Red	"	"
18	Moreton Hybrid	"	"
19	Sunleaper	"	"
20	First Pik	"	"
21	Jet Star	"	"
22	Supersonic	"	"
23	Celebrity	"	"
24	Primetime	"	"
25	Big Beef	"	"

Table 2. Diversity statistics of heirloom and modern tomato cultivars based on eight SSR loci^a.

Type	sample size	%Poly	Alleles	He ^b	Ho ^c	private alleles
heirloom	13.00	0.875	3.375	0.445	0.048	9
modern	11.13	0.750	2.750	0.356	0.266	4

^a TMS56, TMS1, TMS26, EST253712, TMS29, TMS34, TMS4, TMS42.

^b Expected heterozygosity.

^c Observed heterozygosity.

Table 3. AMOVA of heirloom versus modern tomato cultivars based on eight SSR loci^a.

Source of variation	d.f.	Sum of squares	Variance components	Percentage of variation	P-value
Between types					
heirloom vs. modern	1	3.077	0.06317	4.04	0.233
Within types	48	72.003	1.50007	95.96	
Total	49	75.080	1.56324		

^a TMS56, TMS1, TMS26, EST253712, TMS29, TMS34, TMS4, TMS42.

Table 4. AMOVA of heirloom versus modern tomato cultivars based on 22 phenotypic traits^a.

Source of variation	d.f.	Sum of squares	Variance components	Percentage of variation	P-value
Between types					
heirloom vs. modern	1	8.837	0.38494	8.71	0.002
Within types	23	92.763	4.03317	91.29	
Total	24	101.600	4.41810		

^a Growth habit, canopy size, flowers per inflorescence, maturity, leaf type, inflorescence type, fruit set no., ext. color imm. fruit, ext. appear. mature fruit, shoulder color, int. flesh color mat. fruit, mat. fruit int. color intensity, fruit shape, pistil scar, ext. color mat. fruit, fruit firmness, nipped fruit, jointless, radial cracking, concentric cracking, cuticle cracking, uniformity of fruit size. All traits were considered together as a profile and analyzed using an AMOVA in Arlequin.



Fig. 1. Principle components analysis based on presence/absence of alleles at eight SSR loci in 25 tomato cultivars.

Conclusions

- No significant differences were found in molecular genetic variation between heirloom and modern types in tomato (Tables 2, 3). However, sample sizes were small and trends indicated that the heirlooms may contain more rare alleles than the modern type.

- Heirloom and modern types appear to be genetically diverged in a principle components analysis of genotypes (Fig. 1).

- There was a small but statistically significant difference in phenotypic variation between heirloom and modern types, with 8.71% of the variation found between types (Table 4).

- These techniques will be useful to apply to tomato cultivars, to explore the question of whether genetic diversity has recently decreased in cultivated tomato.

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