Processing Tomato Breeding and Genetics Research 2002.

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Introduction

The Ohio State University/OARDC tomato breeding and genetics research program is focused on variety and breeding line development for the processing industry in the Mid-West and Mid-Atlantic states. The long-term sustainability of plant breeding efforts requires the identification of new sources of genetic variation and new traits. My research therefore devotes efforts to developing new populations to expand our base of useful genetics. Developmental research has centered on structuring populations for simultaneous trait identification, genetic mapping, and breeding.

Breeding New Varieties and Parental Lines for the Great Lakes Tomato Industry

The 2002 growing season was marked by early rains followed by lower than normal precipitation. Despite adverse conditions, varieties in the OX three hundred series performed well in plot trials and in limited strip trials. Varieties OX323 and OX325 were approved for release and I am working with OSU's Office of Technology Licensing to identify a commercial partner or partner for these varieties. Characteristics of OX323 and OX325 that support their release are excellent yield, field holding, and firmness. Both varieties mature late in the season and both have good to excellent color and color uniformity.

Table 1. Summary statistics for processing quality traits (three year data for 2000, 2001, 2002). Data are ranked by L-dif, one measure of color uniformity. More detailed results and statistics will be posted under "current research" at www.oardc.ohio-state.edu/tomato.

	Color										S. Solids		%			
Genotype	L	rank	Hue	rank	Ldif	rank	Hdif	rank	pH	rank	BRIX	rank	Cracked	rank	Force	rank
H9423	42.96	19	40.30	2	3.12	1	4.03	1	4.28	2	4.89	9	23	14	5.97	1
TR12	40.88	5	43.17	11	3.26	2	4.97	4	4.28	2	5.11	4	33	18	5.21	7
OX23	41.40	12	42.53	9	3.34	3	4.55	2	4.34	4	5.01	6	23	14	5.17	8
OX264	40.74	3	41.76	7	3.61	4	5.60	6	4.40	11	4.58	17	18	11	4.62	16
OX52	41.56	16	44.05	16	3.81	5	6.77	14	4.34	4	4.72	14	23	14	4.77	12
9242	39.43	1	40.23	1	3.82	6	4.78	3	4.43	17	5.18	3	50	19	4.50	21
OX323	42.59	17	43.77	13	3.85	7	6.50	12	4.40	11	4.85	11	3	2	5.43	2
7983	41.38	11	44.01	15	3.92	8	6.66	13	4.35	7	5.32	1	50	19	5.23	6
OX325	40.75	4	41.00	5	3.97	9	5.46	5	4.38	9	4.78	13	8	4	4.85	11
OX327	40.65	2	40.42	3	3.98	10	6.09	9	4.42	15	4.89	9	0	1	5.35	3
981670.2-2	41.30	9	44.36	18	4.04	11	6.13	10	4.39	10	5.03	5	10	5	4.76	13
OX324	41.50	14	42.14	8	4.21	12	5.94	7	4.41	14	4.97	7	5	3	4.94	10
OX328	41.45	13	43.33	12	4.21	12	7.22	18	4.42	15	4.54	19	23	14	4.63	15
PS696	42.78	18	44.97	20	4.25	14	6.80	15	4.25	1	4.83	12	18	11	5.25	5
FG98-52	41.55	15	44.51	19	4.26	15	7.36	21	4.44	19	5.19	2	15	10	4.62	16
OX150	41.30	9	44.24	17	4.37	16	6.81	16	4.36	8	4.58	17	20	13	4.67	14
OX331	41.05	7	40.78	4	4.44	17	5.99	8	4.40	11	4.71	15	10	5	5.09	9
OX329	40.90	6	42.85	10	4.44	17	6.31	11	4.44	19	4.52	20	10	5	4.57	19
987034-1	43.16	20	45.91	21	4.57	19	7.34	19	4.43	17	4.63	16	13	8	4.56	20
E3259	41.17	8	41.08	6	5.06	20	7.02	17	4.47	21	4.25	21	nd	nd	4.62	16
8245	43.39	21	43.99	14	5.10	21	7.35	20	4.34	4	4.96	8	13	8	5.35	3
Mean	41.52		42.83		4.078		6.175		4.38		4.835		18.4		4.96	
LSD (0.05)	1.718		2.48		0.833		1.711		0.067		0.304		25.12		0.409	
LSD (0.30)	0.904		1.304		0.438		0.9		0.035		0.159		12.76		0.215	

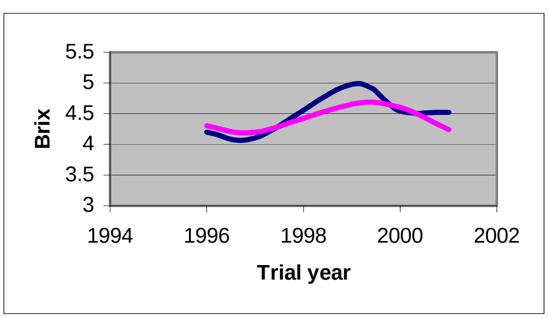
Table 2. Field performance data based on once-over mechanical harvesting in Fremont, OH (2000, 2001, 2002).

Genotype	Tons per acre (ripe)	rank	Tons per acre (potential)	rank	% Green	rank	% Cull	rank	Avg Fruit Weight (ounces)	rank	Folliear Disease Index (0-3)	rank	Fruit Rot Index (0-3)	rank	Blossom End Rot Index (0-3)	rank
OX331	44.0	1	51.1	2	12.8	11	5.4	10	2.2	5	1.3	4	1.3	15	0.0	1
OX328	44.0	2	51.0	3	11.5	6	6.9	16	2.0	18	1.4	13	0.9	3	0.0	1
OX325	43.8	3	51.6	1	15.8	18	4.6	5	2.3	4	1.2	3	1.3	15	0.0	1
981670.2-2	43.8	4	50.6	4	11.5	6	5.7	11	2.0	15	1.1	2	0.9	3	0.0	1
FG98-52	42.5	5	48.8	6	12.2	9	4.2	4	2.1	11	1.4	13	0.9	3	0.0	1
PS696	42.3	6	45.9	8	10.9	4	6.5	15	2.2	9	1.3	4	1.4	19	2.1	15
OX323	39.8	7	44.6	12	11.9	8	4.0	3	2.1	12	1.4	13	1.0	10	0.0	1
OX329	39.2	8	45.3	11	9.2	3	10.6	20	2.0	19	1.4	13	0.9	3	0.0	1
8245	39.0	9	43.7	14	8.9	1	6.1	12	2.2	10	1.3	4	1.2	13	1.0	12
OX327	38.7	10	48.6	7	20.7	21	5.1	8	2.2	5	1.3	4	1.0	10	0.1	11
OX324	38.7	11	49.4	5	20.4	20	3.9	2	2.4	3	1.0	1	1.2	13	0.0	1
OX23	38.6	12	45.4	10	12.7	10	6.3	13	2.0	17	1.5	18	0.9	3	5.3	20
OX150	38.4	13	45.5	9	13.4	13	5.3	9	2.1	13	1.5	18	0.9	3	2.3	16
987034-1	37.9	14	43.9	13	8.9	1	11.9	21	2.0	14	1.3	4	1.3	15	0.0	1
OX264	36.0	15	41.8	15	11.1	5	7.5	17	1.8	21	1.4	13	0.4	1	1.1	13
E3259	33.7	16	39.5	17	13.2	12	7.7	18	2.2	5	1.7	20	1.4	19	0.0	1
OX52	33.2	17	41.7	16	15.6	17	2.3	1	1.9	20	1.3	4	0.8	2	2.3	16
TR12	32.9	18	38.9	18	14.7	16	5.0	7	2.0	15	1.3	4	0.9	3	3.5	19
9242	30.6	19	36.3	19	13.6	14	9.6	19	2.4	2	1.3	4	1.4	19	1.8	14
7983	28.7	20	35.8	20	13.7	15	4.7	6	2.2	5	1.3	4	1.0	10	5.3	20
H9423	27.7	21	33.3	21	16.9	19	6.4	14	2.4	1	1.8	21	1.3	15	2.9	18
Mean	37.8		44.4		13.3		6.2		2.1		1.4		1.1		1.3	
LSD (0.05)	8.3		8.4		5.4		5.1		0.2		0.4		ns		ns	
LSD (0.30)	4.2		4.3		2.8		2.7		0.1		0.2		ns		ns	

Past progress and future improvement goals

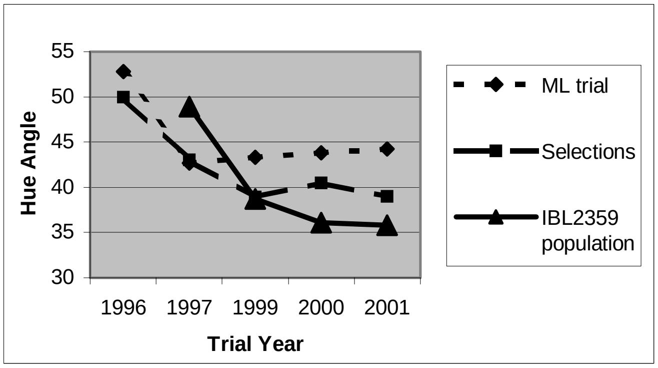
Improvements in color, color uniformity, and firmness have come at the expense of soluble solids (Figure 1 and Figure 2). Our progress in developing breeding stock with improved color has not reached a plateau (Figure 2), and we are therefore modifying selection efforts in order to increase soluble solids.

Figure 1. Graphical indication of soluble solids. Solids have decreased in our breeding populations since 1999 indicating a need to select more intensively for BRIX value.



Blue line represents “observation harvest trial” of 72 varieties and checks.
Pink line represents “multi-location trial” of 36 varieties and checks.

Figure 2. Improvement in color is indicated by a decrease in Hue values. We have made steady progress in developing populations to improve color and lycopene content.



Development of new disease resistance

Bacterial Canker. Gitta Coaker, a graduate student, has helped us understand how we can incorporate resistance to bacterial canker into the breeding program by helping us understand the action of resistance. Two genes interact to produce resistance, and both are associated with negative characteristics. The highest resistance will come from pyramiding genes on chromosome two and five. Gitta's work has helped to identify breeding lines that retain resistance, but no longer have the negative characteristics of small fruit size and very low seed set that was associated with resistance in the wild donor.

Bacterial Spot. The successful development of resistance from Hawaii 7998 is being aggressively followed by a project that aims to develop a broader based resistance from PI114490. Populations have been screened and we have moved into the second phase of this effort, the identification of parental lines (Table 3). We expect to select new breeding lines with resistance or tolerance in 2003 and expect to begin yield and quality trials by 2004. This project is year ahead of schedule. Lines that combine tolerance to race T1 and resistance to bacterial speck will enter trials in 2003.

Table 3. Disease and yield ratings from field trials inoculated race T2 strains of bacterial spot pathogen.

Genotype	Average Disease (T2) (as male, female, self)	Yield Index	
PI114490	1.50	1.75	
2k15949	3.57	3.13	
BR7087	4.46	5.50	
2k16027	4.62	8.25	***
2k15882	4.68	7.50	jtd
BR7055	4.86	7.50	***
OH 987034	4.88	6.25	
OH 8245	5.10	8.13	
BR7069	5.11	6.83	
OH 7870	5.23	7.50	
2k15887	5.29	5.00	jtd
2k16033	5.36	7.63	
BR7164	5.39	6.83	
OH 88119	6.41	6.75	
Ha7981	6.50	3.38	
Ha7998	7.00	5.00	
Mean	4.97	6.06	
LSD 0.05	1.76	0.9499	

Managing Quality in Tomatoes for Processing

Last year with the assistance of an award from the USDA/IFAFS grant program we begun collaborative efforts to help growers manage new varieties for optimum quality. We are devoting most of our efforts to the management of color disorders through variety choice, soil tests to select growing locations, and nutrient management. Internal white tissue, yellow eye, yellow shoulder, and green shoulder represent a range of symptom severity for a single problem, Yellow Shoulder Disorder (YSD). Developmental abnormalities include a reduction in cell size and a more random arrangement of cells in the sectored tissue. The green chloroplasts in YSD tissue fail to develop into red chromoplasts. These alterations are triggered very early in fruit development and are not reversed by delaying harvest.

The key to successful management strategies is to treat the problem before we see it in the field. Climate, field conditions, and variety all contribute to the occurrence and severity of YSD. Probable causes of weather related YSD are the effect of rain and temperature on root growth, the efficiency of nutrient mining, fruit development, and pigment development. Other than supplemental irrigation, there is very little that can be done to manage weather-related causes of YSD. Some contributing factors can be managed. Location effects that have been correlated with YSD are available potassium (K), available magnesium (Mg), available calcium (Ca), organic matter, soil pH, and soil fixation capacity. The predictive equations developed by Hartz and co-workers in California are showing utility to our diverse soils and growing conditions. Results from these studies are summarized under the "managing color disorders" link at http://www.oardc.ohio-state.edu/tomato. The web site also contains some tools that will facilitate information and technology transfer related to color quality management.

Variety choice is important to management of color disorders

An interesting result from both 2001and 2002 was the fact that varieties that have proven to be uniform in our multi-year tests also showed a stronger correlation with the Hartz ratio (Table 2). The criteria that we use for classifying varieties as "uniform" or "non-uniform" correlate well with processor grades for a high percentage of number 1 tomatoes and low percentage of cull tomatoes. Varieties that are classified as uniform are less susceptible to YSD. We recommend that fields with a history of YSD or a high risk of YSD based on soil test results should not be planted to varieties that are considered non-uniform (for example PS696, Ohio 8245, or H9035). Varieties such as Heinz 9423, GEM 401, TR12, and OX23 are "uniform" varieties and provide excellent alternatives for high risk soils.

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Appendix. Trial Data From Multi-location trials.

Table 4. Two year summary for 2001 and 2002 ranked by yield

				Color[1]			
Genotype	T/A	Fruit wt oz	Brix	L	Hue	Ldif	Hdif
PS696	43.27	2.06	5.12	44.14	46.86	5.17	9.17
OX23	41.56	1.90	5.00	41.87	42.25	3.70	5.33
OX325	37.00	2.22	5.15	41.15	40.79	3.92	6.36
OX323	36.94	1.95	5.24	42.51	43.56	4.41	8.50
O8245	36.73	1.96	5.37	43.72	42.51	4.91	7.28
H9704	36.34	2.15	4.89	45.31	42.69	4.24	6.49
FG99-19	36.15	1.93	5.25	39.71	41.64	3.70	6.77
OX328	35.09	1.85	4.82	40.13	40.95	3.33	5.49
OX331	34.41	1.92	5.38	41.33	42.04	4.62	7.65
9816	32.44	1.98	5.70	41.65	42.63	3.88	5.82
OX327	32.20	1.99	5.25	40.26	38.7	2.89	4.61
PS2130	28.70	2.30	5.09	39.49	38.85	3.35	5.74
TR12	28.21	1.89	5.23	42.55	43.68	3.43	5.97
GEM818	27.99	2.10	5.16	42.39	40.99	3.36	4.93
FG99-15	27.38	2.23	5.64	38.25	37.09	2.76	3.09
H9423	27.33	2.19	5.21	44.04	40.9	3.86	4.97
O7983	26.24	1.99	5.48	42.92	44.17	4.13	6.92
GEM611	25.14	2.15	5.13	43.4	43.78	4.71	7.84
Mean	32.95	2.04	5.23	41.96	42.41	3.90	6.27
LSD 0.05	21.91	0.31	0.60	2.80	3.99	ns	ns
LSD 0.3	7.04	0.15	0.28	1.46	2.09	0.74	1.77

[1] Color traits are L for lightness to darkness, Hue for color, Ldif for internal white tissue, and Hdif for yellow shoulder disorder. Lower values are better color. Hue values have a high negative correlation with a/b ratio.

Table 5. Summary of yield data for 2002.

Genotype	Yield T/A	Rank	% Cull	Rank	Frt wt oz	Rank	Brix	Rank	Foliar Dis. index	Rank
FG00-118	46.5	1	1.94	2	2.13	18	5.23	20	0.5	10
FG99-24	42.5	2	7.26	29	2.00	26	5.6	7	0.33	8
H9704	40.5	3	6.55	27	2.12	19	4.9	34	0.67	16
OX23	40.5	4	5.25	21	1.84	35	4.97	32	0.5	12
PS696	39.5	5	3.84	9	2.14	17	5.17	22	0.33	6
FG99-36	39.0	6	8.18	31	2.19	13	5.08	27	0.25	2
FG99-44	38.0	7	6.44	26	2.08	22	4.72	36	0.58	14
OX325	37.0	8	4.38	13	2.18	15	5.17	23	0.5	9
GEM32	36.0	9	2.96	4	2.21	12	5.15	25	0.83	23
O8245	36.0	10	5.91	24	2.07	24	5.27	19	0.67	17
PS31212	35.0	12	4.38	14	2.28	6	5.75	4	0.33	4
FG00-117	35.0	11	11.01	34	2.18	14	5.03	29	0.83	24
FG00-119	34.5	13	5.86	23	1.78	36	5.15	24	0.58	15
FG99-42	33.0	14	8.03	30	2.66	1	5.37	15	0.58	13
OX323	32.5	15	5.57	22	1.93	28	5.35	16	0.5	11
OX328	31.5	16	10.06	33	1.95	27	4.87	35	0.83	26
FG00-115	30.0	17	5.05	20	2.25	9	5.05	28	0.33	5
FG00-125	29.5	18	18.57	36	2.49	3	4.93	33	1.25	35
Sun6352	29.0	20	9.01	32	2.23	10	6.33	1	0.25	1
OX327	29.0	19	4.39	15	2.00	25	5.42	12	0.33	7
OX331	28.5	21	4.77	19	1.85	34	5.73	5	0.92	31
FG99-19	27.5	23	4.61	17	1.88	32	5.6	8	0.75	22
FG00-127	27.5	22	4.7	18	2.09	21	5	31	0.75	20
PS2130	27.0	25	3.28	6	2.34	4	5.15	26	0.92	27
GEM818	27.0	24	4.32	12	2.10	20	5.23	21	0.92	30
H9423	26.5	26	3.51	8	2.16	16	5.4	13	0.83	25
O7983	26.0	27	2.41	3	1.86	33	5.58	11	0.7	18
GEM31	25.5	28	1.07	1	1.92	29	5.58	10	0.75	21
TR12	24.0	29	4.18	11	1.91	30	5.4	14	1.17	34
Sun6333	23.5	30	6.26	25	2.57	2	5.58	9	0.75	19
O9816	22.0	31	4.07	10	2.08	23	6.05	2	1.42	36
2k-3612	20.0	32	6.87	28	1.90	31	5.6	6	0.25	3
FG99-15	20.0	33	11.13	35	2.22	11	6	3	1.00	32
GEM611	19.5	34	3.29	7	2.25	8	5.02	30	0.92	29
FG00-124	18.5	35	4.43	16	2.26	7	5.32	17	1.08	33
2k-3614	10.0	36	3.13	5	2.29	5	5.3	18	0.92	28
Mean	30.27		5.79		2.12		5.33		0.7	
LSD 0.05	21.91		4.45		0.33		0.66		0.75	

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