

Processing Tomato Breeding and Genetics Research 2003.

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Introduction

The Ohio State University/OARDC tomato breeding 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. The OSU/OARDC program develops new populations to expand our base of useful genetics. Developmental research has centered on structuring populations for simultaneous trait identification, genetic mapping, and breeding. Our goal is to apply new discoveries through variety development.

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

The 2003 growing season contrasted with the two previous years. In 2001 and 2002, early rains were followed by lower than normal precipitation. In 2003 early rains were followed by more rain. Over three years variety trial locations have experienced as little as 0.9 inches and as much as 7.2 inches of precipitation during peak fruit set. Despite diverse and adverse conditions, varieties OX323 and OX325 continued to perform well in plot trials.

Table 1. Weather conditions at OARDC trial locations over three years.

| Fremont | 2001 | | | 2002 | | | 2003 | | |
|-----------------|------|------|----------|------|------|------------|------|------|------------|
| | June | July | May-Sept | June | July | May - Sept | June | July | May - Sept |
| Avg High Temp | 80.2 | 84.5 | 78.3 | 83.5 | 88.2 | 80.3 | 76.8 | 82.7 | 76.7 |
| Avg Low Temp | 57.4 | 59.3 | 54.1 | 58.6 | 63.9 | 55.6 | 54.2 | 58.9 | 53.0 |
| Avg Temp | 68.8 | 71.9 | 66.2 | 71.1 | 76.0 | 68.0 | 65.5 | 70.8 | 64.9 |
| Normal Avg Temp | 69.1 | 72.9 | 67.1 | 69.1 | 72.9 | 67.1 | 69.1 | 72.9 | 67.1 |
| Total Precip | 1.6 | 3.6 | 15.5 | 3.7 | 3.6 | 18.8 | 2.7 | 5.4 | 22.0 |
| Normal Precip | 4.0 | 3.9 | 17.9 | 4.0 | 3.8 | 17.9 | 4.0 | 3.8 | 17.9 |

| Wooster | 2001 | | | 2002 | | | 2003 | | |
|-----------------|------|------|----------|------|------|------------|------|------|------------|
| | June | July | May-Sept | June | July | May - Sept | June | July | May - Sept |
| Avg High Temp | 79.8 | 83.5 | 78.1 | 83.4 | 87.7 | 81.5 | 76.8 | 82.3 | 76.8 |
| Avg Low Temp | 56.6 | 58.5 | 55.0 | 58.2 | 62.3 | 55.6 | 55.5 | 60.2 | 55.1 |
| Avg Temp | 68.3 | 71.3 | 66.4 | 70.5 | 75.2 | 68.4 | 65.9 | 70.8 | 65.5 |
| Normal Avg Temp | 67.6 | 71.6 | 66.1 | 67.6 | 71.6 | 66.1 | 67.6 | 71.5 | 66.1 |
| Total Precip | 1.5 | 1.1 | 13.0 | 3.3 | 0.9 | 13.6 | 3.9 | 7.2 | 25.7 |
| Normal Precip | 3.9 | 4.0 | 18.8 | 3.9 | 4.0 | 18.8 | 3.9 | 4.1 | 18.8 |
| Solar Radiation | 465 | 490 | 410 | 474 | 489 | 422 | 402 | 426 | 376 |

Table 2. Summary for yield and processing quality traits over three years (2001, 2002, 2003).

| Variety | Yield | | % Cull | | Frt Wt. | | pH | Brx | Color | | | | | | | | |
|----------|-------|------|--------|------|---------|------|-----|-----|-------|------|--------|------|-----|------|--------|------|----|
| | T/A | rank | rank | rank | gm | rank | | | L | rank | L diff | rank | Hue | rank | H diff | rank | |
| 2k3612 | 23.3 | 22 | 8.0 | 14 | 61.8 | 10 | 4.3 | 4.8 | 4 | 41.2 | 6 | 2.9 | 2 | 38.2 | 1 | 4.1 | 3 |
| 2k3614 | 26.4 | 19 | 7.6 | 12 | 67.8 | 1 | 4.4 | 4.7 | 7 | 40.5 | 3 | 4.5 | 11 | 42.5 | 8 | 6.8 | 11 |
| 9816 | 37.4 | 6 | 8.4 | 16 | 58.5 | 21 | 4.4 | 4.6 | 12 | 42.2 | 12 | 4.5 | 12 | 45.2 | 17 | 6.9 | 12 |
| FG00-115 | 35.1 | 9 | 7.5 | 11 | 65.9 | 5 | 4.5 | 4.3 | 19 | 45.4 | 22 | 6.4 | 22 | 48.0 | 22 | 12.3 | 22 |
| FG00-117 | 35.7 | 8 | 10.4 | 18 | 61.6 | 11 | 4.4 | 4.8 | 3 | 41.7 | 10 | 4.8 | 15 | 46.3 | 18 | 9.3 | 19 |
| FG00-118 | 43.5 | 1 | 7.8 | 13 | 61.0 | 13 | 4.4 | 4.7 | 9 | 41.3 | 7 | 2.7 | 1 | 40.1 | 4 | 4.2 | 4 |
| FG00-124 | 24.7 | 21 | 8.2 | 15 | 66.9 | 3 | 4.5 | 4.2 | 21 | 41.5 | 8 | 5.1 | 16 | 46.4 | 19 | 11.4 | 21 |
| FG00-125 | 29.6 | 14 | 13.2 | 22 | 67.2 | 2 | 4.4 | 4.5 | 16 | 38.3 | 1 | 3.2 | 4 | 38.7 | 3 | 3.9 | 2 |
| FG00-127 | 29.8 | 13 | 8.8 | 17 | 60.8 | 14 | 4.4 | 4.3 | 18 | 40.9 | 4 | 3.0 | 3 | 40.9 | 5 | 5.0 | 7 |
| FG99-15 | 26.9 | 16 | 10.7 | 19 | 66.3 | 4 | 4.5 | 4.7 | 8 | 38.5 | 2 | 3.4 | 6 | 38.2 | 2 | 2.7 | 1 |
| FG99-19 | 38.1 | 5 | 7.4 | 10 | 60.0 | 17 | 4.5 | 4.7 | 11 | 43.3 | 15 | 5.5 | 21 | 46.9 | 21 | 11.3 | 20 |
| FG99-24 | 33.6 | 11 | 12.9 | 21 | 59.1 | 19 | 4.4 | 4.6 | 14 | 41.5 | 9 | 4.6 | 13 | 42.9 | 9 | 8.1 | 16 |
| GEM611 | 26.4 | 18 | 4.9 | 6 | 62.0 | 9 | 4.4 | 4.6 | 13 | 42.8 | 14 | 5.2 | 18 | 44.4 | 16 | 8.9 | 18 |
| GEM818 | 28.8 | 15 | 6.2 | 8 | 60.5 | 16 | 4.3 | 4.4 | 17 | 43.6 | 18 | 3.4 | 5 | 43.0 | 11 | 4.4 | 5 |
| H9423 | 26.6 | 17 | 3.2 | 3 | 60.7 | 15 | 4.4 | 4.5 | 15 | 43.9 | 19 | 3.7 | 7 | 41.5 | 7 | 4.9 | 6 |
| H9704 | 33.5 | 12 | 3.7 | 5 | 62.3 | 7 | 4.4 | 4.8 | 6 | 45.4 | 21 | 4.7 | 14 | 42.9 | 10 | 7.2 | 13 |
| O7983 | 25.6 | 20 | 11.8 | 20 | 61.1 | 12 | 4.4 | 5.1 | 1 | 42.7 | 13 | 5.1 | 17 | 44.3 | 15 | 8.8 | 17 |
| O8245 | 33.8 | 10 | 3.6 | 4 | 59.2 | 18 | 4.3 | 5.0 | 2 | 43.4 | 16 | 5.4 | 19 | 43.6 | 13 | 7.6 | 15 |
| OX23 | 37.1 | 7 | 5.2 | 7 | 57.2 | 22 | 4.5 | 4.8 | 5 | 42.1 | 11 | 4.2 | 8 | 43.0 | 12 | 5.7 | 8 |
| OX323 | 39.6 | 4 | 3.2 | 2 | 58.9 | 20 | 4.4 | 4.2 | 22 | 44.5 | 20 | 5.4 | 20 | 43.8 | 14 | 6.5 | 10 |
| OX325 | 40.1 | 3 | 2.7 | 1 | 65.2 | 6 | 4.4 | 4.3 | 20 | 41.0 | 5 | 4.2 | 9 | 41.4 | 6 | 6.4 | 9 |
| PS696 | 41.2 | 2 | 7.2 | 9 | 62.1 | 8 | 4.2 | 4.7 | 10 | 43.4 | 17 | 4.4 | 10 | 46.4 | 20 | 7.2 | 14 |

Table 3. Summary for yield and processing quality traits over two years (2001 and 2003).

| Variety | T/A | SD | Cull | SD | Frt wt. | SD | pH | Brx |
|----------|------|------|------|-----|---------|-----|-----|-----|
| FG01-138 | 37.3 | 12.5 | 3.5 | 4.9 | 66.5 | 6.1 | 4.3 | 4.8 |
| FG01-140 | 35.0 | 16.3 | 4.7 | 6.7 | 67.4 | 4.8 | 4.3 | 4.5 |
| FG01-158 | 40.7 | 13.3 | 3.6 | 5.0 | 70.6 | 5.9 | 4.4 | 4.5 |
| FG01-160 | 33.0 | 16.2 | 4.4 | 6.1 | 68.7 | 1.0 | 4.4 | 4.7 |
| FG01-163 | 39.1 | 8.0 | 2.8 | 3.9 | 70.9 | 9.5 | 4.3 | 4.6 |
| FG01-168 | 41.2 | 11.6 | 3.8 | 5.3 | 68.8 | 7.9 | 4.4 | 4.3 |
| FG99-36 | 34.5 | 6.4 | 8.2 | 0.0 | 58.5 | 4.9 | 4.3 | 4.7 |
| FG99-42 | 28.9 | 5.8 | 6.1 | 2.8 | 70.2 | 7.5 | 4.4 | 4.3 |
| FG99-44 | 31.9 | 8.6 | 6.8 | 0.6 | 60.2 | 1.5 | 4.3 | 4.4 |
| GEM31 | 30.1 | 6.5 | 3.0 | 2.7 | 57.0 | 3.5 | 4.3 | 4.7 |
| GEM32 | 37.0 | 1.5 | 4.4 | 2.0 | 61.7 | 1.3 | 4.3 | 4.6 |
| Sun6333 | 28.9 | 7.6 | 10.0 | 5.2 | 70.8 | 3.0 | 4.3 | 5.1 |

Development of new disease resistance

DNA-based Marker Assisted Selection (MAS) was used to pyramid resistance to bacterial speck (*Pseudomonas syringae* pv. *tomato*) and spot (*Xanthomonas campestris* pv. *vesicatoria*). *Pto* is a gene conferring resistance to race 0 of the bacterial speck pathogen. *Rx3* is a quantitative trait locus (QTL) conferring as much as 45% of the variation for resistance to race T1 strains of the bacterial spot pathogen. Both genes map to chromosome 5 of tomato, and varieties carrying *Pto* are often more susceptible to bacterial spot. Selection of F₃ plants homozygous for both *Pto* and *Rx3* lead to the identification of 12 populations with acceptable horticultural characteristics and improved resistance to both bacterial diseases. These populations were accepted by the Crop Variety Release and Distribution Committee (CVRDC) for release as germplasm.

Two inbred backcross (IBC) lines were used to pyramid resistance to bacterial speck conferred by the gene *Pto* and resistance to race T1 strains of bacterial spot conferred by the gene *Rx3*. OH 88119 is susceptible to both diseases and was used as recurrent parent in developing two IBC lines. Line OH 9834 (released by the CVRDC in 2002) was derived by three backcrosses to OH 88119 with Hawaii7998 serving as the resistant donor of *Rx3*. Line OH 981205 was derived by four backcrosses to OH 88119 with Spectrum 882 (Seminis vegetable Seed, Co.) serving as the resistance donor of *Pto*. A cross was made between OH 9834 and OH 981205 to develop an F₂ population. Subsequent generations were derived from self-pollination of selected F₂ individuals.

MAS was applied to 419 F₂ plants and 3,716 F₃ plants in order to select 33 homozygous recombinant families that bring *Pto* and a DNA-based marker linked to *Rx3* into coupling phase recombination. Plants selected through MAS were transplanted to the field in 2002 in plots consisting of F₃ plants that were homozygous for desirable recombination events and derived from a single F₂ individual. Field evaluations of resistance, yield potential, and quality potential were based on F₃ plots and F₄ plots in replicated trials (two replicates each year) conducted in 2002 and 2003. Field trials for speck resistance relied on natural infestation (2003) while field trials for spot resistance were the results of infestation from a border trial containing peppers inoculated with strains 89 and 110c, both race T1 (2002). Field trials for resistance to bacterial spot were evaluated quantitatively using a 1-12 scale adapted from Horsfall and Barratt (1945; *Phytopathology* 35:655). Field trials for resistance to bacterial speck were scored qualitatively. *Xanthomonas* strains 89, 110c, and *P. syringae* strain DC3000 were used for greenhouse inoculations where resistance was based on the presence of a hypersensitive response (HR).

Based on the results of field evaluations, we released bulked seed from 12 F₄ families, each family representing an independent homozygous recombinant event bringing *Pto* and *Rx3* into coupling phase (cis) genetic linkage. All populations are in the Ohio 88119 background, with populations 2K2-7530 and 2K2-7536 showing the most promise. Fruit have a small stem scar and core, are uniform ripening (u), and are attached by a jointless pedicel (j2). These populations show acceptable horticultural traits, acceptable fruit quality, and increased resistance to bacterial speck and bacterial spot. We have observed that one consequence of the *Pto*-*Rx3* introgression is the loss of concentrated fruit set and earliness that characterizes Ohio 88119.

Managing For Color

With the assistance of a grant from the USDA/IFAFS program we are developing management strategies to reduce 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 sectorized 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.

Drip irrigation trials were initiated in 2003 to investigate the possibility of adding K when the plant is at in maximum growth. Results of these trials are presented in Table 4-6.

Table 4. Variety Differences in YSD under drip irrigation and K injection at Fremont 2003

| Fremont Location | 2003 | | | | | | | |
|------------------|----------|-------|----------|-------|----------|--------|----------|--------|
| | 696 | | GEM 611 | | OX23 | | H 9423 | |
| | Good Frt | % YSD | Good Frt | %YSD | Good Frt | %YSD | Good Frt | %YSD |
| Irrigation | 0.70 | 0.30 | 0.7188 | 0.28 | 0.74 | 0.26 | 0.68 | 0.32 |
| Early K | 0.66 | 0.34 | 0.6667 | 0.33 | 0.71 | 0.29 | 0.75 | 0.25 |
| Mid K | 0.66 | 0.34 | 0.6771 | 0.32 | 0.84 | **0.16 | 0.75 | **0.25 |
| Late K | 0.56 | 0.44 | 0.6458 | 0.35 | 0.68 | 0.32 | 0.61 | 0.39 |
| No Irrigation | 0.66 | 0.34 | 0.6458 | 0.35 | 0.80 | 0.20 | 0.60 | 0.40 |
| Average | 0.65 | 0.35 | 0.67 | 0.33 | 0.75 | 0.25 | 0.68 | 0.32 |
| SD | 0.050 | 0.050 | 0.030 | 0.030 | 0.068 | 0.068 | 0.070 | 0.070 |

Table 5. Variety Differences in Yield under drip irrigation and K injection at Fremont 2003

| Fremont Location | | 2003 | | | | | | | |
|------------------|---------|-------|--------|--------|---------|-------|--------|--------|--|
| Treatment | PS 696 | | | | GEM 611 | | | | |
| | Red T/A | % Red | %Green | % Cull | Red T/A | % Red | %Green | % Cull | |
| Irrigation | 43.09 | 81.3 | 16.7 | 2.1 | 32.81 | 78.2 | 16.4 | 5.4 | |
| Early K | 37.90 | 80.7 | 15.8 | 3.5 | 37.50 | 85.5 | 10.7 | 3.8 | |
| Mid K | **49.71 | 85.7 | 11.0 | 3.3 | **42.03 | 84.5 | 12.2 | 3.3 | |
| Late K | 46.81 | 86.7 | 9.7 | 3.6 | 38.35 | 83.3 | 12.9 | 3.8 | |
| No Irrigation | 41.90 | 82.3 | 14.9 | 2.8 | 36.85 | 81.8 | 14.0 | 4.2 | |
| Average | 43.88 | 83.34 | 13.63 | 3.04 | 37.51 | 82.66 | 13.26 | 4.08 | |
| SD | 4.55 | 2.69 | 3.08 | 0.64 | 3.30 | 2.86 | 2.12 | 0.81 | |
| LSD 0.05 | 6.46 | | | | 5.36 | | | | |

| Treatment | OX23 | | | | H 9423 | | | |
|---------------|---------|-------|--------|--------|---------|-------|--------|--------|
| | Red T/A | % Red | %Green | % Cull | Red T/A | % Red | %Green | % Cull |
| Irrigation | 33.35 | 73.2 | 19.5 | 7.3 | 37.56 | 82.5 | 14.7 | 2.8 |
| Early K | 34.28 | 81.3 | 11.4 | 7.3 | 34.53 | 85.8 | 11.6 | 2.6 |
| Mid K | 34.44 | 84.1 | 11.7 | 4.2 | 36.78 | 88.3 | 8.5 | 3.2 |
| Late K | 36.84 | 80.2 | 13.9 | 5.9 | 37.38 | 88.1 | 9.1 | 2.8 |
| No Irrigation | 37.84 | 78.9 | 16.4 | 4.7 | 37.25 | 80.9 | 15.9 | 3.1 |
| Average | 35.35 | 79.55 | 14.58 | 5.86 | 36.70 | 85.12 | 11.97 | 2.92 |
| SD | 1.90 | 4.05 | 3.42 | 1.43 | 1.25 | 3.31 | 3.31 | 0.25 |
| LSD 0.05 | 8.26 | | | | 6.14 | | | |

Table 6. Variety Differences in Yield of YSD free fruit under drip irrigation and K injection at Fremont 2003.

| Treatment | PS 696 | | | GEM611 | | | OX23 | | | H 9423 | | |
|---------------|--------|------|---------|--------|------|---------|-------|------|---------|--------|------|---------|
| | T/A | % | T/Ax% | T/A | % | T/Ax% | T/A | % | T/Ax% | T/A | % | T/Ax% |
| Irrigation | 43.09 | 0.70 | 30.03 | 32.81 | 0.72 | 23.59 | 33.35 | 0.74 | 24.66 | 37.56 | 0.68 | 25.43 |
| Early K | 37.90 | 0.66 | 24.87 | 37.50 | 0.67 | 25.00 | 34.28 | 0.71 | 24.28 | 34.53 | 0.75 | 25.89 |
| Mid K | 49.71 | 0.66 | **32.63 | 42.03 | 0.68 | **28.46 | 34.44 | 0.84 | **29.06 | 36.78 | 0.75 | **27.58 |
| Late K | 46.81 | 0.56 | 26.33 | 38.35 | 0.65 | 24.77 | 36.84 | 0.68 | 24.94 | 37.38 | 0.61 | 22.97 |
| No Irrigation | 41.90 | 0.66 | 27.50 | 36.85 | 0.65 | 23.80 | 37.84 | 0.80 | 30.35 | 37.25 | 0.60 | 22.51 |
| Average | | | 28.27 | | | 25.12 | | | 26.66 | | | 24.88 |
| SD | | | 3.08 | | | 1.96 | | | 2.83 | | | 2.12 |

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Appendix. 2003 Trial Data From Multi-location trials (54 varieties). Ranked by composite performance.

| GEN | Ripe Yield | | % Cull | | Frt Wt. (gm) | | Disease Index | | Soluble Solids (Brix) | | pH | ACID |
|----------|------------|------|--------|------|--------------|------|---------------|------|-----------------------|------|------|------|
| | Mean | rank | Mean | rank | Mean | rank | Mean | rank | Mean | rank | Mean | Mean |
| OX325 | 37.3 | 3 | 2.7 | 1 | 71.2 | 4 | 1.13 | 22 | 4.68 | 31 | 4.48 | 5.33 |
| U2008 | 36.0 | 5 | 9.7 | 40 | 69.6 | 8 | 0.88 | 5 | 4.90 | 14 | 4.33 | 5.48 |
| GEM111 | 35.1 | 7 | 5.3 | 12 | 64.4 | 23 | 1.00 | 9 | 4.85 | 16 | 4.33 | 5.45 |
| FG01158 | 31.3 | 21 | 7.1 | 21 | 66.5 | 18 | 0.88 | 5 | 4.98 | 11 | 4.40 | 5.13 |
| FG01163 | 33.4 | 13 | 5.6 | 14 | 64.2 | 24 | 1.13 | 22 | 5.15 | 5 | 4.25 | 5.33 |
| OX323 | 35.5 | 6 | 3.2 | 2 | 62.6 | 31 | 1.00 | 9 | 4.40 | 47 | 4.40 | 5.13 |
| FG9919 | 42.0 | 1 | 7.4 | 24 | 61.5 | 36 | 1.00 | 9 | 4.65 | 33 | 4.43 | 4.73 |
| C232 | 28.4 | 33 | 9.0 | 37 | 69.9 | 7 | 0.75 | 2 | 5.00 | 8 | 4.20 | 5.33 |
| GEM31 | 34.6 | 9 | 4.9 | 7 | 59.4 | 46 | 0.88 | 5 | 4.73 | 26 | 4.30 | 5.78 |
| FG00118 | 36.4 | 4 | 7.8 | 29 | 67.6 | 14 | 1.25 | 29 | 4.70 | 29 | 4.33 | 4.98 |
| FG00115 | 32.0 | 19 | 7.5 | 26 | 71.4 | 3 | 0.63 | 1 | 4.30 | 50 | 4.38 | 4.58 |
| GEM94 | 34.5 | 10 | 5.1 | 10 | 65.5 | 18 | 1.13 | 22 | 4.53 | 44 | 4.20 | 5.33 |
| C258 | 35.1 | 7 | 13.5 | 51 | 70.1 | 6 | 1.38 | 40 | 4.83 | 17 | 4.28 | 4.55 |
| GEM32 | 38.1 | 2 | 5.8 | 16 | 60.8 | 42 | 1.25 | 29 | 4.63 | 36 | 4.30 | 5.65 |
| GEM89 | 27.9 | 35 | 7.4 | 24 | 68.9 | 10 | 1.00 | 9 | 4.80 | 20 | 4.30 | 5.05 |
| H3702 | 31.0 | 22 | 6.6 | 19 | 66.7 | 16 | 1.63 | 46 | 5.33 | 2 | 4.15 | 5.88 |
| C205 | 33.0 | 16 | 12.7 | 47 | 73.7 | 1 | 1.13 | 22 | 4.65 | 33 | 4.35 | 5.35 |
| Sun6333 | 34.3 | 11 | 13.7 | 52 | 68.7 | 11 | 1.63 | 46 | 5.10 | 6 | 4.30 | 5.05 |
| H9704 | 27.8 | 36 | 3.7 | 5 | 65.5 | 18 | 1.25 | 29 | 4.75 | 25 | 4.20 | 5.88 |
| FG01138 | 28.5 | 32 | 7.0 | 20 | 62.1 | 32 | 1.25 | 29 | 5.00 | 8 | 4.25 | 5.88 |
| OX23 | 28.3 | 34 | 5.2 | 11 | 57.6 | 50 | 0.75 | 2 | 4.78 | 23 | 4.30 | 5.78 |
| H9423 | 30.0 | 26 | 3.2 | 2 | 63.7 | 27 | 1.25 | 29 | 4.60 | 39 | 4.18 | 5.85 |
| FG01168 | 33.0 | 16 | 7.5 | 26 | 63.3 | 29 | 1.25 | 29 | 4.08 | 54 | 4.43 | 5.15 |
| Sun6363 | 30.8 | 23 | 12.2 | 46 | 62.1 | 32 | 1.25 | 29 | 5.55 | 1 | 4.20 | 5.08 |
| GEM611 | 29.0 | 31 | 4.9 | 7 | 58.5 | 48 | 0.88 | 5 | 4.60 | 39 | 4.23 | 6.28 |
| GEM818 | 30.3 | 25 | 6.2 | 17 | 62.1 | 32 | 1.00 | 9 | 4.43 | 46 | 4.40 | 4.85 |
| 8245 | 27.8 | 36 | 3.6 | 4 | 61.2 | 38 | 1.13 | 22 | 4.95 | 13 | 4.13 | 6.03 |
| 9816 | 25.0 | 43 | 8.4 | 33 | 61.5 | 36 | 1.00 | 9 | 4.63 | 36 | 4.35 | 4.23 |
| PS696 | 34.2 | 12 | 7.2 | 22 | 61.0 | 41 | 1.75 | 53 | 4.98 | 11 | 4.33 | 5.65 |
| PX240431 | 33.1 | 15 | 12.9 | 48 | 67.6 | 15 | 1.13 | 22 | 4.13 | 53 | 4.35 | 4.60 |
| C125 | 24.1 | 47 | 5.7 | 15 | 63.7 | 27 | 1.00 | 9 | 4.90 | 14 | 4.23 | 5.70 |
| C227 | 29.1 | 30 | 10.1 | 42 | 72.3 | 2 | 1.25 | 29 | 4.55 | 42 | 4.28 | 4.98 |
| RedSky | 32.6 | 18 | 9.4 | 38 | 62.8 | 30 | 1.63 | 46 | 4.73 | 26 | 4.30 | 4.98 |
| 2k3614 | 23.8 | 49 | 7.6 | 28 | 66.7 | 16 | 1.00 | 9 | 4.73 | 26 | 4.40 | 5.55 |
| FG9942 | 24.8 | 44 | 4.1 | 6 | 64.9 | 22 | 1.00 | 9 | 4.25 | 51 | 4.38 | 5.78 |
| PS31212 | 31.8 | 20 | 8.5 | 34 | 57.2 | 52 | 1.50 | 44 | 5.05 | 8 | 4.20 | 5.18 |
| FG01160 | 21.5 | 51 | 8.8 | 35 | 68.0 | 12 | 1.25 | 29 | 5.18 | 4 | 4.35 | 6.10 |
| FG9915 | 25.9 | 40 | 10.7 | 44 | 64.2 | 24 | 0.75 | 2 | 4.70 | 29 | 4.43 | 3.70 |
| Sun6359 | 30.4 | 24 | 20.1 | 54 | 67.8 | 13 | 1.75 | 53 | 4.80 | 20 | 4.20 | 5.48 |
| PX240196 | 33.2 | 14 | 13.7 | 52 | 61.2 | 38 | 1.38 | 40 | 4.68 | 31 | 4.23 | 4.90 |
| U2006 | 25.7 | 42 | 6.3 | 18 | 61.7 | 35 | 1.63 | 46 | 5.33 | 2 | 4.20 | 5.75 |
| Mean | 29.7 | | 8.1 | | 64.0 | | 1.19 | | 4.73 | | 4.29 | 5.32 |
| LSD 0.05 | 8.7 | | 5.0 | | 8.1 | | 0.67 | | 0.51 | | 0.16 | 0.90 |

Appendix (Continued). 2003 Trial Data From Multi-location trials (54 varieties).

| GEN | Ripe Yield | | % Cull | | Frt . Wt. gm | | Disease Index | | Soluble Solids (Brix) | | pH | ACID | |
|----------|------------|------|--------|------|--------------|------|---------------|------|-----------------------|------|------|------|------|
| | Mean | rank | Mean | rank | Mean | rank | Mean | rank | Mean | rank | | Mean | Mean |
| FG9944 | 25.8 | 41 | 7.3 | 23 | 61.2 | 38 | 1.00 | 9 | 4.35 | 48 | 4.28 | 5.35 | |
| GEM46 | 29.2 | 29 | 5.5 | 13 | 60.8 | 42 | 1.38 | 40 | 4.55 | 42 | 4.25 | 5.10 | |
| 2k3612 | 17.7 | 54 | 8.0 | 30 | 66.5 | 18 | 1.13 | 22 | 4.80 | 20 | 4.40 | 5.53 | |
| FG00124 | 21.3 | 52 | 8.2 | 31 | 71.0 | 5 | 1.00 | 9 | 4.20 | 52 | 4.40 | 5.25 | |
| TX82 | 29.9 | 28 | 5.0 | 9 | 53.3 | 54 | 1.50 | 44 | 4.63 | 36 | 4.25 | 5.33 | |
| FG00125 | 24.1 | 48 | 13.2 | 50 | 69.2 | 9 | 1.00 | 9 | 4.45 | 45 | 4.33 | 5.10 | |
| FG00117 | 27.4 | 39 | 10.4 | 43 | 59.0 | 47 | 1.25 | 29 | 4.83 | 17 | 4.28 | 4.58 | |
| FG01140 | 23.6 | 50 | 9.5 | 39 | 64.0 | 26 | 1.38 | 40 | 4.78 | 23 | 4.33 | 5.60 | |
| FG9936 | 30.0 | 26 | 8.3 | 32 | 55.1 | 53 | 1.63 | 46 | 4.65 | 33 | 4.25 | 5.33 | |
| PX240396 | 27.8 | 36 | 9.8 | 41 | 57.4 | 51 | 1.63 | 46 | 4.83 | 17 | 4.15 | 5.18 | |
| FG9924 | 24.1 | 46 | 12.9 | 48 | 58.1 | 49 | 1.00 | 9 | 4.60 | 39 | 4.23 | 5.93 | |
| O7983 | 24.4 | 45 | 11.8 | 45 | 59.6 | 44 | 1.63 | 46 | 5.10 | 6 | 4.23 | 5.85 | |
| FG00127 | 21.1 | 53 | 8.8 | 35 | 59.6 | 44 | 1.25 | 29 | 4.33 | 49 | 4.23 | 6.00 | |
| Mean | 29.7 | | 8.1 | | 64.0 | | 1.19 | | 4.73 | | 4.29 | 5.32 | |
| LSD 0.05 | 8.7 | | 5.0 | | 8.1 | | 0.67 | | 0.51 | | 0.16 | 0.90 | |

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