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Title: Evaluation of the performance of PSU tomato breeding lines and F₁ hybrids under commercial production conditions in Pennsylvania

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Introduction:

Over the past several years, the *Penn State Tomato Genetics and Breeding Program* has developed processing and fresh market tomato breeding lines for production under PA conditions. The PSU tomato breeding lines have many desirable characteristics including disease resistance, high fruit quality, high yield and adaptation to PA conditions. The ultimate goal of the tomato-breeding program is to develop F₁ hybrids from crosses between advanced inbred lines and release them as commercial varieties. However, to achieve this goal, this process involves development of hundreds of “experimental hybrids” and evaluating them in different target environments in comparison with current commercial cultivars. At Penn State, we have been developing experimental hybrids during the past two years. For example, during the winter and spring 2013, we developed a total of 96 new experimental hybrids, including 60 large size fresh market and 36 grape tomato hybrids. During the early 2014, we will be making a total of a total of 114 new experimental hybrids, including 54 large size fresh market and 60 grape tomato hybrids. Our general goal is to evaluate the commercial potential of these experimental hybrids under PA conditions, including the Penn State Research Farm and several commercial fields.

This report describes the results of the following objectives:

1. Evaluate the performance of the 96 experimental hybrids under conditions at the Russell E. Larson Agricultural Research and Extension Center at Rock Springs.
2. Evaluate the performance of a sub-set of 10 experimental hybrids at the Southeast Research and Extension Center in Landisville, PA and in two commercial fields in PA.

Methods and Results:

Development of the experimental hybrids. To develop large size fresh market hybrid tomatoes, a total of 19 lines with various desirable characteristics were chosen. Four inbred lines were used as female and 15 as male parents and a total of 60 hybrids developed. To develop fresh market grape and Campari/cocktail type tomatoes, a total of 13 advanced inbred lines with various desirable characteristics were chosen. Four inbred lines were used as female and 9 as male parents and a total of 36 hybrids were developed.

Evaluation of the 96 experimental hybrids at the Russell E. Larson Agricultural Research and Extension Center. During the summer 2013, the 96 hybrids along with their parental lines as well as several current commercial cultivars and inbred lines were grown. Throughout the season all the hybrids were evaluated for numerous horticultural characteristics, including yield (visual), disease resistance,

maturity, fruit size, firmness, color (inside and out), locule distribution and plant type. A few seed companies visited the field and evaluated our experimental hybrids. Comparisons were made between our new experimental hybrids and several current commercial cultivars under field conditions. Many PSU experimental hybrids exhibited excellent performance and several outperformed commercial cultivars this past season. Below are select data from the large fresh market (Table 1) and grape tomato hybrids (Table 2) as well as a few pictures from the 2013 field trial (Figure 1). These hybrids will be reevaluated again next year at Penn State as well as by a few seed companies who have expressed interest in these hybrids.

Table 1. Select large fresh market tomato hybrids evaluated in 2013.

Large Fresh Market Hybrid	Comments
PSFH-19	** One of the best hybrids, very high yield. Medium plant with large fruit. Round flat fruit. Good stem scar. Good blossom end scar. Okay color. Uniform fruit size. Good disease resistance.
PSFH-25	*Excellent color. Very firm. Very good disease resistance. Good yield. Fruit size issue. Excellent disease resistance. Potentially sold as high lycopene. Good taste. Overall good.
PSFH-34	*1/2 medium size plant. Very high yield. Mostly round flat fruit. Compact plant. Medium to large fruit. Good color. Good firmness. Nice distribution. Excellent disease resistance.
PSFH-35	** Medium plant size. Medium large fruit. Very high yield. Excellent disease resistance. Very firm. Good color. Smooth fruit. Uniform fruit size. Excellent hybrid.
PSFH-36	*1/2 medium size plant. Medium size fruit. Very firm. Good taste. Good disease resistance. Very competitive. Should be released. Uniform fruit size. High yield.
PSFH-44	** Similar to 45. Medium to large fruit. Compact plant. Overall good disease resistance. High yield. Good firm. Nice distribution. Very competitive. Excellent taste.
PSFH-46	** High yield. Medium to large fruit. Uniform fruit size. Excellent color in/out. Excellent distribution. Good firm. Some bacterial disease.
PSFH-47	*** Extremely high yield. Medium to large fruit. Excellent color. Uniform fruit size. Medium to large plant. Some bacterial disease. Some early blight. Overall a great hybrid.
PSFH-48	*** Determinate but big plant. Excellent hybrid. Large fruit. Round fruit. Very firm. Okay to good color. Very healthy.
PSFH-51	*1/2 very similar to 52. A bit smaller fruit. Very healthy plants.
PSFH-52	** Very high yield. Large fruit. Uniform size fruit. Very firm. Good color. Excellent hybrid. Smooth fruit. Thick walls. Round flat to round globe.
PSFH-57	***Excellent hybrid. Hi yield. Medium to large fruit. Most round flat. Smooth. Firm. Very good color. Nice stem and blossom end. Excellent distribution. Impressive yield. High disease resistance. Good coverage.
PSFH-58	**Reasonably good hybrid. High yield. Medium large fruit. Uniform fruit size. Round globe. Very nice color. Good coverage. Compact. Good stem and blossom end. Repeat.
PSFH-59	** Better than 60. Very high yield. Medium large fruit. Good firm. Color okay. Good disease resistance. Some early blight. Smooth shoulder. No stem scar.

Table2. Select grape tomato hybrids evaluated in 2013.

Grape Hybrid	Plant habit	Leaf Type	Shape / Size (1-7)	Fruit color (1-5)	Shoulder Color (u/g)	Fruit appearance (1-5)	Flavor (1-5)	Firmness (1-5)	Jointed (y/n)	Cluster Size (# frts/cluster)	Ripening Uniformity (1-5)	Cracking & Defects (1-5)	Yield (1-5)	General health (1-5) / Disease (Describe)	Overall (1-5)	Comments
PSGH-1	I	T	E 1.25	3	G	4	4	3	Y	8-10	4	5	5	5	4.5	*** Loosely jointed. Good plant size.
PSGH-2	I	P	C 1.25	3	G	4	3.5	3	N	10-12	5	5	4.5	5	4.5	*** Excellent hybrid.
PSGH-6	I	T	EL/R 1.75	3	G	3	2.5	2	Y	5-7	3.5	5	4	4	3	Huge plant. Not very desirable.
PSGH-7	I	T	C 2	2.5	G	3.5	2.5	3	Y	6-8	3.5	4.5	4	4.5	4	* Indeterminate medium size plant. No cracking. Some yellow shoulder. Elongated cocktail type fruit.
PSGH-8	I	T	C 2	3.5	G	4.5	3.5	3.5	N	6-8	3	5	4	5	4.5	*** Excellent hybrid. Very large grape. Cocktail size.
PSGH-9	I	T	C 2.25	4	G	4.5	3	4	N	6-8	4.5	4.5	5	5	5	*** No cracking. Excellent hybrid. Large cocktail size grape.
PSGH-11	I UPR	P	O 1.25	4	G	4.5	3.5	4	N	8-10	3.5	5	4	5	4.5	** Very nice upright habit. Good size grape.
PSGH-12	I	P	E 1.25	4.5	G	5	3.5	3.5	N	10-12	4	5	4.5	5	4.5	** Somewhat upright. Similar to hybrid 11.
PSGH-16	I SM	T	LRG C 1.175	3.5	G	4.5	3	3.5	Y	6-8	3	5	4	5	4.5	** Overall an excellent hybrid. Small indeterminate plant type. Nice fruit shape and size. Huge grape/ cocktail size fruit.
PSGH-18	I	T	EL O 2.25	3	G	4.5	3	4	N	8-10	3	5	4	5	4.5	*** Small plant. Thick skinned elongated specialty grape. Some fruit a little blocky. Very firm, good plant size with not too much foliage.

Table continued on next page

PSGH-20	I	P	O 1.25	4	G	5	4	4	N	10-12	3	5	4.5	5	4.5	** Indeterminate upright habit with beautiful clusters. Excellent clusters. High yield of very firm fruit.
PSGH-21	I	TP	O 1.25	4	G	5	3.5	4	N	10-12	3.5	5	4.5	4.5	4	** Overall an excellent hybrid.
PSGH-27	I	T	EL SQ 2.5	2.5	G	5	2.5	4.5	N	6-8	3	5	4	5	4.5	*** Specialty type grape. Very long thick skinned fruit. Cocktail size.
PSGH-28	I	T	O 1.5	4.5	G	5	4.5	3	Y	10-12	4	5	5	5	5	Excellent hybrid. High yield. Excellent fruit size shape and color.
PSGH-30	I	TP	O 1.25	4	G	5	4	3.5	Y	10-12	5	5	5	4.25	4.5	*** Good size plant. Loosely jointed. Very high yield. Uniform size fruit and ripening.
PSGH-31	I	TP	O 1.5	5	G	5	3	3.5	N	8-10	4	5	4.5	4.5	4.5	*** Small determinate plants. Excellent plant size. Beautiful shape fruit with excellent color.
PSGH-33	I	TP	E 1.5	4	G	5	2.5	2.5	Y	12-14	5	5	5	5	5	*** Extremely high yield. Elongated round fruit. Very long clusters.
PSGH-34	D	T	LRG O 2	5	G	5	3	3.5	Y	5-7	3	5	4	5	4.5	*** Large determinate plant. Very large grape to small plum. Excellent color and disease resistance.
PSGH-36	I	T	EL PL 3	3.5	G	4.5	2.5	3	Y	5-7	4	5	5	5	5	*** Loosely jointed. Very elongated large grape (small but elongated plum). Extremely high yield. Healthy.

Shape: F=flat, FR=flat round, R=round, SQ=square, C=cylindrical, E=elliptical, H=heart, OB=obovate, OV=oval/teardrop, P=pear

Size: 1=currant, 2=cherry/grape, 3=cocktail, 4=girl, 5=boy, 6=B'wine, 7=huge

Fruit Color: O=orange, R=red, P=pink, Y=yellow, G=green, B=brown, W=white

Fruit Appearance/Flavor/General Health/Overall: 1=worst to 5=best

Firmness: 1=soft, 5=firm

Yield/Ripening Uniformity (Across All Plants): 1=low to 5=high

Cracks and Defects: 1=severe, 5= none, Z=zipper, CF=cat facing, Ch=shoulder checking, C=concentric, R=radial, S=splitting, OL=open locules



Figure 1. Select pictures of grape and fresh market tomato hybrids from the 2013 field trial conducted at the Russell E. Larson Research and Education Center at Rock Springs, PA.

Evaluation of a subset of 10 experimental hybrids at SEAREC and on two commercial farms. To evaluate the performance and yield of fresh market tomato F₁ hybrids under commercial conditions, three replicated field trials were established across the state. One at the Southeast Research and Extension Center in Landisville, PA (SEAREC) and two on commercial farms in Mifflin and Lancaster Co. in collaboration with John Esslinger, Penn State Extension Educator and Jeff Stoltzfus, Adult Ag Instructor, Eastern Lancaster Area School District. Ten fresh market tomato F₁ hybrids from the Penn State Tomato Genetics and Breeding Program were selected and transplants produced by PI Foolad. Three trials were transplanted into raised beds with plastic mulch (one mechanical and two by-hand) with a single-row of drip irrigation in early June. Tomatoes were staked, fertigated, and managed following commercial production standards for fresh-market tomatoes. Individual plots were 12 ft and five or six plants planted at 24-in. in-row spacing depending on the constraints of the commercial field. Each hybrid was replicated three times in order to enable statistical analyses.

Unfortunately, before the experimental hybrids could be evaluated multiple hybrids in each trial were diagnosed with tomato/tobacco mosaic virus (ToMV/TMV) and two of the three trials were quickly destroyed to prevent the virus from spreading into the commercial planting. While most viruses that we are concerned about in vegetable crops are insect transmitted, this one can be easily transmitted mechanically and can persist on hard surfaces for several weeks. Symptoms vary depending on the tomato cultivar, virus strain and environmental conditions however, a light-dark green mottling of the leaves is common (see picture left).



One trial was maintained for the duration of the season and the following observations were made by John Esslinger on 13 Sept 2013.

Experimental Hybrid	Fruit Size (oz)	Vine Height (in.)	General Comments
PSU HYB-1	6-8	28	Healthy vine, appears to be late maturing
PSU HYB-2	5-7	32	Healthy vine, heavy fruit set, some zippers on fruit
PSU HYB-3	7-9	26	Appears to be early, good fruit set to the top of the plant
PSU HYB-4	7-9	27	Some fruit cracking, still putting on new growth
PSU HYB-5	7-10	34	Healthy plant, nice fruit quality
PSU HYB-6	6-8	28	Healthy plant, appears to be later maturing
PSU HYB-7	6-8	25	Some fruit cracking
PSU HYB-8	7-9	26	Slight amount of cracking, small amount of early blight
PSU HYB-9	7-9	26	Healthy plant
PSU HYB-10	8-10	30	Healthy plant, showing new growth
Mountain Glory	8-9	24	Some radial cracking
Tasti-Lee	7-9	27	Healthy plant