A Proposed Alternative Production Regime for Cherry and Grape Tomato Using Compact Plants and Once-over Harvest

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SUMMARY. This report presents preliminary data and arguments supporting the investigation and possible adoption of a low-cost method of cherry and grape tomato (*Solanum lycopersicum*) production. Cherry and grape tomato crops are currently grown using indeterminate or relatively large determinate plants requiring trellising and significant hand labor at harvest. In contrast, processing tomato crops are usually determinate cultivars raised without supporting systems, and they are harvested mechanically. In Summer 2009, a Mississippi trial of home garden tomato cultivars included a compact, mounding yellow-fruited cherry tomato that produced more than 2 kg of fruit per plant in the first harvest. The architecture of the plant, high yield potential, and concentrated set indicate that there is potential to grow commercial cherry and grape tomato crops in much the same way commercial processing tomatoes are grown: unsupported on bare or mulched beds, with once-over harvest. Such a system could reduce the monetary and labor costs of production of cherry and grape tomatoes. Seed companies, tomato growers, and supporting agencies should work together to further investigate the potential of this system of cherry and grape tomato production.

Most commercial cherry and grape tomato cultivars are indeterminate, with average fruit size of less than 10 g to around 30 g. Farmers in the United States and abroad usually raise these tomatoes in greenhouses using hydroponic production systems with elaborate support systems. In fields, they are grown on raised soil beds often with plastic mulch, drip irrigation, and stake and string trellises that can be nearly 3 m tall. The trellis systems for

large-fruited field tomatoes have been reported to account for about 5% of the production budget, costing over \$460/acre, plus \$64/acre in installation and maintenance during the season (Bryant et al., 2004). Similar trellis systems are used for grape and cherry tomato, as well. Picking grape and cherry tomatoes is labor intensive (Stall et al., 1982). Over several harvests, picking laborers pull hundreds of ripe or ripening fruit from each plant and into buckets or trays. These fruit are then taken to a packing facility for additional grading and packaging. Bryant et al. (2004) estimated that the picking, grading, and packing labor for large-fruited tomatoes costs around \$1930/acre, accounting for over 20% of the specified \$9069/acre production costs. Because of the small fruit size and high numbers of fruit per plant, the picking and packing labor

for a cherry or grape tomato crop can be substantially higher.

In contrast, tomatoes grown for processing are usually determinate roma- or paste-type tomatoes, with an average fruit size of 65 to 85 g. Processing tomatoes are grown without trellises on raised or flat beds, almost always without plastic mulch, and with or without irrigation. When irrigated, the irrigation may be sub-soil, furrow, or sprinkler-type. Harvest occurs most often by machines, rather than by hand. The harvest machines work by undercutting the vines and conveying the vines and fruit upward. The harvester shakes and separates the fruit from the vines, dumping the vines back on the field. Fruit move to a grading area on the machine where mechanical and hand graders remove soil clods, under- and over-ripe fruit, as well as diseased fruit and damaged fruit. The usable fruit then is elevated from the mechanical harvester into bulk containers on trailers for transportation to a central processing facility (Hartz et al., 2008). A production budget created by Michigan State University agricultural economists for processing tomatoes estimates that harvest and field grading labor cost around \$100/acre in 2002, accounting for less than 5% of the production budget (Dartt et al., 2002). California has estimated harvest labor, excluding trucking labor, at \$67/acre, just over 5% of total costs in a processing tomato crop budget (Miyao et al., 2001).

Recently, some new determinate cherry tomato lines with high yield potential have become available to homeowners. Floranova's (Dereham, England) home garden line of vegetables includes several determinate tomato lines being marketed for hanging basket, patio, and pot culture. The D. Palmer Seed Co. (Yuma, AZ) currently markets determinate cherry tomato 'Mito' and 'Tombo'

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
112.0851	cwt/acre	kg·ha ⁻¹	0.0089
0.3048	ft	m	3.2808
2.54	inch(es)	cm	0.3937
0.4536	lb	kg	2.2046
1.1209	lb/acre	kg·ha ⁻¹	0.8922
28.3495	oz	g	0.0353

as field production alternatives to greenhouse cherry tomatoes. The objective of this report was to present data from a field trial of determinate, home garden container-type tomato cultivars and information from the literature to explore the idea of using similar cultivars in commercial production of grape and cherry tomatoes.

Materials and methods

A field evaluation of 12 determinate and dwarf tomato cultivars for homeowner use as container or small-space garden plants was conducted at the Mississippi Agriculture and Forestry Experiment Station's Truck Crops Branch at Crystal Springs. The trial evaluated yield and ornamental traits of large- and small-fruited entries. The trial had four replicates of 10 entries in single-plant plots in a randomized complete block design. On 21 Apr. 2009, greenhouse-grown transplants were set 24 inches apart into raised beds on 72-inch centers with black polyethylene mulch cover (2-ft-wide bed tops, about 6 inches tall), and subsurface drip irrigation. All recommended phosphorus and potassium fertilizer, and 60 lb/acre nitrogen (N), was incorporated into the soil at bedding. Using the bed-foot method of Simone and Hochmoth (2007), two side-dress applications of 30 lb/acre N as calcium nitrate applied through the drip irrigation brought the total N application to 120 lb/acre. The plants were maintained, without trellises or other supports, using pest,

disease, and insect controls and practices outlined in a regional vegetable production manual (Southeastern Vegetable Extension Workers, 2009) and local practices. These included scouting the crop; weekly fungicide applications, pre- and post-emergent herbicide applications, combined with hand hoeing and weed pulling; and insecticide applications as necessary to control outbreaks of silverleaf whitefly (*Bemisia tabaci*) and tomato fruit worm (*Helio verpa*). Fruit from each of five hand harvests [66, 69, 73, 76, and 83 d after transplanting (DAT)] of each plant were weighed after picking all fruit at the breaker stage or beyond (U.S. Department of Agriculture, 1991), and grading into marketable and cull categories. In addition, growth index [(widest plant width + perpendicular width + height)/3] was recorded for each plant on the first harvest date (66 DAT), before picking. All data were analyzed using PROC ANOVA, with means separated by least significant difference at $P = 0.05$ (SAS, version 9.1; SAS Institute, Cary, NC).

Results and discussion

'Tumbling Tom Yellow' matured into a bushy plant, with a mounding habit and a fairly concentrated yield of round, yellow fruit (Table 1). Nearly 45% of the fruit of 'Tumbling Tom Yellow' was harvested at the first picking, yielding more than 2 kg of marketable fruit convert to original units/plant with less than 4% cull fruit (Table 1), the

equivalent of 19,725 kg·ha⁻¹. If this or other cultivars could produce a marketable yield of 2 kg/plant using recommended processing tomato production methods at the low end of the recommended crop spacing as listed by Hartz et al. (2008), cherry and grape tomato growers could achieve yields exceeding 33,000 kg·ha⁻¹ marketable fruit. Maynard and Hochmuth (1997) list a good cherry tomato yield as being 600 cwt/acre. Panthee and Gardner (2006) reported that their highest grape tomato yields equaled 520 cwt/acre in a North Carolina trial. The first harvest of 'Tumbling Tom Yellow' in this trial approached one-third of their reported highest yield without the expense of trellising or multiple harvests, and in only 66 DAT.

The possibility of high yields combined with a fairly concentrated set of mature fruit seen in our limited Mississippi trial demonstrates the potential suitability of this type of cultivar and its growth characteristics for use in cherry and grape tomato breeding and production. In addition, 'Tumbling Tom Yellow' had very few cracked or rotten fruit under the conditions of our trial. This trait would also be critical to the success of any new commercial cherry and grape tomatoes. If this crop were planted in a similar manner to commercial paste tomatoes and harvested in a once-over, destructive harvest by hand or by machine, growers of cherry and grape tomatoes may see significant reductions in field establishment and harvest labor costs. The

Table 1. Plant size and yield of determinate tomato cultivars grown unstaked on raised beds at Crystal Springs, MS, in 2009.

Cultivar	Plant size (66 DAT)*			First harvest (66 DAT)		All harvests	
	Widest width (cm) ^y	Ht (cm)	Growth index ^x	Marketable yield (kg/plant) ^y	Total yield (kg/plant)	Marketable yield (kg/plant)	Total yield (kg/plant)
Basket Vee	132	48	94.4	0.17	0.3	2.6	5.1
Tiny Tim	53	32	43.6	0.11	0.1	0.4	0.7
Tumbling Tom Red	100	34	70.8	1.04	1.2	2.7	2.2
Bush Steak	102	47	80.6	0.15	0.2	3.6	6.0
Patio	50	41	43.1	0.12	0.2	1.3	1.8
Tumbling Tom Yellow	104	38	75.8	2.12	2.2	4.4	4.9
Lunch Box	126	48	83.5	0.02	0.1	1.8	2.7
Window Box Roma	53	38	43.3	0.62	0.7	1.8	2.2
Patio Princess	75	42	57.3	0.34	0.1	1.8	2.3
Fresh Salsa	100	51	77.0	0.24	0.4	1.5	3.2
LSD _{0.05} ^w	30.7	10.3	19.6	0.35	0.38	0.97	1.53

*DAT = days after transplanting.

^y1 cm = 0.3937 inch, 1 kg = 2.2046 lb.

^xGrowth index = (widest plant width + perpendicular width + height)/3.

^wLeast significant difference at $P = 0.05$.

adoption of determinate small-fruited tomato cultivars with concentrated fruit maturation will still allow small growers to profitably produce and market cherry and grape tomatoes. However, instead of harvesting by machine, the vines could be clipped by hand at the soil line, and the fruit shaken off the vine into a container. The fruit could then be field graded or taken to a covered grading and packing area to prepare them for local sale. Finally, as with many other vegetable crops, growers wishing to have an extended cropping season of cherry or grape tomatoes would simply make multiple plantings over time.

A review of five 2009 national and regional commercial vegetable seed catalogs showed that the commercial cherry tomato cultivars offered for sale were indeterminate cultivars or large, determinate types that require staking when field grown. However, even though current commercial vegetable seed vendors do not offer compact determinate cherry and grape tomato lines, the idea of using them instead of large framed plants predates our work by at least 27 years. Stall et al. (1982) published results of a study that compared determinate and indeterminate cherry tomato cultivars and breeding lines for fruit production in north Florida. Similar to our thoughts, they concluded that the compact determinate cherry tomato architecture offered a compelling alternative to traditional staked cherry tomato cultivars, especially for smaller commercial producers. It is unclear why the idea of using compact determinate cherry and

grape tomato cultivars in commercial field production has not been adopted to any great degree across the country. However, the regional nature of the publication by Stall et al. (1982) may be a contributing factor, as may the lack of prior publications suggesting a cropping system that uses once-over harvest for small-fruited tomatoes.

Based on our data and a review of the past and current state of the tomato seed and production industries, it may be concluded that growing compact determinate cherry and grape tomatoes without supporting the plants and using once-over harvest may be of value to vegetable farmers and the produce industry. We recommend that university, industry support personnel, and growers consider setting up test plantings of existing compact determinate grape and cherry tomato cultivars, and that the seed industry work on developing and expanding these product lines.

Literature cited

- Bryant, K.J., R.L. Rainey, and H. Hauk. 2004. Estimating 2004 costs of production: Arkansas irrigated tomatoes. Univ. Arkansas Coop. Ext. Serv. AG-821. 22 Mar. 2010. <http://www.aragriculture.org/horticulture/budgets/Tomatoes_Irrigated.pdf>.
- Dartt, B., R. Black, P. Marks, and V. Morrone. 2002. Cost of processing tomato production in Monroe County, Michigan. Michigan State Univ., Dept. Agr. Econ. Staff Paper 2002-41. 22 Mar. 2010. <https://www.msu.edu/~blackj/Staff_Paper_2002-41.pdf>.
- Hartz, T., G. Miyao, J. Mickler, M. Lestrangle, S. Stoddard, J. Nuñez, and B. Aegerter. 2008. Processing tomato production in California. Univ. California, Div. Agr. Natural Resources, Veg. Production Ser. Publ. 7228. 22 Mar. 2010. <<http://ucanr.org/freepubs/docs/7228.pdf>>.
- Maynard, D.N. and G.J. Hochmuth. 1997. Knott's handbook for vegetable growers. 4th ed. Wiley, New York.
- Miyao, G., K.M. Klonsky, and R.L. De Moura. 2001. 2001. Sample costs to produce processing tomatoes, Sacramento Valley, Yolo and Solano counties. 22 Mar. 2010. <<http://coststudies.ucdavis.edu/files/tomssv2001.pdf>>.
- Simmons, E.H. and G.J. Hochmuth. 2007. Soil and fertilizer management for vegetable production in Florida, Univ. Florida, Inst. Food. Agr. Sci., Hort. Ser. No. 711.
- Southeastern Vegetable Extension Workers. 2009. Southeastern U.S. 2009 vegetable crop handbook. G.J. Holms and J.M. Kemble (eds.). Vance Publishing, Lincolnshire, IL.
- Stall, W.M., S.J. Locascio, and J.J. Allen. 1982. Cherry tomato evaluations. Proc. Florida State Hort. Soc. 95:270-271.
- Panthee, D.R. and R.G. Gardner. 2006. 2006 replicated grape tomato trial. Mountain Horticultural Crops Research Station total yield data means. 22 Mar. 2010. <<http://www.ces.ncsu.edu/fletcher/programs/tomato/trials/2006grape-trial.html>>.
- U.S. Department of Agriculture. 1991. United States standards for grades of fresh tomatoes, U.S. Dept. Agr., Agr. Mktg. Serv., Washington, DC.