Integrated Pest Management
University of Missouri

DECEMBER 2019

Missouri Produce Growers *Bulletin*
A Publication of University of Missouri

High Tunnel and Greenhouse Tomato Production Nears Half of Fresh Vegetable Sales

James Quinn and John Kruse

Everyone knows how important high tunnels and greenhouses have become for fresh tomatoes, and the 2017 Census of Agriculture has documented this. Not only has it risen to 47% in auction centered counties*, it is well over half of total vegetable sales in the counties of Barton, Daviess, Moniteau and Morgan. And had it not been for the increased usage of high tunnels and greenhouses, sales of vegetables produced in these auction centered counties would have declined (as compared to 2012). If this has perked your interest, then 'read on' to review how vegetable production fared in the main produce auction counties since 2007 & 2012*.

The first table details fresh vegetable production in the open field. It is somewhat surprising to see a decline since 2012, in sales, acreage and number of farms. This decline was not consistent across the various counties, with a number posting sizeable gains (e.g. Audrain). Since 2007 sales from field vegetable production was up, sometimes greatly, for 9 of the 12 counties considered.

*** The Census provides the most comprehensive view into agriculture (by the numbers) every five years. As we did following the last Census, a number of tables have been created to specifically look at counties across the state heavily involved with growers selling to produce auctions and the produce facilities nearby Rich Hill. https://ipm.missouri.edu/MPG/2014/8/2012-Census-of-Ag-Verifies-Produce-Auction-Impact/**

In conducting the Census of Agriculture, USDA's National Agricultural Statistical Service (NASS) attempts to contact every farming operation in the state. An important part of doing this is having a good list of farms. While the list NASS has is good and well maintained, it is not complete. As farms go in and out business it is often difficult to keep up with all the changes, especially for smaller, specialty farms.

Field vegetable (fresh) in Missouri for 2007,2012, & 2017 for selected counties; number of farms with acres and sales ($1,000)

Counties	2007			2012			2017			% increase in sales over 2012	% increase in sales over 2007
	farms	acres	sales	farms	acres	sales	farms	acres	sales		
Audrain	29	42	138	23	63	222	28	103	572	158%	314%
Barton	7	87	301	25	151	606	20	89	304	-50%	1%
Dallas	29	68	314	40	121	398	27	98	447	12%	42%
Daviess	11	64	204	30	134	499	16	39	219	-56%	7%
Benton	7	57	197	8	30	120	3	11	63	-27%	-68%
Henry	11	42	215	9	47	171	2	10	58	-32%	-73%
Johnson	42	84	230	26	74	368	37	84	422	15%	83%
Pettis	14	76	187	4	6	30	7	15	83	-3%	-55%
4 County Auction	**74**	**259**	**829**	**47**	**157**	**689**	**49**	**121**	**626**	-9%	-24%
Moniteau	29	106	465	45	162	697	41	138	1,099	58%	136%
Morgan	45	121	419	34	83	333	30	97	539	62%	29%
Central Auction	**74**	**227**	**884**	**79**	**245**	**1,030**	**71**	**235**	**1,638**	59%	85%
Vernon	9	96	244	50	879	3,527	38	316	1,757	-50%	620%
Bates	14	88	308	12	84	337	9	61	499	48%	62%
Rich Hill Produce Businesses	**23**	**184**	**552**	**62**	**963**	**3,864**	**47**	**377**	**2,256**	-42%	309%
Webster	24	45	156	32	57	229	41	95	372	62%	138%
Total	271	976	3,378	338	1,891	7,537	299	1,157	6,434		
% increase from previous census				25%	94%	123%	-12%	-39%	-15%		

Yellow highlighted box for sales are adjusted as follows: acres were multiplied by average sales per acre for that year. Average sales per acre was calculated by summing sales from counties without a yellow highlight, of that given year, and then divided by the corresponding acres. Orange highlighted boxes were calculated using average farm size from the 2012 census. Green boxes were calculated by dividing total sales by the average sales per acre.

Also in this Issue:

The second and third tables** address the production from greenhouses or high tunnels, which is divided into various market uses in Table 39 in the 2017 census. The most complete information was available in the category 'Total Greenhouse Vegetables and Fresh Herbs' of which tomatoes constituted 91% of the sales. One can see from Table 2 that sales were up in most counties and surged 87% (overall) since 2012. The number of farms (again) decreased similarly to the field vegetable production just reviewed. A decline in farms of 12 to 13% is one out of eight. Why might this have occurred? The best rationale offered (to the article authors who made some inquiries on this) was that a number of Amish/ Mennonite growers 'got into it' after they lost construction employment or similar following the great recession (2007 & 2008). Now that things have picked up, a number are returning to that line of work. There are almost certainly other contributing factors as well.

** Unfortunately insufficient data existed to include Henry, Pettis and Webster counties.

Greenhouse or high tunnel vegetables and herbs in Missouri for 2007,2012, & 2017 for selected counties; number of farms with square footage and sales ($1,000)

Counties	2007			2012			2017			% increase in sales over	% increase in sales over
	farms	sq ft	sales	farms	sq ft	sales	farms	sq ft	sales	2012	2007
Audrain	5	14,552	109	13	35,281	179	15	80,999	546	206%	400%
Barton	3	7,488	56	10	36,980	173	11	83,672	605	249%	977%
Dallas	3	6,360	48	13	81,244	287	14	112,375	236	-18%	391%
Daviess	5	20,360	124	20	134,444	405	11	95,616	494	22%	297%
Benton	4	38,700	220	4	28,500	86	5	10,080	63	-27%	-71%
Johnson	4	3,850	28	12	46,200	161	7	37,836	184	14%	568%
4 County Auction	**8**	**42,550**	**248**	**16**	**74,700**	**247**	**12**	**47,916**	**247**	0%	0%
Moniteau	11	50,400	378	14	260,020	644	16	390,672	1,312	104%	247%
Morgan	15	89,740	675	17	97,553	444	20	262,517	1,701	283%	152%
Central Auction	26	140,140	1,053	31	357,573	1,088	36	653,189	3,013	177%	186%
Vernon	5	23,815	186	19	213,516	451	9	46,584	298	-34%	60%
Bates	3	6,000	43	4	28,500	86	1	5,176	25	-71%	-41%
Rich Hill Produce Businesses	8	29,815	229	23	242,016	537	10	51,760	323	-40%	41%
Total	58	261,265	1,867	126	962,238	2,916	109	1,125,527	5,463		
% increase from previous census				117%	268%	56%	-13%	17%	87%		

Yellow highlighted box for sales are adjusted as follows: square footage was multiplied by average sales per sq ft for that year. Average sales per sq ft was calculated by summing sales from counties without a yellow highlight, of that given year, and then divided by the corresponding square footage. The square foot for the operation in Bates County in 2017 is based on the average size an operation in Vernon County in 2017.

To provide a picture of total vegetable production Table 3 was created. The strong increase in sales from high tunnels and greenhouses is sufficiently large to offset the decline in field sales and lift total sales to an increase of 13% (from 2012 for the selected counties). Contrast this to the entire state, where a decline in fresh vegetable sales of 11% has occurred in those five years. Over 10 years the results are even more stark, where for these selected counties, total sales has increased 146% whereby for the state, sales only increased 19% (and 19% is less than 2% annually, which is less than the rate of inflation).

Total sales* of fresh vegetables in Missouri for 2007, 2012, & 2017 for selected counties and the entire state ($1,000)

Counties	2007			2012			2017			% increase in sales over	% increase in sales over
	Field	Covered	Total	Field	Covered	Total	Field	Covered	Total	2012	2007
Audrain	138	109	247	222	179	401	572	546	1,118	179%	352%
Barton	301	56	357	606	173	779	304	605	909	17%	155%
Dallas	314	48	362	398	287	685	447	236	683	0%	89%
Daviess	204	124	328	499	405	904	219	494	713	-21%	117%
4 County Auction (Benton & Johnson only)	427	248	675	689	247	936	626	247	873	-7%	29%
Central Auction	884	1,053	1,937	1,030	1,088	2,118	1,638	3,013	4,651	120%	140%
Rich Hill Produce Businesses	552	229	781	3,864	537	4,401	2,256	323	2,579	-41%	230%
Above	2,820	1,867	4,687	7,308	2,916	10,224	6,062	5,463	11,525	13%	146%
Statewide	32,832	3,706	36,538	43,215	5,719	48,934	32,083	11,517	43,600	-11%	19%

Several values are estimates, including field statewide value(s). A statewide average sales per acre had to be calculated for fresh vegetables (as the average with the census includes processing vegetables, which tend to be lower value). It was calculated by averaging all the counties for a given year where sales for a given county was available, and processing acreage was 0 to 10. For 2007 this was 26 counties, 29 in 2012, and 39 in 2017. This estimated that average sales per acre was $2985 in 2007, $4374 in 2012, and $3811 in 2017.

The results of the 2017 Census appears to document the rising importance of fresh vegetables coming from produce auctions and like facilities (as a percentage of what is produced in Missouri). Based on sales, these selected counties now produce over one quarter of Missouri's supply. This increase has been steady; it was 13% in 2007 and 20% in 2012. Local fresh produce is in demand and an important source of a healthy diet. The growers for auction facilities and similar businesses have become critical to this supply.

Missouri Agricultural Trends from the 2017 Census of Agriculture

In April 2019, the new Census of Agriculture results were released for Missouri. The census covers a wide range of topics but this article will focus on the changes in the number of farms by size and sales class; the number of farms by type; and the sales, revenue, and net cash income by type of farm.

The 2017 census finds that Missouri farm numbers declined from 99,171 in 2012 to 95,320 in 2017, a continuation of a long term trend. Yet Missouri continues to be second only to Texas in the total number of farms in the state. A more detailed look at farm number by size of farm suggests that farm numbers declined in all but three size class which included 1- 9 acres, 10 – 49 acres, and >2000 acres. Farms in the 220-259 acre size range had the greatest percentage decline at 14.5 percent while many of the other categories varied around 10 percent.

Of Missouri's 95,320 farms, 68 percent have sales of less than $25,000 per farm, 30 percent have sales between $25,000 and $1,000,000 per farm, and 2 percent have sales of $1,000,000 or more per farm. Farms with less than $25,000 per farm in sales, account for 3.3% of total farm sales, farms with sales between $25,000 and $1,000,000 per farm account for 42.1% of total farm sales, and farms with sales of $1,000,000 or more per farm account for 54.6% of total farm sales.

Novelty Melon Trial Results

James Quinn, Ramon Arancibia, and Dave Trinklein

Novelty, specialty or personalized melons are generally smaller and different from traditional Midwest watermelons, cantaloupes or muskmelons. A very successful example has been Sugar Cube, a smaller and sweeter cantaloupe now popular with some growers and consumers. In the summer of 2019, the Missouri Department of Agriculture funded a modest project by MU Extension, to evaluate four novelty melons on yield, quality and storage. Included in the evaluation were Brilliant (Canary), Honey Orange (crispy flesh Honeydew), Lambkin (Piel De Sapo), and Lilly (small & early Crenshaw). Each has an appearance and taste profile distinctly different from cantaloupe. The project was previously described in a December 2018 MPG bulletin article.

Planting, plot preparation and cultural notes:

Summary: for detailed description, see page 6

The above-mentioned varieties were seeded on April 29th in plastic plug trays (32 cells per tray) and greenhouse grown until 2 days before planting. They were planted on May 22nd. Two border rows were planted on May 20th (varieties Eden's Gem and Snow Leopard).

Raised beds (6) covered with white on black plastic mulch were made on May 17. Approximately 2/3rds of fertility needs was applied as pre-plant granular fertilizer to the bed tops, before covering with plastic mulch, and 1/3rd was latter via drip irrigation. Plots were 25 feet long, as 10 plants set 2.5 feet apart. Rows were 6 feet apart. Evaluation melons were replicated 4 times; border row melons 2 times.

Pests were controlled by standard commercial practices. Herbicides applied on May 20 and June 11. Field insecticide applications on May 24, June 3, and June 10. Foliar fungicide applications were made about weekly until early August.

Data Collection:

Yields: Harvest began the week of July 22-26 and continued the following 4 weeks. Sufficiently ripened fruit were picked, weighed and sorted to marketable or cull, for every plot. Two harvests occurred for each week except for the 3rd week, which had three. Data were summarized per week.

Quality Assessment: Two representative fruits, of each variety, were selected from six different harvests and measured for soluble solid percentage (Brix), exterior length & width and interior seed cavity length & width.

Storage Observation: One representative fruit for each variety was selected from the harvest on August 5th and 12th. These were stored in a CoolBot refrigerated room at 58-62 F until August 19th. Visual observations were made to the exterior and interior, soluble solids measured, and the flesh was evaluated orally for taste. Photos after storage were taken. One melon each of Brilliant, Honey Orange and Lilly was selected and a photo taken at harvest and one week later at room temperature, to determine if any color change was notable.

Consumer Acceptance: Scorecards were made for each melon, asking taste participants rate each entry from 1 (worst) to 5 (best) for (each) sweetness, flavor and texture. Eight tastings were conducted in 6 different counties on seven dates (July 23 & 31, August 1,11,15, & 28, and September 19). Properly completed scorecards collected per variety ranged from 219 to 227.

Crop Growth, Yields and Discussion:

Crop growth was excellent, no diseases were seen, cucumber beetle numbers remained less than one per plant and few weeds broke through (which were hand eliminated until mid-July). See photos.

Key yield data are presented in Table 1. Yields were very high for all varieties near or exceeding 500 cwt (100 lb) per acre. For comparison, in a 2017 production trial conducted by Purdue University, Sugar Cube produced 433 cwt (100 lb) per acre. Our only explanation for the superior yields is the weather was generally sunny, not overly hot and the pest control was excellent.

The average fruit weight was as expected for Brilliant, Lilly, and Sugar Cube. Fruits for Lambkin and Honey Orange were larger than expected from their seed catalog descriptions (3 lb fruit). The peak week for fruit maturation was July 28-August 3 (2nd week). For Sugar Cube and Lilly it was notable the percentage of total yield in the first two weeks was more than that of the other varieties trialed (80% compared to about 50% for others). All varieties except Lilly had similar culls rates. A rain event of 1.14 inches on July 29 triggered much of the cracking on Lily that resulted in the higher cull percentage. Some cracking on other varieties also occurred with this rain event, but seemed a normal or expected amount. Lilly would have yielded higher if its cull rate were similar to the others. Some varmint damage occurred, but the majority of the latter was to the border row melons.

Melon Field in Mid-June

Melon Field in Mid-July

Table 1: Marketable Fruit Yield Data

Variety Name	Fruit per plant	Av weight of fruit (oz / lb)	Weight (100 lb) per acre	Percentage mature in 1st two weeks	Percentage Cull (by weight)
Brilliant	3.9	71 / 4.4	502*	56%	9%
Honey Orange	3.9	80 / 5.0	566*	54%	11%
Lambkin	3.9	71 / 4.4	502*	49%	8%
Lilly	2.6**	120 / 7.5	557*	82%	28%**
Sugar Cube	8.2**	33 / 2.0	496*	83%	9%

* no significant difference between any varieties by weight for marketable fruit.

** significant difference

Quality Assessment:

Fruit quality data is presented in Table 2. Honey Orange was the highest for soluble solids followed by Lambkin, Brilliant, Sugar Cube and Lilly. Compared to previous Midwest variety trials, information was only available for Sugar Cube. For this study, it had lower soluble solids than reported in the 2017 Indiana trial (13.3 °Brix). For that study and a 2008 Kentucky trial, specialty melons varied from 10.6 to 17.8 °Brix, 13 to 15 °Brix being typical. As in this study, 'honeydew' type melons were generally highest.

Storage Observation:

The storage temperature was selected that is commonly used by growers to partially chill (but not refrigerate) for a short time some warm season vegetables like melons, tomatoes, cucumbers, peppers, and summer squash. Alternatively, melons sometimes are also moved by growers to an air-conditioned room (about 70 degrees F) or just put in a farm shed. One week at the CoolBot temperature would be the equivalent of 2 to 3 days in a farm shed with no cooling or 4-5 days at room temperature.

There was no decline with any of the varieties after one week, as indicated by rind surface spots or other discoloration and interior rotting, softness or poor taste. Thus, that information is not presented. Soluble solids for all melons were of expected range (see Table 2); data not presented. After 2 weeks, Sugar Cube stored the poorest and Lilly had notable decline on the exterior. The others held up remarkably well.

A question arose on whether storing certain melons would influence their coloration, especially noticeable greening of the rind or a greenish hue. After one week at room temperature, the rind of Lilly notably lost its green coloring. For Honey Orange and Brilliant the change in greenish hue was subtle, but lessened such that the former appeared whiter and the latter a deeper yellow.

See page 7 for photos.

Consumer Acceptance:

Consumer tasting was extensive, occurring on 7 dates spaced over 3 months, in 6 counties and 8 locations in Missouri. A total of over 200 scorecards successfully filled out for each of the 5 different novelty melons. The types of events or situations at which tastings were conducted included - the Missouri State Fair, a research farm field day, an extension council meeting, on the University of Missouri campus, a vegetable farm field tour, and a Master Gardener meeting.

The information gathered with the scorecards was good, but little difference could be discerned from the ratings for sweetness, flavor or texture. When a melon was good, it was good for all. Nonetheless, consumer acceptance was adequately assessed and is presented as the average of the 3 characteristics in Table 4. Between the article authors own tasting of the melons, others close to the project and consumer responses at tastings, a comments section was developed and is presented.

Table 2: Fruit dimension and soluble solids.

Variety Name	Fruit		Seed Cavity		Total Soluble Solids (°Brix)
	Fruit Length (inches)	Fruit Width (inches)	Length (inches)	Width (inches)	
Brilliant	8.1	5.9	5.3	2.6	12.7
Honey Orange	6.9	6.3	4.1	3.1	15.1
Lambkin	7.7	5.8	4.8	2.7	13.5
Lilly	10.0	6.6	6.7	3.0	11.7
Sugar Cube	4.9	4.8	2.8	2.0	12.0

Table 3: Storage observations after 14 days at 60° F.

Variety	Part	Observation	
		Visual	Taste
Brilliant	exterior	OK, but some brown speckles	
	interior	OK	Good taste, just slightly softer
Honey Orange	exterior	Small bumps turning tan	
	interior	OK	Excellent, slightly soft; appears to ripen in storage
Lambkin	exterior	Slight browning on a few cracks	
	interior	OK	Excellent, no loss of texture
Lilly	exterior	Small rot spots developing	
	interior	OK, rot is from outside	Creamy, still very good
Sugar Cube	exterior	Large rot spots developing	
	interior	Decay evident in certain places	Something is 'off', too musky

Table 4: Consumer rating and comments on fruit quality.

Variety Name	Consumer Rating	Comments	
		Texture or sweetness	Flavor or general
Brilliant	3.90	Very crispy. Tasted sweet even if °Brix less than 12.	Mild flavor, generally liked. Broadly appealing.
Honey Orange	3.63	Very crispy, but can soften if stored. Super sweet; best when °Brix 14 or above.	Subtle delicious flavors required high °Brix to perceive. If °Brix too low then less accepted.
Lambkin	3.91	Crispy flesh if less ripe or firm if ripe; good both ways. Consistently sweet.	Tropical to piney flavors appealed to many as 'different'. Consistently sweet.
Lilly	3.25	Old time melon with creamy texture appealed to specific customers. Being less sweet hurt its rating.	It's more delicate cantaloupe type flavor also appealed to certain consumers.
Sugar Cube	3.90	Firm but not crispy. Enjoyed even if Brix slightly low.	Rich, robust flavor. What many felt a cantaloupe should taste like.

Challenges regarding ripening:

Sugar Cube is excellent for the indicators it presents upon ripening. The netting turns tan and the ribbing stays greenish, lightening to tan when fully ripe. The stem easily slips when the ribbing is still greenish. All the other melons were more challenging to access ripeness. The cues and additional comments are presented for each below. Harvesting three times per week, versus two, would assist with full ripening before splitting.

- Brilliant- rind first turns bright yellow. Best sweetness if left until shift to a golden color occurs. Stem generally needs to be cut off, but can be forcibly slipped if golden color develops.
- Honey Orange- the most challenging. Rind should become very white and have minimal if any greenish hue. Some tiny bumps seem to develop sporadically on the surface. Bottom of melon should have some orange color coming through. Tiny cracks developing are a final indicator that full ripeness has been reached. These may be towards the stem end or where most exposed to the sun. Challenge to slip even at full ripeness.
- Lambkin- the green mottled rind made locating it in the foliage more difficult than any others. Yellow patches with the green needed indicating ripening. If these patches were a bit golden, was full ripeness. Could be forcibly slipped when fully ripe which further indicated ripeness; if it couldn't be tugged off, it wasn't fully ripe. If less than fully ripe, its flesh was crunchier and still had good flavor.
- Lilly- the rind needs to turn to a creamy white, with some yellow developing (the more the better). An absence of green is good, but a little is acceptable. Some small cracks near the melon tips by the stem are another ripeness indicator and there could be just a bit of softness to the rind at either end. Can be forcibly slipped at full ripeness, but usually needs to be cut.

Summary:

The results of this project should give confidence to growers interested in novelty melons, especially for Brilliant (Canary type) and Lambkin (Piel De Sapo). Both had excellent yields compared to Sugar Cube, stored better than it, and were well received by consumers. Lambkin should be marketed under a more interesting or descriptive name.

Honey Orange and Lilly should be considered more cautiously for production, although yields for both were excellent. Regarding Lilly's tendency to crack when ripe, this might be lessened by restricting irrigation. Lilly may also develop a following from consumers who feel a ripe fruit should be soft. To them the creamy texture is a real selling point.

When Honey Orange was at peak ripeness, it was enthusiastically received. Unfortunately, if not fully ripe, the flavor was less acceptable even with melons having Brix levels of 12 or 13. If a grower can't ensure his harvesters can determine ripeness, it could be challenging to market or generate consumer enthusiasm.

Three Marketing Considerations:

What's in a name?

A lot, especially to the consumer.

- **Sugar Cube is great for conveying it is 'sweeter than normal'.**
- **For any Canary type melon, calling it just that is good, as the name comes from the bright color. Sometimes it is called Juan Canary melon.**
- **Honey Orange seems adequate, but some consumers don't like honeydew melons in general. With its crispy flesh, it's not like a normal honeydew. Could a better alternative name be found?**
- **There is some recognition by some consumers of 'Crenshaw', thus marketing under this name would seem the best approach.**
- **Piel de Sapo is nonsensical for the Midwest. Translated this means 'frog's skin'. While Lambkin might be endearing to some, it explains nothing of the melon. Two interesting names, that seemed to be favorably received by a number of individuals, were 'Gator melon' and 'Dino Egg'. A grower is free to call or market a melon as he/she chooses, and this would be a good situation to do so.**

What's a consumer willing to pay for a premium melon?

Sugar Cube is a great size at around 2 lb, it often sells for $3 to $5. The average weights for Brilliant, Honey Orange and Lambkin are at least twice that, so would need to be sold for $6 to $10 (or more) to return the same revenue per area. Would the consumer pay this amount? For a typical sized Lilly, it would need to be priced (on average) at $11 to $18.

How to market wholesale?

Cantaloupes are often marketed in bins. Sugar Cube is small enough to be marketed in standard produce boxes holding 20 or 25 pounds. These melons are too large for that and big enough for a bin. Would a wholesale buyer want to purchase that many? An easy solution, if growing Brilliant, Lambkin, and Honey Orange, would be to sell mixed in a bin as they are quite similar in weight. The appearance of the three together is attractive and would provide some flexibility if their harvests are unequal.

Supplemental Information to Results from the Novelty Melon Trial

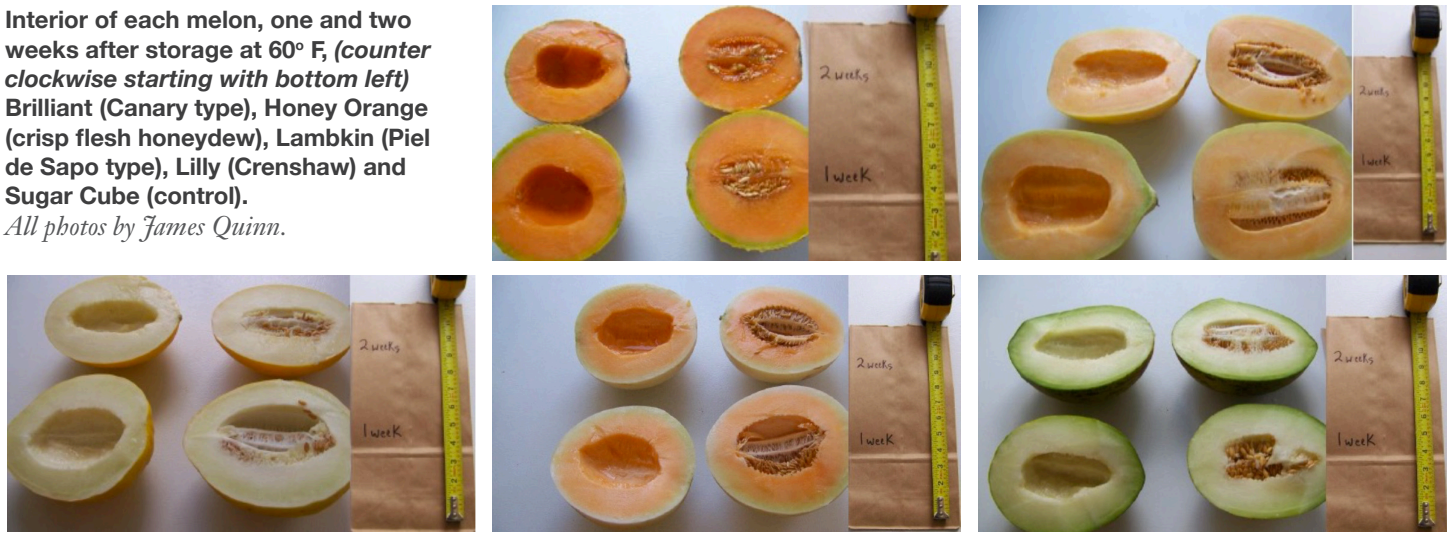
Sugar Cube (the standard or control), Brilliant, Honey Orange, Lambkin, and Lilly were seeded on April 29th in the research greenhouse range on the campus of the University of Missouri. Additionally, Eden's Gem and Snow Leopard were seeded on April 22nd to serve as border plants. All seeds were donated by Johnny's Selected Seeds (Winslow, ME). Plastic plug trays (32 cells per tray) filled with Pro-mix BX (a standard growing mix) received two seeds per cell and placed on a greenhouse bench to germinate. The seedlings were subsequently thinned to one per cell. Plants were hardened off for 2-3 days before planting which was by hand. Border rows were on May 20th and all others on May 22nd.

The area used had a mix of grasses and forbs in 2018, which was terminated in August with glyphosate herbicide. It was then tilled and seeded to buckwheat, cowpeas, radish and wheat. On March 21st glyphosate herbicide was applied on the area and turnip seed was broadcast on March 28th. The plot was field cultivated on May 14, roto-tilled on May 16 and raised beds (6) covered with white on black plastic mulch were made on May 17. Pre-plant granular fertilizer was applied to the bed tops before covering with plastic mulch at the following (actual) rates per acre: N 54, P_2O_5 88, K_2O 36. A soil test (University of Missouri Soil Lab) indicated the following additional fertilizers would benefit the crop during its growth: N 10; P_2O_5 40; K_2O 50; Ca 20 (actual rates per acre) which were applied through drip irrigation.

Plants were set into white plastic-mulched raised beds and there was no need to water in (rained that evening). All plants were sprayed with Warrior the day before planting. Each plot was 25 feet long, with 10 plants set 2.5 feet apart within the row and 6 feet between rows. Each melon variety was replicated four times in a randomized block design (excluding the border rows). Dual Magnum (1 pint/ac) and Sandea (0.7 oz/ac) were applied to aisle rows on May 20. Prowl H_2O (2 pts/ac), Sandea (0.7 oz/ac), Select (10 oz/ac), gramoxone (3 pts/ac) and crop oil concentrate (1 qt/ac) were applied on June 11. Following the latter, straw was distributed at the density of 2 bales per 1,000 sq feet.

Drip irrigation was used to provide water, when required, and the additional fertilizer recommended above. The fertigation dates were June 20 & 25 and July 9, 12,17, & 18. Plots were only watered two additional times after July 18. Field insecticide applications were as follows: Assail (May 24), Warrior (June 3), Assail (June 10). Additional insecticide applications were made on border plants only on June 20, 24, 25 and July 12. Foliar fungicide applications were made weekly (specific dates were May 28; June 3, 10, 19, 20, & 25; July 9, 16, & 22; Aug. 2 & 16). Fungicides used included Bravo, Copper Sulfate, Copper Octanoate, Mancozeb, and Rally. A beehive was placed adjacent to the plot on June 11 to facilitate.

Interior of each melon, one and two weeks after storage at 60° F, *(counter clockwise starting with bottom left)* Brilliant (Canary type), Honey Orange (crisp flesh honeydew), Lambkin (Piel de Sapo type), Lilly (Crenshaw) and Sugar Cube (control).
All photos by James Quinn.



Exterior photos of Lambkin (top) and Sugar Cube (bottom) at one week (left) and two weeks (right) after storage at 60° F.

Exterior photos of Brilliant (top), Lilly (bottom left) and Honey Orange (bottom right). Left photo is following harvest and right is one week later (stored at room temperature).

Microbial water testing results Londa Nwadike

As many of you know, the microbial quality of the water that you are using pre-harvest, as well as post-harvest is very important to the safety of your produce. In order to know the quality of the water you are using, the water must be tested regularly. Growers using municipal (rural or city) water can utilize the annual test results from the municipal water source, but for growers using ground or surface water, testing is essential. The Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR) requires produce growers to develop a microbial water quality profile (MWQP) of their agricultural water source(s) over time and Good Agricultural Practices (GAPs) auditors also require water testing. Importantly, knowing the quality of your water can help to provide a safer product to customers.

Therefore, the University of Missouri and Kansas State University Extension have been providing free microbial water testing to produce growers at our laboratory in Olathe, Kansas, through a grant from USDA. Missouri Department of Agriculture Produce Safety personnel and University of Missouri Extension personnel and others have generously helped to coordinate the pick-up and delivery of these samples to the laboratory as the samples need to arrive on ice at the lab within 24 hours to maximize accuracy.

So far, our laboratory has tested 378 water samples from 158 Kansas and Missouri produce farms. The samples were tested for generic *Escherichia coli*, an indicator of fecal contamination of water, using one of the methods allowed by both the FSMA regulations and GAPs auditors.

According to the FSMA Produce Safety Rule, the generic *E. coli* population in an agricultural water source that will likely touch the harvestable portion of the crop BEFORE harvest (for mixing chemicals, irrigation, etc.) must be less than a geometric mean (~average) of 126 CFU/100 mL over time and a standard threshold value (~range) over time of 410 CFU/100 mL. For POST harvest use (washing produce, washing hands, washing packing tables, etc), the water must have no detectable generic *E. coli*/100 mL water (generally considered to be potable water).

The complete results of our water testing are included in Table 1 below. Overall, 48% of all samples tested had no detectable generic *E. coli*, and therefore would be acceptable for post-harvest use (although any surface water must be treated before using post-harvest). Ninety-one (91%) of all samples were below the geometric mean level and EPA recreational water standard (which is what GAPs audits also require for pre-harvest water) of 126 CFU generic *E. coli*/100mL, which means that the water is readily acceptable for pre-harvest use. Notably, 6 (1.5%) of samples (all were surface water samples) exceeded 2420 CFU/100 mL, the maximum reportable value of the laboratory test. Many of these very high results were from samples taken in May 2019, when rainfall levels were extremely high, and therefore runoff into surface water sources was also high.

Surface water (pond, stream, river) samples (n=185) contained the highest percentage (85%) of positive generic *E. coli* tests, with 15% of surface water samples above the geometric mean level, 11% above the standard threshold value, and 3% above the test's maximum reportable value.

MU and KSU Extension have received another USDA grant to continue to provide free microbial water testing to MO and KS produce growers through the fall of 2022. Through this new grant, starting on January 1, 2020, MO produce growers can get their water sources used for produce (both pre- and post-harvest) tested through your local public health department for free. More details on how to complete the required submission form and other details of the free water testing are still being determined, so more information will be provided to all produce growers in the upcoming months.

We will also be providing more information on this new USDA water quality project, including additional trainings and resources related to water quality, in the upcoming months.

WHO'S WHO

MU Extension

James Quinn
Editor
573-634-2824
quinnja@missouri.edu

Dave Trinklein
State Floriculture Specialist
573-882-9631
trinkleind@missouri.edu

Jared Fogue
MU IPM Program
Media Specialist
foguej@missouri.edu

MU Extension County Specialists

Adair: Jennifer Schutter
660-665-9866

Bates: Ramón Arancibia
660-679-4167

Daviess: Tim Baker
660-663-3232

Greene: Patrick Byers
417-881-8909

Henry: Travis Harper
660-885-5556

Morgan: Joni Harper
573-378-5358

Vernon: Pat Miller
417-448-2560

Webster: Patrick Byers
417-859-2044

Table 1. Generic *E. coli* prevalence data by agricultural water source.

	Total (n=378)	Surface (n=185)	Ground (n=170)	Other (n=23)
0 MPN / 100mL	183	28	138	17
1- 126 MPN/100 mL	162	128	28	6
127-410 MPN/100 mL	11	8	3	0
411- 2420 MPN/100 mL	16	15	1	0
Above 2420 MPN/ 100mL	6	6	0	0

The Missouri Produce Growers (MPG) bulletin is published by the University of Missouri with funding support from both the Missouri Department of Agriculture (MDA) Cooperative Agreement to Enhance Produce Safety from the US Food and Drug Administration (FDA) and the USDA NIFA (National Institute of Food and Agriculture) CPPM – Extension Implementation Program.