

2018

Staff Contact

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RESEARCH REPORT Heirloom and Hybrid Tomato Variety Trial in High Tunnel

In a Nutshell:

- Farmers conducted high tunnel tomato variety trials comparing hybrid varieties Big Beef and Bigdena, and heirloom varieties Black Krim and Italian Heirloom.

Key findings

- At Lee Matteson and Rose Schick's, Big Beef produced higher yield earlier in the season, but end-of-year cumulative yield was not different between varieties. Bigdena, however, better held its fruit size throughout the growing season. At Rob Faux's, Italian Heirloom provided higher end-of-season yield than Black Krim, but the difference was not statistically significant.
- Both farms plan to continue using each of the trialed varieties, as they all performed well and are preferred by customers for different characteristics.

BACKGROUND

Growing tomatoes in the high tunnel gives farmers an early jump on the tomato market, and can help protect the plants from some environmental stressors. Typically, farmers choose hybrid tomato varieties in the high tunnel (rather than open-pollinated or "heirloom" varieties) for the hybrids' bred resistance to disease. This is the third year in a row of high tunnel tomato variety trials, but the first year to include both hybrid and heirloom varieties. Rob Faux of Genuine Faux Farm in Tripoli, said, "We would like to optimize our high tunnel tomato production, but we are committed to growing heirloom varieties on our farm. If we can better assess how well these varieties produce in the high tunnel, we can determine appropriate prices and determine whether we should investigate other varieties."

In 2016, two farmers compared Mountain Fresh Plus and Rebelski in the high tunnel, curious if the determinate variety, Mountain Fresh Plus, would provide a better yield in a short window. Yield at both farms was lower than reported in other published high tunnel variety trials, but Rebelski yield outperformed Mountain Fresh Plus; at Tim Landgraf's by 1.4 lb/plant, and by 2.1 lb/plant at Mark Queen's.^[1]

In 2017, three farms compared Big Beef to Rebelski, or Big Beef to Bigdena. No farms showed statistical differences in overall yield. The two farms that compared Big Beef and Rebelski both found that Rebelski produced more fruits and smaller fruits, consistent with the varietal descriptions. All farms decided to continue using Big Beef, and Lee Matteson and Rose Schick, who compared Big Beef and Bigdena, will continue using both varieties in the high tunnel.^[2]

Objective: Compare yield characteristics of select hybrid (Matteson/Schick) and heirloom (Faux) tomato varieties grown in high tunnels.

METHODS

This project was conducted by farmers at two Iowa farms: Rob Faux (Genuine Faux Farm) in Tripoli and Lee Matteson and Rose Schick (Lee's Greens) in Nevada. The farmers planted three or four replications of their preferred tomato varieties in randomized, replicated trials. Faux trialed the varieties Black Krim and Italian Heirloom, while Matteson/Schick collected their second year of data comparing Big Beef and

Bigdena. Varieties were selected based on farmer preference. Seeds for this trial were from Johnny's Seeds and Seed Savers Exchange. Catalog descriptions of the varieties are in **Table 1**.

TABLE 1. Seed varieties and information.

VARIETY (SOURCE)	DAYS TO MATURITY	COST (\$/500 SEEDS)	DESCRIPTION
Big Beef (Johnny's)	70	\$23.55	"Nice combination of size, taste, and earliness. Still unsurpassed as the top choice for fresh market beefsteak tomatoes. Large, avg. 10-12 oz., mostly blemish-free, globe-shaped red fruit. They have full flavor - among the best - and ripen early for their size. Broad disease resistance package. High resistance to Alternaria stem canker, Fusarium wilt races 1, 2, gray leaf spot, nematodes, tobacco mosaic virus, and Verticillium wilt. AAS winner."
Bigdena (Johnny's)	77	\$311.88	"High yields of large, flavorful fruit. Vigorous, open plants produce very high yields of uniform, 10-12 oz., red fruits that are mostly smooth with slight shoulder ribs. Very good flavor with nice internal color and quality. High resistance to Fusarium wilt races 1, 2, Fusarium crown and root rot, leaf mold, tobacco mosaic virus, tomato mosaic virus, and Verticillium wilt."
Black Krim (Seed Savers)	70-90	\$10.75	"(aka Black Crimea) Introduced to SSE by Lars Olov Rosenstrom of Sweden. Originially from Krim, Russia. Beefsteak fruits are a unique combination of violet-brown and purple-red—they turn almost black with sufficient sunlight and heat. Excellent full flavor."
Italian Heirloom (Seed Savers)	70-80	\$13.75	"Winner of SSE's 2012 Tomato Tasting. Outstanding variety from Italy. Plants are loaded with red fruits weighing over a pound. One of the most productive varieties we have grown at Heritage Farm. Excellent full tomato flavor. Ideal for slicing and canning—very little waste and easy to peel."

Prices and descriptions are from each seed company's website (accessed April 3, 2019).

Cooperators

Rob Faux - Tripoli
 Lee Matteson & Rose Schick - Nevada

Funding

Ceres Trust

Production practices including mulching, spacing, irrigation, planting dates and harvest dates were determined by farm and are detailed in **Table 2**. The number of plants per plot ranged from 16 to 20, and both farms used 24 in. by 24 in. spacing between plants. Both farms grew their own transplants, and transplanted in-ground in high tunnels; the high tunnel at Matteson/Schick was heated for early-season production.

Farmers harvested fruit as it was mature and needed for market, counting number of fruits and weighing fruit by plot during each harvest. Data were analyzed using JMP Pro 13 (SAS Institute Inc., Cary, NC) statistical software. For Matteson/Schick, a repeated measures approach was used to examine the effects of harvest date,

treatment, and their interaction on cumulative tomato yield. Due to irregular harvest dates among plots at Faux, repeated measures could not be employed. Instead, means separation among varieties was computed using Tukey's least significant difference (LSD) to examine effects of variety on end-of-year tomato yield. Statistical significance is reported at the 90% confidence level.

TABLE 2. Production practices by farm.

FARM	MATTESON/SCHICK	FAUX
Varieties trialed	Bigdena, Big Beef	Black Krim, Italian Heirloom
Start date	Jan. 11	March 10
Transplant date	Feb. 18 (heated high tunnel)	May 28, June 27
In-row spacing	24 in.	24 in.
Between-row spacing	24 in.	24 in.
Trellis style	Single leader	Two leaders; stake and weave
Management	All suckers removed; fertilizer 20-20-20 at 200 ppm N; calcium nitrate weekly once fruit set	Strip lower leaves; farm compost to high tunnel (~1 ft ³ /30ft ²); worm castings with transplant.
Harvest window dates (days)	May 29 – Aug. 21 (84)	July 31 – Oct. 21 (82)

RESULTS AND DISCUSSION

Matteson/Schick

Figure 1 shows cumulative yields through the season at Matteson/Schick's. Bold lines represent the varietal average and lighter lines show the individual plot yields. A repeated measures analysis showed that for the period of June 6 – July 9, Big Beef produced more pounds of fruit than Bigdena, but by the end of the season the production was not statistically different, with Big Beef producing an end-of-season average of 15.7 lb/plant compared to Bigdena's 16.0 lb/plant.

Matteson and Schick were interested in tracking fruit size over the season, as fruit size does matter to customers at farmers market, and they felt that Bigdena held its size better throughout the season, while Big Beef produced larger fruit early, and smaller fruit later in the season. This was supported by the data, which is displayed in **Figure 2**. Fruits from both varieties were smaller at the end of the season than at the beginning, but Big Beef started larger (average of 0.74 lb/fruit compared to 0.69 lb/fruit for Bigdena) and ended smaller (0.37 lb/fruit for Big Beef compared to 0.43 lb/fruit for Bigdena). The linear model for Big Beef showed that fruit size declined at a statistically faster rate (-0.096 oz/day) than the linear model for Bigdena (-0.064 oz/day). Bigdena held its fruit size throughout the

Cumulative Yield at Matteson/Schick

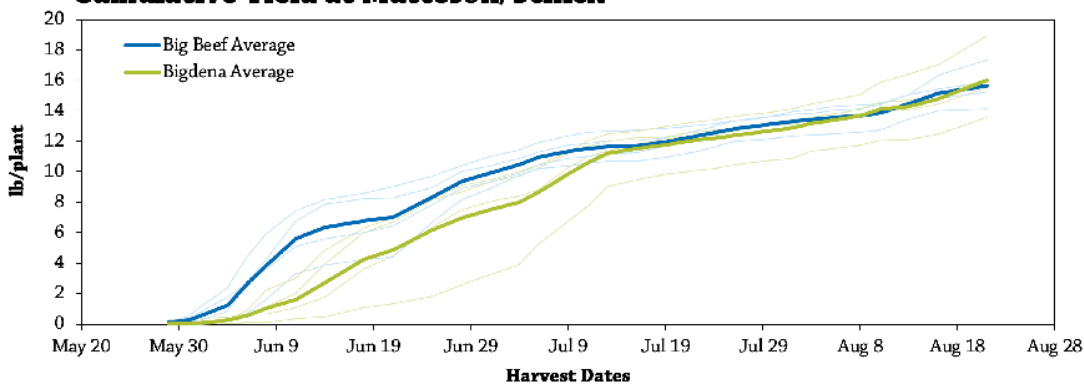


FIGURE 1. Cumulative yield shown in lb/plant at Matteson/Schick's. Bold lines are the average values for each variety; light lines are individual plot values. The last date is the final yield in lb/plant. The dotted vertical lines indicate the time period during which average yields of Big Beef and Bigdena were statistically different with 90% certainty. Final yield in lb/plant were not statistically different.

Mean Fruit Size at Matteson/Schick

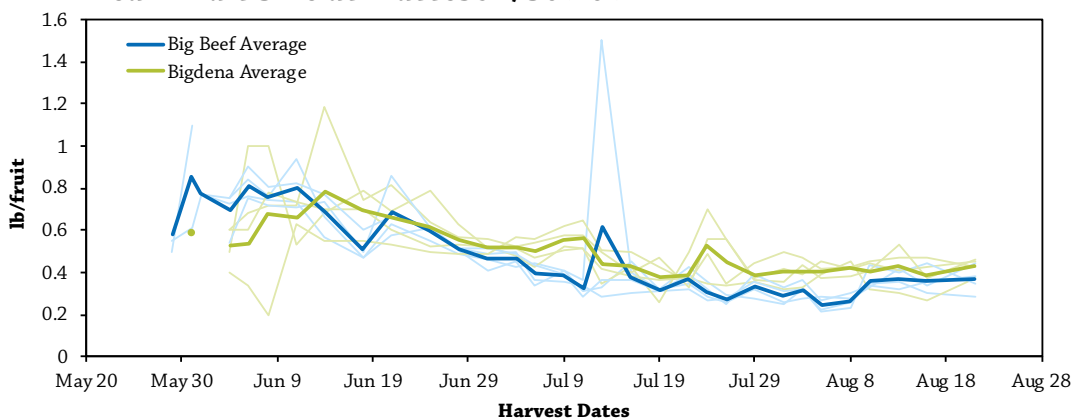


FIGURE 2. Mean fruit size of successive harvests shown in lb/fruit at Matteson/Schick's. Bold lines are the average values for each variety; light lines are individual plot values. A comparison of linear models showed that Big Beef's fruit size declined at a faster rate over the harvest season than did fruit size of Bigdena.

season better than Big Beef. End-of-season total yield values for Big Beef and Bigdena are provided in **Table 3**.

TABLE 3. End-of-season yield at Matteson/Schick's.

VARIETY	LB/PLANT	FRUIT/PLANT
Big Beef	15.7	31.6
Bigdena	16.0	30.1
LSD	2.9	5.0

By column, because mean values did not differ by more than the least significant difference (LSD), the varieties are considered statistically equal with 90% certainty.

Faux

Due to irregular harvest dates among plots at Faux's, only end-of-season values for yield characteristics are compared. Statistically, there were no significant differences in tomato yield (lb/plant or fruit/plant) or size of tomato (lb/fruit).

TABLE 4. End-of-season yield and yield components at Faux's.

VARIETY	LB/FRUIT	LB/PLANT	FRUIT/PLANT
Black Krim	0.62	5.8	9.2
Italian Heirloom	0.62	7.3	12.0
LSD	0.20	4.5	5.4

By column, because mean values did not differ by more than the least significant difference (LSD), the varieties are considered statistically equal with 90% certainty.



Black Krim (left) and Italian Heirloom (right) tomatoes grown at Faux's.

Economic considerations

Enterprise budgets were not done for this project, but a back-of-the-envelope calculation provides some insight into the effect of seed cost on overall revenue. If all seeds purchased are successfully planted, the cost per seed (and thus, per plant) ranges from \$0.02 for Black Krim to \$0.62 for Bigdena. **Table 5** shows the estimated revenue per plant, less seed cost, using the varietal yield at each farm. All of these are quality seeds, but Bigdena is a more expensive F1 hybrid. Though Bigdena has a higher price tag, Matteson/Schick achieved high enough yields such that seed cost equaled 1% of revenue; a small factor in production costs. However, if Bigdena seeds went unused or transplants failed, the seed cost would quickly diminish profitability.

TABLE 5. Estimated return on seed cost, by variety at each farm.

FARM	VARIETY	COST PER SEED (\$/ PLANT)	YIELD (LB/PLANT)	RETAIL TOMATO PRICE (\$/LB)	ESTIMATED REVENUE (\$/PLANT)	ESTIMATED REVENUE – SEED COST (\$/ PLANT)
Matteson/Schick	Big Beef	\$0.05	15.7	\$3.30	\$51.81	\$51.76
	Bigdena	\$0.62	16.0	\$3.30	\$52.80	\$52.18
Faux	Black Krim	\$0.02	5.8	\$3.30	\$19.14	\$19.12
	Italian Heirloom	\$0.03	7.3	\$3.30	\$24.09	\$24.06

Values were estimated using lb/plant from each farm, a tomato market value of \$3.30/lb, and the cost of seed in Table 1.

CONCLUSIONS AND NEXT STEPS

Matteson/Schick and Faux each compared two tomato varieties in randomized, replicated trials their high tunnels. Matteson/Schick, in a heated high tunnel, compared Big Beef and Bigdena (hybrids), while Faux compared Black Krim and Italian Heirloom (open-pollinated heirlooms). At Matteson/Schick's, Big Beef had statistically higher yield until July 9, at which point cumulative yield from Bigdena caught up, and yields between the two varieties were not statistically different. Bigdena's fruit, however, held its size better throughout the season, while Big Beef produced larger tomatoes early and smaller fruits at the end of the season. At Faux, end-of-season yields were not statistically different between the two varieties, and the varieties both had an average fruit size of 0.62 lb/fruit.

Schick and Matteson want tomatoes ready early in the season, and Big Beef is an early starter. However, the combination with Bigdena has advantages, too. "Big Beef has better name recognition at the farmers market, and its harvest started sooner. But it seems to do the traditional bell curve for harvest with tomato size declining as the season goes along which decreases the amount that can be sold to restaurant customers and more



Tomatoes in the heated high tunnel at Matteson/Schick's on April 3.

have to go to seconds," said Schick. She continued, "It seemed to us that Bigdena has two flushes. Its harvest starts later than Big Beef, has a flush (in July), then has another one later (in late August)."

Faux noted that "if you can only pick one heirloom tomato variety, it should be Italian Heirloom." In past years, Faux's farm records indicate that fruit size of Italian heirloom was typically 0.75 lb/fruit, and that he typically expects 20 fruit/plant. In comparison to his expectations, 2018 was a mediocre tomato season. Faux also notes that the plants themselves are on the small-side and a "bit wispy", but the production from them is excellent. The only issue he has with Italian Heirloom is occasional sunscald because there is less leaf cover.

Faux prefers Black Krim for a gourmet tomato. Also a smaller plant, he notes that they like warmer and drier weather; the opposite of the 2018 growing season. He also noted that because they are a black variety (rose-colored with greening/blackish shoulders), deciding when they are ripe is more difficult.

APPENDIX – WEATHER CONDITIONS

TABLE A1. Weather data for 2018 and historical averages.

MONTH	MATTESON AND SCHICK: NEVADA				FAUX: TRIPOLI			
	GROWING DEGREE DAYS (BASE 50 °F)		DAILY HIGH TEMP °F		GROWING DEGREE DAYS (BASE 50 °F)		DAILY HIGH TEMP °F	
	2018	AVG.	2018	AVG.	2018	AVG	2018	AVG
April	98	182	50	61	83	154	47	58
May	519	379	79	72	499	352	77	70
June	674	594	83	81	646	561	82	80
July	700	714	84	85	686	670	83	83
August	668	654	82	82	654	611	82	81
September	498	450	76	76	465	416	75	74
October	145	217	58	63	129	190	57	61

Monthly growing degree days and average daily high temperature for the current year and historical averages are reported from the nearest weather station. Climate data were accessed from the Central and Tripoli weather stations.^[3] Historical data include years 1980-2018.

REFERENCES

1. Kolbe, L., T. Landgraf and M. Quee. 2016. Determinate Tomato in High Tunnel, Variety Trial. Practical Farmers of Iowa Cooperators' Program. <https://practicalfarmers.org/research/determinate-tomato-in-high-tunnel-variety-trial/> (accessed April 2019).
2. Kolbe, L., T. Landgraf, L. Matteson, M. Quee and R. Schick. 2017. Tomato in High Tunnel, Variety Trial. Practical Farmes of Iowa Cooperators' Program. <https://practicalfarmers.org/research/tomato-in-high-tunnel-variety-trial/> (accessed April 2019).
3. Iowa Environmental Mesonet. 2019. Iowa Environmental Mesonet. Iowa State University Department of Agronomy. <http://mesonet.agron.iastate.edu/> (accessed March 2019).



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