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Horticulture Research

Determinate Tomato in High Tunnel, Variety Trial

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In a Nutshell

- Two farms conducted replicated variety trials in high tunnels of two determinate tomato varieties, Mountain Fresh Plus and Rebelski.

Key Findings

- Yield at both farms was lower than yields reported in other published high tunnel variety trials.
- Rebelski yield was higher at Landgraf's, with 1.4 lb/plant difference.
- Rebelski yield was also higher at Quee's, with 2.1 lb/plant difference.

Project Timeline:

May 2016 - September 2016

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. Indeterminate tomatoes are often grown in high tunnels because they will continually bear fruit and ripen over a longer period of time. Farmers in this study, however, wanted to use a determinate tomato variety, which ripens during a shorter window, to more quickly make space for a fall crop after tomato harvest. In this project, two farmers selected two determinate tomato varieties (Mountain Fresh Plus [MFP] and Rebelski) to trial inside their high tunnels. These varieties were selected based on positive farmer experience, the varietal similarities, and the availability of organic and untreated seed, donated by Johnny's Seeds. Catalog descriptions of the varieties can be seen in **Table 1**.

No publications were available showing MFP and Rebelski in head-to-head trials, in the field or in a high tunnel. Separately, both varieties were tested in high tunnel variety trials around the country. In a New Hampshire variety trial, Rebelski tied with Arbason for highest yield per plant (14 lb/plant), averaged 11 oz per fruit, and 74% of fruits were marketable (Sideman and Warren, 2013). In a Rhode Island study, however, Rebelski tomatoes had an internal discoloration and green core, potentially due to a potassium deficiency or heat. Though the plants were strong, producing 21.4 marketable lb/plant and 10.7 oz/fruit, taste was lacking and the variety was not recommended (Radin, 2014).

In a Kansas variety trial, MFP was among 10 varieties tested. MFP had the most marketable fruit per plant (41.5), but because the fruit were among the smallest at 5.4 oz/fruit, the yield per plant of MFP fell in the middle of the group at 14.3 lb/plant. The harvest window in the high tunnel was June 27 – Sept. 13 (78 days); MFP was noted as better later in the season (Rivard et al., 2014).

Trellised tomatoes in the high tunnel at Landgraf on July 11. Plants were kept to two leaders.

"We have grown determinate tomatoes in our high tunnel for many years, and are always interested in finding a better fit as to quality and productivity," said Landgraf. Quee, who regularly uses Rebelski for indoor production said, "I'm pretty happy with our indoor tomatoes, the seeds are expensive. Taking part in this trial might help me find a cheaper alternative or establish that the more expensive seeds are worth the added expense."

Table 1

Varietal information from Johnny's Selected Seeds 2016 Catalog

Variety	Days to Maturity	Cost ($/500 seeds)	Disease Resistance	Description
Mountain Fresh Plus (MFP)	75	$27.55	High Resistance to: Fusarium Wilt 1 & 2, Nematodes, Verticillim Wilt	"The most widely grown market tomato in the East and Midwest. Able to tolerate cool and wet conditions, this big red tomato produces attractive 8-16 oz slicers."
Rebelski	75	$408.00	High Resistance to: Fusarium Wilt 1 & 2, Verticillim Wilt, Fusarium Crown and Root Rot, Leaf Mold, Powdery Mildew, Tobacco Mosaic Virus	"Greenhouse tomato for fresh market. Rebelski combines very good flavor, texture, presentation, and an excellent disease package. Bright red, shiny, ribbed fruits avg. 7-8 oz, and are crack-resistant. Enough firmness to withstand some handling. An excellent disease package keeps the crop healthy over a long season. Very high yield potential."

Methods

This project was conducted at two Iowa farms: Tim Landgraf (One Step at a Time Gardens in Kanawha) and Mark Quee (Scattergood Farm at Scattergood Friends School in West Branch).

Each farmer planted four replications of the two tomato varieties inside a high tunnel in a randomized, paired trial. Landgraf used 10 plants per plot, Quee used 15 plants per plot. Spacing, mulch, trellis style, and planting date were determined by farm, and noted in Table 2. Plants for the trial were started indoors and transplanted to the high tunnel (in-ground). The tomato varieties chosen were Mountain Fresh Plus (MFP) and Rebelski. All seed for this trail was provided by Johnny's Selected Seeds.

Farmers harvested, counted and weighed tomatoes as fruit matured. Harvest windows are noted in **Table 2**.

Table 2

Production practices and trial design by farm

Farm	Tim Landgraf	Mark Quee
Start Date	March 28	March 1
Transplant Date	May 26	April 13
In-Row Spacing	16 in.	24 in.
Between-Row Spacing	48 in.	36 in.
Trellis Style	Florida weave	Teepee-type string to purlin
Management	2 leaders; Strip lower leaves; Copper spray; Farm compost to high tunnel (~1 ft3/30ft2); Worm castings with transplant.	Single leader; Pruned suckers; 1 qt worm castings with each transplant; 2 rows of cowpea between tomato rows.
Plants per Plot	10	15
Number of Reps	4	4
Plot ft²	53.3	90
Transplant to Harvest, Days	67	80
Harvest Window Dates; Days	Aug. 1–Sept. 26; 54	July 2-Aug 25; 56

Data were analyzed using JMP Pro 12 (SAS Institute Inc., Cary, NC) and comparisons among measured variables employ least squares means for accuracy. A repeated measures approach was used to examine the effects of harvest date, treatment, and their interaction on cumulative tomato yield. For some yield characteristics (percent cull, fruit weight) means are compared using Tukey's least significant difference (LSD). Statistical significance is reported at the $P \leq 0.10$ and $P \leq 0.05$ levels.

Results and Discussion

Monthly growing degree days and mean maximum daily temperature for the current year and historical averages are reported from the nearest weather station to each farm (**Table 3**). Because tomatoes were grown inside high tunnels, rainfall is not reported. 2016 had warm June, but otherwise GDD and mean maximum temperatures were not different than historical averages.

Table 3

Monthly Growing Degree Days (GDD) (Base 50°F) and Mean Maximum Daily Temperature for May 2016 - Sept. 2016*

Month	Tim				Mark			
	GDD		Mean Max. Daily Temp. ˚F		GDD		Mean Max. Daily Temp. ˚F	
	2016	*Avg.*	*2016*	*Avg.*	*2016*	*Avg.*	*2016*	*Avg.*
Apr.	166	163	59	59	192	210	62	62
May	341	365	69	72	390	418	72	73
June	607	564	83	80	681	616	87	82
July	664	695	81	85	711	741	83	87
Aug.	638	637	81	83	728	691	84	85
Sept.	418	427	76	75	573	489	81	78

*Temperature and growing degree day data accessed from weather stations nearest farm locations (Iowa Environmental Mesonet, 2016). Mark: Iowa City; Tim: Iowa – North Central Climate Division.

Figure 1 shows cumulative yields through the season at each farm. Bold lines represent the varietal average and lighter lines show the individual plot yields. Using repeated measures analysis, average yields for Rebelski were statistically greater than MFP at both farms. The vertical dotted lines in **Figure 1** represent the date at which cumulative yields of the two varieties became (and remained) different at each farm (Sept. 5 at Landgraf; July 31 at Quee).Though the farmers' harvest windows were offset by 30 days (Landgraf earlier), at both farms Rebelski overtook MFP 4-5 weeks into harvesting.

Yield per plant and yield components for the two tomato varieties by farm can be seen in **Table 4**. At each farm, yield and fruit count was statistically different between varieties, as shown in **Figure 1** and **Table 4**. Fruit weight, however, did not differ between the two varieties at either farm. At Landgraf, Rebelski had an average of six more marketable tomatoes per plant, resulting in 1.4 lb more fruit per plant ($P \leq 0.10$). At Quee, Rebelski had an average of 3.4 more tomatoes per plant, resulting in 3.1 lb more marketable fruit per plant ($P \leq 0.10$). Overall, Landgraf had lower yields than Quee due to smaller fruit size (around 0.35 lb per fruit instead of 0.50 lb per fruit). The percent of cull fruit was low at Landgraf, and not statistically different between MFP and Rebelski. At Quee, Rebelski had 10% more cull fruit than MFP ($P \leq 0.10$).

Figure 1

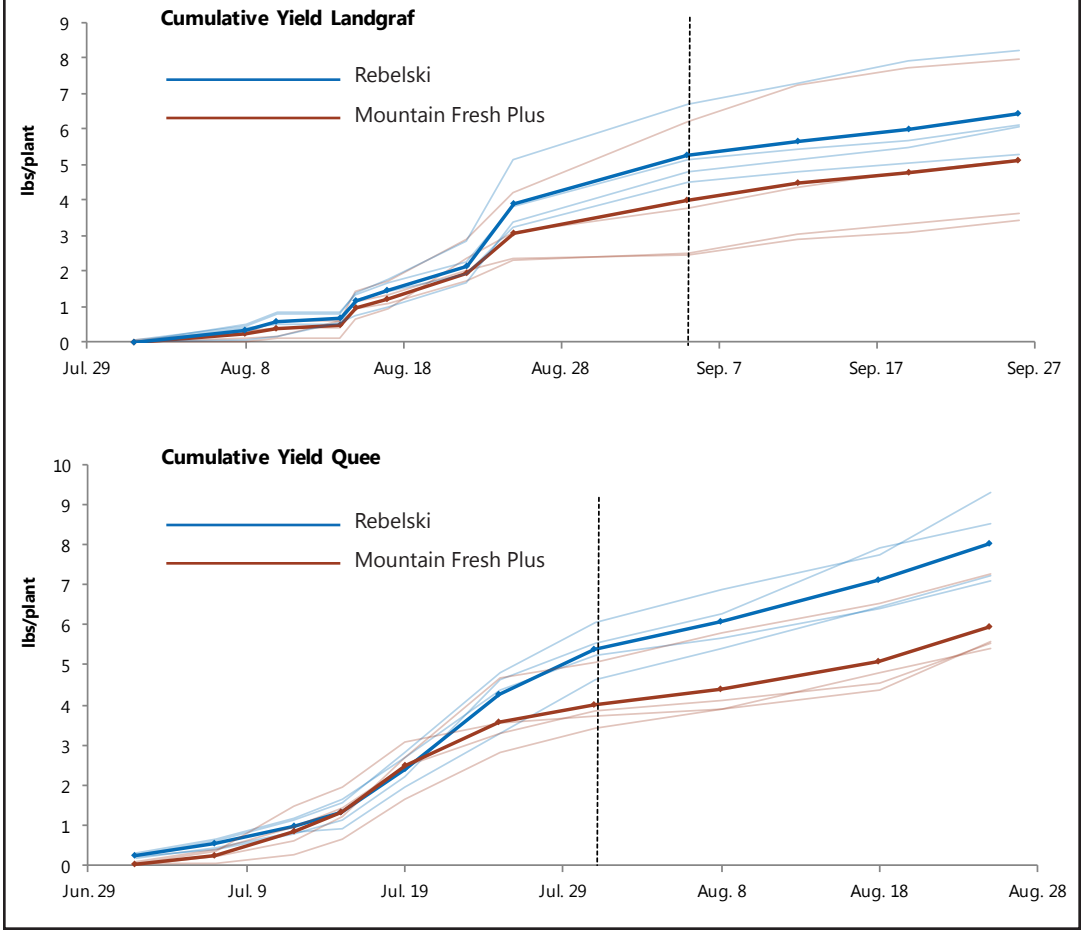

Figure 1. Cumulative yield shown in lb/plant at each farm. Bold lines are the average values for each variety; light lines are individual plot values. The last date is the final yield. The dotted vertical lines indicate the date at which average yields of Rebelski and MFP became and remained significantly different at $P \leq 0.10$.

Table 4

End-of-season yield and yield components for the two tomato varieties at each farm

Farm	Yield (lb/plant)		Fruit Count (no. fruit/plant)		Fruit Weight (lb/fruit)		Cull Fruit (% no. of fruit)	
	MFP	*Rebelski*	*MFP*	*Rebelski*	*MFP*	*Rebelski*	*MFP*	*Rebelski*
Landgraf	**5.0***	**6.4**	**13.9**	**18.9**	0.36	0.34	0.085	0.026
Quee	**5.9**	**8.0**	**11.4**	**14.8**	0.50	0.54	**0.19**	**0.29**

*By farm, values in bold are significantly different at $P \leq 0.10$ using Tukey's LSD.

July 19 tomato harvest being weighed at Quee. MFP is on the scale.

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) is $0.06 for MFP and $0.82 for Rebelski. If tomato retail tomato price is assumed to be $3.30/lb, both farms would make more revenue per plant using Rebelski when factoring in seed cost (**Table 5**). However, if Rebelski seeds went unused or transplants failed, the seed cost would quickly diminish profitability. A full enterprise budget could show if labor and other inputs (pest and disease management) differ by variety.

Table 5

Estimated revenue per plant, less seed cost, by variety at each farm*

Farm	Variety	Cost per seed (Cost per plant)	Yield (lb/plant)	Retail tomato price ($/lb)	Estimated revenue ($/plant)	Estimated Revenue – Seed Cost / Plant
Landgraf	MFP	$0.06	5.0	$3.30	$16.50	$16.44
	Rebelski	$0.82	6.4	$3.30	$21.12	$20.30
Quee	MFP	$0.06	5.9	$3.30	$19.47	$19.41
	Rebelski	$0.82	8.0	$3.30	$26.40	$25.58

*Values were estimated using lb/plant from **Table 4**, a tomato market value of $3.30/lb, and the cost of seed in **Table 1**.

Conclusions and Next Steps

Landgraf was impressed with the performance of the disease package in Rebelski, and noted that it appeared viable longer. He also noted that Rebelski acted more as a semi-indeterminate than a determinate variety. But even with high yields and better disease resistance in Rebelski, he is not changing his production to Rebelski. As a grower, Landgraf is looking for size and flavor. During the farm's field day in August, MFP was the winner in a tomato taste test featuring 16 varieties. His favorite high tunnel variety, Big Beef, was not tested in this project. "As a hybrid slicer in the high tunnel," said Landgraf, "Big Beef produces a larger slicer than either Rebelski or MFP." He also added that the expensive seed makes Rebelski somewhat cost prohibitive.

Quee did not find either variety "particularly inspiring" for flavor, but was pleased with the productivity from the high tunnel in a year where field tomatoes did poorly. He recalled that Rebelski were bigger, typically, but was pleasantly surprised with the production of MFP. "I think I'll definitely plant both again," said Quee. "Rebelski has been a big performer for me, and I wonder, as we have more years of tomatoes in the high tunnel, if the disease resistance package of Rebelski will become more important." Quee also noted that his trellising system failed twice under the weight of the plants, which shortened his harvest window.

Tomato plants beginning up the teepee style trellis in Quee's high tunnel on May 11.

Young tomato plants in the high tunnel at Landgraf on June 9. MFP are the shorter plants.

References

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