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Introduction

Typical vegetable cultivar yield trials are very labor intensive and require extensive contiguous areas for replicated plots. Often the results from even these well-designed experiments are of limited interest to refereed journals, thus there is little incentive for university faculty to conduct these types of trials. Every year new vegetable cultivars are introduced, and there is intense interest from commercial growers and home gardeners to learn if the new cultivars will perform better than the current standards in their particular region. In response to these conflicting demands, a new type of multilocational trial was initiated with assistance from Master Gardener groups, based on Citizen Science principles. Citizen Science is a participatory system of conducting research involving nonscientists in the collection of research data. It has been used in other vegetable production studies (Gittleman et al. 2012).

Materials and Methods

Each year Kansas State University Research and Extension Master Gardener (MG) groups receive flats of selected tomato and pepper cultivars for planting in demonstration or community gardens. Information on the study methodology is provided to each group. In exchange for these "free" plants, the MG groups are required to collect various types of data throughout the season, entering their observations on standardized forms. Participants are instructed to establish and manage all the plants using uniform spacing and cultural practices at each site. Data recorded include information about the garden plot, such as soil texture, tillage depth, fertilization, irrigation, transplanting dates, plant spacing, and care. Observational data is recorded at least 3 times during the season, where the new cultivars are compared to a common standard in terms of vigor, disease resistance, relative yield, uniformity, and cracking (Table 1). A simple 3-point scale is used, with a rating of 1 for poor performance, 2 for fair performance, and 3 for good performance. If a new cultivar earns an identical numerical rating to the check, to further compare the two cultivars, a plus (+) is added to denote that the new cultivar is better than the check, a zero (0) indicates they are equivalent, and a minus (-) for new cultivars that are judged inferior to the check. A similar relative-comparison system is used in the All-America Selections^{R} vegetable trials (Lawson 2013). A column is provided for comments.

Table 1. Example rating sheet.

Please rate all the varieties on a 1=poor, 2=fair, and 3=good scale Please also compare the test varieties with the "check" and rate them better (+), worse (-) or same (0) (Thus, the boxes of the test varieties will include two entries, i.e., 2+)							
Plant Characteristics				**Fruit Characteristics**			
Variety	**# Plants**	**Vigor**	**Disease Resistance**	**Relative Yield**	**Uniformity**	**Cracking**	**Comments**
Jetstar-Check	6	3	3	2	3	2	Sunscald
Country Taste	6	3 -	3 0	2 -	2 -	3 +	
Big Beef	5	3 +	3 0	3 +	3 -	2 -	
Pink Beauty	6	3 0	3 0	3 +	3 +	3 +	
Mr. Ugly	6	2 0	3 0	1 -	2 -	2 0	Blossom end rot

Each planting location is treated as one replication, with observational data being collected at 6 to 10 sites per year. Yield data is also recorded at 2 to 3 sites each year. Observations from these multiple trial sites are then used to evaluate both current recommended cultivars and potential new cultivars.

The best performing cultivars in a particular year are retained in the trial for next year to confirm, while poorly performing cultivars are usually dropped and replaced by a new cultivar for next season. Reported here are the summary of the tomato trials conducted from 2007–2013. The primary goal of this study was to identify the best performing tomato cultivars to help update the list of K-State recommended vegetable varieties.

All the plants were started from seeds direct-sown into plastic 6-packs which were raised in the greenhouse. Each group gets a flat containing 6 plants each of 10 different cultivars. The check cultivars have varied from year to year, depending on available seed. Crista (four times), Celebrity (twice), and Amelia (once) have been used for the determinate type tomatoes. Jetstar has been used for all years except one, when Jetsetter was used as the check cultivar for the indeterminate types.

Results

The cultivars evaluated in the trials are listed in Table 2 (indeterminates) and Table 3 (determinates). A total of 11 indeterminate and 23 determinate cultivars have been assessed with this system. As an example of the results, mean ratings for yield, uniformity, and cracking are shown in Figures 1 and 2 for indeterminate and determinate cultivars assessed in 2012. The n values shown are the number of plants of each cultivar the rating is based on. From Figure 1, it can be seen that Pink Beauty was rated higher in yield, uniformity, and resistance to cracking, whereas Mr. Ugly was rated lower in all parameters. The other two cultivars examined, Big Beef

and Country Taste, were very similar to the check Jetstar, although Big Beef was more prone to cracking in 2012.

Results for determinate varieties show greater yield in 2012 for Florida 91, Primo Red, and Charger, whereas all cultivars exhibited fewer cracking defects than the check Celebrity, except for Charger, which was similar (Figure 2).

Table 2. Indeterminate tomato cultivars evaluated.

2007	2008	2009	2010	2011	2012	2013
Jetstar-Check	Jetstar-Check	Jetstar-Check	Jetstar-Check	Jetsetter-Check	Jetstar-Check	Jetstar - Check
Big Beef	Big Beef	Jetsetter	Pink Beauty	Big Beef	Big Beef	Big Beef
Beefy Boy	Conestoga	Country Taste	Country Taste	Country Taste	Country Taste	Abraham Lincoln
	Grandma's Pick			Conestoga	Abraham Lincoln	
				Mr. Ugly	Mr. Ugly	
					Pink Beauty	
					Grandma's Pick	

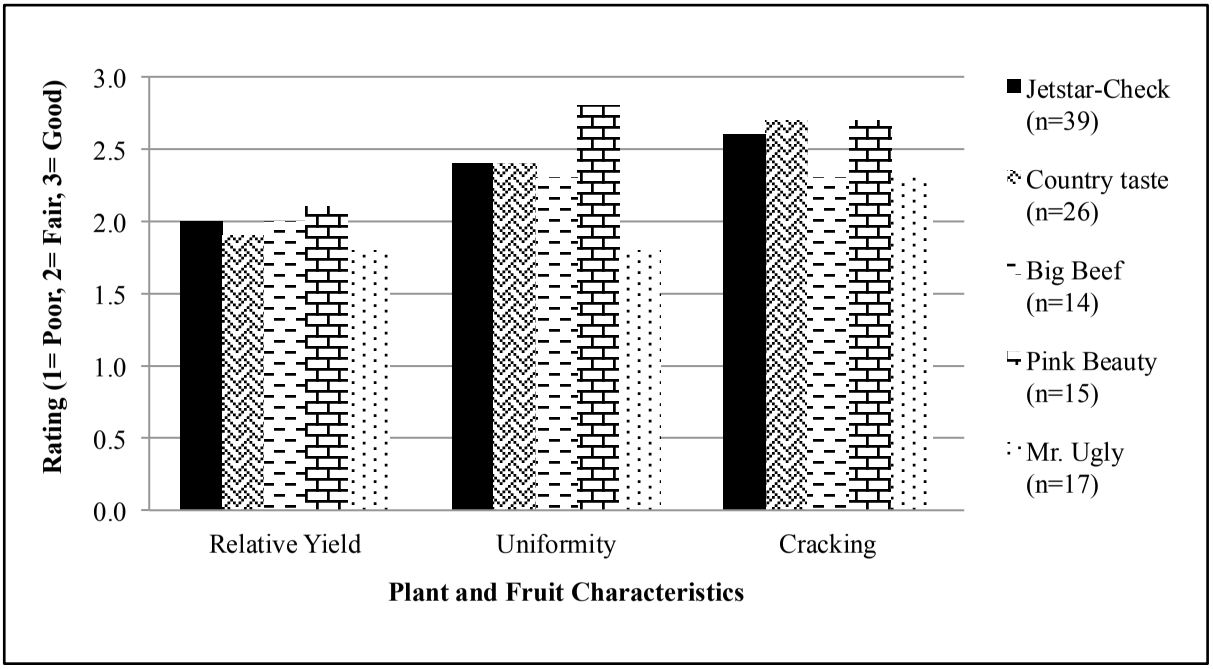

Figure 1. Indeterminate tomato cultivar ratings — 2012.

Table 3. Determinate tomato cultivars evaluated.

2007	2008	2009	2010	2011	2012	2013
Celebrity-Check	**Crista-Check**	**Crista-Check**	**Amelia-Check**	**Crista-Check**	**Celebrity-Check**	**Crista – Check**
Crista	Amelia	Road Runner 3	Road Runner 3	Tribeca	Defiant	Defiant
BHN 602	BHN 602	Security 28	Security 28	BHN 602	BHN 961	BHN 964
Florida 91	Florida 91	Florida 91	Valley Girl	Florida 91	Florida 91	Red Deuce
RFT-6153	RFT 6153	RFT 6153	Mt. Fresh	Mt. Fresh	Mt. Fresh	Hy Beef
Sunmaster	Scarlet Red	Scarlet Red	Scarlet Red	Hy Beef	Charger	Charger
		Husky	Primo Red	Primo Red	Primo Red	Red Bounty
		Red Defender		Fabulous	Fabulous	
		Mt. Glory		Mt. Glory		
				Red Defender		

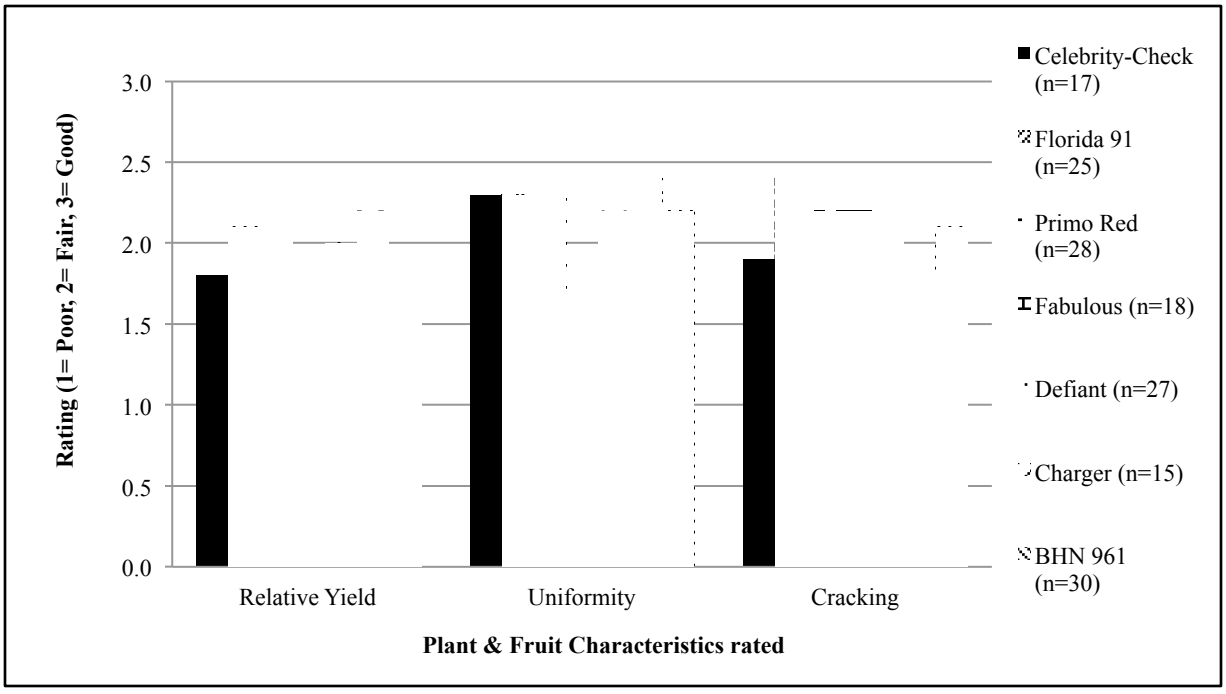

Figure 2. Determinate tomato cultivar ratings — 2012.

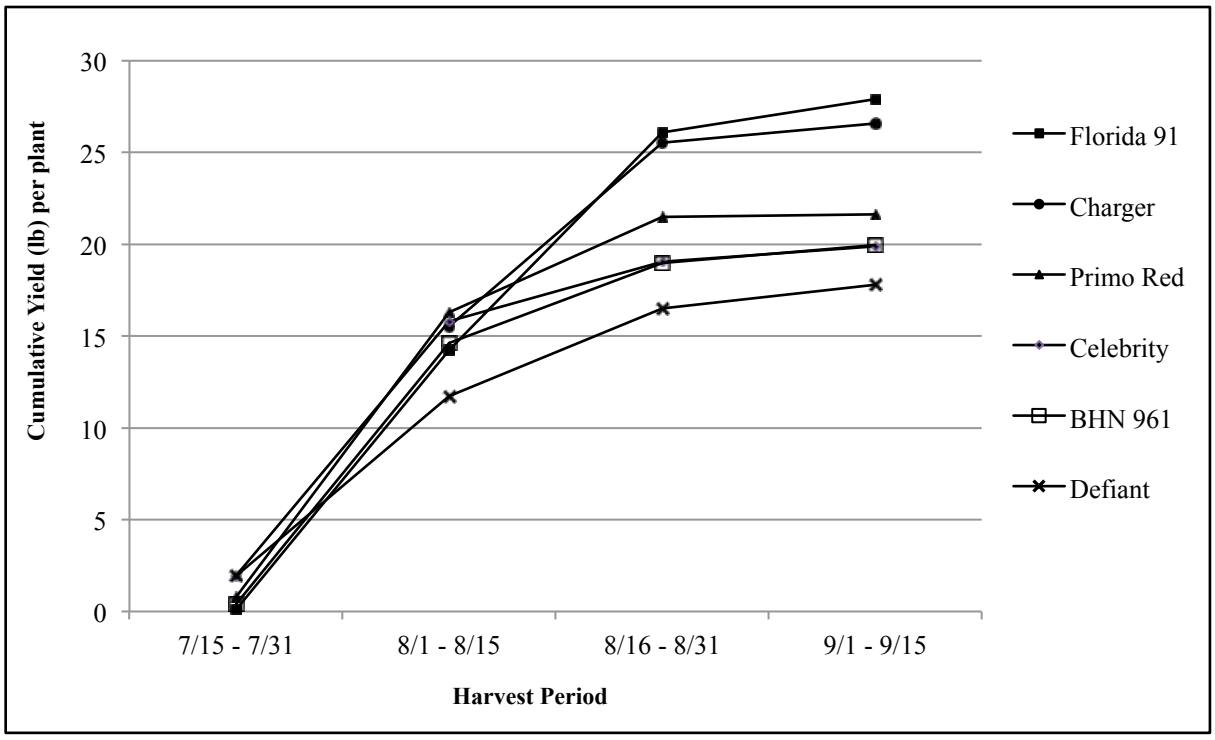

Figure 3. Yield data recorded at St. Joseph, MO, for determinate tomato — 2012.

Yield data from the St. Joseph, MO, site is shown in Figure 3. The top two yielding cultivars (Florida 91 and Charger) each averaged over 25 lb/plant. The check cultivar Celebrity and BHN 961 each yielded 20 lb/plant, with Primo Red slightly above, and Defiant slightly below this value. These yield results are consistent with the mean rankings provided by the other sites, with the exception of the total yield of Defiant. Defiant is a smaller-fruited cultivar, and averaged over 70 fruit per plant at that location, whereas other cultivars produced between 38–55 fruit per plant (data not shown).

After several years of good performance compared to popular check varieties, the new cultivars will be added to the Kansas State University Horticulture Report "Recommended Vegetable Varieties" (Carey et al. 2009). Although Big Beef did not distinguish itself in 2012, it has proven to be an excellent variety with performance exceeding the check in 3 out of 5 years and equaling the check one year (Table 4). No other indeterminate cultivar has surpassed Jetstar more than half the time.

Table 4. Recommended indeterminate tomato cultivars.

Cultivar	Performance Exceeds Check	Sources
Jetstar	Check	HR, PT, HPS, TGS
Jetsetter	Check	TW, HPS
Big Beef	3 / 5 (1 time equal)	HR, RU, SW, ST, TW, JS, HPS
Abraham Lincoln	1 / 2	HPS
Conestoga	1 / 2	HR, ST
Grandmas Pick	1 / 2	SW, TW
Pink Beauty	1 / 2	JS
Country Taste	1 / 4	PT, HPS
Beefy Boy	0 / 1 (1 time equal)	PA

Table 5. Recommended determinate tomato cultivars.

Cultivar	Performance Exceeds Check	Sources
Amelia	Check	HR, SW, TW
Crista	Check	HR
Celebrity	Check	HR, RU, SW, ST, TW, JS, PT, TGS
Defiant	2 / 2	JS
Charger	2 / 2	RU, SW, JS, HPS, TGS
Hy Beef	2 / 2	ST
Sunmaster	1 / 1	
BHN 964	1 / 1	RU
Red Deuce	1 / 1	SW
Red Bounty	1 / 1	HR, SW
Florida 91	3 / 5 (1 time equal)	SW, TW, TGS
Primo Red	2 / 3	HR, SW, ST
Red Defender	1 / 2	HR
RFT 6153	1 / 3 (1 time equal)	SW
BHN 602	1 / 3 (1 time equal)	SW
Scarlet Red	1 / 3	HR, SW, ST
Mt. Fresh	1 / 3	HR, SW, ST, TW, JS, HPS
BHN 961	0 / 1 (1 time equal)	SW
Fabulous	0 / 2 (1 time equal)	PA

Considering the determinate cultivars, Florida 91 has been rated better than the check cultivar in 3 out of 5 years (Table 5). Several cultivars have earned better ratings in both years that they have been evaluated, including Defiant, Charger, and Hy Beef. Primo Red has exceeded the check in 2 out of 3 years. Cultivars that need more evaluation, but that have exceeded the check cultivar in the one year that they were evaluated, include BHN 964, Red Deuce, and Red Bounty.

Determinate cultivars that have performed poorly in both years they were evaluated include Mt. Glory, Security 28, and Road Runner 3 (Table 6). Fabulous did not outperform the check in either year it was evaluated, but was rated equivalent once.

Table 6. Determinate cultivars that have performed poorly.

Cultivar	Performance Exceeds Check
Mt. Glory	0 / 2
Security 28	0 / 2
Road Runner 3	0 / 2
Husky	0 / 1
Valley Girl	0 / 1
Tribeca	0 / 1

Conclusions

Replicated field plot data is still the preferred measure of vegetable production performance. However, when this data is not available locally, the authors feel the multilocational observational data reported here has some value, particularly when consistent results are obtained over several years. Most state Extension programs have a cadre of Master Gardeners, and with the explosion of interest in community gardens and local food production there is increasing interest in local vegetable performance trials.

References

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