Participatory variety trials for flavor, quality and agronomic performance to increase direct-market opportunities and on-farm trialing capacity for organic growers

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ABSTRACT

Sales to local food markets can be a valuable opportunity for organic producers. Access to these markets depends on raising high-quality produce. Given their unique environments, organic farmers benefit from a better understanding of which varieties are likely to perform well on their farms, and meet the quality criteria of their customers. This research evaluates diverse varieties of nine species of common vegetable crops for agronomic performance and culinary quality. Trials were grown on eight organic farms in the Madison, WI region, and on organic land at the West Madison research station. Outcomes include productivity data that is immediately useful to organic farmers and plant breeders, as well as detailed information about how four local chefs perceive the flavor and over-all quality of each variety. This research also laid an important foundation for future collaborative research and plant breeding to develop excellent varieties for organic production in the upper Midwest.

Introduction

Nationwide, the demand for direct-market organic produce is growing. According to the USDA local food sales increased from $1 billion in 2005 to $6.1 billion in 2012; and the market for organic produce has seen double-digit growth over the last 20 years (USDA-ERS, 2015). Nonetheless, Lammerts van Bueren estimates that 95% of crops grown on organic farms are not bred for organic environments (Lammerts van Bueren et al., 2014). Furthermore, relatively few breeding programs focus on adaptation to a "region of intended use," aiming instead for broad adaptation to a wide range of environments (Hoagland et al., 2015). This puts organic farmers at a disadvantage, since few varieties they rely on are selected for optimal performance in organic systems, and fewer still are selected for adaptation to farmers' unique local conditions. More regionally-specific research is needed to understand which new and existing varieties of important crops meet the needs of organic farmers in the environment of intended use (Renaud et al., 2010).

Organic farmers are also becoming interested in culinary traits that consumers desire, such as flavor, nutrition and aesthetic appeal (Hoagland et al. 2014). Research indicates that these traits, primarily nutrition, can vary dramatically within species based on how certain cultivars interact with the environment (Meagy 2013). Researchers in Oregon and New York have begun incorporating sensory evaluation into variety trials focused on regional adaptation in organic crops (Navazio 2014, Mazourek 2014). These projects rely on participatory methods to ensure that research priorities reflect the needs of local farmers and other food systems stakeholders. Farmers may collaborate with researchers at any stage in the research process, from defining hypotheses, to collecting data, to publicizing results. These methods not only help create relevant research, they encourage immediate implementation of findings and recommendations, since farmers feel greater ownership of the process and resulting information. Recent initiatives have expanded the scope of participation to include non-farmer stakeholders such as chefs, bakers, brewers, produce buyers, CSA members and the broader public.

Wisconsin is ranked 2nd in the US for total number of organic farms, and 3rd in the US for organic vegetable farms (Silva et al. 2012). In Dane County alone, over 100 farms sell directly to local restaurants, grocers, and food hubs (USDA-ERS, 2014). Identifying varieties that perform well under organic management in Wisconsin's unique environment, and exhibit the culinary characteristics that customers desire, is essential to supporting these farmers. In a 2012 survey, Wisconsin organic vegetable farmers identified carrots, sweet corn, melon, onions, cucumber, peppers and winter squash as priority crops for variety trialing and plant breeding (Lyon et al., 2015). For our trials, kale and beets were added to this list based on conversations with participating farmers. The 2012 Lyon et al. survey and farmer conversations were used to identify disease tolerance, yield, germination, season extension and flavor as priority traits that farmers were interested in improving across crop species.

The goals for this project were:

1) Identify high-performing varieties in organic systems
2) Establish a network of farmers, chefs and researchers to enable future participatory variety trials and breeding.

Methods and Materials

Funding from the CERES trust supported the on-farm trials as well as overall project coordination. We include both the research station trials and the on-farm trials in this report, as they are part of the same effort. Variety trials were conducted on organically-managed land at the University of Wisconsin West Madison Agricultural Research Station (WMARS). Trial species and varieties were selected in collaboration with 10 participating farmers and 5 local chefs. Variety submissions were solicited from independent plant breeders and seed companies around the country. Trial varieties were selected based on lack of previous trialing in Wisconsin and purported high quality in organic production systems.

Carrots, kale, beets and peppers and winter squash were grown in trial plots on 2-4 local farms. Several school and community gardens participated in a lettuce evaluation but we are unable to include their observations in analyses due to institutional review board (IRB) restrictions on including minors in research. These were excellent outreach opportunities, and students learned about organic horticulture, local food systems, plant breeding, and how to conduct research. Growers selected which species and the number of varieties they wanted to trial, based on capacity and market interests. Farmers managed on-farm trials according to their standard practices. Data were collected from these trials through qualitative evaluation forms. Each farm was sent seed for a core set of four to five varieties of crops they wished to trial, and could choose to add other optional varieties for that crop. The observations we ask farmers to collect on the varieties in their trials are the following:

- Would you grow this again?
- How marketable is it?
- What did you think of the flavor?
- Strongest points and Major flaws
- Productivity compared to others in the trial and your favorite variety
- Susceptibility to insect/disease/stress compared to other varieties
- Best/Worst Variety (choose one best and one worst variety for each crop)
- General Notes (any other observations that don't fit in the previous categories)

Though this data is largely qualitative, it provides good information about the varieties and farmers' preferences for each species. Researchers visited each on-farm trial at least once during the season to strengthen relationships with farmers, hear feedback and ensure that trials were managed in a way that would yield usable information.

Squash, cucumber, melon, kale, greens, beets, and onion trials were grown in the demonstration garden plots at WMARS, on land that has been managed to certified organic standards for 6 years. The land has not been certified organic because of the occasional use of treated seeds in the ornamental flower displays in the garden (in separate beds from vegetable plots, separated by grass buffers). Treated seeds were not used in the vegetable trials and all management was conducted according to NOP standards. The soil in the demonstration gardens is very fertile, with an organic matter content between 5 and 7%. Fertility is maintained through an annual oat cover crop and applications of alfalfa mulch. No pesticides were used on the variety trials so the researchers could identify varieties displaying some resistance to pathogens and pests. OMRI approved pesticides exist for some of the diseases observed in the demonstration garden but were not applied because to help researchers identify varietal resistance. Hand weeding and mulch were used to control weeds in the trial beds and overhead irrigation was used when necessary. Each crop was planted, managed, and harvested according to recommendations from the seed companies and breeders, as well as the expert wisdom of trial manager Brian Emerson.

Germination, first flowering and first fruit data were taken early in the season at WMARS. For fruiting crops, marketable fruits were weighed to determine an average marketable yield per plant. For kale, harvests were weighed in 10-leaf bunches and average bunch weights were calculated for each variety. Additional data (average height, average leaf weight, disease damage and pest damage) were taken on kale per the request of participating farmers. Additional data collection was pursued for other species in consultation with breeders and farmers. Cucumbers, for example, were subject to a powdery mildew rating, since this is a common pathogen affecting cucurbits.

The number of plants in a "plot" varied across species, but was consistent within species, so that each variety was equally weighted in yield measurements. For some crops,

unmarketable yield was also measured by weight. Fruits or leaves were deemed unmarketable if they were damaged by disease, insects, or physiological deformities to an extent that they could not be sold at a farmers market. For each crop, harvests began as soon as the first fruits were ripe, or leaves mature, and continued at regular intervals throughout the season. Winter squash were harvested in early October and evaluated for marketable and unmarketable fruits after 60 and 100 days of storage. Onions were harvested in mid-August and early September according to maturity, weighed at harvest and evaluated for numbers of marketable and unmarketable bulbs after 90 days of storage. Additional information on planting and first harvest dates for each species can be found in the WMARS Production Summaries on Dr. Dawson's website: *dawson.horticulture.wisc.edu* .

In addition to the production data collected, certain crops were selected for a culinary evaluation involving four Madison chefs. Chefs were recruited by PI Dr. Julie Dawson and Madison Chef Tory Miller in 2013, and volunteered their time without compensation. Winter squash, peppers, kale, greens, beets, and melon were subject to culinary evaluation, and carrots will be evaluated in the near future. For crops with many varieties in the trial, such as kale and cucumbers, trained members of the field crew performed a preliminary flavor evaluation to obtain baseline data and in some cases narrow the scope before bringing varieties to the chefs. These screening evaluations employed a quantitative descriptive analysis (QDA) form (see Figure 1. as an example) and were asked to rank 7 elements of flavor and color on a scale from "none" to "too high," giving the researchers a basic characterization of each variety. Elements evaluated included color, texture, sweetness, acidity, saltiness, bitterness, and intensity. Crew members were also asked to identify favorites and provide comments to elaborate their descriptions. In some cases, on the favorites from crew tastings were selected for evaluation by local chefs, while in other cases chefs requested a complete set of varieties for their flavor evaluations.

Initially, the chefs used a similar QDA form to the one used in the crew screenings. While this yielded useful information about how the chefs perceive flavor, participants felt than a detailed description of each variety was not immediately relevant to them or the farmers they purchase from. Accordingly, we replaced the QDA method with a more qualitative evaluation

Peppers

Variety					notes
Color	poor	fair	good	excellent	
Texture	poor	fair	good	excellent	
Sweetness	low	fair	good	excellent	too sweet
Acidity	none	low	medium	high	too high
Saltiness	none	low	medium	high	too high
Bitterness	none	low	medium	high	too high
Flavor intensity	low	fair	good	excellent	too intense
off flavors	present	absent	description:		

Figure 1. Sample Quantitative Descriptive Analysis for Vegetable Flavor Evaluations

that included chef-developed questions like: "Would you buy this for your restaurant?" and "How would you use this?" Chefs were also asked to select favorites and least favorites for each species and to give a 1- 10 ranking of flavor intensity. The focus on flavor intensity came out of conversations with chefs about their broad preferences in vegetable crops, which generally include intense flavors and novels colors shapes, and stories. Tailoring the evaluation to reflect chef's priorities helped maintain their enthusiasm throughout the trial. The results of the quantitative descriptive analysis were distributed to participating chefs, farmers, breeders and seed companies in early February 2016.

Figure 2. Chefs evaluating vegetables at a tasting event

Results

Detailed results for all crops can be downloaded from *dawson.horticulture.wisc.edu.*
The winter squash summary is provided in full at the end of this document as an example.

Beets

Beets were included in the on-farm trials, and in the WMARS trial plots, though productivity data was not recorded for the trial plots. Three farms grew two varieties of purple

beets: Boro and Rhonda, both from High Mowing Seed Company. All the farmers reported they would buy both varieties again, though they had a slight preference for Boro despite one report of poor germination. Both of these varieties will be included in future trials. In the culinary evaluations, neither Boro nor Rhonda was outstanding. 7 varieties of beets were evaluated in total, all grown at WMARS in trial plots or breeder Irwin Goldman's nearby field. Goldman's Badger series (Flame, Torch and Sunset), as well as his high and low geosmin breeding lines out-performed both Boro and Rhonda in the chefs' culinary evaluations. No clear leaders emerged in flavor intensity rankings.

Carrots

7 varieties of carrots were grown on three farms, and at WMARS on certified organic land as part of a winter trial. Productivity data has not yet been collected for the winter trial, and a flavor evaluation of the winter carrots is forthcoming. Of the 7 varieties trialed, Miami and Yaya emerged as favorites among the farmers, for their high yield of marketable roots and good flavor. Nectar and Negovia were generally not preferred.

Cucumber

14 varieties and breeding lines of cucumber were grown at WMARS, and were evaluated for flavor by the field crew and breeder Yiqun Weng, but were not included in the chef evaluations due to time restraints. Two of Dr. Weng's breeding lines, WI7440 and WI7552, excelled with high average numbers of marketable fruits per plant and low incidence of powdery mildew, which commonly afflicts cucumbers. WI7440 also ranked well in the flavor evaluations, exhibiting a good balance of sweetness and acid as well as a color that tasters preferred.

Kale and Greens

20 varieties of kale were grown at WMARS, and Madison chefs evaluated 18 varieties. In the research station trials,

Figure 4. Kale from the 2015 variety trials

Galega de Folhas Lisas from Seeds of Italy and Kale Coalition from Adaptive Seeds had the highest average bunch weight, while Curly Roja, Ripbor and Meadowlark had the lowest insect damage scores, and Darkibor, Curly Roja, Galega de Folhas Lisas and Old Growth Palm had the lowest disease scores. Neither pest nor disease pressure were very high at the research station, so more information is needed to make stronger judgments about how varieties perform in more challenging environments. From the on-farm trials, Darkibor emerged as a strong favorite for yield, color and flavor over Redbor. In the chefs' evaluation, participants unanimously agreed they would buy Sutherland, Ripbor, Meadowlark and Redbor for their restaurants, though Darkibor, Hudson Valley Dino and Black Magic were all rated highly for flavor intensity. In addition to the kale, five varieties of greens (chicory, radicchio and endive) were grown in the on-farm trials and evaluated for production characteristics. Leonardo Radicchio was the most consistent favorite among farmers, for its color, flavor and high marketable yield.

Melon

17 varieties and breeding lines of melon were grown at the West Madison Agricultural Research Station (WMARS). 16 of these varieties were evaluated for flavor, with one variety excluded due to under-ripe fruit. Iroquois Cantaloupe form Hudson Valley Seed Library, Artemis from Vitalis and three breeding lines from Vitalis offered early harvests, a trait, which farmers prefer in the short season of the upper Midwest. Serenade from Johnny's Selected Seeds had the highest number of marketable fruits, and Iroquois Cantaloupe had the highest percentage of marketable fruit, as well as uniform ripening and an easy "slip" which growers use to determine ripeness. In the flavor evaluations, Artemis and E25G.00109 were unanimously identified as varieties chefs would by for their restaurant. Melemelon ranked the highest for flavor intensity and was a strong favorite for at least one of the chefs.

Onion

19 varieties of onion were trialed at WMARS. Onions were not included in the 2015 flavor evaluations due to time constraints. All varieties except Newburg, Pink Hybrid and Red Hybrid had good or excellent germination. The highest per row yields by weight came from Bejo Seeds

varieties Red Carpet, Sedona and Yankee, though some of the breeding lines from Cornell were also high yielding.

Peppers

19 varieties of sweet and 14 varieties of hot peppers were trialed at WMARS. 12 varieties of sweet and 3 varieties of hot peppers were grown on 2 organic farms. Hot peppers Aji 14 from UW-Madison, Bastan from Vitalis and Wisconsin Wroaster from UW-Madison had particularly high yields. Bastan was also a favorite for it's chocolate color, and Wisconsin Wroaster had desirable growth habit for easy picking. Sweet peppers JPRS3829, JPRC985 and JPRC999, all breeding lines from Johnny's Selected Seeds, had the highest per plant yields. While Vitalis variety E20B.52005 had the highest average fruit weight, it also experiences high soft rot incidence. Farmers growing pepper trials generally agreed that they would grow all the trial varieties again, though some of the breeding lines from Johnny's were identified as ripening later than the farmers would like, though they were still highly marketable. The chefs did not prefer many of the sweet peppers, except for Carmen. The Aji peppers stood out as favorites, as did a novel variety called "Habanada." This is a habanero pepper that's been selected for low capsaicin, making its spiciness nearly undetectable. Chefs enjoyed the flavor of this pepper as well as the novelty and excitement of bringing something brand new to market.

Figure 5. UW Madison plant breeder Jim Nienhuis's Wisconsin Wroaster peppers

Winter Squash

25 varieties of winter squash were grown at WMARS and 9 were included in the chefs' flavor evaluations. Lower Salmon River, a variety from Adaptive Seeds, Butterscotch and Sweet Dumpling from Johnny's Selected Seeds, Tiana from Vitalis and NY13-9914, a breeding line from Cornell, all produced 100% marketable fruits at harvest time. Tiana and Oregon Sweet Homestead from Adaptive tied for highest total harvest weight. Pests were not a problem in the

trial gardens, but powdery mildew was prevalent. After 100 days of storage, Nutterbutter, Honeynut and Havana had the highest number of marketable fruits. In the flavor evaluations, chefs unanimously said they would buy E30R.00013, a breeding line from Vitalis Seeds, and Butterscotch from Johnny's for their restaurants. Those varieties also had the highest flavor intensity ratings of the group. Two farmers trialed butternut squash, and preferred the larger squash Havana and Tiana for their markets. Chefs are interested in both larger squash and single-serving sized butternuts, and we are looking for early maturing larger squash for this year's trial. Both chefs and farmers liked the flavor of Nutterbutter.

Breeding lines related to Honeynut in the squash trials, from Michael Mazourek at Cornell University

Conclusion

These varieties trials laid an important foundation for future participatory projects aimed at increasing the number of high-performing and regionally adapted vegetable varieties available to organic farmers. All the farmers who participated in the 2015 trials have agreed to participate again, and the number of chefs involved in flavor evaluations will likely increase in the 2016 season. In response to chef feedback, one important modification will be made to the flavor evaluations moving forward. When asked to identify a "favorite" variety, the chefs found it difficult to single out one variety over other "good" options. In the future we will get better preference information from the chefs by asking them whether and how much they like each variety, rather than asking them to select a single favorite. The farmer evaluations will remain much the same in 2016, as we build a body of consistent data that local farmers can consult when selecting varieties. The full results from these trials are available to the public on Dr. Dawson's website (dawson.horticulture.wisc.edu), and will be presented at three conferences and circulated widely through the FairShare CSA Coalition list-serve, which reaches over 50 local farmers. Thanks to the generous support of the Ceres Trust, this research will reach a broad

range of local food system stakeholders committed to supporting Wisconsin's direct-market organic farming community.

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University of Wisconsin

Urban and Regional Food Systems

2015 Vegetable Variety Screening Trials

WINTER SQUASH and PUMPKIN

Trial Notes: All varieties planted June 3, 2015. Planted in mounds and mulched with chopped alfalfa hay. High incidence of Angular Leaf Spot in early season. No significant varietal difference in disease resistance. Four plants per mound and 12 ft between mounds.

Cultivar	Type	Company	Germ	First Female Flower	Date Harvested	Total Harvest Weight (kg)	AVG Fruit Size (kg): 10 Fruit sample	STDV Fruit Size (gm): 10 Fruit Sample	Total #M Fruit	Total # UM Fruit	Total # Fruit	% M Fruit	# M Fruit/ plant	60 Day Storage: #M	60 Day Storage: #UM	60 Day Storage % M	100 Day Storage # M	100 Day Storage # UM	100 Day Storage % M
Discus	*C. maxima*	Adaptive Seeds	0.75	17-Jul	2-Oct	27	2.1	0.8	13	3	16	83%	3.3	6	0	100	3	3	50
Lower Salmon River	*C. maxima*	Adaptive Seeds	1.00	28-Jul	16-Oct	63	3.8	0.8	17	0	17	100%	4.3	15	1	94	10	5	63
Oregon Homestead Sweet Meat	*C. maxima*	Adaptive Seeds	1.00	28-Jul	16-Oct	109	6.0	1.1	16	11	27	59%	4.0	12	4	75	7	5	44
Potimarron	*C. maxima*	Adaptive Seeds	0.75	17-Jul	2-Oct	102	2.0	0.5	49	13	63	79%	12.3	25	0	100	23	2	92
E30R.00013	*C. maxima*	Vitalis	1.00	28-Jul	16-Oct	74	1.3	0.2	64	14	78	82%	16.0	38	0	100	36	2	95
E30R.079	*C. maxima*	Vitalis	1.00	28-Jul	16-Oct	35	1.2	0.4	32	7	39	82%	8.0	22	1	96	21	1	91
Orange Summer	*C. maxima*	Vitalis	1.00	28-Jul	16-Oct	90	1.7	0.5	49	4	53	93%	12.3	40	0	100	37	3	93
Doran Round	*C. moschata*	Adaptive Seeds	0.75	28-Jul	16-Oct	40	1.5	0.3	27	31	57	47%	6.7	7	5	58	2	5	17
Violina Rugosa	*C. moschata*	Adaptive Seeds	0.75	28-Jul	16-Oct	52	4.4	1.8	12	3	15	82%	3.0	0	4	0	0	0	0
NY 13-9028	*C. moschata x C. maxima*	Cornell -- Michael Mazourek	0.25	28-Jul	16-Oct	58	0.5	0.1	168	36	204	82%	42.0	30	3	91	24	6	73
NY 13-9912	*C. moschata x C. maxima*	Cornell -- Michael Mazourek	1.00	28-Jul	16-Oct	62	0.8	0.1	92	8	100	92%	23.0	22	2	92	19	3	79
NY 13-9914	*C. moschata x C. maxima*	Cornell -- Michael Mazourek	0.50	28-Jul	16-Oct	52	0.6	0.1	112	0	112	100%	28.0	27	0	100	25	2	93
Honeynut	*C. moschata*	High Mowing Organic Seeds	1.00	28-Jul	2-Oct	24	0.4	0.1	62	4	66	94%	15.5	20	0	100	30	9	150

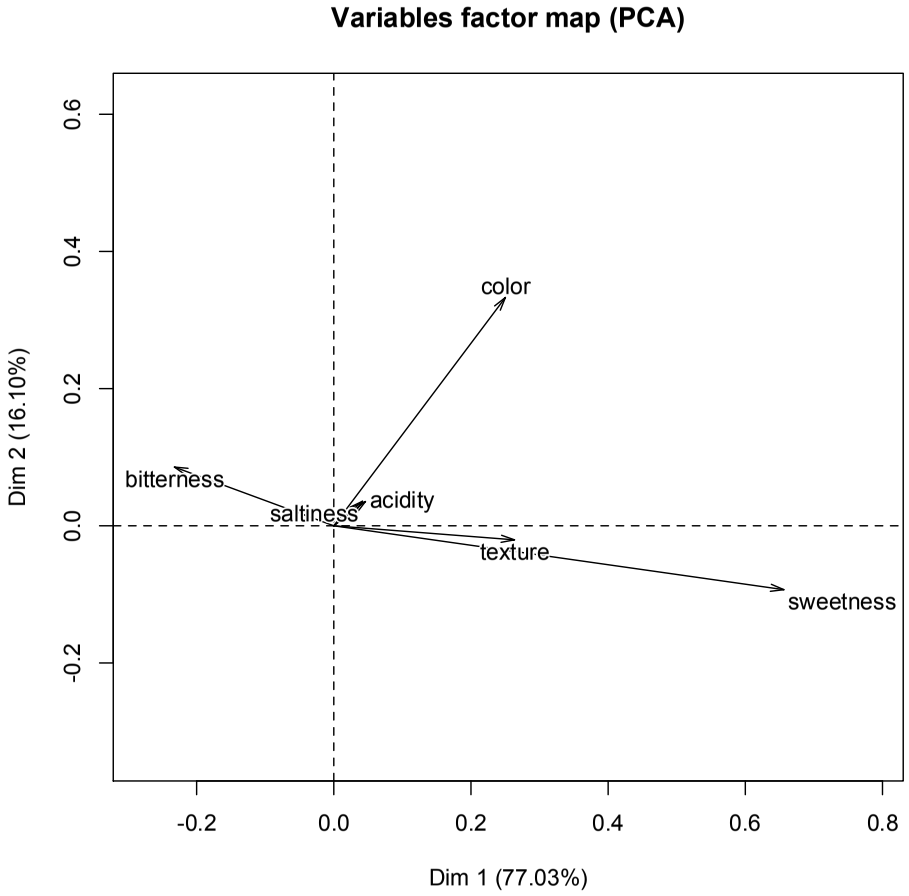
Cultivar	Type	Company	Germ	First Female Flower	Date Harvested	Total Harvest Weight (kg)	AVG Fruit Size (kg): 10 Fruit sample	STDV Fruit Size (gm): 10 Fruit Sample	Total #M Fruit	Total # UM Fruit	Total # Fruit	% M Fruit	# M Fruit/ plant	60 Day Storage: #M	60 Day Storage: #UM	60 Day Storage % M	100 Day Storage # M	100 Day Storage # UM	100 Day Storage % M
Nutterbutter	*C. moschata*	High Mowing Organic Seeds	1.00	28-Jul	2-Oct	63	1.2	0.2	61	13	74	82%	15.3	20	0	100	20	0	100
Buttermilk	*C. moschata*	UW -- Jim Nienhuis	1.00	28-Jul	16-Oct	13	1.3	0.4	10	2	12	83%	2.5	9	1	90	6	3	60
Butterscotch	*C. moschata*	Johnny's Selected Seeds	0.75	28-Jul	16-Oct	24	0.6	0.2	36	0	36	100%	9.0	19	1	95	10	9	50
E30B.00012	*C. moschata*	Vitalis	1.00	28-Jul	16-Oct	64	1.2	0.3	57	1	58	98%	14.3	44	2	96	33	11	72
Havana	*C. moschata*	Vitalis	1.00	28-Jul	16-Oct	78	1.5	0.4	49	7	56	88%	12.3	36	0	100	36	0	100
Tiana	*C. moschata*	Vitalis	0.75	28-Jul	16-Oct	108	1.3	0.2	77	0	77	100%	19.3	42	0	100	38	4	90
Ayote	*C. moschata*	SOSS seed exchange	1.00	28-Jul	16-Oct	3	1.6	1.1	2	0	2	100%	0.5	0	2	0	0	0	0
Cruzan	*C. moschata*	SOSS seed exchange	1.00	28-Jul	16-Oct	26	3.7	0.8	7	3	10	70%	1.8	3	4	43	2	1	29
Invincible	*C. moschata*	SOSS seed exchange	1.00	28-Jul	16-Oct	71	3.9	3.1	15	5	20	75%	3.8	4	3	57	3	1	43
Candystick Dessert	*C. pepo*	Adaptive Seeds	1.00	28-Jul	2-Oct	28	0.6	0.1	45	7	52	87%	11.3	25	3	89	17	8	61
Honey Boat	*C. pepo*	Adaptive Seeds	0.75	28-Jul	2-Oct	15	0.6	0.1	25	8	33	76%	6.3	8	3	73	6	2	55
Sweet Dumpling	*C. pepo*	Johnny's Selected Seeds	0.75	28-Jul	2-Oct	30	0.7	0.1	53	0	53	100%	10.7	30	0	100	24	6	80

Farm	Farmer	Species	Varieties	Would you grow this again?	How marketable is it?	What did you think of the flavor?	Strongest point	Major flaws	Which variety was the best/worst?	General Notes
Wild Ridge	Anna Metscher	squash	Havana	yes	good	good	nice color	variety of sizes	worst	
Wild Ridge	Anna Metscher	squash	Nutterbutter	yes	very good	very good! Sweet	good size for CSA	some disease	medium	
Stoney Acres	Kat Becker	squash	Nutterbutter		not to chefs - they want big squash	Great	cute	too small		
Wild Ridge	Anna Metscher	squash	Tiana	yes	very good	very good	good size	didn't like the color	best	
Stoney Acres	Kat Becker	squash	Tiana	maybe	very	fine - but really our chefs and even CSA folks like bigger squash so they loved that.	Size		Size is needed for our markets so this was the best.	
Stoney Acres	Kat Becker	squash	Honeynut	maybe	not to chefs - they want big squash	Good		too small, color		

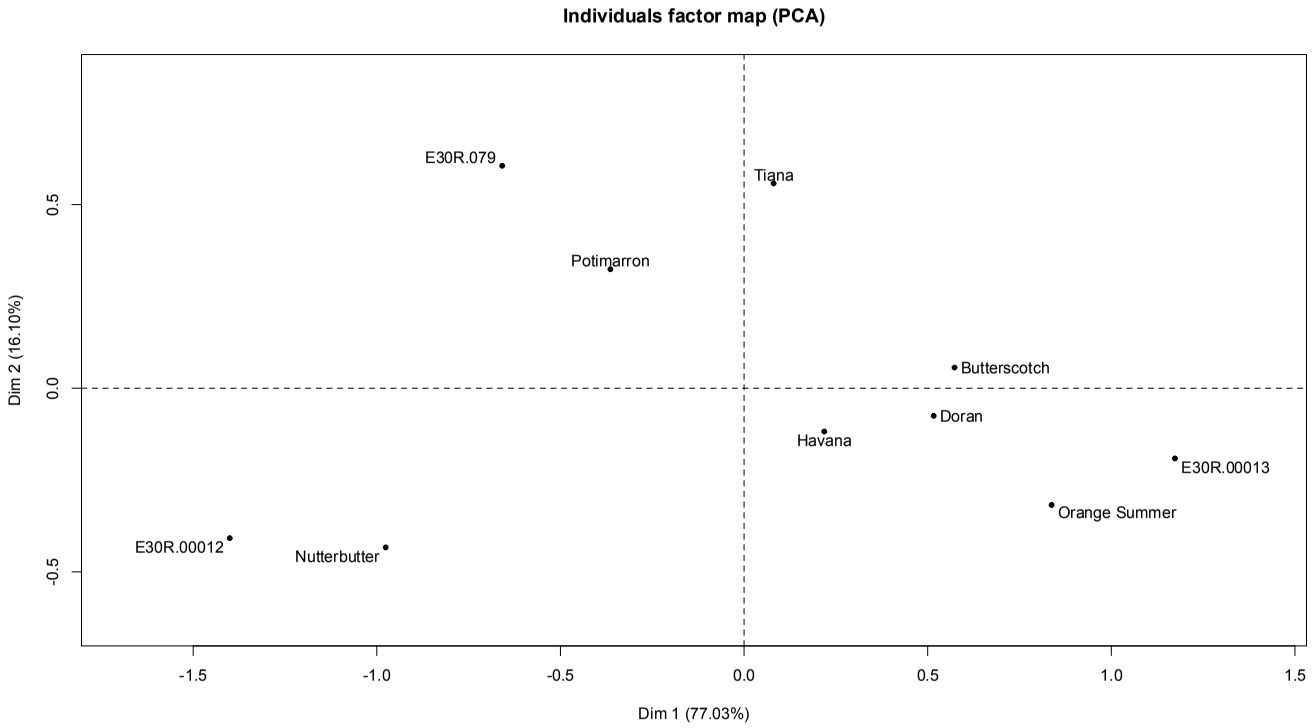
Trial management	soil type	prior crop	cover crop	bed preparation	planting method	planting date	plant spacing	fertilizer	mulch	irrigation	pest or pathogen treatments
Anna Metscher	sandy loam	fall succession	clover	tillage	transplant	GH 5/11, transplant 6/13	1 row at 2'	2 buckets compost	no	drip	none
Kat and Tony	Freeon and Magnor Silt Loam	fallow-oats/peas	none	chisel plow, disk, raised bed/plastic	seed into holes	5.21.16	18 inches 1 row/bed	fertrell super K onto beds at rate of 2 Tbs/hole once growing	plastic	drip	none

Variety	Type	Date	Number of Chefs	Flavor Intensity (1-9, 9=high)	Buy for yourself	Buy for your restaurant	How would you serve it?	Description of unique flavor characteristics	Strongest point	Major flaws
Butterscotch	butternut	12.8.15	4	6	1	1	blend to make soup ; desert ; roasted or sauted to showcase natural sweetness ; very simply	not a huge fan of the texture. Nutty oaky flavor I like ; very rich, great for desert ; great density and depth of flavor! Sweet and rich and earthy ; buttery	good crust when cooked, that was delicious ; sweetness ; great sweet and rich taste and firm texture made this a favorite ; buttery	grainy ; . ; . ; .
Tiana	butternut	12.8.15	4	5.75	0.5	0.75	cold in a ketchup for our polenta fries ; . ; slightly denser textuer than previous, richer body. Serve roasted or mashed ; roasted or candied	citrus, kind of sweet and sour in a good way ; . ; nuttery and buttery flavor, would be highlighted by simple proportions ; slightly bitter, firmer texture	citrusy ; buttery ; flavor, texture, great taste with little off flavors make this a winner for me ; firm	a little grainy ; . ; . ; bitter
NYS9028	butternut	12.8.15	3	5.67	0.67	0.67	roasted, blended, very versetile ; roasted or soup ; soup	carrot and rutabegga. Good texture ; dense and carrot-like in flavor and sweetness ; nutty	yummy new flavors, love the flavor not really "squashy" more carroty/rutagegga ; flavor ; .	none ; . ; .
Honeynut	butternut	12.8.15	4	4.75	0.75	0.75	roasted as a side ; . ; mild, very soft texture and slighlty sweet. Good for soup puree, pie ; soup	good texture almost rutabegga. Mild flavor and little nutty and buttery ; . ; sweet and nutty, though not as rich as the previous one ; slightly grainy	root veggie flavor ; . ; flavor ; NA	none, this is not that much better than the others, just my preference :) ; dry, astringent ; soft texture ; grainy
Nutterbutter	butternut	12.8.15	3	4.33	0.67	0.67	with butter and sal and pepper. So good by itself ; soup ; with other things	great texture, buttery ; . ; mild flavor	good alone, really liked this one, makes a great holiday side ; dry ; too mild	none ; . ; too mild
NYS9912	butternut	12.8.15	4	4.25	0.25	0.25	in a soup ; . ; stringy, soft texture. Good for puree or soup ; puree	buttery and nutty, but not overpowering ; . ; mild and some light hay or straw earthiness ; slightly stringy	smooth and creamy, yum ; . ; . ; .	a little bland ; . ; texture, flavor ; .
E30R.00013	red kuri	12.8.15	4	6.5	1	1	roasted ; . ; roasted or braised, great flavor and natural sweetness, good body ; puree	bright and summery ; . ; earthy rick flavor and nice firm texture. Slightly smoky finish ; slight sweet, pumpkin, smooth texture	dosen't taste like anter? ; . ; appearance ; smooth texture	a little stringy ; . ; . ; .
Orange Summer	red kuri	12.8.15	4	5.75	1	0.75	blended as a sauce, for something very versatile though ; . ; fine texture and mild flavor, would be good for puree or pie. Also good roasted and sauted ; puree	citrus undertones, smokey ; . ; mild earthy flavor, slightly mineral finsih would be good for curry or stew ; strong flavor, soft texture, slight pumpkin flavor	smokiness ; oily ; texture, appearance ; flavor	none ; slight fishy flavor ; mildness, slightly astringent finish ; .
Potimarron	red kuri	12.8.15	4	5.75	0.75	0.75	for a holdiay special as a side ; . ; roasted, sauted, soup, pure; great rich texture has many applications ; soup	strong flavor, right away, then it dies ; . ; rich, dense earthy, sweet and carroty in flavor ; smooth	strong squash flavor. Good sometimes ; creamy ; flavor, appearance ; NA	strong squash flavor ; . ; . ; .
Grand				5.44	0.74	0.74				

Squash							
Variety	**intensity*** **	**color*** **	**texture*** **	**sweet*** **	**bitter*** **	**acidity**	**saltiness**
Red Kuri							
E30R.00013	3.2	3.1	3.1	3.6	1.5	1.6	1.7
Orange Sumr	3.2	2.8	3.0	3.3	1.5	1.5	1.9
Potimarron	2.5	3.0	2.7	2.1	2.0	1.6	1.9
E30R.079	1.9	3.3	2.4	1.8	2.0	1.5	1.8
Butterscotch							
Doran	2.8	3.0	2.5	3.0	1.4	1.5	1.7
Havana	2.8	2.9	3.0	2.6	1.6	1.5	1.7
Tiana	2.7	3.4	2.7	2.5	1.9	1.7	1.7
Butterscotch	2.7	3.1	3.1	2.9	1.6	1.7	1.6
Nutterbutter	2.2	2.2	2.6	1.8	2.0	1.5	1.5
E30B.00012	1.7	2.1	2.1	1.5	2.0	1.4	1.7
Significant differences among varieties *** $p < 0.0001$, ** $p < 0.01$, * $p < 0.05$							

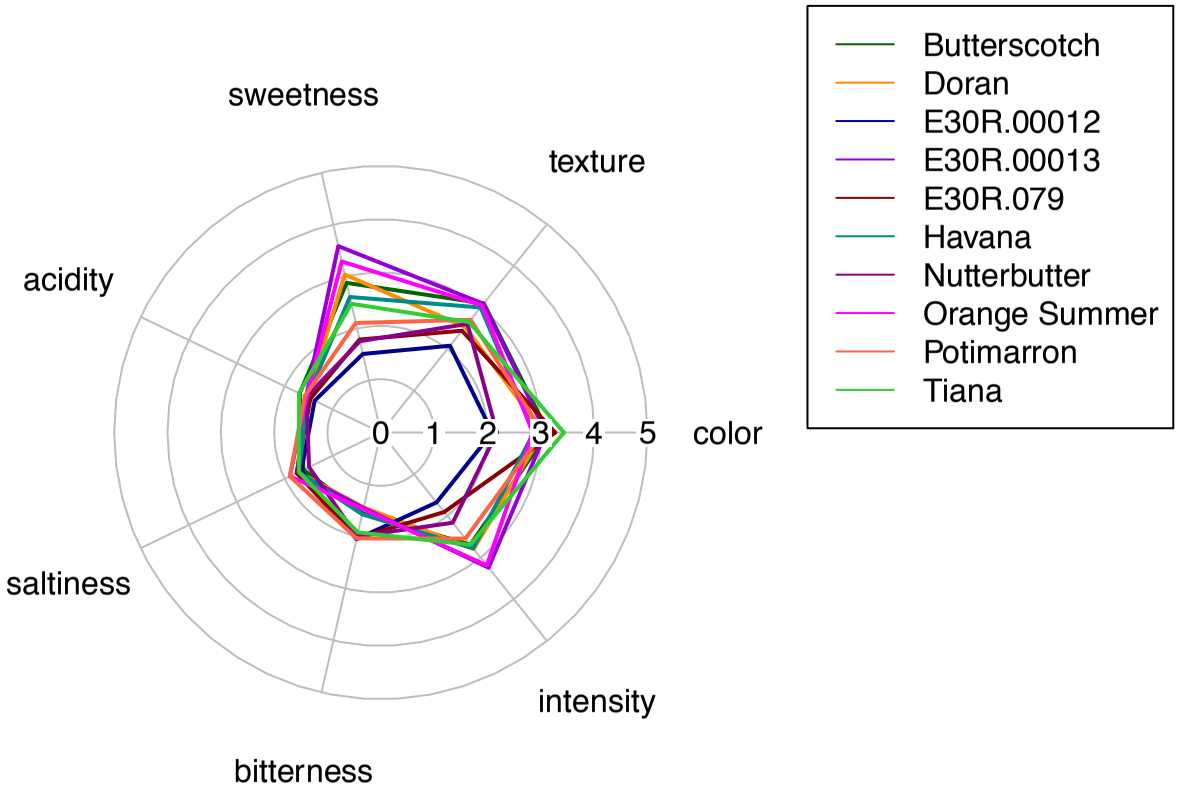


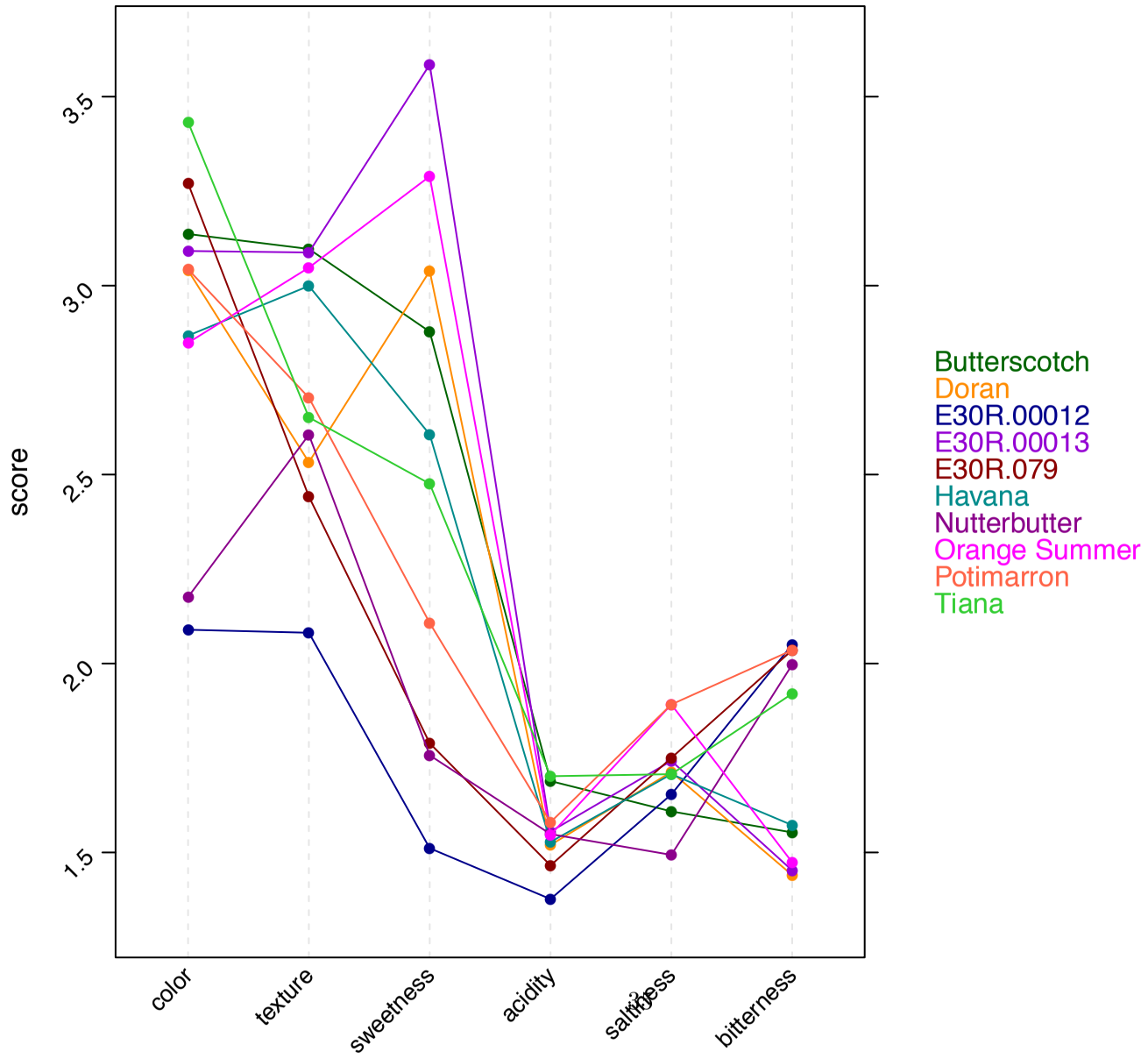
Representation of quality characteristics, based on crew evaluation, resulting from a principal component analysis of all crew quality evaluation data. The length of the arrow for each characteristic is proportional to its contribution to the variation among varieties, and the direction of the arrow is in the direction of increasing scores for that characteristic. This shows how related the characteristics are to each other, and is also used to read the following graph of varieties. The individual (variety) factor map on the next page plots where each variety lands relative to these quality components



Representation of varieties, based on crew evaluation, resulting from a principal component analysis of all crew quality evaluation data. The position of each variety shows how it was evaluated for the different quality characteristics on the previous page. For example, a variety that near or beyond the end of the color arrow would show particularly intense color and a variety on the opposite side of the graph than the direction in which the color arrow points would have poor color. This can be done for each of the quality characteristics. This graph also shows how varieties are related to each other for the complete set of quality characteristics, and characteristics that contributed more to the variation among varieties have greater weight in determining where varieties are positioned on the graph. This can be helpful in making selections based on multiple characteristics at once. This graph helps us select which varieties we send to the group of chefs we are working with for further quality evaluation

Squash


sweetness
texture
acidity
color
saltiness
intensity
bitterness
0
1
2
3
4
5
Butterscotch
Doran
E30R.00012
E30R.00013
E30R.079
Havana
Nutterbutter
Orange Summer
Potimarron
Tiana


score
3.5
3.0
2.5
2.0
1.5
color
texture
sweetness
acidity
saltiness
bitterness
Butterscotch
Doran
E30R.00012
E30R.00013
E30R.079
Havana
Nutterbutter
Orange Summer
Potimarron
Tiana