Variety Trial Report:

2016 Northern Organic Vegetable Improvement Collaborative

UW-Madison Organic Research and Extension Program
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Organic Sweet Corn

"Nirvana" © Crookham Company

UW Extension
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NOVIC

ORGANIC seed ALLIANCE

Introduction

About NOVIC:
In its second iteration, the Northern Organic Vegetable Improvement Collaborative (NOVIC) joins researchers and farmers in Northern U.S. states to address organic farmers' seed and plant breeding needs. The collaborative includes researchers and educators from Oregon State University, University of Wisconsin-Madison, Cornell University, Washington State University, Organic Seed Alliance, and the USDA. The project partners with over 30 organic farmers to breed new varieties, identify the best performing existing varieties for organic agriculture, and educate farmers on organic seed production and plant variety improvement.

NOVIC conducts vegetable variety trials on certified organic ground, at research stations, and on cooperating organic farms, using the mother-daughter trailing method adopted from international agriculture. Trials include the five crops in the NOVIC breeding program (sweet corn, red bell and roasting peppers, tomatoes, cabbage, and winter squash) and one additional crop chosen by farmers regionally.

Results for NOVIC variety trials are published in the Organic Variety Trial Database, a national database of organic variety trial results maintained by collaborators at eOrganic. Reports can also be found on the UW-Organic site. See varietytrials.eorganic.info/ for national trial results, or uworganic.wisc.edu for UW-Madison organic variety trial results.

The overall goal of NOVIC is to develop open-pollinated varieties specifically adapted to meet the needs of organic growers. NOVIC breeding efforts focus on key traits to improve market presence for the focal crops. For sweet corn in particular, high quality, early maturing hybrid and open-pollinated varieties are the desired outcome. Growing high quality sweet corn under organic management also requires additional traits, such as tolerance of/resistance to common pests and diseases.

About this Trial:
All UW-Madison NOVIC trials take place at the West Madison Agricultural Research Station (WMARS) at 8502 Mineral Point Road, Verona, WI 53593. Trials can be viewed in person during the annual WMARS Organic Research Field Day during late summer (please feel free to contact westmadison@cals.wisc.edu for more info on field days). Due to the complexities of harvest measurements in this crop, and the diversity of farmers' cultural practices, sweet corn trials were not planted on farm sites in 2016.

While strong markets exist for organic sweet corn, there are many challenges in its production. Variety selection is an important part of rising to these challenges, but unfortunately, many commercially available varieties are bred under conventional management systems, making them less competitive when grown organically. The NOVIC sweet corn trials aim to elucidate how six promising varieties, including several new breeding lines, perform when grown under industry standard organic management.

Methods

Field Methods:
The sweet corn trial was planted in four-row plots (two outer "border" rows and two inner data rows), with three replications in

a complete randomized block design. Rows within plots were 14.25' long, including a 3' alley (thus, 11.25' of corn plus 3' for an alley), with 3' between rows. Fifteen plants per plot row (9 in. in-row spacing) were transplanted when they reached 2-3 leaves. An increasingly popular method to improve early maturation of varieties, transplanting the corn was also chosen over direct seeding to help with stand counts to ensure relatively stable sample populations. Data was never gathered from the plants at the end of the two data rows. Thus 26 plants, or 20 row-feet, would be a full stand count at harvest.

All varieties were first seeded by West Star Organics in Cottage Grove, WI on May 15th, and were transplanted on June 3rd into freshly rototilled ground that had been amended in early spring with feathermeal (13-0-0) at a rate of 0.75ton/acre and Midwest BioAg's Microhume product at a rate of 20lb/acre. Supplemental water was provided every 2-3 days during the first two weeks after transplanting to improve survival, but most of the season relied only on rainfall. However, summer 2016 was a particularly wet season, and between June 3rd and August 1st there were 12.5in of rain accumulation.

Plots were too small to cultivate by tractor, so stirrup hoes were used regularly for weed control until all plots had passed 3 feet in height. No major pest pressure was noted during the first month after transplanting. Six weeks after transplanting one application of Dipel brand *Bacillus thuringiensis* (Bt) was made after tassel emergence in hopes of controlling European Corn Borer, of which there had been several recent observations.

Target harvest dates for each variety were set to be three weeks after the date 50% of plants in the data rows of plots had emerged silks. Because of logistical constraints, all plots had to be harvested at once, so as target harvest dates approached, ears were sampled from border rows to determine maturity and a compromise date was chosen. Finally, all plots were harvested August 1st.

Immediately prior to harvest, stand counts, tassel height (in), and ear height (in) of the uppermost ear were all recorded for all data rows. At harvest, total ears, number of smutted ears, number of other unusable ears, and weight of marketable ears (lbs) were recorded. Two representative marketable ears were then chosen for field taste tests and husk ratings (see appendix), and 10 marketable ears were randomly chosen for average tip blank length, and average ear weight (lbs), length and width (in).

In addition, lodging response to a large thunderstorm that occurred on July 23rd was visually assessed (% flattened, where 100% means corn is lying flat and 0% is standing straight).

Analysis:
Data was averaged to a plot level using Microsoft Excel, and was analyzed at a variety level using R Studio. Marketable ear weight and count per plot was adjusted based on stand count. Normality and variances for each outcome were assessed visually by plot and determined to be acceptable for a standard ANOVA. The TukeyHSD function was used as an initial post-hoc test and the HSD.test function was used to group means based on significant differences. Each variety was approached as a different treatment, and the three above tests were used for each trait outcome.

Results

Results are presented here in text, and can also be viewed in Tables 1 and 2 below. Some traits also have corresponding figures.

Silk Date:
Silk date is an important data point for determining early maturing varieties, especially because logistical constraints forced us to harvest all varieties at the same time, and indeed there were some significant differences for silking date (F=4.207, p=0.022). AP426 took the longest to silk, at 61 days, which was significantly longer than Mirai 131Y at 56 days (p=0.046) or Xtratender 2171 at 55 days (p=0.014). The other varieties were not significantly different from the rest.

Average Top Ear Height:
The average height of the uppermost ear at its ligule was significantly different between varieties (F=4.088, p=0.024). Mirai 131Y averaged 20.33in off the ground, which was significantly different from Xtratender 274A, which averaged 14.27in (p=0.0096). The other varieties were not statistically different from the rest.

Average Tassel Height:
The average height of the tassel at the ligule from which it emerged was significantly different between varieties (F=10.21, p=0.00076). AP426 was significantly taller than the other varieties at 58.03in. The other varieties were not significantly different from each other.

Percent Lodging:
Percent lodging after the particularly bad thunderstorm did not vary between varieties significantly, although there was a trend (F=3.31, p=0.054). Varieties Nirvana and AP246 were visibly more affected than the other varieties. (Fig 1)

Percent Smutted:
The percent of ears smutted did not vary significantly by variety. However, there did appear to be a pattern in the infection of the field; two reps on the western side of the experiment did experience smut, while the easternmost rep had no incidences of smut. In addition, Xtratender 274A and AP426 experienced no smut in any of the reps.

Percent Unusable:
The total percent unusable ears varied significantly by variety (F=6.19, p=0.0058). Xtratender 2171 yielded the most unusable ears, with about 50% of the yield unusable due to a variety of causes, but primarily corn earworm. Mirai 131Y, XTH20173, and

Variety	Avg Plants Surviving at Harvest	Days Till Silk		Adj Marketable Yield		Adj Number Marketable Ears		Marketable Yield		Number Marketable Ears		Percent Lodging		Percent Smutted		Percent Unusable	
	%	#		lb		#		lb		#		%		%		%	
Xtratender 274A	87.18	57	ab	16.77	a	27.57	ab	16.71	a	27.47	ab	35.19	a	0.00	a	31.20	b
Nirvana	96.15	58	ab	16.33	ab	34.09	a	16.26	a	33.93	a	62.96	a	3.45	a	32.21	b
XTH2017	94.87	58	ab	15.93	ab	33.03	a	15.83	ab	32.80	a	38.89	a	6.25	a	42.53	ab
Xtratender 2171	97.44	55	b	14.52	abc	27.51	ab	14.43	abc	27.30	ab	33.33	a	7.40	a	50.03	a
Mirai 131Y	96.15	56	b	13.48	bc	22.96	b	13.47	bc	22.93	b	27.78	a	9.09	a	45.53	ab
AP426	98.72	61	a	12.01	c	26.36	ab	11.98	c	26.30	ab	53.70	a	0.00	a	41.71	ab

Table 1: Sweet Corn Variety Trial Results
Results by variety for the 2016 NOVIC Sweet Corn Trial are color coded with green being most desirable for the trait and red being least desired. Means for traits that showed significant differences in ANOVA (p<0.05) were grouped using multiple comparisons of treatment means using the Tukey method; varieties that share a letter for that trait are not statistically significantly different from each other. Marketable Yield and Average Number of Marketable Ears were adjusted for stand count.

AP426 all had a similar percent of unusable yield. Nirvana and Xtratender 274A had the least percent unusable ears. (Fig 2)

Marketable Yield:
Marketable yield adjusted for stand count was significantly different between varieties (F=6.43, p=0.0050 for number of ears, F=9.39, p=0.0011 for yield by weight). Per 20 row feet (28 plants), Xtratender 274A yielded the highest by weight, with 16.77 lbs of marketable ears, while AP426 yielded the lowest with 12.01 lbs. However, in terms of the number of marketable ears, Nirvana yielded the highest, at 34.09 ears per the 26-plant plots, closely followed by XTH20173 at 33.03 ears. AP426 and Mirai 131Y yielded the lowest number of marketable ears per plot, at 26.36 and 22.96 ears respectively. (Fig 3)

Marketable yield not adjusted for stand count also varied significantly by variety (F=3.48, p=0.040 for number of ears, F=3.32, p=0.045 for yield by weight). The yield order is the same, but the differences are statistically significant only between Xtratender 274A, the top yielder, with a 15.97lb average, and AP426, the lowest yielding variety at an average of 11.69lb. (Fig 5)

Husk Appearance and Protection
While not statistically significant (p=0.12 for appearance, p=0.63 for protection), there were some differences between varieties in the appearance of the quality of husks. (See Table 2)

Flavor and Tenderness
While not statistically significant (p=0.26 for flavor, p=0.19 for tenderness), the ratings did differ slightly between varieties (see Table 2).

Tip Blank
The amount of tip blank (unpollinated, late-developing kernels at the tip of the ear) varied significantly between varieties (F=8.024, p=0.0021). Xtratender 2171 had the least tip blank with an average of just 0.12in, which follows from it also being the earliest variety to silk. Xtratender 274A had the largest average area of tip blank at 0.67in, despite silking just a few days later. (Fig 4)

Average Ear Size
Average ear weight varied significantly by variety (F=8.61, p=0.0016). Xtratender 274A had the largest ears, followed closely by Mirai 131Y. AP426 had the smallest ears by weight, closely trailing XTH20173. Average ear length also varied significantly

Variety	Avg Tassel Height		Avg Top Ear Height		Husk Appearance	Husk Protection	Flavor	Tenderness	Tip Blank		Avg Ear Weight		Avg Ear Length		Avg Ear Diameter	
	in		in		1-5 (see appendix)	1-5 (see appendix)	1-5 (see appendix)	1-5 (see appendix)	in		lb		in		in	
Xtratender 274A	46.63	b	14.27	b	4.0	3.33	3.83	2.67	0.60	a	0.68	a	8.77	ab	2.09	a
Nirvana	50.27	b	18.17	ab	3.2	4.00	3.83	2.83	0.14	cd	0.53	bc	7.80	c	2	ab
XTH2017	52.20	b	17.53	ab	4.0	3.68	3.17	3.50	0.50	ab	0.51	bc	7.73	c	1.93	ab
Xtratender 2171	50.60	b	17.67	ab	4.0	3.00	4.33	1.17	0.12	d	0.54	bc	8.18	bc	1.94	ab
Mirai 131Y	50.03	b	20.33	a	3.5	2.67	3.5	2.50	0.47	abc	0.63	ab	8.90	a	2.01	ab
AP426	58.03	a	18.03	ab	4.2	3.33	3.67	3.83	0.25	bcd	0.49	c	7.97	c	1.81	b

Table 2: Sweet Corn Variety Trial Results
Results by variety for the 2016 NOVIC Sweet Corn Trial are color coded with green being most desirable for the trait and red being least desired. Means for traits that showed significant differences in ANOVA ($p<0.05$) were grouped using multiple comparisons of treatment means by the Tukey method; varieties that share a letter for that trait are not statistically significantly different from each other.

by variety (F=14.94, p=0.00010), with Mirai 131Y having the longest average ears at 8.9in. XTH20173 had the shortest ears at 7.73in. The top two yielders, Xtratender 274A and Nirvana, measured in at 8.8 and 7.8in respectively. In keeping with the size differences, average ear diameter also varied significantly by variety (F=4.81, p=0.014). The top yielder, Xtratender 274A, had the widest ears at an average of 2.1in, while the lowest yielder, AP426, had the thinnest ears at 1.8in.

Interpretation and Additional Resources

The results of a variety trial must always be approached with caution. Annual weather fluctuations, soil type, and aspects of a farm's microclimate can have a huge impact on varietal performance. So, while there appear to be a few clear winners here, these results are mostly a place to start when considering new varieties to try.

Both Nirvana and Xtratender 274A performed consistently well, even despite Nirvana experiencing a high rate of lodging. Both varieties also matured relatively quickly, had a low rate of smut, and less unusable ears. Xtratender 274A also had the largest ears, although it had the most tip blank, while Nirvana had the second least. Xtratender 274A also grew lowest to the ground.

Transplanting the corn was labor intensive, but it paid off by allowing for an earlier start. With minimal supplemental water, and that only at the beginning, all varieties had high survival rates.

Pest pressure was relatively minimal, although it was noted at harvest that corn earworm was a common cause of un-marketability, and one possible recourse to address this problem next year could be to increase spray applications of Bt, or to apply a mixture of organic vegetable oil and Bt directly to the ears beginning after silking. For more information on organic management of corn earworm, see the UW-Extension publication below.

Varieties for this trial were chosen by Dr. Bill Tracy's lab at UW-Madison. If you would like to suggest a variety for inclusion in this trial, or have any questions about the design, conditions, management or results of the trial, please contact Dylan Bruce. Resources for organic sweet corn production can be found by contacting your local extension agent, and many are available online. One such online resource is available from National Center for Appropriate Technology.

1. Contact Dylan Bruce at: dbruce3@wisc.edu.
2. NCAT's guide, Sweet Corn: Organic Production, can be found at https://attra.ncat.org/attra-pub/viewhtml.php?id=31
3. UW Extension Corn Earworm guide https://learningstore.uwex.edu/Assets/pdfs/A3655.pdf

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United States Department of Agriculture

National Institute of Food and Agriculture

Appendix

Variety Descriptions and Seed Sources:

Xtra-Tender 274A:
"74 Days to maturity. This Xtra-Tender bicolor sweet corn offers superb eating quality and tenderness in a 74 day variety. Very refined 8" ears are produced on sturdy plants with few tillers and have 18 to 20 rows of nicely contrasted yellow and white kernels. A dark green husk with long dark green flags covers the tender and sweet kernels well over the tip. An excellent sweet corn variety for roadside and local markets. Isolation required. Supplied as untreated seed."

- Supplied as untreated seed by Illinois Seed Foundation. Description from Harris Seeds.

Nirvana
"75 Days to maturity. Nirvana is the best of all worlds. It has vigor and emergence with the highest quality taste and texture. Its sweetness and bite is truly unique. Nirvana is high yeilding with uniform, full tipped ears that have good kernel contrast and rowing. Nirvana continues to raise the bar with exceptional snap, ease in packing and its holding power. In trial after trial, Nirvana has proven to be a game changer."

- Supplied by Crookham Company

XTH2017
"73 Days to maturity. XTH20173 sweet corn is a strong growing, augmented, supersweet bicolor that has superb eating quality, good sweetness, a tender pericarp and resistance to the new strains of rust. Its 7-1/4 to 8" ears have great eye-appeal and are set at 23" on sturdy and clean 6' plants. The easy to snap ears have a dark green husk package that offers excellent tip cover and ample dark green flag leaves. XTH20173's ears have good kernel color contrast, and are filled well to the tip with 14-18 rows of shiny bicolor kernels. Resistant to the new rust strains (Rp1-GDJ) and intermediate resistance to Stewart's Bacterial Wilt. Isolation required."

- Supplied as untreated seed by Illinois Seed Foundation. Description from Harris Seeds.

Xtra-Tender 2171:
"71 Days to maturity. Early super sweet (sh2) with good cool soil germination. Widely adaptable variety with excellent eating quality. Better husk protection and tighter, more attractive husks than Xtra-Tender 270A, which it replaced. 16 straight, refined rows on ears that are 8-8½". 6' plants. Good cool-soil vigor. Intermediate resistance to southern corn leaf blight and Stewart's wilt."

- Supplied as untreated seed by Illinois Seed Foundation. Description from Johnny's Seeds.

Mirai 131Y:
"MIRAI® is widely regarded as the best tasting corn there is! This supersweet yellow hybrid variety has unrivaled sweetness, tenderness and rich flavor. The ears grow a large 8" in length and have superb tip fill. Tolerant to NCLB, common rust and Stewart's bacterial wilt."

- Supplied as untreated seed by Vermont Bean Seed Company. Description from Honeyman Farms.

AP426:
"78 Days to maturity. AP 426 begins with an explosion of flavor. The taste and bite of this main season Augmented variety is exceptional. AP 426 has a great retail presentation with a good size ear, nice kernel contrast, good tip fill, a dark protective husk and abundant flags. The plant is sturdy and has good emergence. AP 426 will be a strong leader in the main season varieties. Disease Ratings: Intermediate/Moderate Resistance to MDMV. Intermediate/Moderate Resistance to Northern Corn Leaf Blight.

- Supplied by Crookham Company

1-5 Rating Scales:

Trait	Description	Score
Husk appearance:	Dark green, flag leaves > 6 inches	5
	Green husks, 4-6 inch flags	4
	Green husks, 2-4 inch flags	3
	Pale green 1-2 inch flags	2
	Yellow or brown or no flag leaves	1
Husk protection:	V. Long > = 3 inches beyond ear tip	5
	Long 2 3 inches	4
	Medium 1 2 inches	3
	Short < = 1 inch	2
	Exposed ear tips	1
Flavor:	Excellent, sweet and good corn flavor	5
	Pleasant	4
	Acceptable	3
	Little sweetness	2
	Objectionable	1
Tenderness:	Very tender not chewy	5
	Easy to bite through with slight chewiness	4
	Initial resistance to biting	3
	Slightly hard to bite through	2
	Tough hard to bite through	1

Figures:

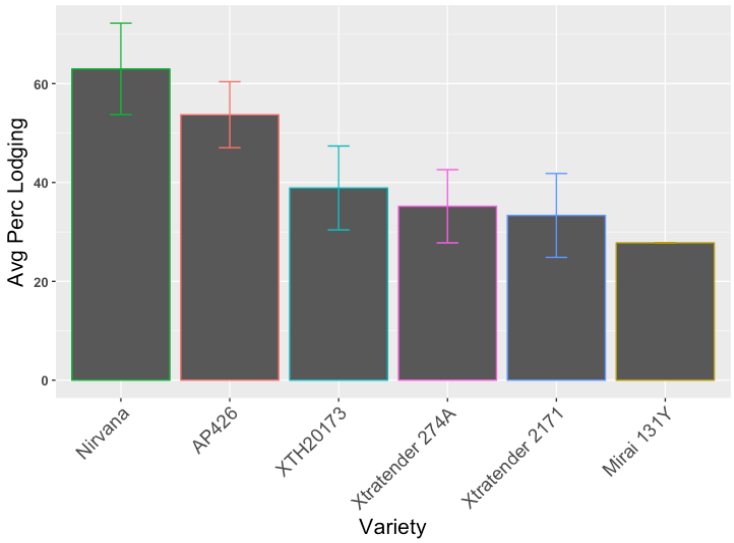

Figure 1: Percent Lodging. While not statistically significant, there did appear to be differences in the lodging response after a large thunderstorm.

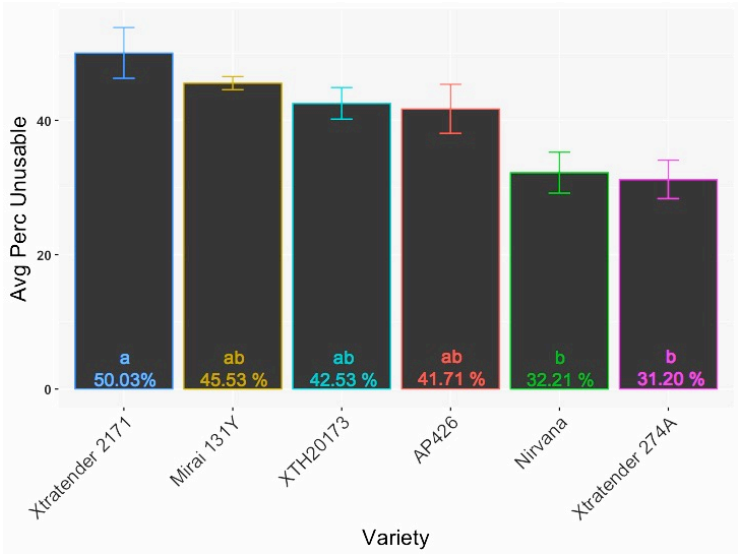

Figure 2: Percent of Ears Unusable. Means were grouped using multiple comparisons of means by the Tukey method; varieties that share a letter for that trait are not statistically significantly different from each other.

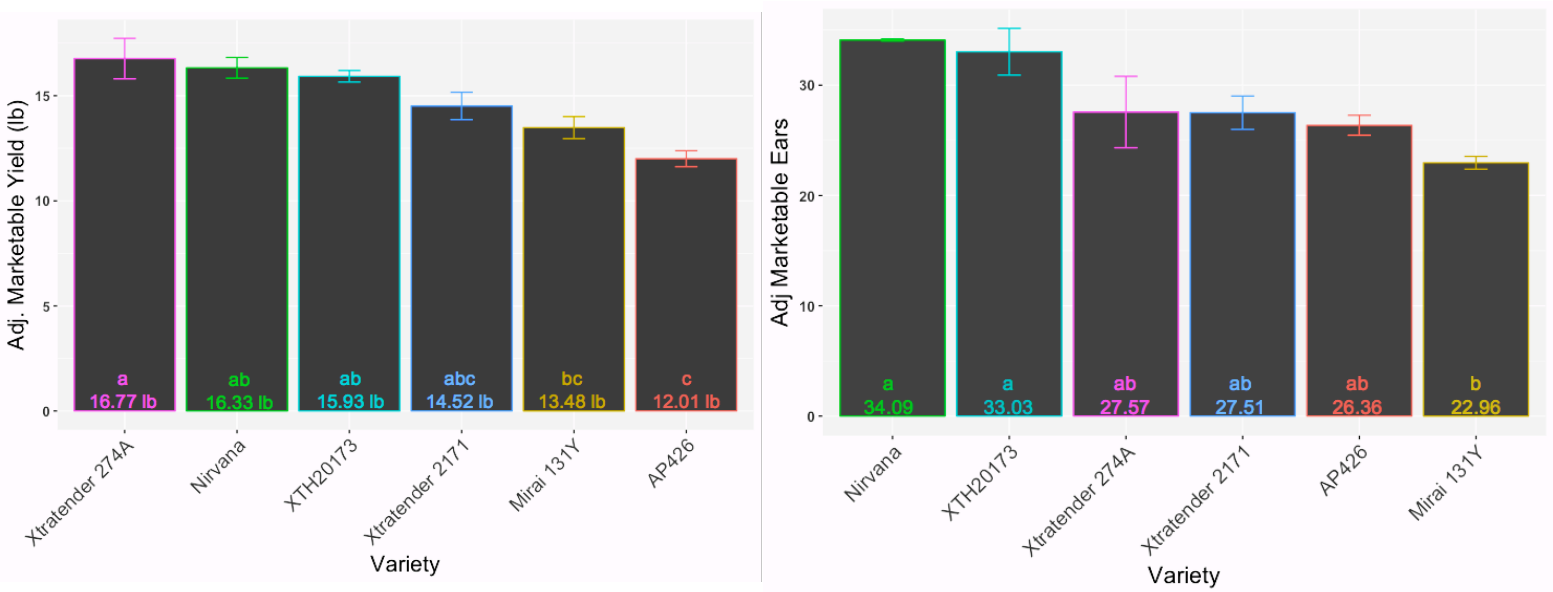

Figure 3: Adjusted Marketable Yield. Means were grouped using multiple comparisons of means by the Tukey method; varieties that share a letter for that trait are not statistically significantly different from each other. Yields were adjusted for stand count.

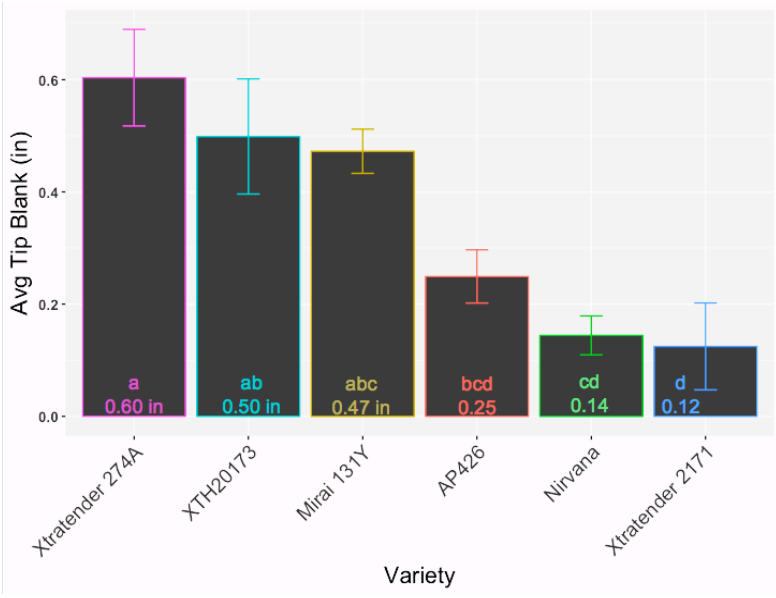

Figure 4: Average Tip Blank Length. Means were grouped using multiple comparisons of means by the Tukey method; varieties that share a letter for that trait are not statistically significantly different from each other.

Unadjusted Yield Results:

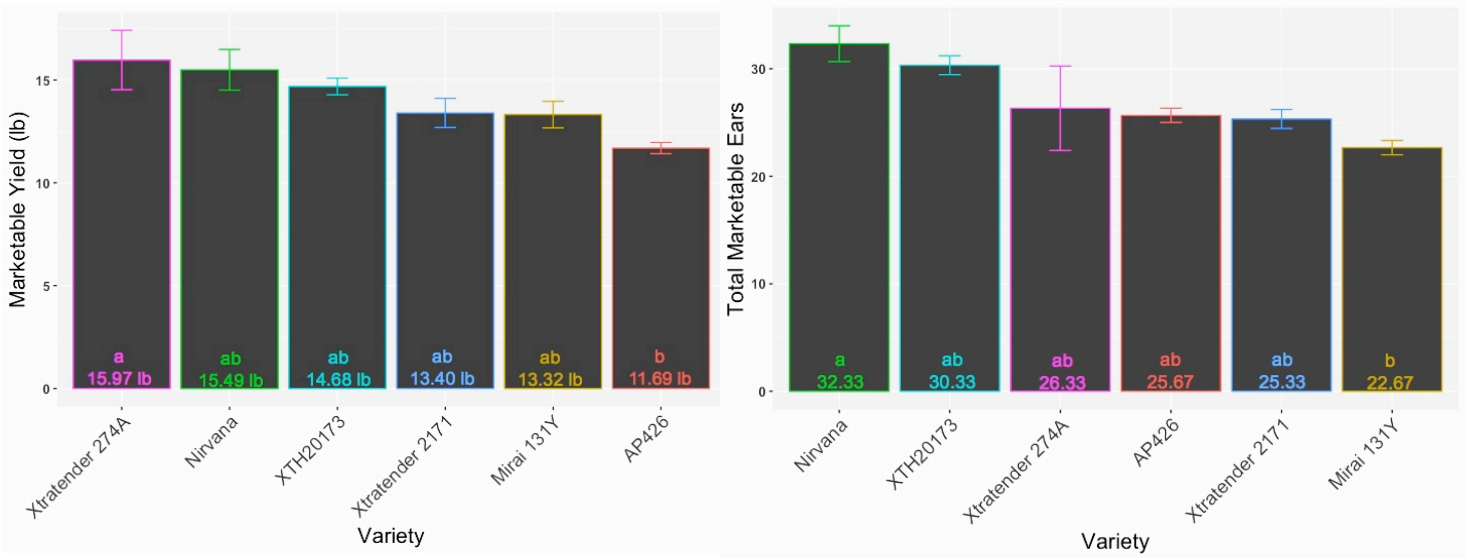

Figure 5: Unadjusted Marketable Yield. Means were grouped using multiple comparisons of means by the Tukey method; varieties that share a letter for that trait are not statistically significantly different from each other. Yields were adjusted for stand count.