

Variety Trial Report:

2016 Northern Organic Vegetable Improvement Collaborative

UW-Madison Organic Research and Extension Program

Dr. Erin Silva, Dylan Bruce

Organic Red Roasting and Bell Peppers



"Carmen F1" © Johnny's Selected Seeds

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 red peppers in particular, high quality, early maturing hybrid and open-pollinated varieties are the desired outcome. Growing high quality red peppers 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, or contact Dylan to set up individual visits). 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 and generally high prices exist for organic red peppers, there are many challenges in its production. The extra maturation time and sugar content in comparison to growing these varieties for green bells can allow increased disease and pest pressure, the ever-present nemeses of the organic farmer. Variety selection is an important part of rising to these challenges, yet unfortunately, many commercially available varieties are bred under conventional management systems, making them less competitive when grown organically. The NOVIC red pepper trials aim to elucidate how five commercial varieties and one promising breeding line of red bell peppers, and four commercial varieties of red roasting pepper perform when grown under industry standard organic management.

Solanaceous soft rot incidence was so high in most varieties, especially the bell types, that the other outcomes of this trial are likely skewed by its prevalence. This provides a very good metric for what varieties – and particularly what type – of red pepper can still yield well under soft-rot pressure, but yield and percent of fruit deemed unmarketable would likely be very different with less disease pressure.

Methods

Field Methods:

The red pepper trial was planted in single-row plots, with two outer “border” rows at the perimeter of the field, with three replications in a complete randomized block design. Rows within plots were 20’ long, including a 2’ space (thus, 18’ of peppers plus 2’ for a visual break), with twelve plants per row (18 in. in-row spacing) and 9’ between rows. Data was never gathered from the plants at the end of the two data rows. Thus 10 plants was a full stand count at harvest.

All varieties were first seeded by West Star Organics in Cottage Grove, WI on April 11th, and after some delays because of weather, were transplanted on June 7th into freshly rototilled ground that had drip irrigation under plastic mulch laid with a Mechanical Transplanter Company Model 85 Mulch Layer. The field 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. Drip irrigation was used as needed – every 1-2 days during particularly dry periods – but a surprising amount of the season relied only on rainfall. While 2016 was a particularly wet year, and between June 7th and August 25th there was ~16.64in of rain accumulation, the plastic mulch had the

effect of both holding in moisture longer, and preventing infiltration in that specific area during light rains.

Aisles were mulched at a rate of 10 tons of ground hay per acre. Before mulching stirrup hoes were used regularly for weed control. After a bad thunderstorm in late July that washed away significant patches of mulch, intermittent hand weeding was used to control weeds setting seed. No major pest pressure was noted until harvest, when it became apparent that European corn borer was a significant issue (including finding them inside seemingly healthy fruit without any visible damage).

Weekly harvest began on August 25th, one week after the commercial check variety for early maturation, Ace F1, averaged five ripe fruits per plot. Prior to that, ripe and rotten fruit were removed. Prior to and during regular harvests, fruit affected by soft rot was counted in the field and removed separately, to prevent transmission to fruit going into storage.

At each harvest, total fruit picked, number of unmarketable fruit, and number and weight of marketable fruit (g) were recorded. Beginning the second harvest, representative marketable fruit were pulled aside for analyses of size and soluble solids (Brix). Samples for Brix were frozen and tested later. While Brix readings must be approached with caution, and do not necessarily equate to overall quality, it is commonly used as a proxy for quality. For instance, International Ag Labs, Inc., a consultancy, rates bell pepper quality using Brix poor at 4, average at 6, good at 8, and excellent at 12. During the fourth harvest field taste tests were also conducted.

Analysis:

Data was averaged to a plot level using Microsoft Excel, and was analyzed to a variety level using R Studio. Normality and variances for each outcome were assessed visually by plot and mostly determined to be acceptable for a standard ANOVA. Transformations were used as needed. 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 outcome. For analyzing the difference between bell and roasting types, t-test or non-parametric alternatives were used.

Results

Results are presented here in text, and can also be viewed in Table 1 below. Some traits also have corresponding figures, which can be viewed at the end of the report.

Early Ripening and Early Rot Incidence:

Early ripening fruit and early onset of diseases are important data points for determining early maturing varieties under organic production. (“Early” here means “before first harvest”). Indeed, there were definite differences for both traits, with variety significantly effecting both outcomes ($F=3.12$, $p=0.017$ for early maturation, and $F=10.65$, $p=0.0041$ for early rot). Bell types showed significantly higher early rot ($t=2.93$, $p=0.0068$) while roasting types (as well as Ace F1) began maturing significantly earlier ($t=-3.26$, $p=0.0018$). The differences by variety for both early rot (Fig 1) and early maturation (Fig 2) were readily visible. Stocky Red Roaster and Carmen F1 stood out as early maturing varieties, while the varieties worst affected by soft rot were

already showing significant signs of disease pressure.

Hereafter the results will be presented separately for Bell types and Roasting types.

Red Bell Types

Total Fruit Set:

Total fruit set removed from the plots, including marketable, soft rot-affected, and other unmarketable fruit, was very significantly effected by variety ($F=29.04$, $p=5.52 \times 10^{-6}$). The two smallest varieties (see below) by far set the most fruit per plot, with Ace F1 averaging 153.33, followed by King of the North at 108.88 fruit per plot (10 plants). X3r Red Knight and Aristotle tied for the least at an average of 68.67 fruit per plot (Fig 3). These trends held true over the course of the harvest season, with Ace F1 clearly yielding more. Ace F1, King of the North, and Enza Zaden E20B all had their peak yields at the third harvest, on September 8th (Fig 4).

Marketable Yield:

Average weekly harvest marketable yield weight per plot was significantly different depending on variety ($F=12.40$, $p=0.00032$). Ace F1, the check variety for this trial, had the heaviest average marketable yield per harvest, at 1314g (2.90lb), while Aristotle, Revolution and Enza Zaden E20B yielded the lowest, averaging under a pound per harvest (Fig 5). X3R Red Knight had similarly low marketable yields for most harvests, but a decent initial harvest brought its average up (Fig 6).

Variety also had a very significant effect on average number of marketable fruit ($F=25.84$, $p=9.90 \times 10^{-6}$). Once again, Ace F1 led the pack averaging 10.67 marketable fruit per plot per harvest, far ahead of the next runner up, which was again King of the

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North, averaging 6.25 marketable fruit per harvest. Revolution, hit hardest by the soft rot, averaged less than one marketable fruit per harvest. (Fig 7)

Overall, Ace F1 yielded the highest with an average plot season total of 13.22lb, followed by King of the North at 8.28lb, with Revolution yielding the lowest average total at 0.93 lbs (Fig 8).

Soft Rot Incidence:

Percentage of total fruit affected by soft rot was significantly influenced by variety (F=13.74, p=0.00020). Not surprisingly, the rankings essentially invert the marketable yield and total fruit rankings; Revolution had the highest percentage of fruit effected at 88.98%, while Ace F1 had only 50.54% total fruit effected by soft rot. These trends and rankings generally held true over the course of the harvest season (Fig 9).

The average number of fruit affected by soft rot per harvest was slightly less significant (F=3.74, p=0.032); the only significant difference was between Ace F1, with an

average of 19.42 fruit, and X3R Red Knight, with an average of 11.33 fruit. While this is in keeping with the rankings of overall fruit set, the magnitude is not the same, suggesting that there were differences in tolerance to the disease. Moreover, while not statistically significant, the rankings of the other varieties were in a different order.

Unmarketable Yield:

Total percentage of fruit deemed to be unmarketable, including soft rot, was significantly influenced by variety (F=9.50, p=0.0010). Revolution had the highest total percent unmarketable fruit at 98.62% and Enza Zaden E20B had the second highest percentage of unmarketable fruit at 94.59% unmarketable fruit. Once again Ace F1 (73.92%) and King of the North (77.05%) fared best with the lowest percentage of unmarketable fruit (Fig 10).

Variety had a similarly significant effect on percentage of fruit deemed unmarketable *not* including fruit with soft rot (F=8.94, p=0.0013). Rankings were largely the same, but percentages were lower; Revolution still

Bell Pepper Variety	Avg Season Total Fruit	Avg Marketable Yield	Avg Number Marketable Fruit	Total Marketable Yield	Total Marketable Fruit	Total Percent Unusable	Percent Fruit w/ Soft Rot	Avg Fruit Weight	Avg Width	Avg Length	Avg Brix	Avg Taste
	per plot	g	per harvest	lb	per plot	%	%	g	cm	cm	*Brix	1=poor 9=excellent
Ace F1	153.3 a	1314 a	10.67 a	13.21	42.66	73.92 b	50.54 d	126.63 c	7.90	9.99	7.41 a	5
King of the north	108.3 b	979.5 ab	6.25 a	8.28	25.00	77.05 ab	58.02 cd	156.95 bc	7.90	7.23	7.02 a	3.08
X3R Red Knight F1	68.67 c	580.2 bc	1.75 b	4.33	7.00	90.88 ab	66.18 bcd	373.6 ab	10.92	10.42	6.51 a	5.67
Enza Zaden E20B	86.33 bc	405.2 c	1.25 b	3.23	5.00	94.59 a	77.05 abc	315.61 abc	9.61	12.83	7.96 a	2.22
Aristotle X3R F1	68.67 c	392.8 c	1.50 b	3.57	6.00	88.67 ab	81.60 ab	261.89 abc	9.47	12.25	8.33 a	6.25
Revolution F1	70.67 c	322.4 c	0.33 c	0.93	1.33	91.87 ab	88.98 a	503.58 a	9.25	10	7.03 a	ND
Roasting Pepper Variety	Avg Season Total Fruit	Avg Marketable Yield	Avg Number Marketable Fruit	Total Marketable Yield	Total Marketable Fruit	Total Percent Unusable	Percent Fruit w/ Soft Rot	Average Fruit Weight	Avg Width	Avg Length	Avg Brix	Avg Taste
	per plot	g	per harvest	lb	per plot	%	%	g	cm	cm	*Brix	1=poor 9=excellent
Carmen F1	189 a	1792 a	19.00 a	20.21	76.00	60.20 a	39.63 a	94.49 a	6.53	16.53	8.25 a	4.33
Corno di Toro	173.3 ab	878.9 b	15.67 ab	10.53	62.67	64.90 a	37.80 a	60.37 a	4.66	14.13	7.14 b	4.17
Bridge to Paris	218.7 a	856.7 b	12.83 ab	10.26	51.33	76.96 a	43.32 a	67.01 a	4.17	16.15	7.97 a	5.67
Stocky Red Roaster	106.3 b	590.1 b	8.17 b	4.95	32.67	70.49 a	44.50 a	69.95 a	4.83	12.03	7.85 ab	5.08

Table 1: Red Sweet Pepper Trial Results

Results by variety for the 2016 NOVIC Red Pepper 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. At the harvest when taste test occurred no marketable fruit was harvested from Revolution F1 plots.

had the highest percentage unmarketable fruit, at 81.23%, while King of the North and Ace F1 fared best at 44.69 and 44.17% respectively. Rot discovered post harvest (too small to notice in field) was a significant cause across varieties, as was bug damage from European corn borer. Some varieties also had incidences of bacterial speck caused by *Xanthomonas* sp. Falling off green was also a common reason for being deemed unmarketable, since this was a red pepper trial. See Appendix for a table of causes.

Fruit Size:

Variety had a significant effect on average marketable fruit weight ($F=6.85$, $p=0.0039$). Ace F1 and King of the North had the lowest fruit weights, while Revolution had by far the heaviest fruit (over a pound on average at 503.58g). By dimensions, King of the North was the smallest, followed by Ace F1, while Enza Zaden E20B and Aristotle X3R were the largest (see Table 1).

Fruit Quality:

Difference in average °Brix (soluble solids) between varieties was not significant, but there was a trend ($F=3.15$, $p=0.064$). Aristotle had the highest average brix at 8.33 °Brix, with Enza Zaden E20B close behind at 7.96 °Brix. X3R Red Knight averaged the worst at 6.51 °Brix. However, it is noteworthy that these rankings did not match up to taste ratings, which ranked Aristotle highest, X3R Red Knight second, Ace F1 third, King of the North fourth, and Enza Zaden worst (Revolution was not tested for taste.)

Red Roasting Types

Total Fruit Set:

Total fruit set removed from the plots was significantly effected by variety ($F=8.47$, $p=0.0099$). Bridge to Paris by far set the

most fruit per plot on average (218.7), followed by Carmen F1 (189) – Stocky Red Roaster set the least at an average of 106.3 fruit per plot (Fig 11). These rankings mostly held over the course of the harvest, although by the last harvest Corno di Toro was yielding the most total fruit (Fig 12).

Average Marketable Yield per Harvest:

Average weekly harvest marketable yield weight per plot was significantly different depending on variety ($F=31.26$, $p=0.00020$; Fig 13). Carmen F1 had the heaviest average marketable yield per harvest, at 1792g (3.95lb), while the remaining varieties all averaged less than half that weight. Corno di Toro had the second heaviest average harvests and Stocky Red Roaster by far had the least at 590.1g. This held true over the course of the harvest season (Fig 14).

Variety also had a very significant effect on average number of marketable fruit ($F=4.89$, $p=0.039$; Fig 15). Once again, Carmen F1 led the pack averaging 19 marketable fruit per plot per harvest. The next runner up, was again Corno di Toro, averaging 15.67 marketable fruit per harvest. Stocky Red Roaster again brought up the rear, averaging just 8.17 marketable fruit per plot per harvest. Carmen F1 clearly yielded the most marketable fruit, with a season total average of 20.21lb and 76 marketable fruit per plot. Stocky Red Roaster yielded just 4.95lb and 32.67 fruit per plot. (Fig 16)

Soft Rot Incidence:

Percentage of total roasting pepper fruit effected by soft rot was not significantly influenced by variety ($F=0.37$, $p=0.78$). However, there were some differences visible. Not surprisingly, the rankings almost inverted the marketable yield and total fruit rankings; Stocky Red Roaster had the highest percentage of fruit effected at

44.50%, with Bridge to Paris close behind at 43.32% fruit effected. Corno di Toro and Carmen F1 had only 37.80% and 39.63% respectively. Percentage of fruit with rot over time mostly held to these rankings, although interestingly Carmen F1 started with relatively high rate but declined steadily. Corno di Toro, on the other hand, started with a low rate of infection, but by the last harvest had the highest percentage of fruit effected (Fig 17). However, this is in keeping with the total fruit set over time, and Corno di Toro still averaged the lowest incidence.

The average number of fruit per variety effected by soft rot each harvest was slightly significant ($F=5.46$, $p=0.030$); the only significant difference was between Bridge to Paris, with an average of 23.42 effected fruit, and Stocky Red Roaster, with an average of just 12.08 effected fruit. These rankings are in keeping with the total fruit set, and the magnitude is mostly the same, suggesting that there were not significant differences in tolerance to the disease.

Unmarketable Yield:

Total percentage of fruit deemed to be unmarketable, including soft rot, was not significantly influenced by variety, although there was a trend ($F=3.71$, $p=0.070$). Bridge to Paris had the highest total percentage of unmarketable fruit at 76.96%, followed closely by Stocky Red Roaster at 70.49% unmarketable fruit. Once again Carmen F1 (60.20%) and Corno di Toro (64.60%) fared best with the lowest percentage of unmarketable fruit.

Variety did have a significant effect on percentage of fruit deemed unmarketable *not* including fruit with soft rot ($F=24.41$, $p=0.00044$). Rankings were largely the same, but percentages were lower; Bridge to Paris still had the highest percentage

unmarketable fruit, at 60.23%, while Carmen F1 fared best at 32.74% unmarketable fruit. Rot discovered post harvest (too small to notice in field) was a significant cause across varieties, as was bug damage from European corn borer. Some varieties also had incidences of bacterial speck caused by *Xanthomonas* sp., although Carmen F1 did not. Falling off green was also a common reason for being deemed unmarketable, since this was a red pepper trial. See Appendix for a table of causes.

Fruit Size:

Variety did not have a significant effect on average marketable fruit weight, although there was a trend ($F=4.05$, $p=0.058$). Corno di Toro had the lowest fruit weight at 60.37g, while Carmen F1 had by far the heaviest fruit at an average of 94.49g. By dimensions, Stocky Red Roaster was the smallest, followed by Corno di Toro, while Carmen F1 was the largest (see Table 1 below).

Fruit Quality:

Difference in average Brix (soluble solids) between varieties was significant ($F=11.72$, $p=0.011$). Carmen F1 had the highest average brix at 8.25 °Brix, with Bridge to Paris close behind at 7.97 °Brix and Corno di Toro averaging lowest at 7.14 °Brix. However, it should be noted that the Brix rankings did not match up to the taste rankings. In taste tests, Corno di Toro scored the lowest, followed by Carmen F1 and then Stocky Red Roaster, with Bridge to Paris scoring the best.

Interpretation and Additional Resources

The results of a variety trial must always be approached with caution. Annual weather

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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 (Carmen F1 for roasting types, and Ace F1 for bell types), these results are mostly a place to start when considering new varieties to try. First and foremost, there was an extremely high incidence of soft rot; the results of the trial may have been significantly different if not for that fact.

Soft rot can be caused by several genera, but symptoms are similar across species. The soft rot pressure our field experienced was likely influenced by the hot and wet conditions that prevailed for most of the summer and into the harvest season. Another factor that may have contributed to the problem was over-fertilization. While the level of N in the soil wasn't enough to cause blossom drop or other problems, high rates of N fertilization are associated with increased vulnerability to the disease. For pepper crops, the University of Wisconsin Extension's Nutrient Application Guidelines recommends a total nitrogen application of 80lb N/acre, while our rate of feathermeal application provided a total of 117-195lb/acre (at 60-100% availability, adjusted for yield).

Soft rot does require a wound for infection, which was likely often provided by European corn borer; In fact, anecdotally, European corn borer was a significant secondary cause of unmarketability during harvests, and may have been a vector throughout the season. The disease proved particularly challenging to manage because the fruit turn extremely soft – almost liquid – making it very hard to remove them from the field. For information on the disease see the World Vegetable Center publication below.

The roasting pepper types were obviously much less susceptible to the disease. This might be partly due to the fact that water collects at the top of the bell fruits, and does not on the sloped tops of the roasting type fruits. Roasting peppers are also less susceptible to European corn borer; in a study conducted by Cornell University (see below), Corno di Toro had less fruit damaged by corn borer than other Italian sweet and bell type peppers included in the study, including Ace F1. Interestingly, Corno di Toro had the lowest soft rot incidence in our trial. Carmen F1, which also had a very low incidence of rot, is also an Italian Corno di Toro type. European corn borer damage was not quantified in this trial.

Varieties for this trial were chosen by Dr. Michael Mazourek's lab at Cornell University. (It should be noted that Aristotle X3R F1, while tested here for red bell production, is noted by the seller (Seedway Seeds) for its "excellent green color" – falling off green was a frequent cause of being deemed unmarketable for Aristotle X3R, so it may perform much better for green bell production). If you would like to suggest a variety for inclusion in this trial, or have any questions about the design, conditions, results, or management of the trial, please contact Dylan Bruce. Resources for organic red pepper production can be found by contacting your local extension agent, and many are available online. For a useful, if somewhat dated guide on fresh market production from the University of Wisconsin Extension, see the link below. Couple regional information found there with organic production principles found in the sustainable agriculture guides published by the [National Center for Appropriate Technology](#) (NCAT).

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1. Contact Dylan Bruce at dbruce3@wisc.edu.
2. The World Vegetable Center's Bacterial Soft Rot Fact Sheet: www.avrdc.org/download/publications/crop-guides/peppers/bact_rot.pdf
3. UW Extension's Nutrient application guidelines for field, vegetable, and fruit crops: <http://learningstore.uwex.edu/assets/pdfs/A2809.pdf>
4. Cornell University's "Greenhouse Evaluation of *Capsicum* Accessions for Resistance to European Corn Borer: <http://hortsci.ashspublications.org/content/39/6/1336.full.pdf>
5. UW-Madison Extension's guide, "Growing tomatoes, peppers, and eggplants in Wisconsin: <http://learningstore.uwex.edu/assets/pdfs/a3687.pdf>
6. NCAT's Organic Production guides: <https://attra.ncat.org/organic.html>

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United States
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Agriculture

National Institute
of Food and
Agriculture

Appendix

Variety Descriptions and Seed Sources:

Bell Types

King of the North - Certified Organic from Hudson Valley Seed Library (OP)

"Introduced in 1934 by Harris Seeds of Rochester, NY, King of the North is a fast-maturing pepper that finds short seasons and cool temperatures to be no match. In fact, while all peppers like some heat,

we've found in our trials that the King does better in a moderately warm summer than in a scorcher. *88 days to maturity from transplant.*"

Ace F1 - Untreated from Johnny's Selected Seed

"Extra-early, highly productive standard. Huge yields of medium sized 3-4 lobed fruits. Has apparent tolerance to blossom drop as nearly every flower produces a pepper. Widely adapted but performs particularly well in cool climates where bell peppers are difficult to grow successfully."

X3R Red Knight F1 - Untreated from Johnny's Selected Seeds

"King Arthur type with better disease resistance and a more compact open plant. Get a jump on the season with a large, early, green-to-red pepper. Big, blocky, thick-walled, and turns red early. Fruity and sweet. Widely adapted."

Revolution F1 - Untreated from Harris Seeds

"Revolution pepper produces large to extra-large fruit and has a strong disease package. Medium tall plants produce good yields of blocky fruit and have intermediate resistance to phytophthora and CMV, and resistance to BLS (races 1,2,3,5). The medium green to red maturing fruit has good wall thickness and a four lobed shape. Revolution has been noted to have early maturity, concentrated set and good yield ability during cool growing periods. *72 days to maturity from transplant.*"

Aristotle X3R F1 - Untreated from Seedway

"Excellent green color and smooth blocky fruit. A smart choice for the combination of earliness, disease resistance and high yields with very few culls. Small plant results in mostly concentrated set. Anthocyanin-less. *71 days to maturity.*"

Enza Zaden E20B - Untreated from Enza Zaden

Breeding line from Enza Zaden. Expected to be early.

Roasting Types

Bridge to Paris - Certified Organic from Hudson Valley Seed Library (OP)

"... from Sullivan's Favorite Frying Pepper, which itself was bred out from hybrid variety La Paris. Plants are large (up to 36 inches in height) and loaded with big peppers. The flavor and texture are first-rate: extremely sweet when ripe, with thick bell pepper-like skin. *88 days to maturity from transplant.*"

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Carmen F1 - Certified Organic from Johnny's Selected Seeds

"Italian frying pepper. A beautiful pepper of the Italian "bull's horn" (corno di toro) type from Johnny's plant breeders Janika Eckert and Rob Johnston. Tapered fruits avg. 6" long x 2 1/2" wide, 5 oz. (142 gm), and ripen from green to deep carmine red. Maturity is early on an upright, medium-size plant. AAS winner."

Corno di Toro - Certified Organic Seed from High Mowing Seeds (OP)

"Highly attractive scarlet fruits were extremely popular in our taste tests. Tapering fruits are 8-10" long and narrow, often with the slight bull horn curve for which they are named, with deep crimson red color when fully ripe. Plants are very vigorous

with an excellent upright habit. 8-10" fruits. *Days to maturity: 70 days green, 78 red*"

Stocky Red Roaster - Certified Organic from Wild Garden Seeds (OP)

"This is our Red Italian with refinement—selected for straight uncrumpled sides, smooth skin, thicker walls, and a rich red color. By far the quickest for uniform roasting and easy skin removal, and the thicker flesh holds up well to fire. Fruits are 6-7" long, 2 1/4" broad at the crown, sweet, heavy fruiting, and long keeping. *102 days to maturity from transplant at OSU/Corvallis, OR.*"

Figures:

Note: some traits have had means grouped using honest significant differences; varieties that share a letter are not statistically significantly different.

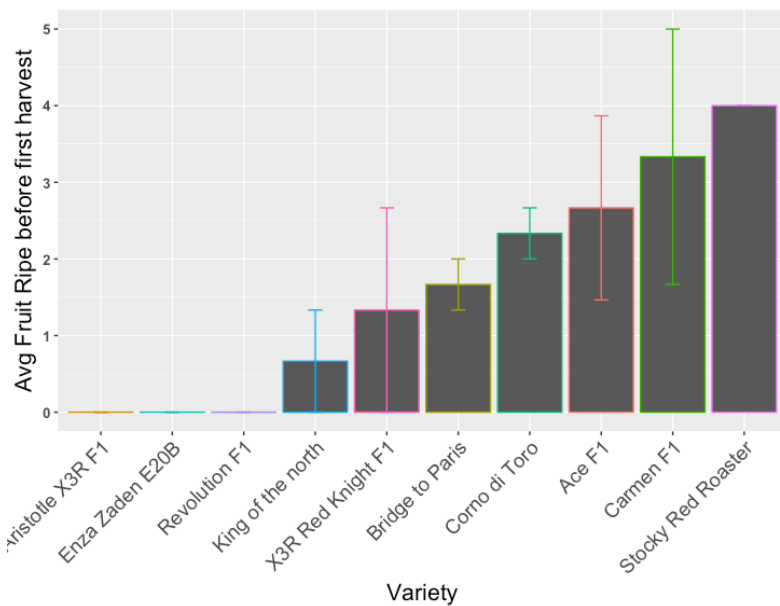


Figure 1: Early Ripening. Variety significantly influenced early maturation of fruit. Roasting types generally matured earlier, with the exception of Ace F1.

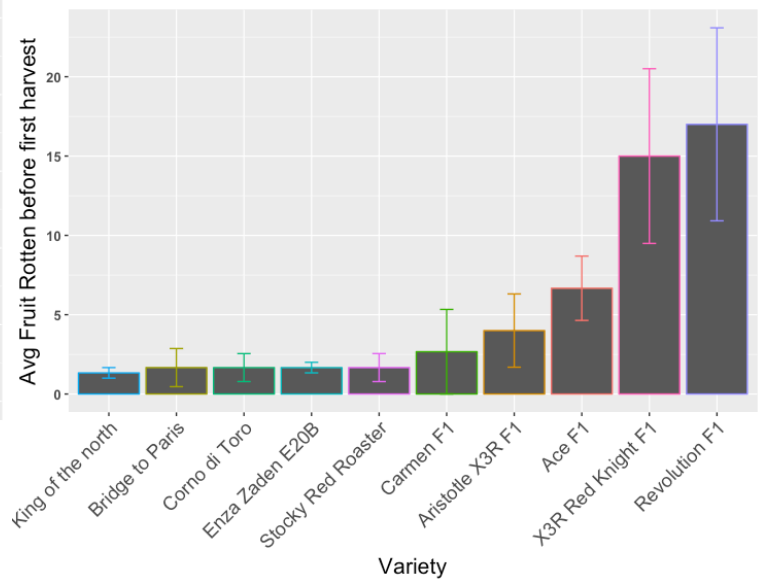


Figure 2: Early Rot Incidence. Variety significantly influenced rates of early rot of fruit. Bell types generally saw much higher rates of rot.

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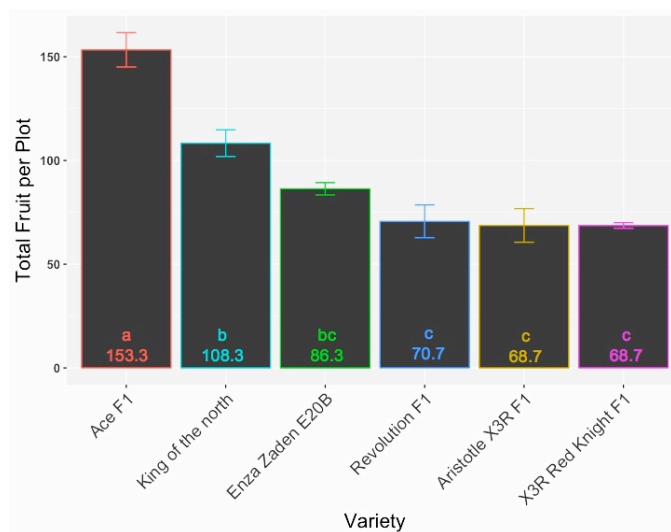


Figure 3: Bell Type Total Fruit Set. Variety significantly affected total fruit set, with Ace F1 setting significantly more fruit than any other varieties. However, Ace F1 and King of the North are also the two varieties with the smallest fruits.

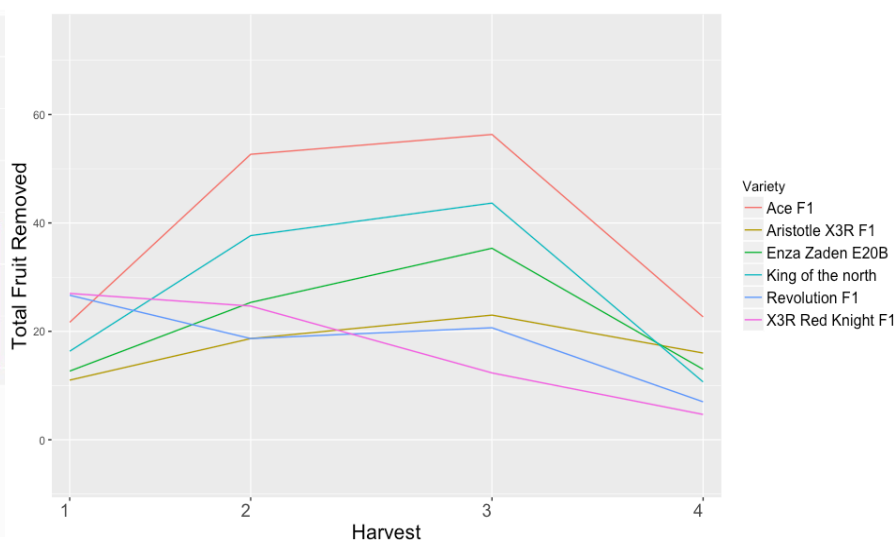


Figure 4: Bell Type Fruit Set Over Time. Fruit set over time (number of fruit removed per plot per harvest) varied depending on variety. Counts include both marketable and unmarketable fruit. First harvest occurred 8/25, second 8/31, third 9/8, and the final harvest 9/15.

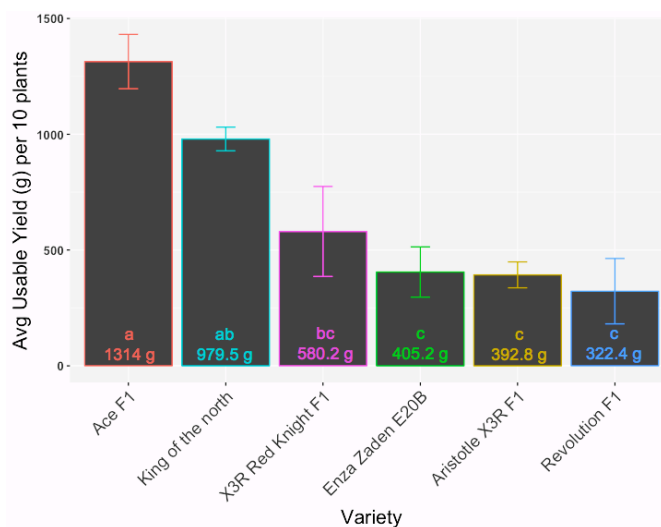


Figure 5: Bell Type Average Marketable Yield. Variety significantly affected average marketable yield, with Ace F1 yielding more than any other varieties. However, Ace F1 and King of the North also set the most fruit.

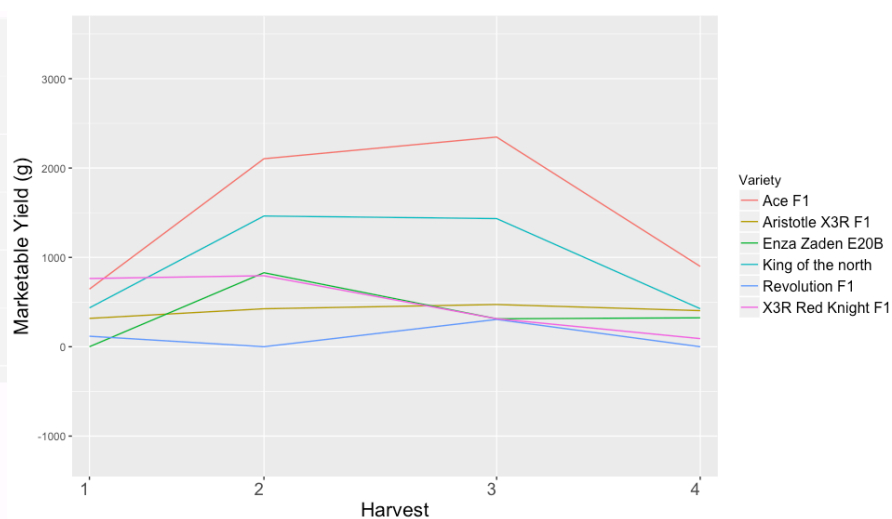


Figure 6: Bell Type Marketable Yield Over Time. Ace F1 followed by King of the North clearly yielded the best once the season had picked up. X3R Red Knight yielded similarly poorly to the remaining three varieties, but an initially decent harvest brought its average up. First harvest occurred 8/25, second 8/31, third 9/8, and the final harvest 9/15.

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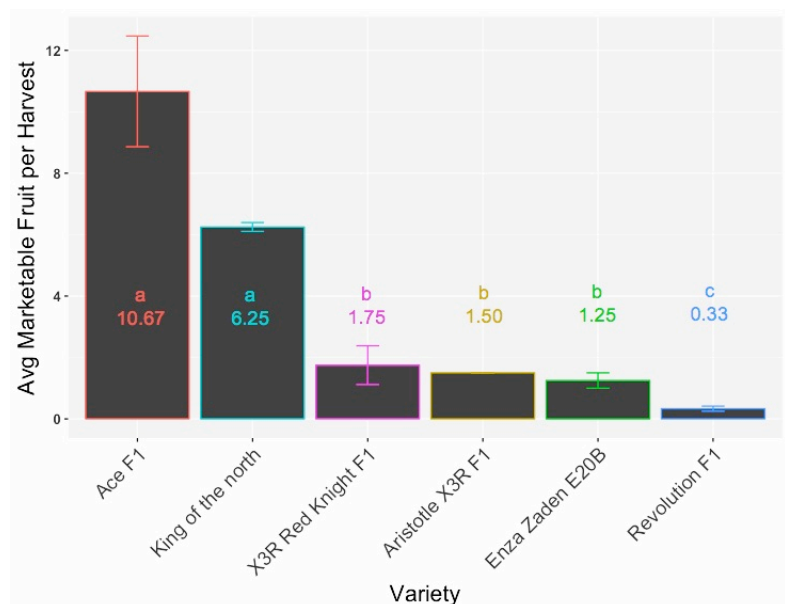


Figure 7: Bell Type Marketable Fruit per Harvest. Number of marketable fruit per harvest was significantly effected by variety, with generally the same rankings as marketable weight.

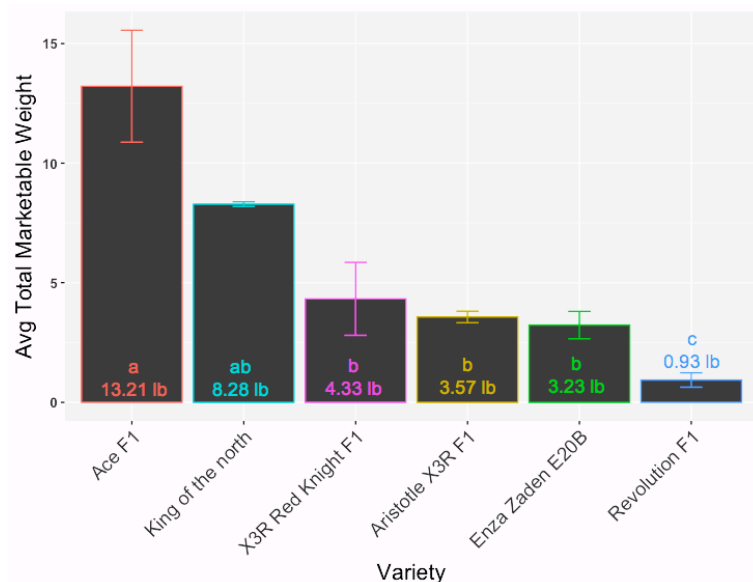


Figure 8: Bell Type Total Marketable Yield.

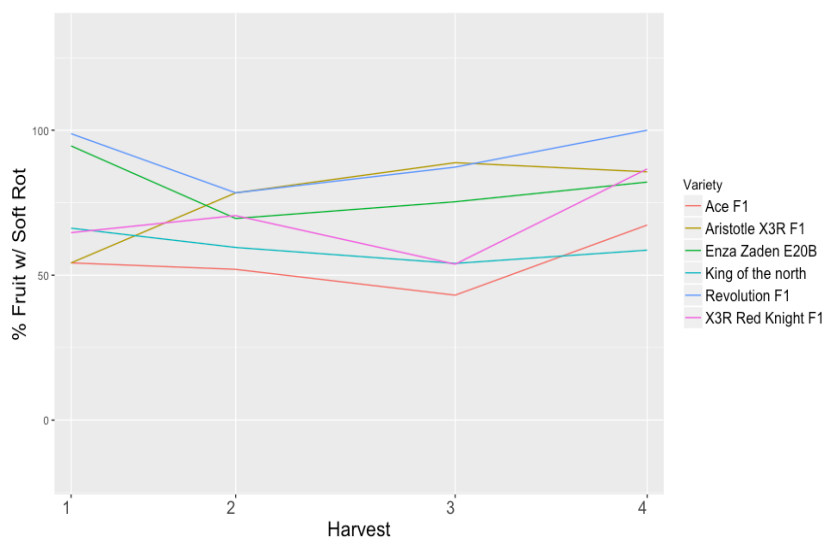


Figure 9: Bell Type Soft Rot Over Time. Ace F1 followed by King of the North had the lowest incidence of soft rot over the season. Revolution by far had the highest rate. First harvest occurred 8/25, second 8/31, third 9/8, and the final harvest 9/15.

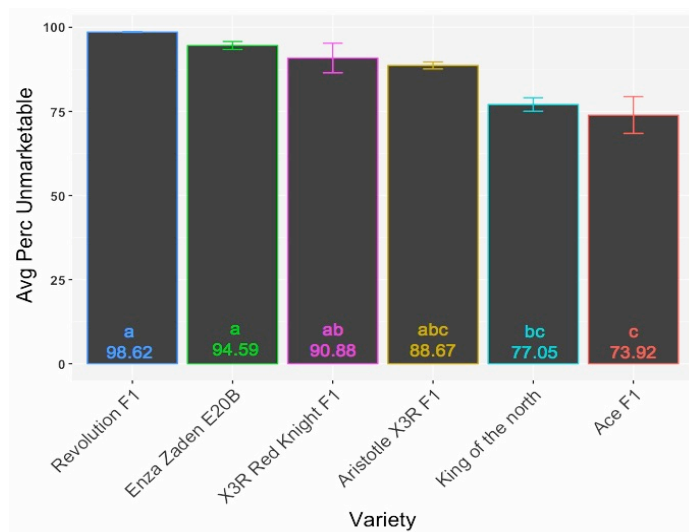


Figure 10: Bell Type Percent Unmarketable per Harvest. Percent of fruit per harvest deemed unmarketable was significantly effected by variety, with generally the same rankings as percent rot.

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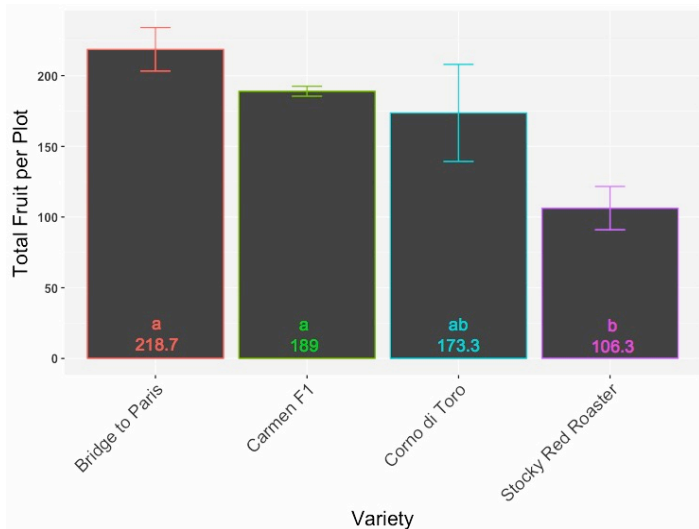


Figure 11: Roasting Type Total Fruit Set. Variety significantly effected total fruit set, with Bridge to Paris setting more fruit than any other varieties. However, Carmen F1 set a statistically similar amount, with much larger fruits.

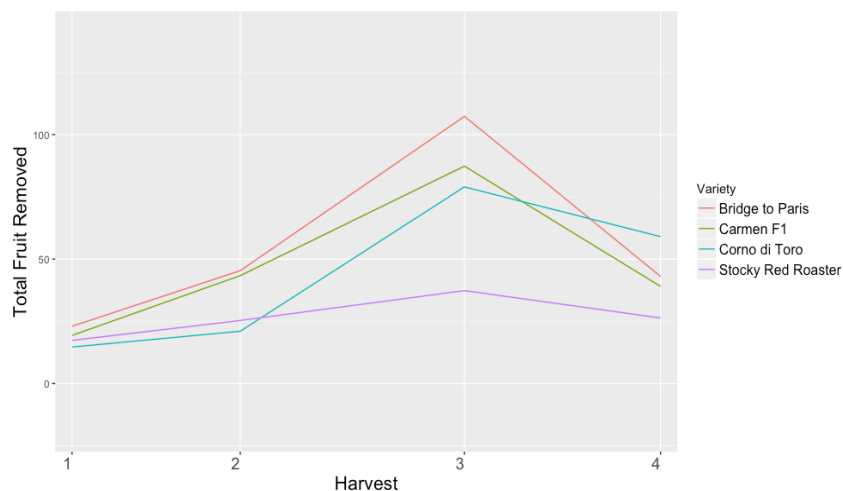


Figure 12: Roasting Type Fruit Set Over Time. Fruit set over time (number of fruit removed per plot per harvest) varied depending on variety. Counts include both marketable and unmarketable fruit. First harvest occurred 8/25, second 8/31, third 9/8, and the final harvest 9/15.

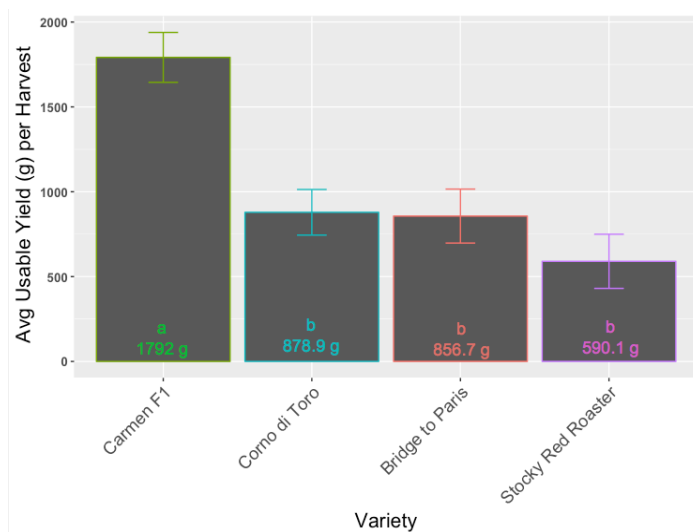


Figure 13: Roasting Type Average Marketable Yield. Variety significantly effected average marketable yield, with Carmen F1 yielding significantly more than any other variety.

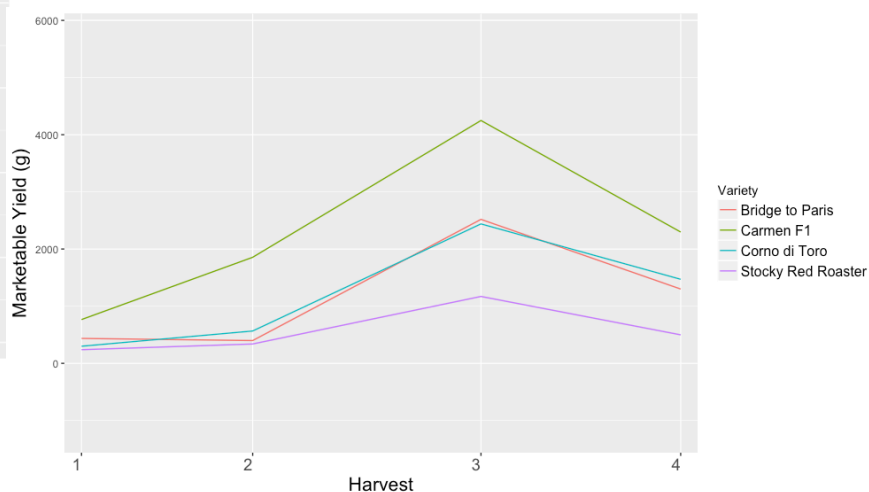


Figure 14: Roasting Type Marketable Yield Over Time. Carmen F1 was the clear winner throughout the season. First harvest occurred 8/25, second 8/31, third 9/8, and the final harvest 9/15.

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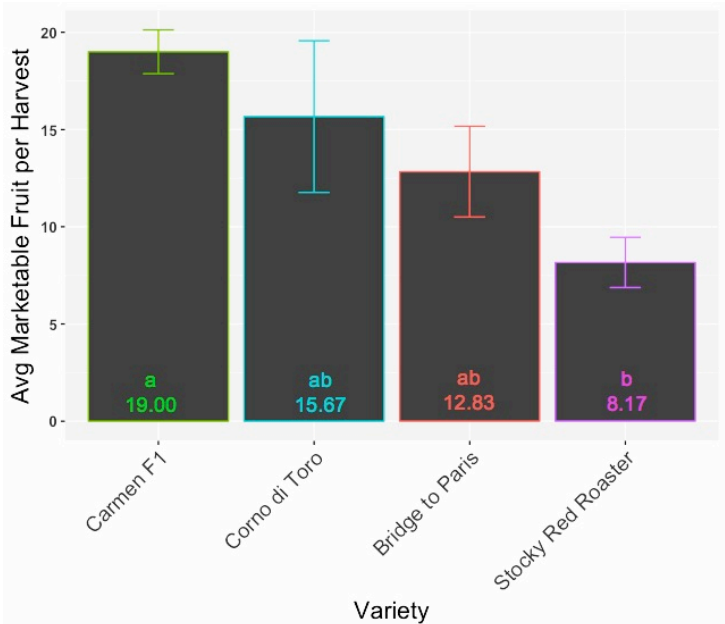


Figure 15: Roasting Type Marketable Fruit per Harvest. Number of marketable fruit per harvest was significantly effected by variety, with the same rankings as marketable weight.

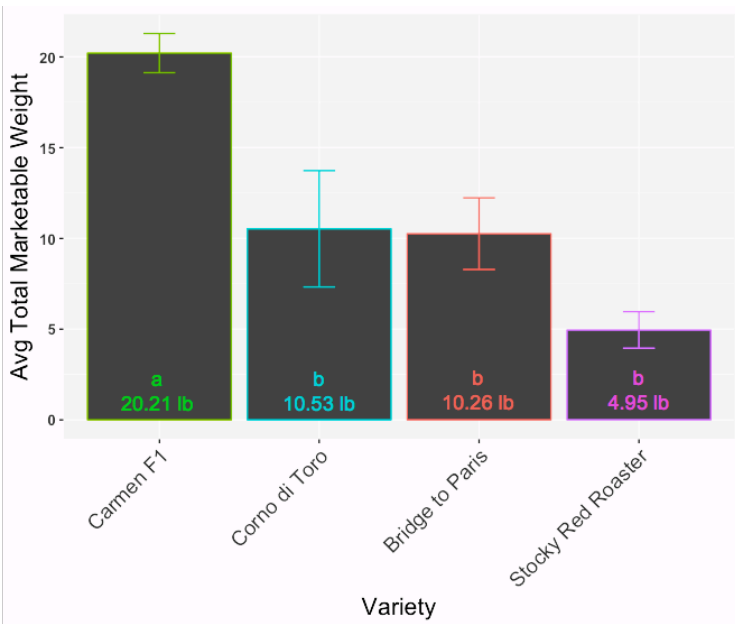


Figure 16: Roasting Type Total Marketable Yield. Carmen F1 yielded significantly more marketable fruit weight per plot than any other variety over the course of the harvest season.

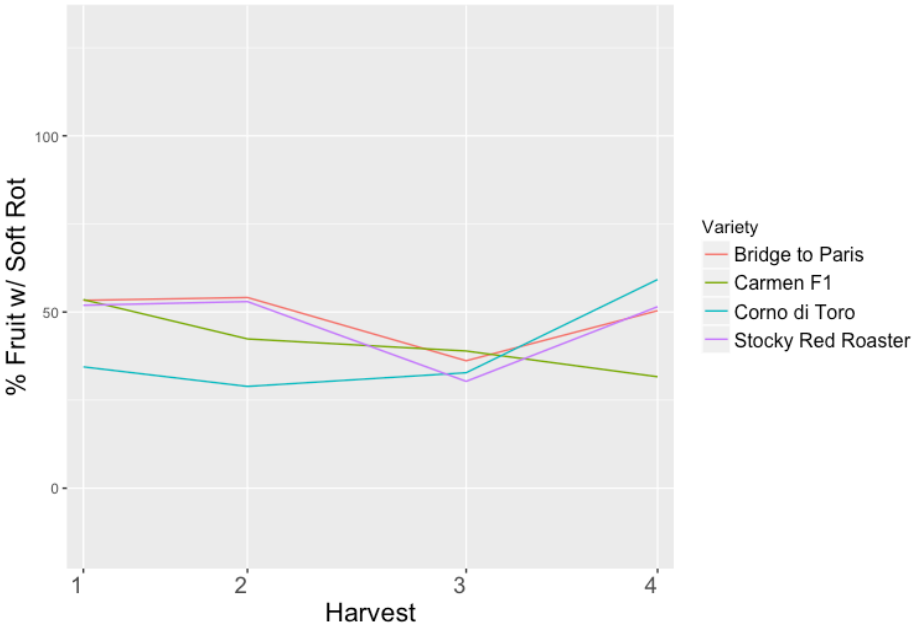


Figure 17: Percentage of fruit with rot over time. Carmen F1 started with relatively high rate but declined steadily. Corno di Toro, on the other hand, started with a low rate of infection, but by the last harvest had the highest percentage of fruit effected. First harvest occurred 8/25, second 8/31, third 9/8, and the final harvest 9/15.

1-9 Rating Scale:

Trait	Description	Score
Taste	Excellent	9
	Very Good	7
	Good	5
	Fair	3
	Poor or Flavorless	1

*One of the taste testers did not like bell peppers, which significantly lowered the average. Score is highly subjective and should only be used for comparison between varieties in this trial.

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Variety	Primary Causes of Unmarketability
King of the North	Rot, bug damage, fell off green
Ace F1	Rot, bug damage, sunscald, misshapen, spotting
X3R Red Knight F1	Rot, bug damage, fell off green, misshapen, BER,
Revolution F1	Rot, bug damage, fell off green,
Aristotle X3R F1	Fell off green, misshapen, scarring
Enza Zaden E20B	Rot, bug damage, fell off green, sunscald
Bridge to Paris	Bug damage, BER, fell off green, spotting, sunscald
Carmen F1	Rot, bug damage, fell off green, scarring
Corno di Toro	Rot, spotting, bug damage, fell off green, BER, sunscald
Stocky Red Roaster	Rot, bug damage, BER, spotting, sunscald
BER = blossom end rot, spotting = Xanthomonas sp. bacterial speck, bug damage = European Corn Borer	
Causes presented in order of prevalence	

Grower Results:

UW-Madison NOVICII Crop: Peppers Sites Grown*: Luna Circle in Rio, WI; Scotch Hill Farm in Broadhead, WI; Spooner Ag Station, Spooner WI					
Variety	Type	Yield Potential	Taste	Overall Score	Notes/Comments
1=poor, 3=best					
Enza Zaden E20B	Bell	2; 2; 2	1; 2	2; 2	Later to produce than ace or Carmen but large fruits; delicious when red, very big blocky peppers;
Ace F1	Bell	1; 2; 2	2; 1	1; 2	Earliest to produce - steady to produce but not extremely productive; tasty both green and red
Carmen F1	Roaster	3; 3; 3	3; 3	3; 3	Second earliest and best fruit set - some large, most average, but over twice the harvest weight of other varieties; "Carmen is best!" - earliest fruit set, biggest, delicious, and prolific;
Stocky Red Roaster	Roaster	1; 2; 1	2; 2	2; 2	Later to mature. Fruits smaller than Carmen and not as prolific; also good flavor;
Bridge to Paris	Roaster	2; 1; 3	1; 2	1; 1	Fruits are very prolific, but small. Used in CSA boxes because of difficulty selling at market; good flavor
* all traits presented in order of growing sites shown here					
- Tricia Bross of Luna Circle notes "while I prefer growing roasting peppers because they are more prolific and have less rot, a good large red bell will sell much better."					
- Dela Ends of Scotch Hill Farm notes "I would grow all these roasters again but especially Carmen."					
- Overall and taste ratings not reported by Spooner Ag Station					

