

## Red pepper variety trial for Ontario and British Columbia

### IN A NUTSHELL

Mike and the other farmers wanted to document the best red pepper varieties for production across different farms in southern Ontario and on one farm in British Columbia. From their replicated multi-farm trial they found:

- Ace F1 is still the red pepper to beat in terms of productivity and flavour
- Some growers around Guelph experienced extreme levels of pepper maggot infestation, which prevented some data collection for the trial
- Most Ontario growers mentioned that they would not likely grow these varieties of red peppers outdoors again, but instead would stick to poly tunnels or hoop houses as yields and quality are better
- Ace F1, Sprinter, and Crimson Carillon surfaced as favourites for the unreplicated hoop house trial in British Columbia

### MOTIVATION

High yielding, early maturing, flavourful, blocky red peppers are desired by ecological vegetable farmers in Canada. Along these lines, Mike Smith of the Guelph Centre for Urban Organic Farming wanted to test different varieties to see which ones met these criteria — both when grown in the field and in a hoop house. To complement Mike's question on pepper yields between the hoop house and the fields, six other farmers participated in the variety trial for field-grown peppers.

Growers chose pepper varieties that included three commonly grown hybrid varieties, as well as an older open-pollinated variety that was bred for the northeast United States, and two new varieties. These new varieties include a farmer-bred variety that was supported by the EFAO's Farmer-Led Research Program, as well as one that was bred at Cornell University from the same parental lines.

### METHODS

In 2022 growers compared six varieties of red sweet bell pepper (**Table 1**) in a randomized and replicated trial. One grower, Karlo, grew only King Arthur, Renegade Red, and Yankee Bell and the other growers grew all six varieties. Crop management records for seeding dates, and transplant dates can be found in **Table 2**. Growers used either drip or overhead sprinkler irrigation and organic fertilizers as required.

### PLOT LOCATION

- Growers avoided the edge of the field and the end of the bed when planting the trial.
- Growers planted the trial in a homogenous area of the field and avoided areas with known soil, shade, or irrigation differences which may have affected plots.



### FARMER-RESEARCHERS

Mike Smith, Guelph Centre for Urban Organic Farming  
 Anne Dockendorff, Silver Rapids Farm  
 Matthew Brearley, Castlegarth Farm  
 Karlo Bobinac, Jones Family Greens  
 Angie Koch and Nikola Barsoum, CASSP Demonstration Gardens at Fertile Ground  
 David Catzel, Siri van Gruen and Gillian Murphy, FarmFolk CityFolk Research and Education Seed Farm (British Columbia)

### FUNDING

Brian and Joannah Lawson Family Foundation  
 The Arrell Family Foundation  
 The Bauta Family Initiative on Canadian Seed Security, a program of SeedChange

- When possible, they planted the trial in a spot which had the same crop on either side.

### TRIAL ARRANGEMENT

- For each planting, growers created two replicated blocks with a plot for each of the six varieties containing 10+ pepper plants each.
- Growers distributed the plots randomly either in multiple side-by-side beds or across one bed.
- Suggested spacing for growers in-row: 12"-18" and between-row: 24"-36"
- Growers used stakes to label plots and drew field maps showing the order and location of varieties.



Pepper trial at Silver Rapids Farm

**Table 1.** Complete list of pepper varieties that the growers selected to trial in 2022.

CODE	VARIETY	DTM	TYPE	SOURCE	CERTIFICATION	INTELLECTUAL PROPERTY <sup>1</sup>
PV1	King Arthur F1 (check)	59 green; 79 red ripe	F1	Johnny's Selected Seed	Untreated	No
PV2	Renegade Red	62-75 days	OP	Hawthorn	Organic	OSSI pledged <sup>2</sup>
PV3	Yankee Bell	60 green; 80 red ripe	OP	Annapolis Seeds	Organic	No
PV4	Ace F1	50 green; 70 red ripe	F1	Johnny's Selected Seed	Untreated	No
PV5	Sprinter F1	60 green; 80 red ripe	F1	Johnny's Selected Seed	Organic	No
PV6	Crimson Carillon	58-67 green; 72-80 red	OP	Fruition	Organic	No

<sup>1</sup> No Plant Breeders Rights Granted in Canada, see <https://inspection.canada.ca/plant-varieties/plant-breeders-rights/varieties/eng/1300463863953/1300463978655>

<sup>2</sup> Open Source Seed Initiative, <https://osseeds.org/>

## DATA ANALYSIS

To evaluate the impact of pepper variety on germination, early season vigour, yield, and flavour, we used an analysis of variance (ANOVA) to calculate a probability value (p-value) based on the difference we observed among treatments. We used a cut-off value of 0.05, meaning we wanted to have 95% confidence in any difference we observed. If the p-value was less than the cut-off value, we had confidence to say the treatment produced differences. If the p-value was more than the cut-off value, we concluded there was no statistical difference. If we detected a difference among treatments, we conducted another test (i.e. a post-hoc test called the least significant difference, LSD) to determine where the differences occurred between treatments.

We could make these statistical calculations because this trial's experimental design involved replication of the treatments both on-farm and across several farms.

## FINDINGS

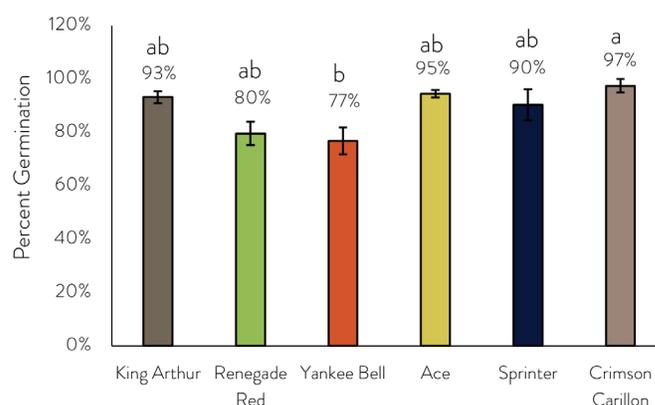
### GERMINATION

Seed source can affect the germination rate and performance of a variety, such that the results presented here are based on the specific varieties and seed sources trialed.

Growers recorded germination rates for each of the red pepper varieties they chose to grow. They found a significant difference in germination among varieties (P=0.01). Using an LSD of 11% as seen in **Figure 1**, growers found that Sprinter had the lowest germination.

### EARLY SEASON VIGOUR

Growers evaluated each red pepper variety for early season vigour around a month after planting. For each replicate they ranked seedling vigour, including seedling size, health, and growth rate, on a scale from very poor (1) to very high (5). Growers found no significant difference (P=0.71) in early season vigour of red pepper among varieties in the trial (**Table 3**).



**Figure 1.** Mean germination rate for each variety across farms. <sup>a</sup>- Lower case letters denote significant differences between varieties, based on a Tukey post-hoc multiple comparisons test.

### YIELD

Each week during the harvest season growers collected yield data for each of the replicate varieties. Once the growers harvested the ripe red peppers, they graded them into marketable and non-marketable fruits and counted and weighed each respectively. The data shows the mean total number and weight of both marketable and non-marketable ripe red peppers collected over the growing season, averaged across farms (**Table 4**).

Growers found a significant difference in marketable ripe red pepper fruit count (P=0.03) among varieties. Using an LSD of 22 as seen in **Table 4**, growers found that Ace was more productive than King Aruthur, Sprinter, and Yankee Bell, with Renegade Red and Crimson Carillon intermediate among the varieties.

The growers did not find a significant difference in marketable ripe red pepper fruit weight (P=0.15), non-marketable fruit count (P=0.81) or non-marketable fruit weight (P=0.60) among varieties.

**Table 2.** Crop management records

FARMER	SEEDING DATE	TRANSPLANT DATE	WEEKS BETWEEN SEEDING AND TRANSPLANT	BEGAN HARVESTING	STOPPED HARVESTING	WEEKS OF HARVESTING
Mike Smith	March 28	June 2	9.5 weeks	NA	NA	NA
Anne Dockendorff	March 31	June 15	11 weeks	August 23	September 3	1.5 weeks
Matthew Brearley	April 7	June 5	8.5 weeks	September 1	September 30	4 weeks
Karlo Bobinac	April 1	June 6	9.5 weeks	August 16	September 30	2 weeks
Nikola Barsoum	April 5	June 2	8.5 weeks	September 13	September 29	2.5 weeks
David Catzel, Siri van Gruen, and Gillian Murphy	March 31, 2022	June 24, 2022	12 weeks	October 25	October 25	NA

**Table 3.** Mean early season vigour rating for each variety across farms.

VARIETY	EARLY SEASON VIGOUR RATING
King Arthur	4.0
Renegade Red	3.9
Sprinter	3.9
Ace	4.3
Yankee Bell	4.3
Crimson Carillon	3.9
<b>LSD</b>	<b>NS</b>

*NS: Not significant; all similar*



Pepper Trial at Jones Family Greens

**Table 4.** Mean total marketable and non-marketable ripe red pepper fruit count and weight for each variety across farms.

VARIETY	MARKETABLE POD COUNT	MARKETABLE POD WEIGHT (g)	NON-MARKETABLE POD COUNT	NON-MARKETABLE POD WEIGHT (g)
King Arthur	11 b	2101.0	9	1601.4
Renegade Red	14 ab	1917.9	8	1090.1
Sprinter	10 b	1901.7	6	871.1
Ace	38 a	4832.2	6	678.2
Yankee Bell	4 b	829.6	2	468.4
Crimson Carillon	13 ab	1805.8	5	649.2
<b>LSD</b>	<b>22</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>

*\*- Lower case letters denote significant differences between varieties, based on a Tukey post-hoc multiple comparisons test.  
NS: Not significant; all similar*

**Table 5.** Mean total final harvest of marketable and non-marketable unripe green pepper fruit count and weight for each variety across farms.

VARIETY	MARKETABLE UNRIPE GREEN FRUIT COUNT	MARKETABLE UNRIPE GREEN FRUIT WEIGHT (g)	NON-MARKETABLE UNRIPE GREEN FRUIT COUNT	NON-MARKETABLE UNRIPE GREEN FRUIT WEIGHT (g)
King Arthur	17	3285.2	2	203.4
Renegade Red	16	2375.6	5	586.8
Sprinter	11	1779.4	4	479.0
Ace	21	2907.7	0	0.0
Yankee Bell	5	606.7	0	0.0
Crimson Carillon	9	1500.0	0	0.0
<b>LSD</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>

### FINAL HARVEST

At the end of the growing season, when a first frost was forecasted, growers performed a final harvest on the trial. They harvested all of the peppers from each replicate and variety. Once harvested, the growers graded the harvested peppers into marketable and non-marketable fruits for both ripe (red) and unripe (green) peppers and counted and weighed each group. The data shows the mean total number and weight of marketable and non-marketable unripe green peppers collected during the final harvest averaged across farms (**Table 5**). We added all marketable and non-marketable ripe red peppers to the yield totals (**Table 4**).

Despite the yield of red ripe red peppers from Ace, growers did not find a significant difference in marketable unripe green pepper fruit count (P=0.90), fruit weight (P=0.82), non-marketable unripe green pepper fruit count (P=0.49) or non-marketable fruit weight (P=0.50) among varieties (**Table 5**). The lack of detectable difference among varieties may be due to high variation in the data among farms.

### FLAVOUR AND OVERALL

During the trial, growers rated each variety for flavour and overall rating. For flavour, growers tasted each variety of ripe red peppers and rated them on a scale for general taste and bitterness as follows: poor taste and bitter (1), okay (3), and excellent taste and sweet (5). They also took overall ratings on a scale for overall performance as follows: poor (1), okay (3), and excellent (5).

Growers found a significant difference in flavour (P=0.01) among ripe red pepper varieties. Using an LSD of 0.7 as seen in **Table 6**, growers found that Ace was a better tasting variety compared to King Arthur and Sprinter, which had a less desirable flavour. Renegade Red and Crimson Carillon were intermediate among the varieties.

The growers did not find a significant difference in overall rating (P=0.53) among any of the ripe red pepper varieties although Ace was a distinct front runner among participants.

Growers' notes on flavour and overall ranking of each variety in the trial can be seen in **Table 7**. Growers' answers to "Would you grow this variety of red pepper again?" can be found in **Table 8**.



Summer Student Yara Ibrahim at GCUOF

**Table 6.** Mean flavour and overall rating for each variety across farms.

VARIETY	FLAVOUR RATING <sup>a</sup>	OVERALL RATING
King Arthur	3.0 b	2.7
Renegade Red	4.0 ab	2.7
Sprinter	3.0 b	2.5
Ace	4.7 a	4.0
Yankee Bell	4.0 ab	2.0
Crimson Carillon	3.5 ab	3.0
<b>LSD</b>	<b>0.7</b>	<b>NS</b>

<sup>a</sup> - Lower case letters denote significant differences between varieties, based on a Tukey post-hoc multiple comparisons test.  
NS: Not significant; all similar

**Table 7.** Growers' notes on flavour and overall ranking of each variety in the trial

VARIETY	AD	MB	KB	NB	FF
KING ARTHUR		Mild sweetness, thick flesh not overly strong pepper flavour even when green	Pepper tasted good, had a crisp texture, even portions that we're not fully red were still sweet	Okay flavour, watery and sweet, large, beautiful, biggest ones, decent, productive and taste	
RENEGADE RED	Also excellent flavour, both varieties tasted the same to me	Sweet good pepper flavour juicy flesh	Pepper tasted good but was less sweet than PV1. Flesh was thicker than PV1. Crisp texture and sweet.	Juicy ones, good flavour, ya, better, crisp, and juicy, produced well, not as early, good flavour	
SPRINTER		Good pepper flavour, sweet and juicy flesh		Yum check mark, great overall	Nice, blocky peppers, great vigour, high yield though some peppers on the smaller side, and healthy plants
ACE	Excellent sweet flavour	Good pepper flavour, juicy flesh thin skin		Excellent sweet flavour, juicy, good crunch, yum! Early producer, high yield, good flavour	Nice, blocky peppers, great vigour, high yield, and healthy plants
YANKEE BELL		Thick skin dry flesh little flavour		Versatile flavour, really good, yum! slower to ripen, nice flavour, later to ripe probably latest	
CRIMSON CARILLON		Juicy, mild sweet flavour thick skin		The skin is a little tough but tastes good. smaller peppers, produced well, good flavour, overall really good	Nice, blocky peppers, less vigour but healthy plants

AD-Anne Dockendorff; MB-Matthew Breaeley; KB-Karlo Bobinac; NB-Nikola Bobinac; FF-FarmFolk (BC)

**Table 8.** Growers answered the question: “Would you grow this variety of red pepper again?”

VARIETY	AD	MB	KB	NB	FF
KING ARTHUR	No	No	No	No	No
RENEGADE RED	No	Yes	No	No	No
SPRINTER	No	No	No	No	Yes
ACE	Yes	Yes	-	Yes	Yes
YANKEE BELL	No	No	-	No	No
CRIMSON CARILLON	No	No	-	Yes	Yes

AD-Anne Dockendorff; MB-Matthew Breaeley; KB-Karlo Bobinac; NB-Nikola Bobinac; FF-FarmFolk (BC)



Yara evaluating peppers at GCUOF



Pepper Maggot damage at GCUOF

**Table 9.** Total final harvest of marketable ripe red pepper and unripe green pepper fruit count and weight and non-marketable count and weight for each variety in the unreplicated hoop house trial in British Columbia.

VARIETY	MARKETABLE RIPE RED FRUIT COUNT	MARKETABLE RIPE RED FRUIT WEIGHT (g)	MARKETABLE UNRIPE GREEN FRUIT COUNT	MARKETABLE UNRIPE GREEN FRUIT WEIGHT (g)	NON-MARKETABLE FRUIT COUNT	NON-MARKETABLE FRUIT WEIGHT (g)
King Arthur	2	468	3	2900	1	200
Renegade Red	3	876	7	1000	X	X
Sprinter	19	2500	28	3500	2	400
Ace	15	2700	24	3000	X	X
Yankee Bell	3	650	37	4209	X	X
Crimson Carillon	14	200	19	3000	X	X

\* no statistical analysis was run due to lack of replication

## CONTEXT AND CAVEATS

Due to an extreme pepper maggot infestation in the Guelph area Mike was unable to collect any marketable harvest from his pepper replications. As such no yield, flavour, or overall data was collected by his farm. Karlo also noted that he had bad pepper maggot damage.

To prevent pepper maggot damage, OMAFRA horticulture experts suggest covering the crop with a mesh size under 1.5 mm x 1.5 mm to exclude the flies. They recommend covering the plants starting at the end of June for eight weeks as adult flies are usually active for about eight weeks beginning in July.

Anne, in northern Ontario, and Angie, in southern Ontario, both noted that low temperatures in June which set-back and/or killed (in Anne's case) many of their pepper plants. From this experience, Anne says she will only grow peppers under cover from now on.



Ripening peppers at Fertile Ground CSA

## NEXT STEPS

"After the crop failure due to Pepper Maggot at the GCUOF. My future pepper crops will be covered with protect-net when I do outdoor peppers. I still hope to crop them in a hoop house next season." Mike

## HOOP HOUSE TRIAL FROM BC

Growers from FarmFolk CityFolk Research and Education Seed Farm in British Columbia conducted a similar variety trial as growers in Ontario but grew the plants in a hoop house instead of in the field.

They started seeds on March 31 and transplanted into the hoop house on June 24 in two rows per 50 foot bed with 24" in row spacing and 12" between row spacing. They used no compost or fertilizer, applied drip irrigation and weeded the rows by hand.

Ace F1 and Yankee Bell had the highest germination for the BC growers at 87% and 81% respectively. King Arthur and Sprinter both had a germination of 70% while Renegade Red and Crimson Carillon had the lowest germination at 30% and 16% respectively.

The BC growers ranked all six varieties as 3 or moderate for early season plant vigour.

Harvest data for the growers doing the unreplicated hoop house trial in BC can be found in **Table 9**.

The growers rated the flavour of all six varieties. They rated Sprinter, Ace F1, and Crimson Carillon as a 4, with excellent flavour; and King Arthur, Renegade Red, and Yankee Bell as a 3, with moderate flavour.

The growers rated the overall performance of all six varieties. Sprinter, Ace F1, and Crimson Carillon all received a 5 or very high overall rating. Yankee Bell received a rating of 3 or moderate, and King Arthur and Renegade Red received a rating of 2 or low.

## TAKE HOME MESSAGE

Ace F1 is still the red pepper to beat in terms of productivity (fruit count), and flavour.

"For the trial 'Ace' was the largest overall producer but for flavour the Renegade Red won hands down so moving forward I will grow both varieties but I will only be growing in a poly tunnel for production as the yields are better." - Matthew Brearley

With the arrival of pepper maggot in southern Ontario, it is nearly impossible to grow any variety of red pepper in the fields. "We would not grow these peppers outside again. Most pepper could not ripen to a fully red colour before either getting diseased, or damaged by insects/animals...We would be open to growing them in a greenhouse."- Karlo