CANOVI
Canadian Organic Vegetable Improvement
ALÉBIO
Amélioration des légumes biologiques au Canada

Trial Report: Orange Nantes Carrots 2022

Goal: This trial's original goal was to **test the CANOVI orange Nantes carrot population** alongside **commercial hybrid (F1) and open-pollinated (OP) cultivars** to gauge its readiness for commercialization. However, the CANOVI orange population had low germination – due to a thrips issue in our greenhouse seed production – so **our adjusted goal became to compare commercial orange carrot cultivars,** with emphasis on **identifying OP cultivars that compete well with hybrids**.

Background: The **CANOVI Orange Nantes carrot breeding project** began in 2018, in response to BC grower interest in a **sweet, deep orange, open pollinated Nantes variety** that could be **produced for both roots and seed in BC**. The goal was to provide a viable replacement for workhorse hybrids like Bolero F1, in order to strengthen regional and Canadian seed security. CANOVI on-farm and hub site carrot trials have been conducted in 2018-2020, and in 2022.

Varieties: CANOVI Orange was trialed alongside two F1 and two OP orange Nantes carrot varieties that are commercially available. The OP varieties were chosen for having been selected in different regions; Touchon Deluxe is an heirloom strain selected and grown for seed in British Columbia, while Dulcinea was selected in Western New York State. Details are below.

Participants: 30, of whom **13** collected supplementary data**.**

Variety	OP / F1	Days to Maturity	Breeder	Seed Source
CANOVI Orange	OP		CANOVI	CANOVI / UBC
Dulcinea	OP	60	Fruition Seeds	Fruition Seeds
Touchon Deluxe	OP	65-70	Heirloom / Unknown	BC Eco Seed Coop
Bolero F1	F1	75	Vilmorin	Johnny's Selected Seeds
Naval F1	F1	72	Bejo Seeds	Johnny's Selected Seeds

Planting: Participants planted **12 linear feet per variety** at **approximately 1" spacing after thinning**, using single or multiple rows per bed. Seeds were **sown in June or early July** for harvest in September-October. Participants used their usual organic methods for soil fertility and weed management.

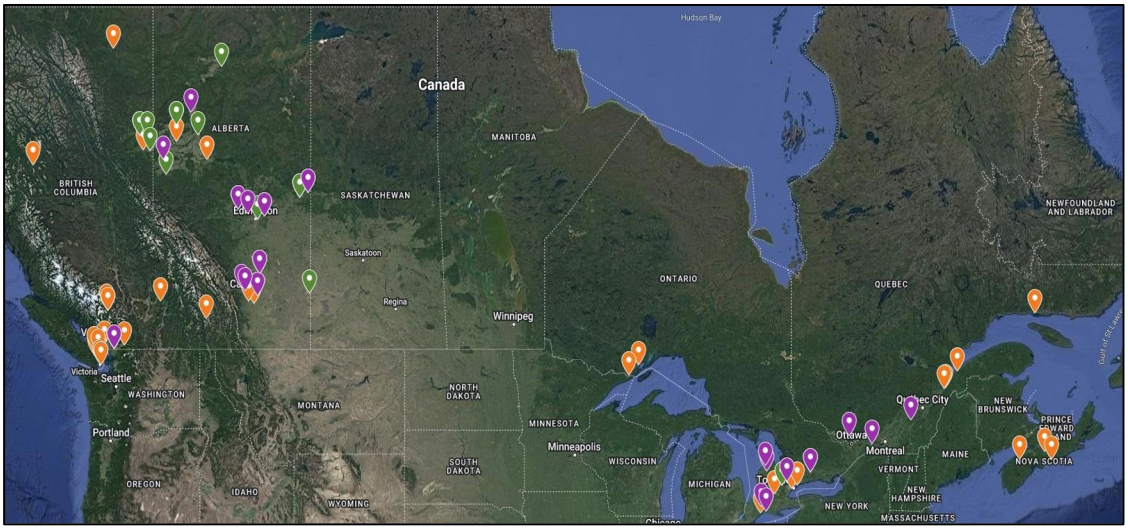
Evaluation: Participants evaluated varieties using the desktop or mobile SeedLinked app. Germination, early vigour, canopy cover, uniformity, yield, marketability, appearance, and flavour were rated on a scale of **1 (low) to 5 (high). A rubric was provided** that defined the rating scale for each trait. A subset of participants collected **quantitative yield data** and submitted comments on marketability and relative maturity.

Results and analysis: Interactive plots were available on the SeedLinked website immediately after trial closure. In addition, CANOVI researchers performed **statistical analysis** and presented results in a **webinar** and in this **trial report**.

Please view the **2022 CANOVI Carrot Trial Protocol** for full instructions and the evaluation rubric.

Images: Duncan McHugh, UBC Centre for Sustainable Food Systems (top); Solveig Hanson (bottom).

Participant Locations



Orange Flag = Carrot Trial Participant

- **When we divided participants by East-West region,** we found many regional differences in trait ratings.
  - East = 13 participants in NS, QC and ON
  - West = 17 participants in BC and AB

Mean Ratings by Region

	Appearance	Canopy Cover **	Flavor *	Germination *	Marketability *	Uniformity *	Vigor *	Yield ^
East	**3.5**	**2.8**	**3.8**	**2.5**	**3.5**	**3.4**	**3.5**	**2.8**
West	**3.5**	**2.8**	**3.8**	**2.5**	**3.5**	**3.4**	**3.5**	**2.8**

Green = High rating; Yellow = Mid-range rating; Red = Low rating

- **All traits except appearance** were rated **significantly higher on Western farms** than Eastern farms.

- There were **no cases of genotype x environment interaction (GxE)** in which one variety did significantly worse or better in one region than the other.

	P (<F)	Strength of evidence
^	<0.10	Weak
*	<0.05	Moderate
**	<0.01	Strong
***	<0.001	Very strong

Mean Ratings by Variety

	Appearance	Canopy Cover ***	Flavor	Germination ***	Marketability ^	Uniformity *	Vigor ***	Yield ***
Bolero	3.9	4.0	4.0	4.2	3.9	3.9	4.3	4.1
Naval	3.7	3.5	3.8	3.6	3.9	3.8	3.6	3.6
Touchon Deluxe	3.6	3.4	3.6	3.2	3.7	3.3	3.4	3.4
Dulcinea	3.6	3.0	3.7	2.8	3.5	3.4	3.2	3.0
CANOVI Orange	3.3	2.0	3.6	1.2	3.1	3.1	2.9	1.8

Means and significant variation by variety in 2-way fixed effects ANOVA with East/West as environmental variable
Green = High rating; Yellow = Mid-range rating; Red = Low rating

- The **productivity traits** of germination***, canopy cover***, vigour***, and yield*** varied strongly among varieties**. Variety rank is consistent** for these traits, in both East and West regions, and is shown in the table above.

- For the **quality traits** of uniformity* and marketability^, CANOVI Orange was rated significantly lower than one or two commercial varieties. However, no significant differences existed between commercial varieties Bolero F1, Naval F1, Touchon Deluxe, and Dulcinea.

- **No significant differences in appearance or flavour** were found among varieties.

Quantitative Yield

Naval F1

	Marketable Yield (Lbs)	Total Yield (Lbs)	Percent Marketable Yield
Naval	11.9	16.0	77%
Bolero	9.2	12.4	71%
Touchon Deluxe	7.3	10.1	74%
Dulcinea	5.6	8.0	69%
CANOVI Orange	2.1	2.8	71%
Mean	**7.2**	**9.9**	**73%**

Dulcinea

Yield from 12 linear feet, as measured by 13 CANOVI trial participants

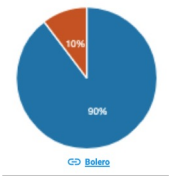
- **Percent marketable yield was quite similar** among varieties.

- Note that **Naval F1**, not Bolero F1, gave the **highest average yield** for these 13 participants.

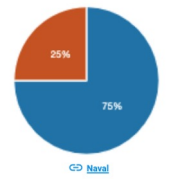
	P (<F)	Strength of evidence
^	<0.10	Weak
*	<0.05	Moderate
**	<0.01	Strong
***	<0.001	Very strong

Images: Gabriel Legaré, QC

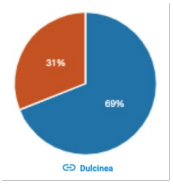
Varieties by Overall Preference



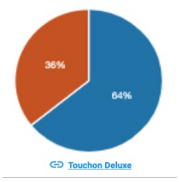
Bolero F1



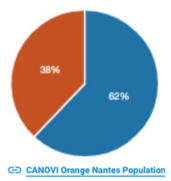
Naval F1



Dulcinea



Touchon Deluxe



CANOVI Orange

Blue = Would grow again
Red = Would not grow again
Varieties are ordered by percent of participants who would grow the variety again

Results by Variety

- On **Eastern farms**, Bolero F1 received the highest rankings for all traits except marketability and uniformity, but there was **no significant difference between Bolero F1 and Naval F1, Touchon Deluxe, or Dulcinea for any trait**.
- On **Western farms**, Bolero F1 received the highest rating for all traits, but **Naval F1 was rated lower only for germination^**, and **Touchon Deluxe was rated lower only for germination* and vigour^.**
- **Of the two OP varieties trialed, Touchon Deluxe** showed slightly better germination, vigour, and yield. It did show **variability in shape and flavour** among farms, but it worked well on some farms.
- **Dulcinea grew a bit slower** than Bolero and Naval in the West – one grower noted Dulcinea needed one more cultivation than Bolero – but still produced **reasonable yields of high quality roots**.
- **In the East, CANOVI Orange was rated lower for productivity traits but not quality traits**. In the West, it was rated lower for all traits except flavour. CANOVI researchers will refresh the genetics of this population in 2023 and continue selection.

This research is part of Organic Science Cluster 3, led by the Organic Federation of Canada in collaboration with the Organic Agriculture Centre of Canada at Dalhousie University, supported by Agriculture and Agri-Food Canada's Canadian Agricultural Partnership-AgriScience Program, The Bauta Family Initiative on Canadian Seed Security, and the Centre for Sustainable Food Systems at the UBC Farm.

Trial data analysis and report by Dr. Solveig Hanson, CSFS at UBC Farm. For more information, please visit seedsecurity.ca/en/302-canovi or email solveig.hanson@ubc.ca.

Variety images: Solveig Hanson.

organic SCIENCE CLUSTER 3

UBC FARM Centre for Sustainable Food Systems

THE BAUTA FAMILY INITIATIVE ON CANADIAN SEED SECURITY

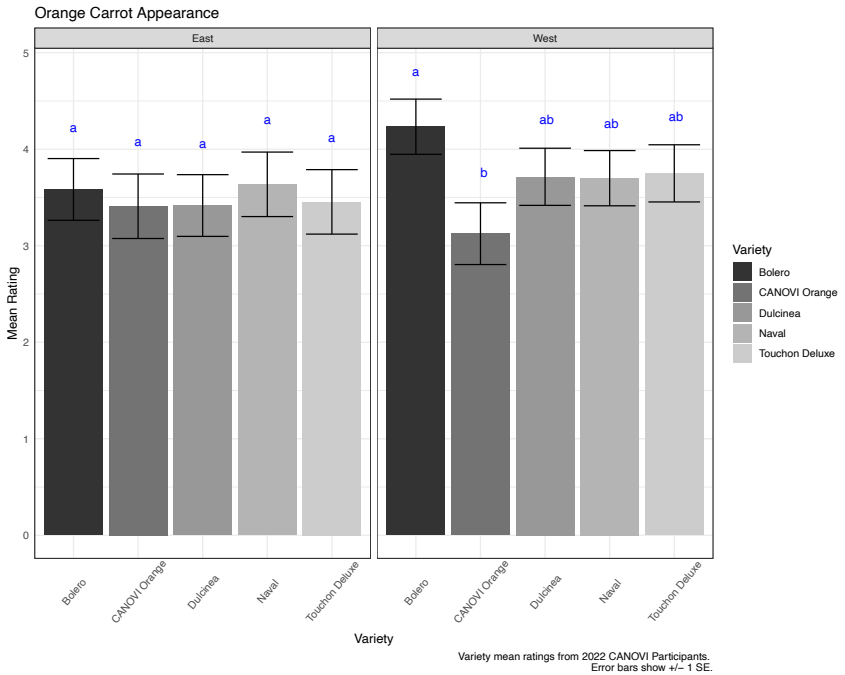
Analytical Methods and Supporting Data: CANOVI Orange Nantes Carrot Trial 2022

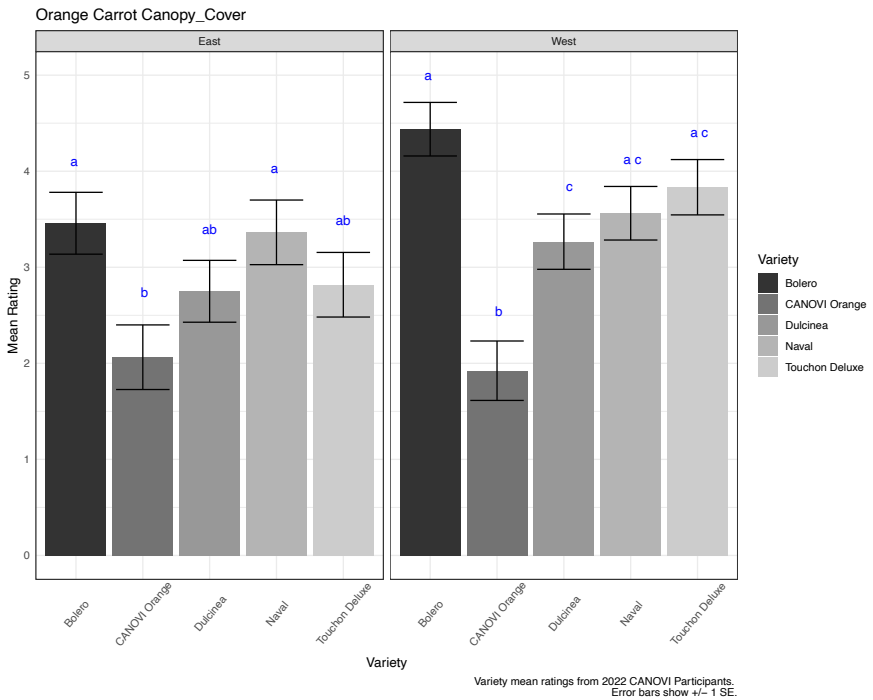
Trait ratings were analyzed by variety, region, and variety-region interaction using **a two-way fixed effects Analysis of Variance**. That is, **we looked for significant differences in ratings among varieties and between East-West regions**.
N = 30 participants, with n_{East} = 13 participants in NS, QC and ON and n_{West} = 17 participants in BC and AB.

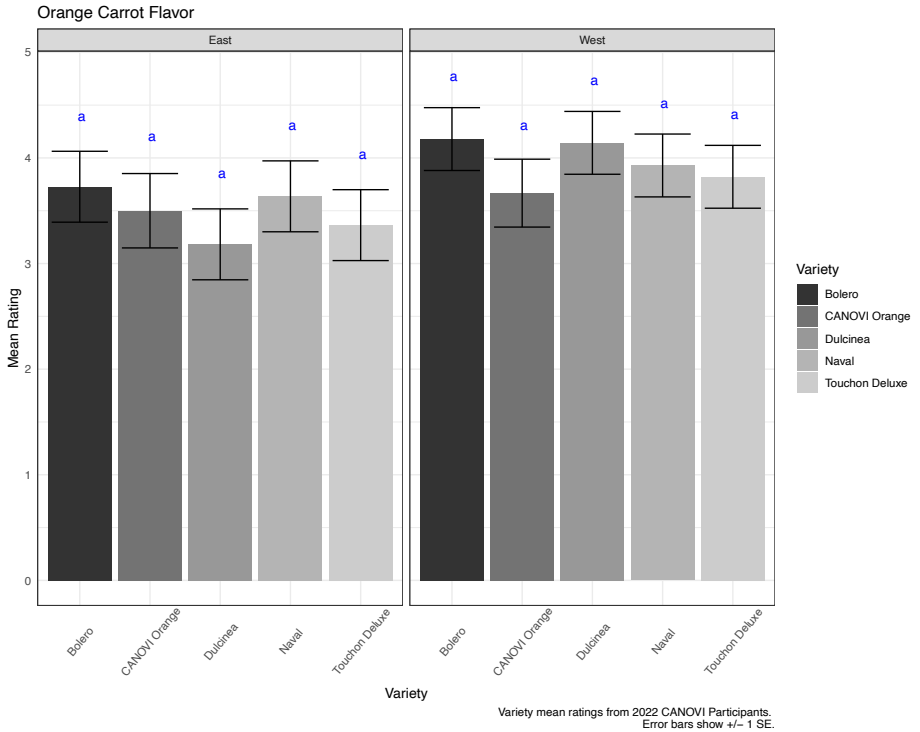
Trait	Source of Variation	DF	SS	MS	F	Pr >F	Sig
Appearance	Variety	4	5.93	1.48	1.21	0.31	
	East_West	1	1.50	1.50	1.22	0.27	
	Variety:East_West	4	2.92	0.73	0.59	0.67	
	Residuals	117	143.64	1.23	NA	NA	
Canopy Cover	Variety	4	57.91	14.48	11.64	4.89E-08	***
	East_West	1	9.00	9.00	7.23	0.008	**
	Variety:East_West	4	6.27	1.57	1.26	0.29	
	Residuals	122	151.77	1.24	NA	NA	
Flavor	Variety	4	2.38	0.60	0.48	0.75	
	East_West	1	6.73	6.73	5.43	0.02	*
	Variety:East_West	4	2.18	0.55	0.44	0.78	
	Residuals	112	138.83	1.24	NA	NA	
Germination	Variety	4	147.66	36.92	29.55	9.47E-18	***
	East_West	1	8.45	8.45	6.77	0.01	*
	Variety:East_West	4	4.69	1.17	0.94	0.44	
	Residuals	138	172.40	1.25	NA	NA	
Marketability	Variety	4	12.74	3.18	2.02	0.096	^
	East_West	1	8.56	8.56	5.43	0.02	*
	Variety:East_West	4	4.31	1.08	0.68	0.61	
	Residuals	118	186.14	1.58	NA	NA	
Uniformity	Variety	4	11.67	2.92	2.90	0.03	*
	East_West	1	4.17	4.17	4.14	0.04	*
	Variety:East_West	4	5.84	1.46	1.45	0.22	
	Residuals	117	117.85	1.01	NA	NA	
Vigor	Variety	4	29.94	7.48	5.68	3.20E-04	***
	East_West	1	5.92	5.92	4.49	0.04	*
	Variety:East_West	4	2.55	0.64	0.48	0.75	
	Residuals	121	159.55	1.32	NA	NA	
Yield	Variety	4	74.20	18.55	12.94	8.18E-09	***
	East_West	1	5.39	5.39	3.76	0.055	^
	Variety:East_West	4	3.19	0.80	0.56	0.69	
	Residuals	122	174.87	1.43	NA	NA	

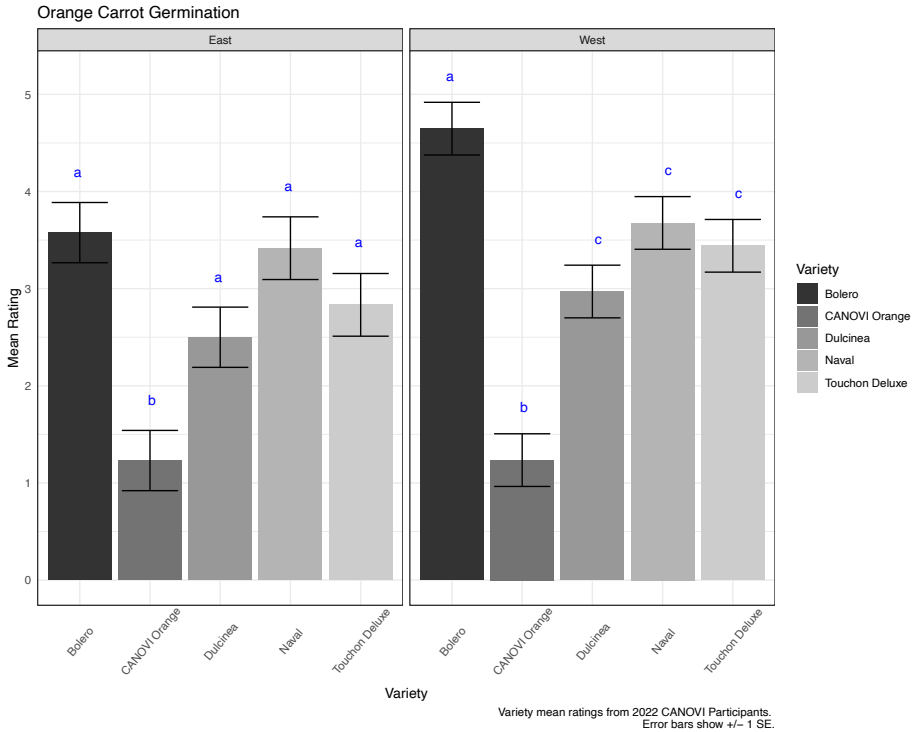
	P (<F)	Strength of evidence
^	<0.10	Weak
*	<0.05	Moderate
**	<0.01	Strong
***	<0.001	Very strong

The following pages display barplots of mean ratings for each trait, with error bars showing +/- 1 SE around the mean. **Different letters denote a statistically significant difference in ratings** between varieties **within region** at P < 0.10. At times, a significant pairwise comparison appears within a region, even though ANOVA shows no significant variety effect.






Orange Carrot Flavor
East
West
Mean Rating
0
1
2
3
4
5
a
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety
Variety mean ratings from 2022 CANOVI Participants.
Error bars show +/– 1 SE.


Orange Carrot Germination
East
West
Mean Rating
0
1
2
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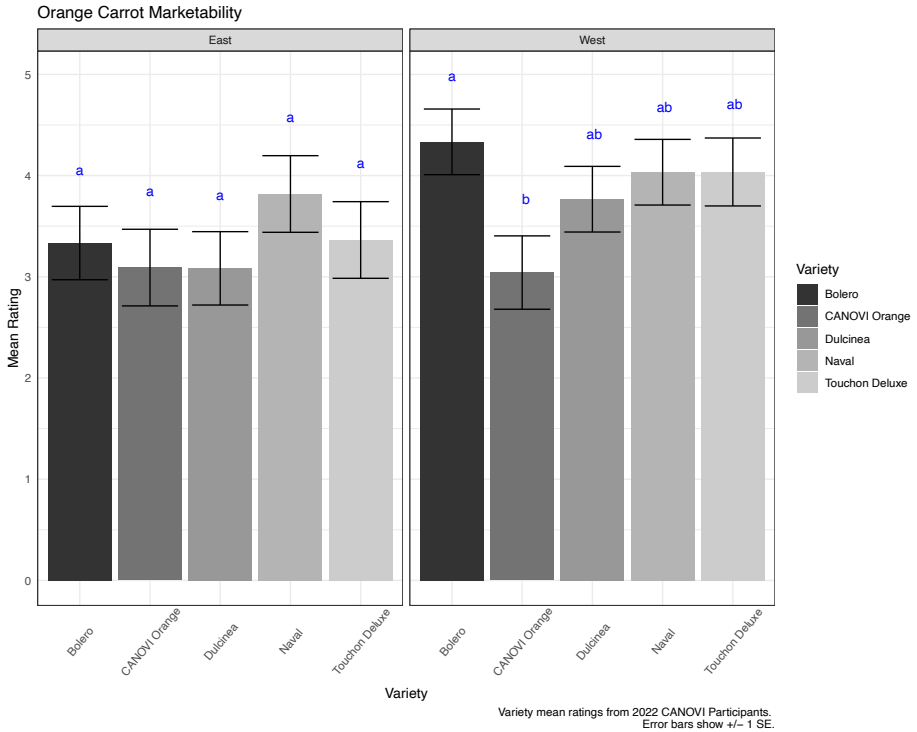
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety
Variety mean ratings from 2022 CANOVI Participants.
Error bars show +/– 1 SE.


Orange Carrot Marketability
East
West
Mean Rating
0
1
2
3
4
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a
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a
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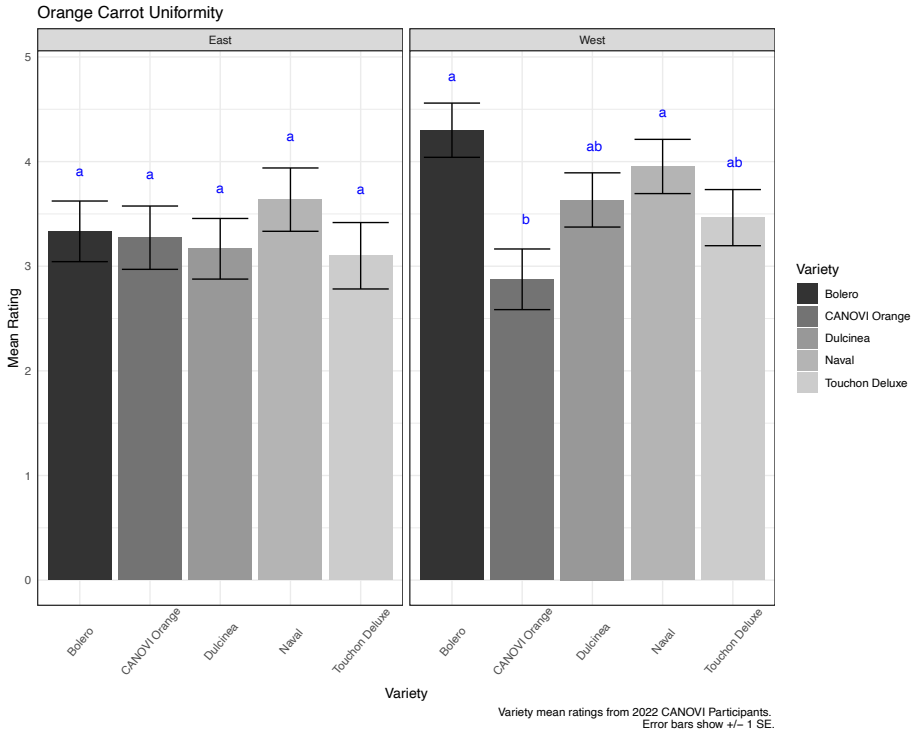
a
a
b
ab
ab
ab
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety
Variety
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety mean ratings from 2022 CANOVI Participants.
Error bars show +/– 1 SE.


Orange Carrot Uniformity
East
West
Mean Rating
0
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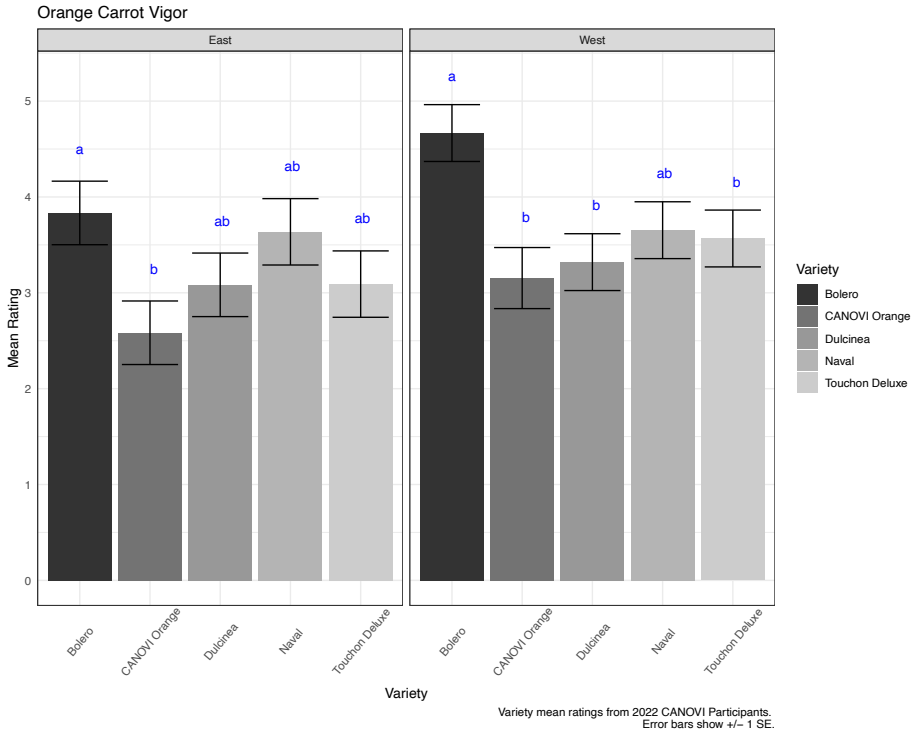
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety
Variety
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety mean ratings from 2022 CANOVI Participants.
Error bars show +/– 1 SE.


Orange Carrot Vigor
East
West
Mean Rating
0
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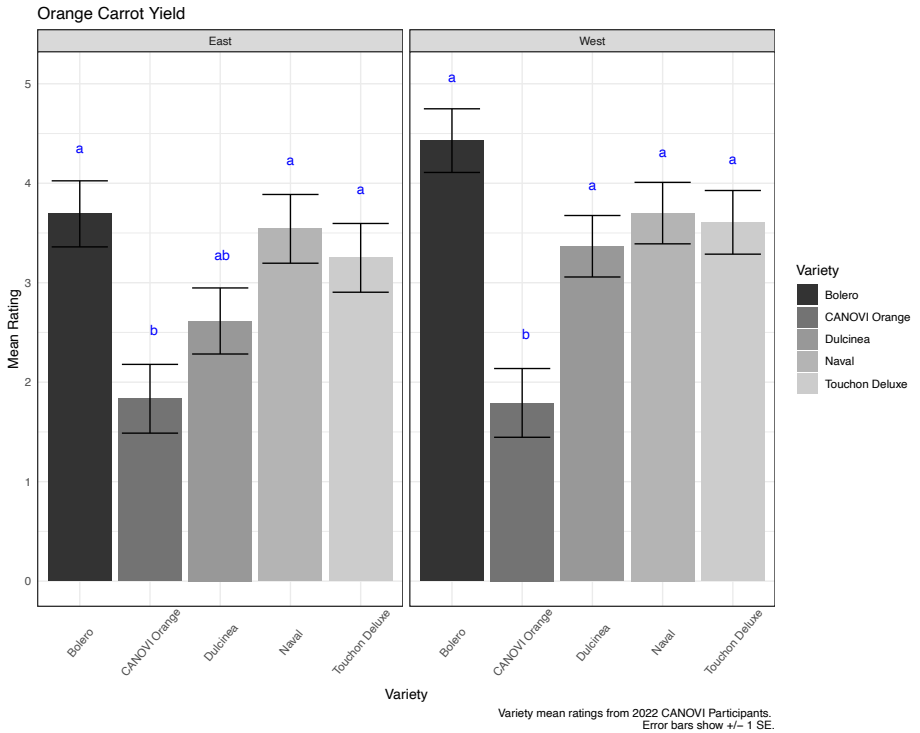
ab
b
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety
Variety
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety mean ratings from 2022 CANOVI Participants.
Error bars show +/– 1 SE.


Orange Carrot Yield
East
West
Mean Rating
0
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a
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety
Variety
Bolero
CANOVI Orange
Dulcinea
Naval
Touchon Deluxe
Variety mean ratings from 2022 CANOVI Participants.
Error bars show +/– 1 SE.

UBC Farm Hub Site Harvest Data: CANOVI Orange Carrot Trial 2022

Harvest 74 Days After Planting

Variety	Days to Maturity	Breeder	Seed Source	Appearance	Uniformity	Marketability	Yield	Flavor	Marketable Yield (Lbs)	Total Yield (Lbs)	Percent Marketable Yield
CIOA Orange Flavour Select		OSA - CIOA	OSA	4.5	4.5	4	5	5	4.54	5.22	87%
Bolero	75	Vilmorin	Johnny's	4.5	4.5	4	4	4.5	3.44	4.04	85%
Dolciva	105	Sativa	High Mowing	4.5	4	4.5	4	5	3.27	3.79	86%
Touchon Deluxe	65-70	Heirloom	BC Eco Seed Coop	4.5	3.5	4.5	3.5	4.5	2.73	3.65	74%
Naval	72	Bejo	Johnny's	3.5	4	3.5	3.5	5	2.73	3.71	72%
Bollin		Sativa	High Mowing	4	3.5	4.5	3.5	5	2.58	3.05	85%
CIOA Orange Strain Cross		OSA - CIOA	OSA	4	3.5	4	3.5	5	2.52	3.44	75%
Treenetaler		Sativa	High Mowing	3	3.5	3.5	3.5	2.5	2.29	2.92	79%
Rumba	72	Nash Huber	Jardins de la Gaillarde	3	4	3.5	3	4	1.81	2.15	83%
Bangor	90	Bejo	High Mowing	4	4	3.5	2	3.5	1.63	1.84	94%
Dulcinea	60	Fruition	Fruition	4	4	4.5	2.5	4	1.37	2.23	58%
CIOA Uber Flavour Select		OSA - CIOA	OSA	1.5	2.5	1.5	3	2.5	0.92	2.92	30%
CANOVI Orange		CANOVI	UBC	2.5	3	2.5	1	2.5	0.34	0.66	36%

Mean of best 2 replicates
Green = High; Yellow = Mid-range; Red = Low

CIOA Orange Flavour Select, bred by Organic Seed Alliance in collaboration with University of Wisconsin-Madison, showed outstanding flavour, yield, appearance, and uniformity at 74 day harvest. *CIOA = Carrot Improvement for Organic Agriculture*

Dolciva, an OP variety from Swiss organic and biodynamic breeder Sativa, performed similarly to Bolero in our hub site trials at 74 day harvest.

Touchon Deluxe offered strong yield and quality at both 74 and 95 day harvests.

UBC Farm Hub Site Harvest Data: CANOVI Orange Carrot Trial 2022

Harvest 95 Days After Planting

Variety	Days to Maturity	Breeder	Seed Source	Appearance	Uniformity	Marketability	Yield	Flavor	Marketable Yield (Lbs)	Total Yield (Lbs)	Percent Marketable Yield
Touchon Deluxe	65-70	Heirloom	BC Eco Seed Coop	4.5	4.5	5	5	4	8.09	9.48	85%
Bolero	75	Vilmorin	Johnny's	4	4.5	4	5	4	7.25	10.85	68%
Bollin		Sativa	High Mowing	4	4	4.5	4.5	4.5	6.76	7.86	86%
Bangor	90	Bejo	High Mowing	4	4	3.5	4	4.5	6.36	8.98	71%
Dolciva	105	Sativa	High Mowing	4.5	4	4	3.5	4	5.66	7.2	78%
Treenetaler		Sativa	High Mowing	4	3.5	4	4	4.5	5.57	7.63	73%
Rumba	72	Nash Huber	Jardins de la Gaillarde	3.5	4	3.5	3.5	4	5.27	6.23	86%
Dulcinea	60	Fruition	Fruition	3.5	3.5	3.5	3.5	4.5	4.3	7.18	59%
CIOA Orange Strain Cross		OSA - CIOA	OSA	3	3	3	3	5	4.28	6.65	60%
CIOA Orange Flavour Select		OSA - CIOA	OSA	3	3	2.5	4	4	3.9	7.87	50%
Naval	72	Bejo	Johnny's	3.5	4	3.5	3.5	4.5	3.89	5.39	72%
CIOA Uber Flavour Select		OSA - CIOA	OSA	1.5	2	1.5	3	2.5	1.04	4.61	22%
CANOVI Orange		CANOVI	UBC	2	NA	1	1	3.5	0	0.55	0%

Mean of best 2 replicates
Green = High; Yellow = Mid-range; Red = Low

Bollin, an OP variety from Swiss organic and biodynamic breeder Sativa, performed similarly to Bolero in our hub site trials at 95 day harvest.

Touchon Deluxe offered strong yield and quality at both 74 and 95 day harvests.

Treentaler improved dramatically in flavour between 74 day and 95 day harvests and yieldedreasonably in both slots.