

# Carrot Variety Trial Report 2018

## BC Seed Trials and Canadian Organic Vegetable Improvement



# Background and Objectives

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This report presents results from vegetable variety trials conducted by a farmer network developed jointly as part of the BC Seed Trials project and Canadian Organic Vegetable Improvement (CANOVI). The BC Seed Trials was a collaboration between the Bauta Family Initiative on Canadian Seed Security, the Centre for Sustainable Food Systems at UBC Farm, and FarmFolk CityFolk from 2016 - 2018. Through conducting vegetable variety trials on farms throughout British Columbia, this project identified varieties with strong regional performance for both fresh market and seed production.

In 2019, the BC Seed Trials became part of the Canadian Organic Vegetable Crop Improvement (CANOVI) Variety Trials Network, connecting trial networks across Canada to continue on-farm variety trials in support of participatory plant breeding for organic agriculture. More information, including trial reports for other crops and years, can be found at [www.seedsecurity.ca/canovi](http://www.seedsecurity.ca/canovi).

## ***Carrot Variety Trials***

We chose carrots for the 2018 BC Seed Trials and CANOVI research network for several reasons. As a popular direct-market and wholesale crop, they are important to diversified vegetable growers and regional seed production. Storage carrots provide an opportunity to extend the market season and offer a local product through the late fall and winter. Trial participants preferred Nantes-type carrots, which are cylindrical with blunt tips, because of their storage capacity and good flavour. Participants also reported a need for better OP varieties in this carrot type.

## ***Seed Production Considerations***

Although Pacific Northwest climates are generally favorable to carrot seed production, carrot seed is challenging to grow in some parts of BC due to the presence of the common weed Queen Anne's lace (aka wild carrot) which cross-pollinates freely with domesticated carrots. FarmFolk CityFolk, in partnership with the University of Manitoba, has been conducting research into the feasibility of producing carrot seed in enclosures to prevent cross-pollination.

# Materials and Methods

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## ***Trial Design***

We used a Mother-Baby trial design<sup>1</sup>, which pairs larger, researcher-managed “mother” trials (usually at research stations) with a group of farmer-managed “baby” trials on participating farms. Mother trials consisted of three plots of each variety, arranged in a

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<sup>1</sup> Sieglinde Snapp, “Quantifying Farmer Evaluation of Technologies: The Mother and Baby Trial Design,” in *Quantitative Analysis of Data from Participatory Methods in Plant Breeding*, ed. Mauricio R. Bellon and Jane Reeves (Mexico: CIMMYT, 2002), 9–17, <https://cgspace.cgiar.org/handle/10568/76948>.

Randomized Complete Block Design, while baby trials consisted of single plots of each variety with an additional second plot of a check variety, used to assess within-site variation.

### ***Trial Locations***

For the BC Seed Trials in 2017 and 2018, the UBC Farm in Vancouver, BC, served as the certified organic mother site, while Wisbey Veggies in Abbotsford, BC, served as the conventional mother site. The UBC Farm and Wisbey Veggies are in Plant Hardiness Zone 8a and 8b, respectively<sup>2</sup>. In addition to the replicated mother sites, carrot trials were grown on 29 total on-farm sites across Canada, including 11 in BC, 10 in Ontario, 5 in Quebec, and 2 in the Maritimes Provinces, ranging from Zones 8a to 3b.

Most of these farms were certified organic. Those farms that were not certified organic employed a range of ecological practices from using integrated pest management (IPM) to guide their use of conventional inputs, to complying with most organic standards but opting out of certification.

### ***Planting Specifications***

To encourage similarity in spacing between trials, we provided farmers with planting guidelines, with the instructions that farmers should vary the bed spacing as needed based on their growing system.

<b>Plot size</b>	12 row-feet per variety
<b>Target seeding rate</b>	Seeded at roughly 20 seeds/foot and thinned to 1 inch, aiming for 15 roots per foot after thinning
<b>Seeding method</b>	Direct seeding by hand at most locations

### ***Planting and Harvest Dates***

Growers were asked to time carrot seeding for late fall harvest, and to harvest at around 100-120 days, given their farm conditions, and to evaluate the trial when most varieties were a marketable size, around 35-40 days.

<b>Location</b>	<b>Seeding</b>	<b>Harvest</b>	<b>Storage Evaluation</b>
UBC Farm	June 20, 2018	Oct. 11, 2018	Dec. 13, 2018
Wisbey Veggies	June 2, 2018	Sept. 23, 2018	Feb. 23, 2018
Other on-farm sites	June 13 – July 7, 2018	Sept. 19 – Oct. 27, 2018	N/A

**Table 1.** *Planting, harvest, and storage evaluation dates for hub sites.*

### ***Varieties and Seed Sources***

We intentionally included multiple seed sources for some varieties in order to evaluate seed production quality and variety maintenance across multiple companies that maintain their own open-pollinated seed stocks. For example, we trialed ‘Rumba,’ grown by farmer Nash

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<sup>2</sup> “Plant Hardiness Zones in Canada,” accessed December 19, 2019, <http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness/index.html>.

Huber for Fedco as well as the same variety grown by BC EcoSeed Co-op (BCESC). In this report, varieties that were sourced from multiple companies have the company or grower name indicated in the entry names (e.g. 'Rumba – BCESC').

The research team (consisting of researchers from UBC, FarmFolk CityFolk, and the Bauta Initiative) chose varieties based on an online search for all carrot varieties described as having a Nantes-type shape and good storage qualities. The trial included commercial varieties developed by public or private plant breeders; heirloom varieties produced by mid-to-large scale companies and smaller BC companies; and varieties developed by farmer-breeders for adaptation to the Pacific Northwest (PNW). We included untreated conventionally grown seed only when certified organic seed was not available. 'Bolero F1' was included as a check variety due to its well-known performance, allowing better comparison between sites. Three other varieties were grown at all 12 participating farms: 'Dolciva,' 'Scarlet Nantes,' 'Nash's Nantes,' and 'Muscade.' All other varieties were each grown on a subset of 6 farms.

Variety Code	Variety	OP?	Source
CA-01	Bolero F1 (check variety)	No	Osborne
CA-04	Muscade	Yes	Gourmet International
CA-05	Rumba - Nash	Yes	Fedco
CA-07	Berlicumer - FCS	Yes	Full Circle Seeds
CA-08	Nantes Prima	Yes	Gourmet Seeds
CA-09	Dolciva	Yes	High Mowing
CA-10	Scarlet Nantes (check)	Yes	High Mowing
CA-11	Nash's Nantes	Yes	Nash Huber
CA-12	Berlicumer - SSS	Yes	Salt Spring Seeds
CA-14	Rumba - BCESC	Yes	BC EcoSeed Co-op
CA-16	Nantes di Chioggia	Yes	Seeds from Italy
CA-17	Touchon	Yes	Vesey's
CA-18	Dan's Nantes	Yes	Salt Spring Seeds
CA-19	Nash's Nantes - BCESC	Yes	BC EcoSeed Co-op

**Table 2.** Varieties planted in 2018-2019 trials. Seed source abbreviations are included in variety names in cases where the same variety was included from multiple seed sources. For example, 'Berlicumer – FCS' indicates 'Berlicumer' from Full Circle Seeds.

### **Data Collection and Analysis**

We developed evaluation protocols based on consultation with farmer participants and seed company stakeholders, and using a province-wide survey of vegetable growers conducted in early 2016. Evaluations at on-farm sites were more minimal and emphasized farmers' notes and scores, while evaluations at the UBC Farm and Wisbey Veggies were more extensive, including quantitative yield measurements. Disease and insect damage scores were only collected if damage was observable, in other words if a disease did not show up no score was reported.

Table 3 displays all of the characteristics we evaluated. While only the most relevant traits are reported in this analysis, additional data is available upon request from Dr. Alex Lyon (alexandra.lyon@ubc.ca).

Evaluation Window	UBC Farm & Wisbey Veggies	On-Farm Sites
3-4 weeks after seeding	<ul style="list-style-type: none"> <li>Seedling vigour rating &amp; notes</li> </ul>	<ul style="list-style-type: none"> <li>Seedling vigour rating &amp; notes</li> </ul>
Several times mid-season	<ul style="list-style-type: none"> <li>Note presence of carrot root fly and any other pests or diseases</li> </ul>	<ul style="list-style-type: none"> <li>Note presence of carrot root fly and any other pests or diseases</li> </ul>
At harvest	<ul style="list-style-type: none"> <li>Top height (comparative rating)</li> <li>Foliar blight (disease score)</li> <li>Bolting (count of plants bolted by harvest time)</li> <li>Cavity spot (disease score)</li> <li>Root knot nematode (disease score)</li> <li>Carrot rust fly (disease score)</li> <li>Yield (count of roots)</li> <li>Yield (weight)</li> <li>Marketable/unmarketable yield (percent by weight)</li> <li>Root shape (classified by type)</li> <li>Root smoothness (rating)</li> <li>Uniformity (rating)</li> <li>Colour (rating)</li> <li>Flavour (rating)</li> </ul>	<ul style="list-style-type: none"> <li>Top height (rating)</li> <li>Foliar blight (disease score)</li> <li>Powdery mildew (disease score)</li> <li>Notes on top quality</li> <li>Root smoothness (rating)</li> <li>Uniformity (rating)</li> <li>Root shape (classified by type)</li> <li>Comments on root appearance</li> <li>Carrot rust fly damage (rating)</li> <li>Open-ended questions</li> </ul>
Post-harvest	<ul style="list-style-type: none"> <li>Root sprouting (rating)</li> <li>Top sprouting (rating)</li> <li>Rotting (number of roots)</li> <li>Core colour (rating)</li> <li>Neck/shoulder shape (notes)</li> <li>Flavour (rating)</li> </ul>	<ul style="list-style-type: none"> <li>N/A – optional notes</li> </ul>

**Table 3.** Varieties planted in 2018-2019 trials. Seed source abbreviations are included in variety names in cases where the same variety was included from multiple seed sources. For example, ‘Berlicumer – FCS’ indicates ‘Berlicumer’ from Full Circle Seeds.

## Results for Replicated Trials

### Overview

In Tables 4a and b we have displayed quantitative yield variables (including the number of marketable roots, marketable root weight, and percent marketable by weight) as well as carrot top height, in the form of a “heat map” with most favourable values in green and least favourable values in red for each trait. This allows viewers to quickly see best performing varieties for several traits.

For the qualitative ratings in Tables 6a and b, we have created an Index Score which serves a similar purpose of summarizing all of the ratings in one number. Varieties with the highest index score performed best on the combination of these variables.

### **Comparison of UBC Farm and Wisbey Mother Sites**

UBC Farm had significantly higher total harvested weight than Wisbey Veggies based on Analysis of Variance ( $F = 7.19$ ,  $p = 0.019$ ). UBC Farm also had higher percent of carrots marketable by weight, though this difference was of marginal significance between the two sites ( $F = 3.42$ ,  $p = 0.08$ ). In contrast, the trials Wisbey Veggies experienced less bolting than at UBC Farm, across all varieties. Additional comparisons between sites are included in the discussion of each trait.

This data represents one year only, at sites which varied in multiple ways besides organic or conventional management practices including soil type, climate, and other management practices. For example, idiosyncrasies of trial plot management such as irrigation scheduling at Wisbey Veggies may have had an oversized and unrepresented negative effect on yields. Future additions to this report will compare multiple years of data across these mother sites.

<b>Carrot Yield and Top Weight at UBC Farm</b>				
<b>Variety</b>	<b>Marketable Roots (Count)</b>	<b>Marketable Weight (kg)</b>	<b>Percent Marketable by Weight</b>	<b>Top Weight (kg)</b>
	From 4 ft subsample	From 4 ft subsample	From 4 ft subsample	From 4 ft subsample
Nantes di Chioggia	28.33	31.39	94%	7.33
Bolero F1	33.33	24.94	86%	8.51
Touchon	28.67	22.19	87%	7.44
Rumba - BCESC	30.67	25.42	94%	5.81
Muscade	19.67	28.79	79%	7.11
Rumba - Nash	20.67	32.29	87%	5.91
Berlicumer - FCS	26.00	33.93	86%	3.93
Nantes Prima	18.67	29.20	93%	3.43
Dolciva	28.00	26.11	89%	9.26
Scarlet Nantes	30.00	26.96	81%	7.18
Nash's Nantes	23.33	34.65	84%	8.13
Berlicumer - SSS	20.00	19.68	91%	7.05
Dan's Nantes	24.33	25.10	76%	7.08
Nash's Nantes - BCESC	19.33	28.27	91%	5.53

**Table 4a. Comparison of Quantitative Variables (UBC Farm).** Results are colour-coded on a spectrum from green to red: green cells are the most favourable and red the least favourable for each trait. All results are the mean of three plots for that variety.

Carrot Yield and Top Weight at Wisbey Veggies				
Variety	Marketable Roots (Count)	Marketable Weight (kg)	Percent Marketable by Weight	Top Weight (kg)
	From 4 ft subsample	From 4 ft subsample	From 4 ft subsample	From 4 ft subsample
Touchon	11.33	20.47	52%	7.69
Nantes di Chioggia	11.33	23.65	44%	8.17
Berlicumer - SSS	15.67	31.55	53%	5.93
Muscade	10.33	20.03	18%	5.55
Dan's Nantes	12.33	25.80	29%	5.74
Dolciva	10.33	19.45	49%	6.65
Berlicumer - FCS	8.67	18.00	36%	5.15
Scarlet Nantes	12.00	28.50	37%	5.34
Rumba - Nash	10.33	14.38	39%	5.91
Nash's Nantes	9.00	18.60	2%	10.10
Rumba - BCESC	17.00	20.47	38%	4.61
Nantes Prima	6.33	15.20	41%	6.83
Bolero F1	7.00	23.15	52%	7.58
Nash's Nantes - BCESC	7.00	24.60	28%	6.24

**Table 4b. Comparison of Quantitative Variables (Wisbey Veggies).** Results are colour-coded on a spectrum from green to red—green cells are the most favourable and red the least favourable for each trait. All results are the mean of three plots for that variety.

**Marketable Yield**

In terms of percent of roots that were marketable by weight—a good measure of overall resilience to environmental challenges—‘Nantes di Chioggia,’ ‘Rumba’ from BCESC, and ‘Nantes Prima’ were top performing varieties at UBC Farm, while ‘Touchon,’ ‘Berlicummer,’ and ‘Bolero F1’ were best performing at Wisbey.

Primary reasons for unmarketability at UBC Farm included size (i.e. too small), cracking, carrot rust fly or rodent damage, or split roots (i.e. roots with multiple points), while the Wisbey site experience more gnarled deformed, and bumpy roots.

**Bolting**

For UBC Farm, the varieties with the least bolting were ‘Nantes Prima’ and ‘Rumba – BCESC,’ and ‘Scarlet Nantes.’ For Wisbey Veggies, ‘Bolero F1’ showed the least bolting, followed by ‘Berlicumer,’ ‘Scarlet Nantes,’ and ‘Nash’s Nantes’ (Table 5). One variety, ‘Dan’s Nantes,’ seemed to have crossed in seed production with wild carrot (*Daucus carota*), also known as Queen Anne’s Lace. This may have contributed to the amount of bolting.

Variety	UBC Farm	Wisbey
Berlicumer - FCS	5	0.33
Berlicumer - SSS	2.33	0.67
Bolero F1	1.67	0
Dan's Nantes	3.33	1
Dolciva	2.33	1
Muscade	5	3
Nantes di Chioggia	3.33	3
Nantes Prima	0	0.67
Nash's Nantes	1	1
Nash's Nantes - BCESC	1.67	0.5
Rumba - BCESC	0.33	1
Rumba - Nash	1	1.33
Scarlet Nantes	0.67	0.5
Touchon	3.33	1.67

**Table 5. Number of bolted plants at harvest, for UBC Farm and Wisbey Veggies.** *Results are the mean of bolted plants in three 12-foot at each location.*

### **Traits Measured as Ratings**

We measured early Vigour, foliar height, blight, shape, shape uniformity, and root smoothness as 1-9 ratings, with 1 being the worst performing and 9 the best performing entry in the trial. Table 6 a and b display the average rating for each variety at UBC Farm and Wisbey Veggies. The Index Score consists of the sum of all 1-9 quality scores.

Top performing varieties in terms qualitative traits at UBC Farm included ‘Bolero F1’, ‘Berlicumer’, and ‘Dan’s Nantes’. At Wisbey Veggies, top performers for quality traits were ‘Nantes di Chioggia’, ‘Muscade’, and ‘Touchon’. ‘Bolero’ had the most consistent Nantes shape overall, while other varieties were more tapered or variable.

### **Root Shape**

A “Nantes” shape in carrots is defined by a cylindrical root with a rounded tip, often called a “cigar shape” because it is an even width from top to bottom, in contrast to more tapered varieties. The varieties rated as having the clearest Nantes shape at UBC Farm were ‘Scarlet Nantes,’ ‘Bolero,’ ‘Nantes di Chioggia,’ and ‘Berlicumer’ from Full Circle Seeds.



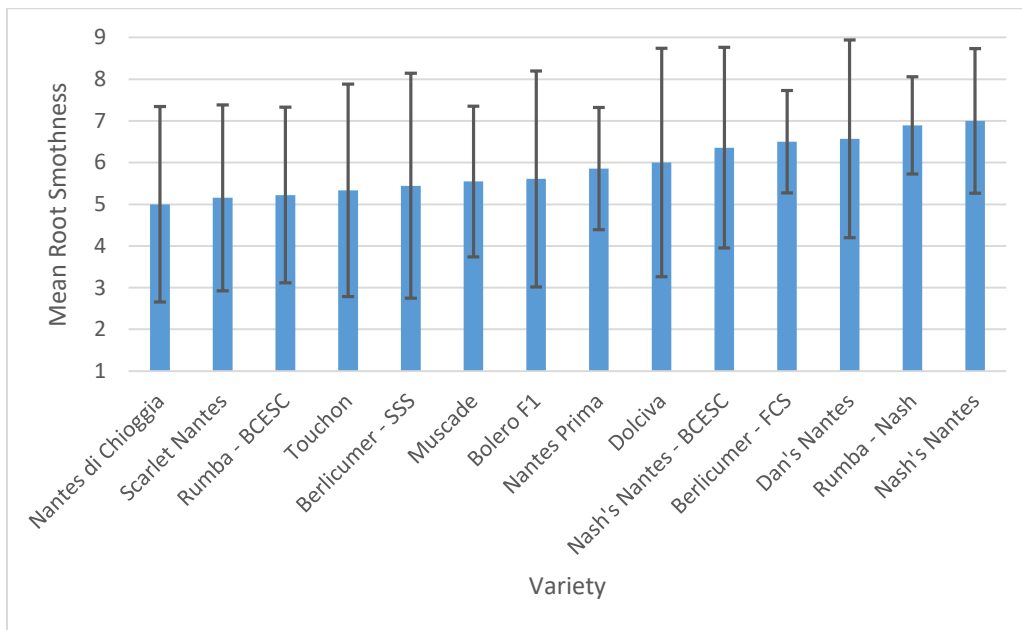
Carrot Quality Ratings at UBC Farm						
Variety	Early Vigour	Foliar Height	Blight	Shape Uniformity	Root Smoothness	Index Score
Bolero F1	4.33	8.67	7.33	7.67	7.00	35.00
Berlicumer - SSS	3.67	7.67	7.67	7.67	7.00	33.67
Dan's Nantes	5.67	6.33	7.00	6.33	7.67	33.00
Rumba - Nash	5.67	6.33	7.33	5.67	6.33	31.33
Rumba - BCEESC	6.33	5.33	7.00	6.33	5.67	30.67
Muscade	3.67	7.67	7.67	2.00	7.00	28.00
Nantes di Chioggia	3.00	4.67	6.33	5.67	7.67	27.33
Nash's Nantes - BCEESC	3.00	6.33	7.00	4.33	6.33	27.00
Dolciva	3.00	5.33	7.33	3.67	7.67	27.00
Nash's Nantes	5.00	5.00	6.33	3.67	5.00	25.00
Touchon	2.00	5.67	6.33	4.33	5.67	24.00
Scarlet Nantes	2.33	5.67	6.67	4.33	5.67	24.67
Berlicumer - FCS	4.33	4.33	5.67	5.67	3.67	23.67
Nantes Prima	1.67	1.15	5.67	4.00	6.00	18.49

Carrot Quality Ratings at Wisbey Veggies					
Variety	Foliar Height	Blight	Shape Uniformity	Root Smoothness	Index Score
Nantes di Chioggia	7.67	8.67	5.33	7.00	28.67
Muscade	6.33	9.00	5.67	6.33	27.33
Touchon	7.67	9.00	5.67	4.67	27.00
Dolciva	4.33	9.00	7.67	5.33	26.33
Bolero F1	7.00	9.00	4.33	4.33	24.67
Nantes Prima	5.67	9.00	6.33	3.00	24.00
Dan's Nantes	6.33	9.00	5.00	5.00	25.33
Berlicumer - FCS	4.33	9.00	6.00	4.50	23.83
Rumba - BCEESC	4.33	9.00	3.00	6.50	22.83
Berlicumer - SSS	3.67	9.00	7.00	5.00	24.67
Nash's Nantes - BCECS	5.00	9.00	3.00	4.00	21.00
Scarlet Nantes	4.00	8.75	4.33	4.33	21.42
Rumba - Nash	3.00	9.00	6.33	4.67	23.00
Nash's Nantes	3.00	9.00	6.33	4.00	22.33

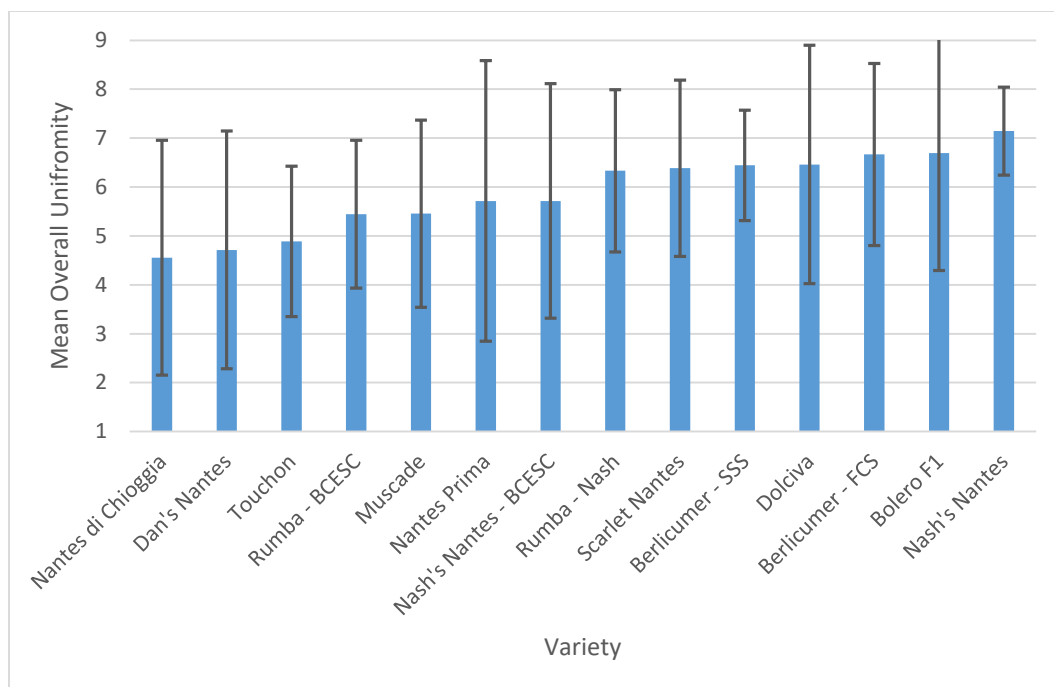
**Table 6a-b. Comparison of traits rated on a 1-9 scale at UBC Farm and Wisbey Veggies.** For each trait, 1 is the least favourable and 9 the most favourable rating. Results represent the mean of three plots per variety. The Index Score was calculated as the sum of all ratings. Early vigour data was missing for Wisbey Veggies.

## Ratings from Baby Sites/On-farm Trials

Figures 1 and 2 present the results for root smoothness and uniformity in the on-farm trials. Farmers rated ‘Nash’s Nantes’—sourced from Nash’s Organic Produce (Sequim, WA)—highest for both variables. As would be expected for a hybrid, ‘Bolero F1’ was highly uniform; however, it performed only moderately for root smoothness in farmer ratings. Farmers’ ratings of the varieties varied widely, making it difficult to identify clear trends. The overlapping error bars in tables 1 and 2 indicate little or no significant difference between varieties looking across all farm sites, though some may have performed much better than others on individual sites.



**Figure 1. Mean rating for root smoothness of 14 carrot varieties at 6 on-farm sites.** Data are included from the sites that submitted their ratings. A score of 1 indicates the least smooth and 9 indicates the most smooth roots. Error bars indicated standard deviation.



**Figure 2. Mean rating for overall uniformity of 14 carrot varieties at 6 on-farm sites.** Data are included from the sites that submitted their ratings. A score of 1 indicates the least uniform and 9 indicates the most uniform variety. Error bars indicate standard deviation.

## Farmer Comments and Notes

### Season Notes

A consensus among farmer comments from British Columbia was that they had trouble with germination due to a hot and dry season. These farmers also observed that carrots grew very quickly because of the heat and needed to be harvested quickly and earlier than expected.

### Trait Priorities

When asked about their top priorities for selecting carrot varieties or breeding new carrot varieties, traits mentioned most by farmers included:

- 1) Size and shape to optimize storage
- 2) Bright colour and crisp/sweet taste
- 3) Strong tops for bunching

### Farmer Comments on Variety Performance

Farmers were asked to record their three favourite and least favourite varieties as well as comments, out of 14 trial varieties. 7 farmers answered the question (Tables 7 and 8).

Overall, ‘Nash’s Nantes,’ ‘Bolero,’ and ‘Rumba’ fared best in farmers’ comments. ‘Nantes Prima’ received the most negative comments. Two varieties – ‘Nash’s Nantes’ and ‘Scarlet Nantes’ were selected by different farmers as favourite and *least* favourite varieties. The wide range of varieties selected as favourites and least favourites is consistent with the high variation in the on-farm data, and may suggest that varieties performed differently across sites.

<b>Favourite Variety</b>	<b>Comments</b>
‘Nash’s Nantes’, BCESC <i>(Named by 3 of 7)</i>	Vigour and germination similar to hybrid check Good size Strong tops
‘Nash’s Nantes’, Nash’s Organic Produce <i>(Named by 1 of 7)</i>	Uniform "Nantes" shape Bright orange Good Sweet Flavor Stored well
‘Bolero F1’ <i>(Named by 3 of 7)</i>	Best and earliest germination Uniform No rot or rust fly damage No branching/ splitting
‘Rumba’, BCESC and Nash’s Organic Produce <i>(Named by 2 of 7)</i>	Favourite for storage Good taste, uniformity, and root shape Good looking, straight roots
Nantes di Chioggia <i>(Named by 1 of 7)</i>	Uniform “Nantes” shape Bright orange Crisp Sweet
‘Berlicumer’, Salt Spring Seeds <i>(Named by 1 of 7)</i>	Appealing appearance Nice tops Long, smooth, and uniform roots
‘Scarlet Nantes’ <i>(Named by 1 of 7)</i>	Appealing appearance Long, fat roots Some reddish color at the base of the tops Appealing shape

**Table 7. Farmer comments on favourite varieties.** *Farmers were asked to record their three favourite and least favourite varieties as well as comments, out of 14 trial varieties. 7 farmers answered the question.*

<b>Least Favourite Variety</b>	<b>Comments</b>
Nantes Prima (Named by 3 of 7 commentors)	Poor germination (mentioned by 3 commentors) Low vigour Many off-types Lacking flavour
'Rumba', BCESC (Named by 1 of 7)	Poor germination Least uniform Most rotting
Nash's Nantes, BCESC	Poor germination and appearance
Scarlet Nantes	Unpleasant taste after short storage, prone to rotting.
Touchon	Needs varietal maintainance, unattractive roots.
Dan's Nantes	Roots not uniform Cracked roots
Nantes di Chioggia	Too skinny A bit of yellowing at tips

**Table 8. Farmer comments on least favourite varieties.** *Farmers were asked to record their three favourite and least favourite varieties as well as comments, out of 14 trial varieties. 7 farmers answered the question. 7 farmers answered the question.*

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For additional copies of this and other research reports, visit [www.seedsecurity.ca/canovi](http://www.seedsecurity.ca/canovi).

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