



2012 Organic Broccoli Variety Trial Results

The following tables present the results of organic broccoli variety trials that took place on research stations and cooperating farms in Washington, Oregon, Wisconsin, and Minnesota in 2012. These trials were part of the USDA-OREI funded project Northern Organic Variety Improvement Collaborative. Trials will continue in 2013.

Detailed descriptions of the trial methods and rating systems are listed after the results tables.



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Table 1: NOVIC 2012 Washington Broccoli Data - Part 1

Variety Name	Percent Prime Heads	Heat Tolerance (1-5)	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Regrowth Potential (1-5)
Arcadia	0.72 ab	3.86 a	3.54 abc	2.46 bc	3.43 ab	2.71 a
Bay Meadows	0.65 ab	4.43 a	4.03 ab	2.69 abc	2.97 ab	2.79 a
Belstar	0.80 a	3.69 a	4.03 ab	2.03 c	2.21 b	2.83 a
Common Ground	0.43 ab	3.14 a	2.69 abc	3.19 abc	3.20 ab	3.57 a
Green King	0.58 ab	2.57 a	1.89 c	4.06 ab	2.43 ab	2.57 a
Gypsy	0.74 ab	4.66 a	4.07 ab	2.71 abc	4.11 a	2.14 a
Marathon	0.42 ab	3.71 a	4.43 a	2.13 c	2.49 ab	2.42 a
OSU Composite	0.43 ab	2.66 a	3.00 abc	3.03 abc	3.66 ab	2.93 a
Solstice	0.35 b	3.14 a	2.26 bc	3.54 abc	3.54 ab	4.29 a
Umpqua	0.34 b	2.60 a	2.31 bc	4.26 a	2.34 ab	3.50 a
Windsor	0.60 ab	3.29 a	3.97 ab	3.14 abc	3.74 ab	3.14 a

Letters after the scores represent groups of varieties whose means are not significantly different for that trait. In other words, all the varieties which have a score with an "a" after the number have essentially the same score for that trait. NA indicates that data were not available for that trait for a particular variety. For more information on how traits were measured, please see the protocols at the end of this document.



Table 2: NOVIC 2012 Washington Broccoli Data - Part 2

Variety Name	Head Size (cm)	Head Weight (g)	Trimming (1-5)	Head Height (cm)	Canopy Height (cm)	Overall (1-9)
Arcadia	11.26 a	270.60 a	3.29 a	31.01 a	34.51 a	7.56 a
Bay Meadows	10.55 a	236.80 ab	3.36 a	29.49 a	31.63 a	6.56 ab
Belstar	11.66 a	282.00 a	3.14 a	30.43 a	25.67 a	5.94 ab
Common Ground	8.27 a	112.70 ab	3.43 a	36.49 a	26.94 a	3.67 b
Green King	9.37 a	151.10 ab	3.17 a	25.49 a	26.61 a	5.11 ab
Gypsy	10.11 a	218.00 ab	2.57 a	30.13 a	33.26 a	7.28 a
Marathon	10.03 a	261.40 ab	2.43 a	27.96 a	28.86 a	6.39 ab
OSU Composite	8.97 a	158.20 ab	3.29 a	36.49 a	30.48 a	6.83 ab
Solstice	7.39 a	90.67 b	3.07 a	34.94 a	26.76 a	3.94 b
Umpqua	8.54 a	122.90 ab	2.21 a	28.02 a	28.07 a	4.44 ab
Windsor	8.56 a	150.40 ab	3.63 a	33.22 a	27.64 a	5.61 ab

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Table 3: NOVIC 2012 Oregon Broccoli Data - Part 1

Variety Name	Percent Prime Heads	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Head Size (cm)
Arcadia	0.67 a	3.80 a	2.10 bc	2.80 bcd	10.08 ab
Belstar	0.37 a	3.80 a	1.80 c	2.20 d	11.52 a
Common Ground	0.57 a	3.33 a	2.50 bc	3.33 abc	8.13 b
Green King	0.65 a	2.67 a	5.00 a	2.75 bcd	9.70 ab
Gypsy	0.72 a	3.33 a	2.00 bc	2.83 bcd	11.55 a
OSU Composite	0.51 a	3.50 a	2.50 bc	4.17 a	8.50 ab
Solstice	0.58 a	3.50 a	3.17 b	4.00 a	7.82 b
Umpqua	0.42 a	2.83 a	3.17 b	2.42 cd	8.77 ab
Windsor	0.70 a	3.25 a	2.17 bc	3.58 ab	10.62 ab

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Table 4: NOVIC 2012 Oregon Broccoli Data - Part 2

Variety Name	Head Weight (g)	Trimming (1-5)	Head Height (cm)	Canopy Height (cm)	Notes
Arcadia	152.20 abc	3.38 ab	39.53 abcd	52.10 a	*2nd rep of Arcadia had one blind plant and one that never matured,
Belstar	187.80 a	2.00 b	34.67 cd	46.40 a	
Common Ground	89.40 c	3.33 ab	48.78 a	49.33 a	very small heads. Suspected syphmylium damage,
Green King	142.30 abc	2.83 ab	32.94 d	47.42 a	past peak maturity at harvest,
Gypsy	211.50 a	4.50 a	44.94 abc	59.83 a	*3rd rep of Gypsy had two blind plants, Harvested a few days past prime-heads were a little soft,
OSU Composite	111.00 bc	3.67 ab	47.67 ab	56.17 a	more mature the head the less trimming needed. Suspected symphylium damage, less mature heads have more leaves,
Solstice	82.24 c	3.83 ab	43.44 abcd	49.42 a	very little heads. Suspected symphylium damage,
Umpqua	112.20 bc	3.33 ab	37.22 bcd	52.75 a	small heads. Suspected symphylium damage,
Windsor	175.20 ab	3.42 ab	41.39 abcd	51.75 a	Harvested a few days past prime-heads were a little soft,

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Table 5: NOVIC 2012 Wisconsin Broccoli Data - Part 1

Variety Name	Foliar Disease	Percent Prime Heads	Heat Tolerance (1-5)	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Regrowth Potential (1-5)
Arcadia	5.00 a	0.62 a	2.50 ab	3.17 a	2.42 a	2.83 a	2.75 abc
Bay Meadows	4.67 ab	0.72 a	3.08 ab	4.00 a	2.08 a	3.17 a	2.12 abc
Belstar	5.00 a	0.77 a	2.33 ab	3.58 a	2.08 a	2.42 a	1.00 c
Common Ground	3.50 c	0.41 a	2.17 ab	3.25 a	2.33 a	3.67 a	4.00 a
Green King	5.00 a	0.64 a	3.67 a	3.75 a	3.00 a	3.08 a	2.62 abc
Gypsy	5.00 a	0.79 a	2.58 ab	3.83 a	2.33 a	2.33 a	3.00 abc
Marathon	5.00 a	0.44 a	1.38 b	3.50 a	2.25 a	2.12 a	1.25 bc
OSU Composite	4.17 b	0.50 a	3.17 ab	3.83 a	2.58 a	3.83 a	3.38 ab
Solstice	5.00 a	0.43 a	2.92 ab	3.58 a	2.75 a	3.67 a	3.38 ab
Umpqua	4.83 a	0.45 a	2.92 ab	3.33 a	3.17 a	2.58 a	3.75 a
Windsor	5.00 a	0.67 a	2.25 ab	4.17 a	2.17 a	3.50 a	4.12 a

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Table 6: NOVIC 2012 Wisconsin Broccoli Data - Part 2

Variety Name	Head Size (cm)	Head Weight (g)	Trimming (1-5)	Head Height (cm)	Canopy Height (cm)
Arcadia	12.42 abc	0.22 bcde	4.25 a	53.14 a	48.32 a
Bay Meadows	12.58 abc	0.30 abcd	3.42 ab	41.13 bcde	45.27 a
Belstar	14.95 a	0.37 ab	2.58 ab	45.69 abcd	43.40 a
Common Ground	10.63 bc	0.16 de	3.17 ab	56.07 a	47.28 a
Green King	9.47 c	0.14 e	2.00 b	33.97 e	42.54 a
Gypsy	13.20 abc	0.32 abc	4.00 ab	47.76 abcd	46.74 a
Marathon	14.60 ab	0.42 a	2.00 b	49.82 abcd	42.08 a
OSU Composite	10.02 c	0.17 cde	3.58 ab	51.67 ab	43.94 a
Solstice	10.28 c	0.16 de	3.58 ab	50.43 abc	43.92 a
Umpqua	11.05 abc	0.14 e	3.58 ab	39.17 de	41.57 a
Windsor	9.40 c	0.15 e	2.75 ab	40.78 cde	41.53 a

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Table 7: NOVIC 2012 New York Broccoli Data - Part 1

Variety Name	Insect Damage (1-5)	Percent Prime Heads	Heat Tolerance (1-5)	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Regrowth Potential (1-5)
Arcadia	3.12 a	0.41 a	3.25 ab	4.00 a	3.75 abcd	4.50 ab	2.67 abc
Bay Meadows	3.21 a	0.41 a	3.20 ab	4.00 a	3.40 bcd	3.80 abc	5.00 a
Belstar	3.12 a	0.25 a	2.20 bc	3.20 a	3.90 abcd	3.80 abc	1.00 c
Common Ground	2.96 a	0.15 a	3.00 abc	3.25 a	4.33 abc	4.08 ab	2.67 abc
Green King	3.00 a	0.47 a	4.08 a	3.67 a	4.75 a	3.67 abc	5.00 a
Gypsy	3.04 a	0.41 a	2.75 abc	4.17 a	3.08 d	3.58 abc	3.67 ab
Marathon	3.21 a	0.23 a	1.70 c	4.30 a	3.30 cd	3.00 c	1.00 c
OSU Composite	3.04 a	0.26 a	2.92 abc	3.50 a	3.83 abcd	4.58 a	3.00 abc
Solstice	3.08 a	0.18 a	2.92 abc	3.33 a	4.25 abc	4.33 ab	2.00 bc
Umpqua	2.83 a	0.25 a	3.33 ab	3.33 a	4.50 ab	3.50 bc	3.17 abc
Windsor	3.00 a	0.51 a	3.17 ab	3.67 a	3.50 bcd	4.25 ab	3.83 ab

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Table 8: NOVIC 2012 New York Broccoli Data - Part 2

Variety Name	Trimming (1-5)	Head Height (cm)	Canopy Height (cm)	Overall (1-9)	Notes
Arcadia	2.67 a	45.94 ab	42.58 a	9.50 a	excellent,
Bay Meadows	3.75 a	42.47 b	45.57 a	6.70	immature, almost ready,
Belstar	3.50 a	44.67 ab	38.43 a	6.90	
Common Ground	4.00 a	51.33 a	41.36 a	2.90 de	
Green King	3.50 a	40.00 b	38.67 a	7.80 abc	
Gypsy	2.83 a	48.17 ab	45.19 a	6.50	awful looking,
Marathon	1.75 a	46.60 ab	43.50 a	8.30 ab	
OSU Composite	3.67 a	46.00 ab	37.47 a	2.40 e	
Solstice	3.50 a	52.50 a	41.36 a	4.30 bcde	
Umpqua	3.17 a	45.33 ab	41.25 a	3.40 cde	
Windsor	3.50 a	46.94 ab	42.22 a	7.30 abcd	

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NOVIC Broccoli Variety Trial Protocol (final 5/10/11 JRM, LM)

Broccoli is labor intensive and may require many visits to the field if maturity of entries in the trial varies significantly. It is helpful to stay in close contact with the grower to time the visits for maximum number of entries ready at the same time. For this reason, we are suggesting that growers walk the field on a weekly basis as part of providing an overall rating through the season so that they will have a good sense of when things are ready. The overall rating scale implemented this year is designed to encourage the weekly walk-through.

Expected maturity for a spring harvested broccoli trial will run between 45 and 70 days depending on the variety and the heat units available.

Row cover and certified organic sprays may be used as needed to control pests and diseases.

Transplant production:

Transplants should be started about 5-6 weeks prior to setting in the field (mid April for transfer to the field during the 3rd week of May). They are hardened off for about one week. There are 36 plants per plot (you should start extra in case plants have to be replaced).

Experimental Design:

Broccoli is grown in many different planting arrangements, for example, ranging from single 36" rows to three row beds (one foot between rows and an 18" wheel track skip between beds). Within row spacing varies from 8" to about 18". Use whatever arrangement is the standard for the farm. Head size will vary depending on amount of space available to the plant, and all other things being equal, greater area is needed in a spring planting compared to a fall planting to achieve the same head size. An "ideal" springtime spacing would be 18" x 18" which is 19,360 plants per acres. This translates into two row plots each row with 18 plants in 27' or three row plots with 12 plants per row in 18'. If using other configurations, select one that approximates 20,000 plants per acre if possible.

Broccoli descriptors: The following are traits that growers indicated are the most important to evaluate:

- Uniformity in head size (ideal is ~5" diameter) and maturity
- Early (and easy) harvest
- Head size
- Disease resistance
- Insect resistance
- Buttoning

These have been incorporated into the following set of evaluation parameters:

Traits possibly measured in field prior to harvest:

- *Insect damage:* Type of insect damage may vary from location to location. The three pests expected to cause the most damage in Oregon are flea beetle, cabbage butterfly (and related

lepidoptern pests), and aphids. Ratings should be initiated whenever anywhere in the trial, approximately 10% leaf defoliation is observed in a plot with flea beetle and lepidoptern pests, and when aphid colonies are present on 20% of the plants in a plot. Whenever the trial is visited, changes in pest damage should be evaluated, and rated again if significant changes have occurred. Rate on a 1-5 scale where 1=severe pest damage and 5=healthy plants. If the pest is not present rate as a 5 (all entries in a trial are given 5's if not disease present as opposed to leaving blank, which would indicate that the trial was not evaluated).

- *Foliar diseases:* Fungal and bacterial diseases may be present in certain regions, but specific pathogen will vary. In Oregon we can expect to see periodic epidemics of downy mildew. Ratings should be initiated in any trial when 20% of the plants in a plot are affected anywhere in the trial. Score on a 1-5 scale where 1=severely damaged plot and 5=all plants in plot are healthy. If the disease is not present rate as a 5. (all entries in a trial are given 5's if not disease present as a opposed to leaving blank, which would indicate that the trial was not evaluated)

Traits measured in the field at harvest:

- *Days to harvest:* Record the date upon which the heads are harvested. At least five heads should be prime to be considered harvestable.
- *Head uniformity:* Rating is done when five heads are prime and ready to harvest. Count separately for each variety; number of prime, young and over mature heads.
 - Young heads will typically be small, will have very fine beads and may be a lighter color than a mature head. Count plants without heads, or that are <2.5" but otherwise mature as young.
 - Prime heads will be medium (>2.5") to large in size, with mature color, well developed beads, and will be firm or just beginning to soften when pressed.
 - Over-mature heads will be loose, may have irregular shaped domes, and have large buds that may be beginning to show flower color.
- *Regrowth potential:* Take this rating at the mother trial site only since it requires additional post-harvest visits to the field. Take rating using a 1-5 scale where 1=low and 5=high, about one week after harvesting central head. Low regrowth potential would be where little side shoot development is apparent, and any flower buds are tiny. High regrowth potential will have well developed side shoots growing above the central cut stalk with well developed broccoli heads forming. Regrowth potential will be observed on the whole plot and will be reported as a single score. We will try to assemble a photo scale for this trait.
- *Canopy and head height:* Choose 3 plants per plot with mature, marketable heads and measure height to top of the crown and to the highest leaf for head and canopy height respectively. Plants should have prime head if possible, and chose "typical" plants that represent the plot.
- *Head color:* Rating scale of 1 – 5 where 1 is light green and 5 is dark blue-green/purple. The rating is taken on the five prime heads and reported as a single number averaged over the five. (Standardized paint chip cards will be provided.)
- *Head firmness:* Scale of 1 – 5 where 1 = very loose, 2 = soft, 3 = intermediate, 4 = medium hard, 5 = very firm. To gauge this, lightly press on the head with the fingers of one hand. This is also done on the five prime heads and is a single number integrated over the five heads.
- *Bead size:* Beads are the individual immature flowers on a broccoli head (botanically speaking these are florets, but the term "florets" in broccoli refers to the small branches that make up the head). Bead size is rated on a 1 – 5 scale where 1 is very fine (this will almost never be used in this trial), 2 is fine, 3 is medium, 4 is medium coarse, and 5 is coarse. Bead size will be included

on the photo card. It should be rated on the five heads selected for harvest and should be a single score averaged over heads.

- *Heat stress*: Rate prime heads at harvest for this trait. Rate on a scale of 1 - 5 where 1 = unmarketable, 2 = severe, 3 = noticeable, 4 = low, 5 = none. Heat stress will cause leafy heads, uneven bead and floret development, including cat's eye (florets appear large and leafy), and starring or rosetting (center beads in a floret under developed compared to outer beads). The photo card will include examples to standardize ratings. It should be rated on the five heads selected for harvest and should be a single score averaged over heads.
- *Overall*: For hub trials, walk the trial once a week beginning five weeks after transplanting and continuing until first harvest is made. Rank the varieties from 1-9 (assuming nine entries) where 1=worst and 9=best. Criteria for ranking will vary depending on growth stage and will be somewhat subjective, so notes as to what stands out at a particular date would be helpful. The criteria will mainly be based on vigor, uniformity, and plant color. With daughter trials, have farmer walk the trial once a week as described above and give an overall rating to each plot using the same scale. Ideally, the same person should rate each week.
- *Harvest*: Five heads are harvested for yield. Heads are chosen such that they are at prime maturity and representative of overall production, and from any row, but avoid end plants. Heads should be cut at least 6 inches below the top of the crown. Do not trim excess leaves. Heads must be at least 2.5-3" diameter and firm to be considered marketable.

Post harvest: These measurements are generally taken from materials harvested in the field and brought to the field laboratory, but can be done in the field.

- Make sure head and stem are trimmed to a 6" length. Do not strip leaves remaining on the stem before rating leaves on stem.
- *Head size*: Lay 5 heads just touching side by side along a meter stick and record the length divided by 5.
- *Leaves on stem below head*: Rate amount of leaves remaining on stem that need to be trimmed on a 1-5 scale where 1= many large leaves that obscure the head, 3=some leaves on stem that wrap around the head, or 5= trimming is minimal. (A visual score card for this trait will be developed.)
- *Head weight*: Trim largest leaves from stem and weigh the five heads and record (divide by 5 for an average).

The data obtained will be weight per head but will not give an accurate yield since it is not a per unit area basis.