

2011 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 2011. These trials were part of the USDA-OREI funded project Northern Organic Variety Improvement Collaborative. Trials will continue in 2012 and 2013. Detailed descriptions of the trial methods and rating systems are listed after the results tables.



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Table 1: NOVIC 2011 Washington Broccoli Data - Part 1

Variety Name	Number of Prime Heads	Percent Prime Heads	Heat Tolerance (1-5)	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Canopy Height (cm)
Arcadia	23.33 abcd	0.63 abc	4.17 a	3.50 a	2.50 b	2.67 bc	61.72 a
Belstar	26.33 abcd	0.71 abc	4.17 a	3.83 a	2.33 b	2.25 c	48.42 bc
Common Ground Pop 2010	11.00 cd	0.32 bc	4.33 a	3.00 ab	3.33 ab	4.33 a	45.44 c
East Coast Pop	10.00 d	0.29 c	3.83 a	1.83 b	4.50 a	2.67 bc	48.17 bc
Green Goliath	30.17 a	0.85 a	4.00 a	4.00 a	2.83 b	2.67 bc	47.03 c
Gypsy	27.50 ab	0.75 ab	4.17 a	3.50 a	2.67 b	3.50 abc	59.94 ab
Oregon Longneck	10.50 cd	0.31 bc	3.67 a	2.50 ab	4.17 a	4.17 a	48.28 bc
OSU10 Broccoli Composite	13.33 bcd	0.37 bc	3.67 a	3.00 ab	3.33 ab	3.00 abc	56.11 abc
Windsor	26.83 abc	0.72 abc	4.67 a	4.00 a	2.50 b	3.83 ab	51.44 abc

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 2011 Washington Broccoli Data - Part 2

Variety Name	Head Height (cm)	Head Size (cm)	Head Weight (g)	Leaf Trim (1-5)	Notes
Arcadia	38.44 ab	12.17 a	276.67 abcd	3.80 a	Good dark color, decent stature, more cluster than dome-shaped head,
Belstar	34.89 abcd	12.42 a	335.63 ab	3.20 a	Poor light color, poor stature, High incidence of pink-brown spotting on head, coinciding with buds remaining smaller than non-spotted buds,
Common Ground Pop 2010	38.56 ab	8.00 b	159.13 d	3.00 a	
East Coast Pop	31.56 cd	9.48 ab	175.23 cd	3.00 a	High variability in architecture, early budding (50 percent),
Green Goliath	29.36 d	11.92 ab	391.87 a	2.80 a	Poor color, great stature, some brown and yellow spotting on head,
Gypsy	34.08 bcd	10.77 ab	366.03 a	2.40 a	
Oregon Longneck	39.17 ab	7.97 b	135.27 d	3.00 a	Very early budding (70 percent),
OSU10 Broccoli Composite	40.00 a	9.73 ab	195.87 bcd	4.00 a	Poor stature, early budding (40 percent),
Windsor	35.64 abc	10.77 ab	317.60 abc	2.80 a	Excellent stature, good color; Small leaves protruding out of head (90 percent of plants in plot), small leaves protruding from most heads,

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Table 3: NOVIC 2011 Oregon Broccoli Data

Variety Name	Number of Prime Heads	Percent Prime Heads	Heat Tolerance (1-5)	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Canopy Height (cm)	Head Height (cm)	Head Size (cm)	Head Weight (g)	Leaf Trim (1-5)
Arcadia	16.00 a	0.46 ab	5.00 a	4.00 ab	2.33 bc	2.67 bc	49.61 a	35.69 a	11.12 a	237.80 ab	2.67 a
Belstar	11.50 a	0.32 ab	4.67 a	4.83 a	1.33 c	1.50 d	42.61 a	33.44 a	11.43 a	274.77 ab	3.08 a
Common Ground Pop 2010	12.50 a	0.35 ab	3.83 a	3.25 b	3.33 ab	4.17 a	47.72 a	42.94 a	10.15 a	155.20 b	3.17 a
East Coast Pop	17.50 a	0.50 ab	3.50 a	3.50 b	4.67 a	2.50 cd	44.72 a	31.39 a	11.20 a	204.20 ab	2.75 a
Green Goliath	10.83 a	0.30 b	3.75 a	4.00 ab	3.75 ab	2.25 cd	41.44 a	31.72 a	8.45 a	201.33 ab	3.50 a
Gypsy	21.83 a	0.62 a	4.33 a	4.08 ab	2.83 abc	2.83 bc	54.94 a	39.72 a	13.62 a	318.63 a	3.67 a
Oregon Longneck	14.50 a	0.42 ab	3.40 a	2.80 b	4.20 ab	4.30 a	47.61 a	42.94 a	10.00 a	139.37 b	2.60 a
OSU10 Broccoli Composite	14.50 a	0.41 ab	3.67 a	3.00 b	3.33 ab	4.00 a	51.33 a	42.94 a	11.03 a	186.17 ab	2.67 a
Windsor	20.83 a	0.61 a	4.83 a	3.75 ab	2.75 abc	3.58 ab	51.58 a	42.17 a	12.47 a	276.37 ab	2.50 a

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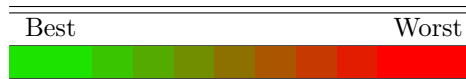


Table 4: NOVIC 2011 Wisconsin Broccoli Data - Part 1

Variety Name	Foliar Disease Resistance	Number of Prime Heads	Percent Prime Heads	Heat Tolerance (1-5)	Head Firmness (1-5)	Bead Size (1-5)	Head Color (1-5)	Canopy Height (cm)
Arcadia	5.00 a	9.00 a	0.37 abc	3.50 ab	4.00 ab	2.17 a	2.00 bc	59.17 a
Belstar	5.00 a	11.17 a	0.42 abc	1.25 b	3.25 ab	2.50 a	1.25 c	49.46 ab
Common Ground Pop (unknown year)	4.00 b	6.00 a	0.60 abc	2.75 ab	1.75 b	2.75 a	3.50 ab	51.92 ab
Common Ground Pop 2009	3.00 c	9.00 a	0.30 c	2.67 ab	3.67 ab	2.33 a	2.00 bc	47.28 b
Common Ground Pop 2010	3.00 c	11.33 a	0.38 abc	3.00 ab	3.33 ab	2.67 a	3.67 ab	46.44 b
East Coast Pop	5.00 a	5.00 a	0.32 bc	4.17 a	3.17 ab	2.71 a	2.29 abc	46.07 b
Green Goliath	4.57 ab	16.17 a	0.77 ab	4.33 a	4.00 ab	2.00 a	2.67 abc	46.11 b
Gypsy	5.00 a	15.50 a	0.66 abc	4.00 a	4.57 a	1.86 a	1.57 c	56.98 ab
Oregon	4.57 ab	7.50 a	0.42 abc	3.33 ab	2.67 ab	3.17 a	3.83 a	52.89 ab
Longneck								
OSU10	4.86 ab	8.00 a	0.42 abc	3.50 ab	3.67 ab	2.50 a	3.67 ab	50.58 ab
Broccoli Composite								
Windsor	5.00 a	18.20 a	0.81 a	4.33 a	4.17 a	1.50 a	3.67 ab	54.78 ab

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Table 5: NOVIC 2011 Wisconsin Broccoli Data - Part 2

Variety Name	Head Height (cm)	Head Size (cm)	Head Weight (g)	Leaf Trim (1-5)	Notes
Arcadia	42.81 ab	5.86 a	104.80 a	3.33 a	
Belstar	40.08 b	8.32 a	145.21 a	4.67 a	head firmness and bead size were very uneven,
Common Ground Pop (unknown year)	51.92 a	12.86 a	94.26 a	NA NA	head firmness and bead size were very uneven,
Common Ground Pop 2009	42.22 ab	8.77 a	107.00 a	3.67 a	
Common Ground Pop 2010	40.83 ab	8.10 a	95.67 a	4.00 a	
East Coast Pop	35.36 b	11.04 a	122.20 a	1.75 a	
Green Goliath	35.58 b	13.67 a	195.30 a	3.60 a	
Gypsy	41.36 ab	7.38 a	126.89 a	1.50 a	
Oregon Longneck	46.56 ab	8.46 a	75.02 a	3.80 a	
OSU10 Broccoli Composite	43.72 ab	9.70 a	92.59 a	3.80 a	Wide variation in head color—patchy coloration.,
Windsor	46.14 ab	11.71 a	171.77 a	3.60 a	

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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.