

## **Report to the Pennsylvania Vegetable Research and Marketing Board**

### **Keeping PA Vegetable Growers Profitable: Statewide Cultivar Trials**

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In the 2014 growing season we evaluated 25 broccoli cultivars (Table 1) in a spring and fall crop in three locations to determine which are best suited for Pennsylvania. Cultivars were evaluated in a conventional system in the western part of the state at Yarnick's Farm in Indiana (spring crop) and Janoski's Farm and Greenhouse in Clinton (fall crop); in the central part at Pennsylvania State University's Russell E. Larson Research Center in Rock Springs and in southeastern Pennsylvania State University's Southeast Research and Extension Center in Landisville.

'Imperial' was used as the standard based on conversations with growers. Four- to six-week-old transplants were planted in April for the spring crop and in August for the fall crop. Plants were planted in a bare ground system in the central and southeastern locations and in a plasticulture system in the western locations. In the bare ground system, rows were spaced 30-36 inches apart with plants spaced 12 inches apart in each row. In the plasticulture system, beds covered with black plastic were spaced on 5 foot centers and transplants were planted in a double row with 11-12 inch in-row spacing for the spring crop and in a single row with 15 inch in-row spacing for the fall crop.

A drip irrigation system was used to supplement rainfall in both production systems to provide plants with 1-1.5 acre-inches of water each week. Pests were managed following recommendations in the 2014 Commercial Vegetable Production Recommendation guide.

Heads were harvested when they reach maturity: when beads were tight and had dark green buds and stalks were cut to 5 inches long. Harvested heads were categorized as marketable or unmarketable, counted, weighed. Additionally, head diameter was determined for marketable heads. Unmarketable heads were less than 4 inches in diameter, were over mature or had diseased beads.

Cultivars were arranged in a randomized complete block design with each cultivar replicated four or five times. Data was collected from 10 plants per plot per replication. Data were analyzed using the mixed procedure and means were separated using pdiff.

## **Results**

### ***Spring Crop***

#### ***Western Pennsylvania***

'Imperial' heads weighed 0.80 lb which was not different than most cultivars (Table 1). 'Castle Dome' heads weighed more with a mean of 1.22 lb/head and 'Expo' and 'Legacy' less at 0.31 and 0.15 lb/head, respectively.

Out of 10 'Imperial' plants 10.0 heads were marketable which was not different than most other cultivars (Table 2). Fewer marketable heads were harvested from 'Blue Wind', 'Avenger', 'Legacy' and 'Expo' plants.

The diameter of 'Imperial' heads was 5.25 inches which was not different than most other cultivars (Table 3). 'Expo' and 'Legacy' heads had smaller diameters at 2.05 and 1.07 inches, respectively.

In general, very few heads were unmarketable (Table 4). The weight of unmarketable heads from 'Tahoe' and 'Blue Wind' was more than from 'Imperial'. All the remaining cultivars were not different than 'Imperial'.

#### ***Central Pennsylvania***

'Imperial' heads weighed 0.67 lb, which was not different than most cultivars (Table 1). 'Green Magic' and 'Blue Wind' weighed less at 0.27 and 0.25 lb/head, respectively.

Out of 10 'Imperial' plants 4.3 heads were marketable which was not different than most other cultivars (Table 2). More marketable heads were harvested from 'BC 1691' and 'Izabal' plants.

The diameter of 'Imperial' heads was 4.43 inches which was not different than most other cultivars (Table 3). 'Green Magic' heads had smaller diameters at 2.06 inches.

The weight of unmarketable heads from all other cultivars was not different than 'Imperial' (Table 4).

#### ***Southeastern Pennsylvania***

'Imperial' heads weighed 0.57 lb, which was not different than most cultivars (Table 1). 'Avenger' and 'Legacy' weighed less at 0.34 and 0 lb/head, respectively. Production of 'Legacy' heads was affected by high temperatures.

Out of 10 'Imperial' plants 8.6 heads were marketable which was not different than most other cultivars (Table 2). Fewer marketable heads were harvested from 'Green Gold', 'B2914', 'Tahoe', 'Amadeus', 'Expo', 'Emerald Jewel', 'Blue Wind', 'Avenger' and 'Legacy' plants.

The diameter of 'Imperial' heads was 4.91 inches which was not different than most other cultivars (Table 3). 'Blue Wind', 'Avenger' and 'Legacy' heads had a smaller diameter at 3.3, 2.35 and 0 inches, respectively.

The weight of unmarketable heads from 'Imperial' was 0.26 which was not different than most other cultivars (Table 4). Unmarketable heads from 'Avenger', 'Luna', 'Green Gold', 'Legacy', 'Expo', 'Blue Wind', 'BC1691' and 'Dura Pak 19' were heavier.

### **Fall Crop**

#### ***Western Pennsylvania***

'Imperial' heads weighed 1.07 lb which was not different than most cultivars (Table 5). 'Avenger', 'Izabal', 'Dura Pak 19', 'BC 1691' and 'Green Gold' weighed more, between 1.47 and 1.24 lb/head. 'Bay Meadows', 'Tahoe', 'Amadeus' and 'Diplomat' weighed less, between 0.90 and 0.76 lb/head.

Out of 10 'Imperial' plants 9.6 heads were marketable which was not different than most other cultivars (Table 6). Fewer marketable heads were harvested from 'Blue Wind' and 'Expo' plants.

The diameter of 'Imperial' heads was 5.80 which was not different than most cultivars (Table 7). 'Blue Wind', 'Castle Dome', 'Captain' and 'Avenger' had larger diameters and 'Amadeus' had smaller diameters.

The weight of unmarketable heads from all other cultivars was not different than 'Imperial' (Table 8).

#### ***Central Pennsylvania***

The fall crop in central Pennsylvania grew abnormally and as a result was not harvested. Several causes were investigated and in the end herbicide drift injury was suspected.

#### ***Southeastern Pennsylvania***

'Imperial' heads weighed 0.60 lb (Table 5). 'Imperial', 'Expo', 'Tahoe', 'Green Gold', 'Avenger', 'Legacy', 'B2914' and 'BC 1691' weighed more. 'Amadeus', 'Captain' and 'Blue Wind' weighed less.

Out of 10 'Imperial' plants 9.6 heads were marketable which was not different than most other cultivars (Table 6). Fewer marketable heads were harvested from 'Avenger', 'BC 1691', 'Expo', 'Captain', 'Legacy' and 'Blue Wind' plants.

The diameter of 'Imperial' heads was 5.36 which was not different than most cultivars (Table 7). 'Luna', 'Amadeus', 'Captain' and 'Blue Wind' had smaller diameters.

The weight of unmarketable heads from 'Imperial' was 0.12 lb/head which was not different than most other cultivars (Table 8). 'BC1764', 'Luna', 'Bay Meadows' and 'Lieutenant' produced smaller unmarketable heads.

Yearly environmental conditions can affect results and recommendations; therefore, we have proposed to evaluate the same broccoli cultivars again in 2015. However, based on these results for the spring broccoli crop and compared to 'Imperial', 'Legacy' had lower marketable head weight; 'Avenger', 'Blue Wind', 'Expo' and 'Legacy' produced fewer marketable heads; 'Legacy' heads had a smaller diameter; and 'Blue Wind' produced more unmarketable heads in two of the three study sites. For the fall broccoli crop, compared to 'Imperial', 'Avenger', 'Izabal' and 'Green Gold' had higher and 'Amadeus' lower marketable head weight; 'BlueWind' and 'Expo' produced fewer marketable heads; and 'Amadeus' heads had a smaller diameter in the two study sites. Unmarketable head weight was largely not different than 'Imperial'.

Table 1. Mean marketable individual head weight (lb) of 25 cultivars of spring broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Central Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<b>0.80<sup>z</sup> b-e</b>	<b>0.67 a-d</b>	<b>0.57 a-e</b>
Amadeus	0.61 c-f	0.53 a-e	0.50 c-f
Avenger	0.74 b-e	0.83 a	<b>0.35 f</b>
B2914	0.55 ef	0.66 a-d	0.52 c-f
Bay Meadows	0.69 b-e	0.52 b-e	0.57 a-f
BC 1691	0.73 b-e	0.62 a-d	0.60 a-d
BC 1764	0.82 b-e	0.37 de	0.51 c-f
Blue Wind	0.81 b-e	<b>0.25 e</b>	0.39 def
Burney	0.77 b-e	0.60 a-d	0.58 a-e
Captain	0.93 abc	0.41 cde	0.50 c-f
Castle Dome	<b>1.21 a</b>	0.36 de	0.56 b-f
Diplomat	0.62 c-f	0.54 a-e	0.51 c-f
Dura Pak 16	0.81 b-e	0.54 a-e	0.53 c-f
Dura Pak 19	0.82 b-e	0.49 b-e	0.54 b-f
Emerald Crown	0.94 abc	0.48 b-e	0.62 abc
Emerald Jewel	0.69 b-e	0.59 a-d	0.38 ef
Expo	<b>0.31 fg</b>	0.63 a-d	0.77 a
Green Gold	0.91 a-d	0.70 abc	0.75 ab
Green Magic	1.01 ab	<b>0.27 e</b>	0.64 abc
Gypsy	0.89 a-d	0.66 a-d	0.58 a-e
Izabal	0.60 def	0.72 ab	0.64 abc
Legacy	<b>0.15 g</b>	0.67 a-d	<b>&lt;0 g</b>
Lieutenant	0.63 c-f	0.57 a-e	0.52 c-f
Luna	0.92 a-d	0.70 abc	0.66 abc
Tahoe	0.62 c-f	0.65 a-d	0.58 a-e

<sup>z</sup>Values are the mean of 5 replications in the western and southeastern sites and 4 in the central site; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.

Table 2. Mean number of marketable heads per plot<sup>2</sup> of 25 cultivars of spring broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Central Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<b>10.0<sup>y</sup> a</b>	<b>4.3 c-h</b>	<b>8.6 a</b>
Amadeus	9.8 a	6.0 a-e	4.4 efg
Avenger	3.4 c	5.3 b-g	0.78 hi
B2914	9.0 a	7.0 a-d	5.3 c-f
Bay Meadows	9.2 a	6.8 a-d	7.0 a-d
BC1691	9.8 a	8.8 a	6.6 a-e
BC1764	9.8 a	1.8 h	6.8 a-e
Blue Wind	6.0 b	1.5 gh	1.0 hi
Burney	10.0 a	5.5 a-f	6.2 a-e
Captain	9.2 a	2.8 e-h	7.0 a-d
Castle Dome	8.4 ab	1.9 fgh	8.2 ab
Diplomat	9.8 a	5.8 a-e	7.4 abc
Dura Pak 16	8.2 ab	4.3 c-h	7.0 a-d
Dura Pak 19	9.2 a	4.0 d-h	6.4 a-e
Emerald Crown	10.0 a	5.8 a-e	8.0 ab
Emerald Jewel	9.0 a	6.3 a-d	2.2 ghi
Expo	1.6 c	2.8 e-h	2.8 fgh
Green Gold	9.8 a	7.5 abc	5.8 b-e
Green Magic	10.0 a	2.8 e-h	7.0 a-d
Gypsy	10.0 a	5.8 a-e	7.6 abc
Izabal	9.6 a	7.8 ab	8.4 a
Legacy	1.6 c	7.0 a-d	0 i
Lieutenant	10.0 a	6.0 a-e	6.6 a-e
Luna	10.0 a	7.3 a-d	7.2 abc
Tahoe	9.6 a	6.3 a-d	4.6 d-g

<sup>2</sup>Plots consisted of 10 plants.

<sup>y</sup> Values are the mean of 5 replications in the western and southeastern sites and 4 in the central site; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.

Table 3. Mean diameter (inches) of marketable heads of 25 cultivars of spring broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Central Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<b>5.25<sup>z</sup></b> a-e	<b>4.43</b> a	<b>4.91</b> a
Amadeus	4.78 b-e	4.48 a	4.78 ab
Avenger	4.78 b-e	5.06 a	<b>2.38</b> c
B2914	3.62 ef	4.58 a	4.98 a
Bay Meadows	5.04 b-e	4.44 a	5.02 a
BC 1691	4.32 cde	4.64 a	4.89 a
BC 1764	5.89 abc	3.42 ab	5.02 a
Blue Wind	6.10 abc	2.88 ab	<b>3.30</b> bc
Burney	5.08 a-e	4.46 a	4.88 a
Captain	6.51 ab	3.55 ab	5.02 a
Castle Dome	6.79 a	4.43 a	4.98 a
Diplomat	4.28 cde	4.68 a	5.26 a
Dura Pak 16	5.55 abc	4.41 a	5.07 a
Dura Pak 19	6.24 ab	3.26 ab	5.07 a
Emerald Crown	5.37 a-d	3.38 ab	4.75 ab
Emerald Jewel	5.34 a-e	4.79 a	4.11 ab
Expo	<b>2.05</b> fg	4.33 a	5.23 a
Green Gold	5.08 a-e	4.53 a	4.98 a
Green Magic	5.86 abc	<b>2.06</b> b	4.89 a
Gypsy	5.75 abc	4.87 a	4.88 a
Izabal	3.71 def	4.47 a	4.65 ab
Legacy	<b>1.07</b> g	4.98 a	<b>&lt;0</b> d
Lieutenant	4.85 b-e	4.84 a	4.98 a
Luna	5.20 a-e	4.49 a	4.86 a
Tahoe	4.40 cde	4.41 a	4.83 ab

<sup>z</sup>Values are the mean of 5 replications in the western and southeastern sites and 4 in the central site; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.

Table 4. Mean unmarketable individual head weight (lb) of 25 cultivars of spring broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Central Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<1 <sup>z</sup> c	<b>0.33 ab</b>	<b>0.26 b</b>
Amadeus	0 c	0.15 b	0.52 a-f
Avenger	0.55 abc	0.41 ab	0.78 a
B2914	0 c	0.42 ab	0.56 a-f
Bay Meadows	0.51 abc	0.31 ab	0.40 c-f
BC 1691	<1 c	0.33 ab	0.56 a-e
BC 1764	0.22 bc	0.19 b	0.40 c-f
Blue Wind	1.04 ab	0.26 ab	0.56 a-e
Burney	<1 c	0.70 a	0.48 b-f
Captain	0.49 abc	0.11 b	0.32 ef
Castle Dome	0.90 abc	0.11 b	0.32 ef
Diplomat	0 bc	0.33 ab	0.50 a-f
Dura Pak 16	<1 c	0.31 ab	0.38 def
Dura Pak 19	0.49 abc	0.26 ab	0.56 a-e
Emerald Crown	<1 c	0.35 ab	0.39 c-f
Emerald Jewel	0.43 abc	0.28 ab	0.42 c-f
Expo	0.64 abc	0.40 ab	0.59 a-e
Green Gold	0.14 bc	0.50 ab	0.67 abc
Green Magic	<1 c	0.40 ab	0.49 a-f
Gypsy	<1 c	0.19 b	0.45 b-f
Izabal	<1 c	0.35 ab	0.36 ef
Legacy	0.33 abc	0.25 ab	0.66 a-d
Lieutenant	<1 c	0.16 b	0.42 c-f
Luna	0 bc	0.45 ab	0.72 ab
Tahoe	1.23 a	0.32 ab	0.50 a-f

<sup>z</sup>Values are the mean of 5 replications in the western and southeastern sites and 4 in the central site; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.



Table 5. Mean marketable individual head weight (lb) of 25 cultivars of fall broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<b>1.07<sup>z</sup> e-h</b>	<b>0.60 f-i</b>
Amadeus	0.77 k	0.49 jk
Avenger	1.47 a	0.71 bcd
B2914	1.09 d-h	0.70 cde
Bay Meadows	0.90 ijk	0.62 e-h
BC 1691	1.25 bcd	0.68 cde
BC 1764	1.24 b-e	0.53 ij
Blue Wind	0.95 hij	0.43 k
Burney	1.06 f-i	0.57 f-j
Captain	1.01 g-j	0.43 k
Castle Dome	1.19 c-f	0.56 g-j
Diplomat	0.76 k	0.54 hij
Dura Pak 16	1.16 c-g	0.64 def
Dura Pak 19	1.27 bc	0.63 d-g
Emerald Crown	1.05 f-i	0.63 d-g
Emerald Jewel	1.02 g-j	0.59 f-i
Expo	0.98 hij	0.79 ab
Green Gold	1.24 bcd	0.71 bcd
Green Magic	0.92 h-k	0.64 d-g
Gypsy	1.06 fgh	0.59 f-i
Izabal	1.39 ab	0.80 a
Legacy	1.04 f-i	0.70 cde
Lieutenant	1.03 f-i	0.54 ij
Luna	0.96 hij	0.62 efg
Tahoe	0.86 jk	0.75 abc

<sup>z</sup>Values are the mean of 5 replications; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.

Table 6. Mean marketable number of heads per plot<sup>z</sup> of 25 cultivars of fall broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<b>9.6<sup>z</sup> a</b>	<b>9.6 a</b>
Amadeus	9.6 a	8.6 ab
Avenger	10.0 a	7.8 bcd
B2914	9.8 a	8.4 abc
Bay Meadows	9.8 a	9.8 a
BC 1691	9.6 a	7.8 bcd
BC 1764	9.7 a	9.8 a
Blue Wind	8.0 b	2.2 f
Burney	10.0 a	9.2 ab
Captain	9.4 a	6.6 de
Castle Dome	9.4 a	9.6 a
Diplomat	10.0 a	9.6 a
Dura Pak 16	9.2 a	9.2 ab
Dura Pak 19	9.8 a	9.2 ab
Emerald Crown	9.6 a	9.4 ab
Emerald Jewel	9.5 a	8.8 ab
Expo	6.8 c	6.8 cde
Green Gold	9.4 a	9.4 ab
Green Magic	9.5 a	8.6 ab
Gypsy	9.6 a	9.0 ab
Izabal	10.0 a	8.8 ab
Legacy	9.6 a	5.3 e
Lieutenant	9.2 ab	10 a
Luna	10.0 a	9.8 a
Tahoe	9.6 a	8.6 ab

<sup>z</sup>Plots consisted of 10 plants.

<sup>y</sup> Values are the mean of 5 replications in the western and southeastern sites and 4 in the central site; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.

Table 7. Mean diameter (inches) of marketable heads of 25 cultivars of fall broccoli grown in western, central and southeastern Pennsylvania in 2014.

<b>Cultivar</b>	<b>Western Pennsylvania</b>	<b>Southeastern Pennsylvania</b>
<b>Imperial</b>	<b>5.80<sup>z</sup> d-h</b>	<b>5.361 ab</b>
Amadeus	5.09 i	5.150 de
Avenger	6.44 abc	5.323 a-d
B2914	5.50 e-i	5.306 a-d
Bay Meadows	5.35 ghi	5.405 a
BC 1691	5.94 b-g	5.367 ab
BC 1764	6.19 a-e	5.311 a-d
Blue Wind	6.82 a	4.833 f
Burney	5.43 f-i	5.177 b-e
Captain	6.55 ab	5.039 e
Castle Dome	6.68 a	5.290 a-d
Diplomat	5.33 ghi	5.228 a-e
Dura Pak 16	5.76 d-h	5.376 ab
Dura Pak 19	5.98 b-f	5.312 a-d
Emerald Crown	5.50 f-i	5.272 a-d
Emerald Jewel	5.62 d-i	5.356 abc
Expo	5.31 hi	5.311 a-d
Green Gold	5.71 d-h	5.316 a-d
Green Magic	5.35 f-i	5.258 a-d
Gypsy	5.84 c-h	5.340 a-d
Izabal	6.32 a-d	5.383 a
Legacy	5.63 e-i	5.289 a-d
Lieutenant	5.82 c-h	5.300 a-d
Luna	5.31 hi	5.154 cde
Tahoe	5.32 ghi	5.378 ab

<sup>z</sup>Values are the mean of 5 replications; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.

Table 8. Mean unmarketable individual head weight (lb) of 25 cultivars of fall broccoli grown in western, central and southeastern Pennsylvania in 2014.

Cultivar	Western Pennsylvania	Southeastern Pennsylvania
<b>Imperial</b>	<1	<b>0.12<sup>z</sup></b> cde
Amadeus	0.70	0.27 a-e
Avenger	0	0.58 ab
B2914	0.23	0.36 a-e
Bay Meadows	<1	<1 e
BC 1691	0.09	0.46 a-d
BC 1764	0.11	0.10 de
Blue Wind	0.52	0.48 a-d
Burney	<0	0.36 a-e
Captain	0.33	0.44 a-d
Castle Dome	0.16	0.16 cde
Diplomat	<1	0.18 b-e
Dura Pak 16	0.09	0.30 a-e
Dura Pak 19	0.09	0.25 a-e
Emerald Crown	0.20	0.34 a-e
Emerald Jewel	0.10	0.44 a-d
Expo	0.29	0.53 abc
Green Gold	0.16	0.32 a-e
Green Magic	0.20	0.38 a-e
Gypsy	<1	0.43 a-d
Izabal	<0	0.28 a-e
Legacy	0.13	0.63 a
Lieutenant	0.21	<1 e
Luna	<1	0.09 de
Tahoe	0.02	0.32 a-e

<sup>z</sup>Values are the mean of 5 replications; values followed by different letters within a column are significantly different at the 5% level; values in green are statistically higher than the standard 'Imperial' and values in red are statistically lower.