

**Report to the Oregon Processed Vegetable Commission  
2011–2012**

1. Title: Broccoli Breeding, Evaluation and Seed Production
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3. Cooperators: None
4. Project Status: Terminating 30 June, 2012
5. Project Funding: \$5,770 breeding  
\$3,840 processing  
\$9,611 total

Research efforts were focused on testing various inbred combinations for hybrid production and adaptation to Oregon growing conditions. Trials at the Vegetable Research Farm included a yield trial of OSU derived hybrids, and observation trials of OSU inbreds and hybrids. Breeding funds were used for a major portion of the support of a vegetable breeding technician, student labor, supplies, and research farm expenses. Processing funds were used for processing samples of experimental hybrids.

Objectives:

Develop broccoli varieties adapted to western Oregon with suitable quality, high yields, and disease resistance. Specific traits include:

- Early to midseason maturity
- Concentrated yield potential
- Head rot and downy mildew resistance
- Large openly branched heads that are well exerted and have clean stems for easy trimming and separation into florets
- Firm, uniform florets of good color
- Fine beads with short pedicels, which are retained after freezing

Develop seed production systems using cytoplasmic male sterility (CMS) or self incompatibility (SI) to produce field scale quantities of F<sub>1</sub> hybrid seed.

Conduct pilot scale field production of inbreds and hybrids that produce sufficient quantities of seed.

6. Report of Progress:

*Greenhouse inbred and hybrid seed production:* Cuttings were taken from inbreds and breeding lines grown in the field in 2010 to establish material for crossing and hybrid seed production in the greenhouse during the winter of 2010-2011. A total of 32 cross combinations (tables 1-4) were obtained. Five hybrids had sufficient seed for a four-replicate yield trial (table 1), which also included three commercial check hybrids. Another four entries only had enough seed for three replicates. These were integrated into the four rep trial but the data were analyzed separately (table 2). Twenty-two inbreds

were selfed for seed production (table 5) and an additional hybrid combination with seed only sufficient for a single rep trial was produced (table 3). An additional 22 selections were made in segregating populations and F<sub>1</sub> hybrids.

*Yield Trial:* Data for the nine hybrids are shown in tables 1 and 2, and figures 1 and 2. 'Imperial' had highest gross T/A, but also highest % leaves. Imperial was also highest for yielding based on net T/A, but was not significantly different from Arcadia and S454 x S463. Emerald Pride yielded in the middle of the pack and none of the experimental hybrids were significantly different in net yield. Harvest maturities ranged from 64 to 74 days after transplanting, with experimental hybrids spread throughout that range. Overall, the number of blind plants per plot was down this year, but there were significant differences among hybrids. S454 x S462 in particular had more blind plants than Arcadia and Emerald Pride, but not Imperial. Head sizes among trial entries were not significantly different. Percent leaves ranged from 6.4 to 15.7% for the experimental hybrids and all had significantly lower % leaves than the check hybrids, which ranged from 18.6 – 44.1%. Imperial at 44.1% had the highest percent leaves in the trial, and also the highest proportion of young heads (table 1). This hybrid had variable maturity uniformity, which created difficulty in determining the optimum time to harvest in a once-over harvest operation. Harvesting at a later date may have decreased the young head category, and potentially increased the net T/A, but almost certainly would have resulted in an increased proportion of over mature (cull) heads. In contrast, the other checks and experimental hybrids showed a high degree of uniformity.

The proportion of the head that is made of up of florets was measured again this year for entries in this trial (tables 1 and 2). We wanted to test the hypothesis that commercial hybrids with their heavier heads had more mass in unusable stems and branches compared to the more exerted experimental hybrids. The checks ranged from 54-69% while the experimental ranged from 59 to 73%. Among the checks, Emerald Pride had the lowest percent florets and Arcadia the highest. While experimental hybrids varied, the overall trend appears to be in the direction of these having more usable weight in the florets rather than in the less valuable stems. This suggests that there is a moderate association between exertion and partitioning to florets vs. stems and branches, and that it might be possible to select for further shift in partitioning to florets. In general, OSU hybrids were taller and more exerted than the check hybrids (table 3, figure 3). The two hybrids ranked the highest overall were S454 x S465 and S465 x S446, followed by S411 x S457, S454 x S462, and S454 x S463. S456 x S446 showed heavy downy mildew infection in the trial. Since we have not observed this previously in other S446 hybrid combinations, we infer that S456 was the cause of susceptibility to downy mildew. We could not verify this because all S456 inbred seeds planted in the field failed to germinate.

Table 4 shows net tons per acre for trials conducted since 2000. Yields in general have stayed about the same over years, although this year had a slightly higher overall ton per acre average compared to previous years. The newest crosses do seem to have higher yield potential compared to older hybrid combinations. In particular, the S462, S463 and S465 inbreds show good combining ability with S454 and S446 inbreds.

Samples from the yield trial were blanched and frozen in the OSU department of food science pilot plant. They were evaluated in an in-house cutting in early January, and

samples were displayed at the Northwest Food Processors Association meetings in mid January.

*Observation Trials:* OSU inbred observation notes are shown in table 5. This year we grew out and evaluated a number of the historical lines. Twenty-one additional hybrids with limited seed availability were grown as single reps in the observation trial (table 6). Among the best of these were S410 x S463, S411 x S446, S411 x S456, S411 x S460, S446 x S458, S454 x RS-2, and S463 x S446. The RS- inbreds are quite interesting in that they are extremely tall, but unfortunately, they are difficult to self and have been lost from the trial. We did make selections from these materials so that the genetic material has been preserved. Some head rot was observed in this trial, but was not sufficiently consistent to distinguish among hybrid and inbreds. Table 7 shows inbred combinations that have been made over the years.

*Cytoplasmic Male Sterile (CMS) Facilitated Hybrid Seed Production:* Cuttings of CMS backcross lines in three inbred backgrounds (S410, S411, and S454) were taken into the greenhouse and rooted. Each background was represented by seven lines. Once flowering, these were caged in three groups in the greenhouse, each group with a fertile inbred included. Blue bottle flies were introduced into each cage and allowed to pollinate the flowers within the cage for approximately two weeks. The developing siliques were tagged and the fertile inbreds were transferred to another group, and the process was repeated. Again, the developing siliques were tagged. Table 8 presents, in a qualitative manner, the amount of seed that was set with each inbred combination. CMS inbreds varied greatly with ability to set seed, and there were differences in combining ability with different fertile inbreds. In only one case for a CMS backcross line did both inbred combinations set large quantities of seed. We took cuttings of the three best CMS lines in each group, rooted them, and subsequently transplanted into isolation plots in the field at the vegetable farm. Fertile inbreds were included with each group. The behavior of the pollinators that visited the flowers was observed and at the end of the season, the seed from CMS plants was harvested. As of this writing these are waiting to be cleaned and threshed, after which the amount will be weighed to quantify seed set. By incorporating selection for ability to set large amounts of seed with insect pollinators, we hope to develop CMS inbreds that will be highly efficient seed producers in many inbred cross combinations.

## 7. Summary:

Trials at the Vegetable Research Farm included a yield trial of OSU derived hybrids, and observation trials of OSU inbreds and hybrids. Promising hybrid combinations include S454 x S465, S465 x S446, S411 x S457, S454 x S462, and S454 x S463. There are still many cross combinations that need to be assessed. Selection for high levels of seed set in CMS lines was conducted.

**Table 1. Yield data from a hybrid broccoli trial, 4 rep plots, Corvallis, 2011.<sup>z</sup>**

| Hybrid                | Days to Harvest | No. Plts/ Plot | % Blind Plants | Gross T/A | Young Heads T/A | Culls T/A | Net T/A | Net Heads/A | Head Diameter (cm) | % Leaves | % Florets |
|-----------------------|-----------------|----------------|----------------|-----------|-----------------|-----------|---------|-------------|--------------------|----------|-----------|
| Imperial              | 67              | 29.0           | 3.5            | 9.64      | 2.30            | 0.03      | 4.78    | 14,077      | 12.3               | 44.1     | 60.5      |
| Arcadia               | 71              | 28.8           | 0.9            | 6.05      | 0.37            | 0.00      | 4.61    | 13,787      | 13.1               | 18.6     | 69.2      |
| S454 x S463           | 69              | 29.3           | 4.3            | 3.93      | 0.14            | 0.00      | 3.45    | 13,061      | 12.4               | 8.8      | 65.8      |
| S454 x S465           | 71              | 29.0           | 1.8            | 4.27      | 0.27            | 0.11      | 3.30    | 13,497      | 12.1               | 15.1     | 71.0      |
| Emerald Pride         | 64              | 29.5           | 0.0            | 5.52      | 0.47            | 0.10      | 3.27    | 12,191      | 12.3               | 30.6     | 54.4      |
| S446 x S454           | 67              | 29.3           | 3.4            | 3.92      | 0.20            | 0.06      | 3.09    | 11,610      | 12.5               | 15.2     | 66.1      |
| S445 x S465           | 74              | 27.0           | 4.5            | 3.03      | 0.23            | 0.00      | 2.41    | 12,916      | 11.4               | 13.2     | 67.3      |
| S454 x S462           | 69              | 28.0           | 7.4            | 2.90      | 0.18            | 0.15      | 2.21    | 9,869       | 12.0               | 12.9     | 62.3      |
| LSD 0.05 <sup>y</sup> |                 | 1.8            | 4.5            | 1.63      | 0.28            | 0.13      | 1.45    | 3,371       | NS                 | 15.7     | 5.5       |

<sup>z</sup>Transplanted July 14 in 30' plots, rows 30" apart, 12" between plants. Mean of 4 replications.

<sup>y</sup>NS = not significant.

**Table 2. Yield data from a hybrid broccoli trial, three replicate plots, 2011<sup>z</sup>**

| Hybrid                | Days to Harvest | No. Plts/ Plot | % Blind Plants | Gross T/A | Young Heads T/A | Culls T/A | Net T/A | Net Heads/A | Head Diameter (cm) | % Leaves | % Florets |
|-----------------------|-----------------|----------------|----------------|-----------|-----------------|-----------|---------|-------------|--------------------|----------|-----------|
| S456 x S446           | 71              | 29.3           | 2.3            | 4.70      | 0.56            | 0.00      | 3.80    | 11,810      | 12.6               | 8.7      | 67.7      |
| S465 x S411           | 74              | 28.7           | 2.3            | 4.10      | 0.20            | 0.00      | 3.60    | 11,229      | 12.9               | 6.4      | 67.6      |
| S411 x S457           | 67              | 29.0           | 1.1            | 4.00      | 0.28            | 0.03      | 3.40    | 12,778      | 11.9               | 7.8      | 59.4      |
| S454 x S458           | 71              | 28.3           | 1.1            | 3.70      | 0.48            | 0.17      | 2.60    | 8,131       | 14.5               | 11.2     | 72.5      |
| LSD 0.05 <sup>y</sup> |                 | NS             | NS             | NS        | NS              | NS        | NS      | 1,868       | 2.2                | NS       | 8.8       |

<sup>z</sup>Transplanted July 14 in 30' plots, rows 30" apart, 12" between plants. Mean of 3 replications.

<sup>y</sup>NS = not significant.

**Table 3. Observation notes from a broccoli yield trial, Corvallis, 2011.**

| Line          | Maturity (days) <sup>z</sup> | Head Ht (cm) | Plant Ht (cm) | Head Shape <sup>y</sup> | Bead Size <sup>x</sup> | Bead Color <sup>w</sup> | Stem color <sup>w</sup> | Exsertion <sup>w</sup> | Segmentation <sup>w</sup> | Uniformity <sup>w</sup> | Branching <sup>w</sup> | Overall <sup>w</sup> | Notes   |
|---------------|------------------------------|--------------|---------------|-------------------------|------------------------|-------------------------|-------------------------|------------------------|---------------------------|-------------------------|------------------------|----------------------|---|
| Arcadia       | 88                           | 45           | 71            | 6                       | F                      | 5                       | 5                       | 5                      | 5                         | 3                       | 5                      | 5                    |   |
| Emerald Pride | 81                           | 46           | 75            | 5                       | M                      | 3                       | 5                       | 5                      | 5                         | 3                       | 3                      | 5                    |   |
| Imperial      | 84                           | 33           | 76            | 4                       | F                      | 5                       | 5                       | 1                      | 3                         | 7                       | 1                      | 5                    |   |
| S411 x S457   | 84                           | 58           | 73            | 6                       | F                      | 7                       | 7                       | 7                      | 5                         | 5                       | 7                      | 7                    |   |
| S445 x S465   | 93                           | 60           | 65            | 5                       | F-M                    | 7                       | 7                       | 7                      | 7                         | 5                       | 3                      | 6                    |   |
| S446 x S454   | 84                           | 59           | 69            | 7                       | F                      | 6                       | 5                       | 7                      | 5                         | 3                       | 5                      | 6                    | Some late off-types.                                      |
| S454 x S458   | 88                           | 65           | 67            | 4                       | F                      | 7                       | 7                       | 8                      | 7                         | 1                       | 3                      | 3                    | About half the plants weren't heading at time of harvest. |
| S454 x S462   | 86                           | 57           | 56            | 5                       | M                      | 7                       | 7                       | 8                      | 7                         | 7                       | 5                      | 7                    |   |
| S454 x S463   | 86                           | 55           | 59            | 5                       | F                      | 8                       | 5                       | 6                      | 5                         | 6                       | 5                      | 7                    |   |
| S454 x S465   | 88                           | 45           | 58            | 5                       | F                      | 5                       | 7                       | 7                      | 7                         | 7                       | 3                      | 8                    |   |
| S456 x S446   | 88                           | 56           | 69            | 5                       | F                      | 7                       | 7                       | 6                      | 5                         | 7                       | 7                      | 3                    | Heavy downy mildew infection. Many lodged plants.         |
| S465 x S411   | 90                           | 59           | 64            | 5                       | F                      | 6                       | 7                       | 7                      | 7                         | 5                       | 5                      | 5                    |   |
| S465 x S446   | 91                           | 58           | 68            | 4                       | F                      | 7                       | 7                       | 7                      | 7                         | 6                       | 3                      | 8                    |   |

<sup>z</sup>Transplanted July 14 in 30' plots; rows 30" apart, 12' between plants.

<sup>y</sup>Scale of 1 - 9 where 1 = flat and 9 = extreme dome.

<sup>x</sup>F = fine; M = medium; C = coarse.

<sup>w</sup>Scale of 1-9 where 1 = poor and 9 = excellent.

**Table 4. Yield data (net T/A) from twelve years of broccoli yield trials, Corvallis, 2011<sup>z</sup>**

| Entry       | Tons/Acre |      |      |      |      |      |      |      |      |      |      |                   |
|-------------|-----------|------|------|------|------|------|------|------|------|------|------|-------------------|
|             | 2000      | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011              |
| S387 x S410 |           |      |      |      | 4.62 | 1.39 |      |      |      |      |      |                   |
| S387 x S411 |           |      |      |      | 2.45 |      |      |      |      |      |      |                   |
| S387 x S438 |           | 2.82 |      |      |      |      |      |      |      |      |      |                   |
| S387 x S445 |           |      | 3.79 |      |      |      |      |      |      |      |      |                   |
| S387 x S446 |           | 2.73 |      | 5.40 |      |      |      | 4.27 |      |      |      |                   |
| S387 x S454 | 3.83      | 4.14 | 5.67 | 6.40 | 3.34 |      | 1.32 | 4.17 | 2.21 | 2.06 |      |                   |
| S410 x S442 |           |      |      |      |      | 2.32 |      |      |      |      |      |                   |
| S410 x S445 |           |      | 3.87 |      |      |      |      |      |      |      |      |                   |
| S410 x S446 |           |      |      |      | 3.43 | 1.36 |      |      |      |      |      |                   |
| S410 x S447 |           |      |      |      |      | 1.46 |      |      |      |      |      |                   |
| S410 x S454 | 3.79      | 3.72 | 5.35 | 5.70 | 3.79 |      |      |      | 4.39 |      |      |                   |
| S410 x S456 |           |      |      |      |      |      |      |      | 2.61 |      |      |                   |
| S410 x S461 |           |      |      |      |      |      |      |      | 1.92 | 2.54 |      |                   |
| S411 x S445 |           |      | 3.58 |      |      |      |      |      |      |      |      |                   |
| S411 x S446 |           | 3.70 |      | 5.30 |      |      | 4.23 |      |      | 4.30 | 3.25 |                   |
| S411 x S447 |           |      |      |      |      |      |      |      |      | 3.18 |      |                   |
| S411 x S449 |           |      |      |      |      |      |      |      |      | 2.65 |      |                   |
| S411 x S454 | 3.49      | 3.96 | 3.30 |      | 2.72 |      | 4.22 |      |      |      |      |                   |
| S411 x S455 |           |      |      |      |      |      |      |      | 5.40 | 4.24 | 3.53 |                   |
| S411 x S457 |           |      |      |      |      |      |      |      |      |      | 3.48 | 3.40 <sup>y</sup> |
| S438 x S442 |           | 4.22 |      |      |      |      |      |      |      |      |      |                   |
| S440 x S446 |           |      |      | 5.10 |      |      |      |      |      |      |      |                   |
| S442 x S411 |           |      |      |      |      |      | 5.28 |      |      |      |      |                   |
| S442 x S454 |           | 3.65 |      |      | 3.92 |      | 3.65 |      |      |      |      |                   |
| S445 x S454 |           | 4.07 | 4.32 | 6.10 | 3.40 |      |      | 3.31 | 3.57 |      |      |                   |
| S445 x S456 |           |      |      |      |      |      |      |      | 3.23 |      |      |                   |
| S445 x S461 |           |      |      |      |      |      |      |      | 1.45 |      |      |                   |
| S445 x S465 |           |      |      |      |      |      |      |      |      |      |      | 2.41              |
| S446 x S454 |           |      |      | 3.70 | 4.83 |      | 3.68 | 4.07 | 2.80 | 3.56 | 2.05 | 3.09              |
| S446 x S455 |           |      |      |      |      |      |      |      |      |      | 3.93 |                   |
| S446 x S462 |           |      |      |      |      |      |      |      |      |      | 3.35 |                   |
| S447 x S410 |           |      |      |      |      |      | 4.29 |      |      |      |      |                   |
| S447 x S411 |           |      |      |      |      |      | 3.41 |      |      |      |      |                   |
| S447 x S454 |           |      |      |      | 2.31 | 2.24 |      | 4.16 | 1.70 | 2.42 |      |                   |
| S448 x S454 |           |      |      |      |      |      |      | 2.79 |      |      |      |                   |
| S449 x S454 |           |      |      |      |      |      |      | 4.30 | 4.19 | 3.45 |      |                   |
| S454 x S455 |           |      |      |      |      |      |      |      | 3.09 | 2.88 |      |                   |
| S454 x S456 |           |      |      |      |      |      |      |      | 3.10 |      | 2.75 |                   |
| S454 x S457 |           |      |      |      |      |      |      |      |      |      | 3.10 |                   |
| S454 x S458 |           |      |      |      |      |      |      |      |      | 2.24 |      | 2.60 <sup>y</sup> |
| S454 x S459 |           |      |      |      |      |      |      |      |      | 2.19 | 2.85 |                   |
| S454 x S462 |           |      |      |      |      |      |      |      |      | 2.04 |      | 2.21              |
| S454 x S463 |           |      |      |      |      |      |      |      |      |      |      | 3.45              |
| S454 x S465 |           |      |      |      |      |      |      |      |      |      |      | 3.30              |
| S456 x S446 |           |      |      |      |      |      |      |      |      |      |      | 3.80 <sup>y</sup> |
| S456 x S454 |           |      |      |      |      |      |      |      |      | 4.26 |      |                   |
| S459 x S446 |           |      |      |      |      |      |      |      |      | 2.32 |      |                   |
| S462 x S446 |           |      |      |      |      |      |      |      |      | 5.95 |      |                   |
| S465 x S411 |           |      |      |      |      |      |      |      |      |      |      | 3.60 <sup>y</sup> |

**Table 4. (continued)**

| Entry         | Tons/Acre |      |      |      |      |      |      |      |      |      |      |      |
|---------------|-----------|------|------|------|------|------|------|------|------|------|------|------|
|               | 2000      | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Arcadia       | 3.73      |      |      |      |      |      |      | 4.09 | 3.87 |      | 3.08 | 4.61 |
| Excelsior     | 2.43      | 3.78 | 4.97 | 3.90 | 3.43 | 2.25 | 4.45 |      |      |      |      |      |
| Legend        | 3.23      |      | 4.71 |      |      |      |      |      |      |      |      |      |
| Regal         | 3.95      | 3.63 |      | 5.30 | 4.17 | 3.30 | 3.62 | 5.21 |      |      |      |      |
| Emerald Pride |           |      |      | 3.40 | 4.54 | 4.32 | 3.91 | 4.23 |      | 3.17 | 3.50 | 3.27 |
| Imperial      |           |      |      |      |      |      |      |      |      | 3.94 | 3.98 | 4.78 |
| LSD 0.05      | 0.52      | 0.84 | 1.39 | 0.90 | 0.93 | 0.79 |      | 0.95 | 0.93 | 1.11 | 0.95 | 1.11 |

<sup>z</sup>Uneven number of plots in 2006 prevented calculation of an LSD.

<sup>y</sup>Entries consisted of three reps, instead of four, requiring the use of a different LSD (1.13) and comparison among only marked entries.

**Table 5. Broccoli observation trial, OSU inbreds, Corvallis, 2011.<sup>z</sup>**

| Inbred | Maturity (days) | Head Ht (cm) | Leaf Canopy Ht (cm) | Head Diam (cm) | Head Shape <sup>y</sup> | Stem Color <sup>x</sup> | Head Color <sup>x</sup> | Bead Size <sup>w</sup> | Head Exsertion <sup>x</sup> | Head Segmentation <sup>x</sup> | Plot Uniformity <sup>x</sup> | Branching <sup>x</sup> | Overall Score <sup>x</sup> | Notes <sup>v</sup>  |
|--------|-----------------|--------------|---------------------|----------------|-------------------------|-------------------------|-------------------------|------------------------|-----------------------------|--------------------------------|------------------------------|------------------------|----------------------------|---|
| S310   | 77              | 38           | 52                  | 13             | 6                       | 5                       | 5                       | C                      | 5                           | 1                              | 1                            | 5                      | 3                          | Variable head development.  |
| S315   | 77              | 40           | 63                  | 10             | 5                       | 3                       | 5                       | F                      | 3                           | 5                              | 5                            | 5                      | 3                          |   |
| S370   | 85              | 54           | 45                  | 12             | 4                       | 5                       | 5                       | C                      | 9                           | 5                              | 7                            | 7                      | 5                          |   |
| S387   | 85              | 55           | 60                  | 14             | 5                       | 5                       | 5                       | M                      | 8                           | 9                              | 5                            | 5                      | 5                          |   |
| S403   | 77              | 52           | 60                  | 9              | 8                       | 7                       | 7                       | C                      | 7                           | 5                              | 3                            | 5                      | 5                          |   |
| S410   | 77              | 40           | 36                  | 10             | 6                       | 7                       | 5                       | M                      | 8                           | 5                              | 7                            | 1                      | 7                          | Heads somewhat soft. Strong apical dominance. Good exsertion, small leaves. |
| S411   | 91              | 49           | 51                  | 14             | 4                       | 7                       | 7                       | F-M                    | 7                           | 7                              | 5                            | 5                      | 6                          |   |
| S437   | 77              | 42           | 49                  | 16             | 6                       | 3                       | 5                       | F-C                    | 7                           | 3                              | -                            | 1                      | 3                          | Head strongly rosetted. High occurrence of cat eye.                         |
| S438   | 85              | 47           | 40                  | 14             | 5                       | 5                       | 7                       | F-M                    | 9                           | 3                              | 5                            | 3                      | 6                          | Low vigor.  |
| S442   | 91              | 67           | 66                  | 14             | 7                       | 7                       | 7                       | F                      | 8                           | 9                              | 3                            | 3                      | 5                          | Leafy heads.  |
| S443   | 85              | 71           | 76                  | 11             | 7                       | 5                       | 7                       | F                      | 8                           | 5                              | 9                            | 3                      | 9                          | Heads slightly soft.  |
| S445   | 91              | 43           | 44                  | 11             | 6                       | 7                       | 8                       | F                      | 7                           | 9                              | 7                            | 3                      | 7                          |   |
| S446   | 91              | 43           | 55                  | 12             | 5                       | 7                       | 8                       | F                      | 7                           | 5                              | 3                            | 3                      | 7                          | Leafy heads, but evaluated early. Some leaning plts & curved stalks.        |
| S447   | 85              | 53           | 64                  | 11             | 6                       | 7                       | 7                       | F                      | 7                           | 7                              | 7                            | 3                      | 7                          | Some leafy heads. Head rot.   |
| S454   | 77              | 55           | 59                  | 10             | 6                       | 7                       | 7                       | F-M                    | 5                           | 5                              | 3                            | 3                      | 6                          |   |
| S457   | 85              | 44           | 48                  | 16             | 5                       | 5                       | 7                       | F                      | 7                           | 7                              | 3                            | 3                      | 5                          | Leafy heads.  |
| S458   | 85              | 47           | 57                  | 12             | 5                       | 5                       | 7                       | F                      | 5                           | 5                              | 7                            | 1                      | 7                          | Head rot present.   |
| S459   | 85              | 48           | 45                  | 13             | 7                       | 5                       | 7                       | F                      | 9                           | 9                              | 5                            | 1                      | 6                          | Slight head rot. Leaning plants.  |
| S460   | 91              | 54           | 56                  | 10             | 6                       | 7                       | 7                       | F-M                    | 7                           | 3                              | 5                            | 1                      | 6                          | Small heads. Some cat eye.  |
| S462   | 85              | 39           | 50                  | 14             | 4                       | 5                       | 7                       | F                      | 6                           | 7                              | 3                            | 5                      | 6                          | One early, coarse beaded off-type.  |
| S463   | 85              | 43           | 51                  | 12             | 6                       | 5                       | 7                       | F                      | 7                           | 5                              | 7                            | 3                      | 8                          | Some cat eye occurring as well as uneven bud development.                   |
| S465   | 91              | 63           | 69                  | 13             | 6                       | 7                       | 5                       | F-M                    | 8                           | 7                              | 7                            | 3                      | 7                          | Variable bead size in older heads.  |

<sup>z</sup>Planted July 8 in 30" rows, thinned to 12" apart.

<sup>y</sup>Scale of 1-9 where 1 = flat and 9 = extreme dome.

<sup>x</sup>Scale of 1-9 where 1 = poor and 9 = excellent.

<sup>w</sup>F = fine, M = medium, C = coarse.

<sup>v</sup>Cat eye: also called starring; when some beads prematurely break into yellow flower.



**Table 6. Broccoli observation trial, OSU hybrids and breeding lines, Corvallis, 2011.<sup>z</sup>**

| Hybrid      | Maturity (days) | Head Ht (cm) | Leaf Canopy Ht (cm) | Head Diam (cm) | Head Shape <sup>y</sup> | Stem Color <sup>x</sup> | Bead Color <sup>x</sup> | Bead Size <sup>w</sup> | Head Exsertion <sup>x</sup> | Head Segmentation <sup>x</sup> | Plot Uniformity <sup>x</sup> | Bran ching <sup>x</sup> | Over-all Score <sup>x</sup> | Notes   |
|-------------|-----------------|--------------|---------------------|----------------|-------------------------|-------------------------|-------------------------|------------------------|-----------------------------|--------------------------------|------------------------------|-------------------------|-----------------------------|---|
| S410 x S463 | 85              | 56           | 51                  | 12             | 8                       | 5                       | 5                       | F-M                    | 8                           | 7                              | 7                            | 5                       | 8                           |   |
| S411 x S446 | 85              | 74           | 74                  | 15             | 8                       | 5                       | 7                       | M                      | 9                           | 7                              | 7                            | 1                       | 9                           | Robust. Stands well. Downy mildew.                    |
| S411 x S456 | 85              | 72           | 68                  | 14             | 7                       | 7                       | 7                       | F-M                    | 9                           | 7                              | 7                            | 3                       | 8                           | Stands well. Slight downy mildew.                     |
| S411 x S460 | 85              | 70           | 67                  | 12             | 6                       | 5                       | 7                       | F                      | 8                           | 5                              | 9                            | 1                       | 9                           | Small heads.  |
| S411 x S462 | 85              | 73           | 75                  | 12             | 6                       | 5                       | 7                       | M                      | 8                           | 3                              | 3                            | 5                       | 5                           | Many leaning plants.                                  |
| S411 x S463 | 85              | 65           | 68                  | 14             | 7                       | 5                       | 5                       | M                      | 7                           | 5                              | 9                            | 3                       | 7                           | Head rot.   |
| S445 x S456 | 85              | 54           | 57                  | 15             | 4                       | 5                       | 7                       | F                      | 7                           | 9                              | 8                            | 5                       | 5                           | Variable bead development. Leafy heads.               |
| S445 x S457 | 85              | 56           | 50                  | 21             | 8                       | 5                       | 5                       | F-M                    | 8                           | 9                              | 8                            | 3                       | 6                           | Variable bead development.                            |
| S445 x S458 | 77              | 49           | 50                  | 16             | 6                       | 7                       | 5                       | M                      | 7                           | 7                              | 5                            | 3                       | 5                           | Head rot. Some lodging.                               |
| S445 x S460 | 85              | 75           | 69                  | 15             | 7                       | 5                       | 5                       | F                      | 8                           | 8                              | 8                            | 5                       | 6                           | Segregating height.                                   |
| S445 x S462 | 85              | 74           | 73                  | 14             | 6                       | 5                       | 7                       | F                      | 8                           | 8                              | 8                            | 3                       | 7                           | One tall leafy off-type.                              |
| S445 x S463 | 85              | 65           | 63                  | 15             | 4                       | 5                       | 7                       | F                      | 8                           | 9                              | 3                            | 3                       | 5                           | Head rot.   |
| S446 x S455 | 85              | 59           | 65                  | 14             | 7                       | 5                       | 7                       | F                      | 7                           | 7                              | 5                            | 3                       | 7                           | Head rot. Leafy heads.                                |
| S446 x S457 | 85              | 50           | 56                  | 14             | 6                       | 5                       | 7                       | F                      | 7                           | 7                              | 5                            | 1                       | 6                           | Head rot.   |
| S446 x S458 | 85              | 53           | 60                  | 15             | 7                       | 5                       | 7                       | F                      | 6                           | 8                              | 8                            | 1                       | 8                           | Head rot. Leafy heads.                                |
| S446 x S460 | 85              | 66           | 69                  | 16             | 5                       | 5                       | 7                       | F                      | 7                           | 7                              | 6                            | 1                       | 7                           | Leafy heads.  |
| S446 x S462 | 85              | 47           | 59                  | 14             | 5                       | 5                       | 7                       | F                      | 5                           | 8                              | 3                            | 5                       | 5                           | Leafy heads.  |
| S446 x S465 | 91              | 47           | 52                  | 12             | 5                       | 7                       | 7                       | F                      | 5                           | 5                              | 3                            | 5                       | 5                           | Very attractive plants. Some variability in bead dev. |

**Table 6. (continued)**

| Hybrid      | Maturity (days) | Head Ht (cm) | Leaf Canopy Ht (cm) | Head Diam (cm) | Head Shape <sup>y</sup> | Stem Color <sup>x</sup> | Bead Color <sup>x</sup> | Bead Size <sup>w</sup> | Head Exsertion <sup>x</sup> | Head Segmentation <sup>x</sup> | Plot Uniformity <sup>x</sup> | Bran ching <sup>x</sup> | Over-all Score <sup>x</sup> | Notes   |
|-------------|-----------------|--------------|---------------------|----------------|-------------------------|-------------------------|-------------------------|------------------------|-----------------------------|--------------------------------|------------------------------|-------------------------|-----------------------------|---|
| S454 x RS-2 | 77              | 72           | 63                  | 14             | 6                       | 7                       | 5                       | F-C                    | 8                           | 6                              | 1                            | 3                       | 8                           | Plot segregating for vigorous plants with strong exsertion w/ lax leaves around head. |
| S454 x RS-3 | 77              | 53           | 55                  | 12             | 7                       | 5                       | 7                       | F-M                    | 8                           | 5                              | 1                            | 1                       | 7                           |   |
| S463 x S446 | 91              | 59           | 66                  | 16             | 6                       | 5                       | 7                       | F                      | 7                           | 7                              | 5                            | 7                       | 8                           |   |

<sup>z</sup>Planted July 14 in 30" rows, thinned to 12" apart.

<sup>y</sup>Scale of 1-9 where 1 = flat and 9 = extreme dome.

<sup>x</sup>Scale of 1-9 where 1 = poor and 9 = excellent.

<sup>w</sup>F = fine, M = medium, C = coarse.

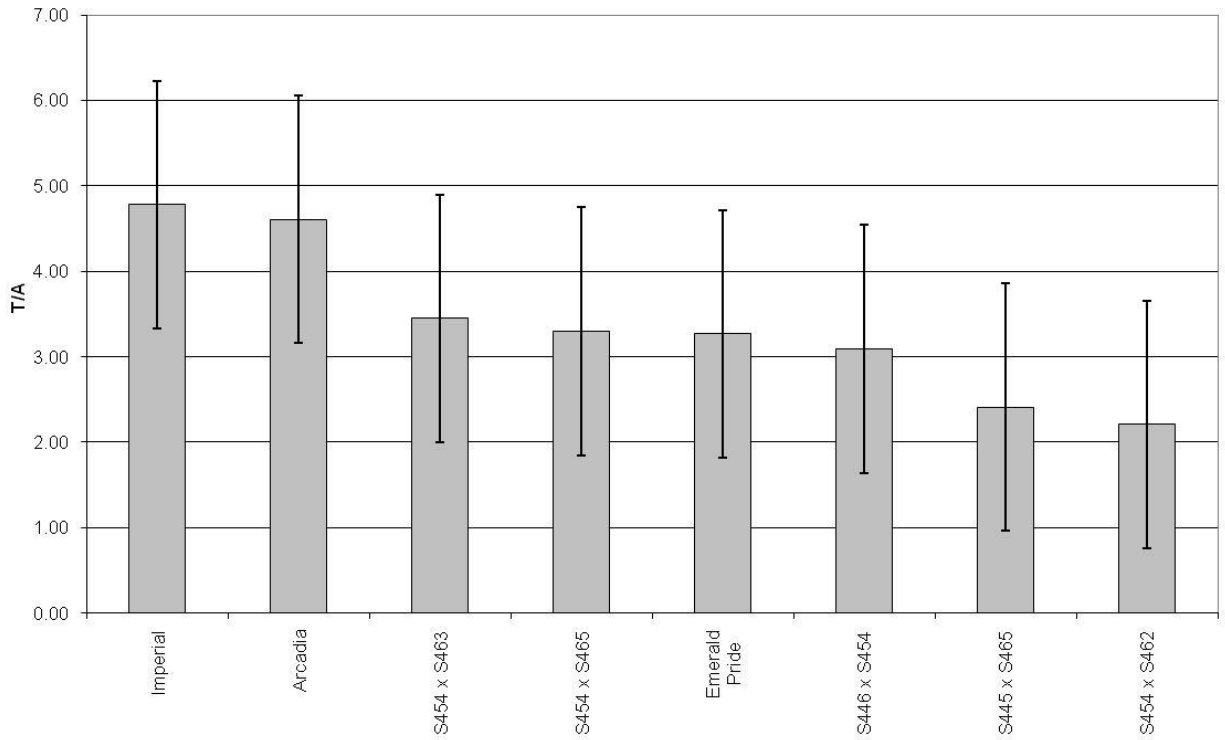
**Table 7. Inbred line combinations tested in 12 years of broccoli yield trials, Corvallis, 2011<sup>2</sup>.**

| Inbred Line | S4 10 | S4 11 | S4 38 | S4 42 | S4 43 | S4 45 | S4 46 | S4 47 | S4 49 | S4 53 | S4 54 | S4 55 | S4 56 | S4 57 | S4 58 | S4 59 | S4 60 | S4 61 | S4 62 | S4 63 | S4 65 | RS1-1-2-3 | RS-2 | RS-3 |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----------|------|------|
| S387        | 2     | 1     | 1     |       | 1     | 1     | 3     |       |       |       | 9     |       |       |       |       |       |       | 1     |       |       |       |           |      |      |
| S396        |       |       |       |       |       | 1     | 2     |       |       |       | 3     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S398        |       |       | 1     |       |       | 1     | 2     |       |       |       | 2     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S399        |       |       |       |       |       |       |       |       |       | 1     | 1     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S400        |       |       | 1     |       |       | 1     | 1     |       |       | 1     | 4     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S410        |       |       |       | 1     |       | 1     | 2     | 2     |       | 1     | 6     |       | 1     |       |       |       |       | 1     |       |       | 1     |           |      |      |
| S411        |       |       |       | 2     |       | 1     | 6     | 2     | 1     | 1     | 5     | 3     | 2     | 2     | 1     | 1     | 2     |       |       | 2     | 1     |           |      |      |
| S438        |       |       |       | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S440        |       |       |       |       |       |       | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S442        |       |       |       |       |       |       |       |       |       |       | 3     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S443        |       |       |       |       |       |       |       |       |       |       | 1     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S445        |       |       |       |       |       |       |       |       |       |       | 5     |       | 2     | 1     | 1     |       | 1     | 1     | 1     | 1     | 1     |           |      |      |
| S446        |       |       |       |       |       |       |       |       |       |       | 7     | 3     | 1     | 2     | 2     | 1     | 2     |       |       | 3     |       | 1         | 1    |      |
| S447        |       |       |       |       |       |       |       |       |       |       | 5     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S448        |       |       |       |       |       |       |       |       |       |       | 1     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S449        |       |       |       |       |       |       |       |       |       |       | 3     |       |       |       |       |       |       |       |       |       |       |           |      |      |
| S454        |       |       |       |       |       |       |       |       |       |       |       | 2     | 3     | 2     | 1     | 2     | 1     |       |       | 1     |       |           | 1    | 1    |
| S463        |       |       |       |       |       |       | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |           |      |      |

**Table 8. Seed set on broccoli CMS lines using three fertile inbreds as pollen donors in the spring 2011 greenhouse using blue bottle flies as a pollen vector.**

| <b>CMS (female) line</b> | <b>Pollen donor</b> | <b>Seed set</b> | <b>Pollen donor</b> | <b>Seed set</b> |
|--------------------------|---------------------|-----------------|---------------------|-----------------|
| CMS 13-1 (454)           | S454                | None            | S445                | Moderate        |
| AN24-3A-1 x S454-1       |                     | Many            |                     | Few             |
| AN25-1A-1 x S454-1       |                     | Moderate        |                     | Few             |
| AN251B-1 x S454-1        |                     | Moderate        |                     | Few             |
| AN25-4B-1-1 x S454-1     |                     | Many            |                     | Few             |
| AN25-4B-2 x S454-1       |                     | Few             |                     | Few             |
| AN25-4B-2 x S454-2       |                     | None            |                     | None            |
| AN21-3A-1 x S445-1       | S445                | None            | S411                | None            |
| AN24-3B-1 x S445-1       |                     | Many            |                     | Many            |
| AN25-4B-1 x S445-1       |                     | None            |                     | Moderate        |
| AN27-1B-1 x S445-1       |                     | Few             |                     | Few             |
| AN25-4B-2 x S445-1       |                     | None            |                     | Many            |
| CMS 14-1 (411)           | S411                | None            | S410                | None            |
| AN24-1A-2 x S411-1       |                     | None            |                     | None            |
| AN25-1A-1 x S411-1       |                     | None            |                     | None            |
| AN25-1B-1 x S411-1       |                     | None            |                     | Many            |
| AN25-4B-2 x S411-1       |                     | Many            |                     | None            |
| AN25-4B-2 x S411-2       |                     | None            |                     | None            |

**Figure 1. Broccoli Yield Trial Net Tons/Acre, 4 Replications, 2011**



**Figure 2. Broccoli Yield Trial Net Tons/Acre, 3 Replications, 2011**

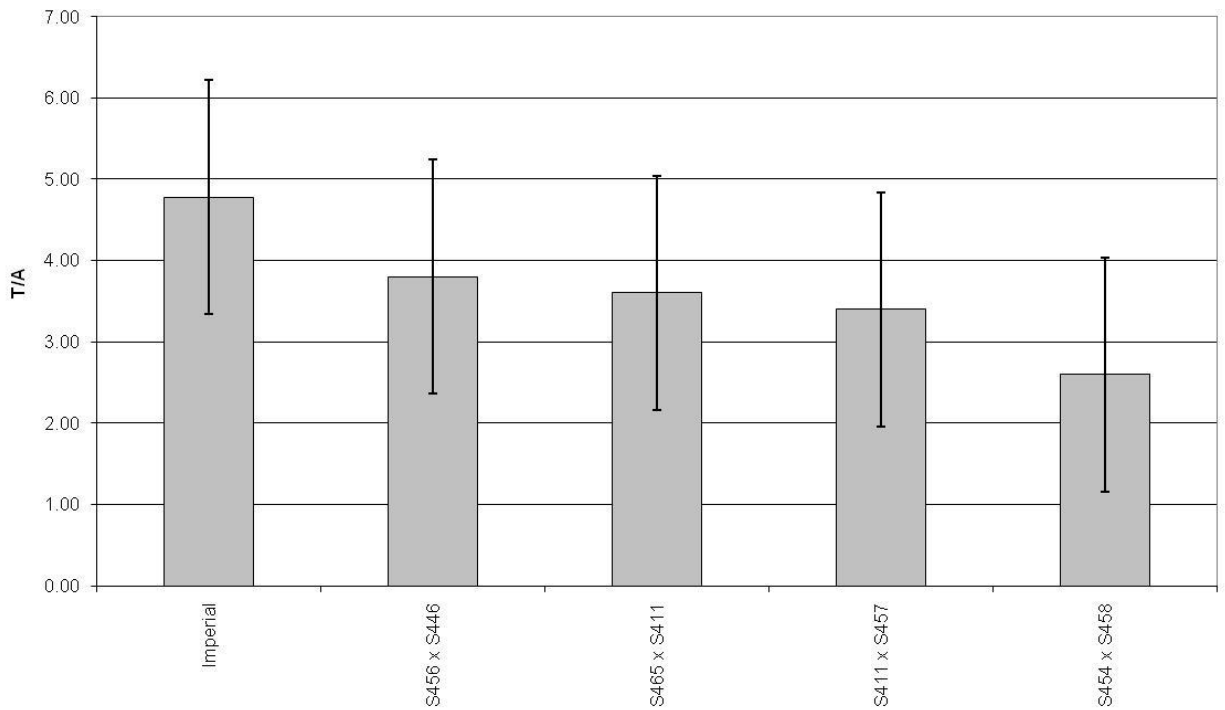


Figure 3. Plant and Head Heights, Broccoli Trial, 2011

