FINAL REPORT

2009-2010 Storage Cabbage Variety Evaluation

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VARIETIES:

Seventeen storage cabbage varieties were evaluated from five seed companies (Table 1). Amtrak, Huron and Rona were used as industry standards. Brutus, the variety planted in the field where the trial was hosted, was also evaluated. Seven of the submitted varieties are new, with five being numbered varieties.

Table 1. Storage cabbage varieties in approximate order of maturity: Kendall, NY, 2009-2010.

	Market Class	YR[1]	Seed Source	Days to Maturity	Plant Spacing	Years in Trial
Green Box Types:						
Reaction	Green, small box	Yes	Bejo	100	14"	2007, 2009
Candella	Green, small box	No	Bejo	110	14"	2005, 2007, 2009
Princeton	Green, small box	Yes	Reeds	118	14"	2005, 2009
BC06146	Green, small box	Yes	Reeds	120-125	14"	2007, 2009
Green Amtrak Types:						
04-203B	Green	Yes	Takii	100	17"	2009
B2791	Green	Yes	Bejo	102	17"	2009
Brutus- *grower std*	Green	No	Bejo	103	17"	2009
Seradox	Green	Yes	Bejo	105	17"	2009
B2792	Green	Yes	Bejo	107	17"	2009
Novator	Green	Yes	Syngenta	110	17"	2007, 2009
Constellation	Green	Yes	Seminis	112	17"	2005, 2007, 2009
Huron- *standard*	Green, standard	Yes	Seminis	115	17"	2001, 2005, 2007, 2009
Amtrak- *standard*	Green, standard	Yes	Bejo	115	17"	2001, 2005, 2007, 2009
07-666A	Green	Yes	Takii	120	17"	2009
Red Types:						
Rona- *standard*	Red, standard	No	Seminis	115	17"	2005, 2007, 2009
Red Box Types:						
SuperRed 115	Red, small box	Yes	Reeds	115	14"	2005, 2009
Caballero	Red, small box	No	Bejo	115	14"	2009

[1]**YR**: Fusarium Yellows Resistant. **Planting Date:** June 29. **Row Spacing:** 30 inches.

PROCEDURES:

Transplant Production. Seeds were seeded into 72-cell trays in Cornell's soil-less potting mix on May 19 and grown in a greenhouse at the NYSAES, Geneva. About once every week they were fertilized with 15-3-17 NPK soluble Peters Mix. Plants were taken outside to harden off on June 19 at which time no further fertilizer was added until 2 days before transplanting. When plants were 2-5 true leaves (4-5 inches tall), they were transplanted by hand into ample soil moisture on June 29, 2009.

Experimental Design. The trial was located in a grower's (Dean Brightly) cabbage (cv. Brutus) field near Kendall, NY in Orleans County and was arranged as a complete randomized design with 17 varieties and 3 replicates. Each replicate consisted of a single row of 30 plants spaced 17" apart with 30" between rows. BC06146, Candella, Princeton, Reaction, Caballero and Super Red 115 were planted with 14" plant spacing for a box market. Fertility and pest management was maintained by the grower.

Field Information. The soil pH was 6.7. Crop rotation included 20 years out of crucifers and the field was previously a peach orchard. Fertilizer application included 600#/A 12-18-25 NPK broadcast incorporated and 30 gal/A 32% N side-dressed 4 weeks after planting. Weed control consisted of 1qt/A Treflan and 0.33 pt Dual Magnum pre-plant incorporated, and 4 oz/A Stinger post-emergence. Chlorothalonil was applied once for management of Alternaria leaf spot. Spintor, Assail, Lannate LV and Leverage 2.7 were applied once and Warrior applied three times during the season for control of insect pests. Soil conditions were considered to be generally wet and the trial was never irrigated.

Harvest Evaluation. All varieties were harvested on October 27 and 29, 2009. First, a field evaluation was conducted to evaluate plant size, uniformity and growth characteristics, and to note splits, rots, off-types and, disease and insect pressure. In the 2 best replicates, the best 25 heads were harvested. Of these, 5 were cut, peeled and evaluated for thrips damage, including severity on a scale of 0 to 5 with 0 having no damage, 3 being the maximum commercially acceptable and 5 being very bad, and depth of layers damaged. The remaining 20 heads were divided into two groups of 10 and weighed separately. Each field replicate transferred into a replicate in storage. One group went into cold (refrigerated) storage and the other into common storage. Cabbage heads were stored in quartered 1 ton cabbage boxes with the different varieties separated by snow fence. Both storages were commercial stores and maintained by Martin Farms in Brockport, NY.

Storage Evaluation. The cabbage was removed from common storage after 15 weeks on February 11, 2010 and from cold storage after 26 weeks on April 28, 2010. It was weighed to determine shrink loss, trimmed and then weighed again to determine trim loss. A sub-sample of 5 heads were cut in half an inspected for internal disorders, and the amount of green color remaining after trimming was measured.

Data Analysis: Statistical differences among entries was determined by General Analysis of Variance (ANOVA) with mean separation by Fisher's Protected LSD test, $p = 0.05$.

2009-2010 Season. The 2009 growing season was cloudy, cool and wet with normal temperatures returning in August, September and November. The trial was planted into ample moisture following decent rainfall and was then subjected to above average rainfall for the month of July. Average temperatures in nearby Waterport for July, August, September and October were 67.4, 70.2, 61.6 and 48.5 ˚F. Similarly, maximum temperatures were 84.5, 91.2, 84.9 and 67.2 ˚F, and minimum temperatures were 51.1, 48.5, 39.2 and 28.4 ˚F. Approximate seasonal rainfall at the trial was 4.7", 2.8", 1.4" and 2.5" for July, August, September and October, respectively. Insect and disease pressure in this trial was low to moderate. Ambient outdoor temperatures during storage were normal in January and February, cooler than normal in December and extremely mild in March and April with temperatures in the 80s in early April.

FIELD RESULTS (Table 2):

Plant Characteristics: *Plant size* – B2792, Novator, Constellation, Amtrak, and Brutus all had large plants and were the largest in the trial, while Reaction had the smallest plant size (small-medium). Plant size varied for Princeton from small-medium to very large. *Uniformity* – 04-203B had excellent uniformity and was the most uniform entry in the trial followed by Reaction and Caballero which had excellent to very good uniformity, while Super Red 115 was the least uniform (very good to good). *Growth habit* – Reaction had the most upright growth habit in the trial, followed by 04-203B and Caballero, which were upright to slightly tipped. Huron and Amtrak had the least upright plant growth in the trial and were slightly tipped.

Off-Types: Overall there were very few off types and unmarketable heads in the trial. *Small Heads* – heads that were less than half the size of the majority per variety were recorded as small off-types, but were included in marketable yield. Novator and 04-203B were the only two varieties in the trial with no abnormally small off-types. Huron had the most abnormally small heads (6.4%), followed by 07-666A (5.7%), SuperRed115 (4.6%), BC06146 (4.3%) and Rona (3.7%). *Unmarketable Heads* – consisted of multiple heads per plant and other strange growth habits of wrapper leaves, not smalls. Reaction, B2792, Constellation, 04-203B, 07-666A, and Brutus all had no off-types. Rona had the highest incidence of off-types (2.9%) followed by Novator (2.6%), and then Huron (2.4%). *Head splits and Rots* – There were no rots or head splits in the trial at harvest.

Maturity: All varieties were harvested on the same date and with different days to maturity and plant spacings, not all varieties were necessarily harvested at their optimum maturity. Sometimes when varieties are harvested when they are over-mature, they do not store as well. The trial was planted on the same day as the grower's cabbage field and was harvested a few days before harvest of the field cabbage began. Using split cores as an indication of maturity, the trial average was 10.6%, with Brutus, Novator, Constellation, 07-666A and Rona having no split cores at harvest. The highest proportion of split cores occurred in B2792 (32.5%), Reaction (30%) and Seradox (28.8%) with Super Red 115 (24.2%) and Caballero (12.5%) having above the trial average incidence of split cores. Incidence of spilt cores was generally higher in the box types with the narrower 14" plant spacing, and in varieties that matured in 105 days or less.

Yield: *Head size* – was measured in pounds per head. B2792 (8.3 lb) had the largest head size in the trial, which was statistically the same as 04-203B (8.1 lb), Seradox (7.5 lb), Amtrak (7.4 lb) and Huron (6.4 lb). Caballero (3.4 lb) had the smallest head size in the trial, followed by Princeton (4.2 lb) and BC06146 (4.2 lb). Of the small box type varieties, Candella (5.0 lb) and SuperRed 115 (5.1 lb) had the largest head weight. *Estimated marketable yield* – was based on weight of 20 heads per replicate, corrected for unmarketable off-types. B2792 (925 cwt/A) had the highest marketable yield in the trial, which was statistically the same as 04-203B (896 cwt/A), Seradox (828 cwt/A) and Amtrak (808 cwt/A). Caballaro (398 cwt/A) and Rona (457 cwt/A) had the lowest marketable yields in the trial.

Insect damage: *Onion thrips* – Thrips damage was relatively low throughout the trial, but all varieties had some level of damage. Huron had the least thrips damage with 0.2 layers affected and a severity rating of 0.01 out of 5.0. Brutus, BC06146 and Rona all had less than 1 layer of thrips damage, and Brutus and Rona had a severity rating less than 0.1. Highest thrips damage occurred in 07-666A (depth: 4.4; severity: 0.5 out of 5.0) and Super Red 115 (depth: 3.9; severity: 0.6 out of 5.0), followed by Candella (depth: 3.8; severity: 0.4) and Novator (depth: 2.0; severity: 0.8 out of 5.0).

STORAGE RESULTS (Table 3):

Storability: In general, total loss, final head weight and greenness were very similar when the varieties came out after 15 weeks in common storage and after 26 weeks in cold storage. Shrink loss and amount of unmarketable heads were higher out of common storage while trim loss was higher out of cold storage.

Shrink loss – differences in shrink loss were not significant. Out of common storage, Novator (13.2%) had the lowest shrink loss, which was closely followed by Huron (13.3%) and 07-666A (13.4%), while Caballero (18.0%) had the highest shrink loss. Out of cold storage, B2792 (6.6%) had the lowest shrink loss, which was closely followed by Seradox (6.8%), while Caballero (10.1%) had the highest shrink loss. In general, shrink loss was higher in the small box types than in the bigger Amtrak types.

Trim loss – Although no significant differences in trim loss occurred out of storage, Rona (6.3%) had the lowest, while Super Red 115 (12.4%) and Princeton (12.2%) had the highest trim loss. Out of cold storage, Rona (10.7%) had the lowest trim loss, which was only significantly lower than the varieties that had the highest trim loss, including BC06146 (24.7%), Candella (22.6%) and Constellation (21.6%).

Unmarketable heads – there were very few unmarketable heads due to rot in this trial and no significant differences occurred among varieties. Serodox had 10% unmarketable rotten heads out of common storage, Candella had 5% rotten heads each out of common and cold storage, Brutus, Huron and Super Red 115 had 5% rotten heads out of common storage, and Reaction had 5% rotten heads out of cold storage.

Total loss – differences in total loss were not significant. Out of common storage, Rona had the lowest total loss (20.9%) followed by 04-203B (21.7%) and Novator (21.8%), while Super Red 115 (29.0%) had the highest total loss. Out of cold storage, B2792 (19.5%) had the lowest total loss followed by Rona (20.2%) and 04-203B (20.2%), while BC06146 (34.4%) had the highest total loss. In general, the small green box types had higher total losses than the other types.

Final head weight – significant differences occurred among varieties out of common and cold storage. Out of common storage, 04-203B (6.5 lb) had the largest head weight, which was not significantly different than B2792 (6.0 lb), Seradox (5.8 lb), Amtrak (5.4 lb) and Novator (4.8 lb). Caballero (2.6 lb) had the smallest heads, which were not significantly different than all of the small box entries and Constellation. Out of cold storage, B2792 (7.1 lb) had the largest head weight, which was significantly the same as 04-203B (6.4 lb), Amtrak (6.0 lb), Seradox (5.8 lb) and Huron (5.3 lb). Caballero (2.6 lb) had the smallest head weight, which was not significantly different from all of the small box entries and Constellation.

Greenness – measured by millimeters of green leaves on cut head after trimming. Out of common storage, 07-666A (7.2 mm) had the greenest color, which was statistically the same as Brutus (6.9 mm), Huron (6.2 mm), Novator (4.0 mm) and Amtrak (5.9 mm), while 04-203B (1.5 mm) had significantly the least green color of all of the varieties in the trial. Out of cold storage, Novator (7.9 mm) and B2792 (7.8 mm) were the greenest heads, while BC06146 (1.1 mm) had the least green color.

Physiological disorders: Very few physiological disorders were observed in this trial. Super Red 115 had 50% cavity spot (tiny pitted black spots) out of each common and cold storage.

SCHEMATIC DIAGRAM OF RELATIVE STORABILITY (Figure 1):

Figure 1 is a schematic diagram that illustrates the relative head size of varieties coming out of the field (dark green or red) compared to coming out of 15 weeks in common storage (light green or pink) and 26 weeks in cold storage (yellow or purple). The head diameter is scaled according to average head size in pounds.

Small green box types – Candella and BC06146 stored slightly better in common storage as indicated by the light green circles being bigger, while Reaction and Princeton stored slightly better in long term cold storage (yellow circles are bigger). All varieties had very similar storability as indicated by similar differences in circle size between the field (dark green) and out of storage.

Green Amtrak types – with exception of 04-203B and Constellation, all varieties stored better in long-term cold storage compared to common (yellow circles are bigger). All varieties had relatively similar storability. Huron and Amtrak appear to be most suited for long-term cold storage than for common storage, because there is more difference in circle size between the yellow and light green circles compared to other varieties. Constellation is the least suited for long term cold storage.

Reds – Super Red 115 planted with narrow 14" plant spacing was larger than Rona planted at standard plant spacing. Rona and Super Red 115 stored slightly better in common storage than they did in long term

cold storage (pink circles are bigger than purple circles), while Cabellero stored well in both (pink and purple circles same size). Rona appeared to be less suitable for long-term storage compared to the other red varieties.

VARIETY SUMMARIES:

Rank Score: For each trait/variable (i.e. head size, % shrink, yield, etc.), except plant size, split cores, and greenness of red varieties, the entries were ranked from best (=1) to worst (=17) (data not shown). The rank scores for all of the variables for each of the field, common and cold storage evaluations are added up separately, and then totaled for a total rank score (= field + common + cold, data not shown). Low rank scores indicate that a variety is performing very well across several traits/variables. **The trial average rank score for field + common + cold is 51 + 40 + 40 = 131.**

Ratings:
☻ ☻ ☻ ☻ ☻ - perfect; ☻ ☻ ☻ ☻ - very good; ☻ ☻ ☻ - average; ☻ ☻ - below average; ☻ - unacceptable.

Green Box Types (14 inch plant spacing):

Reaction (Bejo). ☻ ☻ ☻½ Green, 100 days to maturity, 14" plant spacing, YR. Small to medium plant size with excellent to very good plant uniformity (2nd best in trial) and most upright growth habit in the trial. Below average off-types (2.3%) due to abnormally small heads, but no unmarketable heads. Most mature variety in the trial at harvest with 30% split cores. Second largest head size (4.4 lb) and estimated marketable yield (527 cwt/A) out of the field in green box category. Above average thrips damage at harvest (depth: 2.6; severity: 0.4 out of 5.0, 3rd worst in trial). Nice solid heads, cores are a bit wide, some air spaces beside base. Out of common storage, one of highest shrink losses (17.1%, 2nd worst in trial) in the trial, but lowest trim loss (10%) of green box types with above average total loss (27%) and no rots. Out of cold storage, second lowest shrink loss (9.1%), lowest trim loss (16.9%) and lowest total loss (26%) of green box types with 5% rots. Second largest head size out of common (3.3 lb) and cold (3.5 lb) storage of green box types. Below trial average green color out of both storage types. **Rank Score (field + common + cold): 49+59+57 = 165 (1st out of box types, 12th in trial).**

Candella (Bejo). ☻ ☻½ Green, 110 days to maturity, 14" plant spacing, not YR. Large to medium plant size (3rd largest in trial) with very good plant uniformity and upright to slightly-tipped growth habit. Below average off-types due to abnormally small (1.1%) and unmarketable (1.1%) heads. At harvest, 10% of the heads had split cores. Largest head size (5.0 lb) and estimated marketable yield (587 cwt/A) out of the field in green box category. Above average thrips damage at harvest (depth: 3.8; severity: 0.4 out of 5.0, 2nd worst in trial). Solid heads, cores are a bit wide, some air spaces beside base, size not uniform. Out of common storage, one of highest shrink losses (16.9%, 3rd worst in trial) in the trial, above average trim loss (10.1%), above average total loss (27%) and 5% rots. Out of cold storage, above average shrink loss (9.3%), trim loss (22.6%, 2nd highest in trial) due to thrips, and total loss (31.8%, 3rd worst in trial) with 5% rot. Largest head size out of common (3.8 lb) and cold (3.6 lb) storage of green box types. Below trial average green color out of both storage types, least green color of green box types. Not as suitable for long term storage. **Rank Score (field + common + cold): 56+60+63 = 179 (3rd out of box types, 14th in trial).**

Princeton (Reeds). ☻ ☻ ☻½ Green, 118 days to maturity, 14" plant spacing, YR. Variable plant size ranging from small-medium to very large with very good plant uniformity and upright to slightly-tipped growth habit (4th best in trial). Below average off-types due to abnormally small heads (1.1%) and 1.1% unmarketable heads. At harvest, 7.5% of the heads had split cores, although it looked like it was not quite ready. Smallest head size (4.2 lb, 2nd smallest in trial) and estimated marketable yield (489 cwt/A, 4th smallest in trial) out of the field in green box category. Below average thrips damage at harvest (depth: 1.0; severity: 0.3 out of 5.0). Heads

looked good, although size was variable. Out of common storage, of green box types, lowest shrink loss (15.7%) and highest trim loss (12.2%, 2nd highest in trial) and total loss (27.9%, 2nd worst in trial), and no rot. Out of cold storage, lowest shrink loss (8.6%), second lowest trim loss (17%) and lowest total loss (25.7%) of green box types, and no rot. Of green box types, smallest and second smallest head size out of common (3.1 lb, 2nd smallest in trial) and cold (3.2 lb) storage, respectively. Below trial average green color out of common storage, and above average green color out of cold storage. Best suited for long term storage of green box types. **Rank Score (field + common + cold): 56+63+54 = 173 (2nd out of box types, 13th in trial).**

BC06146 (Reeds). ☻ ☻½ Green, 120-125 days to maturity, 14" plant spacing, YR. Large plant size with very good plant uniformity and upright to slightly-tipped growth habit. Above average off-types due to abnormally small (4.3%) and unmarketable (1.1%) heads. At harvest, 2.5% of the heads had split cores, although it looked like it was not quite ready. Smallest head size (4.2 lb, 2nd smallest in trial) and second smallest estimated marketable yield (496 cwt/A, 2nd smallest in trial) out of the field in green box category. Below average thrips damage at harvest (depth: 0.6; severity: 0.2 out of 5.0, 4th best in trial). Nice solid heads, cores a bit wide with air spaces beside core. Out of common storage, second lowest shrink loss (16.2%) of green box types, second highest trim loss (11.3%, 3rd worst in trial) of green box types, above average total loss (27.5%, 3rd worst in trial) and no rot. Out of cold storage, of green box types, highest shrink loss (9.7%, 2nd worst in trial), trim loss (24.7%, worst in trial) and total loss (34.47%, worst in trial) with no rots. Of green box types, second smallest and smallest head size out of common (3.2 lb, 3rd smallest in trial) and cold (2.9 lb, 2nd smallest in trial) storage, respectively. Below trial average green color out of common and cold (worst in trial) storage. Heads looked yellow, especially above the core out of cold storage. Not suited well for long term storage. **Rank Score (field + common + cold): 58+59+74 = 191 (4th out of box types, last in trial).**

Green Amtrak Types (18" plant spacing):

04-203B (Takii). ☻ ☻ ☻½ **(short term storage only)** Green, 100 days to maturity, YR. Medium large plant size with excellent plant uniformity (best in the trial) and upright to slightly-tipped growth habit (2nd best in trial). Only variety in the trial that had no off-types of any kind. At harvest, 10% of the heads had split cores. Second largest head size (8.1 lb) and estimated marketable yield (896 cwt/A) in the trial out of the field. Below average thrips damage at harvest (depth: 1.4; severity: 0.1 out of 5.0). Out of common storage, below average shrink loss (14.0%, 4th best in trial), trim loss (7.7%, 4th best in trial) and total loss (21.7%, 2nd best in trial) with no rot. Out of cold storage, below average shrink loss (7.3%, 4th best in trial), trim loss (12.8%, 3rd best in trial) and total loss (20.2%, 2nd best in trial) with no rots. Largest and second largest head size out of common (6.5 lb, 1st in trial) and cold (6.4 lb, 2nd best in trial) storage. Least green (i.e. most yellow) heads out of common and cold (2nd least green) storage. Heads looked yellow, especially above the core out of storage, had thick leaves and some were odd shaped. Despite high yields and reduced weight loss out of storage, this variety did not look like it stored well, and would be better for short-term storage. **Rank Score (field + common + cold): 20+26+23 = 69 (1st in trial).**

B2791 (Bejo). ☻ ☻ ☻½ Green, 102 days to maturity, YR. Medium plant size with very good plant uniformity and upright to slightly-tipped growth habit. Below average abnormally small off-types (1.3%) and above average (2%) unmarketable off-types. At harvest, 5.6% of the heads had split cores. Average head size (5.9 lb) and estimated marketable yield (638 cwt/A) out of the field. Below average thrips damage at harvest (depth: 1.4; severity: 0.1 out of 5.0). Out of common storage, average shrink loss (15.2%), below average trim loss (8.8%) with below average total loss (24%) and no rot. Out of cold storage, average shrink loss (8.0%), below average trim loss (13.2, 5th best in trial) and below average total loss (21.2%, 3rd best in trial) with no rots. Average head size out of common (4.5 lb) and cold (4.7 lb) storage. Average green color out of common and cold storage. Looks good, some heads have air spaces beside the core. **Rank Score (field + common + cold): 53+35+31 = 119 (6th in trial).**

Brutus (Bejo). ☻ ☻ ☻½ Green, 103 days to maturity, not YR. One of largest plant sizes in the trial with very good to excellent plant uniformity (4th best in trial) and slightly-tipped to upright growth habit. Below average abnormally small off-types (2.2%) and no unmarketable off-types. At harvest, none of the heads had split cores. Average head size (5.8 lb) and estimated marketable yield (647 cwt/A) out of the field. Below average thrips damage at harvest (depth: 0.4 ; severity: 0.02 out of 5.0; 2nd best in trial). Out of common storage, above average shrink loss (16.4%), below average trim loss (7.6%) with below average total loss (24%) and 5% rot. Out of cold storage, below average shrink loss (7.8 %), above average trim loss (16.5%) and average total loss (24.3 %) with no rots. Average head size out of common (4.4 lb) and cold (4.5 lb) storage. Above average green color out of common (2nd best in trial) and cold storage. Looks good, some heads are flat. **Rank Score (field + common + cold): 39+32+40 = 111 (4th in trial).**

Seradox (Bejo). ☻ ☻ ☻½ Green, 105 days to maturity, YR. One of largest plant sizes in the trial with very good to excellent plant uniformity and slightly-tipped to upright growth habit. Below average abnormally small off-types (1.3%) and average unmarketable off-types. At harvest, 28.8% of the heads had split cores. Third best head size (7.5 lb) and estimated marketable yield (828 cwt/A) out of the field. Above average thrips damage at harvest (depth: 2.8; severity: 0.2 out of 5.0). Out of common storage, above average shrink loss (16.6%), average trim loss (9.3%) due to thrips and total loss (25.9%), and 10% rot. Out of cold storage, below average shrink loss (6.8 %, 2nd best in trial), above average trim loss (16.6%) and below average total loss (23.4 %) with no rots. Above average head size out of common (5.8 lb, 3rd best in trial) and cold (5.8 lb, 4th best in trial) storage. Below average and average green color out of common and cold storage, respectively. Nice round heads. **Rank Score (field + common + cold): 42+49+34 = 125 (9th in trial).**

B2792 (Bejo). ☻ ☻ ☻ ☻½ Green, 107 days to maturity, YR. One of largest plant sizes in the trial with very good plant uniformity and upright to slightly-tipped growth habit (3rd best in trial). Average abnormally small off-types (2.6%) and no unmarketable off-types. At harvest, 32.5% of the heads had split cores, but it did not look over-mature. Largest head size (8.3 lb) and estimated marketable yield (925 cwt/A) out of the field. Average thrips damage at harvest (depth: 1.7; severity: 0.2 out of 5.0). Out of common storage, above average shrink loss (16.7%), below average trim loss (8.7%) with average total loss (25.4%) and no rot. Out of cold storage, lowest shrink loss (6.6 %, best in trial) and total loss (19.5%, best in trial) and below average trim loss (12.9%, 4th best in trial) with no rots. Second largest and largest head size out of common (6.0 lb, 2nd best in trial) and cold (7.1 lb, best in trial) storage. Below average and second best green color out of common and cold storage, respectively. Nice round heads, looks good. This variety does well in long term storage. **Rank Score (field + common + cold): 33+39+10 = 82 (2nd best in trial).**

Novator (Syngenta). ☻ ☻ ☻½ Green, 110 days to maturity, YR. One of largest plant sizes in the trial with very good to excellent plant uniformity and upright to slightly-tipped growth habit. One of two varieties that had no abnormally small off-types, but had 2.6% unmarketable off-types. At harvest, no heads had split cores. Above average head size (6.3 lb) and estimated marketable yield (683 cwt/A) out of the field. Above average thrips damage at harvest (depth: 2.0; severity: 0.8 out of 5.0, 2nd worst in trial). Out of common storage, lowest shrink loss (13.2%, best in trial) in the trial, below average trim loss (8.7%) and total loss (21.8%), and no rot. Out of cold storage, below average shrink loss (7.3 %, 4th best in trial), above average trim loss (16.1%) and below average total loss (23.4%) with no rots. Above average and below average head size out of common (4.8 lb, 5th best in trial) and cold (5.1 lb) storage, respectively. Above average green color out of common (4th best in trial) and cold (best in trial) storage, respectively. Stores well in common storage and stays green in long-term storage. Heads are course at the base. **Rank Score (field + common + cold): 54+19+30 = 103 (3rd best in trial).**

Constellation (Seminis). ☻ ☻ ½ Green, 112 days to maturity, YR. One of largest plant sizes in the trial with very good plant uniformity and slightly-tipped to upright growth habit. Average amount of abnormally small off-types (2.5%) and no unmarketable off-types. At harvest, no heads had split cores, looked like it might be

slightly immature. Below average head size (5.2 lb) and estimated marketable yield (575 cwt/A, smallest of Amtrak types) out of the field. Below average thrips damage at harvest (depth: 1.2; severity: 0.1 out of 5.0). Out of common storage, below average shrink loss (14.4%, 5th best in trial), average trim loss (9.3%) and below average total loss (23.7%), and no rot. Out of cold storage, above average shrink loss (9.5%, highest in Amtrak types), trim loss (21.6%, highest in Amtrak types) and total loss (31.9%, highest in Amtrak types and 2nd highest in trial) with no rots. Smallest head size of Amtrak types out of common (4.1 lb) and cold (3.7 lb) storage. Average green color out of common and cold storage, respectively. Stores well in common storage and stays green in long-term storage. Large air spaces beside core. Did not store well in long term storage, perhaps was immature? **Rank Score (field + common + cold): 57+33+59 = 149 (11th in trial).**

Huron (Seminis). ☻ ☻ ☻½ Green, 115 days to maturity, YR. Large plant size with very good to good plant uniformity and slightly-tipped growth habit (worst in trial). Most abnormally small off-types (6.4%) in trial and second highest unmarketable off-types (2.4%). At harvest, 10% of heads had split cores. Above average head size (6.4 lb, 5th best in trial) and estimated marketable yield (692 cwt/A, 5th best in trial) out of the field. Best tolerance to thrips in the trial at harvest (depth: 0.2; severity: 0.01 out of 5.0). Out of common storage, below average shrink loss (13.3%, 2nd best in trial), above average trim loss (12.4%) and average total loss (25.7%), and 5% rot. Out of cold storage, below average shrink loss (7.6%, 5th best in trial), average trim loss (15.2%) and below average total loss (22.8%) with no rots. Average and above average head size out of common (4.5 lb) and cold (5.3 lb, 5th best in trial) storage, respectively. Above and below average green color out of common (3rd best in trial) and cold storage, respectively. Air spaces beside core, some odd shaped heads. R**ank Score (field + common + cold): 51+38+36 = 125 (8th in trial).**

Amtrak (Bejo). ☻ ☻ ☻½ Green, 115 days to maturity, YR. One of largest plant sizes in the trial with very good plant uniformity and slightly-tipped growth habit (worst in trial). Average abnormally small off-types (2.6%) and above average unmarketable off-types (1.4%). At harvest, 7.5% of heads had split cores. Above average head size (7.4 lb, 4th best in trial) and estimated marketable yield (808 cwt/A, 4th best in trial) out of the field. Slightly above average thrips damage at harvest (depth: 1.0; severity: 0.4 out of 5.0). Out of common storage, average shrink loss (15.6%), trim loss (9.9%) and total loss (25.5%), and no rot. Out of cold storage, below average shrink loss (7.9%), trim loss (14.0%) and total loss (21.9%) with no rots. Above average head size out of common (5.4 lb, 4th best in trial) and cold (6.0 lb, 4th best in trial) storage. Above average green color out of common (5th best in trial) and cold (4th best in trial) storage. Solid heads, some air spaces beside core and some long cores. R**ank Score (field + common + cold): 52+35+26 = 113 (5th in trial).**

07-666A (Takii). ☻ ☻ ☻½ Green, 120 days to maturity, YR. Large medium plant size with very good plant uniformity and upright to slightly-tipped growth habit (3rd best in trial). Second highest incidence of abnormally small off-types (5.7%) in trial, but no unmarketable off-types. At harvest, no heads had split cores. Slightly above average head size (6.0 lb) and estimated marketable yield (662 cwt/A) out of the field. One of most susceptible varieties to thrips in the trial at harvest (depth: 4.4; severity: 0.5 out of 5.0, worst in trial). Out of common storage, below average shrink loss (13.4%, 3rd best in trial), above average trim loss (10.2%) and below average total loss (23.6%, 4th best in trial), and no rot. Out of cold storage, below average shrink loss (7.2%), trim loss (14.9%) and total loss (22.2%) with no rots. Slightly above average head size out of common (4.6 lb) and cold (4.7 lb) storage. Most green color out of common (best in trial) and above average green color out of cold (3rd best in trial) storage. Nice round heads, looks good. R**ank Score (field + common + cold): 59+26+28 = 113 (tied for 5th in trial).**

Red Standard:

Rona (Seminis). ☻ ☻ ☻½ Red, 115 days to maturity, not YR. Large plant size (2nd in trial) with very good plant uniformity and slightly-tipped to upright growth habit. Above average abnormally small off-types (3.7%) and unmarketable (2.9%) off-types. At harvest, no heads had split cores. Below average head size (4.2 lb, 2nd

lowest in trial) and estimated marketable yield (457 cwt/A, 2nd lowest in trial) out of the field. Below average thrips damage at harvest (depth: 0.7; severity: 0.04 out of 5.0, 3rd best in trial). Out of common storage, below average shrink loss (14.6%, best of red varieties), and lowest trim loss (6.3%, best in trial) and total loss (20.9%, best in trial), and no rot. Out of cold storage, above average shrink loss (9.5%, best of reds), but below average trim loss (10.7%, best in trial) and total loss (20.2%, 2nd best in trial) with no rots. Below average head size out of common (3.7 lb) and cold (3.1 lb) storage. Generally nice round heads, some variability in size. **Rank Score (field + common + cold): 71+20+30 = 121 (7th in trial).**

Red Box Types:

Super Red 115 (Reeds). ☻☻ Red, 115 days to maturity, YR, 14" plant spacing. Large plant size with very good to good plant uniformity and upright to slightly-tipped growth habit. Above average abnormally small off-types (4.6%, highest of reds) and average unmarketable (1.2%) off-types. At harvest, 24.2% heads had split cores. Below average head size (5.1 lb, largest of reds) and estimated marketable yield (601 cwt/A, largest of reds) out of the field. One of most susceptible varieties to thrips damage in the trial (depth: 3.9; severity: 0.6 out of 5.0, worst in trial). Out of common storage, above average shrink loss (16.6%), trim loss (12.4%, worst in trial) and total loss (29.0%, worst in trial), and 5% rot. Out of cold storage, above average shrink loss (9.6%), but below average trim loss (12.0%, 2nd best in trial) and total loss (21.6%, 4th best in trial) with no rots. Below average head size out of common (4.1 lb, largest of reds) and cold (3.8 lb, largest of reds) storage. Oblong heads, 50% had cavity spot out of both storage types, short cores. **Rank Score (field + common + cold): 73+53+29 = 155 (12th in trial).**

Cabellaro (Bejo). ☻☻☻ Red, 115 days to maturity, not YR, 14" plant spacing. Medium plant size with excellent to very good plant uniformity (3rd best in trial) and upright to slightly-tipped growth habit (2nd best in trial). Average amount of abnormally small off-types (2.4%, lowest of reds) and unmarketable (1.1%) off-types. At harvest, 12.5% heads had split cores. Smallest head size (3.4 lb) and estimated marketable yield (398 cwt/A) in the entire trial out of the field. Below average thrips damage (depth: 1.0; severity: 0.1 out of 5.0, 5th best in trial). Out of common storage, above average shrink loss (18%, highest in trial), below average trim loss (7.0 %) and average total loss (24.9%), and no rot. Out of cold storage, highest shrink loss (10.1%) in trial, below average trim loss (14.5%, worst of reds) and average total loss (24.6%, 2nd worst in trial) with no rots. Smallest head size out of storage in the entire trial out of common (2.6 lb) and cold (2.6 lb) storage. Nice tight pretty heads, make very nice mini cabbage. **Rank Score (field + common + cold): 51+40+40 = 131 (10th in trial).**

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FOR MORE INFORMATION:

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Table 2. Plant characteristics, off-types, maturity, yield and onion thrips damage of storage cabbage varieties, Kendall, NY, 2009.

Variety	Plant Characteristics			Off-types[4]		Maturity	Yield		Onion Thrips Damage	
	Size (Rank)[1]	Uniformity (Rank)[2]	Growth Habit (Rank)[3]	Percent Small	Percent Unmarketable	% split cores at harvest	Average Head Size (pounds)	Estimated Marketable Yield (cwt/A)[6]	Depth[7]	Severity[8]
Green Box Types:										
Reaction	SM (9)	E-VG (2)	**U (1)**	**2.3**	**0.0**	30.0 ab	4.4 d-f[5]	527 e-g	2.6 a-c	0.4 a-d
Candella	LM (3)	VG (7)	U-ST (6)	**1.1**	**1.1**	**10.0 cd**	5.0 d-f	587 d-g	3.8 ab	0.4 a-d
Princeton	Var SM-VL (7)	VG (11)	U-ST (4)	**1.1**	**1.1**	**7.5 cd**	4.2 ef	489 e-g	**1.0 cd**	**0.3 b-e**
BC06146	L (5)	VG (8)	U-ST (5)	4.3	**1.1**	**2.5 d**	4.2 ef	496 e-g	**0.6 d**	**0.2 c-e**
Green Amtrak Types:										
04-203B	ML (6)	**E (1)**	UU-ST (2)	**0.0***	**0.0**	**10.0 cd**	**8.1 ab**	**896 ab**	**1.4 cd**	**0.1 e**
B2791	M (8)	VG (9)	U-ST (7)	**1.3**	2.0	**5.6 d**	**5.9 c-e**	638 c-f	**1.4 cd**	**0.1 e**
Brutus	**L (1)**	VG-E (4)	ST-U (9)	**2.2**	**0.0**	**0.0 d**	**5.8 c-e**	**647 c-f**	**0.4 d**	**0.02 e**
Seradox	L (5)	VG-E (5)	ST-U (8)	**1.3**	1.3	28.8 ab	**7.5 a-c**	**828 a-c**	2.8 a-c	**0.2 c-e**
B2792	**L (1)**	VG (6)	U-ST (3)	**2.6**	**0.0**	32.5 a	**8.3 a**	**925 a**	**1.7 cd**	**0.2 c-e**
Novator	**L (1)**	VG-E (6)	U-ST (8)	**0.0**	2.6	**0.0 d**	**6.3 b-d**	**683 b-e**	2.0 b-d	0.8 a
Constellation	**L (1)**	VG (10)	ST-U (10)	**2.5**	**0.0**	**0.0 d**	5.2 d-f	575 e-g	**1.2 cd**	**0.1 e**
Huron (std)	L (4)	VG-G (9)	ST (10)	6.4	2.4	**10.0 cd**	**6.4 a-d**	**692 b-e**	**0.2 d**	**0.01 e**
Amtrak (std)	**L (1)**	VG (9)	ST (10)	**2.6**	1.4	**7.5 cd**	**7.4 a-c**	**808 a-d**	**1.0 cd**	0.4 a-e
07-666A	LM (5)	VG (7)	U-ST (3)	5.7	**0.0**	**0.0 d**	**6.0 c-e**	**662 c-f**	4.4 a	0.5 a-c
Red Types:										
Rona (std)	L (2)	VG (11)	ST-U (8)	3.7	2.9	**0.0 d**	4.2 ef	457 fg	**0.7 d**	**0.04 e**
Red Box Types:										
SuperRed 115	L (5)	VG-G (12)	U-ST (7)	4.6	1.2	24.2 abc	5.1 d-f	601 d-g	3.9 a	0.6 ab
Caballero	M (6)	E-VG (3)	UU-ST (2)	**2.4**	**1.1**	12.5 bcd	3.4 f	398 g	**1.0 cd**	**0.1 de**
Trial Average[9]				***2.6***	***1.1***	***10.6***	***5.7***	***642***	***1.8***	***0.3***
P Value				***NS***	***NS***	***0.0010***	***0.0014***	***0.0034***	***0.0000***	***0.0017***

[1]***Plant Size:*** **S** – small; **M** – medium; **L** – large; **VL** – very large. For combinations, the first trait listed is the strongest. Ex. SM = more small than medium, ML is smaller than LM. Rank: in order from largest to smallest, based on evaluations of 3 replicates. **Var** = trait is variable across replicates, range is shown. [2]***Uniformity:*** **E** – Excellent; **VG** – Very Good; **G** – Good. For combinations, the first trait listed is the strongest. Ex. VG-G is more very good than it is good. Rank: in order of Excellent to Good. [3]***Growth habit:*** **UU**- most upright; **U** – upright; **ST** – slightly tipped; **T** – tipped. For combinations, the first trait listed is the strongest. Rank is in order of most upright to tipped. [4]***Type of off-types:*** **small** – abnormally small heads, less than half the size of other heads; **unmarketable** - multiple heads, odd head and wrapper leaf formations. [5]Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, P<0.05. [6]***Estimated Marketable Yield*** = based on the weight of 20 heads per replicate extrapolated to cwt per acre, 30" row spacing and 14" or 17" plant spacing, corrected for % unmarketable, small off-types included. [7]***Depth of onion thrips damage:*** number of leaf layers damaged by thrips. [8]***Thrips damage severity rating:*** 0 = no damage; 1 = trace; 2 = low; 3 = maximum commercial acceptability; 4 = high; 5 = severe. [9]***Trial average:*** the average of all replicates for all varieties per harvest. *Numbers in **bold** are equal to or better than the trial average. underlined values indicate the best result per variable.

Table 3. Shrink, trim, unmarketable heads, total loss, final head size and greenness of storage cabbage varieties out of common and cold (refrigerated) storage, 2010.

	Common Storage (15 weeks, 11-Feb-2010)						Cold Storage (26 weeks, 28-Apr-2010)					
Entry	% shrink loss	% trim loss	% unmarketable heads[1]	% total loss	final avg. head wt (lb)	green (mm)[2]	% shrink loss	% trim loss	% unmarketable heads[1]	% total loss	final avg. head wt (lb)	green (mm)[2]
Green Box Types:												
Reaction	17.1	10.0	**0.0**	27.1	3.3 ef[5]	4.5 c-e	9.1	16.9 b-d	5.0	26.0	3.5 f-h	4.7
Candella	16.9	10.1	5.0	27.0	3.8 d-f	4.1 e	9.3	22.6 ab	5.0	31.8	3.6 d-h	2.7
Princeton	15.7	12.2	**0.0**	27.9	3.1 ef	4.3 de	8.6	17.0 b-d	**0.0**	25.7	3.2 f-h	**5.5**
BC06146	16.2	11.3	**0.0**	27.5	3.2 ef	4.8 b-e	9.7	24.7 a	**0.0**	34.4	2.9 gh	1.1
Green Amtrak Types:												
04-203B	**14.0**	**7.7**	**0.0**	**21.7**	**6.5 a**	1.5 f	**7.3**	**12.8 d**	**0.0**	**20.2**	**6.4 ab**	2.6
B2791	**15.2**	**8.8**	**0.0**	**24.0**	**4.5 b-e**	4.7 b-e	**8.0**	**13.2 d**	**0.0**	**21.2**	**4.7 b-f**	**5.1**
Brutus	16.4	**7.6**	5.0	**24.0**	**4.4 b-e**	**6.9 a**	**7.8**	16.5 b-d	**0.0**	24.3	**4.5 c-g**	**5.8**
Seradox	16.6	**9.3**	10.0	25.9	**5.8 a-c**	3.5 e	**6.8**	16.6 b-d	**0.0**	**23.4**	**5.8 a-c**	**5.1**
B2792	16.7	**8.7**	**0.0**	25.4	**6.0 ab**	4.4 c-e	**6.6**	**12.9 d**	**0.0**	**19.5**	**7.1 a**	**7.8**
Novator	**13.2**[4]	**8.7**	**0.0**	**21.8**	**4.8 a-e**	**6.0 a-c**	**7.3**	16.1 b-d	**0.0**	**23.4**	**5.1 b-e**	**7.9**
Constellation	**14.4**	**9.3**	**0.0**	**23.7**	4.1 c-f	**4.9 b-e**	9.5	21.6 a-c	**0.0**	31.9	3.7 d-h	**5.1**
Huron (std)	**13.3**	12.4	5.0	25.7	**4.5 b-e**	**6.2 ab**	**7.6**	**15.2 cd**	**0.0**	**22.8**	**5.3 a-d**	3.2
Amtrak (std)	15.6	9.9	**0.0**	25.5	**5.4 a-d**	**5.9 a-d**	**7.9**	**14.0 cd**	**0.0**	**21.9**	**6.0 a-c**	**6.3**
07-666A	**13.4**	10.2	**0.0**	**23.6**	**4.6 b-e**	**7.2 a**	**7.2**	**14.9 cd**	**0.0**	**22.2**	**4.7 b-f**	**6.8**
Red Types:												
Rona (std)	**14.6**	**6.3**	**0.0**	**20.9**	3.7 ef	--	9.5	**10.7 d**	**0.0**	**20.2**	3.1 f-h	--
Red Box Types:												
SuperRed 115	16.6	12.4	5.0	29.0	4.1 c-f	--	9.6	**12.0 d**	**0.0**	**21.6**	3.8 d-h	--
Caballero	18.0	**7.0**	**0.0**	**24.9**	2.6 f	--	10.1	**14.5 cd**	**0.0**	24.6	2.6 h	--
Trial Average[3]	***15.5***	***9.5***	***1.8***	***25.0***	***4.4***	***4.9***	***8.3***	***15.9***	***0.6***	***24.2***	***4.5***	***5.0***
P Value	***NS***[6]	***NS***	***NS***	***NS***	***0.0080***	***0.0004***	***NS***	***0.0234***	***NS***	***NS***	***0.0016***	***NS***

[1]unmarketable heads included in shrink loss. [2]milimeters of green on cut head after trimming. [3]***Trial Average:*** average of all data pooled together. [4]Numbers in **bold** are equal to or better than the trial average. Underlined values indicate the best result per variable. [5]Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, $p < 0.05$. [6]NS: not significant, $p > 0.05$.

Figure 1. Summary of scale diagrams for average head size prior to storage, and after common (15 weeks) and cold (26 weeks) storage, presented in order of approximate maturity by type.