Horticulture and Crop Science Series No. 705 **January 2001**

Fresh Market and Processing Cabbage Germplasm Evaluation Results in 2000

Information on the Effects of Planting Date and Genotype on Fresh Market and Processing Cabbage Yield and Head Traits in Ohio in 2000

Matthew D. Kleinhenz and Brenda Schult
Department of Horticulture and Crop Science
The Ohio State University
Ohio Agricultural Research and Development Center (OARDC)
Wooster, Ohio

Acknowledgments

This work was funded in part by the Ohio Agricultural Research and Development Center, Ohio State University Extension, The OSU Department of Horticulture and Crop Science, Ohio Vegetable and Small Fruit Research and Development Fund, the Fremont Company, Cabbage, Inc., and cooperating seed companies. This support is greatly appreciated.

Ken Scaife, Rick Callendar, Melissa Frantz, Darla French, Ted Radovich and staff of the Vegetable Crops Research Branch provided excellent technical assistance and took a positive "can-do" approach throughout each phase of this project. Their cooperation and input is greatly appreciated.

Seed for the genotypes tested in these studies was provided by:

Abbott and Cobb
American Takii
Asgrow Seeds
Bejo
d. Palmer
Harris Moran
Orsetti
Reed's Seed
Sakata
Vilmorin, Inc.

The Grower's Section

A complete description of this study and our findings begins on page 3. The "Grower's Section" is offered for quick reference.

What Did We Do?

We planted twenty-four varieties and experimental lines of fresh market cabbage at the Vegetable Crops Research Branch in Fremont, OH on May 12 and June 30, 2000. We also planted twelve varieties of processing cabbage on May 15 and July 6, 2000 at the same location but in a separate study. Replicated field plots were used (this was not an un-replicated strip trial). Plots and heads were examined regularly throughout the season and at harvest. Post-harvest evaluations of quality continue in the lab.

Why Did We Do this Project?

This project was undertaken to assist Ohio cabbage growers in identifying varieties with desirable traits. Head traits (e.g., size, weight, density, freedom from physiological disorders, core size, etc.), marketable yield, and resistance to biological and environmental stresses and other variety traits influence a grower's return from cabbage production. To be successful, Ohio cabbage growers must have available varieties adapted to the state's production and market conditions. Because cabbage varieties often differ in traits which affect grower return, scientifically measuring and documenting the performance of varieties under varied, local conditions is important. Equipped with reliable information from unbiased testing programs, growers can be confident that the varieties they choose will be adapted to their needs.

What did We Find?

Fresh Market Study

1. **Yield**. See Tables 6, 8 and 10 for more information. In the spring, total and marketable yield averaged 40 and 38 ton/A, respectively. But, in the summer, total and marketable yield averaged 29 and 21 ton/A, respectively. Cheers variety had the greatest marketable yield in the spring planting while SuperElite Hybrid had the greatest marketable yield in the summer planting. The marketable yield of twelve of twenty-four entries listed in Table 10 was similar following planting in May and June.

2. **Head and Core Traits**. See Tables 7, 9, and 10 for more information. Head weight and size tended to be greater in the May versus June planting. However, the percent of the head's volume taken up by the core tended to be slightly greater in the summer versus spring planting. Head density was mostly not effected by planting date. Head density was also similar, regardless of head size. Head size, weight, and density of fourteen of twenty-four entries listed in Table 10 similar following planting in May and June.

Processing Study

1. **Yield**. See Tables 13, 14, and 17 for more information. In the spring, total and marketable yield averaged 38 and 37 ton/A, respectively. But, in the summer, total and marketable yield averaged 35 and 30 ton/A, respectively. Geronimo variety had the greatest marketable yield in the spring planting while Hinova had the greatest marketable yield in the summer planting. The marketable yield of seven of twelve

entries listed in Table 17 was similar following planting in May and July.

2. **Head and Core Traits**. See Tables 15, 16, and 17 for more information. Head weight and density and core size tended to be greater in the May versus July planting. Head weight of eight of twelve entries listed in Table 17 was similar following planting in May and July.

For more information on this bulletin or to receive copies of this or similar publications, please contact:

Dr. Matt Kleinhenz
Asst. Professor and Extension Vegetable Specialist
Department of Horticulture and Crop Science
The OSU-OARDC
1680 Madison Avenue
Wooster, OH 44691-4096

phone: 330.263.3810
FAX: 330.263.3887
Email: kleinhenz.1@osu.edu
Web: http://www.oardc.ohio-state.edu/kleinhenz

Project Details

Materials and Methods

See Tables 1 and 2 for a list of the genotypes examined in the fresh market and processing studies.

Transplant Production. Entries were solicited from cooperating seed companies in winter 1999-2000. Transplants were seeded in spring, allowed to develop 2-4 true leaves in the greenhouse, and hardened-off before planting into the field.

Plot Establishment. A randomized complete block design was used in each study. Each study contained four replications per entry per planting and two planting dates (fresh market -- May 12, June 30; processing -- May 15, July 6). The fresh market study included twenty-four genotypes and the processing study included twelve genotypes. Two-row plots were established with a cone-type two-row transplanter. Each row was 15 ft. long with 30 in. between rows and 11 in. (fresh market) and 18 in. (processing) between transplants. A 0-46-0 fertilizer was used to supply 60 lb. P_2O_5 and a 0-0-60 fertilizer was used to supply 250 lb. K_2O in September 1999. Ammonium nitrate was broadcast to supply 70 lb N/A on May 5, 2000. A nutrient starter solution (0.7 qt. 10-34-0/50 gal. water) was delivered next to the transplants.

Plot Maintenance. Dead transplants were replaced (if possible) within one week of initial planting. Standard pest management strategies based on scouting, thresholds, and application of labeled pesticides were employed.

Data Collection (Field). Plots were reviewed twice per week to assess development. Notes on plant stature, head shape, and other traits were taken on mature entries immediately prior to harvest.

Data Collection (at Harvest). Harvest readiness for individual entries was estimated from published maturity information and visual examination of the five plots per entry. At maturity, all heads were collected from within the center 10 ft. of both rows in each plot. Heads were scored as marketable or unmarketable (too small, split, rotten, or containing evidence of blackrot or tipburn) and weighed as a group. Ten marketable heads were then selected at random from the harvested group for further evaluation. Five outer leaves were removed from each head before they were re-weighed individually. Heads were then cut in half longitudinally and the core length and base width as well as the head polar and equatorial diameter of each head recorded.

Additional Quality Analysis. Two additional marketable heads from each plot were collected at harvest and sent to The OSU Food Industries Center for further evaluation (fresh market study only). In addition, tissue from one marketable head from each plot was prepared for isothiocyanate analysis (fresh market study only). Isothiocyanates are among the compounds known to contribute to cabbage flavor. Consumption of food products thought to contain high levels of isothiocyanates, such as cabbage, is also thought to have specific health benefits.

Statistical Analysis. Head density was estimated through calculation using replicate averages of head

weight and polar diameter. Likewise, the percent of the head volume contained in the core was estimated through calculation using replicate averages of head polar diameter and core length and base width. Replicate averages were calculated and used in means analysis. Main effects and interactions of planting date, entry, and replicate were analyzed with fully specified model statements in SAS (alpha = 0.10). The Fisher Least Significant Difference test (alpha = 0.10) was used to analyze the effect of planting date and replicate while the Duncan Multiple Range test (alpha = 0.10) was used to analyze the effect of entry.

Results

Fresh Market Study

Data are contained in Tables 4-10. The planting date-x-entry interaction was significant (% = 0.10) for five of seven head and core traits but not significant for marketable or total yield (Table 4). Planting on May 12 versus June 30 tended to result in larger, heavier heads and greater total and marketable yield (Table 5). Planting date, though, did not effect head density or core volume (Table 5). Core volume was relatively constant at approximately 1% of head volume. Marketable yield in the May planting ranged from 20.3 ton/A to 59.0 ton/A (Table 6). Marketable yield in the June planting ranged from 6.6 ton/A to 31.9 ton/A (Table 8). Marketable yield for twelve of twenty-four entries was similar after planting in May versus June and head density was similarly unaffected by planting date in fourteen entries (Table 10). In three entries, none of the nine traits studied were impacted by planting date (Table 10) while in five entries six of nine traits were effected by planting date (Table 10).

Processing Study

Data are contained in Tables 11-17. The planting date-x-entry interaction was significant (% = 0.10) for total and marketable yield and five of seven head and core traits (Table 11). Planting on May 15 versus July 6 tended to result in heavier, more dense heads with larger cores and greater total and marketable yield (Table 12). Planting date, though, did not effect calculated core volume (Table 12). Core volume was relatively constant at approximately 1% of head volume. Marketable yield in the May planting ranged from 25.1 ton/A to 46.0 ton/A (Table 13). Marketable yield in the July planting ranged from 19.6 ton/A to 34.2 ton/A (Table 14). Marketable yield for seven of twelve entries was similar after planting in May versus July and head density was similarly unaffected by planting date in eight entries (Table 17). In all entries, at least one of nine traits studied was effected by planting date (Table 17). In four entries, at least six of nine traits were effected by planting date (Table 17).

Table 1. Number of days to harvest (DTH) for twenty-four genotypes of fresh market cabbage planted on May 12 and June 30, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

Entry			May 12	June 30
Name	#	Company	DTH	DTH
Arena	1	Sakata	123	131
Blue Dynasty	2	Asgrow Seeds	95	87
Blue Lagoon F1	3	Harris Moran	84	87
Blue Thunder F1	4	Harris Moran	110	104
Blue Vantage	5	Sakata	95	87
Bronco	6	Bejo	119	122
Cheers	7	American Takii	110	104
Emblem	8	Sakata	95	87
Green Cup	9	American Takii	110	104
HMX 0225	10	Harris Moran	119	131
HMX 0228 F1	11	Harris Moran	95	104
Matsumo	12	Bejo	110	104
Solid Blue # 780	13	Abbott & Cobb	119	122
Solid Blue # 790	14	Abbott & Cobb	110	122
SuperElite Hybrid	15	Reed's Seed	119	122
XP 5210157	16	Asgrow Seeds	84	104
XP 5210387	17	Asgrow Seeds	95	104
DPSX 308	18	d. Palmer	95	87
DPSX 309	19	d. Palmer	110	104
DPSX 315	20	d. Palmer	95	87
DPSX 327	21	d. Palmer	110	122
Red Dynasty	22	d. Palmer	95	87
Primero	23	Bejo	80	87
Red Success	24	Orsetti	84	87

Table 2. Number of days to harvest (DTH) for twelve genotypes of processing cabbage planted on May 15 and July 6, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

Entry			May 15	July 6
Name	#	Company	DTH	DTH
Benefit	1	Bejo	100	114
Bobcat Hybrid	2	Reed's Seed	105	118
Geronimo (1772)	3	Bejo	108	121
HMX 0221	4	Harris Moran	117	121
HMX 0222	5	Harris Moran	117	121
HMX 0223	6	Harris Moran	120	121
HMX 0224	7	Harris Moran	114	118
NIZ 95-23	8	Vilmorin, Inc.	120	121
Score	9	Bejo	111	114
Bravo	10	Harris Moran	108	113
Hinova	11	Bejo	107	112
Almanac	12	Bejo	104	98

Table 3. Climatic data for fresh market and processing cabbage studies planted at the OSU Vegetable Crops Research Branch in Fremont, OH in 2000.

	-- Avg. Temp (F) --		-------Precipitation (in.)-------		
	High	Low	Actual	Normal	-/+ Normal
Fresh Market Study					
Planting 1 (May 12)					
May 12 - June 6 (25 d)	71.2	50.8	4.62	3.5	1.12
June 7 - July 27 (50 d)	80.3	59.2	7.76	6.5	1.26
July 28 - Aug. 22 (25 d)	79.3	59.2	4.98	3.0	1.98
Total			17.36	13.0	4.36
Planting 2 (June 30)					
June 30 - July 24 (25 d)	79.4	58.1	1.38	3.3	-1.92
July 25 - Sept. 12 (50 d)	80.1	59.1	7.20	5.1	2.10
Sept. 13 - Oct. 7 (25 d)	70.5	46.3	4.40	2.5	1.90
Total			12.98	10.9	2.08
Processing Study					
Planting 1 (May 15)					
May 15 - June 9 (25 d)	71.2	51.3	4.58	3.6	0.98
June 10 - July 30 (50 d)	80.8	59.7	10.11	6.4	3.71
July 31 - Aug. 25 (25 d)	78.8	58.2	2.75	2.8	-0.05
Total			17.44	12.8	4.64
Planting 2 (July 6)					
July 6 - July 31 (25 d)	80.0	58.5	3.14	2.9	0.24
Aug. 1 - Sept. 20 (50 d)	78.7	56.9	4.83	5.5	-0.67
Sept. 21 - Oct. 15 (25 d)	67.2	43.5	4.19	2.2	1.99
Total			12.16	10.6	1.56

Table 4. Influence of planting date and entry on yield and head traits for twenty-four genotypes of fresh market cabbage planted on May 12 and June 30, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

				head				core		
		yield (ton/A)		weight	density	diameter (cm.)		length	base width	% of
Source	df	marketable	total	(kg)	(g/cm^3)	polar	equatorial	(cm.)	(cm.)	head volume
		Pr > F								
Planting Date (PD)	1	<0.0001	<0.0001	<0.001	0.4546	<0.0001	<0.0001	0.9427	<0.0001	0.5227
Entry (E)	23	<0.0001	<0.0001	<0.001	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
PD x E	23	0.6176	0.1857	<0.001	0.0119	0.0273	0.3848	0.7587	<0.0001	<0.0001

Table 5. Influence of planting date on yield and head traits for twenty-four genotypes of fresh market cabbage planted on May 12 and June 30, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

				head				core		
		yield (ton/A)		weight	density	diameter (cm.)		length	base width	% of
Planting Date	N	marketable	total	(kg)	(g/cm^3)	polar	equatorial	(cm.)	(cm.)	head volume
May 12, 2000	72	37.6 a	40.2 a	2.3 a	1.13 a	15.9 a	17.1 a	7.8 a	3.16 a	1.00 a
June 30, 2000	72	21.3 b	28.5 b	1.6 b	1.06 a	14.6 b	16.0 b	7.8 a	2.82 b	1.02 a
$L.S.D._{(0.10)}$		2.68	2.50	0.10	0.14	0.28	0.35	0.22	0.06	0.04

Table 6. Average yield of twenty-four genotypes of fresh market cabbage planted on May 12, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

Entry		Yield (ton/A)		Marketable Yield (%)	
Name	#	marketable	total	by weight	by # heads
Arena	1	26.2	28.3	91.6	80.6
Blue Dynasty	2	35.5	36.6	96.4	89.3
Blue Lagoon F1	3	32.4	32.6	99.0	96.7
Blue Thunder F1	4	45.3	45.3	100.0	100.0
Blue Vantage	5	28.7	30.8	90.0	73.9
Bronco	6	43.6	44.5	97.5	92.2
Cheers	7	59.0	62.6	94.1	93.7
Emblem	8	38.6	39.6	95.9	89.2
Green Cup	9	47.2	52.1	91.5	87.8
HMX 0225	10	22.7	26.7	85.1	66.9
HMX 0228 F1	11	42.8	43.7	97.6	96.8
Matsumo	12	54.0	69.9	77.7	74.9
Solid Blue # 780	13	39.6	41.2	94.8	87.7
Solid Blue # 790	14	45.8	45.8	100.0	100.0
SuperElite Hybrid	15	46.9	49.1	95.1	86.2
XP 5210157	16	35.8	36.2	98.8	95.6
XP 5210387	17	32.8	33.4	97.8	94.2
DPSX 308	18	32.5	35.2	92.6	78.0
DPSX 309	19	45.7	52.1	87.7	79.8
DPSX 315	20	32.8	35.2	93.1	82.9
DPSX 327	21	42.1	46.9	90.2	84.8
Red Dynasty	22	26.1	26.7	97.8	89.8
Primero	23	20.3	24.4	77.3	68.8
Red Success	24	24.7	25.8	96.0	83.7
Pr > F		***	***	*	**
DMRT $_{(0.10)}$		15.1	14.5	14.0	19.3

*, **, and *** denote significance at the 0.10, 0.05, and 0.001 level, respectively.

Table 7. Head and core traits for twenty-four genotypes of fresh market cabbage planted on May 12, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

		Head					Core		
				Diameter		length/		base	percent
Entry		weight	density	polar	equatorial	width	length	width	of head
Name	#	(kg)	(g/cm^3)	(cm)	(cm)	ratio	(cm)	(cm)	volume
Arena	1	2.1	0.8	17.0	16.0	1.1	8.0	3.6	1.0
Blue Dynasty	2	1.9	1.1	15.0	16.4	0.9	7.6	2.9	1.0
Blue Lagoon F1	3	3.7	1.9	15.3	15.5	1.0	7.1	2.9	0.8
Blue Thunder F1	4	2.0	1.0	15.9	17.3	0.9	8.6	3.4	1.2
Blue Vantage	5	2.0	1.1	15.2	17.5	0.9	7.3	2.7	0.8
Bronco	6	2.4	1.1	16.1	17.3	0.9	7.4	3.7	1.2
Cheers	7	3.0	1.1	17.3	20.3	0.9	8.3	3.5	1.0
Emblem	8	2.0	0.9	15.8	16.7	1.0	8.8	3.1	1.0
Green Cup	9	2.3	1.0	16.4	18.5	0.9	8.3	3.4	1.1
HMX 0225	10	1.6	0.5	18.7	13.5	1.4	8.1	2.8	0.5
HMX 0228 F1	11	2.2	1.0	16.0	17.3	0.9	8.1	2.9	0.8
Matsumo	12	2.5	1.3	15.2	19.5	0.8	7.0	3.1	1.0
Solid Blue # 780	13	2.3	1.0	16.1	17.2	0.9	8.2	3.2	1.0
Solid Blue # 790	14	2.0	1.1	15.2	17.4	0.9	8.5	3.2	1.3
SuperElite Hybrid	15	2.6	1.1	16.6	18.4	0.9	8.8	3.3	1.1
XP 5210157	16	4.4	1.7	16.9	16.6	1.0	7.0	2.8	0.6
XP 5210387	17	1.9	0.9	15.8	16.7	1.0	6.1	2.9	0.7
DPSX 308	18	2.2	1.4	14.2	19.1	0.7	7.9	2.8	1.1
DPSX 309	19	2.8	1.5	15.3	21.0	0.7	7.4	3.6	1.4
DPSX 315	20	2.2	0.9	16.3	17.1	1.0	8.7	3.6	1.3
DPSX 327	21	2.3	1.2	15.6	19.0	0.8	8.4	3.3	1.2
Red Dynasty	22	1.2	0.7	14.8	14.0	1.1	6.9	3.0	1.0
Primero	23	1.3	0.7	15.4	14.0	1.1	7.7	3.2	1.1
Red Success	24	3.5	2.1	14.7	15.3	1.0	7.1	2.7	0.8
Pr > F		***	***	***	***	***	**	***	***
DMRT $_{(0.10)}$		0.66	0.13	1.4	2.07	0.06	1.23	0.36	0.22

** and *** denote significance at the 0.05 and 0.001 level, respectively.

Table 8. Average yield of twenty-four genotypes of fresh market cabbage planted on June 30, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

Entry		Yield (ton/A)		Marketable Yield (%)	
Name	#	marketable	total	by weight	by # heads
Arena	1	15.4	25.8	48.4	43.2
Blue Dynasty	2	24.5	27.3	88.6	74.8
Blue Lagoon F1	3	27.2	31.3	86.9	81.1
Blue Thunder F1	4	27.5	39.0	67.9	58.0
Blue Vantage	5	25.0	28.9	75.3	64.7
Bronco	6	23.7	30.1	73.7	72.1
Cheers	7	29.0	38.5	72.8	63.8
Emblem	8	25.6	27.3	73.3	70.8
Green Cup	9	25.8	35.3	71.9	65.2
HMX 0225	10	14.2	19.6	65.1	49.4
HMX 0228 F1	11	18.4	29.2	62.3	55.3
Matsumo	12	21.3	32.9	62.8	57.9
Solid Blue # 780	13	24.8	29.0	81.1	70.6
Solid Blue # 790	14	25.3	31.5	77.5	72.6
SuperElite Hybrid	15	31.9	35.6	85.9	79.4
XP 5210157	16	16.7	27.3	57.6	46.3
XP 5210387	17	17.7	28.9	54.8	46.1
DPSX 308	18	20.2	23.4	79.8	66.1
DPSX 309	19	25.9	30.8	83.5	75.7
DPSX 315	20	8.8	13.1	55.1	36.0
DPSX 327	21	24.1	40.8	64.1	55.8
Red Dynasty	22	6.6	13.5	35.4	26.9
Primero	23	15.2	22.2	67.6	59.0
Red Success	24	15.3	23.5	64.0	56.6
Pr > F		**	***	NS	***
DMRT $_{(0.10)}$		11.96	10.2	32.2	30.6

** and *** denote significance at the 0.05 and 0.001 level, respectively.

Table 9. Yield and head traits of twenty-four genotypes of fresh market cabbage planted on June 30, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

		Head					Core		
				Diameter		length/		base	percent
Entry		weight	density	polar	equatorial	width	length	width	of head
Name	#	(kg)	(g/cm^3)	(cm)	(cm)	ratio	(cm)	(cm)	volume
Arena	1	1.6	0.8	15.3	14.8	1.0	7.3	2.9	0.8
Blue Dynasty	2	1.7	3.2	14.6	16.4	0.9	8.3	3.0	1.1
Blue Lagoon F1	3	1.5	0.8	15.2	14.9	1.0	7.3	3.0	0.9
Blue Thunder F1	4	1.9	1.2	14.3	17.2	0.8	8.7	3.0	1.4
Blue Vantage	5	1.8	1.0	15.1	17.1	0.9	7.6	3.1	1.1
Bronco	6	1.7	0.9	15.5	15.6	1.0	7.8	2.9	0.9
Cheers	7	1.8	1.1	14.6	17.5	0.8	8.2	3.0	1.2
Emblem	8	1.8	0.8	16.1	16.7	1.0	9.4	3.3	1.2
Green Cup	9	1.6	1.1	14.1	16.4	0.9	8.1	2.7	1.1
HMX 0225	10	1.3	0.4	18.8	12.0	1.6	9.6	2.5	0.4
HMX 0228 F1	11	1.5	1.0	14.2	15.5	0.9	7.9	2.5	0.8
Matsumo	12	1.7	1.5	12.8	16.9	0.8	6.0	2.7	1.1
Solid Blue # 780	13	1.6	0.8	15.7	16.0	1.0	7.8	2.8	0.8
Solid Blue # 790	14	1.6	0.8	15.5	16.4	1.0	9.0	2.5	0.8
SuperElite Hybrid	15	1.9	0.9	16.1	16.7	1.0	8.9	2.8	0.9
XP 5210157	16	1.6	1.0	14.4	15.5	0.9	6.6	.	0.7
XP 5210387	17	1.5	1.0	14.4	15.1	0.9	6.3	2.5	0.7
DPSX 308	18	1.4	1.3	12.6	16.6	0.8	7.5	2.9	1.6
DPSX 309	19	1.5	1.6	12.2	16.5	0.7	6.5	2.8	1.5
DPSX 315	20	1.1	0.9	13.0	13.6	1.0	7.7	3.0	1.6
DPSX 327	21	2.0	1.0	15.5	18.1	0.9	8.7	2.6	0.8
Red Dynasty	22	0.9	0.6	14.0	12.9	1.1	7.1	3.0	1.1
Primero	23	1.1	0.8	14.0	13.0	1.1	7.7	2.6	1.0
Red Success	24	1.2	0.8	14.1	14.2	1.0	7.3	2.8	1.0
Pr > F		***	**	***	***	***	***	***	***
$DMRT_{(0.10)}$		0.38	1.07	1.45	1.56	0.06	1.06	0.29	0.27

** and *** denote significance at the 0.05 and 0.001 level, respectively.

Table 10. Influence of planting date on yield and head traits of twenty-four genotypes of fresh market cabbage planted on May 12 and June 30, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH. An asterisk (*) indicates that planting date had a significant effect on the variables listed within within the genotype according to the Fisher Least Significant Difference test (alpha = 0.10). Analysis based on the mean of three replicates per planting.

Entry		yield (ton/A)		head				core			# of 9 traits
Name	#	marketable	total	weight (kg)	density (g/cm^3)	diameter (cm.) polar	diameter (cm.) equatorial	length (cm.)	base width (cm.)	% of head volume	effected by planting date
Arena	1					*			*		2
Blue Dynasty	2										0
Blue Lagoon F1	3			*	*						2
Blue Thunder F1	4	*			*	*			*		4
Blue Vantage	5								*	*	2
Bronco	6				*				*	*	3
Cheers	7	*	*	*		*	*		*		6
Emblem	8										0
Green Cup	9	*	*	*		*	*		*		6
HMX 0225	10			*	*		*	*			4
HMX 0228 F1	11	*	*	*		*	*		*		6
Matsumo	12	*	*	*	*	*	*				6
Solid Blue # 780	13				*					*	2
Solid Blue # 790	14	*			*				*	*	4
SuperElite Hybrid	15			*					*		2
XP 5210157	16	*		*	*	*					4
XP 5210387	17										0
DPSX 308	18									*	1
DPSX 309	19	*	*	*		*	*		*		6
DPSX 315	20	*	*			*	*	*			5
DPSX 327	21	*			*				*	*	4
Red Dynasty	22	*	*							*	3
Primero	23					*			*		2
Red Success	24	*		*	*		*				4
number comparisons of 24 significant		12	7	10	10	10	8	2	12	7	

Table 11. Influence of planting date and entry on yield and head traits for twelve genotypes of processing cabbage planted on May 15 and July 6, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

				head				core		
		yield (ton/A)		weight	density	diameter (cm.)		length	base width	% of
Source	df	marketable	total	(kg)	(g/cm^3)	polar	equatorial	(cm.)	(cm.)	head volume
		Pr > F								
Planting Date (PD)	1	<0.0001	0.0348	0.0024	<0.0001	<0.0001	0.8887	0.0124	<0.0010	0.4027
Entry (E)	11	0.0027	0.0023	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	0.5086
PD x E	11	0.0520	0.0904	0.0021	0.0608	<0.0001	0.0826	0.0291	0.1306	0.3856

Table 12. Influence of planting date on yield and head traits for twelve genotypes of processing cabbage planted on May 15 and July 6, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

				head				core		
		yield (ton/A)		weight	density	diameter (cm.)		length	base width	% of
Planting Date	N	marketable	total	(kg)	(g/cm^3)	polar	equatorial	(cm.)	(cm.)	head volume
May 15, 2000	48	37.0 a	38.0 a	2.80 a	1.08 a	17.5 a	18.9 a	7.7 a	3.6 a	1.1 a
July 6, 2000	48	29.9 b	34.8 b	2.55 b	0.99 b	16.6 b	18.8 a	7.1 b	3.2 b	0.9 a
$L.S.D._{(0.10)}$		2.43	2.41	0.13	0.02	0.26	0.43	0.43	0.17	0.54

Table 13. Average yield of twelve genotypes of processing cabbage planted on May 15, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

Entry		Yield (ton/A)		Marketable Yield (%)	
Name	#	marketable	total	by weight	by # heads
Benefit	1	25.1	25.9	97	92
Bobcat Hybrid	2	38.6	38.7	100	98
Geronimo (1772)	3	46.0	47.9	96	95
HMX 0221	4	26.5	28.1	94	84
HMX 0222	5	34.1	36.4	100	100
HMX 0223	6	39.8	40.7	98	95
HMX 0224	7	30.8	30.8	100	98
NIZ 95-23	8	44.6	47.2	94	92
Score	9	34.7	36.5	95	95
Bravo	10	42.1	42.1	100	100
Hinova	11	36.2	37.4	97	95
Almanac	12	42.4	43.4	98	95
Pr > F		**	***	NS	*
DMRT $_{(0.10)}$		10.5	9.9	7.2	9.0

*, **, and *** denote significance at the 0.10, 0.05, and 0.001 level, respectively.

Table 14. Average yield of twelve genotypes of processing cabbage planted on July 6, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

Entry		Yield (ton /A)		Marketable Yield (%)	
Name	#	marketable	total	weight	# heads
Benefit	1	19.6	32.9	59	60
Bobcat Hybrid	2	28.2	34.9	82	82
Geronimo (1772)	3	26.5	33.7	81	75
HMX 0221	4	33.4	34.2	97	97
HMX 0222	5	31.9	35.6	89	90
HMX 0223	6	31.8	33.0	96	93
HMX 0224	7	28.0	31.1	92	87
NIZ 95-23	8	29.8	33.6	90	85
Score	9	32.7	32.8	100	96
Bravo	10	32.5	38.9	83	77
Hinova	11	34.2	34.3	100	98
Almanac	12	30.2	42.7	69	71
Pr > F		NS	NS	***	***
DMRT $_{(0.10)}$		9.7	9.8	16.1	14.8

*** denotes significance at the 0.001 level.

Table 15. Head and core traits of twelve genotypes of processing cabbage planted on May 15, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

		Head					Core		
				Diameter		length/		base	percent
Entry		weight	density	polar	equatorial	width	length	width	of head
Name	#	(kg)	(g/cm^3)	(cm)	(cm)	ratio	(cm)	(cm)	volume
Benefit	1	2.6	1.1	16.0	18.6	0.9	6.7	3.5	0.8
Bobcat Hybrid	2	3.1	1.1	17.3	20.0	1.0	6.9	3.8	0.8
Geronimo (1772)	3	4.2	1.1	19.3	22.9	1.1	7.9	3.9	0.9
HMX 0221	4	2.7	1.0	17.6	18.5	0.9	6.5	4.0	1.2
HMX 0222	5	3.1	0.9	18.6	19.5	0.9	7.4	3.9	1.0
HMX 0223	6	3.0	0.9	18.5	19.0	0.9	7.6	3.8	0.9
HMX 0224	7	3.1	1.0	18.3	19.6	0.9	7.6	3.7	0.9
NIZ 95-23	8	3.4	0.9	19.1	20.3	1.0	8.4	3.8	0.7
Score	9	2.9	0.9	18.2	19.0	1.0	7.2	3.5	1.0
Bravo	10	2.8	0.9	18.1	18.9	1.0	7.1	3.3	1.1
Hinova	11	2.7	1.0	17.4	19.1	0.9	7.1	3.0	0.7
Almanac	12	2.8	1.1	17.0	20.2	0.9	7.3	2.9	0.4
Pr > F		***	***	***	***	**	***	***	***
DMRT $_{(0.10)}$		0.52	0.08	1.08	1.67	0.10	0.82	0.20	0.16

** and *** denote significance at the 0.05 and 0.001 level, respectively.

Table 16. Head and core traits for twelve genotypes of processing cabbage planted on July 6, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH.

		Head					Core		
				Diameter		length/		base	percent
Entry		weight	density	polar	equatorial	width	length	width	of head
Name	#	(kg)	(g/cm^3)	(cm)	(cm)	ratio	(cm)	(cm)	volume
Benefit	1	2.8	1.2	16.5	20.4	0.9	7.7	3.1	0.9
Bobcat Hybrid	2	2.6	1.1	16.5	19.8	0.9	7.5	3.3	0.7
Geronimo (1772)	3	2.5	1.1	16.4	19.0	0.9	7.3	3.4	0.8
HMX 0221	4	2.5	1.0	16.5	18.4	0.9	7.1	3.5	1.1
HMX 0222	5	2.4	1.0	16.5	18.5	0.9	7.3	3.2	0.7
HMX 0223	6	2.5	1.0	16.7	18.9	0.9	7.8	3.2	1.0
HMX 0224	7	2.8	1.1	16.9	20.0	0.9	8.3	3.1	0.7
NIZ 95-23	8	2.9	1.1	17.1	20.0	0.9	8.8	3.0	0.8
Score	9	3.2	1.1	17.5	20.6	0.9	8.7	3.1	0.8
Bravo	10	3.4	1.2	17.8	21.0	0.9	8.9	3.0	0.9
Hinova	11	3.4	1.0	18.3	20.7	0.9	8.7	3.0	4.7
Almanac	12	4.0	1.1	19.1	22.2	0.9	8.3	3.1	0.6
Pr > F		NS	***	**	*	NS	**	NS	NS
DMRT $_{(0.10)}$		0.52	0.11	1.11	1.76	0.26	2.42	1.00	3.23

*, **, and *** denote significance at the 0.10, 0.05 and 0.001 level, respectively.

Table 17. Influence of planting date on yield and head traits of twelve genotypes of processing cabbage planted on May 15 and July 6, 2000 at the OSU Vegetable Crops Research Branch in Fremont, OH. An asterisk (*) indicates that planting date had a significant effect on the variables listed within within the genotype according to the Fisher Least Significant Difference test (alpha = 0.10). Analysis based on the mean of four replicates per planting.

Entry		yield (ton/A)		head				core			traits
						diameter (cm.)					
Name	#	marketable	total	weight (kg)	density (g/cm^3)	polar	equatorial	length (cm.)	base width (cm.)	% of head volume	effected by planting date
Benefit	1				*		*				2
Bobcat Hybrid	2	*							*		2
Geronimo (1772)	3	*	*	*	*	*	*		*	*	8
HMX 0221	4	*	*	*		*	*	*	*		7
HMX 0222	5				*				*	*	3
HMX 0223	6	*		*	*	*	*		*		6
HMX 0224	7				*		*		*	*	4
NIZ 95-23	8	*	*	*	*	*			*		6
Score	9				*	*			*		3
Bravo	10					*			*	*	3
Hinova	11				*	*				*	3
Almanac	12				*	*					2
number comparisons of 12 significant		5	3	4	9	8	5	1	9	5	