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Fresh Market Cabbage Germplasm Evaluation Results in 1999

Information on the Effects of Planting Date and Genotype on Fresh Market Cabbage Yield and Head Traits in Ohio in 1999

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Abbott and Cobb	**Harris Moran**
American Takii	**Petoseed**
Asgrow	**Reed's**
Bejo	**Rispen's**
d. Palmer	**Sakata**

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Project Summary

Twenty-three varieties and experimental lines of fresh market cabbage were planted on May 11 and June 18, 1999 at the Vegetable Crops Research Branch in Fremont, OH. Three additional entries were planted on June 18, 1999 only. Plots of each entry were replicated five times per planting date and arranged in randomized complete block design, including planting date as a replication and design factor. Transplants were set into each plot, consisting of two rows spaced at 30 inches and with 10 inches between plants. Entries were harvested when mature. The total and individual weight of ten heads per plot were recorded. The weight, size (polar and equatorial diameter), and core dimensions were recorded on five individual heads per plot. Subjective estimates of head density, internal color, and other traits were also made at harvest. Two heads per plot were sent to The OSU Food Industries Center for culinary and light processing quality evaluation.

Overall, the June 18 planting led to slightly smaller, more dense heads with smaller cores than planting on May 11. Head density, calculated from measurements of head volume and weight, increased fourteen percent on average from May to June planting. Differences in head size, head density , and core dimensions between May and June plantings were numerically small but statistically significant. Total and individual head weight, head density, and the percent of the head volume contained in the core were impacted by the interaction of genotype and planting date. Head weight in most genotypes was less in the June planting compared to the May planting. But, the magnitude of the reduction in head weight with June planting varied among genotypes. Planting in June versus May significantly changed 5-6 of eight head and core traits evaluated statistically in four genotypes. In contrast, planting in June versus May significantly changed 0-1 of eight head and core traits evaluated statistically in six genotypes. Taken together, these data may assist growers in matching varieties and planting dates more successfully.

Introduction

Variety selection is an important management decision. Diverse market demands and the need for sequential plantings complicate variety selection in fresh market cabbage production. Research-based information on how a variety responds to changes in planting date, for example, may assist growers in identifying varieties largely unaffected by planting date or in selecting varieties specifically for early or late planting.

Project Goals

The primary goal of these studies was to develop information useful to Ohio growers in selecting varieties, especially for different planting periods. These studies were also designed to help explain how the interaction between genotype and growing environment impacts specific crop traits.

To accomplish these goals, we planted a wide assortment of fresh market cabbage varieties and experimental lines in fully replicated plots in May and June. Yield and physical external and internal head traits were recorded. Samples were also submitted to The OSU Food Industries Center for culinary and light processing quality evaluation. Additional samples were retained for isothiocyanate analysis in the lab.

Isothiocyanates impart flavor and may affect human health.

Materials and Methods

Transplant Production. Entries were solicited from cooperating seed companies in winter 1998-99 (Table 1). Transplants were seeded in early 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. The experiment contained five replications per entry per planting, two planting dates (May 11, June 18), twenty-three entries planted in May, and twenty-six entries planted in June. The two-row plots were established with a cone-type two-row transplanter. Each row was 15 ft. long (each row containing approx. 17 plants), with 30 in. between rows and 10 in. 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 1998. Ammonium nitrate was broadcast to supply 70 lb N/A on May 1, 1999. 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. Irrigation was applied on July 1 (0.10 in.) and July 16 (0.5 in.).

Data Collection (Field). Plots were reviewed two-three times weekly 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, ten consecutive heads were removed from one row in each plot. These heads were weighed untrimmed as a group and individually. Five marketable heads were then selected at random from the ten-head group for further evaluation. Five outer leaves were removed from the five heads before they were re-weighed individually. Thereafter, the polar and equatorial diameter of each whole head were recorded. Heads were then cut in half longitudinally and the core length and base width recorded.

Additional Quality Analysis. Two heads remaining from the ten-head group collected at harvest were sent to The OSU Food Industries Center for further evaluation.

Statistical Analysis. Head density was estimated at harvest and 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. Plots of untrimmed weight (kg) by polar diameter (cm.) were also prepared from data of twenty-five individual heads per entry per planting.

Results

Overall, for the twenty-three entries planted in both May and June, the planting date (PD) by entry (E) interaction was significant for head weight (total 10, average single), head density, core length, and the percent of the head volume occupied by the core (Table 3). The effects of PD and E on other head traits (diameters, core size) were largely independent.

Among entries planted in both May and June, average head weight ranged from 0.71 kg - 1.79 kg in spring and 0.82 kg - 1.46 kg in summer. Small changes in average head weight due to planting date led to shifts in the rank order of entries for average head weight within a planting date. Examples of this shift in rank order in average head weight due to planting date include: i) entry #22 being ranked 6th in average head weight in spring and 1st in summer, ii) entry #9 being ranked 5th in average head weight in spring and 2nd in summer, and iii) entry #1 being ranked 7th in average head weight in spring and 3rd in summer(Table 9). Similar results were found for the effect of planting date when tested within individual entries (Table 8). Individual entries were unchanged, moderately changed, or significantly changed by different planting dates (Table 8). For example, 0-1 of the eight factors studied were significantly effected by planting date in nine entries. In contrast, 5-6 of the eight factors studied were changed by planting date in five entries (Table 8).

The effect of planting date was significant in all variables studied, except head equatorial diameter and the percent of the head volume occupied by the core (Table 3). Heads removed from plots planted in May tended to be heavier, larger, and contain larger cores than heads removed from plots planted in June (Table 4). However, the effect of planting date on head weight, density, and core size were specific to entry (see PD x E discussion above). Differences between planting date in head and core size and head density were numerically small but statistically significant (Table 4).

Estimates of head density were calculated from replicate averages of whole head weight and polar diameter. Average head density was twelve percent greater in the June planting than the May planting (Table 4). Interestingly, a generally consistent relationship was found between polar head diameter and head density for the 569 and 645 individual heads analyzed from the May and June plantings, respectively (Figure 1). While head density varied within a particular head polar diameter, head density tended to remain constant across different head sizes and between May and June plantings for the entries studied here (Figure 1). Similar plots to those shown in Figure 1 for individual entries are available and will be provided upon request.

Interpretation

Variety selection is an important management decision. Diverse markets and the need for sequential plantings complicate variety selection in fresh market cabbage. Research-based information on how a variety responds to changes in planting date, for example, may assist growers in identifying varieties largely unaffected by planting date or in selecting varieties specifically for early or late planting.

The 1999 season was characterized for above average temperatures and below average rainfall (Table 2).

Moisture deficits persisted throughout crop development in these studies. For example, rainfall was well below average for the period during which the June-planted fresh market type crop developed, especially in the first and last 25 days of the 100-day period described in Table 2.

Planting date and entry had statistically significant effects on nearly all of the traits studied. It is possible, though, that the physical changes (e.g., head weight and size) in many entries following later planting or differences among some entries may be undetectable in many real-world scenarios. Changes in head density, maturity, and other factors may be very important to growers and consumers, however. Growers are encouraged to review the following tables to identify entries with head, core, or maturity characteristics that will be optimal for their unique situation.

For more information on this project or report, please contact Matt Kleinhenz (ph. 330-263-3810; E-mail kleinhenz.1@osu.edu).

Table 1. Fresh market cabbage genotypes planted at the Vegetable Crops Research Branch in Fremont, OH in 1999.

Entry	#	Evaluated in 1998?	Date Planted	Date Harvested	# of Days to Harvest
AC780	1	no	11-May	30-Aug	112
			18-Jun	17-Oct	122
AC790	2	no	11-May	19-Aug	101
			18-Jun	29-Sep	104
AC831	3	no	11-May	7-Sep	120
			18-Jun	19-Oct	124
AC841	4	no	11-May	12-Aug	94
			18-Jun	19-Oct	124
Atlantis	5	no	11-May	19-Jul	70
			18-Jun	26-Aug	77
Blue Dynasty	6	no	11-May	19-Aug	100
			18-Jun	7-Sep	82
Bobcat	8	yes	11-May	26-Jul	77
			18-Jun	30-Aug	74
Bronco	9	yes	11-May	5-Aug	84
			18-Jun	7-Oct	112
Cheers	10	no	11-May	29-Jul	80
			18-Jun	29-Sep	104
Columbia	11	no	11-May	19-Jul	70
			18-Jun	23-Aug	67
Discovery	12	yes	11-May	15-Jul	66
			18-Jun	23-Aug	67
DPSX 315	13	yes	11-May	19-Aug	101
			18-Jun	29-Sep	104
Emblem	14	no	11-May	29-Jul	80
			18-Jun	7-Sep	82
Fresco	15	yes	11-May	26-Jul	77
			18-Jun	7-Sep	82
Gideon	16	yes	11-May	26-Aug	108
			18-Jun	7-Oct	112
Red Dynasty	19	yes	11-May	16-Aug	98
			18-Jun	7-Oct	112
Rocket	20	yes	11-May	15-Jul	66
			18-Jun	23-Aug	67
Silver Dynasty	21	yes	11-May	23-Aug	105
			18-Jun	19-Oct	124
Superelite	22	yes	11-May	23-Aug	105
			18-Jun	19-Oct	124
Supreme Vantage	23	no	11-May	15-Jul	66
			18-Jun	23-Aug	67
Sure Vantage	24	no	11-May	19-Aug	101
			18-Jun	7-Oct	112
Vantage Point	25	no	11-May	26-Aug	108
			18-Jun	29-Sep	104
Morris	27	no	11-May	15-Jul	66
			18-Jun	26-Aug	70
Blue Gem	28	yes	18-Jun	7-Sep	82
Gourmet	29	no	18-Jun	7-Sep	82
Little Rock	30	no	18-Jun	7-Oct	112

Table 2. Climatic data for fresh market cabbage experiments planted at the Vegetable Crops Branch in Fremont, OH in 1999 on May 11 (Planting 1) and June 18 (Planting 2).

	Average Temp. (F)		------ Precipitation (in.) -------		
	High	Low	Actual	Normal	deficit
Planting 1					
May 11 - June 5 (25 d)	74.5	49.2	2.66	3.4	- 0.74
June 6 - July 26 (50 d)	85.9	58.9	4.71	6.5	- 1.79
July 27 - Aug. 21 (25 d)	83.0	56.7	1.92	3.0	- 1.08
Total			9.29	12.9	- 3.61
Planting 2					
June 18 - July 13 (25 d)	84.1	57.9	0.83	3.3	- 2.47
July 14 - Sept. 2 (50 d)	83.5	57.1	4.82	5.6	- 0.78
Sept. 3 - Sept. 28 (25 d)	79.7	46.3	0.31	2.7	- 2.39
Total			5.96	11.6	- 5.64

Irrigation was supplied on July 1 (0.10 in.) and July 16 (0.50 in.).

Table 3. Influence of planting date and entry on yield and head traits for twenty-three genotypes of fresh market cabbage planted on May 11 and June 18, 1999 at the Vegetable Crops Research Branch in Fremont, OH. Only those entries planted in both May and June were included in analysis.

		head yield		head			core		
		10 heads	average head	density	head diameter (cm.)		length	base width	volume as %
Source	df	weight (kg)		(g/cm^{-3})	polar	equatorial	(cm.)	(cm.)	of head volume
		Pr > F							
Planting Date (PD)	1	<0.0001	<0.0001	<0.0001	<0.0001	0.1180	<0.0001	<0.0001	0.7006
Entry (E)	22	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
PD x E	22	0.0131	0.0124	0.0036	0.2875	0.2495	0.0859	0.1056	0.0051

Table 4. Influence of planting date on yield and head traits for twenty-three genotypes of fresh market cabbage planted at the Vegetable Crops Research Branch in Fremont, OH in 1999. Only those entries planted in both May and June were included in analysis.

		head yield		head			core		
		10 heads	average head	density	head diameter (cm.)		length	base width	volume as %
Planting Date	N	weight (kg)		(g/cm^{-3})	polar	equatorial	(cm.)	(cm.)	of head volume
May 11, 1999	114	12.60 a	1.26 a	0.782 b	14.48 a	13.34 a	6.76 a	3.07 a	1.08 a
June 18, 1999	115	10.88 b	1.09 b	0.888 a	13.29 b	13.08 b	6.35 b	2.78 b	1.06 a
$L.S.D._{(0.10)}$		0.55	0.06	0.031	0.23	0.27	0.15	0.06	0.06

Table 5. Yield and head traits for twenty-three genotypes of fresh market cabbage planted on May 11, 1999 in Fremont, OH.

Entry	Entry #	Head Yield			Head Diameter		Core		
		10 heads	average head	head density	polar	equatorial	length	base width	head volume in core
		weight (kg)		(g/cm^3)	(cm.)				%
AC780	1	15.1	1.5	0.8	15.1	14.8	6.3	3.1	0.8
AC790	2	14.5	1.4	1.0	14.0	14.5	6.9	2.8	1.0
AC831	3	9.5	0.9	0.7	13.5	11.5	6.8	2.9	1.1
AC841	4	10.0	1.0	0.7	13.8	12.4	7.0	2.9	1.2
ATLANTIS	5	8.4	0.8	0.6	13.6	10.8	5.5	2.8	0.9
BLUE DYNASTY	6	13.5	1.4	0.8	14.7	13.7	6.5	2.9	0.9
BOBCAT	8	16.3	1.6	1.0	14.7	14.3	6.5	3.2	1.1
BRONCO	9	14.9	1.5	0.8	15.8	14.3	6.7	3.9	1.3
CHEERS	10	13.7	1.4	0.8	14.7	14.6	7.3	3.0	1.0
COLUMBIA	11	9.3	0.9	0.7	13.7	11.9	6.5	3.2	1.3
DISCOVERY	12	7.6	0.8	5.3	12.8	11.6	6.7	3.2	1.6
DPSX 315 (red)	13	10.7	1.1	1.0	12.7	12.5	6.4	2.9	1.3
EMBLEM	14	10.8	1.1	0.8	13.8	12.8	7.4	2.9	1.2
FRESCO	15	14.4	1.4	0.8	15.2	14.4	6.9	3.1	0.9
GIDEON	16	13.9	1.4	0.8	15.1	12.9	5.9	3.0	0.8
RED DYNASTY	19	10.3	1.0	0.7	14.6	11.9	6.8	3.4	1.3
ROCKET	20	9.5	0.9	5.4	13.9	13.1	7.5	3.1	1.3
SILVER DYNASTY	21	15.9	1.6	0.9	14.8	13.4	5.7	2.5	0.5
SUPERELITE	22	15.8	1.6	0.9	14.9	14.9	7.2	3.0	1.0
SUPREME VANTAGE	23	9.6	1.0	6.4	13.4	12.5	6.7	3.0	1.3
SURE VANTAGE	24	17.0	1.7	0.9	15.4	15.1	7.2	3.1	0.9
VANTAGE	25	13.8	1.4	0.9	14.3	14.1	7.3	2.8	1.0
MORRIS	27	9.8	1.0	6.5	13.4	12.9	5.8	3.1	1.2
$DMRT_{(0.10)}$		4.14	0.41	0.20	1.52	1.74	0.95	0.48	0.38

Table 6. Yield and head traits for twenty-six genotypes of fresh market cabbage planted on June 18, 1999 in Fremont, OH

		Head Yield			Head Diameter		Core		
Entry	Entry#	10 heads weight (kg)	average head weight (kg)	head density (g/cm^3)	polar (cm.)	equatorial (cm.)	length (cm.)	base width (cm.)	head volume in core %
AC780	1	13.1	1.3	1.1	13.0	13.2	6.7	2.8	1.2
AC790	2	10.5	1.1	1.1	12.4	13.9	6.9	2.8	1.4
AC831	3	9.0	0.9	0.9	12.5	11.9	6.3	2.6	1.1
AC841	4	10.7	1.1	1.0	12.7	12.2	5.7	2.2	0.7
ATLANTIS	5	10.7	1.1	0.7	14.1	13.3	5.7	2.9	0.9
BLUE DYNASTY	6	11.6	1.2	0.8	13.6	13.6	6.1	2.7	0.9
BOBCAT	8	10.9	1.1	0.8	14.0	14.0	6.0	2.9	0.9
BRONCO	9	14.8	1.5	0.9	14.5	14.4	6.5	3.4	1.3
CHEERS	10	10.7	1.1	0.9	13.0	12.8	6.4	2.8	1.1
COLUMBIA	11	9.8	1.0	1.9	13.7	12.4	6.9	3.1	1.3
DISCOVERY	12	9.1	0.9	1.0	12.0	11.9	6.6	2.8	1.5
DPSX 315 (red)	13	9.6	1.0	1.1	12.1	12.3	6.5	3.0	1.7
EMBLEM	14	10.5	1.1	0.8	13.8	13.5	6.8	3.0	1.2
FRESCO	15	13.4	1.4	0.8	14.7	14.0	6.6	2.9	0.9
GIDEON	16	12.7	1.3	0.8	14.6	13.1	6.0	3.1	0.9
RED DYNASTY	19	9.6	1.0	1.9	13.7	12.7	7.0	2.9	1.1
ROCKET	20	9.2	0.9	0.7	13.3	12.4	6.6	2.5	0.9
SILVER DYNASTY	21	12.7	1.3	0.9	14.0	13.3	4.9	2.6	0.6
SUPERELITE	22	13.3	1.3	2.1	14.0	14.2	6.9	2.8	1.0
SUPREME VANTAGE	23	9.4	0.9	0.7	13.8	12.3	6.7	2.7	0.9
SURE VANTAGE	24	12.6	1.3	0.9	13.7	14.3	6.6	2.8	1.0
VANTAGE	25	12.5	1.3	2.1	14.1	14.0	7.1	2.8	1.0
MORRIS	27	9.3	0.9	0.8	13.3	13.5	6.2	2.7	0.9
BLUE GEM	28	11.9	1.2	0.9	13.7	14.5	6.9	2.7	1.0
GOURMET	29	11.0	1.1	0.9	13.4	14.1	7.1	2.7	1.1
LITTLE ROCK	30	12.0	1.2	1.1	12.7	12.6	6.4	2.7	1.2
$DMRT_{(0.10)}$		2.65	0.26	0.17	1.23	1.66	0.89	0.24	0.28

Table 7. Average yield and head traits for twenty-three genotypes of fresh market cabbage planted on May 11 and June 18, 1999 in Fremont, OH.

		Head Yield			Head Diameter		Core		
		10 heads	single head	head density	polar	equatorial	length	base width	head volume in core
Entry	Entry #	weight (kg)		(g/cm^3)	(cm.)				%
AC780	1	14.1	1.4	1.0	14.1	14.0	6.5	2.9	1.0
AC790	2	12.5	1.3	1.0	13.2	14.2	6.9	2.8	1.2
AC831	3	9.2	0.9	0.8	13.0	11.7	6.6	2.7	1.1
AC841	4	10.3	1.0	0.9	13.3	12.3	6.4	2.6	0.9
ATLANTIS	5	9.6	1.0	0.7	13.8	12.0	5.6	2.9	0.9
BLUE DYNASTY	6	12.5	1.3	0.8	14.2	13.7	6.3	2.8	0.9
BOBCAT	8	13.6	1.4	0.9	14.3	14.2	6.3	3.1	1.0
BRONCO	9	14.8	1.5	0.8	15.1	14.4	6.6	3.7	1.3
CHEERS	10	12.2	1.2	0.9	13.9	13.7	6.9	2.9	1.1
COLUMBIA	11	9.5	1.0	1.3	13.7	12.1	6.7	3.1	1.3
DISCOVERY	12	8.3	0.8	3.2	12.4	11.7	6.7	3.0	1.5
DPSX 315 (red)	13	10.2	1.0	1.0	12.4	12.4	6.4	3.0	1.5
EMBLEM	14	10.7	1.1	0.8	13.8	13.2	7.1	3.0	1.2
FRESCO	15	13.9	1.4	0.8	14.9	14.2	6.7	3.0	0.9
GIDEON	16	13.3	1.3	0.8	14.9	13.0	6.0	3.0	0.8
RED DYNASTY	19	9.9	1.0	1.3	14.2	12.3	6.9	3.1	1.2
ROCKET	20	9.3	0.9	3.1	13.6	12.7	7.1	2.8	1.1
SILVER DYNASTY	21	14.3	1.4	0.9	14.4	13.4	5.3	2.5	0.6
SUPERELITE	22	14.5	1.5	1.5	14.4	14.6	7.1	2.9	1.0
SUPREME VANTAGE	23	9.5	1.0	3.6	13.6	12.4	6.7	2.8	1.1
SURE VANTAGE	24	14.8	1.5	0.9	14.5	14.7	6.9	2.9	1.0
VANTAGE	25	13.1	1.3	1.5	14.2	14.0	7.2	2.8	1.0
MORRIS	27	9.6	1.0	3.6	13.4	13.2	6.0	2.9	1.1

Table 8. Influence of planting date on yield and head traits for twenty-three genotypes of fresh market cabbage planted on May 11 and June 18, 1999 at the Vegetable Crops Research Branch in Fremont, OH. An asterisk ("*") indicates that planting date significantly effected the variable listed within the genotype according to the Fisher Least Significant Difference test ($\propto$ = 0.10).

Entry		N	head yield: 10 heads weight (kg)	head yield: average head weight (kg)	head density (g/cm^{-3})	core: head diameter (cm.) polar	core: head diameter (cm.) equatorial	core: length (cm.)	core: base width (cm.)	core: volume as % of head volume	# of traits of 8 effected by planting date
AC 780	1	10			*	*	*		*	*	5
AC 790	2	10	*	*		*				*	4
AC 831	3	10			*	*			*		3
AC 841	4	10			*	*		*	*		4
Atlantis	5	9					*				1
Blue Dynasty	6	10				*			*		2
Bobcat	8	10	*	*		*		*	*		5
Bronco	9	10			*	*				*	3
Cheers	10	10	*	*		*	*	*	*		6
Columbia	11	10							*	*	2
Discovery	12	10			*				*		2
DPSX 315	13	10									0
Emblem	14	10						*			1
Fresco	15	10			*				*		2
Gideon	16	10				*					1
Red Dynasty	19	10			*	*					2
Rocket	20	10			*	*	*		*	*	5
Silver Dynasty	21	10									0
Superelite	22	10								*	1
Sup. Vantage	23	10									0
Sure Vantage	24	10	*	*	*	*		*	*		6
Vantage Point	25	10									0
Morris	27	10							*		1
	# comparisons of 23 significant		4	4	9	12	4	5	12	6	

Table 9. Fresh market cabbage entries ranked from high to low in average head weight after planting on May 11 and June 18, 1999 in Fremont, OH.

Rank	Entry		Entry	Rank		Change With Summer
	Spring	Summer		Spring	Summer	
1	8	22	1	7	3	4
2	24	9	2	10	11	1
3	21	1	3	21	21	0
4	16	16	4	16	10	6
5	9	15	5	22	16	6
6	22	21	6	12	9	3
7	1	25	8	1	14	-13
8	10	24	9	5	2	3
9	25	6	10	8	13	-5
10	2	4	11	20	12	8
11	15	2	12	23	22	1
12	6	11	13	14	18	-4
13	14	10	14	13	15	-2
14	13	8	15	11	5	6
15	19	14	16	4	4	0
16	4	5	19	15	17	-2
17	23	19	20	19	23	-4
18	27	13	21	3	6	-3
19	20	27	22	6	1	5
20	11	23	23	17	20	-3
21	3	3	24	2	8	-6
22	5	12	25	9	7	2
23	12	20				

Table 10. Plant characteristics of fresh market cabbage entries after planting on May 11 and June 18, 1999 in Fremont, OH.

Entry	Entry #	Planting 1=early 2=late	Frame[1] Uprightness	Frame[2] Size (1-5)	Head[3] Shape	Internal Density[4] (1-5)	Internal[5] Color	Midrib[6] Size (1-5)
AC780	1	1	U-T	3.4	R	1	CR	2
		2	VT	3	R-F	1.1	CR	2.6
AC790	2	1	ST	3.6	F-R	2.2	CR-W-GR	2.4
		2	VT	4.2	F	2	CR-GR	2.4
AC831	3	1	U	3.6	R-E	1.2	R	2
		2	T	4.6	R-F	1.8	R	2
AC841	4	1			R-T	1.2	R	3.4
		2	U-SLT	4.2	R-F	1	R	2.2
ATLANTIS	5	1				2	W-CR	2.2
		2	ST-VT	4.5	R	2	CR-Y	2.5
BLUE DYNASTY	6	1	U-ST	4	R	1.2	W	3
		2	ST-VT	3.4	R	2	W-CR	2.6
BOBCAT	8	1	SLT	2	R	3	CR	3
		2	ST	3.6	R-F-O	3.2	CR-Y	3
BRONCO	9	1	U	3.2	R-E-T	1	W-GR	2
		2	ST-VT	3.8	R-P	1	CR	2.4
CHEERS	10	1	SLT	2.2	R	3.4	CREAM	3
		2	SLT-VT	3.2	R-P	1.2	CR-W	2
COLUMBIA	11	1	ST		R	2.2	CR	3
		2	ST	5	R-T	3	CR	3
DISCOVERY	12	1			R	2	W	2.2
		2	ST	4.6	R	2.2	CR-Y	2
DPSX 315 (red)	13	1	ST	2.4	R	2	R	3.4
		2	SLT	3.2	R-F	1.6	R	2.4
EMBLEM	14	1	SLT	3.2	R	5	W	3
		2	SLT	3.4	R-F	3.6	CR	2
FRESCO	15	1	SLT	3.2	T	2.4	CR	3
		2	ST	3.4	R-F	2.8	CR	3.4
GIDEON	16	1	U	2.8	R-E	1	CR	2
		2	SLT-VT	3.6	R	1	CR-Y	2.4
RED DYNASTY	19	1	U-ST	3.6	T	1	R	4
		2	SLT-VT	4	R	2	R	3
ROCKET	20	1			R	2.6	CR	3
		2	U-ST	4.6	R	3.6	CR-GR	2.8
SILVER DYNASTY	21	1	U-ST	2.8	R-E	1.2	CR-W	2.8
		2	SLT-VT	2.8	R	1.6	CR-W	2.6
SUPERELITE	22	1	U-ST		R		CR-W	
		2	ST-VT	2.2	R-F	1.2	CR-W	2.8
SUPREME VANTAGE	23	1			R	3.4	CR	3
		2	U-ST	4.8	R	4.2	CR-Y	3.8
SURE VANTAGE	24	1	U-ST	2.6	R	2	W	2
		2	SLT-VT	4.2	R-F	2	CR	2.2
VANTAGE	25	1	U-ST-VT	3	R-F	1	CR-W	2
		2	SLT-VT	3	R-F	1.8	CR	2.4
MORRIS	27	1			R	3	CR	3
		2	ST	4.6	R-F	2.4	CR-Y	2.6
BLUE GEM	28	2	ST-VT	4	R-F	1.8	CR-W	2.2
GOURMET	29	2	VT	4.8	R-F	3.2	CR-W	2.2
LITTLE ROCK	30	2	SLT-VT	4.6	R-F-O	1.2	CR	2

[1]Uprightness: U=upright, S=slightly tipped, T=tipped, V=very tipped

[2]Frame size: 1=large, 5=small

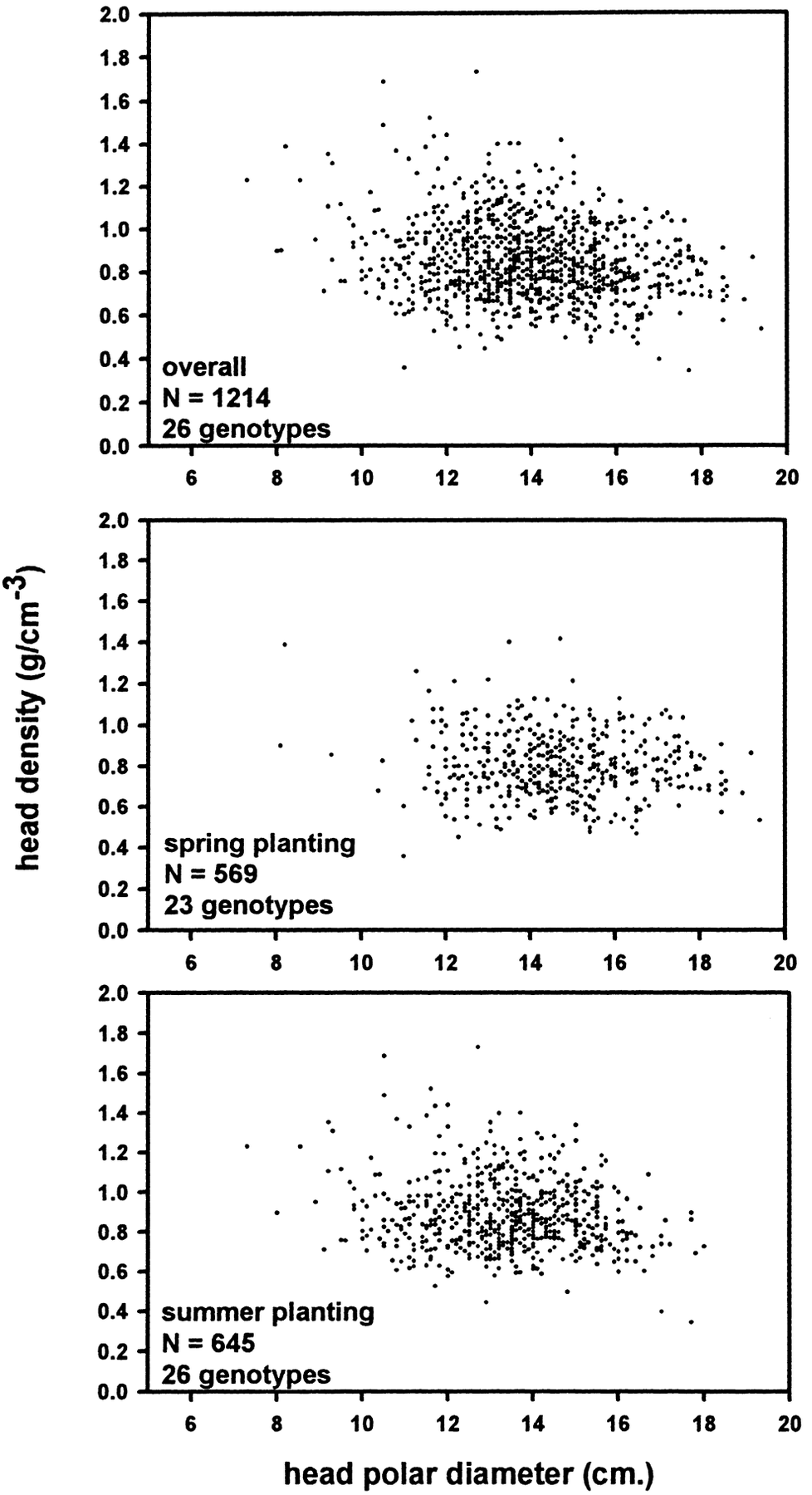
[3]Shape: R=round, T=teardrop, E=egg, P=pointed, O=odd shape

[4]Density: 1=dense, 5=open air space within head

[5]Internal color: W=white, CR=cream, Y=yellow

[6]Midrib: 1=small, 5=large

Figure 1. Relationship between Fresh Market Cabbage Head Size and Density in Ohio in 1999.



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