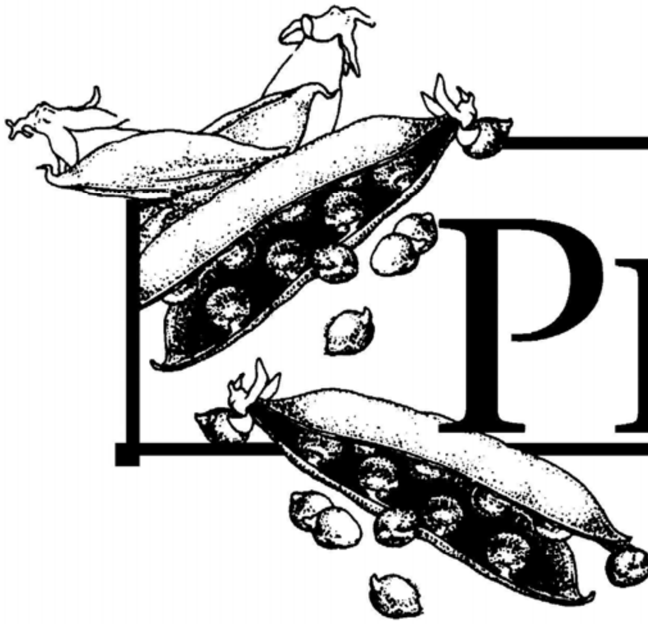
University of Delaware



PEA

Variety Trial Results

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2012

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Crites Seeds, Inc.
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2012 University of Delaware Pea Variety Trial

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Introduction

The 2012 Pea Variety Trials were conducted at the University of Delaware Research and Education Center. The purpose of these trials is to evaluate and identify varieties best adapted for our production region. Yield, quality and maturity are important characteristics that can vary for any one variety between production regions. Similar trials have been conducted on the farm since 1994.

Trials were planted on two dates (mid- March and mid-April) to place the varieties in the planting season appropriate for their maturity classification. This year's trials were planted on March 15 and April 13. Early maturing varieties are generally planted during the first half of the planting season and longer maturing varieties are planted in the second half. Later plantings are exposed to warmer conditions, which generate quicker accumulations of heat units. Thus, longer maturing varieties are used in later plantings.

Materials and Methods

Planting and Crop Management

Twenty-eight varieties were planted in the March 15 trial, and 18 varieties in the April 13 trial. The trials were located in Field 19-B at the University of Delaware Research Farm in Georgetown, DE. Both were irrigated as needed, and grown under standard commercial management practices. Weed control in both trials was excellent.

Planting Date:	**Early Trial** – March 15, 2012; 28 varieties **Late Trial** – April 13, 2012; 18 varieties
Herbicide:	Pursuit @ 2 oz/A + Dual II Magnum @ 1 pt/A, preemergence with 30% UAN at 25 gal/A (applied 3-16-12 and 4-16-12)
Planting:	Trials were planted using an Almaco drill with 9 rows spaced 8 inches apart. Seeding rate was 8 to 9 seeds per foot of row.
Stands:	**Early Trial –** stands were variable because of seed corn maggot damage **Late Trial -** stands were excellent
Plot Design:	6 x 30 foot plots arranged in a randomized complete block design with 3 replications

Varieties in the 2012 Early Pea Trial

Variety	Company
Assist	Brotherton Seed Co. Inc.
BSC2210	Brotherton Seed Co. Inc.
BSC3129	Brotherton Seed Co. Inc.
BSC2030	Brotherton Seed Co. Inc.
BSC5760	Brotherton Seed Co. Inc.
BSC5641	Brotherton Seed Co. Inc.
CS-430AF*	Crites Seeds, Inc.
CMG-416AF*	Crites Seeds, Inc.
CS-424F	Crites Seeds, Inc.
CS-432F	Crites Seeds, Inc.
Salinero (XP08520702)	Monsanto Vegetable Seed
Pizarro*	Monsanto Vegetable Seed
EX 08570935*	Monsanto Vegetable Seed
Reliance* (XP08540793)	Monsanto Vegetable Seed
Sherwood	Monsanto Vegetable Seed
PA0826 (EX 08250826)	Monsanto Vegetable Seed
Strike	Pure Line Seeds, Inc.
PLS-M14	Pure Line Seeds, Inc.
PLS-534*	Pure Line Seeds, Inc.
PLS-304*	Pure Line Seeds, Inc.
PLS-046	Pure Line Seeds, Inc.
FP2311*	Seneca Foods
FP2269*	Seneca Foods
FP2292	Seneca Foods
FP2289*	Seneca Foods
Icebreaker*	check variety
Cabree	check variety
Icepack*	check variety

***Afila Variety**

Varieties in the 2012 Late Pea Trial

Variety	Company
BSC4551	Brotherton Seed Co. Inc.
BSC5091	Brotherton Seed Co. Inc.
CS-433AF*	Crites Seeds, Inc.
CS-426AF*	Crites Seeds, Inc.
CMG-401AF*	Crites Seeds, Inc.
EXP-06325	Crites Seeds, Inc.
EX 08260893	Monsanto Vegetable Seed
Hyperion* (XP08250833)	Monsanto Vegetable Seed
Maurice* (XP08250838)	Monsanto Vegetable Seed
Prometheus (EX08560906)	Monsanto Vegetable Seed
Mundial	Monsanto Vegetable Seed
PLS-566*	Pure Line Seeds, Inc.
PLS-116	Pure Line Seeds, Inc.
PLS-1051	Pure Line Seeds, Inc.
PLS-183*	Pure Line Seeds, Inc.
PLS-167*	Pure Line Seeds, Inc.
PLS-196*	Pure Line Seeds, Inc.
Ashton	check variety

Pre Harvest Data

Stand counts of emerged plants were completed on April 9, 2012 for the Early Trial (25 DAP) and on May 4, 2012 (21 DAP) for the Late Trial. The number of emerged plants was counted for a three foot long section of row in three (Early Trial) or four (Late Trial) randomly selected locations in each plot. The date of first flower and peak flowering was noted for each plot.

Harvest Procedure

Each variety was harvested as near to a tenderometer reading of 100 as possible. Pre-harvest samples were taken two to three days prior to reaching this maturity level whenever possible. All three replications for each variety were harvested on the same day.

Plants were pulled from a 6 x 25 foot section of the plot (150 ft^2). The vines were weighed and fed into a stationary FMC viner. Shelled peas were collected and cleaned (removing leaves, stones, and other trash). The clean, shelled peas were weighed. A 700 g sub-sample was put through a size separator that segregated peas into the following sizes according to their diameter:

12/32 inch or greater (#4 sieve size); between 11/32 and 12/32 inch (#3 sieve size); between 9/32 and 11/32 inch (#1 and #2 sieve size); and peas smaller than 9/32 inch (trash). After each size was weighed, peas with sieve sizes 1 through 4 were recombined into a bulk sample with the smallest (trash) peas removed. Three tenderometer readings were taken from this bulked sample. The average is reported.

Ten plants were taken from each variety and the following measurements were taken: vine length; number of nodes setting usable pods; number of pods per plant; pod length; and peas per pod. Statistics for pod length and number of peas per pod were calculated based on ten pods that were randomly selected from the ten sampled plants.

Discussion of Trial Results

The results for the two trials are reported in separate sections. Each section consists of twelve tables of results and one chart. In most tables the variety means are listed in descending order. Means followed by the same letter are not significantly different as determined by Fischer's protected LSD with 5% error (α=0.05). The LSD value and p-value for the effect of the independent variable are included at the bottom of each table.

Rainfall was below average during the time the trials were conducted and irrigation was necessary. Temperatures were higher than average in mid-March when the Early Trial was planted. Plants emerged in less than one week after planting, which is very unusual for this planting date. Temperatures were average or below average at the end of March and average for April. May was warmer than average, especially the end of the month when the varieties in the Early Trial were being harvested. Harvest of the Early Trial began on May 19, which is about a week earlier than the typical first harvest date for this trial. The harvest of the Late Trial was delayed and spread out, partly as a result of a week of cooler than average weather from June 13 through 19. Complete weather data and heat unit accumulation for the trials is included in Appendices A & B.

Tables 2E and 2L report the average stand counts, percent stand and seed treatment components for each variety in the trial. Although the Early Trial emerged very quickly, we still saw reduced stands for some varieties which were at least partially caused by seed corn maggot. Seed corn maggot damage is not uncommon in early planted peas in Delaware and is sometimes observed in this trial. Varieties that had been treated with an insecticide (either Cruiser or Lorsban) fared better than those that had not. Stands in the Late Trial were excellent for all varieties and no seed corn maggot damage was observed in this planting.

Tables 3E and 3L report the net and gross yields adjusted to a tenderometer reading of 100. The adjustment calculation procedure is based on the method described by Pumphrey *et al.* (see Appendix C: Adjusting Pea Yields to a T-Reading of 100). Briefly, the adjustment factor (Y) is the percent of yield at a T-reading of 100 for the T-reading at harvest (X).

$$Y = -1059.1 - 8.405X + 200X^{1/2}$$

and

$$\text{Yield adjusted to a T-reading of 100} = \frac{\text{Yield at T-reading } X}{(Y/100)}$$

The net yield is calculated by subtracting the percent of peas smaller than 9/32 inch, trash, (as determined by sizing of a 700 g sub-sample) from the gross yield.

Yields in the Early Trial were slightly lower than what we have seen in past years for this trial. The highest yielding variety in the early trial was CS-424F, which was also one of the latest varieties in the trial. BSC 3129, CS-432F, CMG-416AF, BSC2030 also were not significantly different than CS-424F in terms of yield and matured at a similar time. BSC2210, PLS-046 and PLS-M14 were also not significantly different than CS-424F in terms of yield, but matured earlier. Assist was the earliest maturing variety in the trial and produced the highest yield of the early varieties (Chart 1E). Low yields in the early check varieties Icepack and Icebreaker were partially due to low stands for these two varieties. Strike and CS-430 had matured at a similar time to the early check varieties (Icebreaker, Icepack and Cabree) and had significantly higher yields than Icepack and Icebreaker and numerically higher yields than Cabree.

Yields in the Late Trial were average or above average compared to what we have seen in past years for this trial. The highest yielding variety in the late trial was CS-433AF. Prometheus, BSC4551, EX 08260893 and Mundial were not significantly different than CS-433AF in terms of yield. The aforementioned varieties and PLS-566 all had significantly higher yields than the trial check variety, Ashton. In this trial there were some varieties that matured several days later than the standard late varieties. Maurice was the latest maturing variety in the trial, and was harvested at T-reading of 96 five days after Ashton. Prometheus was also very late maturing and had a significantly higher yield than Maurice. As mentioned previously, the cooler than average weather during the end of the Late Trial harvest probably slowed down the later varieties and spread out harvest longer than would be expected in a more typical year.

Early Trial Pre-Harvest Data

Table 1E: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Assist	41	524	46	580
BSC2210	42	540	46	580
Salinero	43	550	49	647
Cabree	43	550	49	647
Strike	43	550	50	673
Pizarro	44	555	50	673
Sherwood	44	555	50	673
Icebreaker	44	555	50	673
CS-430AF	45	567	50	673
FP2289	45	567	50	673
Icepack	45	567	50	673
FP2292	45	567	50	673
FP2269	46	580	50	673
PLS-046	46	580	52	713
PA0826	46	580	53	729
PLS-M14	47	609	50	673
PLS-534	48	625	53	729
PLS-304	48	625	53	729
CMG-416AF	48	625	53	729
FP2311	48	625	53	729
Reliance	48	625	59	863
CS-424F	49	647	54	756
CS-432F	50	673	54	756
BSC3129	50	673	54	756
BSC2030	51	697	59	863
EX 08570935	52	713	59	863
BSC5760	52	713	60	890
BSC5641	53	729	60	890

Table 2E: Stand Counts (Plants/Yard), Percent Stand, and Seed Treatment

Variety	Plants/Yd		% Stand (at 8 seeds/ft)	Seed Treatment					
				Captan	Alliegence	Maxim	Apron	Cruiser	Lorsban
Assist	24.8	a	103	x	x			x	
BSC5760	21.3	b	89	x	x			x	
CS-424F	21.2	bc	88			x	x	x	
BSC3129	21.0	bc	88	x	x			x	
PLS-304	20.6	bcd	86	x	x			x	
PLS-046	19.0	bcde	79	x	x			x	
CMG-416AF	18.9	bcdef	79			x	x	x	
Cabree	18.1	bcdef	75	x					x
PA0826	18.0	cdef	75	x	x				
Strike	17.3	def	72	x	x			x	
BSC2030	17.1	ef	71	x	x			x	
CS-430AF	16.7	efg	69			x	x	x	
CS-432F	16.7	efg	69			x	x	x	
BSC5641	16.1	efgh	67	x	x			x	
PLS-M14	15.7	fghi	65	x	x			x	
PLS-534	13.6	ghij	56	*this seed appeared to have been accidentally left untreated*					
Salinero	13.3	hij	56	x	x				
FP2311	13.3	hij	56			x	x		
Sherwood	13.1	hij	55	x	x				
BSC2210	12.9	hij	54	x	x			x	
Icepack	12.8	ij	53	x	x				
Reliance	11.4	jk	48	x	x				
Icebreaker	10.9	jkl	45	x	x				
EX 08570935	10.6	jkl	44	x	x				
FP2292	10.3	jkl	43			x	x		
FP2289	10.3	jkl	43			x	x		
Pizarro	9.1	kl	38	x	x				
FP2269	8.0	l	33			x	x		
p-value	<0.0001								
LSD	3.2332								

Early Trial Harvest Data

Table 3E: Weight of Vines from 150 ft^2 Harvest Area (lbs.)

Variety	Vine Weight (lbs.)	
BSC5641	92	a
BSC2030	90	ab
PLS-304	80	abc
BSC3129	77	abc
BSC5760	75	abc
CS-432F	75	abcd
CMG-416AF	72	bcde
PLS-046	71	cdef
CS-424F	69	cdefg
PLS-M14	68	cdefg
Strike	67	cedfgh
CS-430AF	57	defghi
PLS-534	55	efghij
Cabree	54	fghij
FP2311	52	ghij
BSC2210	52	ghij
EX 08570935	50	hijk
Assist	47	ijkl
PA0826	44	ijklm
Reliance	43	ijklm
Sherwood	43	ijklm
Salinero	39	jklmn
FP2269	33	klmn
FP2289	31	lmn
Icebreaker	30	lmn
Pizarro	29	mn
FP2292	24	n
Icepack	22	n
p-value	<0.0001	
LSD	17.72	

Table 4E: Net Yields (% Trash Subtracted) and Gross Yields Adjusted to a Tenderometer Reading of 100 (lbs/A)

Variety	Adj. Net Yield (lbs/A)		Adj. Gross Yield (lbs/A)	
CS-424F	5211	a	5216	ab
BSC3129	5096	ab	5491	a
CS-432F	5090	ab	5182	ab
CMG-416AF	4768	abc	4777	abc
BSC5641	4741	abc	4788	abc
BSC2030	4711	abc	4727	abc
BSC2210	4378	abcd	4417	abcd
PLS-046	4190	abcde	4363	abcd
PLS-M14	3973	abcde	4102	bcde
BSC5760	3945	bcde	4084	bcde
Strike	3870	bcdef	3923	bcdef
CS-430AF	3824	cdef	3844	cdefg
PLS-304	3566	cdefg	3809	cdefg
FP2311	3436	defgh	3501	cdefgh
Assist	3247	defghi	3355	defghi
Cabree	2988	efghij	3022	efghij
Reliance	2959	efghij	3041	efghij
EX 08570935	2661	fghijk	2757	fghijk
PLS-534	2355	ghijkl	2587	ghijkl
Sherwood	2341	ghijkl	2407	hijkl
FP2289	2278	hijkl	2289	hijkl
Salinero	2258	hijkl	2300	hijkl
FP2269	2102	ijkl	2168	ijkl
Icebreaker	1876	jkl	1912	jkl
PA0826	1843	jkl	2178	ijkl
Pizarro	1631	kl	1667	kl
FP2292	1560	kl	1609	kl
Icepack	1374	l	1394	l
p-value	<0.0001		<0.0001	
LSD	1249.4		1311.9	

Table 5E: Pea Size (% peas by weight in each class) and Tenderometer Reading at Harvest

Variety	% #4	% #3	% #1 & #2	% Trash	T-reading at Harvest
FP2289	81.6 a	14.6 p	3.4 l	0.5 hi	106 ghijk
BSC2210	80.8 a	13.0 p	5.5 kl	0.7 ghi	116 d
Pizarro	71.2 ab	18.8 op	8.1 jkl	1.9 defghi	122 c
Strike	69.6 b	21.0 no	8.1 jkl	1.2 efghi	105 hijk
Salinero	67.6 b	22.6 no	7.8 jkl	1.9 defghi	108 ghij
FP2292	61.3 bc	24.9 mno	11.2 hijk	2.6 defgh	105 hijk
Cabree	61.3 bc	30.0 klm	7.7 jkl	0.9 fghi	127 b
FP2269	60.8 bcd	26.1 lmn	10.1 ijkl	3.0 defg	102 kl
CS-430AF	52.9 cde	37.3 fghij	9.2 ijkl	0.5 hi	108 ghij
CS-432F	52.3 cde	33.0 ijk	12.9 efghij	1.8 defghi	113 def
Sherwood	50.1 de	34.0 hijk	13.2 efghij	2.7 defgh	104 ijkl
CMG-416AF	48.8 e	38.9 fghi	12.2 ghijk	0.2 i	165 a
FP2311	48.2 e	35.3 ghijk	14.4 efghi	2.0 defghi	97 m
PLS-046	46.2 ef	32.2 jkl	17.6 defgh	4.0 d	103 jkl
Icepack	44.5 efg	41.4 efg	12.6 fghij	1.4 efghi	108 ghij
CS-424F	37.1 fgh	47.5 cde	15.3 efghi	0.1 i	129 b
PLS-M14	36.5 fgh	41.2 efg	19.2 def	3.2 def	110 efgh
PLS-534	34.8 gh	32.0 jkl	23.2 cd	9.9 b	105 hijkl
PLS-304	28.3 hi	36.2 ghijk	29.1 bc	6.5 c	111 defg
Assist	26.8 hij	47.4 cde	22.9 cd	3.0 defg	100 lm
Icebreaker	26.6 hij	48.5 cd	23.2 cd	1.7 defghi	116 d
BSC2030	23.4 ijk	57.5 ab	18.7 defg	0.4 hi	114 de
Reliance	17.3 jkl	43.4 def	36.2 a	3.1 def	125 bc
BSC5641	16.9 jkl	62.4 a	19.8 de	0.9 fghi	106 hijk
PA0826	16.9 jkl	34.2 hijk	33.9 ab	15.0 a	108 fghi
EX 08570935	13.3 klm	42.6 def	40.6 a	3.5 de	121 c
BSC3129	12.4 lm	40.1 fgh	40.6 a	6.9 c	88 n
BSC5760	5.3 m	52.6 bc	38.6 a	3.4 de	130 b
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD	10.67	6.36	6.97	2.35	4.93

Table 6E: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
BSC3129	88	n
FP2311	97	m
Assist	100	lm
FP2269	102	kl
PLS-046	103	jkl
Sherwood	104	ijkl
PLS-534	105	hijkl
FP2292	105	hijk
Strike	105	hijk
BSC5641	106	hijk
FP2289	106	ghijk
CS-430AF	108	ghij
Icepack	108	ghij
Salinero	108	ghij
PA0826	108	fghi
PLS-M14	110	efgh
PLS-304	111	defg
CS-432F	113	def
BSC2030	114	de
Icebreaker	116	d
BSC2210	116	d
EX 08570935	121	c
Pizarro	122	c
Reliance	125	bc
Cabree	127	b
CS-424F	129	b
BSC5760	130	b
CMG-416AF	165	a
p-value	<0.0001	
LSD	4.93	

Plant Characteristics for Early Trial Varieties Based on a 10-Plant Sample

Table 7E: Vine Length in Centimeters

Variety	Vine Length (cm)	
CMG-416AF	55.2	a
BSC5641	54.7	a
PLS-M14	54.4	ab
BSC2030	52.9	abc
CS-432F	50.5	abcd
PLS-304	50.4	abcd
Icepack	49.8	bcd
Sherwood	49.6	bcd
PLS-534	49.5	cd
Strike	49.4	cd
BSC3129	48.7	cd
BSC5760	48.5	cd
CS-424F	47.0	de
Assist	43.5	ef
Pizarro	42.5	efg
FP2269	42.3	efg
FP2292	41.2	fgh
Salinero	41.2	fgh
EX 08570935	41.1	fgh
BSC2210	40.7	fgh
CS-430AF	40.6	fgh
Cabree	39.5	fghi
FP2311	39.0	fghi
PLS-046	38.7	fghi
Reliance	38.6	ghi
FP2289	37.2	hi
Icebreaker	35.0	i
PA0826	26.8	j
p-value	<0.0001	
LSD	4.8623	

Table 8E: Number of Pods per Plant

Variety	Pods/Plant	
PLS-534	5.6	a
FP2292	5.2	ab
BSC5641	5.0	abc
BSC3129	4.8	abcd
FP2269	4.8	abcd
Icepack	4.8	abcd
Sherwood	4.5	abcde
BSC2210	4.3	bcdef
CMG-416AF	4.3	bcdef
CS-432F	4.2	bcdef
PLS-M14	4.2	bcdef
CS-424F	4.1	bcdefg
Salinero	3.8	cdefgh
BSC2030	3.8	cdefgh
BSC5760	3.8	cdefgh
CS-430AF	3.8	cdefgh
Strike	3.8	cdefgh
FP2289	3.6	defgh
Reliance	3.5	efghi
PLS-046	3.5	efghi
FP2311	3.5	efghi
PLS-304	3.4	efghi
EX 08570935	3.3	efghi
Assist	3.1	fghi
Icebreaker	2.9	ghi
Cabree	2.9	ghi
Pizarro	2.6	hi
PA0826	2.3	i
p-value	<0.0001	
LSD	1.252	

Table 9E: Number of Pod-Bearing Nodes per Plant

Variety	Nodes w/ Pods/Plant	
FP2269	3.6	a
PLS-534	3.5	a
Sherwood	3.3	ab
FP2292	3.2	abc
CMG-416AF	3.0	abcd
Strike	3.0	abcd
Icepack	3.0	abcd
PLS-M14	2.9	abcde
Salinero	2.7	bcdef
BSC3129	2.7	bcdef
BSC5760	2.7	bcdef
BSC2210	2.6	bcdefg
CS-424F	2.6	bcdefg
CS-432F	2.6	bcdefg
PLS-046	2.5	cdefg
FP2289	2.5	cdefg
BSC5641	2.4	defg
EX 08570935	2.3	defg
Reliance	2.3	defg
Assist	2.3	defg
CS-430AF	2.3	defg
Pizarro	2.2	efgh
BSC2030	2.2	efgh
FP2311	2.1	fgh
PLS-304	2.0	fgh
Icebreaker	2.0	fgh
Cabree	1.9	gh
PA0826	1.5	h
p-value	<0.0001	
LSD	0.7112	

Table 10E: Average Number of Peas/Pod

Variety	Peas/Pod	
BSC5641	7.0	a
BSC3129	6.9	ab
PLS-304	6.8	abc
Reliance	6.7	abcd
BSC2030	6.6	abcde
Icebreaker	6.6	abcde
Sherwood	6.4	abcdef
Icepack	6.3	abcdefg
CS-432F	6.2	abcdefg
FP2269	6.2	abcdefg
BSC2210	6.1	abcdefgh
PLS-M14	6.1	abcdefgh
CS-424F	6.0	bcdefghi
FP2311	5.9	cdefghi
FP2289	5.9	cdefghi
EX 08570935	5.8	defghij
PLS-534	5.8	defghij
PA0826	5.8	defghij
Assist	5.7	efghijk
Strike	5.6	fghijk
Salinero	5.5	fghijk
Pizarro	5.5	fghijk
CMG-416AF	5.5	fghijk
PLS-046	5.4	ghijk
BSC5760	5.2	hijk
CS-430AF	5.1	ijk
FP2292	4.9	jk
Cabree	4.8	k
p-value	<0.0001	
LSD	0.9939	

Table 11E: Average Pod Length (cm)

Variety	Pod Length (cm)	
BSC5641	8.7	a
CMG-416AF	8.1	b
Strike	7.7	bc
BSC3129	7.6	bcd
BSC2030	7.6	bcd
Sherwood	7.6	bcde
CS-424F	7.5	bcdef
CS-432F	7.4	cdefg
PLS-304	7.4	cdefg
FP2311	7.4	cdefg
PLS-534	7.3	cdefgh
EX 08570935	7.3	cdefgh
BSC5760	7.3	cdefgh
Pizarro	7.2	cdefgh
Salinero	7.2	cdefgh
Reliance	7.2	cdefgh
PLS-046	7.2	cdefgh
FP2269	7.0	defghi
FP2289	7.0	efghi
PLS-M14	6.9	fghij
BSC2210	6.8	ghij
Icepack	6.8	ghij
Icebreaker	6.7	hij
Cabree	6.7	hij
FP2292	6.7	hij
CS-430AF	6.5	ijk
PA0826	6.3	jk
Assist	6.0	k
p-value	<0.0001	
LSD	0.6256	

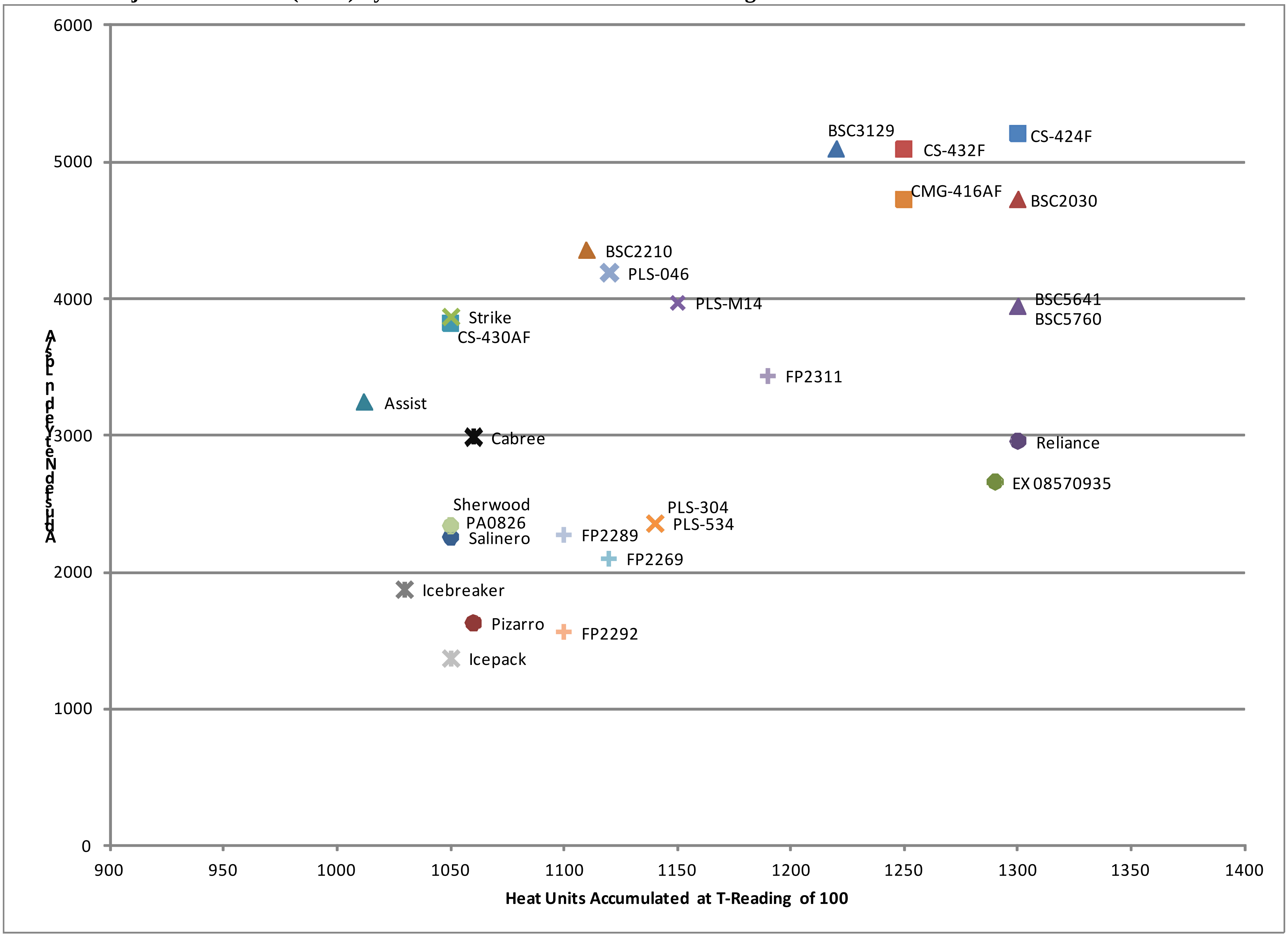
Early Trial Maturity Data

Table 12E: Tenderometer Readings Leading Up To and Including Harvest

Variety	Reported Heat Units	T-Readings Up to and Including Harvest by Date and Accumulated Heat Units													
		17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May
		974	**992**	**1012**	**1033**	**1060**	**1089**	**1120**	**1151**	**1185**	**1219**	**1255**	**1294**	**1334**	**1364**
Assist	1110	84	95	**100***											
Icebreaker	1155	86	94			**116**									
CS-430AF	1260		95			**108**									
Icepack	1170		82			**108**									
Salinero	1155	85	90			**108**									
Strike	1140	80	93			**105**									
Sherwood	1160		88			**104**									
Cabree	1170	76				103	**127**								
Pizarro	1170		74			102	**122**								
BSC2210	1160	74	80			97		**116**							
PA0826	1250							**108**							
FP2289	1190					90		**106**							
FP2292	1155					91		**105**							
PLS-046	1300					87		**103**							
FP2269	1190		68			84		**102**							
PLS-534	1300							96	**105**						
PLS-304	1350							90	99	**111**					
PLS-M14	1140							88	98	**110**					
FP2311	1250							77	84	**97**					
BSC3129	1180							76		**88**					
CMG-416AF	1310												146	**165**	
CS-432F	1370									84			**113**		
BSC5760	1350												96	**130**	
CS-424F	1370												100	**129**	
Reliance	1420												95	**125**	
EX 08570935	1340												100	**121**	
BSC2030	1200													111	**114**
BSC5641	1350												80	105	**106**

***Bold numbers indicated the day on which the variety was harvested and are an average of three samples from each of three replications**

Chart 1E: Adjusted Net Yield (lbs/A) by Heat Units Accumulated at T-Reading of 100



Late Trial Pre-Harvest Data

Table 1L: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
CS-433AF	39	779	42	875
PLS-566	39	779	43	909
BSC5091	39	779	44	945
PLS-116	39	779	44	945
BSC4551	39	779	44	945
PLS-167	39	779	45	984
CS-426AF	41	841	46	1023
PLS-1051	44	945	47	1054
PLS-196	44	945	47	1054
EX 08260893	44	945	47	1054
Ashton	45	984	47	1054
Hyperion	45	984	47	1054
CMG-401AF	45	984	47	1054
EXP-06325	45	984	47	1054
PLS-183	45	984	48	1087
Mundial	46	1023	50	1144
Prometheus	46	1023	51	1170
Maurice	48	1087	52	1195

Table 2L: Stand Counts (Plants/Yard), Percent Stand, and Seed Treatment

Variety	Plants/Yd	% Stand (at 8 seeds/ft)	Seed Treatment				
			Captan	Alliegence	Maxim	Apron	Cruiser
EXP-06325	26.2 a	109			x	x	x
Maurice	26.0 a	108	x	x			
CS-426AF	24.5 a	102			x	x	x
PLS-167	24.3 a	101	x	x			x
Mundial	24.3 a	101	x	x			
PLS-116	23.6 a	98	x	x			x
EX 08260893	23.5 a	98	x	x			
PLS-1051	23.4 a	98	x	x			x
Hyperion	23.3 a	97	x	x			
PLS-566	23.3 a	97	x	x			x
Prometheus	23.1 a	96	x	x			
CS-433AF	23.0 a	96			x	x	x
Ashton	22.7 a	94	x	x			
BSC4551	22.6 a	94	x	x			x
PLS-196	22.4 a	93	x	x			x
CMG-401AF	21.3 a	89			x	x	x
BSC5091	21.2 a	88	x	x			x
PLS-183	20.1 a	84	x	x			x
p-value	0.2708						
LSD	NA						

Late Trial Harvest Data

Table 3L: Weight of Vines from 150 ft^2 Harvest Area (lbs)

Variety	Vine Weight (lbs.)
EX 08260893	89 a
CMG-401AF	81 ab
PLS-1051	75 bc
Prometheus	75 bc
PLS-183	75 bc
Mundial	75 bc
PLS-566	71 bc
Ashton	71 bc
BSC4551	71 bc
Hyperion	70 bc
PLS-196	69 c
CS-426AF	68 cd
EXP-06325	68 cd
CS-433AF	67 cde
Maurice	64 cde
BSC5091	64 cde
PLS-116	56 de
PLS-167	55 e
p-value	0.0011
LSD	12.712

Table 4L: Net Yields (% Trash Subtracted) and Gross Yields Adjusted to a Tenderometer Reading of 100 (lbs/A)

Variety	Adj. Net Yield (lbs/A)	Adj. Gross Yield (lbs/A)
CS-433AF	5032 a	5100 a
Prometheus	4359 ab	4446 abc
BSC4551	4355 ab	4922 ab
EX 08260893	4354 ab	4518 abc
Mundial	4212 abc	4520 abc
PLS-566	4139 bcd	4213 bcd
EXP-06325	3979 bcde	3999 cde
BSC5091	3893 bcdef	4099 bcd
CMG-401AF	3574 bcdefg	3687 cde
Hyperion	3512 cdefg	3652 cdef
PLS-196	3462 cdefgh	3569 defg
PLS-1051	3299 defghi	3481 defg
Ashton	3233 efghi	3338 defg
CS-426AF	3135 fghi	3410 defg
PLS-183	3032 ghi	3128 efg
Maurice	2969 ghi	3190 efg
PLS-116	2638 hi	2788 fg
PLS-167	2466 i	2739 g
p-value	<0.0001	<0.0001
LSD	839.67	875.96

Table 5L: Pea Size (% peas by weight in each class) and Tenderometer Reading at Harvest

Variety	% #4	% #3	% #1 & #2	% Trash	T-reading at Harvest
EXP-06325	45.6 a	45.1 bcdef	8.9 j	0.5 h	162 a
PLS-183	39.7 ab	42.2 cdefg	15.1 ij	3.0 fgh	103 fg
CS-433AF	34.2 bc	47.5 bcde	17.0 hi	1.3 gh	126 b
PLS-566	32.0 c	44.4 bcdef	21.8 fhi	1.8 gh	117 c
PLS-116	27.7 cd	39.9 efgh	26.9 efg	5.5 cdef	111 de
BSC5091	22.5 de	43.3 cdef	29.2 defg	5.0 def	114 cd
CMG-401AF	19.6 ef	52.4 ab	24.9 fgh	3.1 fgh	105 f
EX 08260893	16.6 efg	49.5 bcd	30.4 def	3.5 fg	92 i
Ashton	15.8 efgh	50.0 bc	30.8 def	3.3 fgh	111 cde
BSC4551	15.8 efgh	38.2 fgh	34.6 de	11.5 a	80 j
PLS-1051	15.7 efgh	44.0 cdef	35.3 cd	5.1 def	99 gh
Prometheus	15.4 efgh	58.9 a	23.7 fgh	2.0 gh	105 f
PLS-196	14.3 fgh	49.8 bcd	33.0 de	3.0 fgh	105 f
Hyperion	14.2 fgh	45.0 bcdef	36.9 cd	3.9 efg	106 ef
CS-426AF	10.8 ghi	32.4 h	48.8 ab	8.0 bc	101 fgh
Mundial	8.8 hi	41.8 defg	42.8 bc	6.5 cde	92 i
Maurice	6.5 i	34.3 gh	52.3 a	6.9 cd	96 hi
PLS-167	5.2 i	35.2 gh	49.7 ab	10.0 ab	126 b
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD	7.526	8.0546	8.0803	2.858	5.5812

Table 6L: Tenderometer Reading at Harvest

Variety	Tenderometer Reading
EXP-06325	162 a
PLS-167	126 b
CS-433AF	126 b
PLS-566	117 c
BSC5091	114 cd
Ashton	111 cde
PLS-116	111 de
Hyperion	106 ef
PLS-196	105 f
CMG-401AF	105 f
Prometheus	105 f
PLS-183	103 fg
CS-426AF	101 fgh
PLS-1051	99 gh
Maurice	96 hi
Mundial	92 i
EX 08260893	92 i
BSC4551	80 j
p-value	<0.0001
LSD	5.5812

Plant Characteristics for Late Trial Varieties Based on a 10-Plant Sample

Table 7L: Vine Length in Centimeters

Variety	Vine Length (cm)
Prometheus	62.6 a
EXP-06325	54.8 b
PLS-183	54.5 b
Maurice	53.5 bc
EX 08260893	52.4 bcd
Ashton	51.0 bcde
Hyperion	50.4 cde
PLS-196	48.9 def
CMG-401AF	47.6 efg
CS-426AF	46.5 fgh
PLS-566	44.9 fhi
BSC4551	43.1 hij
PLS-116	42.5 ij
CS-433AF	42.2 ij
PLS-167	41.6 ij
PLS-1051	40.7 jk
BSC5091	37.1 k
Mundial	37.0 k
Prometheus	62.6 a
p-value	<0.0001
LSD	3.802

Table 8L: Number of Pods per Plant

Variety	Pods/Plant
Prometheus	4.8 a
EX 08260893	3.7 b
BSC5091	3.6 b
BSC4551	3.5 bc
Ashton	3.5 bc
Maurice	3.4 bcd
Mundial	3.3 bcd
PLS-566	3.2 bcd
PLS-116	3.2 bcd
CS-433AF	3.1 bcd
PLS-196	3.1 bcd
Hyperion	3.0 bcd
PLS-183	3.0 bcd
PLS-167	3.0 bcd
EXP-06325	2.6 cd
CS-426AF	2.5 d
CMG-401AF	2.5 d
PLS-1051	2.5 d
Prometheus	4.8 a
p-value	0.0008
LSD	0.9465

Table 9L: Number of Pod-Bearing Nodes per Plant

Variety	Nodes w/ Pods/Plant	
PLS-116	2.9	a
Prometheus	2.8	ab
BSC4551	2.5	abc
EX 08260893	2.4	abc
BSC5091	2.3	bcde
Mundial	2.3	bcde
Ashton	2.3	bcde
PLS-196	2.2	cdef
Maurice	2.1	cdefg
CS-433AF	2.1	cdefg
PLS-183	2.1	cdefg
PLS-167	2.1	cdefg
Hyperion	2.0	cdefg
PLS-566	2.0	cdefg
PLS-1051	1.9	defg
CMG-401AF	1.8	dfg
EXP-06325	1.7	fg
CS-426AF	1.6	g
p-value	0.0004	
LSD	0.5658	

Table 10L: Average Number of Peas per Pod

Variety	Peas/Pod	
PLS-167	6.7	a
PLS-566	6.5	a
Hyperion	6.4	a
Ashton	6.2	a
CS-426AF	6.1	a
Prometheus	6.0	a
BSC5091	6.0	a
PLS-196	6.0	a
CMG-401AF	5.9	a
PLS-116	5.9	a
PLS-1051	5.9	a
EXP-06325	5.7	a
Maurice	5.5	a
BSC4551	5.5	a
PLS-183	5.5	a
EX 08260893	5.4	a
CS-433AF	5.4	a
Mundial	5.3	a
p-value	0.8921	
LSD	NA	

Table 11L: Average Pod Length in Centimeters

Variety	Pod Length (cm)	
PLS-116	8.8	a
CS-433AF	7.9	b
PLS-566	7.8	bc
PLS-1051	7.8	bc
PLS-183	7.6	bcd
PLS-196	7.5	bcde
EX 08260893	7.2	bcdef
CMG-401AF	7.2	bcdef
Ashton	7.2	bcdef
Hyperion	7.1	cdef
CS-426AF	7.0	cdef
BSC4551	7.0	def
Prometheus	6.9	def
Mundial	6.9	def
Maurice	6.8	ef
EXP-06325	6.8	ef
PLS-167	6.6	f
BSC5091	6.6	f
p-value	<0.0001	
LSD	0.7706	

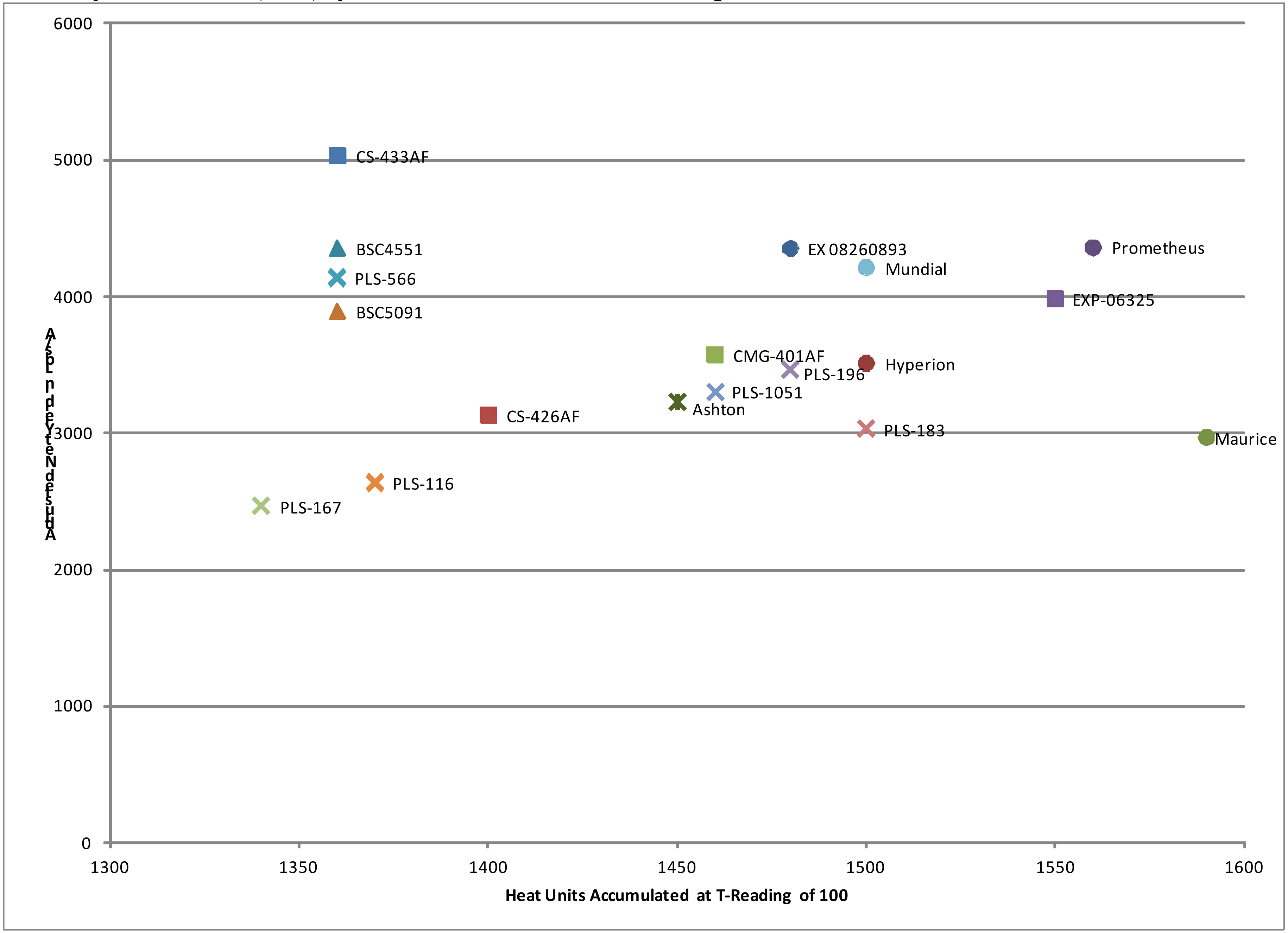
Late Trial Maturity Data

Table 12L: Tenderometer Readings Leading Up To and Including Harvest

	Reported	T-Readings Up to and Including Harvest by Date and Accumulated Heat Units												
	Heat	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun
Variety	**Units**	**1234**	**1259**	**1288**	**1324**	**1361**	**1399**	**1429**	**1462**	**1490**	**1516**	**1541**	**1562**	**1581**
PLS-167	1430			76			**126***							
CS-433AF	1460						119	**126**						
PLS-566	1430			88			**117**							
BSC4551	1380	81		**80**			114							
BSC5091	1450			85			**114**							
PLS-116	1460						**111**							
CS-426AF	1520						**101**							
Ashton	1480							93	**111**					
CMG-401AF	1590							91	**105**					
PLS-1051	1560						81	89	**99**					
PLS-196	1580							83	93	**105**				
EX 08260893	1525							80	79	**92**				
Hyperion	1575							84	85	84	**106**			
PLS-183	1620							78		85	**103**			
Mundial	1600								83	78	**92**			
EXP-06325	1590								83	77	86			**162**
Prometheus	1650										78			**105**
Maurice	1650										60			**96**

*****Bold numbers indicated the day on which the variety was harvested and are an average of three samples from each of three replications

Chart 1L: Adjusted Net Yield (lbs/A) by Heat Units Accumulated at T-Reading of 100



Appendix A: Weather Data for 2012 Early Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall	Accumulated Rainfall
15-Mar-12	0	73.4	46.3	0	0	0	0
16-Mar-12	1	61.2	45.5	13.35	13	0	0
17-Mar-12	2	60.7	44.3	12.5	26	0	0
18-Mar-12	3	67.1	39.2	13.15	39	0	0
19-Mar-12	4	72.8	37.9	15.35	54	0	0
20-Mar-12	5	64.5	47.5	16	70	0	0
21-Mar-12	6	70.2	46.2	18.2	89	0	0
22-Mar-12	7	76	46	21	110	0.01	0.01
23-Mar-12	8	79.1	47.9	23.5	133	0	0.01
24-Mar-12	9	55.3	41.2	8.25	141	0.1	0.11
25-Mar-12	10	41.4	37.8	0	141	0	0.11
26-Mar-12	11	56.3	34.3	5.3	147	0	0.11
27-Mar-12	12	52	29.8	0.9	148	0	0.11
28-Mar-12	13	71.2	34.3	12.75	160	0	0.11
29-Mar-12	14	64.8	42.1	13.45	174	0	0.11
30-Mar-12	15	53.4	31.5	2.45	176	0	0.11
31-Mar-12	16	52.2	43.8	8	184	0.05	0.16
1-Apr-12	17	57.8	41.5	9.65	194	0.02	0.18
2-Apr-12	18	55.5	40.7	8.1	202	0.14	0.32
3-Apr-12	19	65.4	30.7	8.05	210	0	0.32
4-Apr-12	20	74.3	44.9	19.6	230	0	0.32
5-Apr-12	21	59.7	37.5	8.6	238	0	0.32
6-Apr-12	22	57	34.5	5.75	244	0	0.32
7-Apr-12	23	60.3	34.4	7.35	251	0	0.32
8-Apr-12	24	68.8	29	8.9	260	0	0.32
9-Apr-12	25	65	47.7	16.35	277	0.01	0.33
10-Apr-12	26	65.1	41.5	13.3	290	0.01	0.34
11-Apr-12	27	52.3	36.8	4.55	294	0	0.34
12-Apr-12	28	58	38	8	302	0	0.34
13-Apr-12	29	61.8	33.6	7.7	310	0	0.34
14-Apr-12	30	70.8	40	15.4	325	0	0.34
15-Apr-12	31	81.3	60.5	30.9	356	0	0.34
16-Apr-12	32	84.6	62.8	33.7	390	0	0.34
17-Apr-12	33	78.7	55.6	27.15	417	0	0.34
18-Apr-12	34	56.6	49.7	13.15	430	0.02	0.36
19-Apr-12	35	64.7	45.1	14.9	445	0.02	0.38
20-Apr-12	36	73.3	38.3	15.8	461	0	0.38
21-Apr-12	37	78.5	50.8	24.65	486	0.47	0.85
22-Apr-12	38	58.3	44.1	11.2	497	1.83	2.68
23-Apr-12	39	50.3	41	5.65	503	0.01	2.69
24-Apr-12	40	60.2	40.4	10.3	513	0	2.69
25-Apr-12	41	65.8	35.9	10.85	524	0	2.69
26-Apr-12	42	64.8	48.3	16.55	540	0	2.69
27-Apr-12	43	59.4	40.3	9.85	550	0	2.69
28-Apr-12	44	56.9	32.6	4.75	555	0.23	2.92
29-Apr-12	45	63.8	41.3	12.55	567	0.3	3.22
30-Apr-12	46	63.2	42.5	12.85	580	0	3.22
1-May-12	47	80.1	57.3	28.7	609	0.21	3.43
2-May-12	48	63.3	49.7	16.5	625	0.04	3.47
3-May-12	49	74.4	48.6	21.5	647	0.02	3.49
4-May-12	50	78.8	53.3	26.05	673	0	3.49
5-May-12	51	73.1	54.7	23.9	697	0	3.49
6-May-12	52	65.3	47.4	16.35	713	0	3.49

7-May-12	53	70	41.7	15.85	729	0	3.49
8-May-12	54	75.4	57.4	26.4	756	0	3.49
9-May-12	55	69.3	58.2	23.75	779	1.15	4.64
10-May-12	56	65.8	50.1	17.95	797	0.05	4.69
11-May-12	57	69.1	45.2	17.15	814	0	4.69
12-May-12	58	75.6	47.2	21.4	836	0	4.69
13-May-12	59	78.3	56.2	27.25	863	0	4.69
14-May-12	60	73.8	60.6	27.2	890	0	4.69
15-May-12	61	79	64.1	31.55	922	0.25	4.94
16-May-12	62	82.2	63	32.6	954	0	4.94
17-May-12	63	70.5	49.6	20.05	974	0	4.94
18-May-12	64	69.6	45.6	17.6	992	0	4.94
19-May-12	65	74.7	46	20.35	1012	0	4.94
20-May-12	66	70.9	49.6	20.25	1033	0.85	5.79
21-May-12	67	73.8	61.5	27.65	1060	0.05	5.84
22-May-12	68	75.7	61.8	28.75	1089	0.01	5.85
23-May-12	69	79.2	62.6	30.9	1120	0	5.85
24-May-12	70	81.2	60.2	30.7	1151	0	5.85
25-May-12	71	82.1	66.6	34.35	1185	0	5.85
26-May-12	72	85.7	61.5	33.6	1219	0	5.85
27-May-12	73	86.2	66.1	36.15	1255	0	5.85
28-May-12	74	88.2	69.6	38.9	1294	0	5.85
29-May-12	75	87.1	72.7	39.9	1334	0	5.85
30-May-12	76	74.3	66.1	30.2	1364	0.58	6.43

Appendix B: Weather Data for 2012 Late Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall/ Irrigation
13-Apr-12	0	61.8	33.6	0	0	0	0
14-Apr-12	1	70.8	40	15.4	15	0	0
15-Apr-12	2	81.3	60.5	30.9	46	0	0
16-Apr-12	3	84.6	62.8	33.7	80	0	0
17-Apr-12	4	78.7	55.6	27.15	107	0	0
18-Apr-12	5	56.6	49.7	13.15	120	0.02	0.02
19-Apr-12	6	64.7	45.1	14.9	135	0.02	0.04
20-Apr-12	7	73.3	38.3	15.8	151	0	0.04
21-Apr-12	8	78.5	50.8	24.65	176	0.47	0.51
22-Apr-12	9	58.3	44.1	11.2	187	1.83	2.34
23-Apr-12	10	50.3	41	5.65	193	0.01	2.35
24-Apr-12	11	60.2	40.4	10.3	203	0	2.35
25-Apr-12	12	65.8	35.9	10.85	214	0	2.35
26-Apr-12	13	64.8	48.3	16.55	230	0	2.35
27-Apr-12	14	59.4	40.3	9.85	240	0	2.35
28-Apr-12	15	56.9	32.6	4.75	245	0.23	2.58
29-Apr-12	16	63.8	41.3	12.55	257	0.3	2.88
30-Apr-12	17	63.2	42.5	12.85	270	0	2.88
1-May-12	18	80.1	57.3	28.7	299	0.21	3.09
2-May-12	19	63.3	49.7	16.5	315	0.04	3.13
3-May-12	20	74.4	48.6	21.5	337	0.02	3.15
4-May-12	21	78.8	53.3	26.05	363	0	3.15
5-May-12	22	73.1	54.7	23.9	387	0	3.15
6-May-12	23	65.3	47.4	16.35	403	0	3.15
7-May-12	24	70	41.7	15.85	419	0	3.15
8-May-12	25	75.4	57.4	26.4	445	0	3.15
9-May-12	26	69.3	58.2	23.75	469	1.15	4.3
10-May-12	27	65.8	50.1	17.95	487	0.05	4.35
11-May-12	28	69.1	45.2	17.15	504	0	4.35
12-May-12	29	75.6	47.2	21.4	526	0	4.35
13-May-12	30	78.3	56.2	27.25	553	0	4.35
14-May-12	31	73.8	60.6	27.2	580	0	4.35
15-May-12	32	79	64.1	31.55	612	0.25	4.6
16-May-12	33	82.2	63	32.6	644	0	4.6
17-May-12	34	70.5	49.6	20.05	664	0	4.6
18-May-12	35	69.6	45.6	17.6	682	0	4.6
19-May-12	36	74.7	46	20.35	702	0	4.6
20-May-12	37	70.9	49.6	20.25	723	0.85	5.45
21-May-12	38	73.8	61.5	27.65	750	0.05	5.5
22-May-12	39	75.7	61.8	28.75	779	0.01	5.51
23-May-12	40	79.2	62.6	30.9	810	0	5.51
24-May-12	41	81.2	60.2	30.7	841	0	5.51
25-May-12	42	82.1	66.6	34.35	875	0	5.51
26-May-12	43	85.7	61.5	33.6	909	0	5.51
27-May-12	44	86.2	66.1	36.15	945	0	5.51
28-May-12	45	88.2	69.6	38.9	984	0	5.51
29-May-12	46	87.1	72.7	39.9	1023	0	5.51
30-May-12	47	74.3	66.1	30.2	1054	0.58	6.09
31-May-12	48	83.9	63.4	33.65	1087	0.01	6.1
1-Jun-12	49	82.6	60.9	31.75	1119	0.17	6.27
2-Jun-12	50	73.4	56.9	25.15	1144	0.25	6.52
3-Jun-12	51	77.3	54.7	26	1170	0	6.52
4-Jun-12	52	72.5	58	25.25	1195	0.11	6.63

5-Jun-12	53	66.7	51.7	19.2	1215	0.03	6.66
6-Jun-12	54	71.3	47.7	19.5	1234	0	6.66
7-Jun-12	55	78.9	50.7	24.8	1259	0.14	6.8
8-Jun-12	56	82.4	56	29.2	1288	0	6.8
9-Jun-12	57	88.4	62.9	35.65	1324	0	6.8
10-Jun-12	58	92.1	63.1	37.6	1361	0	6.8
11-Jun-12	59	88.6	65.7	37.15	1399	0.01	6.81
12-Jun-12	60	73.6	67.2	30.4	1429	0.36	7.17
13-Jun-12	61	79.6	66	32.8	1462	0	7.17
14-Jun-12	62	73.9	62.3	28.1	1490	0.01	7.18
15-Jun-12	63	75.6	57.3	26.45	1516	0	7.18
16-Jun-12	64	75.6	53	24.3	1541	0	7.18
17-Jun-12	65	70.7	51.7	21.2	1562	0	7.18
18-Jun-12	66	71.6	45.8	18.7	1581	0	7.18

Appendix C: Adjusting Pea Yields to a T-reading of 100

Pumphery FV, RE Ramig, RR Allmoras. 1975 "Yield tenderness relationships in 'Dark Skinned Perfection' peas. Journal of the American Society of Horticultural Science. 100:507-509.

Yield-Tenderness Relationships in 'Dark Skinned Perfection' Peas[1]

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Abstract. Maturity effects on yield of fresh peas (*Pisum sativum* L.) were identified by yield-tenderometer measurements. A percent yield-tenderometer reading relationship was shown to be a useful means for yield adjustment to a common maturity—100 tenderometer reading. Analysis of random error in the predicted percent yield, as a function of tenderometer reading, indicates the need to plan harvests within the 90 to 110 tenderometer range. Alternatively, the yield-tenderometer reading relationships show the possible magnitude of errors incurred in comparing green pea yields when no adjustment is made for dissimilar tenderometer ratings.

Improved techniques are needed for determining and comparing fresh pea (*Pisum sativum* L.) yields. Expressions of fresh pea yields are generally not precise because of harvest at a growth stage when fresh pea wt is increasing rapidly while tenderness may decrease even more rapidly. Pea yields may increase as much as 900 kg/ha daily when growth conditions are favorable. Such a yield increase often causes yield differences between treatments only because the treatments affected maturity. Examples of such treatments are comparisons involving cultivars, tillage, fertilizer, irrigation, or herbicides.

The need for comparing yields of processing peas at a common tenderometer rating, such as 100, has been suggested repeatedly, but, unfortunately there is little published information. Yield and tenderness are inversely related: i.e., yield increases as tenderness decreases (tenderometer readings increase). However, changes in yield and tenderometer readings are generally not a linear function of time (2, 3, 4, 6). Yield increases per unit of increase in tenderometer readings are generally greater when tenderometer values are below 100 to 120 than at higher tenderometer values. Hagedorn et al. (1) reported an unusual linear relationship between yield and tenderometer reading up through readings of 150.

Adjustments of absolute yield to a common base of 100 tenderometer reading is complicated, because temporal changes in yield and tenderometer reading vary between years, fields, and cultivars. Some of the factors influencing increase of fresh pea wt and associated change in tenderness are temperature, wind, humidity, available soil moisture, and soil fertility. However, temperature and moisture are the dominating factors. Yield differences produced by these factors, along with seasonal and field variations preclude direct adjustments of yield based on tenderness rating, i.e., *x* pounds of peas per unit change in tenderometer reading. Norton et al. (4) presented yield-tenderness relationships indirectly in terms of percent yield at a given tenderometer reading. The method for adjusting fields was developed by H. K. Schultz and M. W. Carstens. They used the yield at 100 tenderometer reading as 100 percent yield. Kramer (2) and Sayre (7) used percent of maximum yield as their expression of the observed yields at various tenderometer readings.

Our objectives were to emphasize the need for comparing yields of fresh peas at a common tenderometer reading, and to present additional data in support of the Norton et al. (4) method for adjusting yields.

Methods and Procedures

Dark Skinned Perfection peas were grown in 17 field experiments from which fresh pea yields and tenderness evaluations were made. The experiments were conducted on or near the Columbia Basin Research Center, Pendleton, Oregon. Seeding rates varied from about 130 to 230 kg/ha, in row spacings varying from 15 to 20 cm. Plant environment varied considerably because the data were collected during 11 years from experiments testing fertilizers, herbicides, and tillage—all 3 factors alone or in various combinations. All experiments were dryland, except 2 which were irrigated. In the dryland experiments, about 61 percent of the evapotranspiration was derived from soil water stored prior to pea planting. Longterm rainfall averages during the growing season for peas are 3.9, 3.7, 3.4, and 3.5 cm, respectively, for March, April, May, and June at the Columbia Basin Research Center. Corresponding average monthly temperatures are 6.1, 10.0, 13.3, and 17.2°C.

Fresh pea harvests were made to provide tenderometer readings below 100 at the earliest harvest, near 100 at the middle harvest, and above 100 at the latest harvest. Usually 3 or more harvests were necessary and the interval between harvests was generally 1 or 2 days in each of the 17 experiments. Harvests in the dryland experiments occurred in late June and only rarely in early June, while those under irrigation occurred about 5 days later.

From the data obtained in each experiment, pea yield at 100 tenderometer reading was interpolated. Then the ratio of measured to interpolated yield at 100 tenderometer reading was used to obtain "percent yield" (when multiplied by 100). All percent yields and corresponding tenderometer readings were plotted to obtain a scattergram of percent yield versus tenderometer reading, from which a least squares fit was made using the model: $Y = a + bX + cX^n$, where Y is percent yield, X is tenderometer reading; a, b, and c are parameters to be estimated statistically.

Results and Discussion

Six experiments typify green pea development observed in the 17 experiments. They are presented herein (Figs. 1, 2, and 3) because their greater number of harvests more precisely defined trends. These relationships were typical, also, of those found in the literature.

Yields varied from experiment to experiment, but yields within experiments were usually nonlinear functions of time (Fig. 1). In some experiments rates of yield change (change in slope) were positive throughout all harvests, while in others they became negative soon after the harvest series was initiated.

Tenderometer readings increased as a function of time (Fig. 2), but the tenderometer readings increased more rapidly after tenderometer readings had reached 100. An exponentially increasing tenderness function of time was suggested for both dryland and irrigated peas in Fig. 2.

Pea yields are distinctly nonlinear functions of tenderometer reading (Fig. 3). Field to field variation also caused large separation of curves. These 2 features of the yield-tenderness curves emphasize a critical need for comparing experimental yields within an experiment on a common tenderometer rating basis. We have not found a feasible direct adjustment of yields.

Pea yields expressed as a percent of the yield expected at 100 tenderometer are plotted versus tenderometer reading (Fig. 4), and the estimated equations are shown separately for irrigated and

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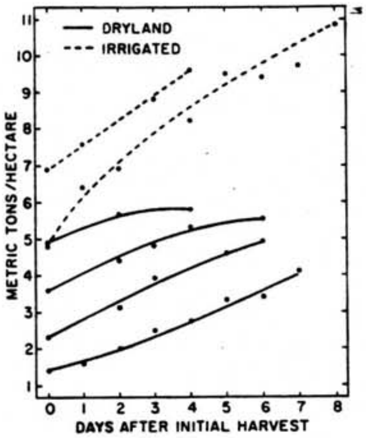

Fig. 1. Yield versus time of harvest for fresh peas in 6 typical experiments.

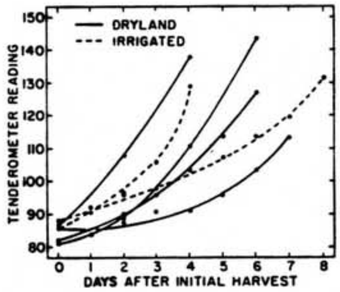

Fig. 2. Tenderometer of fresh peas as affected by time of harvest in 6 typical experiments.

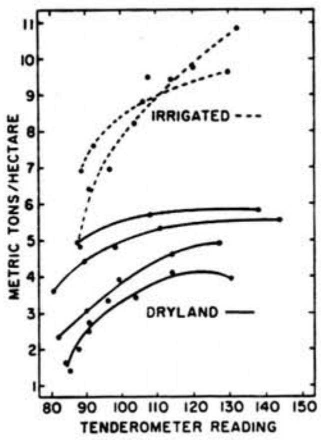

Fig. 3. Yield of fresh peas and associated tenderometer reading in 6 typical experiments.

dryland peas. These equations (Fig. 4) were slightly modified for easy use in adjusting percent yield when tenderometer readings were not 100. The modification involved estimation of Y at 100 tenderometer using equations in Fig. 4. This estimate of Y was then designated as the mean of Y when the mean of X was designated as 100. The equations are shown as follows:

Dryland peas: $(Y-97.21) = -14.134\,(X-100) + 315.14\,(X^{1/2}-10)$

Irrigated peas: $(Y-100.43) = -8.405\,(X-100) + 200.00\,(X^{1/2}-10)$

In these equations, Y is percent yield to be calculated, and X is observed tenderometer reading.

The scatter diagram of Fig. 4 (a composite over the 17 experiments) can be used to adjust yields to a common maturity (100 tenderometer). Such a calibration adjusts for maturity differences. However, the increasing scatter in Fig. 4 as the tenderometer reading deviates from 100 suggests strongly that harvests should be planned to achieve tenderometer readings within the 90 to 110 range. Ordinarily in regression, where the variance of the dependent variable is assumed independent of the independent variable, the precision of predicted dependent variable decreases as the dependent variable becomes larger or smaller than the mean (5). The scatter distribution in Fig. 4 shows a variance dependent on tenderometer reading. We have combined this variance estimate with that of regression in Table 1 to emphasize the true variability characteristics of the calibration in Fig. 4, and the need to plan harvests within the 90 to 110 tenderometer range.

The curves and data points for dryland and irrigated peas were

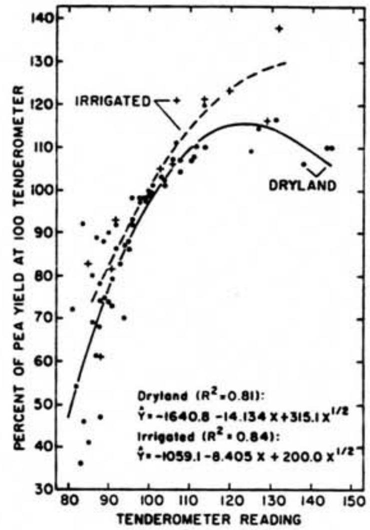

Fig. 4. Percent yield-tenderometer reading relationship for 'Dark Skinned Perfection' pea in irrigated and dryland experiments.

Table 1. Expected random error in estimating a percent-pea-yield at different ranges of tenderometer.[z]

Tenderometer range	$\sigma_{\hat{y}}$	Weighing factor	Estimated true $\sigma_{\hat{y}}$
80-85	8.8[y]	2.1[x]	18.5[w]
85-90	8.7	1.9	16.6
90-95	8.7	0.4	3.5
95-100	8.6	0.4	3.3
100-105	8.6	0.2	1.5
105-110	8.7	0.5	4.5
110-115	8.7	0.5	4.5
115-120	8.8	1.4	12.3

[z] Computations were made using regression composited over irrigated and dryland conditions.

[y] $\sigma_{\hat{y}}$ is the random error expected from multiple regression assuming a variance of y independent of x.

[x] *Weighing factor* is a ratio in which the numerator is the standard error of estimate within the indicated tenderometer range and the denominator is the standard error of estimate for the whole tenderometer range. This ratio approximates the nonuniform variance of percent pea yield at different tenderometer readings.

[w] Estimated true $\sigma_{\hat{y}}$ is the product. (weighing factor) ($\sigma_{\hat{y}}$).

maintained separate in Fig. 4. Above about 110 tenderometer reading the percent yields separate distinctly. This separation of yields indicates a major influence of available soil water on the development of fresh peas in their later stages of growth. We suggest that this factor be carefully evaluated for experiments where irrigation or stored soil water is an experimental variable.

In passing, we note the failure of an appealing normalization procedure involving both yield and tenderometer reading. For each experiment, the maximum and minimum yield or tenderometer readings were noted and the normalized observation computed as $(u-u_{min})/(u_{max}-u_{min})$. The symbol u indicates the variable to be normalized. Nearly the whole range of normalized yield was noted for normalized tenderometer readings <0.5. Furthermore, there was much scatter providing little basis for a calibration.

Norton et al. (4) and Sayre (7) point out that 1 scale is not applicable to all pea cultivars. Norton et al. (4) add that the use of a well-developed scale for 1 cultivar to adjust another cultivar may introduce less error than using a scale developed from only a few points. Information presented in Fig. 4 is consistent with earlier results (1, 2, 4, 7) showing a similar relationship between percent yield and tenderometer readings in the range of 90 to 110. Percent yields changed between 1 and 2 percentage units with each unit change in tenderometer reading.

Experience by the authors indicates that fresh pea yield comparison at a common maturity is essential to good research. Harvesting eac treatment at 2 or more times and interpolating the yield at 1C tenderometer is preferred. When only 1 harvest is possible, yields c: be adjusted to 100 tenderometer by using a percent yield-tenderom eter scale (Fig. 4) which provides more reliable data than merely usin the unadjusted yields.

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