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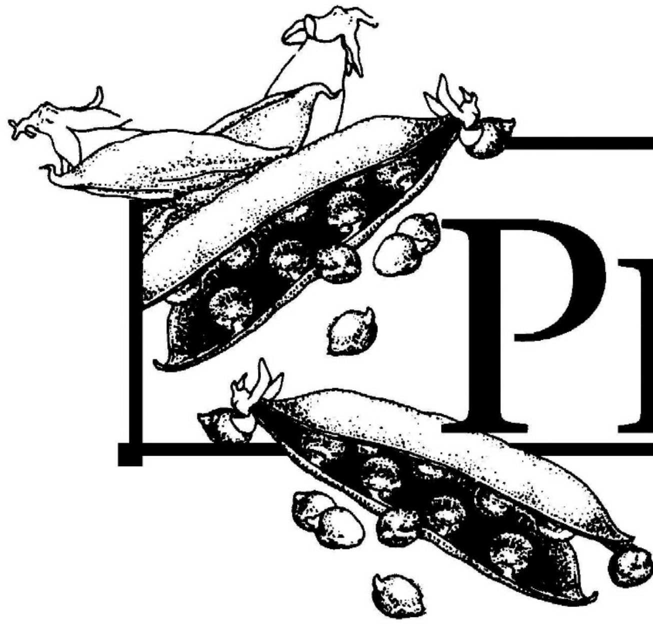

PEA

VARIETY TRIAL RESULTS

Emmalea Ernest & Gordon Johnson

University of Delaware
Carvel Research and Education Center
16483 County Seat Highway
Georgetown, DE 19947

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Table of Contents

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Brotherton Seed Co., Inc.
Crites Seeds, Inc.
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Storm Seeds

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2016 University of Delaware Pea Variety Trial

Emmalea Ernest & Gordon Johnson
University of Delaware
Elbert N. and Ann V. Carvel Research and Education Center
16483 County Seat Highway
Georgetown Delaware 19947
(302) 856-7307
emmalea@udel.edu; gcjohn@udel.edu

Introduction

The 2016 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 17 and April 15. 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-five varieties were planted in the March 17 trial, and 22 varieties in the April 15 trial. The trials were located in Field 27-A at the University of Delaware Research Farm in Georgetown, DE. Field was limed and potassium was applied according to soil test results prior to planting. Both were irrigated as needed, and grown under standard commercial management practices. Weed control in both trials was good.

Planting Date: **Early Trial** – March 17, 2016; 25 varieties
Late Trial – April 15, 2016; 22 varieties

Herbicide: Pursuit @ 2 oz/A + Dual II Magnum @ 1 pt/A with 28% UAN at 30 gal/A (90 lbs N/A) applied preemergence

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.

Insecticide: **Late Trial** – Diazinon Ag 500 3 qt/A incorporated the day before planting

Stands: **Early Trial –** stands of some varieties were reduced by seed corn maggot
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 2016 Early Pea Trial

Variety	Company
Tomahawk*	Crites Seed, Inc.
Exp-36003	Crites Seed, Inc.
CS-453F	Crites Seed, Inc.
Exp-36026	Crites Seed, Inc.
BSC2014	Brotherton Seed Co. Inc
BSC3129	Brotherton Seed Co. Inc
BSC2030*	Brotherton Seed Co. Inc
BSC15L11	Brotherton Seed Co. Inc
BSC5051	Brotherton Seed Co. Inc
228*	Pure Line Seeds, Inc.
304-3*	Pure Line Seeds, Inc.
M-14	Pure Line Seeds, Inc.
11P42*	Pure Line Seeds, Inc.
SV1391QH*	Seminis/Monsanto
SV0935QF*	Seminis/Monsanto
Reliance*	Seminis/Monsanto
SV8112QH*	Seminis/Monsanto
SV7401QH	Seminis/Monsanto
GVS 435*	Gallatin Valley
Jumpstart	check variety
Icepack*	check variety
Strike	check variety
Marias	check variety
Boston	Storm Seeds
Design	Storm Seeds

*** Afila Variety**

Varieties in the 2016 Late Pea Trial

Variety	Company
Exp-36015	Crites Seed, Inc.
CS-424F	Crites Seed, Inc.
CS-437F	Crites Seed, Inc.
CS-452F	Crites Seed, Inc.
CS-444F	Crites Seed, Inc.
613-1*	Pure Line Seeds, Inc.
251*	Pure Line Seeds, Inc.
196*	Pure Line Seeds, Inc.
595-1*	Pure Line Seeds, Inc.
SV8112QH*	Seminis
SV0371QF*	Seminis
SV7688QF*	Seminis
SV1036QF*	Seminis
SV0893QF	Seminis
GV 490	Gallatin Valley Seed
GV 518*	Gallatin Valley Seed
513	Gallatin Valley Seed
GV 555*	Gallatin Valley Seed
Bolero	check variety
Quad	check variety
Grundy	check variety
Valkon	Storm Seeds

*** Afila Variety**

Pre Harvest Data

Stand counts of emerged plants were completed on April 11, 2016 for the Early Trial (25 DAP) and on May 4, 2016 (19 DAP) for the Late Trial. The number of emerged plants was counted for a three foot long section of row in three 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 levels were average during the time the trials were conducted and irrigation was applied as necessary via an overhead linear irrigation system. The weather this year was warmer than typical in March, with a hard freeze in early April. The end of April and first two weeks of May were cooler than average. Harvest of the Early Trial began on May 30, which is about five days later than the typical first harvest date for this trial. The harvest of the Late Trial began on June 15 which is typical for this trial. 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. In the Early Trial, seed corn maggot caused major stand reduction in varieties that did not have an insecticide seed treatment. Varieties that were severely affected by seed corn maggot were evaluated for size and maturity characteristics but not for yield. Stands were good in the Late Trial, regardless of seed treatment. (For the Late Trial diazinon was applied before 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 typical for this trial. The highest yielding varieties in the early trial were BSC3129, BSC5051, Marias, 11P42, CS-453F, Exp-36026, BSC2030 and Strike. The standard variety Strike, was the highest yielding early variety. Tomahawk and Exp-36003 matured at the same time as the earliest standard varieties. (Chart 1E).

Yields in the Late Trial were below average compared to what we have seen in past years for this trial. The highest yielding variety in the late trial was CS-444F. CS-424F and PLS 196 were not significantly different than CS-444F in terms of yield. The aforementioned varieties all had significantly higher yields than all three trial check varieties, Bolero, Grundy and Quad. CS-424F was in the early trial in 2010, 2012 and 2014 and performed well in those trials, as well as the late trial in 2016. Some varieties were severely affected by root rot, particularly Valkon, and GV 490.

Early Trial Pre-Harvest Data

Table 1E: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Jumpstart	48	608	53	680
Strike	48	608	54	699
Exp-36003	49	619	53	680
Icepack	49	619	53	680
Tomahawk	50	629	54	699
Boston	50	629	55	719
M-14	53	680	56	743
11P42	53	680	56	743
Marias	53	680	56	743
GVS 435	53	680	57	766
BSC2014	53	680	58	790
BSC3129	53	680	61	830
304-3	54	699	60	814
CS-453F	56	743	60	814
Exp-36026	56	743	63	870
228	56	743	66	925
Design	57	766	67	946
BSC2030	57	766	69	1006
Reliance	58	790	68	975
SV1391QH	60	814	66	925
SV7401QH	62	848	69	1006
SV8112QH	62	848	69	1006
SV0935QF	63	870	68	975
BSC5051	63	870	69	1006
BSC15L11	64	891	69	1006

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

Variety	Plants/Yd		% Stand (at 8 seeds/ft)	Seed Treatment							
				Captan	**Allegiance**	**Maxim**	**Apron**	**Cruiser**	**Lorsban**	**Thiram**	**Molybdenum**
BSC2014	31.8	a	118	x	x			x			
228	28.7	ab	106	x	x			x			
Strike	24.4	bc	90			x	x		x		
Exp-36003	24.0	bc	89			x	x	x			x
Marias	23.8	bc	88			x	x		x		
Icepack	23.6	bc	87								
Jumpstart	23.2	bcd	86			x	x		x		
CS-453F	23.1	bcd	86			x	x	x			x
Tomahawk	22.8	cd	84			x	x	x			x
BSC3129	22.7	cd	84	x	x			x			
BSC2030	22.6	cd	83	x	x			x			
BSC5051	22.3	cd	83	x	x			x			
BSC15L11	22.1	cd	82	x	x			x			
GVS 435	21.9	cd	81			x	x	x			x
Exp-36026	21.6	cde	80			x	x	x			x
11P42	20.6	cdef	76	x	x			x			
304-3	20.2	cdefg	75	x	x			x			
M-14	17.8	defgh	66	x	x			x			
SV8112QH	16.1	efghi	60	x	x						
SV7401QH	15.1	fghij	56	x	x						
Reliance	14.8	ghij	55	x	x						
Boston	13.4	hij	50							x	
Design	10.9	ij	40							x	
SV0935QF	10.6	ij	39	x	x						
SV1391QH	9.6	j	35	x	x						
p-value	<0.0001										
LSD	5.6566										

Early Trial Harvest Data

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

Variety	Vine Weight (lbs.)	
11P42	93	a
Marias	90	ab
228	89	ab
BSC2030	87	ab
BSC5051	86	ab
BSC2014	85	ab
304-3	83	abc
CS-453F	83	abc
Strike	82	abc
BSC3129	82	abc
M-14	80	abc
Exp-36026	75	bcd
BSC15L11	70	cde
Jumpstart	64	de
Tomahawk	63	de
Exp-36003	60	de
Icepack	60	de
GVS 435	54	ef
Design	40	f
p-value	<0.0001	
LSD	15.441	

The following varieties were not included in the analysis because of very poor stand (damage due to seed corn maggot)

SV1391QH
SV0935QF
Reliance
SV8112QH
SV7401QH
Boston

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)	
BSC3129	5362	a	5430	ab
BSC5051	5256	a	5595	a
Marias	5064	ab	5339	ab
11P42	5058	ab	5432	ab
CS-453F	4869	abc	4945	abcd
Exp-36026	4820	abc	5132	abc
BSC2030	4766	abc	4951	abcd
Strike	4721	abc	4827	abcd
228	4342	bcd	4462	cde
M-14	4266	cde	4801	bcd
Exp-36003	4155	cde	4231	def
BSC2014	4109	cde	4461	cde
304-3	3901	def	3993	efg
BSC15L11	3639	def	3639	fgh
Tomahawk	3542	efg	3702	efgh
Jumpstart	3520	efg	3938	efg
Icepack	3151	fg	3234	gh
GVS 435	2788	gh	2975	hi
Design	2151	hi	2323	i
p-value	<0.0001		0.0003	
LSD	775.46		791.47	

The following varieties were not included in the analysis because of very poor stand (damage due to seed corn maggot)

SV1391QH
SV0935QF
Reliance
SV8112QH
SV7401QH
Boston

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	
Strike	50.4	a	35.2	hij	12.2	l	2.2	hijk	108	hi
Exp-36003	49.8	a	36.8	fghij	11.5	l	1.8	ijk	116	de
CS-453F	42.9	b	42.5	cdefg	13.1	kl	1.5	jk	131	c
GVS 435	37.6	bc	32.3	ij	23.9	fgh	6.2	defg	104	jkl
Tomahawk	36.8	bc	42.1	cdefg	16.9	ijkl	4.3	efghijk	112	fgh
SV1391QH	35.7	cd	41.9	cdefg	19.6	hijk	2.8	ghijk	131	c
304-3	34.6	cd	43.0	cdef	20.1	hij	2.3	hijk	149	a
Marias	32.4	cde	42.5	cdefg	19.9	hijk	5.1	defghi	109	hi
Icepack	31.3	cdef	51.4	ab	14.7	jkl	2.7	ghijk	117	de
M-14	29.3	def	39.1	efgh	21.0	hij	10.6	b	107	ij
11P42	25.7	efg	45.3	bcde	22.2	ghi	6.9	cdef	114	ef
BSC2014	25.3	fg	41.2	defgh	25.6	efgh	8.0	bcd	114	efg
BSC3129	25.0	fg	53.8	a	19.9	hijk	1.3	k	136	b
Exp-36026	20.6	gh	37.6	fghi	35.6	ce	6.1	defg	113	efg
BSC2030	20.3	gh	47.5	abcd	28.4	efg	3.7	fghijk	112	fgh
228	17.6	h	47.3	bcd	32.4	cde	2.7	ghijk	120	d
Design	17.4	h	46.8	bcd	28.1	efg	7.8	bcde	115	ef
BSC5051	16.5	h	47.7	abc	29.6	def	6.2	defg	101	l
Reliance	16.3	h	42.6	cdefg	37.7	c	3.4	fghijk	110	ghi
Boston	9.3	i	41.7	cdefg	38.8	bc	10.2	bc	109	hi
SV7401QH	8.9	i	41.2	defgh	45.6	ab	4.2	efghijk	120	d
SV0935QF	8.8	i	36.6	ghij	49.5	a	5.1	defghij	106	ijk
SV8112QH	7.3	i	39.1	efgh	47.9	a	5.8	defgh	102	kl
Jumpstart	6.8	ij	30.8	j	51.8	a	10.6	b	101	l
BSC15L11	0.2	j	0.9	k	48.4	a	50.5	a	114	efg
p-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
LSD	6.7348		6.3684		6.9177		3.6254		4.0772	

Table 6E: Tenderometer Reading at Harvest

Variety	Tenderometer Reading		Standard Deviation of T-Reading
Jumpstart	101	l	1.8
BSC5051	101	l	6.1
SV8112QH	102	kl	2.4
GVS 435	104	jkl	4.4
SV0935QF	106	ijk	3.8
M-14	107	ij	8.5
Strike	108	hi	3.2
Boston	109	hi	5.7
Marias	109	hi	3.9
Reliance	110	ghi	2.5
Tomahawk	112	fgh	5.9
BSC2030	112	fgh	4.3
Exp-36026	113	efg	4.9
BSC2014	114	efg	8.6
BSC15L11	114	efg	5.5
11P42	114	ef	4.4
Design	115	ef	4.4
Exp-36003	116	de	3.5
Icepack	117	de	3.7
228	120	d	4.9
SV7401QH	120	d	3.9
CS-453F	131	c	7.9
SV1391QH	131	c	3.4
BSC3129	136	b	6.1
304-3	149	a	6.8
p-value	<0.0001		
LSD	4.0772		

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

Table 7E: Vine Length in Centimeters

Variety	Vine Length (cm)	
Design	60.7	a
228	56.3	ab
304-3	54.5	bc
11P42	52.4	bcd
BSC5051	52.2	bcde
SV8112QH	50.4	cdef
SV1391QH	48.0	defg
M-14	47.2	defg
BSC15L11	46.7	efgh
BSC3129	46.3	fgh
BSC2030	45.4	fgh
Exp-36026	44.9	fghi
Strike	44.5	ghij
Marias	44.2	ghij
Icepack	44.2	ghij
SV7401QH	44.1	ghij
BSC2014	43.2	ghijk
Jumpstart	41.6	hijkl
CS-453F	39.6	ijkl
Tomahawk	39.2	jkl
SV0935QF	38.2	kl
GVS 435	38.0	kl
Exp-36003	37.7	kl
Reliance	36.4	lm
Boston	31.8	m
p-value	<0.0001	
LSD	5.56	

Table 8E: Number of Pods per Plant

Variety	Pods/Plant	
Boston	5.1	a
BSC15L11	5.0	a
Design	4.7	ab
11P42	4.6	ab
Marias	4.3	abc
SV8112QH	4.2	abcd
SV7401QH	4.2	abcd
Exp-36003	4.1	abcde
BSC3129	3.8	bcdef
BSC5051	3.7	bcdefg
304-3	3.7	bcdefg
BSC2030	3.6	bcdefg
Exp-36026	3.3	cdefg
SV0935QF	3.3	cdefg
Jumpstart	3.3	cdefg
M-14	3.2	cdefg
228	3.1	defg
CS-453F	3.0	efg
Icepack	3.0	efg
SV1391QH	2.9	fg
Reliance	2.9	fg
GVS 435	2.8	fg
Strike	2.8	fg
Tomahawk	2.6	g
BSC2014	2.6	g
p-value	<0.0001	
LSD	1.13	

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

Variety	Nodes w/ Pods/Plant
Boston	4.3 a
11P42	3.2 b
Exp-36026	2.9 bc
Jumpstart	2.9 bc
Marias	2.8 bcd
Exp-36003	2.7 bcde
Design	2.7 bcde
BSC15L11	2.5 bcdef
SV7401QH	2.5 bcdef
Tomahawk	2.4 cdef
BSC5051	2.4 cdef
Strike	2.4 cdef
BSC2030	2.3 cdefg
304-3	2.3 cdefg
M-14	2.2 cdefg
SV8112QH	2.2 cdefg
GVS 435	2.2 cdefg
Icepack	2.2 cdefg
BSC3129	2.1 defg
CS-453F	2.0 efg
BSC2014	2.0 efg
228	1.9 fg
SV1391QH	1.8 fg
SV0935QF	1.6 g
Reliance	1.6 g
p-value	<0.0001
LSD	0.70

Table 10E: Average Number of Peas/Pod

Variety	Peas/Pod
SV7401QH	6.9 a
Boston	6.7 ab
Design	6.7 ab
BSC15L11	6.6 ab
SV1391QH	6.3 abc
SV0935QF	6.2 abcd
Tomahawk	6.1 abcde
BSC5051	6.1 abcde
Exp-36003	5.7 abcdef
11P42	5.7 abcdef
Reliance	5.7 abcdef
Jumpstart	5.7 abcdef
GVS 435	5.6 bcdef
Exp-36026	5.3 cdef
SV8112QH	5.2 cdef
BSC2030	5.1 cdefg
228	5.1 cdefg
Icepack	5.1 cdefg
Strike	5.0 defg
BSC3129	4.9 efg
M-14	4.8 fg
BSC2014	4.7 fg
304-3	4.7 fg
CS-453F	4.6 fg
Marias	3.9 g
p-value	<0.0001
LSD	1.30

Table 11E: Average Pod Length (cm)

Variety	Pod Length (cm)	
GVS 435	8.1	a
SV0935QF	7.5	ab
Boston	7.2	bc
Design	7.2	bc
Tomahawk	7.1	bcd
SV7401QH	7.1	bcde
BSC5051	7.0	bcdef
Reliance	6.8	bcdefg
304-3	6.8	vcdefg
BSC2030	6.7	cdefg
11P42	6.7	cdefg
SV1391QH	6.7	cdefg
Icepack	6.7	cdefg
Jumpstart	6.6	cdefgh
Exp-36003	6.5	cdefgh
SV8112QH	6.5	cdefgh
228	6.4	defghi
M-14	6.4	efghi
Strike	6.4	fghi
Exp-36026	6.3	fghij
BSC3129	6.2	ghij
Marias	6.1	ghij
BSC2014	5.9	hij
BSC15L11	5.7	ij
CS-453F	5.6	j
p-value	<0.0001	
LSD	0.72	

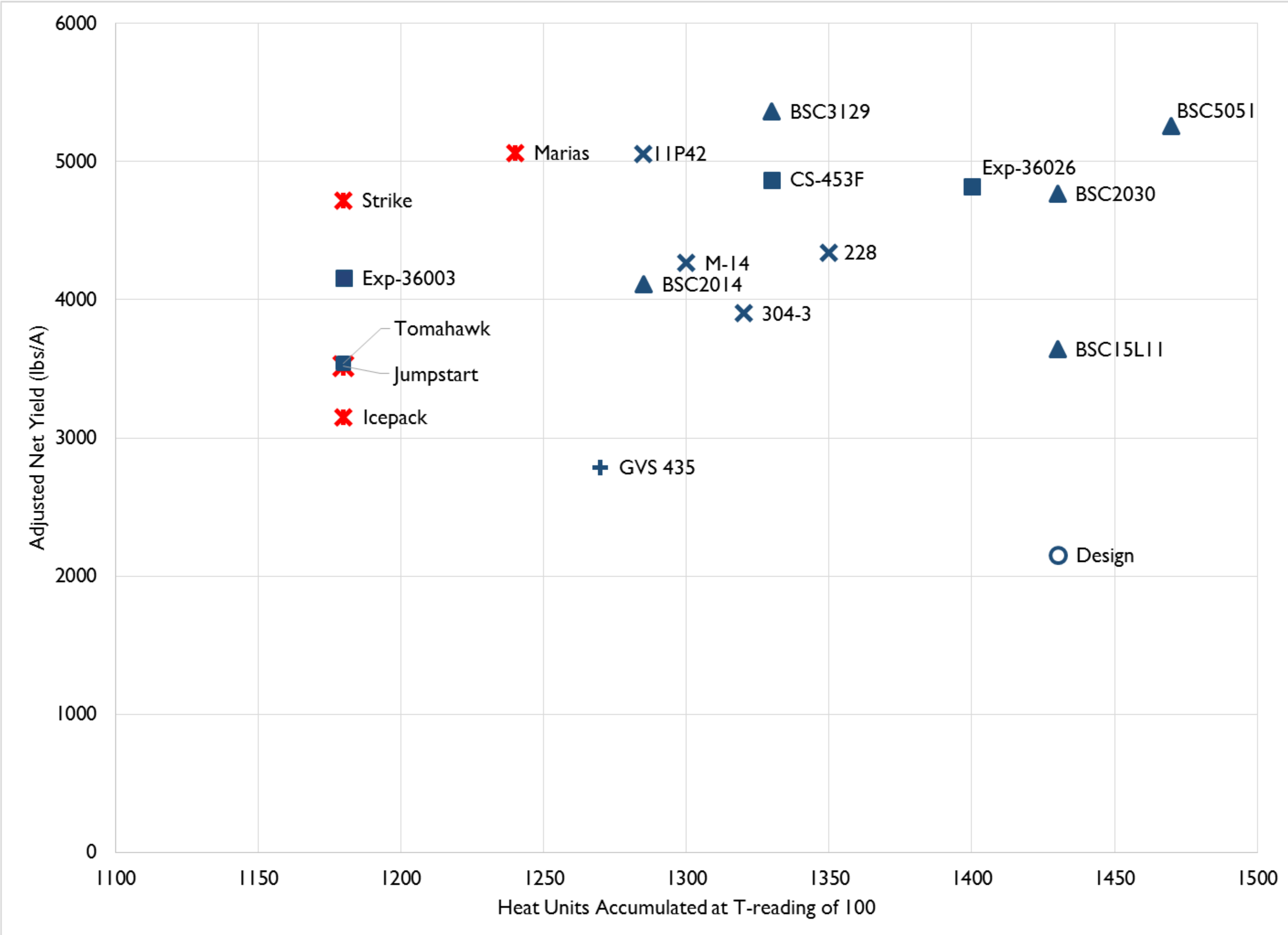
Early Trial Maturity Data

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												
		27 May	28 May	29 May	30 May	31 May	1 Jun	2 Jun	3 Jun	4 Jun	5 Jun	6 Jun	7 Jun	8 Jun
		1079	1115	1145	1176	1211	1244	1273	1302	1335	1371	1409	1445	1469
Jumpstart	1110	92			**101***									
Icepack	1170	80			100	**117**								
Exp-36003	1150				97	**116**								
Tomahawk	1160	89			99	**112**								
Boston	?					**109**								
Strike	1140	76			103	**108**								
Marias	1290					88	101	**109**						
GVS 435	1200					80		**104**						
BSC2014	1200					81	89	91	**114**					
11P42	1330					91	90	92	**114**					
M-14	1330						91	81	**107**					
BSC3129	1265					75		82	88			**136**		
CS-453F	1275						81	77	88			**131**		
SV7401QH	1340								78			**120**		
228	1430											**120**		
Exp-36026	1290											**113**		
SV8112QH	1430											**102**		
304-3	1360											142	**149**	
SV1391QH	1320												**131**	
Design	?												**115**	
BSC15L11	1350											85	**114**	
BSC2030	1340											85	**112**	
Reliance	1420												**110**	
SV0935QF	1340												**106**	
BSC5051	1370												88	**101**

***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

	First Flower		Full Flower	
Variety	**DAP**	**Heat Units**	**DAP**	**Heat Units**
CS-424F	43	831	45	892
GV 490	44	861	46	927
Exp-36015	44	861	46	927
GV 518	44	861	46	927
SV8112QH	45	892	47	960
CS-437F	45	892	47	960
CS-452F	45	892	47	960
613-1	45	892	49	1018
513	46	927	49	1018
SV0371QF	47	960	49	1018
GV 555	47	960	49	1018
Grundy	47	960	49	1018
Bolero	47	960	50	1051
SV1036QF	47	960	50	1051
Quad	49	1018	51	1087
SV7688QF	49	1018	52	1125
SV0893QF	49	1018	52	1125
251	49	1018	51	1087
595-1	49	1018	52	1125
CS-444F	50	1051	52	1125
196	50	1051	52	1125
Valkon	50	1051	53	1161

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

		% Stand	Seed Treatment							
Variety	**Plants/Yd**	(at 8 seeds/ft)	**Captan**	**Allegiance**	**Maxim**	**Apron**	**Cruiser**	**Lorsban**	**Thiram**	**Molybdenum**
Valkon	33.9 a	126							x	
GV 555	33.8 a	125			x	x	x			x
CS-437F	32.9 ab	122			x	x	x			x
SV7688QF	31.3 abc	116	x	x						
GV 518	30.4 abcd	113			x	x	x			x
SV8112QH	29.9 abcde	111	x	x						
Quad	28.4 bcdef	105			x	x		x		
Exp-36015	28.3 bcdef	105			x	x	x			x
513	28.3 bcdef	105			x	x	x			x
CS-424F	28.2 cdef	105			x	x	x			x
SV0371QF	28.1 cdef	104	x	x						
196	28.0 cdef	104	x	x			x			
CS-444F	27.8 cdef	103			x	x	x			x
CS-452F	27.7 cdefg	102			x	x	x			x
SV1036QF	26.7 defgh	99	x	x						
SV0893QF	26.7 defgh	99	x	x						
GV 490	26.6 defgh	99			x	x	x			x
613-1	25.6 efgh	95	x	x			x			
Grundy	24.0 fghi	89			x	x		x		
251	23.1 ghi	86	x	x			x			
595-1	22.7 hi	84	x	x			x			
Bolero	20.2 i	75			x	x		x		
p-value	<0.0001									
LSD	4.6092									

Late Trial Harvest Data

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

Variety	Vine Weight (lbs.)	
CS-444F	94	a
CS-452F	80	b
595-1	77	bc
196	76	bc
513	75	bc
SV0371QF	74	bc
SV8112QH	73	bcd
SV7688QF	73	bcde
Grundy	73	bcde
SV1036QF	70	bcdef
GV 555	70	bcdef
GV 518	68	cdefg
GV 490	62	defgh
613-1	62	efgh
SV0893QF	61	fgh
251	58	ghi
Bolero	58	ghi
CS-424F	56	hi
CS-437F	54	hi
Exp-36015	51	hi
Valkon	49	i
Quad	48	i
p-value	<0.0001	
LSD	11.414	

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

Variety	Adj. Net Yield (lbs/A)		Adj. Gross Yield (lbs/A)	
CS-444F	4206	a	4351	a
CS-424F	4048	ab	4055	ab
196	3728	abc	3799	abc
513	3559	bcd	3569	bcd
CS-452F	3546	bcd	3615	bcd
595-1	3265	cde	3335	cde
SV0893QF	3243	cdef	3336	cde
SV8112QH	3117	cdefg	3184	cdef
SV1036QF	3075	defgh	3086	defg
Bolero	3021	defghi	3073	defg
251	2863	efghij	2962	defgh
Grundy	2806	efghijk	2841	efgh
Exp-36015	2796	efghijk	2823	efgh
Quad	2620	fghijk	2658	fgh
SV0371QF	2536	ghijkl	3015	defg
SV7688QF	2477	hijkl	2525	fghi
GV 555	2437	hijkl	2480	ghij
CS-437F	2424	ijkl	2463	ghij
GV 490	2232	jklm	2724	efgh
613-1	2208	klm	2305	hij
GV 518	1904	lm	1972	ij
Valkon	1722	m	1809	j
p-value	<0.0001		<0.0001	
LSD	637.31		676.09	

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	
SV1036QF	77.0	a	18.2	h	4.4	k	0.4	fg	135	e
513	75.8	a	19.7	gh	4.2	k	0.3	g	155	c
595-1	71.4	ab	17.2	h	9.3	jk	2.1	cdefg	122	f
CS-444F	68.2	abc	18.0	h	10.5	ij	3.3	cd	105	ghi
196	65.8	bc	23.1	gh	9.3	jk	1.8	defg	108	g
Grundy	65.2	bc	25.2	g	8.3	jk	1.2	defg	142	d
CS-424F	60.1	cd	35.0	f	4.7	k	0.2	g	105	gh
Bolero	53.3	de	33.5	f	11.5	ij	1.7	defg	120	f
CS-452F	50.7	ef	37.4	ef	10.0	j	1.9	defg	96	jk
Quad	50.4	ef	37.4	ef	10.8	ij	1.4	defg	168	a
GV 490	48.3	efg	32.6	f	13.1	hij	5.9	b	103	ghi
251	43.1	fgh	38.2	def	15.5	ghi	3.3	cde	125	f
CS-437F	42.9	fgh	44.6	cd	10.9	ij	1.6	defg	160	bc
Exp-36015	40.3	ghi	43.4	cde	15.4	ghi	1.0	efg	121	f
SV0893QF	37.5	hi	42.1	cde	17.8	fgh	2.6	cdef	101	hij
SV7688QF	32.0	ij	44.2	cd	21.9	ef	1.9	defg	122	f
GV 555	31.5	ij	47.1	bc	19.7	fg	1.7	defg	163	ab
Valkon	27.0	jk	41.9	cde	26.7	de	4.3	bc	94	k
GV 518	20.5	k	44.0	cde	32.1	bc	3.4	cd	99	ijk
SV8112QH	8.8	l	60.0	a	29.1	cd	2.1	cdefg	109	g
613-1	6.5	l	52.6	b	36.6	b	4.2	bc	122	f
SV0371QF	1.6	l	23.8	gh	58.8	a	15.8	a	93	k
p-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
LSD	9.08		6.66		5.11		2.28		6.03	

Table 6L: Tenderometer Reading at Harvest

Variety	Tenderometer Reading		Standard Deviation of T-Reading
Quad	168	a	6.3836
GV 555	163	ab	6.3727
CS-437F	160	bc	13.3614
513	155	c	6.3792
Grundy	142	d	6.8557
SV1036QF	135	e	7.7621
251	125	f	6.0438
SV7688QF	122	f	6.1667
613-1	122	f	3.7081
595-1	122	f	7.1434
Exp-36015	121	f	4.7726
Bolero	120	f	7.828
SV8112QH	109	g	7.6485
196	108	g	5.3098
CS-424F	105	gh	3.4075
CS-444F	105	ghi	4.3811
GV 490	103	ghi	4.7288
SV0893QF	101	hij	7.4125
GV 518	99	ijk	2.1082
CS-452F	96	jk	3.3953
Valkon	94	k	7.9844
SV0371QF	93	k	3.3333
p-value	<0.0001		
LSD	6.03		

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

Table 7L: Vine Length in Centimeters

Variety	Vine Length (cm)	
CS-444F	66.2	a
595-1	64.7	a
SV1036QF	57.5	b
SV0893QF	54.5	bc
GV 555	54.5	bc
GV 490	53.7	bcd
613-1	53.4	cde
Grundy	52.4	cdef
Valkon	52.1	cdef
SV7688QF	52.0	cdefg
513	51.0	cdefg
CS-437F	50.9	cdefg
SV0371QF	50.5	defgh
251	49.0	defgh
CS-452F	48.4	efgh
GV 518	48.3	efgh
196	47.5	fghi
Quad	46.6	ghi
Bolero	44.8	hij
CS-424F	43.4	ij
SV8112QH	41.2	jk
Exp-36015	38.6	k
p-value	<0.0001	
LSD	4.66	

Table 8L: Number of Pods per Plant

Variety	Pods/Plant	
Exp-36015	4.2	a
613-1	4.0	ab
CS-452F	3.4	abc
Quad	3.3	abcd
251	3.2	bcde
GV 490	3.2	bcde
GV 518	3.2	bcde
GV 555	3.1	bcde
CS-437F	2.9	cde
SV0371QF	2.9	cde
Bolero	2.9	cde
SV1036QF	2.8	cdef
CS-444F	2.7	cdefg
CS-424F	2.6	cdefg
196	2.6	cdefg
Grundy	2.5	cdefg
SV0893QF	2.4	defg
SV8112QH	2.3	efg
513	2.3	efg
595-1	1.9	fg
Valkon	1.9	fg
SV7688QF	1.8	g
p-value	<0.0001	
LSD	0.96	

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

Variety	Nodes w/ Pods/Plant	
613-1	2.7	a
GV 518	2.6	ab
Exp-36015	2.4	abc
251	2.4	abc
GV 555	2.4	abc
GV 490	2.3	abcd
CS-437F	2.0	bcde
CS-452F	2.0	bcde
196	2.0	bcde
Grundy	2.0	bcde
SV1036QF	1.9	cde
Bolero	1.9	cde
Quad	1.9	cde
CS-424F	1.8	cdef
CS-444F	1.7	def
SV0371QF	1.7	def
SV7688QF	1.5	ef
513	1.5	ef
Valkon	1.5	ef
SV8112QH	1.4	ef
SV0893QF	1.4	ef
595-1	1.2	f
p-value	<0.0001	
LSD	0.66	

Table 10L: Average Number of Peas per Pod

Variety	Peas/Pod	
613-1	8.4	a
Grundy	7.6	ab
SV0371QF	7.5	ab
GV 490	7.5	ab
GV 518	7.4	abc
251	6.9	abcd
SV0893QF	6.6	bcde
196	6.5	bcde
GV 555	6.3	bcdef
Valkon	6.3	bcdef
SV8112QH	5.9	cdefg
CS-424F	5.8	defg
CS-452F	5.7	defg
Bolero	5.7	defg
CS-437F	5.6	defg
CS-444F	5.6	defg
595-1	5.6	defg
SV1036QF	5.4	defg
Quad	5.4	defg
Exp-36015	5.2	efg
513	4.8	fg
SV7688QF	4.7	g
p-value	<0.0001	
LSD	1.57	

Table 11L: Average Pod Length in Centimeters

Variety	Pod Length (cm)	
Grundy	9.3	a
GV 490	8.7	ab
GV 518	8.6	ab
595-1	8.6	ab
196	8.1	bc
613-1	8.1	bcd
251	7.9	bcd
Valkon	7.9	bcd
CS-437F	7.5	cde
SV7688QF	7.3	def
SV1036QF	7.1	efg
Exp-36015	6.8	efgh
513	6.8	efgh
SV0893QF	6.8	efgh
CS-424F	6.7	efgh
GV 555	6.7	efgh
Bolero	6.7	fgh
SV8112QH	6.5	fghi
CS-452F	6.5	ghi
CS-444F	6.3	hi
Quad	6.2	hi
SV0371QF	5.8	i
p-value	<0.0001	
LSD	0.79	

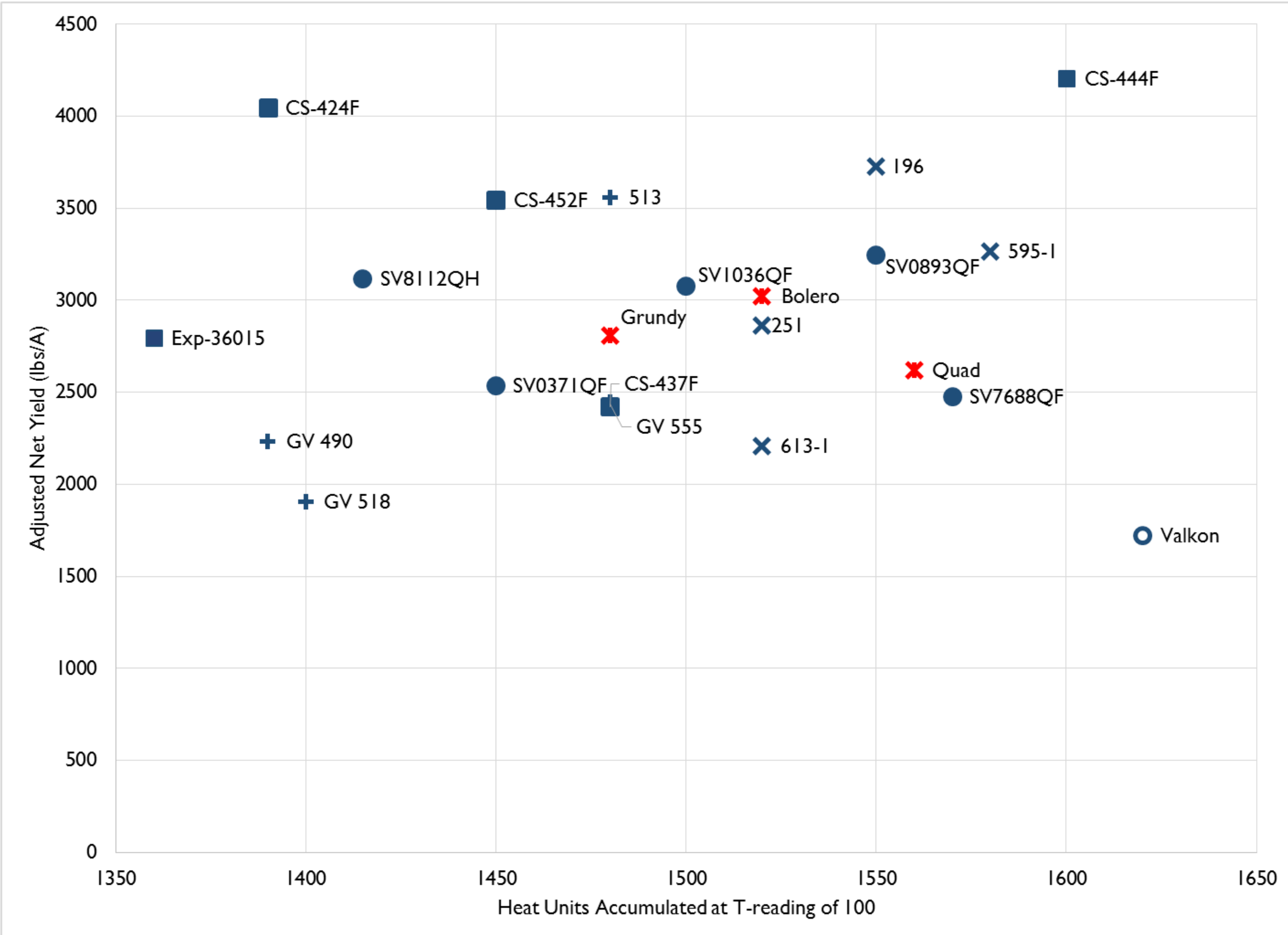
Late Trial Maturity Data

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

Variety	Reported Heat Units	**Date and Accumulated Heat Units**									
		13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun
		1341	1372	1399	1426	1456	1485	1518	1554	1591	1626
Exp-36015	1330	87		**121**							
CS-424F	1350	84		**105**							
GV 518	1350	75		**99**							
GV 490	1380	82		**103**							
SV8112QH	1430	80		88	**109**						
SV0371QF	1480	63		92	**93**						
CS-452F	1450			83	80	**96**					
CS-437F	1405			79	84	81			**160**		
SV1036QF	1525				76				**135**		
251	1520				71				**125**		
613-1	1460			79	78				**122**		
Bolero	1480			76	73				**120**		
SV0893QF	1525			70	66				**101**		
GV 555	1650			86	77				133	**163**	
513	1550				72				144	**155**	
Grundy	1595				79				122	**142**	
SV7688QF	1520								94	**122**	
196	1550								99	**108**	
Quad	1600				66				82	122	**168**
595-1	1550								85	105	**122**
CS-444F	1560								83	96	**105**
Valkon	?								76	77	**94**

*****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 2016 Early Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall
17-Mar-16	0	68.9	41.4	0.0	**0**	0	0.00
18-Mar-16	1	64.3	40.1	12.2	**12**	0	0.00
19-Mar-16	2	47.6	37.0	2.3	**15**	0.13	0.13
20-Mar-16	3	42.8	34.7	-1.3	**15**	0.48	0.61
21-Mar-16	4	49.1	32.3	0.7	**15**	0.1	0.71
22-Mar-16	5	57.8	27.2	2.5	**18**	0	0.71
23-Mar-16	6	71.6	48.3	20.0	**38**	0	0.71
24-Mar-16	7	74.4	49.8	22.1	**60**	0	0.71
25-Mar-16	8	74.8	53.1	24.0	**84**	0.02	0.73
26-Mar-16	9	55.3	41.3	8.3	**92**	0	0.73
27-Mar-16	10	52.4	46.0	9.2	**101**	0	0.73
28-Mar-16	11	68.8	47.8	18.3	**120**	0.48	1.21
29-Mar-16	12	57.2	36.6	6.9	**126**	0	1.21
30-Mar-16	13	59.1	29.7	4.4	**131**	0	1.21
31-Mar-16	14	73.5	47.6	20.6	**151**	0	1.21
1-Apr-16	15	76.6	65.5	31.1	**182**	0.63	1.84
2-Apr-16	16	70.2	49.4	19.8	**202**	0.89	2.73
3-Apr-16	17	50.9	37.3	4.1	**206**	0.09	2.82
4-Apr-16	18	71.6	40.5	16.1	**222**	0.2	3.02
5-Apr-16	19	45.9	28.4	-2.9	**222**	0	3.02
6-Apr-16	20	54.6	24.4	-0.5	**222**	0	3.02
7-Apr-16	21	62.1	49.1	15.6	**238**	0.23	3.25
8-Apr-16	22	52.1	34.7	3.4	**241**	0	3.25
9-Apr-16	23	46.4	34.9	0.6	**242**	0.43	3.68
10-Apr-16	24	49.8	29.1	-0.5	**242**	0	3.68
11-Apr-16	25	68.4	40.4	14.4	**256**	0	3.68
12-Apr-16	26	60.7	44.6	12.7	**269**	0.39	4.07
13-Apr-16	27	55.5	36.1	5.8	**275**	0	4.07
14-Apr-16	28	57.8	30.7	4.3	**279**	0	4.07
15-Apr-16	29	58.5	31.4	5.0	**284**	0	4.07
16-Apr-16	30	60.3	31.7	6.0	**290**	0	4.07
17-Apr-16	31	69.5	33.9	11.7	**302**	0	4.07
18-Apr-16	32	80.5	39.6	20.1	**322**	0	4.07
19-Apr-16	33	82.3	45.2	23.8	**346**	0	4.07
20-Apr-16	34	68.6	40.8	14.7	**360**	**0.3***	4.37
21-Apr-16	35	72.9	40.0	16.5	**377**	0	4.37
22-Apr-16	36	78.1	62.0	30.1	**407**	0.03	4.40
23-Apr-16	37	65.6	51.5	18.6	**425**	0.24	4.64
24-Apr-16	38	67.2	41.1	14.2	**439**	0	4.64
25-Apr-16	39	74.5	43.8	19.2	**459**	0	4.64
26-Apr-16	40	85.4	61.2	33.3	**492**	0	4.64
27-Apr-16	41	61.2	49.2	15.2	**507**	0.26	4.90
28-Apr-16	42	52.8	46.6	9.7	**517**	0.48	5.38
29-Apr-16	43	52.7	47.9	10.3	**527**	0.04	5.42
30-Apr-16	44	58.8	47.9	13.4	**540**	0	5.42
1-May-16	45	54.3	48.8	11.6	**552**	0.49	5.91
2-May-16	46	77.7	50.9	24.3	**576**	0.43	6.34
3-May-16	47	70.1	50.2	20.2	**596**	0.3	6.64
4-May-16	48	54.2	49.6	11.9	**608**	1.1	7.74
5-May-16	49	52.2	48.4	10.3	**619**	0	7.74
6-May-16	50	54.0	47.4	10.7	**629**	0.66	8.40
7-May-16	51	62.3	48.9	15.6	**645**	0.01	8.41
8-May-16	52	71.7	49.0	20.4	**665**	0	8.41

9-May-16	53	67.2	43.1	15.2	**680**	0.01	8.42
10-May-16	54	64.4	51.8	18.1	**699**	0	8.42
11-May-16	55	70.2	51.4	20.8	**719**	0.37	8.79
12-May-16	56	70.5	56.4	23.5	**743**	0	8.79
13-May-16	57	70.1	55.4	22.8	**766**	0.15	8.94
14-May-16	58	76.6	51.7	24.2	**790**	0.16	9.10
15-May-16	59	60.3	47.2	13.8	**803**	0	9.10
16-May-16	60	63.1	37.4	10.3	**814**	0	9.10
17-May-16	61	63.7	48.7	16.2	**830**	0.24	9.34
18-May-16	62	64.5	51.5	18.0	**848**	0	9.34
19-May-16	63	71.9	52.2	22.1	**870**	0	9.34
20-May-16	64	75.9	46.2	21.1	**891**	0	9.34
21-May-16	65	61.7	53.7	17.7	**909**	0.92	10.26
22-May-16	66	58.5	53.5	16.0	**925**	0.14	10.40
23-May-16	67	68.4	55.0	21.7	**946**	0.01	10.41
24-May-16	68	80.3	56.5	28.4	**975**	0.01	10.42
25-May-16	69	85.8	57.4	31.6	**1006**	0	10.42
26-May-16	70	89.5	58.3	33.9	**1040**	0	10.42
27-May-16	71	88.4	68.0	38.2	**1079**	0	10.42
28-May-16	72	88.1	64.6	36.4	**1115**	0	10.42
29-May-16	73	83.4	56.9	30.2	**1145**	0.01	10.43
30-May-16	74	75.5	67.1	31.3	**1176**	1.8	12.23
31-May-16	75	83.6	64.9	34.3	**1211**	0.23	12.46
1-Jun-16	76	82.7	64.5	33.6	**1244**	0	12.46
2-Jun-16	77	71.9	65.5	28.7	**1273**	0	12.46
3-Jun-16	78	74.7	64.3	29.5	**1302**	0.01	12.47
4-Jun-16	79	82.2	62.5	32.4	**1335**	0	12.47
5-Jun-16	80	85.7	66.1	35.9	**1371**	0.04	12.51
6-Jun-16	81	85.3	70.9	38.1	**1409**	0	12.51
7-Jun-16	82	88.1	63.9	36.0	**1445**	**0.36***	12.87
8-Jun-16	83	74.1	54.3	24.2	**1469**	0	12.87

Appendix B: Weather Data for 2016 Late Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall/ Irrigation
15-Apr-16	0	58.5	31.4	0.0	**0**	0	0.00
16-Apr-16	1	60.3	31.7	6.0	**6**	0	0.00
17-Apr-16	2	69.5	33.9	11.7	**18**	0	0.00
18-Apr-16	3	80.5	39.6	20.1	**38**	0	0.00
19-Apr-16	4	82.3	45.2	23.8	**62**	0	0.00
20-Apr-16	5	68.6	40.8	14.7	**76**	0.3*	0.30
21-Apr-16	6	72.9	40.0	16.5	**93**	0	0.30
22-Apr-16	7	78.1	62.0	30.1	**123**	0.03	0.33
23-Apr-16	8	65.6	51.5	18.6	**141**	0.24	0.57
24-Apr-16	9	67.2	41.1	14.2	**155**	0	0.57
25-Apr-16	10	74.5	43.8	19.2	**175**	0	0.57
26-Apr-16	11	85.4	61.2	33.3	**208**	0	0.57
27-Apr-16	12	61.2	49.2	15.2	**223**	0.26	0.83
28-Apr-16	13	52.8	46.6	9.7	**233**	0.48	1.31
29-Apr-16	14	52.7	47.9	10.3	**243**	0.04	1.35
30-Apr-16	15	58.8	47.9	13.4	**256**	0	1.35
1-May-16	16	54.3	48.8	11.6	**268**	0.49	1.84
2-May-16	17	77.7	50.9	24.3	**292**	0.43	2.27
3-May-16	18	70.1	50.2	20.2	**312**	0.3	2.57
4-May-16	19	54.2	49.6	11.9	**324**	1.1	3.67
5-May-16	20	52.2	48.4	10.3	**335**	0	3.67
6-May-16	21	54.0	47.4	10.7	**345**	0.66	4.33
7-May-16	22	62.3	48.9	15.6	**361**	0.01	4.34
8-May-16	23	71.7	49.0	20.4	**381**	0	4.34
9-May-16	24	67.2	43.1	15.2	**396**	0.01	4.35
10-May-16	25	64.4	51.8	18.1	**415**	0	4.35
11-May-16	26	70.2	51.4	20.8	**435**	0.37	4.72
12-May-16	27	70.5	56.4	23.5	**459**	0	4.72
13-May-16	28	70.1	55.4	22.8	**482**	0.15	4.87
14-May-16	29	76.6	51.7	24.2	**506**	0.16	5.03
15-May-16	30	60.3	47.2	13.8	**519**	0	5.03
16-May-16	31	63.1	37.4	10.3	**530**	0	5.03
17-May-16	32	63.7	48.7	16.2	**546**	0.24	5.27
18-May-16	33	64.5	51.5	18.0	**564**	0	5.27
19-May-16	34	71.9	52.2	22.1	**586**	0	5.27
20-May-16	35	75.9	46.2	21.1	**607**	0	5.27
21-May-16	36	61.7	53.7	17.7	**625**	0.92	6.19
22-May-16	37	58.5	53.5	16.0	**641**	0.14	6.33
23-May-16	38	68.4	55.0	21.7	**662**	0.01	6.34
24-May-16	39	80.3	56.5	28.4	**691**	0.01	6.35
25-May-16	40	85.8	57.4	31.6	**722**	0	6.35
26-May-16	41	89.5	58.3	33.9	**756**	0	6.35
27-May-16	42	88.4	68.0	38.2	**794**	0	6.35
28-May-16	43	88.1	64.6	36.4	**831**	0	6.35
29-May-16	44	83.4	56.9	30.2	**861**	0.01	6.36
30-May-16	45	75.5	67.1	31.3	**892**	1.8	8.16
31-May-16	46	83.6	64.9	34.3	**927**	0.23	8.39
1-Jun-16	47	82.7	64.5	33.6	**960**	0	8.39
2-Jun-16	48	71.9	65.5	28.7	**989**	0	8.39
3-Jun-16	49	74.7	64.3	29.5	**1018**	0.01	8.40
4-Jun-16	50	82.2	62.5	32.4	**1051**	0	8.40
5-Jun-16	51	85.7	66.1	35.9	**1087**	0.04	8.44
6-Jun-16	52	85.3	70.9	38.1	**1125**	0	8.44

7-Jun-16	53	88.1	63.9	36.0	**1161**	0.06	8.50
8-Jun-16	54	74.1	54.3	24.2	**1185**	0	8.50
9-Jun-16	55	79.1	50.6	24.9	**1210**	0	8.50
10-Jun-16	56	79.1	55.4	27.3	**1237**	0	8.50
11-Jun-16	57	89.2	59.2	34.2	**1271**	0	8.50
12-Jun-16	58	93.3	68.6	41.0	**1312**	0	8.50
13-Jun-16	59	77.8	60.6	29.2	**1341**	0	8.50
14-Jun-16	60	79.2	61.9	30.6	**1372**	0	8.50
15-Jun-16	61	77.8	56.5	27.2	**1399**	0	8.50
16-Jun-16	62	69.9	64.2	27.1	**1426**	0.54	9.04
17-Jun-16	63	78.2	62.4	30.3	**1456**	0.25	9.29
18-Jun-16	64	81.2	56.6	28.9	**1485**	0	9.29
19-Jun-16	65	87.9	57.2	32.6	**1518**	0	9.29
20-Jun-16	66	89.1	63.7	36.4	**1554**	0	9.29
21-Jun-16	67	87.2	67.3	37.3	**1591**	0.87	10.16
22-Jun-16	68	82.4	65.7	34.1	**1626**	0	10.16

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]

F. V. Pumphrey, R. E. Ramig, and R. R. Allmaras[2]
Columbia Basin Research Center, Pendleton, OR

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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[2] Associate Professor of Agronomy, Columbia Basin Research Center, and Soil Scientists, Columbia Plateau Conservation Research Center, Pendleton, OR. Appreciation is given to Leslie G. Ekin, Agricultural Research Technician, for expert field assistance given in this study.

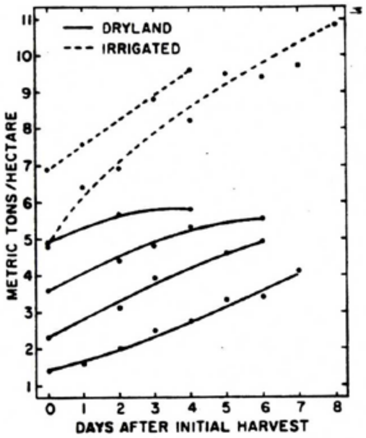

Fig. 1. Yield versus time of harvest for fresh peas in 6 typical experiments.

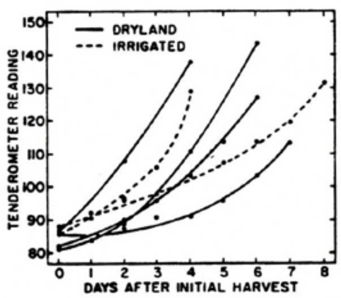

Fig. 2. Tenderometer of fresh peas as affected by time of harvest in 6 typical experiments.

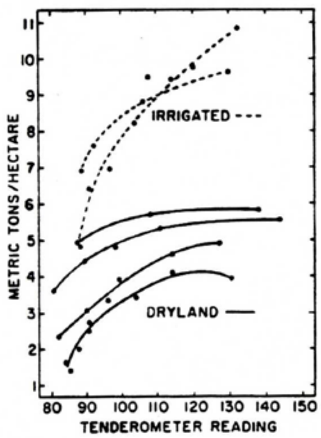

Fig. 3. Yield of fresh peas and associated tenderometer reading in 6 typical experiments.

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

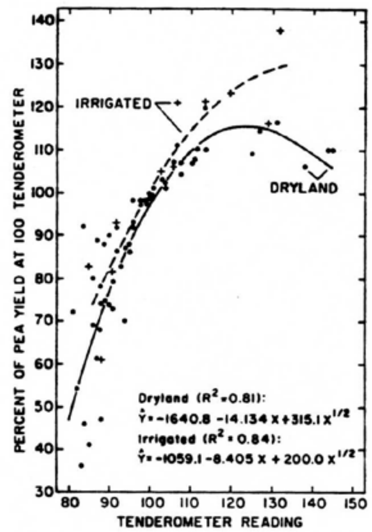

Fig. 4. Percent yield-tenderometer reading relationship for 'Dark Skinned Perfection' pea in irrigated and dryland experiments.

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 und 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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