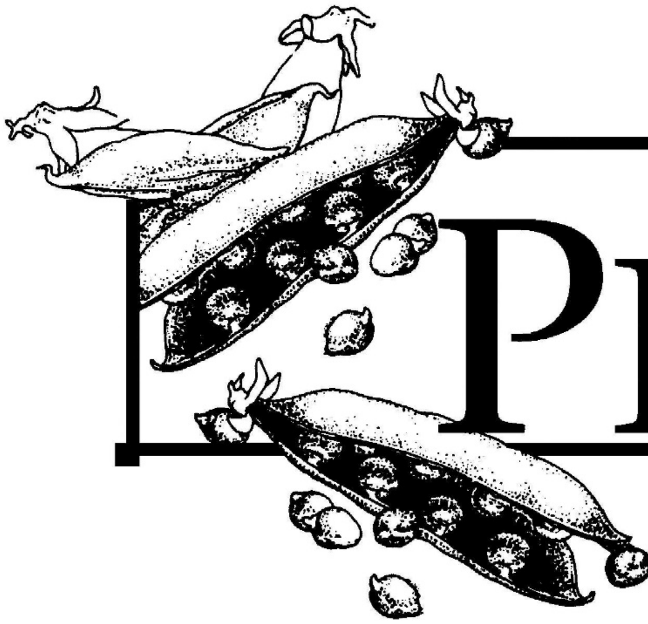

University of Delaware

PEA

Variety Trial Results

2018

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2018 University of Delaware Pea Variety Trial

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Introduction

The 2018 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 19 and April 20. 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

Nineteen varieties were planted in the March 19 trial, and 26 varieties in the April 20 trial. The trials were located in Field 25-C 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 19, 2018; 19 varieties
Late Trial – April 20, 2018; 26 varieties

Herbicide: Pursuit @ 2 oz/A + Dual Magnum @ 1.25 pt/A with 30% UAN at 25 gal/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: **Early Trial** – Diazinon AG500 2 qt/A incorporated on March 12, 2018

Stands: Stands of most varieties in both trials were good or excellent.

Plot Design: 6 x 30 foot plots arranged in a randomized complete block design with 3 replications

Varieties in the 2018 Early Pea Trial

Variety	Company
SV7401QH	Seminis
SV0935QF*	Seminis
SV8112QH*	Seminis
BSC2014	Brotherton Seed Co., Inc.
BSC3129	Brotherton Seed Co., Inc.
BSC3048*	Brotherton Seed Co., Inc.
11P42*	Pure Line Seeds, Inc.
534*	Pure Line Seeds, Inc.
Para	Pure Line Seeds, Inc.
Dakota	Gallatin Valley Seed
Austin*	Gallatin Valley Seed
CS-488F (36003)	Crites Seed, Inc.
CS-481AF*	Crites Seed, Inc.
CS-455AF*	Crites Seed, Inc.
CS-456AF*	Crites Seed, Inc.
Jumpstart	check
Tomahawk*	check
M-14	check
Marias	check

*** Afila Variety**

Varieties in the 2018 Late Pea Trial

Variety	Company
SV6844QG *	Seminis
SV1231QF*	Seminis
SV0371QF*	Seminis
SV7688QF*	Seminis
SV0893QF	Seminis
BSCP064 (EXP064)	Brotherton Seed Co., Inc.
BSCP070 (EXP070)*	Brotherton Seed Co., Inc.
BSC7120*	Brotherton Seed Co., Inc.
Querida	Pure Line Seeds, Inc.
Dancer*	Pure Line Seeds, Inc.
251*	Pure Line Seeds, Inc.
91018	Pure Line Seeds, Inc.
GVS 490	Gallatin Valley Seed
GVS 410	Gallatin Valley Seed
GVS 560*	Gallatin Valley Seed
GVS 806*	Gallatin Valley Seed
GVS 828*	Gallatin Valley Seed
GVS 813	Gallatin Valley Seed
CS-472AF*	Crites Seed, Inc.
CS-482AF*	Crites Seed, Inc.
CS-473AF*	Crites Seed, Inc.
CS-474F	Crites Seed, Inc.
M-14	check
Bolero	check
Hudson	check
PLS 595*	check

*** Afila Variety**

Pre Harvest Data

For the Early Trial, the first plants emerged on April 5 (17 DAP) and stand counts of emerged plants were completed on April 11 (23 DAP). For the Late Trial, the first plants emerged on April 30 (10 DAP) and stand counts of emerged plants were completed on May 8 (18 DAP). 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, apart from three varieties in the late trial with very small size. For these varieties (GVS 813, BSCP064 and BSCP070) all sizes including peas <9/32 inch were used for tenderometer readings and included in final yield. 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, p-value for the effect of the independent variable and the coefficient of variation (CV) are included at the bottom of each table.

Cold and wet spring weather delayed planting of the early trial and wet field condition delayed the late trial. Rainfall levels were almost two inches above average in April and more than six inches above average in May. There were still some dry periods (end of April and mid-June) and irrigation was applied as necessary via an overhead linear irrigation system. Temperatures were below average March, typical for April and June and above average in May. Harvest of the Early Trial began on May 24, which is the typical first harvest date for this trial. The harvest of the Late Trial began on June 12 which is early for this trial, especially considering that it was planted 5 days later than usual. 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. All seed was treated with insecticide (either Cruiser or Lorsban) and seedcorn maggot damage was not apparent in either planting. There were no statistically significant differences in stand counts between varieties in the Early Trail. There were statistically significant differences in stand between varieties in the Late Trial, but all but 3 varieties had ≥ 90% stand. Reduced stand did not seem to be related to seed treatment choice.

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. The exception to this is three small seeded varieties in the Late Trial. For these varieties (GVS 813, BSCP064 and BSCP070) all sizes including peas <9/32 inch were used for tenderometer readings and included in net yield.

Yields in the Early Trial were lower than average for this trial. Average yield for the previous seven early trials is 3968 lbs/A for all varieties trialed. The average yield for the 2018 Early trial was 2462 lbs/A. In five previous years of trials Marias averaged 5478 lbs/A. In the 2018 trial it yielded 1823 lbs/A. CS-488F matured at a similar time to the first early varieties Jumpstart and Tomahawk and had significantly higher net yield than both of these control varieties. Dakota, CS-456AF, and M-14 produced significantly higher net yields than all of the other varieties in the trail. In addition to these three varieties, 11P42 and SV7401QH produced significantly higher yields than three of the control varieties (Marias, Tomahawk and Jumpstart) (Chart 1E).

Yields in the Late Trial were below average compared to what has been observed in past years for this trial. Average yield for the previous seven late trials is 3802 lbs/A for all varieties trialed. The average yield for the 2018 Late Trial was 1786 lbs/A. In five previous years of trials Bolero averaged 4164 lbs/a. In the 2018 trial it yielded 3015 lbs/A as the highest yielding variety in the trial. Six varieties produced net yields that were not significantly different than Bolero: BSC7120, GVS 828, BSCP070, GVS 410, BSCP064, and CS-472AF. These seven varieties produced significantly higher yields than three check varieties, M-14, Hudson and PLS 595. Hudson suffered significant yield loss from environmental stress or root rot such that one replication produced no yield. No other varieties were as significantly affected in this way. Yield was reduced in the later maturing varieties and SV6844QG was least affected of the later varieties in terms of yield. This yield reduction may have been due to extremely hot conditions at the end of the harvest period or to unusually hot conditions at the beginning of June (42 & 43 DAP) when many of the late maturing varieties had just initiated flowering. A split set was observed in Hudson and evidence of poor pollination (blanks in pods and low ratio of peas per pod to pod length) were observed in Querida, 251, PLS 595 and SV7688QF.

Early Trial Pre-Harvest Data

Table 1E: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Dakota	49	610	53	705
CS-488F	49	610	53	705
Jumpstart	50	628	53	705
Tomahawk	50	628	53	705
Austin	52	674	56	786
534	52	674	56	786
Para	52	674	56	786
CS-481AF	52	674	56	786
Marias	52	674	57	821
M-14	52	674	56	786
BSC2014	53	705	56	786
11P42	53	705	56	786
CS-455AF	53	705	56	786
CS-456AF	54	739	57	821
BSC3048	54	739	59	874
SV7401QH	56	786	62	957
BSC3129	56	786	62	957
SV0935QF	56	786	62	957
SV8112QH	57	821	62	957

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
CS-456AF	27.3	a	114			X	X	X			X
Jumpstart	25.3	a	105			X	X		X		
Marias	25.2	a	105			X	X		X		
SV8112QH	24.6	*	103	X	X			X			
Dakota	24.5	a	102			X	X	X			
Para	24.4	a	102			X	X	X			
CS-455AF	23.3	a	97			X	X	X			X
CS-481AF	23.2	a	97			X	X	X			X
BSC3048	22.8	a	95	X	X			X			
Tomahawk	22.8	a	95			X	X		X		
BSC2014	22.8	a	95	X	X			X			
BSC3129	22.8	a	95	X	X			X			
SV0935QF	22.6	a	94	X	X			X			
SV7401QH	22.4	a	93	X	X			X			
11P42	21.2	a	88			X	X	X			
Austin	20.4	*	85			X	X	X			
M-14	20.0	a	83			X	X	X			
CS-488F	19.8	a	83			X	X	X			X
534	16.5	*	69			X	X	X			
p-value	0.2256										
LSD	NS										
CV	25.4										

* average of 2 reps

Early Trial Harvest Data

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

Variety	Vine Weight (lbs.)	
M-14	36	a
11P42	35	ab
CS-456AF	35	abc
SV7401QH	31	abcd
CS-455AF	31	abcd
Dakota	31	abcd
534	30	*
SV0935QF	30	bcde
Para	30	cde
BSC2014	29	cde
BSC3048	27	def
Austin	25	*
CS-481AF	24	efg
BSC3129	23	fgh
SV8112QH	21	*
Marias	20	ghi
CS-488F	18	hi
Tomahawk	15	i
Jumpstart	14	i
p-value	<0.0001	
LSD	5.72	
CV	12.8	

* average of 2 reps

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)	
Dakota	3861	a	3953	ab
CS-456AF	3854	a	4048	a
M-14	3752	a	3798	ab
CS-455AF	3085	b	3414	bc
11P42	3028	b	3603	abc
SV7401QH	2990	b	3605	abc
CS-488F	2960	bc	3201	cd
Austin	2588	*	2639	*
BSC2014	2455	cd	2861	de
534	2109	*	2414	*
Para	2103	de	2438	ef
CS-481AF	2016	de	2280	fg
SV0935QF	1946	de	2161	fgh
BSC3129	1879	e	2116	fgh
Marias	1823	e	2047	fgh
Tomahawk	1768	ef	1796	gh
SV8112QH	1665	*	1989	*
Jumpstart	1600	ef	1913	fgh
BSC3048	1291	f	1653	h
p-value	<0.0001		<0.0001	
LSD	526.1		548.6	
CV	12.5		11.7	

* average of 2 reps

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	
Dakota	55.5	a	33.8	cdef	8.4	j	2.3	gh	119	c
M-14	46.9	b	35.3	cdef	16.7	i	1.2	h	131	b
Tomahawk	42.6	b	42.6	ab	13.3	ij	1.5	h	144	a
Austin	35.6	*	42.9	*	19.6	*	1.9	*	107	*
CS-456AF	34.4	c	34.3	cdef	26.5	gh	4.8	fgh	107	f
CS-481AF	23.2	d	40.9	abc	24.7	h	11.2	cde	106	f
534	22.8	*	37.4	*	27.1	*	12.7	*	107	*
BSC2014	15.9	e	37.1	bcdef	32.9	f	14.1	bcd	112	de
Para	15.4	e	39.5	bcde	31.3	fg	13.9	bcd	113	d
Marias	14.5	ef	39.3	bcde	35.3	def	10.9	de	115	d
CS-488F	11.2	ef	43.1	ab	38.5	de	7.2	efg	95	h
BSC3129	11.0	ef	32.7	ef	44.8	c	11.4	cde	95	h
CS-455AF	9.1	fg	48.0	a	33.2	ef	9.8	def	98	gh
11P42	8.9	fg	40.2	bcd	34.9	def	16.0	bc	109	ef
BSC3048	5.1	gh	33.4	def	39.7	cd	21.8	a	106	f
SV0935QF	1.7	h	31.0	f	57.0	b	10.3	de	99	g
SV7401QH	0.9	h	13.3	g	68.1	a	17.7	ab	98	g
Jumpstart	0.5	h	19.9	g	62.7	a	17.0	ab	97	gh
SV8112QH	0.1	*	9.3	*	73.8	*	16.8	*	97	*
p-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
LSD	5.9		7.2		5.4		5.1		3.5	
CV	19.0		12.2		9.2		28.5		3.5	

* average of 2 reps

Table 6E: Tenderometer Reading at Harvest

Variety	Tenderometer Reading		Standard Deviation of T-Reading
Tomahawk	144	a	2.1
M-14	131	b	1.3
Dakota	119	c	2.3
Marias	115	d	5.7
Para	113	d	2.6
BSC2014	112	de	1.4
11P42	109	ef	3.2
534	107	*	1.4
Austin	107	*	2.8
CS-456AF	107	f	4.3
CS-481AF	106	f	3.9
BSC3048	106	f	3.3
SV0935QF	99	g	5.7
SV7401QH	98	g	0.9
CS-455AF	98	gh	2.9
SV8112QH	97	*	2.4
Jumpstart	97	gh	9.2
BSC3129	95	h	2.3
CS-488F	95	h	6.0
p-value	<0.0001		
LSD	3.5		
CV	3.5		

* average of 2 reps

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

Table 7E: Vine Length in Centimeters

Variety	Vine Length (cm)	
SV7401QH	38	gh
SV0935QF	41	defg
SV8112QH	40	efg
BSC2014	50	abc
BSC3129	51	ab
BSC3048	53	a
11P42	46	bcd
534	44	def
Para	51	ab
Dakota	41	defg
Austin	38	ghi
CS-488F	32	i
CS-481AF	53	a
CS-455AF	44	cde
CS-456AF	49	abc
Jumpstart	39	fg
Tomahawk	33	hi
M-14	55	a
Marias	43	defg
p-value	<0.0001	
LSD	5.5	
CV	14.0	

Table 8E: Number of Pods per Plant

Variety	Pods/Plant	
Marias	5.1	a
Para	4.8	ab
BSC2014	4.6	ab
BSC3048	4.4	abc
CS-455AF	4.0	abcd
BSC3129	3.7	bcde
SV8112QH	3.3	cde
CS-456AF	3.3	cde
CS-481AF	3.2	cde
534	3.1	de
M-14	3.1	de
11P42	3.0	de
Austin	3.0	de
SV7401QH	2.8	de
Dakota	2.8	de
CS-488F	2.8	de
Jumpstart	2.8	de
Tomahawk	2.7	e
SV0935QF	2.6	e
p-value	<0.0001	
LSD	1.3	
CV	42.1	

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

Variety	Nodes w/ Pods/Plant	
BSC3048	3.8	a
Para	3.8	a
BSC2014	3.7	a
Marias	3.7	a
CS-455AF	3.2	ab
M-14	3.0	abc
BSC3129	2.8	bcd
CS-456AF	2.6	bcde
CS-481AF	2.5	bcefg
534	2.4	bcdef
Tomahawk	2.4	bcdef
11P42	2.2	cdef
SV8112QH	2.1	def
Jumpstart	2.1	def
Austin	2.0	def
SV7401QH	1.9	ef
Dakota	1.8	ef
CS-488F	1.8	ef
SV0935QF	1.7	f
p-value	<0.0001	
LSD	1.3	
CV	42.1	

Table 10E: Average Number of Peas/Pod

Variety	Peas/Pod	
SV7401QH	6.5	a
BSC3129	6.4	ab
BSC3048	5.7	abc
CS-488F	5.7	abc
Dakota	5.5	abcd
SV0935QF	5.4	abcde
Austin	5.4	abcde
M-14	5.3	abcdef
Tomahawk	5.1	bcdefg
SV8112QH	4.9	cdefg
CS-455AF	4.9	cdefg
Jumpstart	4.8	cdefg
11P42	4.5	cdefg
CS-456AF	4.5	cdefg
Marias	4.5	cdefg
534	4.2	defg
Para	4.1	efg
CS-481AF	4.0	fg
BSC2014	3.9	g
p-value	0.0013	
LSD	1.3	
CV	30.3	

Table 11E: Average Pod Length (cm)

Variety	Pod Length (cm)	
BSC3129	7.9	a
SV0935QF	7.7	a
Austin	7.5	ab
CS-455AF	7.0	bc
Marias	7.0	bc
M-14	7.0	bcd
534	6.9	bcd
CS-481AF	6.8	cd
Tomahawk	6.8	cd
Dakota	6.8	cd
CS-456AF	6.8	cd
BSC3048	6.7	cd
SV7401QH	6.7	cd
SV8112QH	6.6	cde
CS-488F	6.6	cde
11P42	6.4	cde
Para	6.4	cde
Jumpstart	6.3	de
BSC2014	6.0	e
p-value	<0.0001	
LSD	0.7	
CV	11.3	

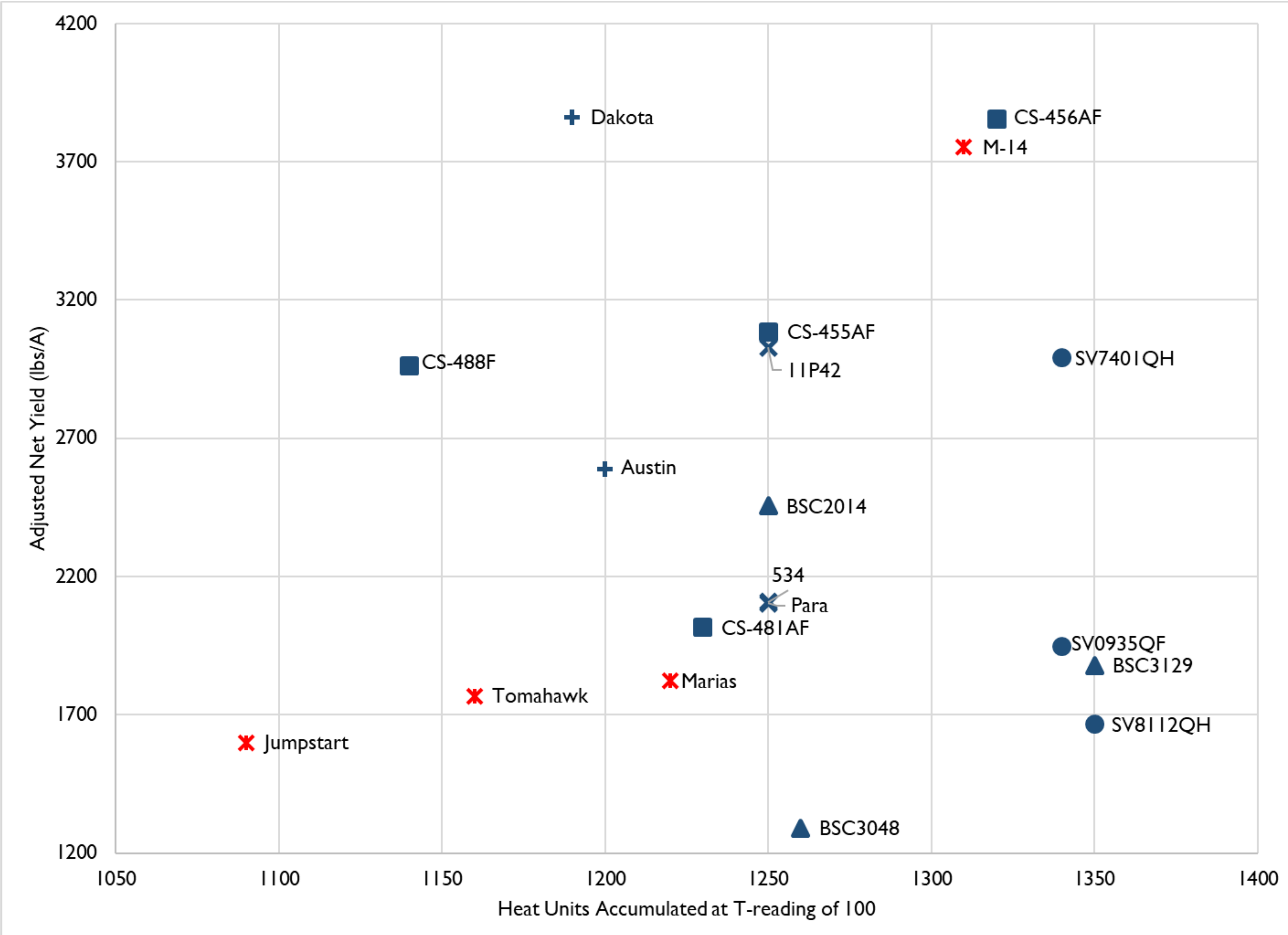
Early Trial Maturity Data

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

	Reported	**T-Readings Up to and Including Harvest by Date and Accumulated Heat Units**								
	Heat	27 May	28 May	29 May	30 May	31 May	1 Jun	2 Jun	3 Jun	4 Jun
Variety	**Units**	1079	1115	1145	1176	1211	1244	1273	1302	1335
Jumpstart	1110	**97***								
CS-488F	1180	85	**95**							
Tomahawk	1160	83	90			**144**				
Dakota	1190	82	87			**119**				
Austin	1250					**107**				
Marias	1290		74			99	**115**			
CS-481AF	1235					90	**106**			
CS-455AF	1260						**98**			
11P42	1270						96	**109**		
534	1270						94	**107**		
BSC3048	1270						83	**106**		
Para	1300							111	**113**	
BSC2014	1300						71	107	**112**	
M-14	1330						90	90	90	**131**
CS-456AF	1280							88	88	**107**
SV0935QF	1340								84	**99**
SV7401QH	1340								82	**98**
SV8112QH	1430								81	**97**
BSC3129	1350								81	**95**

*****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
M-14	34	819	37	920
GVS 410	36	888	37	920
GVS 490	37	920	41	1036
SV0371QF	38	941	41	1036
BSCP064	38	941	41	1036
GVS 828	38	941	41	1036
CS-472AF	38	941	41	1036
BSC7120	39	972	42	1074
BSCP070	39	972	43	1110
CS-473AF	39	972	42	1074
CS-474F	39	972	42	1074
Bolero	39	972	41	1036
GVS 806	40	1002	42	1074
SV1231QF	40	1002	46	1188
PLS 595	40	1002	45	1160
GVS 560	40	1002	45	1160
GVS 813	41	1036	45	1160
Hudson	41	1036	44	1136
SV6844QG	41	1036	46	1188
251	41	1036	43	1110
CS-482AF	41	1036	44	1136
SV7688QF	41	1036	45	1160
91018	41	1036	46	1188
SV0893QF	42	1074	45	1160
Querida	42	1074	46	1188
Dancer	44	1135	46	1188

Table 2L: 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
GVS 560	28.5 a	119			X	X	X			
BSCP070	28.0 ab	117	X	X			X			
CS-474F	27.9 abc	116			X	X	X			X
GVS 828	27.8 abc	116			X	X	X			
M-14	27.8 abc	116			X	X	X			
SV0371QF	26.9 abcd	112	X	X			X			
CS-482AF	26.7 abcde	111			X	X	X			X
Bolero	26.7 abcde	111			X	X		X		
CS-473AF	26.4 abcdef	110			X	X	X			X
BSC7120	25.7 abcdefg	107	X	X			X			
Hudson	25.7 abcdefg	107			X	X		X		
CS-472AF	25.3 abcdefgh	105			X	X	X			X
GVS 806	25.1 abcdefgh	105			X	X	X			
SV0893QF	24.6 abcdefgh	102	X	X			X			
SV1231QF	24.1 bcdefgh	100	X	X			X			
GVS 490	24.0 cdefgh	100			X	X	X			
91018	23.3 defgh	97			X	X	X			
SV7688QF	22.8 efgh	95	X	X			X			
Dancer	22.6 fgh	94			X	X	X			
BSCP064	22.3 gh	93	X	X			X			
GVS 410	22.0 gh	92			X	X	X			
PLS 595	21.8 ghi	91			X	X		X		
SV6844QG	21.5 hi	90	X	X			X			
GVS 813	17.9 ij	75			X	X	X			
251	17.0 j	71			X	X	X			
Querida	10.2 k	42			X	X	X			
p-value	<0.0001									
LSD	3.968									
CV	20.6									

Late Trial Harvest Data

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

Variety	Vine Weight (lbs.)	
GVS 828	28	a
GVS 410	28	ab
BSC7120	26	abc
Dancer	26	abc
GVS 490	25	abc
SV1231QF	24	abcd
SV6844QG	22	abcde
CS-474F	22	abcde
BSCP070	21	abcdef
GVS 806	21	abcdefg
GVS 560	21	abcdefg
Bolero	21	abcdefgh
CS-472AF	20	bcdefgh
BSCP064	20	cdefgh
SV0893QF	19	cdefgh
91018	18	defghi
Hudson	17	*
SV7688QF	16	efghij
PLS 595	14	fghij
M-14	14	ghij
CS-473AF	14	ghij
SV0371QF	14	ghij
CS-482AF	13	hij
GVS 813	12	ij
251	11	ij
Querida	9	j
p-value	<0.0001	
LSD	7.4	
CV	23.5	

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

Variety[1]	Adj. Net Yield (lbs/A)	Adj. Gross Yield (lbs/A)
Bolero	3015 a	3175 a
BSC7120	2724 ab	2779 abc
GVS 828	2701 ab	2931 ab
BSCP070	2576 ab	2576 abcd
GVS 410	2509 abc	2764 abc
BSCP064	2475 abc	2475 abcdef
CS-472AF	2457 abcd	2640 abc
SV6844QG	2220 bcde	2273 bcdefg
GVS 560	2167 bcde	2531 abcde
GVS 490	2102 bcde	2133 cdefgh
SV0893QF	1829 cdef	1871 defghi
CS-474F	1761 def	1823 efghi
CS-482AF	1736 ef	1773 fghij
Dancer	1664 efg	1738 fghij
CS-473AF	1601 efg	1672 ghij
SV1231QF	1574 efgh	1651 ghij
M-14	1558 efgh	1588 ghijk
91018	1377 fghi	1478 hijkl
SV0371QF	1305 fghi	1713 ghij
GVS 806	1274 fghi	1343 ijkl
Hudson	1176 *	1263 *
SV7688QF	1162 fghi	1193 ijkl
PLS 595	1024 ghi	1060 jkl
GVS 813	885 hi	885 kl
251	820 i	857 kl
Querida	741 i	790 l
p-value	<0.0001	<0.0001
LSD	702.8	738.8
CV	23.6	23.6

[1]Bold variety name indicates that peas <9/13 inch were included in net yield.

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	
SV6844QG	46.8	a	36.7	def	14.2	j	2.3	hi	109	de
BSC7120	46.3	a	39.4	bcde	12.2	j	2.1	hi	135	a
PLS 595	39.5	ab	37.8	cdef	19.5	ij	3.3	fghi	118	bc
GVS 490	39.3	ab	41.5	abcde	17.6	ij	1.5	i	111	cd
251	34.0	bc	36.4	def	24.7	hi	5.0	efghi	138	a
Hudson	32.5	*	35.8	*	24.9	*	6.8	*	144	*
M-14	31.1	bcd	47.5	a	19.3	ij	2.1	hi	136	a
CS-474F	27.5	cde	41.9	abcde	26.9	fghi	3.7	fghi	137	a
SV0893QF	27.3	cde	45.2	abc	25.2	ghi	2.3	hi	136	a
Querida	26.2	cde	36.2	def	31.5	efgh	6.2	efgh	122	b
SV1231QF	25.3	cdef	42.9	abcde	26.4	fghi	5.4	efghi	114	cd
CS-482AF	24.5	cdef	48.1	a	25.2	ghi	2.2	hi	140	a
CS-473AF	21.2	defg	42.8	abcde	31.2	efgh	4.7	efghi	138	a
SV7688QF	19.7	efg	46.7	ab	30.9	efgh	2.7	ghi	118	bc
GVS 410	16.1	fg	35.7	ef	39.1	de	9.1	e	96	ghi
Bolero	15.6	fg	44.1	abcd	35.3	def	5.0	efghi	93	i
91018	12.3	gh	45.4	abc	35.2	defg	7.1	efg	112	cd
Dancer	11.9	gh	41.7	abcde	42.0	d	4.3	fghi	123	b
CS-472AF	4.8	hi	35.5	ef	52.7	c	7.0	efg	93	hi
GVS 828	4.2	hi	31.0	f	57.2	bc	7.7	ef	100	fgh
GVS 806	3.3	hi	35.0	ef	56.5	c	5.2	efghi	135	a
GVS 560	0.8	i	11.5	g	73.1	a	14.7	d	124	b
SV0371QF	0.4	i	8.7	gh	66.7	ab	24.3	c	117	bc
BSCP070	0.1	i	2.6	h	59.3	bc	38.0	b	91	i
BSCP064	0.0	i	1.9	h	56.2	c	42.0	b	103	ef
GVS 813	0.0	i	0.9	h	22.1	hij	77.1	a	102	efg
p-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
LSD	10.0		8.0		10.1		4.6		9.0	
CV	31.9		14.6		17		24.4		6.7	

Table 6L: Tenderometer Reading at Harvest

Variety	Tenderometer Reading		Standard Deviation of T-Reading
Hudson	144	*	9.3
CS-482AF	140	a	7.6
CS-473AF	138	a	22.0
251	138	a	10.6
CS-474F	137	a	6.7
M-14	136	a	20.5
SV0893QF	136	a	2.4
GVS 806	135	a	3.9
BSC7120	135	a	3.5
GVS 560	124	b	6.8
Dancer	123	b	3.8
Querida	122	b	7.1
SV7688QF	118	bc	3.7
PLS 595	118	bc	5.1
SV0371QF	117	bc	6.0
SV1231QF	114	cd	6.1
91018	112	cd	3.3
GVS 490	111	cd	9.0
SV6844QG	109	de	3.6
BSCP064	103	ef	4.8
GVS 813	102	efg	5.8
GVS 828	100	fgh	3.6
GVS 410	96	ghi	5.2
CS-472AF	93	hi	3.9
Bolero	93	i	4.6
BSCP070	91	i	2.6
p-value	<0.0001		
LSD	9.0		
CV	6.7		

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

Table 7L: Vine Length in Centimeters

Variety	Vine Length (cm)	
BSC7120	65	a
SV0893QF	64	a
91018	57	b
GVS 410	56	b
SV1231QF	55	b
Dancer	53	bc
SV7688QF	48	cd
GVS 828	48	de
Querida	46	def
GVS 490	45	def
CS-474F	45	def
CS-472AF	44	defg
SV6844QG	44	defgh
M-14	43	efgh
PLS 595	42	fgh
SV0371QF	42	fgh
GVS 560	41	fgh
GVS 806	40	ghi
251	39	hij
CS-473AF	35	ijk
Bolero	34	jk
BSCP070	34	jk
CS-482AF	34	jk
Hudson	33	k
BSCP064	32	k
GVS 813	31	k
p-value	<0.0001	
LSD	5.0	
CV	12.9	

Table 8L: Number of Pods per Plant

Variety	Pods/Plant	
Querida	4.4	a
91018	4.1	ab
SV0893QF	4.0	abc
Dancer	3.5	bcd
GVS 560	3.4	bcd
GVS 806	3.3	bcde
GVS 410	3.2	cdef
GVS 813	3.0	defg
SV1231QF	2.9	defg
BSCP070	2.8	defg
GVS 828	2.7	defgh
SV7688QF	2.5	efghi
BSC7120	2.5	efghi
SV0371QF	2.4	fghi
251	2.4	fghi
CS-474F	2.4	fghi
BSCP064	2.2	ghij
GVS 490	2.2	ghij
PLS 595	2.2	ghij
Bolero	1.9	hijk
CS-472AF	1.8	ijk
Hudson	1.8	ijk
M-14	1.7	ijk
CS-482AF	1.4	jk
CS-473AF	1.4	jk
SV6844QG	1.3	k
p-value	<0.0001	
LSD	0.87	
CV	38.0	

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

Variety	Nodes w/ Pods/Plant	
Querida	3.0	a
91018	2.5	ab
SV0893QF	2.4	bc
GVS 806	2.2	bcd
GVS 410	2.1	bcde
Dancer	2.0	bcdef
GVS 560	2.0	bcdef
GVS 828	1.9	cdefg
CS-474F	1.9	cdefg
GVS 813	1.8	defgh
SV1231QF	1.7	defghi
SV7688QF	1.7	defghi
BSCP070	1.7	defghi
GVS 490	1.7	defghi
PLS 595	1.7	defghi
BSC7120	1.6	efghij
251	1.6	efghij
Hudson	1.6	efghij
SV0371QF	1.5	fghij
M-14	1.5	fghij
BSCP064	1.4	ghij
CS-472AF	1.3	hij
CS-473AF	1.2	ij
Bolero	1.2	ij
SV6844QG	1.1	j
CS-482AF	1.1	j
p-value	<0.0001	
LSD	0.53	
CV	34.9	

Table 10L: Average Number of Peas per Pod

Variety	Peas/Pod	
Dancer	7.0	a
GVS 813	6.7	ab
BSC7120	6.4	abc
91018	6.1	abcd
CS-473AF	6.0	abcd
SV0371QF	5.9	abcde
BSCP064	5.9	abcde
GVS 410	5.8	abcde
GVS 560	5.8	abcde
SV1231QF	5.6	abcdef
GVS 806	5.6	abcdef
CS-472AF	5.5	bcdef
PLS 595	5.5	bcdef
GVS 490	5.2	cdefg
SV0893QF	5.1	cdefg
GVS 828	5.0	cdefg
Hudson	5.0	cdefg
CS-474F	4.9	defg
BSCP070	4.8	defg
Bolero	4.8	defg
251	4.7	defg
SV7688QF	4.5	efg
SV6844QG	4.2	fgh
Querida	4.0	gh
M-14	3.8	gh
CS-482AF	3.0	h
p-value	0.0013	
LSD	1.5	
CV	32.4	

Table 11L: Average Pod Length in Centimeters

Variety	Pod Length (cm)	
PLS 595	8.4	a
Dancer	7.7	ab
GVS 490	7.6	abc
GVS 410	7.5	bcd
SV7688QF	7.2	bcde
91018	7.0	bcdef
BSC7120	6.8	cdefg
GVS 806	6.8	cdefg
CS-474F	6.8	cdefgh
Querida	6.7	cdefghi
251	6.7	defghi
SV1231QF	6.6	efghi
Hudson	6.6	efghi
CS-473AF	6.3	efghij
SV0893QF	6.3	fghij
Bolero	6.1	fghij
CS-472AF	6.0	ghijk
SV6844QG	5.9	hijkl
GVS 813	5.9	ijkl
GVS 560	5.6	jklm
GVS 828	5.6	jklm
M-14	5.6	jklm
SV0371QF	5.2	klm
BSCP070	5.1	lm
BSCP064	5.0	m
CS-482AF	4.9	m
p-value	<0.0001	
LSD	0.88	
CV	15.8	

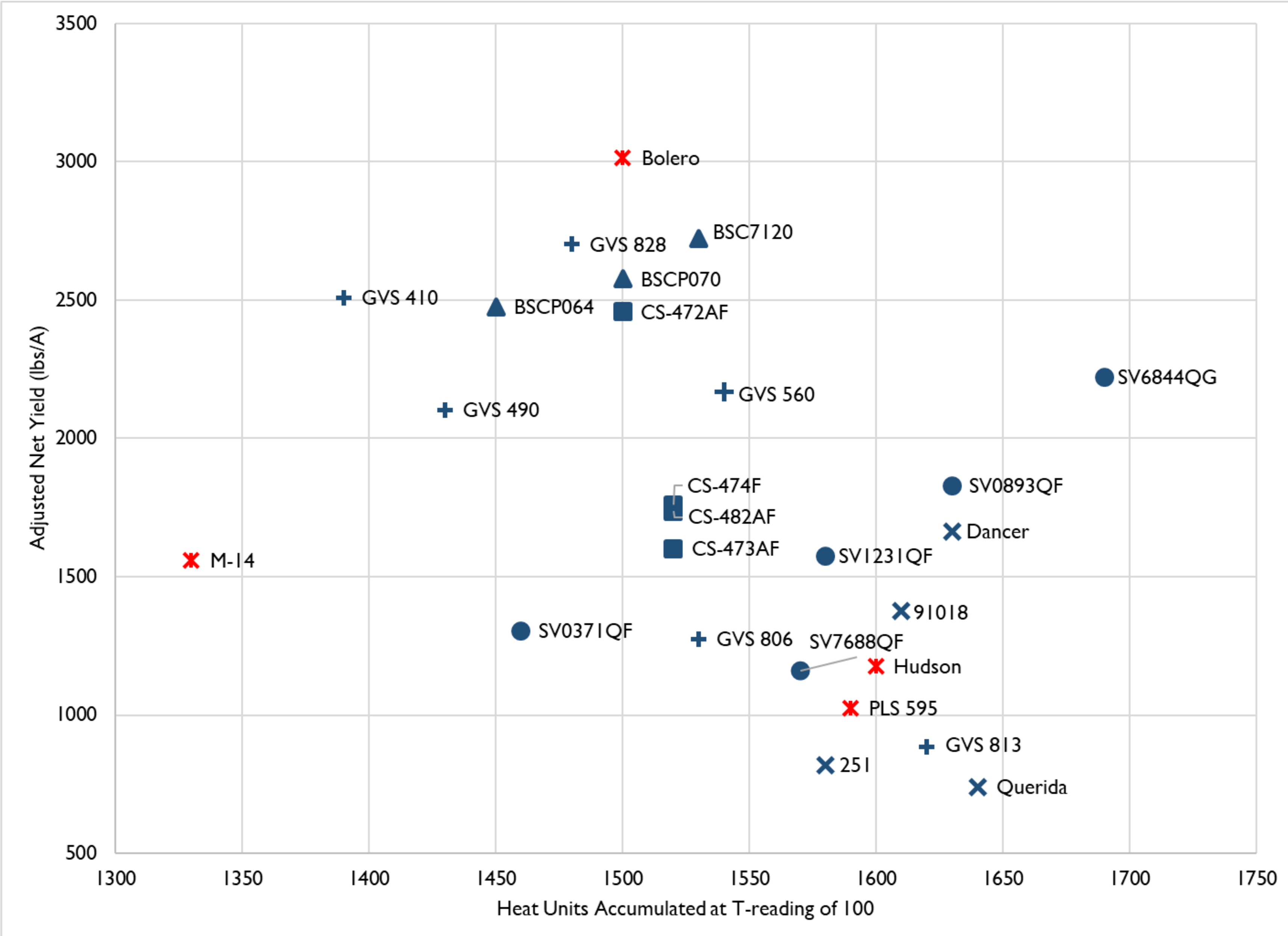
Late Trial Maturity Data

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

Variety	Reported Heat Units	Date and Accumulated Heat Units													
		8 Jun	9 Jun	10 Jun	11 Jun	12 Jun	13 Jun	14 Jun	15 Jun	16 Jun	17 Jun	18 Jun	19 Jun	20 Jun	21 Jun
		1269	1303	1334	1355	1379	1411	1448	1479	1510	1545	1585	1628	1668	1704
M-14	1330	82			108	**136***									
GVS 410	1300	67			93	**96**									
GVS 490	1300				86	86	90	**111**							
BSCP064	1430					91		**103**							
SV0371QF	1480					83		91	**117**						
GVS 828	1500						71	95	**100**						
CS-472AF	1490							83	**93**						
Bolero	1480								**93**						
BSCP070	1560								**91**						
CS-482AF	1520								81			**140**			
CS-473AF	1560								84			**138**			
CS-474F	1600								92			**137**			
BSC7120	1530								90			**135**			
GVS 806	1450							77	87			**135**			
GVS 560	1500								85			**124**			
SV7688QF	1520								72			**118**			
251	1500											109	**138**		
PLS 595	1550											99	**118**		
SV1231QF	1480											105	**114**		
91018	1480											93	**112**		
GVS 813	1450											100	**102**		
Hudson	1540											84	120		**144**
SV0893QF	1525											84	92		**136**
Dancer	1520											90	93		**123**
Querida	1480												99		**122**
SV6844QG	1600											78	81		**109**

***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 2018 Early Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall	Accumulated Rainfall
19-Mar-18	0	55.0	30.5	0.0	0	0.00	0.00
20-Mar-18	1	41.4	33.4	-2.6	0	0.91	0.91
21-Mar-18	2	37.0	31.3	-5.9	0	0.29	1.20
22-Mar-18	3	45.9	32.2	-1.0	0	0.05	1.25
23-Mar-18	4	47.3	32.4	-0.2	0	0.00	1.25
24-Mar-18	5	49.1	30.1	-0.4	0	0.00	1.25
25-Mar-18	6	46.2	27.1	-3.3	0	0.02	1.27
26-Mar-18	7	43.2	27.0	-4.9	0	0.00	1.27
27-Mar-18	8	49.3	25.1	-2.8	0	0.00	1.27
28-Mar-18	9	56.7	39.5	8.1	8	0.03	1.30
29-Mar-18	10	77.6	46.0	21.8	30	0.01	1.31
30-Mar-18	11	73.1	47.1	20.1	50	0.01	1.32
31-Mar-18	12	58.7	36.3	7.5	58	0.00	1.32
1-Apr-18	13	65.2	40.8	13.0	71	0.00	1.32
2-Apr-18	14	49.7	36.7	3.2	74	0.06	1.38
3-Apr-18	15	57.8	38.7	8.3	82	0.03	1.41
4-Apr-18	16	74.4	42.7	18.6	101	0.20	1.61
5-Apr-18	17	49.7	32.0	0.9	101	0.00	1.61
6-Apr-18	18	67.5	32.5	10.0	111	0.00	1.61
7-Apr-18	19	62.7	38.3	10.5	122	0.14	1.75
8-Apr-18	20	47.3	30.8	-1.0	122	0.00	1.75
9-Apr-18	21	45.6	29.6	-2.4	122	0.00	1.75
10-Apr-18	22	52.3	33.6	3.0	125	0.08	1.83
11-Apr-18	23	55.1	27.6	1.4	126	0.00	1.83
12-Apr-18	24	71.1	40.5	15.8	142	0.00	1.83
13-Apr-18	25	79.7	58.1	28.9	171	0.00	1.83
14-Apr-18	26	81.1	62.5	31.8	203	0.00	1.83
15-Apr-18	27	64.3	45.8	15.1	218	0.54	2.37
16-Apr-18	28	68.0	48.4	18.2	236	1.12	3.49
17-Apr-18	29	48.4	39.7	4.1	240	0.01	3.50
18-Apr-18	30	59.2	35.0	7.1	247	0.00	3.50
19-Apr-18	31	56.8	39.5	8.2	255	0.06	3.56
20-Apr-18	32	55.3	34.8	5.1	260	0.00	3.56
21-Apr-18	33	58.9	30.2	4.6	265	0.00	3.56
22-Apr-18	34	63.0	41.4	12.2	277	0.00	3.56
23-Apr-18	35	66.4	38.2	12.3	289	0.00	3.56
24-Apr-18	36	62.7	42.4	12.6	302	0.24	3.80
25-Apr-18	37	72.9	55.7	24.3	326	2.50	6.30
26-Apr-18	38	68.1	51.3	19.7	346	0.00	6.30
27-Apr-18	39	68.1	51.6	19.9	366	0.34	6.64
28-Apr-18	40	74.6	47.9	21.3	387	0.00	6.64
29-Apr-18	41	57.8	46.4	12.1	399	0.06	6.70
30-Apr-18	42	67.8	41.5	14.7	414	0.00	6.70
1-May-18	43	78.0	40.8	19.4	433	0.00	6.70
2-May-18	44	88.6	54.3	31.5	465	0.00	6.70
3-May-18	45	87.3	64.7	36.0	501	0.00	6.70
4-May-18	46	86.9	67.3	37.1	538	0.00	6.70
5-May-18	47	76.3	58.3	27.3	565	0.01	6.71
6-May-18	48	67.7	56.7	22.2	587	0.01	6.72
7-May-18	49	71.6	53.6	22.6	610	0.00	6.72
8-May-18	50	68.9	48.2	18.6	628	0.00	6.72
9-May-18	51	72.3	49.4	20.9	649	0.00	6.72
10-May-18	52	83.0	45.7	24.4	674	0.00	6.72
11-May-18	53	82.2	60.1	31.2	705	0.00	6.72

12-May-18	54	89.8	58.8	34.3	739	1.41	8.13
13-May-18	55	63.7	56.0	19.9	759	0.69	8.82
14-May-18	56	79.0	55.6	27.3	786	1.41	10.23
15-May-18	57	84.6	65.2	34.9	821	0.26	10.49
16-May-18	58	74.2	62.0	28.1	849	0.40	10.89
17-May-18	59	69.9	59.6	24.8	874	0.11	11.00
18-May-18	60	65.6	54.1	19.9	894	2.96	13.96
19-May-18	61	78.1	55.4	26.8	920	1.19	15.15
20-May-18	62	83.5	70.1	36.8	957	0.01	15.16
21-May-18	63	75.0	60.0	27.5	985	0.00	15.16
22-May-18	64	79.6	59.6	29.6	1014	0.48	15.64
23-May-18	65	81.3	65.8	33.6	1048	0.00	15.64
24-May-18	66	82.2	60.4	31.3	1079	0.00	15.64
25-May-18	67	82.6	57.8	30.2	1109	0.00	15.64
26-May-18	68	88.1	69.2	38.7	1148	0.00	15.64
27-May-18	69	85.0	58.8	31.9	1180	1.16	16.80
28-May-18	70	65.7	57.3	21.5	1201	0.10	16.90
29-May-18	71	79.8	62.2	31.0	1232	0.00	16.90
30-May-18	72	75.1	65.0	30.1	1263	0.02	16.92
31-May-18	73	83.2	65.1	34.2	1297	0.01	16.93
1-Jun-18	74	85.7	70.0	37.9	1335	0.09	17.02

Appendix B: Weather Data for 2018 Late Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall/ Irrigation
20-Apr-18	0	55.3	34.8	0.0	**0**	0.00	0.00
21-Apr-18	1	58.9	30.2	4.6	**5**	0.00	0.00
22-Apr-18	2	63.0	41.4	12.2	**17**	0.00	0.00
23-Apr-18	3	66.4	38.2	12.3	**29**	0.00	0.00
24-Apr-18	4	62.7	42.4	12.6	**42**	0.24	0.24
25-Apr-18	5	72.9	55.7	24.3	**66**	2.50	2.74
26-Apr-18	6	68.1	51.3	19.7	**86**	0.00	2.74
27-Apr-18	7	68.1	51.6	19.9	**105**	0.34	3.08
28-Apr-18	8	74.6	47.9	21.3	**127**	0.00	3.08
29-Apr-18	9	57.8	46.4	12.1	**139**	0.06	3.14
30-Apr-18	10	67.8	41.5	14.7	**153**	0.00	3.14
1-May-18	11	78.0	40.8	19.4	**173**	0.00	3.14
2-May-18	12	88.6	54.3	31.5	**204**	0.00	3.14
3-May-18	13	87.3	64.7	36.0	**240**	0.00	3.14
4-May-18	14	86.9	67.3	37.1	**277**	0.00	3.14
5-May-18	15	76.3	58.3	27.3	**305**	0.01	3.15
6-May-18	16	67.7	56.7	22.2	**327**	0.01	3.16
7-May-18	17	71.6	53.6	22.6	**350**	0.00	3.16
8-May-18	18	68.9	48.2	18.6	**368**	0.00	3.16
9-May-18	19	72.3	49.4	20.9	**389**	0.00	3.16
10-May-18	20	83.0	45.7	24.4	**413**	0.00	3.16
11-May-18	21	82.2	60.1	31.2	**444**	0.00	3.16
12-May-18	22	89.8	58.8	34.3	**479**	1.41	4.57
13-May-18	23	63.7	56.0	19.9	**499**	0.69	5.26
14-May-18	24	79.0	55.6	27.3	**526**	1.41	6.67
15-May-18	25	84.6	65.2	34.9	**561**	0.26	6.93
16-May-18	26	74.2	62.0	28.1	**589**	0.40	7.33
17-May-18	27	69.9	59.6	24.8	**614**	0.11	7.44
18-May-18	28	65.6	54.1	19.9	**633**	2.96	10.40
19-May-18	29	78.1	55.4	26.8	**660**	1.19	11.59
20-May-18	30	83.5	70.1	36.8	**697**	0.01	11.60
21-May-18	31	75.0	60.0	27.5	**725**	0.00	11.60
22-May-18	32	79.6	59.6	29.6	**754**	0.48	12.08
23-May-18	33	81.3	65.8	33.6	**788**	0.00	12.08
24-May-18	34	82.2	60.4	31.3	**819**	0.00	12.08
25-May-18	35	82.6	57.8	30.2	**849**	0.00	12.08
26-May-18	36	88.1	69.2	38.7	**888**	0.00	12.08
27-May-18	37	85.0	58.8	31.9	**920**	1.16	13.24
28-May-18	38	65.7	57.3	21.5	**941**	0.10	13.34
29-May-18	39	79.8	62.2	31.0	**972**	0.00	13.34
30-May-18	40	75.1	65.0	30.1	**1002**	0.02	13.36
31-May-18	41	83.2	65.1	34.2	**1036**	0.01	13.37
1-Jun-18	42	85.7	70.0	37.9	**1074**	0.09	13.46
2-Jun-18	43	81.9	70.2	36.1	**1110**	0.00	13.46
3-Jun-18	44	70.9	58.2	24.6	**1135**	0.96	14.42
4-Jun-18	45	74.4	55.2	24.8	**1160**	0.04	14.46
5-Jun-18	46	80.3	55.9	28.1	**1188**	0.00	14.46
6-Jun-18	47	70.7	59.8	25.3	**1213**	0.00	14.46
7-Jun-18	48	75.0	58.2	26.6	**1240**	0.00	14.46
8-Jun-18	49	82.1	56.7	29.4	**1269**	0.00	14.46
9-Jun-18	50	82.9	65.4	34.2	**1303**	4.20	18.66
10-Jun-18	51	76.9	65.6	31.3	**1334**	0.79	19.45
11-Jun-18	52	65.7	56.3	21.0	**1355**	0.16	19.61

12-Jun-18	53	73.0	54.2	23.6	**1379**	0.00	19.61
13-Jun-18	54	82.2	62.5	32.4	**1411**	0.03	19.64
14-Jun-18	55	83.7	69.3	36.5	**1448**	0.00	19.64
15-Jun-18	56	80.4	62.8	31.6	**1479**	0.00	19.64
16-Jun-18	57	84.3	55.9	30.1	**1510**	0.00	19.64
17-Jun-18	58	88.4	63.0	35.7	**1545**	0.00	19.64
18-Jun-18	59	90.8	68.7	39.8	**1585**	0.00	19.64
19-Jun-18	60	90.8	76.0	43.4	**1628**	0.00	19.64
20-Jun-18	61	88.7	70.4	39.6	**1668**	0.00	19.64
21-Jun-18	62	82.7	69.1	35.9	**1704**	0.00	19.64

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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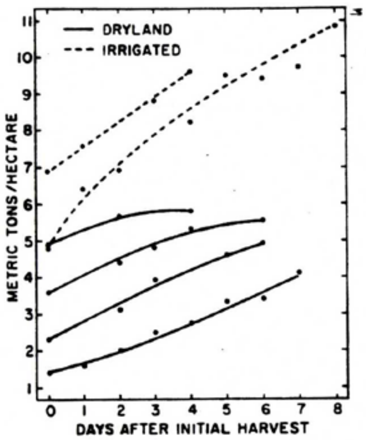

Fig. 1. Yield versus time of harvest for fresh peas in 6 typical experiments.

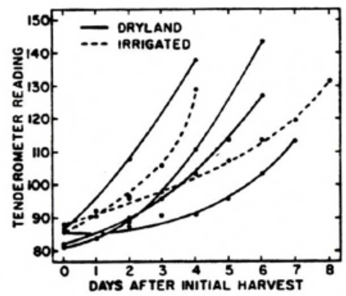

Fig. 2. Tenderometer of fresh peas as affected by time of harvest in 6 typical experiments.

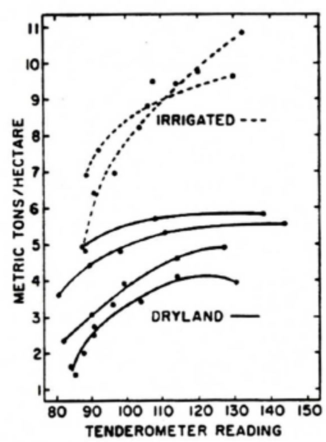

Fig. 3. Yield of fresh peas and associated tenderometer reading in 6 typical experiments.

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

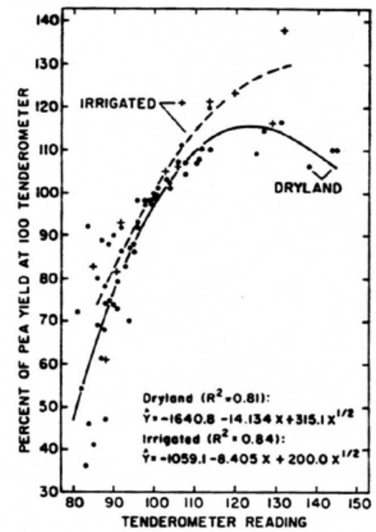

Fig. 4. Percent yield-tenderometer reading relationship for 'Dark Skinned Perfection' pea in irrigated and dryland experiments.

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 each treatment at 2 or more times and interpolating the yield at 100 tenderometer is preferred. When only 1 harvest is possible, yields can be adjusted to 100 tenderometer by using a percent yield-tenderometer scale (Fig. 4) which provides more reliable data than merely using the unadjusted yields.

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