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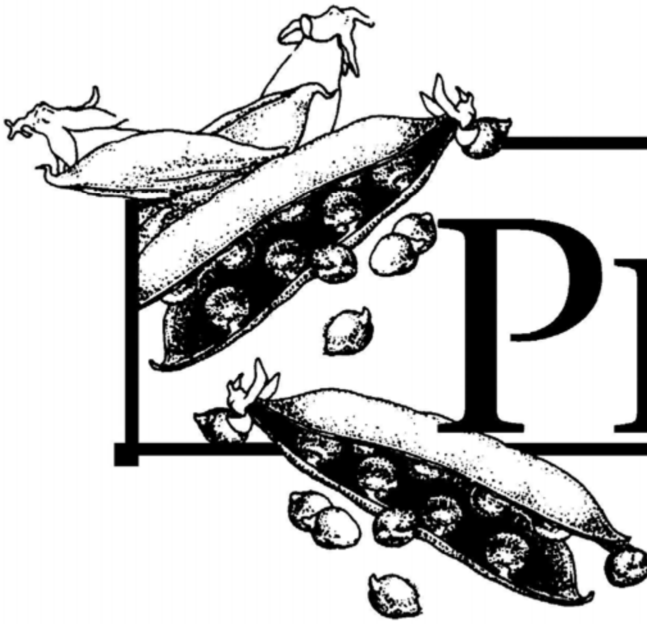

PEA

Variety Trial Results

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2010 University of Delaware Pea Variety Trial

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Introduction

The 2010 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 annually since 1994, except in 1998, 2001, 2004, 2007 and 2009.

This year trials were planted on three dates, March 20, March 25 and April 21. Generally we plant trials on two dates (mid- March and mid-April) to place the varieties in the planting season appropriate for their maturity classification. 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. The March 25 trial was planted to accommodate several early maturing varieties which arrived too late for the March 20 planted trial.

Materials and Methods

Planting and Crop Management

Nineteen varieties were planted in the March 20 trial, five varieties in the March 25 trial and 13 varieties in the April 21 trial. The trials were irrigated as needed, and grown under standard commercial management practices. The March 20 planted trial required extensive hand weeding due to apparent failure of the preemergence herbicide treatment and a robust ragweed seedbank. Weed control in the March 25 and April 21 planted trials was excellent. Aphids were present in all three trials, but not at economic levels. Rainfall was above average for March and below average for April, May and June. Irrigation was necessary. Temperatures were above average for March, April, May and June. Complete weather data and heat unit accumulation for the trials is included in Appendices A, B & C.

Planting Date: **Early Trial I –** March 20, 2010; 19 varieties
Early Trial II – March 25, 2010; 5 varieties
Late Trial – April 21, 2010; 13 varieties

Herbicide: Pursuit @ 1.5 oz/A + Dual II Magnum @ 0.5 pts/A, preemergence pre-plant incorporated with 30% UAN at 25 gal/A

Planting: Trials were planted using an Almaco drill with 9 rows spaced 8 inches apart. Eight seeds per foot of row were planted of each variety.

Stands: **Early Trial I –** emergence and stands were good
Early Trial II – stands were reduced to less than half due to 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 Entered in the 2010 Pea Trials

Variety	**Company**	**Trial**
BSC 1002	Brotherton	Early I
BSC 3048*	Brotherton	Early I
BSC 3060	Brotherton	Early I
CMG-407AF*	Crites Seed, Inc.	Early I
CS-424F	Crites Seed, Inc.	Early I
Marias	Crites Seed, Inc.	Early I
Dakota	Gallatin Valley	Early I
GV 2311*	Gallatin Valley	Early I
Northwind	Gallatin Valley	Early I
Anubis	Limagrain	Early I
Oasis	Limagrain	Early I
Zephyr*	Limagrain	Early I
PLS 046	Pure Line Seed	Early I
PLS 534*	Pure Line Seed	Early I
PLS M14	Pure Line Seed	Early I
Romance*	Seminis	Early I
Cabree	check	Early I & Early II
Icebreaker*	check	Early I & Early II
Icepack*	check	Early I & Early II
Salinero	Seminis	Early II
“EX 0773” (XP 0824 0773)*	Seminis	Early II
BSC 5697	Brotherton	Late
CMG-410AF*	Crites Seed, Inc.	Late
CMG-378F	Crites Seed, Inc.	Late
CS-420AF*	Crites Seed, Inc.	Late
GV 2278*	Gallatin Valley	Late
GV 2291*	Gallatin Valley	Late
PLS 1051	Pure Line Seed	Late
PLS 116	Pure Line Seed	Late
PLS 566*	Pure Line Seed	Late
Reliance*	Seminis	Late
SWEET SAVOR “EX 0899” (EX 0856 0899)*	Seminis	Late
“EX 0833” (EX 0825 0833)*	Seminis	Late
Ashton	check	Late

*****Afila Variety

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). Three tenderometer readings were taken from each 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 ten pods that were randomly selected from the ten sampled plants.

Discussion of Trial Results

The results for the three trials are reported in separate sections. Each section consists of twelve tables of results. 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.

Tables 3EI 3EII and 3L report the net and gross yields adjusted to a tenderometer reading of 100. The adjustment calculation procedure is described in Appendix D: Adjusting Pea Yields to a T-Reading of 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.

Pea yields in Early Trial I were comparable to those from the 2008 trial. Low yields in Early Trial II were the result of sever stand reduction by seed corn maggot. Yields in the Late Trial were lower than in the 2008 late trial, probably because of the excessively hot early June. Statistically significant differences in yield were observed in the two early trials but not the late trial. The varieties with the highest adjusted net yield in the early trial (Table 3EI) were CS-424F and Oasis. The early trial check varieties, Cabree, Icepack, and Icebreaker, were lower yielding but were the earliest varieties harvested. Salinero (from Early Trial II) had a similar maturity to the earliest check, Icebreaker.

Early Trial I Harvest Results

Table 1EI: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Icebreaker	41	665	43	737
Dakota	41	665	43	737
Icepack	41	665	43	737
Cabree	41	665	44	772
Northwind	42	699	44	772
GV 2311	43	737	46	831
PLS 046	43	737	48	888
PLS 534	43	737	46	831
Marias	43	737	47	865
PLS M14	44	772	46	831
CMG-407AF	45	804	47	865
Anubis	45	804	48	888
BSC 3048	45	804	48	888
Romance	46	831	50	931
BSC 3060	46	831	53	972
CS-424F	46	831	51	941
BSC 1002	47	865	53	972
Zephyr	53	972	55	1018
Oasis	54	989	56	1044

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

Variety	Vine Weight (lbs.)	
Oasis	103	a
CMG-407AF	87	b
CS-424F	87	b
BSC 1002	83	bc
BSC 3060	83	bc
Marias	75	bcd
PLS 046	71	cde
Anubis	69	cde
Romance	68	de
PLS 534	68	de
GV 2311	66	def
PLS M14	64	def
Cabree	63	def
BSC 3048	62	def
Dakota	61	ef
Zephyr	59	ef
Icepack	57	ef
Northwind	52	f
LSD	14.38	
p-value	<0.0001	

Table 3EI: Net Yields (% Trash Subtracted) and Gross Yields Adjusted to a Tenderometer Reading of 100 (lbs/A)

Variety	Adj. Net Yield (lbs/A)	Adj. Gross Yield (lbs/A)
CS-424F	6178 a	6226 a
Oasis	5548 ab	5692 ab
CMG-407AF	4684 bc	5170 b
PLS 046	3767 cd	4284 c
PLS 534	3719 d	4108 c
GV 2311	3719 d	3739 cde
Anubis	3663 d	3997 cd
Marias	3594 de	4233 c
PLS M14	3542 de	3869 cde
Dakota	3455 de	3769 cde
Romance	3073 def	3552 cdef
Cabree	2734 efg	3116 efg
Icepack	2726 efg	3021 efg
BSC 3048	2696 efg	3161 defg
BSC 1002	2526 fgh	3216 defg
Northwind	2311 fgh	2659 g
Icebreaker	2207 fgh	2758 fg
Zephyr	2109 gh	2418 g
LSD	919.46	864.57
p-value	<0.0001	<0.0001

Table 4EI: Pea Size (% peas by weight in each class) and Tenderometer Reading at Harvest

Variety	% #4	% #3	% #1 & #2	% Trash	T-reading at Harvest
GV 2311	53.1 a	33.9 bcd	12.5 i	0.6 f	112 a
CS-424F	33.9 b	50.3 a	15.0 i	0.8 f	112 a
Oasis	27.9 bc	44.4 ab	25.2 h	2.5 ef	96 fgh
Anubis	20.5 cd	37.3 bcd	33.7 gh	8.5 def	107 ab
Dakota	19.8 d	38.9 abc	33.0 gh	8.4 def	95 fgh
PLS 046	16.8 de	33.7 bcd	37.2 efg	12.4 cd	98 defg
CMG-407AF	16.3 def	38.7 abc	35.0 fgh	10.0 de	96 efgh
PLS 534	15.6 def	39.1 abc	35.5 fg	9.8 de	106 abc
Icepack	13.7 defg	38.7 abc	37.8 efg	9.7 de	101 bcdef
Northwind	10.9 efgh	35.6 bcd	41.3 defg	12.2 cd	85 i
Marias	8.9 fghi	31.3 cde	44.6 bcdef	15.2 bcd	98 defg
PLS M14	7.7 ghi	41.5 abc	42.4 cdefg	8.3 def	103 bcde
Cabree	7.5 ghij	39.4 abc	40.6 defg	12.5 cd	90 hi
BSC 3048	6.1 hij	30.8 cde	48.0 abcd	15.1 bcd	101 bcdefg
Zephyr	5.9 hij	26.0 de	53.4 ab	14.6 bcd	94 gh
Romance	4.0 hij	26.0 de	56.4 a	13.6 cd	100 cdefg
Icebreaker	2.9 ij	30.1 cde	46.9 abcde	20.2 bc	103 bcd
BSC 1002	2.5 ij	19.2 e	55.7 a	22.6 b	90 hi
LSD	7.49	12.33	10.10	8.37	6.68
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table 5EI: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
Northwind	85	i
BSC 1002	90	hi
Cabree	90	hi
Zephyr	94	gh
Dakota	95	fgh
Oasis	96	fgh
CMG-407AF	96	efgh
PLS 046	98	defg
Marias	98	defg
Romance	100	cdefg
BSC 3048	101	bcdefg
Icepack	101	bcdef
PLS M14	103	bcde
Icebreaker	103	bcd
BSC 3060	106	abc
PLS 534	106	abc
Anubis	107	ab
CS-424F	112	a
LSD	6.68	
p-value	<0.0001	

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

Table 6EI: Vine Length in Centimeters

Variety	Vine Length (cm)	
Oasis	66.6	a
BSC 3048	51.9	b
Icepack	51.6	b
CMG-407AF	50.9	bc
Cabree	49.6	bc
BSC 1002	48.6	bc
BSC 3060	47.4	bcd
PLS 534	47.2	bcd
Zephyr	46.5	cd
Romance	43.1	de
CS-424F	43.0	de
Anubis	43.0	de
PLS M14	42.8	de
PLS 046	40.7	ef
Northwind	40.5	ef
GV 2311	40.4	ef
Icebreaker	38.4	ef
Marias	36.6	fg
LSD	5.08	
p-value	<0.0001	

Table 7EI: Number of Pods per Plant

Variety	Pods/Plant	
BSC 1002	5.6	a
CS-424F	5.3	ab
Oasis	5.1	abc
CMG-407AF	4.6	abcd
BSC 3060	4.5	abcd
PLS 046	4.4	bcde
Romance	4.3	bcde
PLS 534	4.2	bcdef
GV 2311	4.1	cdef
PLS M14	4.0	cdef
BSC 3048	3.9	defg
Marias	3.8	defg
Anubis	3.7	defg
Northwind	3.6	defg
Cabree	3.3	efgh
Icepack	3.1	fghi
Dakota	2.8	ghi
Icebreaker	2.4	hi
LSD	1.18	
p-value	<0.0001	

Table 8EI: Number of Pod-Bearing Nodes per Plant

Variety	Nodes w/ Pods/Plant
CMG-407AF	3.1 a
BSC 1002	3.0 ab
BSC 3048	2.8 abc
Oasis	2.8 abc
PLS 046	2.7 abcd
Anubis	2.7 abcd
CS-424F	2.6 abcd
PLS 534	2.6 abcd
GV 2311	2.6 abcd
BSC 3060	2.5 abcde
Marias	2.4 bcde
PLS M14	2.4 bcde
Northwind	2.2 cdef
Romance	2.2 cdef
Icepack	2.2 cdef
Cabree	2.1 def
Icebreaker	1.9 ef
Dakota	1.7 f
LSD	0.64
p-value	<0.0001

Table 9EI: Average Number of Peas/Pod

Variety	Peas/Pod
BSC 3060	7.4 a
Oasis	7.4 a
GV 2311	6.9 ab
BSC 3048	6.8 abc
Anubis	6.8 abc
PLS M14	6.5 abcd
Icebreaker	6.4 abcde
Cabree	6.3 abcdef
Icepack	6.1 bcdef
Romance	5.9 bcdefg
CS-424F	5.7 bcdefg
Zephyr	5.6 cdefg
Northwind	5.6 cdefg
PLS 046	5.3 defgh
Dakota	5.3 defgh
Marias	5.2 efgh
BSC 1002	5.1 fgh
CMG-407AF	4.7 gh
LSD	1.26
p-value	<0.0001

Table 10EI: Average Pod Length (cm)

Variety	Pod Length (cm)
Oasis	8.7 a
GV 2311	8.1 ab
Anubis	7.7 bc
PLS M14	7.5 bcd
CS-424F	7.3 cde
BSC 3048	7.2 cdef
BSC 3060	7.1 cdef
Marias	7.0 def
Cabree	7.0 def
BSC 1002	7.0 def
Northwind	6.8 efg
Icepack	6.8 efg
CMG-407AF	6.6 fgh
PLS 046	6.5 fgh
Dakota	6.2 ghi
Romance	6.1 hi
PLS 534	6.1 hi
Zephyr	6.0 hi
LSD	0.66
p-value	<0.0001

Early Trial I Maturity Data

Table 11EI: Tenderometer Readings Leading Up To and Including Harvest

	Date and Accumulated Heat Units																	
	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun
Variety	1083	1098	1117	1141	1171	1199	1226	1251	1278	1309	1339	1365	1396	1433	1470	1508	1547	1586
Icebreaker	82		92	**103***														
Cabree	74		87	**90**														
Icepack	76		85			**101**												
Dakota			84			**95**												
Northwind						**85**												
PLS 046								**98**										
Marias								95	**98**									
GV 2311								84	93	**112**								
PLS 534									94	**106**								
PLS M14									89	**103**								
CMG-407AF									84	90	**96**							
Anubis											**107**							
BSC 3048											**101**							
BSC 3060											82	**106**						
Romance												**100**						
BSC 1002												88	**90**					
CS-424F												80			**112**			
Oasis																81		**96**
Zephyr																72		**94**

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

Table 12EI: Summary of Maturity Information for Early Trial I Varieties

Variety	Reported Heat Units	Heat Units at Harvest	T-reading at Harvest
BSC 3060	1110	1365	106
Icebreaker	1155	1141	103
Cabree	1170	1141	90
Icepack	1170	1199	101
Dakota	1188	1199	95
Northwind	1188	1199	85
GV 2311	1220	1309	112
PLS 534	1240	1309	106
PLS M14	1260	1309	103
PLS 046	1260	1251	98
BSC 3048	1270	1339	101
Marias	1290	1278	98
Romance	1290	1365	100
Anubis	1350	1339	107
CMG-407AF	1370	1339	96
CS-424F	1370	1470	112
BSC 1002	1380	1396	90
Oasis	1550	1586	96
Zephyr	1550	1586	94

Early Trial II Harvest Results

Table 1EII: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Salinero	38	653	44	835
Cabree	39	689	43	804
Icepack	40	720	42	781
Icebreaker	40	720	43	804
EX 0773	52	983	54	1014

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

Variety	Vine Weight (lbs.)
EX 0773	56 a
Salinero	34 b
Cabree	26 b
Icepack	25 b
Icebreaker	22 b
LSD	13.76
p-value	0.0025

Table 3EII: 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)
EX 0773	3369 a	3451 a
Salinero	2067 b	2167 b
Icepack	1335 bc	1458 bc
Cabree	1307 bc	1392 bc
Icebreaker	1222 c	1343 c
LSD	802.16	778.09
p-value	0.0012	0.0011

Table 4EII: Pea Size (% peas by weight in each class) and Tenderometer Reading at Harvest

Variety	% #4	% #3	% #1 & #2	% Trash	T-reading at Harvest
Salinero	43.1 a	31.8 c	20.5 b	4.5 c	100 c
Cabree	35.0 b	33.7 c	25.4 b	5.8 bc	111 b
EX 0773	27.4 c	47.7 a	22.2 b	2.7 c	169 a
Icepack	19.7 d	37.5 bc	34.6 a	8.3 ab	103 c
Icebreaker	14.3 d	41.1 b	35.4 a	9.2 a	114 b
LSD	6.94	6.38	8.18	3.33	4.37
p-value	<0.0001	0.0029	0.0074	0.0108	<0.0001

Table 5EII: Tenderometer Reading at Harvest

Variety	Tenderometer Reading
EX 0773	169 a
Icebreaker	114 b
Cabree	111 b
Icepack	103 c
Salinero	100 c
LSD	4.37
p-value	<0.0001

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

Table 6EII: Vine Length in Centimeters

Variety	Vine Length (cm)
Salinero	42.8 a
Cabree	38.5 ab
EX 0773	36.9 b
Icepack	33.5 bc
Icebreaker	28.8 c
LSD	5.12
p-value	<0.0001

Table 7EII: Number of Pods per Plant

Variety	Pods/Plant
Salinero	3.9 a
EX 0773	3.4 ab
Cabree	3.4 ab
Icepack	2.4 bc
Icebreaker	2.1 c
LSD	1.21
p-value	0.0219

Table 8EII: Number of Pod-Bearing Nodes per Plant

Variety	Nodes w/ Pods/Plant
Salinero	3.3 a
EX 0773	2.7 ab
Cabree	2.4 b
Icepack	2.1 bc
Icebreaker	1.6 c
LSD	0.78
p-value	0.0012

Table 9EII: Average Number of Peas/Pod

Variety	Peas/Pod
EX 0773	7.2 a
Icebreaker	6.3 ab
Cabree	6.1 b
Salinero	5.8 bc
Icepack	4.9 c
LSD	1.01
p-value	0.0011

Table 10EII: Average Pod Length (cm)

Variety	Pod Length (cm)
Cabree	7.3 a
Salinero	7.1 a
EX 0773	6.7 ab
Icebreaker	6.7 ab
Icepack	6.3 b
LSD	0.63
p-value	0.0243

Early Trial II Maturity Data

Table 11EII: Tenderometer Readings Leading Up To and Including Harvest

	Date and Accumulated Heat Units														
	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun
Variety	1167	1194	1225	1255	1282	1313	1349	1387	1424	1463	1502	1541	1584	1622	1650
Salinero	89	**100***													
Icebreaker		97	**114**												
Icepack			**103**												
Cabree			93	**111**											
EX 0773															**169**

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

Table 12EII: Summary of Maturity Information for Early Trial II Varieties

Variety	Reported Heat Units	Heat Units at Harvest	T-reading at Harvest
Salinero	1150	1194	100
Icebreaker	1155	1225	114
Icepack	1170	1225	103
Cabree	1170	1255	111
EX 0773	1320	1650	139

Late Trial Harvest Results

Table 1L: Flowering Data

Variety	First Flower		Full Flower	
	DAP	**Heat Units**	**DAP**	**Heat Units**
BSC 5697	40	950	43	1065
GV 2291	40	950	43	1065
PLS 566	41	988	43	1065
Reliance	41	988	43	1065
GV 2278	41	988	44	1104
Sweet Savor EX 0899	42	1027	44	1104
PLS 116	42	1027	45	1147
Ashton	42	1027	47	1213
CMG-378F	43	1065	47	1213
PLS 1051	43	1065	47	1213
CS-420AF	43	1065	45	1147
CMG-410AF	43	1065	46	1186
EX 0833	44	1104	47	1213

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

Variety	Vine Weight (lbs.)
CS-420AF	97 a
CMG-410AF	97 a
CMG-378F	95 a
PLS 1051	91 ab
PLS 116	90 abc
Reliance	87 abc
EX 0833	87 abc
GV 2291	86 abc
PLS 566	78 bcd
Sweet Savor EX 0899	75 cd
GV 2278	66 d
BSC 5697	66 d
Ashton	63 d
LSD	15.6
p-value	0.0004

Table 3L: 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)
PLS 566	4312 a	4397 a
EX 0833	4075 a	4907 a
PLS 116	4053 a	4222 a
PLS 1051	3946 a	4293 a
CS-420AF	3892 a	3964 a
GV 2278	3566 a	3710 a
BSC 5697	3543 a	3882 a
CMG-378F	3456 a	3713 a
GV 2291	3366 a	3402 a
CMG-410AF	3309 a	3497 a
Ashton	3102 a	3406 a
Sweet Savor EX 0899	2995 a	3129 a
Reliance	2145 a	2863 a
LSD	NA	NA
p-value	0.1220	0.2331

Table 4L: Pea Size (% peas by weight in each class) and Tenderometer Reading at Harvest

Variety	% #4	% #3	% #1 & #2	% Trash	T-reading at Harvest
PLS 116	37.2 a	33.3 de	25.5 fg	4.0 efg	95 cd
PLS 566	35.6 a	46.0 b	16.4 h	1.9 fg	106 b
Sweet Savor EX 0899	28.5 ab	38.2 cd	29.1 ef	4.3 ef	112 a
CS-420AF	28.1 ab	47.0 ab	23.1 fgh	1.8 fg	110 ab
GV 2278	27.9 ab	42.7 bc	25.7 fg	3.7 fg	112 a
GV 2291	25.6 b	53.4 a	20.0 gh	1.0 g	111 a
CMG-378F	21.1 bc	35.5 de	36.8 e	6.5 cde	94 cd
PLS 1051	14.3 cd	33.2 de	44.5 bcd	8.0 cd	91 d
CMG-410AF	11.3 de	45.5 b	37.8 cd	5.4 de	108 ab
Ashton	11.1 de	31.2 e	48.8 ab	8.9 c	98 c
BSC 5697	7.7 de	38.2 cd	45.4 bc	8.8 c	109 ab
EX 0833	5.8 de	21.4 f	55.4 a	17.4 g	87 e
Reliance	4.9 e	17.9 f	52.3 ab	24.9 a	95 cd
LSD	9.40	6.95	8.41	3.05	4.52
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table 5L: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
GV 2278	112	a
Sweet Savor EX 0899	112	a
GV 2291	111	a
CS-420AF	110	ab
BSC 5697	109	ab
CMG-410AF	108	ab
PLS 566	106	b
Ashton	98	c
Reliance	95	cd
PLS 116	95	cd
CMG-378F	94	cd
PLS 1051	91	d
EX 0833	87	e
LSD	4.52	
p-value	<0.0001	

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

Table 6L: Vine Length in Centimeters

Variety	Vine Length (cm)	
GV 2291	54.8	a
PLS 116	45.9	b
PLS 566	45.1	bc
Ashton	44.8	bcd
CMG-378F	43.3	bcde
GV 2278	43.1	bcde
Reliance	43.0	bcde
EX 0833	41.8	cdef
CMG-410AF	41.4	cdef
PLS 1051	41.0	def
Sweet Savor EX 0899	40.7	ef
CS-420AF	38.2	fg
BSC 5697	35.6	g
GV 2291	54.8	a
LSD	3.83	
p-value	<0.0001	

Table 7L: Number of Pods per Plant

Variety	Pods/Plant	
GV 2291	4.3	a
EX 0833	3.9	ab
PLS 1051	3.7	abc
GV 2278	3.7	abc
BSC 5697	3.5	abc
Reliance	3.4	abc
Sweet Savor EX 0899	3.3	abc
CS-420AF	3.1	bc
Ashton	3.1	bc
CMG-378F	2.8	cd
PLS 566	2.7	cde
PLS 116	1.9	de
CMG-410AF	1.7	e
GV 2291	4.3	a
LSD	1.09	
p-value	0.0001	

Table 8L: Number of Pod-Bearing Nodes per Plant

Variety	Nodes w/ Pods/Plant	
BSC 5697	2.7	a
GV 2291	2.6	ab
Sweet Savor EX 0899	2.3	abc
Ashton	2.1	bcd
GV 2278	2.1	bcd
Reliance	2.1	bcd
EX 0833	2.1	bcd
CMG-378F	2.0	cd
CS-420AF	2.0	cd
PLS 1051	2.0	cd
PLS 566	1.8	cde
PLS 116	1.7	de
CMG-410AF	1.3	e
LSD	0.57	
p-value	0.0006	

Table 9L: Average Pod Length in Centimeters

Variety	Pod Length (cm)	
PLS 116	8.7	a
CMG-378F	7.6	b
CS-420AF	7.3	bc
PLS 1051	7.1	bcd
GV 2291	7.1	bcd
PLS 566	6.8	bcde
Sweet Savor EX 0899	6.8	bcde
Reliance	6.7	bcde
GV 2278	6.4	cdef
CMG-410AF	6.3	def
Ashton	6.3	def
BSC 5697	6.0	ef
EX 0833	5.6	f
LSD	0.91	
p-value	<0.0001	

Table 10L: Average Number of Peas per Pod

Variety	Peas/Pod	
CMG-378F	6.0	a
PLS 116	6.0	a
CS-420AF	5.7	a
GV 2278	5.6	a
BSC 5697	5.3	a
PLS 566	5.1	a
PLS 1051	5.0	a
EX 0833	5.0	a
Reliance	4.9	a
Sweet Savor EX 0899	4.9	a
Ashton	4.7	a
GV 2291	4.5	a
CMG-410AF	4.3	a
LSD	NA	
p-value	0.4575	

Late Trial Maturity Data

Table 11L: Tenderometer Readings Leading Up To and Including Harvest

	Date and Accumulated Heat Units							
	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun
Variety	1333	1367	1410	1448	1481	1516	1552	1582
Reliance				**95***				
GV 2291	66			88	**111**			
PLS 566				85	**106**			
GV 2278				74	82	**112**		
Sweet Savor EX 0899						**112**		
BSC 5697				83	85	**109**		
Ashton					88	**98**		
CS-420AF						89	**110**	
CMG-410AF					80	93	**108**	
PLS 116					81	93	**95**	
CMG-378F						85	**94**	
PLS 1051						83	**91**	
EX 0833							83	**87**

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

Table 12L: Summary of Maturity Information for Late Trial Varieties

Variety	Reported Heat Units	Heat Units at Harvest	T-reading at Harvest
PLS 1051	1400	1552	91
GV 2291	1420	1481	111
PLS 116	1430	1552	95
Sweet Savor EX 0899	1430	1516	112
BSC 5697	1452	1516	109
GV 2278	1452	1516	112
Ashton	1460	1516	98
CS-420AF	1470	1552	110
PLS 566	1480	1481	106
EX 0833	1520	1582	87
Reliance	1530	1448	95
CMG-410AF	1540	1552	108
CMG-378F	1550	1552	94

Appendix A: Weather Data for 2010 Early Pea Variety Trial I

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall/ Irrigation
20-Mar-10	0	75	43.1	0	0	0.00	0.00
21-Mar-10	1	74.9	49.3	22	22	0.00	0.00
22-Mar-10	2	64.6	51.3	18	40	0.16	0.16
23-Mar-10	3	53.7	46.5	10	50	0.00	0.16
24-Mar-10	4	63.1	44.5	14	64	0.00	0.16
25-Mar-10	5	73.3	39.5	16	80	0.01	0.17
26-Mar-10	6	58.7	37.4	8	88	0.82	0.99
27-Mar-10	7	43.6	29.9	0	88	0.00	0.99
28-Mar-10	8	60.7	30.9	6	94	0.05	1.04
29-Mar-10	9	56.7	52.6	15	109	1.78	2.82
30-Mar-10	10	53.9	42.3	8	117	0.26	3.08
31-Mar-10	11	65.9	43.7	15	132	0.00	3.08
1-Apr-10	12	72.6	42.3	17	149	0.00	3.08
2-Apr-10	13	67.4	42.6	15	164	0.00	3.08
3-Apr-10	14	70.8	45.7	18	182	0.00	3.08
4-Apr-10	15	75.6	51.4	24	206	0.00	3.08
5-Apr-10	16	81.4	49.1	25	231	0.00	3.08
6-Apr-10	17	86.8	56.3	32	263	0.00	3.08
7-Apr-10	18	87.4	68.1	38	301	0.00	3.08
8-Apr-10	19	80.6	67.2	34	334	0.00	3.08
9-Apr-10	20	67.5	47.1	17	352	0.59	3.67
10-Apr-10	21	60.5	38.7	10	361	0.00	3.67
11-Apr-10	22	74.3	43.5	19	380	0.00	3.67
12-Apr-10	23	70.8	45.9	18	399	0.00	3.67
13-Apr-10	24	56	39.9	8	407	0.04	3.71
14-Apr-10	25	62.3	38.1	10	417	0.00	3.71
15-Apr-10	26	70.8	38.7	15	431	0.00	3.71
16-Apr-10	27	84	53.4	29	460	0.00	3.71
17-Apr-10	28	66.1	41.9	14	474	0.00	3.71
18-Apr-10	29	56.9	37.6	7	481	0.00	3.71
19-Apr-10	30	64.3	38.1	11	493	0.00	3.71
20-Apr-10	31	68	36.7	12	505	0.00	3.71
21-Apr-10	32	64.1	46.4	15	520	0.15	3.86
22-Apr-10	33	70.7	45.9	18	539	0.00	3.86
23-Apr-10	34	68.9	47.4	18	557	0.00	3.86
24-Apr-10	35	65.2	39.6	12	569	0.00	3.86
25-Apr-10	36	74.2	50	22	591	0.24	4.10
26-Apr-10	37	58.2	50.8	15	606	0.30	4.40
27-Apr-10	38	63.9	44.3	14	620	0.06	4.46
28-Apr-10	39	57.6	36.2	7	627	0.00	4.46
29-Apr-10	40	67.4	43.9	16	642	0.00	4.46
30-Apr-10	41	80.5	45.2	23	665	(0.60)	5.06
1-May-10	42	87.6	61	34	699	0.00	5.06
2-May-10	43	85.4	69.6	38	737	0.00	5.06
3-May-10	44	80.8	70	35	772	0.00	5.06
4-May-10	45	82.9	60.4	32	804	0.00	5.06
5-May-10	46	80.9	52.5	27	831	(0.60)	5.66
6-May-10	47	85.6	62.2	34	865	0.00	5.66

7-May-10	48	77	49.7	23	888	0.00	5.66
8-May-10	49	83.5	58	31	919	0.00	5.66
9-May-10	50	60.9	43.9	12	931	0.00	5.66
10-May-10	51	61.8	37.3	10	941	(0.60)	6.26
11-May-10	52	58.8	35	7	948	0.12	6.38
12-May-10	53	79	50	25	972	0.06	6.44
13-May-10	54	64.9	48.7	17	989	0.00	6.44
14-May-10	55	85.6	53.1	29	1018	0.37	6.81
15-May-10	56	75.1	56.1	26	1044	0.00	6.81
16-May-10	57	71.3	54.3	23	1067	0.00	6.81
17-May-10	58	63.7	49.5	17	1083	0.03	6.84
18-May-10	59	58.3	51.2	15	1098	1.12	7.96
19-May-10	60	65.9	51.7	19	1117	0.00	7.96
20-May-10	61	77.6	51.1	24	1141	0.00	7.96
21-May-10	62	86.2	54.2	30	1171	0.00	7.96
22-May-10	63	76.4	58.5	27	1199	0.00	7.96
23-May-10	64	72.9	60.6	27	1226	0.00	7.96
24-May-10	65	70.6	60	25	1251	0.00	7.96
25-May-10	66	75.6	58.9	27	1278	0.00	7.96
26-May-10	67	87.4	54.1	31	1309	(0.50)	8.46
27-May-10	68	80.9	59.2	30	1339	0.00	8.46
28-May-10	69	74.3	58.9	27	1365	0.00	8.46
29-May-10	70	82.1	59.5	31	1396	0.00	8.46
30-May-10	71	87.3	66.3	37	1433	0.00	8.46
31-May-10	72	91.3	63.2	37	1470	0.00	8.46
1-Jun-10	73	85.5	69.8	38	1508	0.00	8.46
2-Jun-10	74	89.3	68.2	39	1547	0.00	8.46
3-Jun-10	75	88.4	69.3	39	1586	0.00	8.46

*Parenthesis denote irrigation applied by traveling linear system

Appendix B: Weather Data for 2010 Early Pea Variety Trial II

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall/ Irrigation
25-Mar-10	0	73.3	39.5	0	0	0.01	0.01
26-Mar-10	1	58.7	37.4	8	8	0.82	0.83
27-Mar-10	2	43.6	29.9	-3	5	0.00	0.83
28-Mar-10	3	60.7	30.9	6	11	0.05	0.88
29-Mar-10	4	56.7	52.6	15	25	1.78	2.66
30-Mar-10	5	53.9	42.3	8	33	0.26	2.92
31-Mar-10	6	65.9	43.7	15	48	0.00	2.92
1-Apr-10	7	72.6	42.3	17	66	0.00	2.92
2-Apr-10	8	67.4	42.6	15	81	0.00	2.92
3-Apr-10	9	70.8	45.7	18	99	0.00	2.92
4-Apr-10	10	75.6	51.4	24	122	0.00	2.92
5-Apr-10	11	81.4	49.1	25	148	0.00	2.92
6-Apr-10	12	86.8	56.3	32	179	0.00	2.92
7-Apr-10	13	87.4	68.1	38	217	0.00	2.92
8-Apr-10	14	80.6	67.2	34	251	0.00	2.92
9-Apr-10	15	67.5	47.1	17	268	0.59	3.51
10-Apr-10	16	60.5	38.7	10	278	0.00	3.51
11-Apr-10	17	74.3	43.5	19	297	0.00	3.51
12-Apr-10	18	70.8	45.9	18	315	0.00	3.51
13-Apr-10	19	56	39.9	8	323	0.04	3.55
14-Apr-10	20	62.3	38.1	10	333	0.00	3.55
15-Apr-10	21	70.8	38.7	15	348	0.00	3.55
16-Apr-10	22	84	53.4	29	377	0.00	3.55
17-Apr-10	23	66.1	41.9	14	391	0.00	3.55
18-Apr-10	24	56.9	37.6	7	398	0.00	3.55
19-Apr-10	25	64.3	38.1	11	409	0.00	3.55
20-Apr-10	26	68	36.7	12	421	0.00	3.55
21-Apr-10	27	64.1	46.4	15	437	0.15	3.70
22-Apr-10	28	70.7	45.9	18	455	0.00	3.70
23-Apr-10	29	68.9	47.4	18	473	0.00	3.70
24-Apr-10	30	65.2	39.6	12	485	0.00	3.70
25-Apr-10	31	74.2	50	22	508	0.24	3.94
26-Apr-10	32	58.2	50.8	15	522	0.30	4.24
27-Apr-10	33	63.9	44.3	14	536	0.06	4.30
28-Apr-10	34	57.6	36.2	7	543	0.00	4.30
29-Apr-10	35	67.4	43.9	16	559	0.00	4.30
30-Apr-10	36	80.5	45.2	23	582	(0.60)	4.90
1-May-10	37	87.6	61	34	616	0.00	4.90
2-May-10	38	85.4	69.6	38	653	0.00	4.90
3-May-10	39	80.8	70	35	689	0.00	4.90
4-May-10	40	82.9	60.4	32	720	0.00	4.90
5-May-10	41	80.9	52.5	27	747	(0.60)	5.50
6-May-10	42	85.6	62.2	34	781	0.00	5.50
7-May-10	43	77	49.7	23	804	0.00	5.50
8-May-10	44	83.5	58	31	835	0.00	5.50
9-May-10	45	60.9	43.9	12	848	0.00	5.50
10-May-10	46	61.8	37.3	10	857	(0.60)	6.10
11-May-10	47	58.8	35	7	864	0.12	6.22

12-May-10	48	79	50	25	888	0.06	6.28
13-May-10	49	64.9	48.7	17	905	0.00	6.28
14-May-10	50	85.6	53.1	29	935	0.37	6.65
15-May-10	51	75.1	56.1	26	960	0.00	6.65
16-May-10	52	71.3	54.3	23	983	0.00	6.65
17-May-10	53	63.7	49.5	17	1000	0.03	6.68
18-May-10	54	58.3	51.2	15	1014	1.12	7.80
19-May-10	55	65.9	51.7	19	1033	0.00	7.80
20-May-10	56	77.6	51.1	24	1058	0.00	7.80
21-May-10	57	86.2	54.2	30	1088	0.00	7.80
22-May-10	58	76.4	58.5	27	1115	0.00	7.80
23-May-10	59	72.9	60.6	27	1142	0.00	7.80
24-May-10	60	70.6	60	25	1167	0.00	7.80
25-May-10	61	75.6	58.9	27	1194	0.00	7.80
26-May-10	62	87.4	54.1	31	1225	(0.50)	8.30
27-May-10	63	80.9	59.2	30	1255	0.00	8.30
28-May-10	64	74.3	58.9	27	1282	0.00	8.30
29-May-10	65	82.1	59.5	31	1313	0.00	8.30
30-May-10	66	87.3	66.3	37	1349	0.00	8.30
31-May-10	67	91.3	63.2	37	1387	0.00	8.30
1-Jun-10	68	85.5	69.8	38	1424	0.00	8.30
2-Jun-10	69	89.3	68.2	39	1463	0.00	8.30
3-Jun-10	70	88.4	69.3	39	1502	0.00	8.30
4-Jun-10	71	89.8	68.1	39	1541	0.00	8.30
5-Jun-10	72	90.5	75.3	43	1584	(0.50)	8.80
6-Jun-10	73	90.3	67	39	1622	0.00	8.80
7-Jun-10	74	76.1	58.9	28	1650	0.00	8.80

*Parenthesis denote irrigation applied by traveling linear system

Appendix C: Weather Data for 2010 Late Pea Variety Trial

Date	DAP	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall/ Irrigation*	Accumulated Rainfall/ Irrigation
21-Apr-10	0	64.1	46.4	0	0	0.15	0.15
22-Apr-10	1	70.7	45.9	18	18	0.00	0.15
23-Apr-10	2	68.9	47.4	18	36	0.00	0.15
24-Apr-10	3	65.2	39.6	12	49	0.00	0.15
25-Apr-10	4	74.2	50	22	71	0.24	0.39
26-Apr-10	5	58.2	50.8	15	85	0.30	0.69
27-Apr-10	6	63.9	44.3	14	100	0.06	0.75
28-Apr-10	7	57.6	36.2	7	106	0.00	0.75
29-Apr-10	8	67.4	43.9	16	122	0.00	0.75
30-Apr-10	9	80.5	45.2	23	145	(0.60)	1.35
1-May-10	10	87.6	61	34	179	0.00	1.35
2-May-10	11	85.4	69.6	38	217	0.00	1.35
3-May-10	12	80.8	70	35	252	0.00	1.35
4-May-10	13	82.9	60.4	32	284	0.00	1.35
5-May-10	14	80.9	52.5	27	311	(0.60)	1.95
6-May-10	15	85.6	62.2	34	344	0.00	1.95
7-May-10	16	77	49.7	23	368	0.00	1.95
8-May-10	17	83.5	58	31	399	0.00	1.95
9-May-10	18	60.9	43.9	12	411	0.00	1.95
10-May-10	19	61.8	37.3	10	420	(0.60)	2.55
11-May-10	20	58.8	35	7	427	0.12	2.67
12-May-10	21	79	50	25	452	0.06	2.73
13-May-10	22	64.9	48.7	17	469	0.00	2.73
14-May-10	23	85.6	53.1	29	498	0.37	3.10
15-May-10	24	75.1	56.1	26	524	0.00	3.10
16-May-10	25	71.3	54.3	23	546	0.00	3.10
17-May-10	26	63.7	49.5	17	563	0.03	3.13
18-May-10	27	58.3	51.2	15	578	1.12	4.25
19-May-10	28	65.9	51.7	19	597	0.00	4.25
20-May-10	29	77.6	51.1	24	621	0.00	4.25
21-May-10	30	86.2	54.2	30	651	0.00	4.25
22-May-10	31	76.4	58.5	27	679	0.00	4.25
23-May-10	32	72.9	60.6	27	705	0.00	4.25
24-May-10	33	70.6	60	25	731	0.00	4.25
25-May-10	34	75.6	58.9	27	758	0.00	4.25
26-May-10	35	87.4	54.1	31	789	(0.50)	4.75
27-May-10	36	80.9	59.2	30	819	0.00	4.75
28-May-10	37	74.3	58.9	27	845	0.00	4.75
29-May-10	38	82.1	59.5	31	876	0.00	4.75
30-May-10	39	87.3	66.3	37	913	0.00	4.75
31-May-10	40	91.3	63.2	37	950	0.00	4.75
1-Jun-10	41	85.5	69.8	38	988	0.00	4.75
2-Jun-10	42	89.3	68.2	39	1027	0.00	4.75
3-Jun-10	43	88.4	69.3	39	1065	0.00	4.75
4-Jun-10	44	89.8	68.1	39	1104	0.00	4.75
5-Jun-10	45	90.5	75.3	43	1147	(0.50)	5.25
6-Jun-10	46	90.3	67	39	1186	0.00	5.25
7-Jun-10	47	76.1	58.9	28	1213	0.00	5.25

8-Jun-10	48	76.5	55.7	26	1239	0.00	5.25
9-Jun-10	49	72.3	57.3	25	1264	0.00	5.25
10-Jun-10	50	87.2	68.8	38	1302	(0.50)	5.75
11-Jun-10	51	80.3	60.2	30	1333	0.60	6.35
12-Jun-10	52	86.6	61.9	34	1367	(0.60)	6.95
13-Jun-10	53	92.4	73.8	43	1410	0.00	6.95
14-Jun-10	54	87.3	68	38	1448	0.00	6.95
15-Jun-10	55	78.6	67.7	33	1481	(0.60)	7.55
16-Jun-10	56	83.3	66.7	35	1516	0.00	7.55
17-Jun-10	57	85.5	66.5	36	1552	0.00	7.55
18-Jun-10	58	82.9	57.9	30	1582	0.00	7.55

*Parenthesis denote irrigation applied by traveling linear system

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

T-Reading Adjustment Using Pumphery et al. Systems*

Actual T-Reading	Adjustment Factor
150	130.0
145	130.4
140	130.6
135	130.0
130	128.6
129	128.3
128	127.4
127	127.5
126	126.9
125	126.5
124	125.8
123	125.2
122	124.6
121	123.9
120	123.2
119	122.5
118	121.7
117	120.9
116	120.0
115	119.1
114	118.2
113	117.2
112	116.2
111	115.1
110	113.9
109	112.8
108	111.7
107	110.4
106	109.1
105	107.8
104	106.4
103	105.0
102	103.5
101	102.0
100	100.0
99	98.8
98	97.1
97	95.4
96	93.6
95	91.8
94	89.9
93	88.0
92	86.0
91	83.9
90	81.9

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

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

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

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

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

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

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

Methods and Procedures

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

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

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

Results and Discussion

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

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

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

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

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

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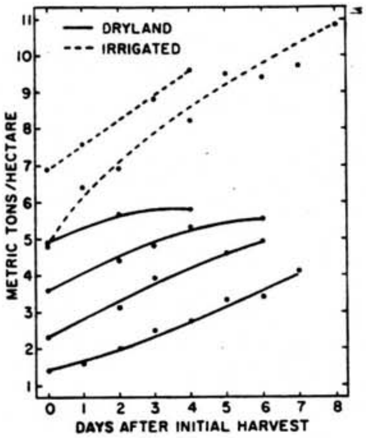

Fig. 1. Yield versus time of harvest for fresh peas in 6 typical experiments.

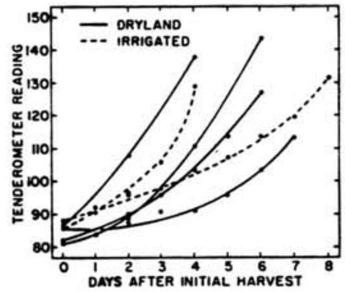

Fig. 2. Tenderometer of fresh peas as affected by time of harvest in 6 typical experiments.

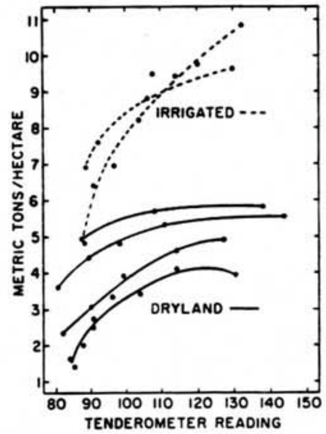

Fig. 3. Yield of fresh peas and associated tenderometer reading in 6 typical experiments.

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

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

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

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

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

The curves and data points for dryland and irrigated peas were

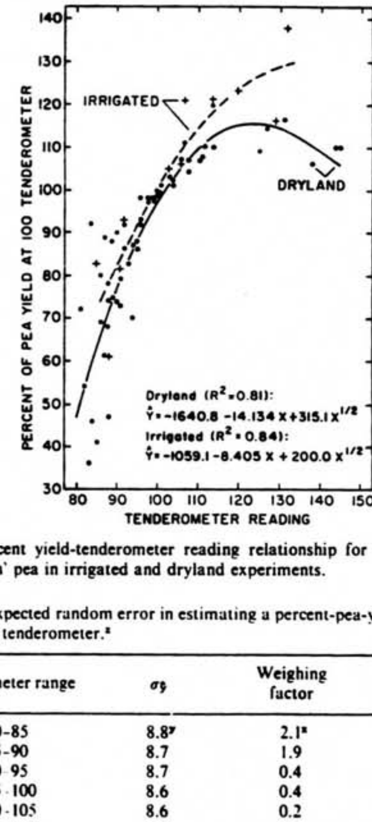

Fig. 4. Percent yield-tenderometer reading relationship for 'Dark Skinned Perfection' pea in irrigated and dryland experiments.

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

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

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

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

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

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

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

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

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

Experience by the authors indicates that fresh pea yield comparison at a common maturity is essential to good research. Harvesting eac treatment at 2 or more times and interpolating the yield at 10 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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