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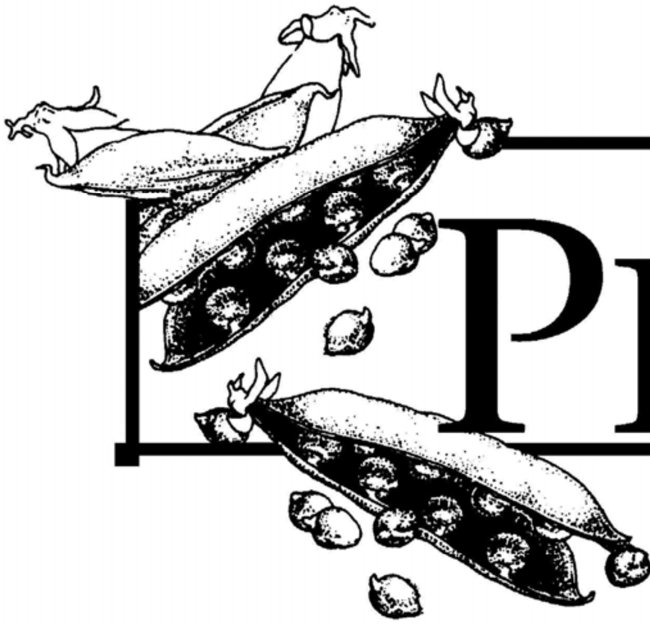

PEA

VARIETY TRIAL RESULTS

2006

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Acknowledgements

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Participating Seed Companies
Crites-Moscow Growers, Inc.
Pure Line Seeds, Inc.
ADM
Advanta Seeds U.K. Ltd.
Brotherton Seed Co.
Syngenta Seeds – Rogers Brand
Seminis Vegetable Seeds

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2006 University of Delaware Pea Variety Trial

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Introduction

The 2006 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, and 2004.

This year the trials were planted on two dates, March 13 and April 12, 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.

Materials and Methods

Planting and Crop Management

Thirteen varieties were planted in the early trial and seventeen varieties were planted in the late trial. The trials were irrigated as needed, and grown under standard commercial management practices. Weed control was good and insect control was not necessary because insect populations were low or non-existent in both trials. Rainfall was well below average for March, April and May and frequent irrigation was necessary. Complete weather data and heat unit accumulation for the trials is included in Appendices A & B.

Planting Date: Early Trial – March 13, 2006; 13 varieties;
Late Trial – April 12, 2006; 17 varieties

Fertilizer: Broadcast before planting: K_2O 150 lbs/A

Herbicide: Early Trial – Pursuit @ 2 oz/A, pre-plant incorporated with 30% UAN at 25 gallons per acre
Late Trial – Pursuit @ 2 oz/A, pre-plant incorporated with 30% UAN at 25 gallons per acre + Dual Magnum @ 0.50 pts/A, preemergence

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. Final stand counts are reported in the results.

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

Irrigation: Overhead sprinkler irrigation – 1 inch/week as needed

Varieties Entered in the 2005 Pea Trials

Variety	**Company**	**Trial**
Marias	Crites Moscow Growers, Inc.	Early
CMG-374AF*	Crites Moscow Growers, Inc.	Early
CMG-407AF*	Crites Moscow Growers, Inc.	Early
Cosima	Brotherton Seed Co.	Early
BSC 373	Brotherton Seed Co.	Early
BSC 348	Brotherton Seed Co.	Early
Sherwood	Seminis Vegetable Seeds	Early
Icepack*	Seminis Vegetable Seeds	Early
PLS – 1*	Pure Line Seeds, Inc.	Early
PLS -24	Pure Line Seeds, Inc.	Early
PLS - 92	Pure Line Seeds, Inc.	Early
Jaguar	ADM/Advanta	Early
EF 680	Check	Early
FP 2280 'Grundy'	Syngenta	Late
FP 2278*	Syngenta	Late
CMG-400F	Crites Moscow Growers, Inc.	Late
CMG-378F	Crites Moscow Growers, Inc.	Late
CMG401AF*	Crites Moscow Growers, Inc.	Late
BSC 608	Brotherton Seed Co.	Late
BSC 689	Brotherton Seed Co.	Late
BSC 746*	Brotherton Seed Co.	Late
EX 0731	Seminis Vegetable Seeds	Late
EX 0794*	Seminis Vegetable Seeds	Late
EX 0729	Seminis Vegetable Seeds	Late
EX 0727	Seminis Vegetable Seeds	Late
Legacy	Pure Line Seeds, Inc.	Late
PLS - 287	Pure Line Seeds, Inc.	Late
Recruit*	Pure Line Seeds, Inc.	Late
Starlight	ADM/Advanta	Late
Bolero	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 on the day of harvest 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 from all the pods on the ten sampled plants.

Discussion of Trial Results

The results for the early and late trials are reported in two separate sections. Each section consists of thirteen 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 4E and 4L report the net and gross yields adjusted to a tenderometer reading of 100. The adjustment calculation procedure is described in Appendix C: 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 the trial, as well as the region, were quite high this year. The varieties with the highest adjusted net yield in the early trial (Table 4E) are Marias, CMG-407 AF, and EF 680. In the late trial the yield differences among many of the varieties were not statistically significant. In fact, there is no statistically significant difference in yield among the top twelve varieties in the late trial.

Early Trial Harvest Results

Table 1E: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Sherwood	46	542	52	630
Icepack	48	560	52	630
Marias	50	586	54	690
PLS - 1	50	586	56	719
EF 680	50	586	56	716
CMG-374AF	51	608	55	706
BSC 373	52	631	57	735
CMG-407AF	52	631	56	719
Cosima	52	631	57	735
PLS -24	53	660	65	906
Jaguar	53	660	57	735
BSC 348	54	690	59	780
PLS - 92	56	719	64	885

Table 2E: Stand Counts (Plants/Yard)

Variety	Plants/Yd	
CMG407AF	26.5	a
PLS1	22.8	ab
Marias	22.0	ab
EF680	21.5	b
PLS92	21.0	b
Icepack	20.5	bc
Sherwood	20.5	bc
Jaguar	19.7	bc
CMG374AF	19.3	bc
BSC348	16.3	cd
Cosima	16.2	cd
PLS24	14.7	d
BSC373	13.8	d
LSD	4.363	
p-value	<0.0001	

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

Variety	Vine Weight (lbs.)	
PLS - 92	137.3	a
PLS -24	122.4	b
Jaguar	112.3	bc
CMG-407AF	111.9	bc
Marias	106.0	cd
BSC 348	96.1	de
Sherwood	94.2	def
Cosima	91.2	ef
BSC 373	89.7	ef
EF 680	87.6	ef
PLS - 1	83.7	ef
CMG-374AF	83.6	ef
Icepack	82.7	f
LSD	13.036	
p-value	0.0014	

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)	
Marias	7049.0	a	7283.2	a
CMG-407AF	6985.9	ab	7151.6	ab
EF 680	6162.8	abc	6334.6	bc
PLS -24	6136.3	bc	6166.2	cd
PLS - 1	5787.1	cd	5835.1	cde
BSC 348	5533.9	cd	5796.4	cde
CMG-374AF	5282.0	cde	5333.7	def
BSC 373	5054.1	de	5374.3	def
Jaguar	5047.7	de	5182.7	ef
PLS - 92	4962.5	de	5165.3	ef
Cosima	4626.8	ef	5260.1	ef
Sherwood	4455.3	ef	4718.0	f
Icepack	4010.3	f	4567.0	f
LSD	906.11		858.28	
p-value	<0.0001		<0.0001	

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	
EF 680	65.3	a	20.8	e	11.2	g	2.7	bcde	103	def
PLS -24	58.3	ab	34.0	bcd	7.2	g	0.5	e	140	a
CMG-374AF	53.6	abc	32.5	cd	12.9	fg	1.0	de	103	de
PLS - 1	53.2	bc	31.6	d	14.4	efg	0.9	de	129	b
CMG-407AF	49.4	bc	31.2	de	16.9	defg	2.4	cde	114	c
Marias	43.5	c	36.0	abcd	17.0	defg	3.4	bcde	114	c
BSC 373	29.8	d	36.1	abcd	27.5	bcd	6.7	b	90	h
Jaguar	29.0	d	45.1	a	23.2	cdef	2.7	bcde	105	d
PLS - 92	24.7	de	46.5	a	24.8	bcde	4.0	bcde	94	gh
BSC 348	22.5	de	43.4	ab	29.3	bc	4.8	bcd	98	fg
Sherwood	16.6	ef	42.2	abc	35.3	b	5.9	bc	98	efg
Cosima	8.2	f	30.6	de	49.1	a	12.0	a	99	efg
Icepack	6.0	f	29.7	de	51.9	a	12.4	a	96	fg
LSD	12.02		10.53		10.81		4.11		5.1	
p-value	<0.0001		0.0016		<0.0001		<0.0001		<0.0001	

Table 6E: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
BSC 373	90	h
PLS - 92	94	gh
Icepack	96	fg
BSC 348	98	fg
Sherwood	98	efg
Cosima	99	efg
EF 680	103	def
CMG-374AF	103	de
Jaguar	105	d
CMG-407AF	114	c
Marias	114	c
PLS - 1	129	b
PLS -24	140	a
LSD	5.1	
p-value	<0.0001	

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

Table 7E: Vine Length in Inches

Variety	Vine Length (in.)	
CMG-407AF	29.2	a
PLS -24	28.5	ab
PLS - 92	26.9	bc
Jaguar	26.1	cd
PLS - 1	25.4	cd
BSC 348	25.3	cd
Icepack	25.1	cd
BSC 373	24.2	d
EF 680	24.2	d
Cosima	23.8	de
Marias	21.6	ef
CMG-374AF	21.5	ef
Sherwood	21.4	f
LSD	2.32	
p-value	<0.0001	

Variety	Pods/Plant	
BSC 373	6.6	a
Cosima	5.4	ab
BSC 348	5.3	abc
PLS - 1	5.3	abc
Marias	4.9	bce
EF 680	4.5	bcd
Jaguar	4.4	bcde
Sherwood	4.1	bcde
Icepack	4.0	cde
PLS - 92	3.9	de
CMG-374AF	3.8	de
PLS -24	3.8	de
CMG-407AF	3.1	e
LSD	1.36	
p-value	<0.0001	

Table 8E: Number of Pods per Plant

Table 9E: Number of Nodes with Pods per Plant

Variety	Nodes w/ Pods/Plant	
BSC 373	3.5	a
Cosima	3.4	ab
PLS - 1	3.2	abc
Marias	3.0	abcd
BSC 348	3.0	abcd
EF 680	2.9	abcde
Sherwood	2.7	bcde
Jaguar	2.6	cde
PLS -24	2.4	de
CMG-407AF	2.4	de
CMG-374AF	2.4	de
Icepack	2.3	de
PLS - 92	2.2	e
LSD	0.72	
p-value	0.0019	

Table 10E: Average Pod Length in Inches

Variety	Pod Length (in.)	
PLS - 92	3.7	a
PLS -24	3.4	b
BSC 373	2.9	c
BSC 348	2.9	cd
EF 680	2.8	cd
Jaguar	2.7	de
Marias	2.7	de
Icepack	2.7	e
Sherwood	2.6	e
CMG-407AF	2.6	ef
PLS - 1	2.6	ef
Cosima	2.5	fg
CMG-374AF	2.4	g
p-value	<0.0001	

Table 11E: Average Number of Peas per Pod

Variety	Peas/Pod	
PLS - 92	6.9	a
BSC 348	5.8	b
Sherwood	5.6	bc
Icepack	5.5	bc
BSC 373	5.5	bc
PLS -24	5.3	bc
EF 680	5.2	c
Jaguar	4.4	d
Marias	4.3	d
CMG-407AF	4.3	d
Cosima	4.1	de
CMG-374AF	3.8	de
PLS - 1	3.6	e
p-value	<0.0001	

Early Trial Maturity Data

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

	Date and Accumulated Heat Units														
	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	4-Jun	5-Jun
Variety	1010	1023	1043	1067	1102	1137	1169	1203	1243	1278	1317	1353	1380	1407	1434
Sherwood	87		94	**98***											
Icepack	88		92	**96**											
Marias					91			**114**							
EF 680					85			**103**							
PLS-1									**129**						
CMG-374AF									**103**						
CMG-407AF										**114**					
Cosima									85	**99**					
BSC 348									87	**98**					
BSC 373									86	**90**					
Jaguar										98	**105**				
PLS-92										84		**94**			
PLS-24										82		87			**140**

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

Table 13E: Summary of Maturity Information for Early Trial Varieties

Variety	Reported Heat Units	Heat Units at Harvest	T-reading at Harvest
Sherwood	1175	1067	98
Icepack	1185	1067	96
Marias	1290	1203	114
EF 680	1220	1203	103
PLS - 1	1300	1243	129
CMG-374AF	1325	1243	103
CMG-407AF	1350	1278	114
Cosima	1290	1278	99
BSC 348	1370	1278	98
BSC 373	1340	1278	90
Jaguar	1380	1317	105
PLS - 92	1350	1353	94
PLS -24	1350	1434	140

Late Trial Harvest Results

Table 1L: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
BSC 608	45	902	48	1008
FP 2278	46	934	48	1008
EX 0794	46	934	48	1008
Starlight	47	968	48	1008
BSC 689	47	968	48	1008
CMG-400F	47	968	49	1043
EX 0731	48	1008	49	1043
BSC 746	48	1008	49	1043
Bolero	48	1008	50	1082
EX 0729	48	1008	50	1082
Legacy	48	1008	50	1082
FP 2280 'Grundy'	48	1008	50	1082
CMG-378F	49	1043	51	1118
Recruit	49	1043	51	1118
CMG401AF	50	1082	51	1118
EX 0727	50	1082	52	1146
PLS - 287	50	1082	53	1172

Table 2L: Stand Counts (Plants/Yard)

Variety	Plants/Yd	
CMG400F	31.3	a
BSC689	28.3	ab
CM378F	28.0	ab
BSC746	27.3	bc
Starlight	27.3	bc
Legacy	26.8	bcd
BSC608	26.7	bcd
Recruit	25.2	bcde
EX0794	25.2	bcde
EX0727	24.0	cde
Bolero	23.7	cde
EX0729	23.5	de
EX0731	23.3	de
PLS287	22.0	ef
FP2278	22.0	ef
CMG401AF	21.5	ef
Grundy	18.3	f
LSD	3.789	
p-value	<0.0001	

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

Variety	Vine Weight (lbs.)	
PLS - 287	145	a
Grundy	131	ab
CMG-378F	120	bc
EX 0727	120	bc
EX 0731	115	bcd
CMG401AF	114	bcde
BSC 746	113	cdef
FP 2278	110	cdefg
BSC 689	108	cdefgh
Starlight	104	cdefgh
Recruit	102	defghi
BSC 608	97	deghi
CMG-400F	96	fghi
Bolero	96	fghi
EX 0794	95	ghi
Legacy	92	hi
EX 0729	86	i
LSD	17.59	
p-value	<0.0001	

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

Variety	Adj. Net Yield (lbs/A)		Adj. Gross Yield (lbs/A)	
CMG-400F	8036.9	a	8067	a
Bolero	7945.6	ab	7953	ab
PLS - 287	7846.5	abc	7986	ab
BSC 746	7808.6	abc	7817	abc
CMG-378F	7700.1	abc	7744	abc
Recruit	7613.7	abc	7628	abc
BSC 689	7557.3	abc	7593	abc
CMG401AF	7411.4	abc	7504	abc
EX 0729	7347.1	abcd	7347	abcd
EX 0731	7310.5	abcd	7552	abc
EX 0727	7301.6	abcd	7512	abc
Starlight	7270.5	abcd	7320	abcd
Grundy (FP 2280)	7187.6	bcde	7221	bcd
Legacy	7082.1	cde	7095	cde
FP 2278	6560.3	de	6666	de
BSC 608	6431.9	e	6656	de
EX 0794	5553.8	f	5891	e
LSD	807.2		779.9	
p-value	<0.0001		0.0002	

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	
BSC 746	74.6	a	23.0	g	2.3	f	0.1	ef	143	cd
Legacy	60.5	b	35.0	ef	4.3	f	0.2	def	165	a
Recruit	53.9	bc	41.6	cdef	4.3	f	0.2	def	136	def
EX 0729	53.7	bc	41.4	cdef	4.9	f	0.0	f	155	b
CMG-400F	53.4	bc	38.0	cdef	8.2	ef	0.4	def	139	de
Bolero	49.4	cd	43.4	bcde	7.1	f	0.1	ef	149	c
BSC 689	47.4	cde	43.3	bcde	8.8	def	0.5	def	135	ef
Grundy	45.9	cde	45.6	bcd	8.1	ef	0.5	def	132	fg
PLS - 287	40.7	def	42.1	bcdef	15.5	cde	1.7	cd	125	g
CMG401AF	38.7	ef	43.4	bcde	16.7	c	1.2	cdef	108	hi
Starlight	32.8	fg	50.4	ab	16.1	cd	0.7	def	142	cd
FP 2278	32.3	fg	43.8	bcd	22.3	c	1.6	cde	113	h
CMG-378F	25.4	g	56.5	a	17.5	c	0.6	def	125	g
EX 0731	14.7	h	46.3	bcd	35.6	b	3.4	b	130	fg
BSC 608	13.3	h	42.4	bcdef	40.9	b	3.4	b	104	ij
EX 0727	12.3	h	48.9	abc	36.0	b	2.8	bc	101	j
EX 0794	7.4	h	34.1	f	52.8	a	5.8	a	103	ij
LSD	9.51		8.41		7.8		1.6		9.5	
p-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	

Table 6L: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
EX 0727	101	j
EX 0794	103	ij
BSC 608	104	ij
CMG401AF	108	hi
FP 2278	113	h
PLS - 287	125	g
CMG-378F	125	g
EX 0731	130	fg
Grundy	132	fg
BSC 689	135	ef
Recruit	136	def
CMG-400F	139	de
Starlight	142	cd
BSC 746	143	cd
Bolero	149	c
EX 0729	155	b
Legacy	165	a
LSD	9.5	
p-value	<0.0001	

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

Table 7L: Vine Length in Inches

Variety	Vine Length (in.)	
Grundy	27.9	a
Bolero	27.8	a
Recruit	26.6	ab
BSC 689	26.4	ab
EX 0794	25.3	bc
EX 0729	25.1	bc
EX 0731	24.1	cd
EX 0727	24.0	cd
Starlight	24.0	cd
CMG-400F	22.5	de
FP 2278	22.4	de
Legacy	21.8	e
PLS - 287	21.7	e
CMG-378F	20.9	e
BSC 746	20.8	e
BSC 608	18.8	f
CMG401AF	18.7	f
LSD	1.84	
p-value	<0.0001	

Table 8L: Number of Pods per Plant

Variety	Pods/Plant	
EX 0727	4.9	a
EX 0731	4.5	ab
Starlight	4.2	abc
Bolero	4.2	abc
FP 2278	3.7	bcd
Grundy	3.5	cd
Recruit	3.5	cd
CMG-378F	3.4	cd
EX 0794	3.3	cd
BSC 689	3.2	d
EX 0729	3.2	d
BSC 608	3.1	d
BSC 746	3.1	d
PLS - 287	3.0	d
CMG-400F	2.9	d
CMG401AF	2.9	d
Legacy	2.8	d
LSD	0.97	
p-value	<0.0001	

Table 9L: Number of Nodes with Pods per Plant

Variety	Nodes w/ Pods/Plant	
EX 0727	2.9	a
EX 0731	2.8	a
Bolero	2.7	ab
BSC 689	2.4	abc
EX 0794	2.4	abc
Starlight	2.4	abc
Grundy	2.2	bcd
FP 2278	2.2	bcd
CMG-400F	2.2	bcd
CMG-378F	2.2	bcd
PLS - 287	2.2	bcd
BSC 608	2.0	cd
EX 0729	2.0	cd
CMG401AF	1.9	cd
Legacy	1.9	cd
Recruit	1.9	cd
BSC 746	1.8	d
LSD	0.53	
p-value	0.0002	

Table 10L: Average Pod Length in Inches

Variety	Pod Length (in.)	
Grundy	3.5	a
Recruit	2.9	b
Legacy	2.8	bc
BSC 689	2.8	bc
PLS - 287	2.8	bc
CMG401AF	2.8	bcd
EX 0729	2.8	bcd
Bolero	2.8	bcd
BSC 746	2.7	cde
EX 0731	2.7	cde
EX 0727	2.6	cdef
CMG-400F	2.6	def
EX 0794	2.5	efg
CMG-378F	2.5	fg
BSC 608	2.4	g
Starlight	2.4	g
FP 2278	2.1	h
p-value	<0.0001	

Table 11L: Average Number of Peas per Pod

Variety	Peas/Pod	
CMG-400F	6.28	a
CMG-378F	5.85	ab
FP 2278	5.84	ab
Grundy	5.71	abc
CMG401AF	5.62	abcd
PLS - 287	5.37	bcde
Recruit	5.29	bcde
BSC 746	5.19	bcdef
EX 0727	5.12	bcdef
EX 0731	5.09	cdef
EX 0729	4.94	cdef
BSC 689	4.88	def
Bolero	4.86	def
BSC 608	4.84	def
Legacy	4.61	ef
Starlight	4.50	f
EX 0794	4.36	f
p-value	<0.0001	

Late Trial Maturity Data

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

	Date and Accumulated Heat Units								
	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun
Variety	1380	1407	1431	1462	1491	1522	1559	1596	1633
FP 2278	81	84			**113***				
BSC 608		85			**104**				
EX 0794	81	82			**103**				
EX 0729					82			**155**	
Bolero		73			85			**149**	
Starlight	78				92			**142**	
CMG-400F					82			**139**	
BSC 689		79			87			**135**	
EX 0731					90			**130**	
CMG-401AF					89			**108**	
Legacy		75			86			122	**165**
BSC 746					82			119	**143**
Recruit					83			119	**136**
FP 2280 'Grundy'								105	**132**
PLS 287					75			109	**125**
CMG-378F					86			107	**125**
EX0727								91	**101**

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

Table 13L: Summary of Maturity Information for Late Trial Varieties

Variety	Reported Heat Units	Heat Units at Harvest	T-reading at Harvest
FP 2278	1500	1462	113
BSC 608	1470	1462	104
EX 0794	1480	1462	103
EX 0729	1500	1522	155
Bolero	1460	1522	149
Starlight	1510	1491	142
CMG-400F	1475	1522	139
BSC 689	1520	1522	135
EX 0731	1520	1522	130
CMG-401AF	1540	1559	108
Legacy	1450	1552	165
BSC 746	1590	1552	143
Recruit	1500	1552	136
Grundy	1600	1559	132
PLS 287	1500	1559	125
CMG-378F	1540	1559	125
EX0727	1580	1596	101

Appendix A: Weather Data for the 2006 Early Pea Variety Trial

Date	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall	Accumulated Rainfall
13-Mar-06	80.78	47.41		Planted	0.00	0.00
14-Mar-06	69.55	38.63	14.1	14.1	0.00	0.00
15-Mar-06	50.52	35.18	2.9	16.9	0.00	0.00
16-Mar-06	54.59	32.58	3.6	20.5	0.00	0.00
17-Mar-06	49.05	29.00	0.0	20.5	0.01	0.01
18-Mar-06	44.83	25.91	0.0	20.5	0.00	0.01
19-Mar-06	49.53	25.91	0.0	20.5	0.00	0.01
20-Mar-06	47.70	23.80	0.0	20.5	0.00	0.01
21-Mar-06	37.90	26.90	0.0	20.5	0.00	0.01
22-Mar-06	45.95	30.24	0.0	20.5	0.00	0.01
23-Mar-06	49.28	32.46	0.9	21.4	0.00	0.01
24-Mar-06	52.25	28.76	0.5	21.9	0.00	0.01
25-Mar-06	43.21	38.02	0.6	22.5	0.04	0.05
26-Mar-06	49.39	36.15	2.8	25.3	0.00	0.05
27-Mar-06	56.57	34.18	5.4	30.7	0.00	0.05
28-Mar-06	61.63	47.93	14.8	45.4	0.00	0.05
29-Mar-06	60.03	35.55	7.8	53.2	0.00	0.05
30-Mar-06	67.69	30.24	9.0	62.2	0.00	0.05
31-Mar-06	73.13	42.98	18.1	80.3	0.00	0.05
1-Apr-06	75.72	51.01	23.4	103.6	0.05	0.10
2-Apr-06	68.29	40.85	14.6	118.2	0.00	0.10
3-Apr-06	63.00	44.00	13.5	131.7	0.13	0.23
4-Apr-06	56.95	37.78	7.4	139.1	0.30	0.53
5-Apr-06	51.64	40.25	5.9	145.0	0.00	0.53
6-Apr-06	61.52	39.89	10.7	155.7	0.00	0.53
7-Apr-06	78.31	41.61	20.0	175.7	0.00	0.53
8-Apr-06	70.41	39.37	14.9	190.6	0.15	0.68
9-Apr-06	55.56	33.56	4.6	195.1	0.01	0.69
10-Apr-06	65.07	29.87	7.5	202.6	0.00	0.69
11-Apr-06	70.39	34.06	12.2	214.8	0.00	0.69
12-Apr-06	73.13	46.94	20.0	234.8	0.00	0.69
13-Apr-06	76.69	52.74	24.7	259.6	0.00	0.69
14-Apr-06	74.73	46.69	20.7	280.3	0.00	0.69
15-Apr-06	83.00	58.00	30.5	310.8	0.00	0.69
16-Apr-06	73.00	51.00	22.0	332.8	0.00	0.69
17-Apr-06	55.60	39.13	7.4	340.1	0.06	0.75
18-Apr-06	68.04	36.03	12.0	352.2	0.00	0.75
19-Apr-06	73.99	47.30	20.6	372.8	0.00	0.75
20-Apr-06	80.53	49.15	24.8	397.7	0.00	0.75
21-Apr-06	68.81	52.00	20.4	418.1	0.40	1.15
22-Apr-06	63.48	54.21	18.8	436.9	0.86	2.01
23-Apr-06	68.52	54.46	21.5	458.4	0.01	2.02
24-Apr-06	72.25	52.97	22.6	481.0	0.00	2.02
25-Apr-06	75.22	46.92	21.1	502.1	0.00	2.02
26-Apr-06	60.03	45.05	12.5	514.6	0.00	2.02
27-Apr-06	69.91	41.36	15.6	530.2	0.00	2.02
28-Apr-06	63.37	40.63	12.0	542.2	0.00	2.02
29-Apr-06	59.77	37.04	8.4	550.7	0.00	2.02
30-Apr-06	63.63	35.31	9.5	560.1	0.00	2.02

1-May-06	62.26	38.03	10.1	570.3	0.00	2.02
2-May-06	74.59	37.41	16.0	586.3	0.00	2.02
3-May-06	73.87	48.67	21.3	607.5	0.00	2.02
4-May-06	80.04	47.05	23.5	631.1	0.00	2.02
5-May-06	80.38	57.20	28.8	659.9	0.00	2.02
6-May-06	79.66	60.17	29.9	689.8	0.00	2.02
7-May-06	62.26	50.29	16.3	706.1	0.00	2.02
8-May-06	59.63	46.29	13.0	719.0	0.19	2.21
9-May-06	69.91	42.09	16.0	735.0	0.00	2.21
10-May-06	77.56	45.57	21.6	756.6	0.00	2.21
11-May-06	72.37	52.25	22.3	778.9	0.49	2.70
12-May-06	72.99	52.23	22.6	801.5	0.04	2.74
13-May-06	72.88	54.73	23.8	825.3	0.00	2.74
14-May-06	59.50	52.23	15.9	841.2	0.05	2.79
15-May-06	73.22	53.73	23.5	864.7	0.10	2.89
16-May-06	67.93	52.84	20.4	885.0	0.20	3.09
17-May-06	73.98	48.52	21.3	906.3	0.00	3.09
18-May-06	76.35	52.86	24.6	930.9	0.08	3.17
19-May-06	66.20	53.22	19.7	950.6	0.08	3.25
20-May-06	73.74	52.63	23.2	973.8	0.00	3.25
21-May-06	74.25	43.10	18.7	992.5	0.00	3.25
22-May-06	68.68	45.70	17.2	1009.7	0.00	3.25
23-May-06	66.83	40.50	13.7	1023.3	0.00	3.25
24-May-06	73.87	44.83	19.4	1042.7	0.00	3.25
25-May-06	74.61	54.86	24.7	1067.4	0.00	3.25
26-May-06	84.70	63.84	34.3	1101.7	0.00	3.25
27-May-06	83.37	66.43	34.9	1136.6	0.00	3.25
28-May-06	82.00	61.86	31.9	1168.5	0.00	3.25
29-May-06	89.62	59.65	34.6	1203.1	0.00	3.25
30-May-06	92.21	66.69	39.5	1242.6	0.00	3.25
31-May-06	86.43	63.59	35.0	1277.6	0.00	3.25
1-Jun-06	90.28	67.68	39.0	1316.6	0.00	3.25
2-Jun-06	84.85	67.03	35.9	1352.5	3.96	7.21
3-Jun-06	73.99	61.72	27.9	1380.4	0.02	7.23
4-Jun-06	77.41	56.17	26.8	1407.2	0.00	7.23
5-Jun-06	74.19	59.88	27.0	1434.2	0.10	7.33

Appendix B: Weather Data for the 2006 Late Pea Variety Trial

Date	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall	Accumulated Rainfall
12-Apr-06	73.13	46.94		Planted	0.00	0.00
13-Apr-06	76.69	52.74	24.7	24.7	0.00	0.00
14-Apr-06	74.73	46.69	20.7	45.4	0.00	0.00
15-Apr-06	83.00	58.00	30.5	75.9	0.00	0.00
16-Apr-06	73.00	51.00	22.0	97.9	0.00	0.00
17-Apr-06	55.60	39.13	7.4	105.3	0.06	0.06
18-Apr-06	68.04	36.03	12.0	117.3	0.00	0.06
19-Apr-06	73.99	47.30	20.6	138.0	0.00	0.06
20-Apr-06	80.53	49.15	24.8	162.8	0.00	0.06
21-Apr-06	68.81	52.00	20.4	183.2	0.40	0.46
22-Apr-06	63.48	54.21	18.8	202.1	0.86	1.32
23-Apr-06	68.52	54.46	21.5	223.6	0.01	1.33
24-Apr-06	72.25	52.97	22.6	246.2	0.00	1.33
25-Apr-06	75.22	46.92	21.1	267.2	0.00	1.33
26-Apr-06	60.03	45.05	12.5	279.8	0.00	1.33
27-Apr-06	69.91	41.36	15.6	295.4	0.00	1.33
28-Apr-06	63.37	40.63	12.0	307.4	0.00	1.33
29-Apr-06	59.77	37.04	8.4	315.8	0.00	1.33
30-Apr-06	63.63	35.31	9.5	325.3	0.00	1.33
1-May-06	62.26	38.03	10.1	335.4	0.00	1.33
2-May-06	74.59	37.41	16.0	351.4	0.00	1.33
3-May-06	73.87	48.67	21.3	372.7	0.00	1.33
4-May-06	80.04	47.05	23.5	396.2	0.00	1.33
5-May-06	80.38	57.20	28.8	425.0	0.00	1.33
6-May-06	79.66	60.17	29.9	454.9	0.00	1.33
7-May-06	62.26	50.29	16.3	471.2	0.00	1.33
8-May-06	59.63	46.29	13.0	484.2	0.19	1.52
9-May-06	69.91	42.09	16.0	500.2	0.00	1.52
10-May-06	77.56	45.57	21.6	521.7	0.00	1.52
11-May-06	72.37	52.25	22.3	544.1	0.49	2.01
12-May-06	72.99	52.23	22.6	566.7	0.04	2.05
13-May-06	72.88	54.73	23.8	590.5	0.00	2.05
14-May-06	59.50	52.23	15.9	606.3	0.05	2.10
15-May-06	73.22	53.73	23.5	629.8	0.10	2.20
16-May-06	67.93	52.84	20.4	650.2	0.20	2.40
17-May-06	73.98	48.52	21.3	671.4	0.00	2.40
18-May-06	76.35	52.86	24.6	696.1	0.08	2.48
19-May-06	66.20	53.22	19.7	715.8	0.08	2.56
20-May-06	73.74	52.63	23.2	738.9	0.00	2.56
21-May-06	74.25	43.10	18.7	757.6	0.00	2.56
22-May-06	68.68	45.70	17.2	774.8	0.00	2.56
23-May-06	66.83	40.50	13.7	788.5	0.00	2.56
24-May-06	73.87	44.83	19.4	807.8	0.00	2.56
25-May-06	74.61	54.86	24.7	832.6	0.00	2.56
26-May-06	84.70	63.84	34.3	866.8	0.00	2.56
27-May-06	83.37	66.43	34.9	901.7	0.00	2.56
28-May-06	82.00	61.86	31.9	933.7	0.00	2.56
29-May-06	89.62	59.65	34.6	968.3	0.00	2.56
30-May-06	92.21	66.69	39.5	1007.7	0.00	2.56

31-May-06	86.43	63.59	35.0	1042.8	0.00	2.56
1-Jun-06	90.28	67.68	39.0	1081.7	0.00	2.56
2-Jun-06	84.85	67.03	35.9	1117.7	3.96	6.52
3-Jun-06	73.99	61.72	27.9	1145.5	0.02	6.54
4-Jun-06	77.41	56.17	26.8	1172.3	0.00	6.54
5-Jun-06	74.19	59.88	27.0	1199.4	0.10	6.64
6-Jun-06	70.65	57.52	24.1	1223.4	0.00	6.64
7-Jun-06	77.07	59.16	28.1	1251.6	0.00	6.64
8-Jun-06	80.51	59.76	30.1	1281.7	0.00	6.64
9-Jun-06	80.38	61.61	31.0	1312.7	0.07	6.71
10-Jun-06	71.51	57.42	24.5	1337.2	0.00	6.71
11-Jun-06	72.14	50.50	21.3	1358.5	0.00	6.71
12-Jun-06	67.93	55.71	21.8	1380.3	0.18	6.89
13-Jun-06	80.02	54.21	27.1	1407.4	0.00	6.89
14-Jun-06	67.05	61.12	24.1	1431.5	0.29	7.18
15-Jun-06	80.89	60.26	30.6	1462.1	0.00	7.18
16-Jun-06	84.22	53.83	29.0	1491.1	0.00	7.18
17-Jun-06	84.72	57.43	31.1	1522.2	0.00	7.18
18-Jun-06	88.18	64.72	36.5	1558.6	0.00	7.18
19-Jun-06	86.22	68.52	37.4	1596.0	0.28	7.46
20-Jun-06	85.23	68.41	36.8	1632.8	0.29	7.75

Appendix C: 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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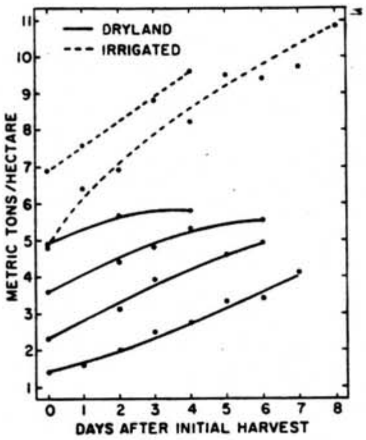

Fig. 1. Yield versus time of harvest for fresh peas in 6 typical experiments.

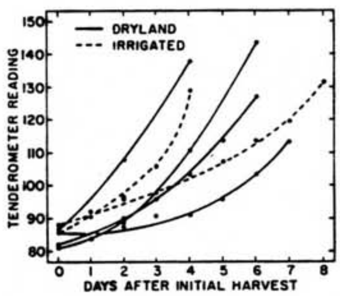

Fig. 2. Tenderometer of fresh peas as affected by time of harvest in 6 typical experiments.

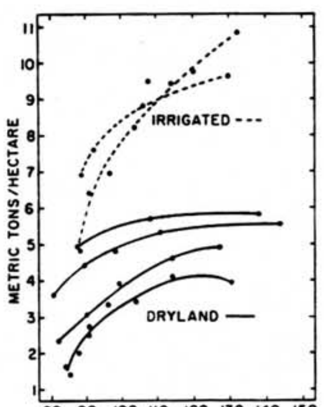

Fig. 3. Yield of fresh peas and associated tenderometer reading in 6 typical experiments.

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

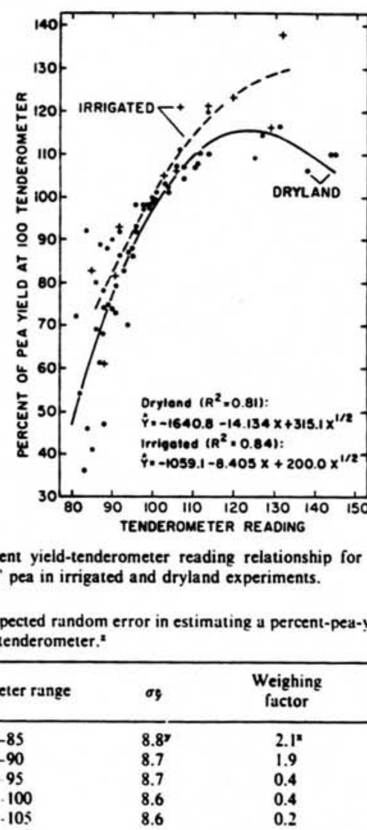

Fig. 4. Percent yield-tenderometer reading relationship for 'Dark Skinned Perfection' pea in irrigated and dryland experiments.

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 ca 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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