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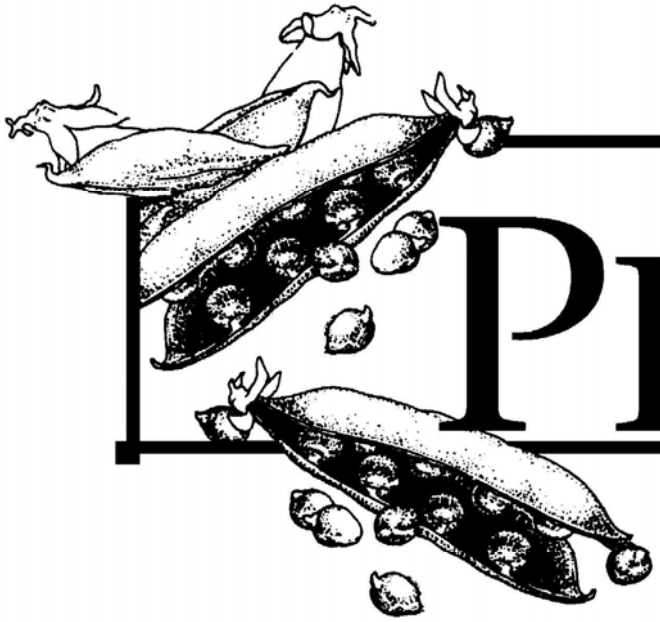

PEA

VARIETY TRIAL RESULTS

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2005

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Participating Seed Companies
Crites-Moscow Growers, Inc.
Pure Line Seeds, Inc.
Advanta Seeds U.K. Ltd.
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Seminis

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2005 University of Delaware Pea Variety Trial

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Introduction

The 2005 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 planting dates, March 7 and April 18, 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

Eleven varieties were planted in the early trial and fifteen varieties were planted in the late trial. The trials were irrigated as needed, and grown under standard commercial management practices. Weed control was excellent and insect control was not necessary because insect populations were low or non-existent in both trials. The weather data and heat unit accumulation for the trials is included in Appendices A & B.

Planting Date: Early Trial – March 7, 2005; eleven varieties;
Late Trial – April 18, 2005; fifteen varieties

Fertilizer: Broadcast before planting: N 60 lbs/A; P_2O_5 0 lbs/A; K_2O 0 lbs/A

Herbicide: Early Trial – Pursuit @ 3 oz/A, pre-plant incorporated
Late Trial – Dual Magnum @ 1.25 pts/A + Pursuit @ 3 oz/A, pre-plant incorporated

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 50 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-307F	Crites - Moscow Growers, Inc.	Early
Deschutes	Crites - Moscow Growers, Inc.	Early
PLS-46-3	Pure Line Seeds	Early
PLS-W90	Pure Line Seeds	Early
PLS-13046	Pure Line Seeds	Early
Reveille	Advanta Seeds U.K. Ltd.	Early
Cosima	Brotherton Seed Co.	Early
BSC 373	Brotherton Seed Co.	Early
BSC 348	Brotherton Seed Co.	Early
EF 680	Standard	Early
CMG-396F	Crites - Moscow Growers, Inc.	Late
CMG-399F	Crites - Moscow Growers, Inc.	Late
Moose	Crites - Moscow Growers, Inc.	Late
Cabaret	Advanta Seeds U.K. Ltd.	Late
Meridian*	Advanta Seeds U.K. Ltd.	Late
BSC 738	Brotherton Seed Co.	Late
BSC 760	Brotherton Seed Co.	Late
BSC 630	Brotherton Seed Co.	Late
FP2280	Syngenta Seeds	Late
FP2288	Syngenta Seeds	Late
8530731	Seminis	Late
8540767	Seminis	Late
8540768	Seminis	Late
Ashton	Seminis	Late
Bolero	Standard	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 combine. 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. The number of peas per pod is the average of all the pods from 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 twenty 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. In most cases blocking had no significant effect on the dependent variable. Exceptions are noted and the p-value for the effect of blocking is included at the bottom of each table.

Weather conditions after the early trial was planted were cold and wet. Consequently, heat units accumulated slowly and the plants did not begin to emerge until 23 days after planting. Stand counts in the early trial differed significantly between varieties (Table 2E) and this variation probably resulted in some of the differences among the varieties' final yields.

Tables 8E and 8L report the net yield 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.

The varieties with the highest adjusted net yield in the early trial (Table 8E) are BSC 373 and Marias. The varieties with the highest adjusted net yield in the late trial (Table 8L) are 8540767, BSC 630, and BSC 738.

Tables 19E, 20E, 19L and 20L report the maturity progression as measured by tenderometer readings and heat units.

Early Trial Harvest Results

Table 1E: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
Reveille	58	543.71	63	616.15
Marias	61	579.26	65	645.89
PLS-46-3	62	599.53	64	629.84
CMG-307F	63	616.15	67	689.50
PLS-13046	63	616.15	69	741.86
Cosima	63	616.15	68	705.92
BSC 373	63	633.30	70	757.51
EF680	63	616.15	68	714.14
Deschutes	64	629.84	68	715.16
BSC 348	65	653.22	70	783.98
PLS-W90	66	675.91	73	821.27

Table 2E: Stand Counts (Plants/Yard)

Variety	Plants/Yd	
Marias	29.00	a
Deschutes	22.17	b
PLS-W90	22.00	b
Cosima	21.67	b
PLS-46-3	21.17	b
PLS-13046	20.00	b
CMG-307F	19.67	b
BSC 373	19.00	b
BSC 348	18.50	bc
Reveille	14.50	cd
EF680	12.33	d
LSD	4.3628	
Variety p-value	<0.0001	
Block p-value	0.4586	

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

Variety	Vine Weight (lbs.)	
Marias	84.96	a
PLS-W90	79.28	ab
BSC 373	78.93	ab
CMG-307F	75.83	ab
BSC 348	73.62	ab
PLS-46-3	69.42	bc
PLS-13046	69.38	bc
Deschutes	69.37	bc
Cosima	67.17	bc
EF680	58.70	cd
Reveille	48.13	d
LSD	13.77	
Variety p-value	0.0014	
Block p-value	0.3283	

Table 4E: Weight of Cleaned Peas from 150 ft^2 Harvest Area (Lbs.)

Variety	Sample Yield (lbs)	
Marias	23.07	a
BSC 373	21.13	a
CMG-307F	17.85	b
BSC 348	16.35	bc
PLS-13046	14.17	c
Deschutes	14.08	c
Cosima	13.88	c
PLS-W90	13.75	cd
PLS-46-3	13.60	cd
EF680	10.83	d
Reveille	7.40	e
LSD	2.96	
Variety p-value	<0.0001	
Block p-value	0.1605	

Table 5E: Gross Yield of Cleaned Peas in Lbs/A

Variety	Gross Yield (lbs/A)	
Marias	6699	a
BSC 373	6137	a
CMG-307F	5184	b
BSC 348	4748	bc
PLS-13046	4114	c
Deschutes	4090	c
Cosima	4032	c
PLS-W90	3993	cd
PLS-46-3	3949	cd
EF680	3146	d
Reveille	2149	e
LSD	858.53	
Variety p-value	<0.0001	
Block p-value	0.1605	

Table 6E: Net Yield (Cleaned Peas Minus Percent Trash) in Lbs/A

Variety	Net Yield (lbs/A)	
Marias	6687	a
BSC 373	6079	a
CMG-307F	5134	b
BSC 348	4686	bc
PLS-13046	4024	cd
Deschutes	3816	de
PLS-46-3	3811	de
PLS-W90	3773	de
Cosima	3702	de
EF680	3080	e
Reveille	1889	f
LSD	869.27	
Variety p-value	<0.0001	
Block p-value	0.1030	

Table 7E: Gross Yield Adjusted to Tenderometer Reading of 100 (Lbs/A)

Variety	Adj. Gross Yld (lbs/A)	
BSC 373	6145	a
Marias	5419	a
PLS-W90	4876	bc
CMG-307F	4681	bcd
BSC 348	4632	bcde
PLS-46-3	4286	cde
Deschutes	3957	def
PLS-13046	3918	def
Cosima	3781	ef
EF680	3196	f
Reveille	2254	g
LSD	880.43	
Variety p-value	<0.0001	
Block p-value	0.3573	

Table 8E: Net Yield Adjusted to Tenderometer Reading of 100 (Lbs/A)

Variety	Adj. Net Yield (lbs/A)	
BSC 373	6086	a
Marias	5409	ab
CMG-307F	4636	bc
PLS-W90	4607	bc
BSC 348	4572	bc
PLS-46-3	4134	cd
PLS-13046	3832	cde
Deschutes	3683	de
Cosima	3467	de
EF680	3129	e
Reveille	1982	f
LSD	867.64	
Variety p-value	<0.0001	
Block p-value	0.2599	

Table 9E: Percent #4 Peas

Variety	Percent #4 Peas	
Marias	61.73	a
CMG-307F	61.45	a
BSC 373	60.58	a
EF680	57.57	a
Deschutes	55.41	a
PLS-13046	40.13	b
BSC 348	33.95	b
Cosima	14.01	c
PLS-W90	10.82	cd
PLS-46-3	9.61	cd
Reveille	4.07	d
LSD	6.98	
Variety p-value	<0.0001	
Block p-value	0.0163*	

*****effect of block is significant

Table 10E: Percent #3 Peas

Variety	Percent #3 Peas	
PLS-46-3	48.25	a
PLS-W90	42.12	b
Cosima	41.88	b
BSC 348	41.14	b
PLS-13046	34.10	c
Marias	31.87	cd
BSC 373	28.97	de
CMG-307F	27.95	def
Reveille	27.61	def
EF680	24.58	ef
Deschutes	23.53	f
LSD	5.09	
Variety p-value	<0.0001	
Block p-value	0.1231	

Table 11E: Percent #1 and #2 Peas

Variety	Percent #1 & #2 Peas	
Reveille	56.13	a
PLS-W90	41.55	b
PLS-46-3	38.65	bc
Cosima	35.55	c
BSC 348	23.61	d
PLS-13046	23.54	d
EF680	15.74	e
Deschutes	14.25	ef
CMG-307F	9.63	fg
BSC 373	9.48	fg
Marias	6.21	g
LSD	5.77	
Variety p-value	<0.0001	
Block p-value	0.2928	

Table 12E: Percent Trash

Variety	Percent Trash	
Reveille	12.19	a
Cosima	8.56	ab
Deschutes	6.81	bc
PLS-W90	5.51	bcd
PLS-46-3	3.50	cde
PLS-13046	2.23	de
EF680	2.11	de
BSC 348	1.31	e
CMG-307F	0.97	e
BSC 373	0.97	e
Marias	0.19	e
LSD	3.69	
Variety p-value	<0.0001	
Block p-value	0.0411*	

*****effect of block is significant

Table 13E: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
Marias	120.67	a
CMG-307F	107.44	b
Cosima	104.33	c
PLS-13046	103.00	c
Deschutes	102.11	cd
BSC 348	101.78	cde
BSC 373	99.78	def
EF680	99.22	ef
Reveille	97.56	fg
PLS-46-3	95.67	g
PLS-W90	87.56	h
LSD	2.83	
Variety p-value	<0.0001	
Block p-value	0.0181*	

*****effect of block is significant

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

Table 14E: Vine Length in Inches

Variety	Vine Length (in.)	
EF680	23.55	a
Deschutes	23.45	a
PLS-46-3	19.70	b
PLS-W90	18.55	bc
Cosima	17.45	bcd
PLS-13046	17.10	cde
BSC 373	16.95	cde
Marias	16.00	de
Reveille	15.65	de
CMG-307F	15.35	de
BSC 348	14.90	e
LSD	2.50	
Variety p-value	<0.0001	

Table 15E: Number of Pods per Plant

Variety	Pods/Plant	
EF680	5.50	a
Deschutes	4.90	ab
PLS-46-3	4.80	abc
BSC 373	4.50	abc
Cosima	4.30	abcd
PLS-13046	4.20	abcd
Reveille	4.10	bcd
CMG-307F	3.90	bcd
PLS-W90	3.70	bcd
Marias	3.50	cd
BSC 348	3.10	d
LSD	1.37	
Variety p-value	0.0458	

Table 16E: Number of Nodes with Pods per Plant

Variety	Nodes w/ Pods/Plant	
EF680	4.00	a
Deschutes	3.60	ab
PLS-46-3	3.40	ab
Reveille	3.20	abc
Cosima	3.10	abc
PLS-13046	2.90	bcd
CMG-307F	2.90	bcd
PLS-W90	2.90	bcd
BSC 373	2.40	cd
Marias	2.40	cd
BSC 348	2.10	d
LSD	0.92	
Variety p-value	0.0029	

Table 17E: Average Pod Length in Inches

Variety	Pod Length (in.)	
PLS-W90	3.35	a
Deschutes	2.70	b
EF680	2.53	bc
CMG-307F	2.40	cd
PLS-13046	2.33	de
PLS-46-3	2.25	def
BSC 373	2.23	def
Marias	2.23	def
Cosima	2.15	ef
BSC 348	2.15	ef
Reveille	2.13	f
LSD	0.20	
Variety p-value	<0.0001	

Table 18E: Average Number of Peas per Pod

Variety	Peas/Pod	
PLS-W90	6.87	a
Deschutes	6.03	b
PLS-13046	5.10	c
EF680	5.04	cd
Cosima	4.81	cde
BSC 373	4.76	cde
Reveille	4.73	cde
Marias	4.63	cdef
BSC 348	4.37	def
CMG-307F	4.35	ef
PLS-46-3	3.98	f
LSD	0.69	
Variety p-value	<0.0001	

Early Trial Maturity Data

Table 19E: Tenderometer Readings Leading Up To and Including Harvest

	Date and Accumulated Heat Units								
	31-May	**1-Jun**	**2-Jun**	**3-Jun**	**4-Jun**	**5-Jun**	**6-Jun**	**7-Jun**	**8-Jun**
Variety	**1035**	**1064**	**1085**	**1104**	**1125**	**1152**	**1184**	**1221**	**1258**
Reveille	90	**97.56***							
PLS-46-3		92			**96**				
EF680	81	88			**99**				
PLS-13046		91			**103**				
Deschutes							**102**		
Cosima		81					**104**		
CMG-307F							**107**		
Marias		89			98		**121**		
BSC 348							88	**102**	
PLS-W90							80	83	**88**
BSC 373							73	92	**100**

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

Table 20E: Summary of Maturity Information for Early Trial Varieties*

Variety	Actual Heat Units	Reported Heat Units
Reveille	1064	1350
PLS-46-3	1125	1240
EF680	1125	1220
PLS-13046	1125	1240
Marias	1125	1300
Deschutes	1184	1340
Cosima	1184	1290
CMG-307F	1184	1315
BSC 348	1221	1350
PLS-W90	1258	1320
BSC 373	1258	1340

* Tenderometer reading of 95 to 105 was considered mature

Late Trial Harvest Results

Table 1L: Flowering Data

Variety	First Flower		Full Flower	
	DAP	Heat Units	DAP	Heat Units
CMG-396F	48	903.40	51	1017.32
CMG-399F	49	940.58	51	1030.14
Moose	51	1017.32	54	1131.73
Cabaret	49	940.58	53	1081.26
Meridian	49	952.84	52	1068.52
BSC738	49	952.84	52	1068.52
BSC760	49	940.58	52	1055.78
BSC630	48	903.40	51	1017.32
FP2280	49	952.84	52	1068.52
FP2288	48	903.40	51	1017.32
8530731	49	940.58	52	1055.78
8540767	49	940.58	51	1030.14
8540768	49	940.58	52	1055.78
Ashton	50	965.11	52	1055.78
Bolero	50	977.38	52	1055.78

Table 2L: Stand Counts (Plants/Yard)

Variety	Plants/Yd	
8530731	32.17	a
FP 2288	31.17	ab
CMG-396F	27.83	abc
BSC 760	27.50	abcd
Cabaret	26.83	bcd
FP 2280	26.33	bcde
BSC 738	25.83	cde
BSC 630	25.83	cde
CMG-399F	23.67	cdef
Ashton	23.50	cdef
Moose	22.83	def
8540768	21.50	ef
Bolero	21.50	ef
Meridian	20.33	f
8540767	20.00	f
LSD	4.851	
Variety p-value	<0.0001	
Block p-value	0.9882	

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

Variety	Vine Weight (lbs.)	
8530731	95.25	a
8540767	83.62	b
Cabaret	82.98	b
FP 2280	82.32	b
BSC 630	80.43	b
8540768	80.37	b
Moose	78.33	b
CMG-399F	78.02	b
FP 2288	75.93	b
Ashton	75.72	b
BSC 738	75.48	b
CMG-396F	75.42	b
Meridian	61.48	c
BSC 760	61.27	c
Bolero	58.58	c
LSD	10.251	
Variety p-value	<0.0001	
Block p-value	0.4413	

Table 4L: Weight of Cleaned Peas from 150 ft^2 Harvest Area (Lbs.)

Variety	Sample Yield (lbs)	
BSC 630	14.28	a
CMG-396F	14.20	a
8540767	13.83	ab
8530731	12.92	abc
8540768	11.78	abc
Ashton	11.23	bcd
Cabaret	10.68	cde
CMG-399F	10.52	cde
BSC 738	10.38	cde
Meridian	10.28	cde
BSC 760	8.63	def
Bolero	8.20	ef
Moose	6.05	gf
FP 2288	5.85	gf
FP 2280	5.35	g
LSD	2.798	
Variety p-value	<0.0001	
Block p-value	0.0014*	

*****effect of block is significant

Table 5L: Gross Yield of Cleaned Peas in Lbs/A

Variety	Gross Yield (lbs/A)	
BSC 630	4148	a
CMG-396F	4124	a
8540767	4017	ab
8530731	3751	abc
8540768	3422	abc
Ashton	3262	bcd
Cabaret	3102	cde
CMG-399F	3054	cde
BSC 738	3015	cde
Meridian	2986	cde
BSC 760	2507	def
Bolero	2381	ef
Moose	1757	fg
FP 2288	1699	fg
FP 2280	1554	g
LSD	812.5	
Variety p-value	<0.0001	
Block p-value	0.0014*	

*****effect of block is significant

Table 6L: Net Yield (Cleaned Peas Minus Percent Trash) in Lbs/A

Variety	Net Yield (lbs/A)	
BSC 630	4105	a
CMG-396F	4056	a
8540767	3896	ab
8530731	3553	abc
8540768	3308	abc
Ashton	3092	bcd
CMG-399F	2974	cde
BSC 738	2962	cde
Cabaret	2922	cde
BSC 760	2450	def
Bolero	2210	efg
Moose	1676	fg
FP 2288	1651	fg
Meridian	1526	g
FP 2280	1503	g
LSD	815.05	
Variety p-value	<0.0001	
Block p-value	0.0019*	

*****effect of block is significant

Table 7L: Gross Yield Adjusted to Tenderometer Reading of 100 (Lbs/A)

Variety	Adj. Gross Yld (lbs/A)	
8540767	3616	a
BSC 630	3497	a
BSC 738	3493	a
8530731	3450	a
CMG-396F	3251	ab
Ashton	3139	abc
8540768	2949	abc
CMG-399F	2839	abcd
Meridian	2628	bcd
BSC 760	2610	bcd
Cabaret	2571	bcd
Bolero	2450	cde
Moose	2106	def
FP 2280	1424	ef
FP 2288	1302	fg
LSD	778.9	
Variety p-value	<0.0001	
Block p-value	0.0023*	

*****effect of block is significant

Table 8L: Net Yield Adjusted to Tenderometer Reading of 100 (Lbs/A)

Variety	Adj. Net Yield (lbs/A)	
8540767	3506	a
BSC 630	3460	a
BSC 738	3433	a
8530731	3268	ab
CMG-396F	3197	abc
Ashton	2974	abcd
8540768	2851	abcd
CMG-399F	2764	abcde
BSC 760	2550	abcde
Cabaret	2422	cde
Bolero	2273	de
Moose	2009	ef
FP 2280	1378	f
Meridian	1342	f
FP 2288	1266	f
LSD	782.1	
Variety p-value	<0.0001	
Block p-value	0.0027*	

*****effect of block is significant

Table 9L: Percent #4 Peas

Variety	Percent #4 Peas	
BSC 630	50.67	a
BSC 760	49.75	ab
BSC 738	41.48	abc
8540767	40.41	bc
Moose	38.78	c
CMG-396F	36.75	c
FP 2280	36.68	c
8540768	35.08	cd
Meridian	26.07	de
CMG-399F	21.20	ef
Bolero	21.11	ef
Ashton	15.46	fg
8530731	6.95	gh
FP 2288	5.66	h
Cabaret	5.41	h
LSD	9.684	
Variety p-value	<0.0001	
Block p-value	0.5989	

Table 10L: Percent #3 Peas

Variety	Percent #3 Peas	
FP 2288	48.18	a
CMG-399F	47.47	a
8530731	45.89	ab
8540768	45.51	ab
Ashton	43.42	abc
Bolero	43.35	abc
CMG-396F	40.42	bcd
BSC 630	40.04	bcd
BSC 738	38.61	cde
Meridian	37.25	cde
8540767	37.22	cde
FP 2280	34.90	de
Cabaret	34.35	de
Moose	34.08	de
BSC 760	33.23	e
LSD	6.753	
Variety p-value	0.0002	
Block p-value	0.6001	

Table 11L: Percent #1 and #2 Peas

Variety	Percent #1 & #2 Peas	
Cabaret	54.36	a
FP 2288	43.22	b
8530731	41.74	bc
Ashton	35.93	cd
Meridian	29.62	de
CMG-399F	28.53	ef
Bolero	28.41	ef
FP 2280	25.17	efg
Moose	22.35	fgh
CMG-396F	21.19	ghi
8540767	19.34	ghi
BSC 738	17.86	hi
8540768	16.05	hi
BSC 760	14.65	ij
BSC 630	8.14	j
LSD	7.173	
Variety p-value	<0.0001	
Block p-value	0.6231	

Table 12L: Percent Trash

Variety	Percent Trash	
Bolero	7.13	a
Meridian	7.07	a
Cabaret	5.89	ab
8530731	5.41	b
Ashton	5.19	b
Moose	4.78	bc
8540768	3.36	cd
FP 2280	3.24	d
8540767	3.03	de
FP 2288	2.93	de
CMG-399F	2.79	de
BSC 760	2.37	def
BSC 738	2.04	def
CMG-396F	1.64	ef
BSC 630	1.15	f
LSD	1.479	
Variety p-value	<0.0001	
Block p-value	0.1001	

Table 13L: Tenderometer Reading at Harvest

Variety	Tenderometer Reading	
FP 2288	138	a
CMG-396F	126	b
Cabaret	117	c
BSC 630	114	cd
8540768	112	de
Meridian	110	ef
8540767	108	fg
FP 2280	106	fgh
8530731	106	gh
CMG-399F	105	gh
Ashton	103	h
Bolero	98	i
BSC 760	97	i
BSC 738	92	j
Moose	89	j
LSD	3.8	
Variety p-value	<0.0001	
Block p-value	0.7840	

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

Table 14L: Vine Length in Inches

Variety	Vine Length (in.)	
Cabaret	29.05	a
CMG-399F	26.90	ab
8540767	26.60	b
8540768	26.35	bc
BSC 738	24.90	bcd
Moose	24.70	bcd
BSC 760	24.30	cd
BSC 630	24.10	d
CMG-396F	24.05	d
Ashton	23.85	d
FP 2288	22.95	d
Bolero	20.30	e
8530731	20.05	e
FP 2280	19.75	e
Meridian	16.15	f
LSD	2.250	
Variety p-value	<0.0001	

Table 15L: Number of Pods per Plant

Variety	Pods/Plant	
CMG-399F	4.20	a
8540767	3.60	ab
BSC 630	3.10	bc
8540768	3.00	bc
Meridian	3.00	bc
Bolero	2.80	bcd
8530731	2.70	bcd
Cabaret	2.60	cd
Ashton	2.60	cd
FP 2288	2.50	cde
CMG-396F	2.50	cde
BSC 738	2.30	cde
BSC 760	2.00	de
Moose	1.90	de
FP 2280	1.60	e
LSD	0.968	
Variety p-value	<0.0001	

Table 16L: Number of Nodes with Pods per Plant

Variety	Nodes w/ Pods/Plant	
CMG-399F	2.30	a
Bolero	2.20	ab
BSC 630	2.10	abc
Meridian	1.90	abc
Cabaret	1.80	bc
8540767	1.80	bc
FP 2288	1.70	cd
CMG-396F	1.70	cd
8540768	1.70	cd
8530731	1.70	cd
Ashton	1.70	cd
BSC 738	1.30	de
Moose	1.30	de
BSC 760	1.20	e
FP 2280	1.10	e
LSD	0.481	
Variety p-value	<0.0001	

Table 17L: Average Pod Length in Inches

Variety	Pod Length (in.)	
BSC 738	2.35	a
FP 2280	2.30	a
Moose	2.28	a
FP 2288	2.20	ab
Meridian	2.20	ab
BSC 760	2.20	ab
8540768	2.15	ab
8540767	2.15	ab
BSC 630	2.10	abc
CMG-399F	2.10	abc
Bolero	2.10	abc
Cabaret	2.03	abc
CMG-396F	1.90	bc
8530731	1.80	c
Ashton	1.80	c
LSD	0.346	
Variety p-value	0.0398	

Table 18L: Average Number of Peas per Pod

Variety	Peas/Pod	
BSC 738	5.43	a
FP 2288	4.52	ab
CMG-396F	4.20	bc
8540767	4.11	bcd
8540768	4.06	bcd
FP 2280	3.94	bcd
BSC 630	3.94	bcd
CMG-399F	3.86	bcd
Cabaret	3.65	bcd
Meridian	3.57	cd
BSC 760	3.55	cde
8530731	3.33	cde
Ashton	3.23	de
Bolero	3.21	de
Moose	2.63	e
LSD	0.929	
Variety p-value	<0.0001	

Late Trial Maturity Data

Table 19L: Tenderometer Readings Leading Up To and Including Harvest

	Date and Accumulated Heat Units				
	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun
Variety	1432	1456	1485	1518	1553
FP 2288	**138**				
CMG-396F	**126**				
Cabaret	115	**117**			
BSC 630	113	**114**			
8540767	**108**				
Meridian	106	**110**			
8530731	106	**106**			
CMG-399F	**105**				
Ashton	100	**103**			
8540768	97	**112**			
Bolero	97	**98**			
BSC 760	91	**97**			
BSC 738	88	92	**92**		
FP 2280		103	**106**		
Moose		80			**89**

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

Table 20L: Summary of Maturity Information for Late Trial Varieties*

Variety	Actual Heat Units	Reported Heat Units
FP 2288	<1432	1380
CMG-396F	<1432	1465
Cabaret	<1432	1500
BSC 630	<1432	1450
8540767	<1432	
Meridian	<1432	1500
8530731	<1432	
CMG-399F	1432	1475
Ashton	1432	1460
8540768	1432	
Bolero	1432	1460
BSC 760	1456	1520
BSC 738	>1485	1530
FP 2280	1456	1600
Moose	>1553	1575

* Tenderometer reading of 95 to 105 was considered mature

Appendix A: Weather Data for the 2005 Early Pea Variety Trial

Date	High	Low	Daily Heat Units	Accumulated Heat Units	Daily Rainfall	Accumulated Rainfall
7-Mar	69.7	38.4		Planted	0.00	0.00
8-Mar	59.3	24.6	1.9	1.9	1.17	1.17
9-Mar	34.8	20.6	0.0	1.9	0.00	1.17
10-Mar	38.5	17.6	0.0	1.9	0.00	1.17
11-Mar	55.3	30.8	3.0	5.0	0.03	1.20
12-Mar	47.3	31.3	0.0	5.0	0.02	1.22
13-Mar	47.2	34.8	1.0	6.0	0.00	1.22
14-Mar	45.0	31.0	0.0	6.0	0.00	1.22
15-Mar	47.0	29.0	0.0	6.0	0.00	1.22
16-Mar	46.0	29.0	0.0	6.0	0.00	1.22
17-Mar	42.0	31.0	0.0	6.0	0.00	1.22
18-Mar	56.0	24.0	0.0	6.0	0.00	1.22
19-Mar	50.8	27.6	0.0	6.0	0.00	1.22
20-Mar	55.4	41.7	8.6	14.5	0.11	1.33
21-Mar	50.9	30.2	0.5	15.1	0.00	1.33
22-Mar	56.8	25.7	1.2	16.3	0.00	1.33
23-Mar	49.5	40.6	5.1	21.4	2.00	3.33
24-Mar	45.9	36.9	1.4	22.8	0.01	3.34
25-Mar	48.3	39.0	3.6	26.4	0.08	3.42
26-Mar	49.4	40.5	4.9	31.3	0.00	3.42
27-Mar	49.3	38.8	4.0	35.4	0.00	3.42
28-Mar	63.9	44.2	14.0	49.4	0.43	3.85
29-Mar	56.7	46.3	11.5	60.9	0.02	3.87
30-Mar	59.4	38.3	8.8	69.7	0.00	3.87
31-Mar	52.0	35.7	3.8	73.5	0.00	3.87
1-Apr	59.3	46.2	12.7	86.2	0.04	3.91
2-Apr	62.6	46.2	14.4	100.6	1.59	5.50
3-Apr	48.8	40.1	4.4	105.1	0.04	5.54
4-Apr	63.5	42.3	12.9	118.0	0.00	5.54
5-Apr	67.8	35.0	11.4	129.4	0.00	5.54
6-Apr	79.8	47.3	23.5	152.9	0.00	5.54
7-Apr	75.3	59.5	27.4	180.3	0.00	5.54
8-Apr	66.6	45.9	16.2	196.6	0.11	5.65
9-Apr	57.9	36.8	7.4	203.9	0.00	5.65
10-Apr	72.5	31.3	11.9	215.8	0.00	5.65
11-Apr	54.0	36.5	5.3	221.1	0.00	5.65
12-Apr	55.4	44.3	9.9	231.0	0.00	5.65
13-Apr	55.7	37.2	6.4	237.4	0.00	5.65
14-Apr	58.3	31.5	4.9	242.3	0.00	5.65
15-Apr	51.5	40.4	5.9	248.2	0.00	5.65
16-Apr	53.5	32.1	2.8	251.0	0.00	5.65
17-Apr	72.6	28.6	10.6	261.6	0.00	5.65
18-Apr	77.3	41.1	19.2	280.8	0.00	5.65
19-Apr	82.9	44.2	23.5	304.4	0.00	5.65
20-Apr	86.9	55.2	31.1	335.5	0.00	5.65
21-Apr	72.4	47.7	20.0	355.5	0.00	5.65
22-Apr	56.3	47.4	11.9	367.3	0.02	5.67
23-Apr	71.1	47.0	19.1	386.4	0.16	5.83
24-Apr	56.3	42.8	9.6	396.0	0.01	5.84

25-Apr	61.9	39.9	10.9	406.9	0.01	5.85
26-Apr	71.4	37.9	14.6	421.5	0.00	5.85
27-Apr	71.0	53.1	22.1	443.5	0.11	5.96
28-Apr	66.7	47.3	17.0	460.5	0.00	5.96
29-Apr	62.5	44.3	13.4	473.9	0.00	5.96
30-Apr	74.5	53.5	24.0	497.9	0.23	6.19
1-May	64.5	45.5	15.0	512.9	0.67	6.86
2-May	62.5	43.1	12.8	525.6	0.10	6.96
3-May	60.5	36.9	8.7	534.3	0.01	6.97
4-May	56.6	42.2	9.4	543.7	0.01	6.98
5-May	61.7	35.1	8.4	552.1	0.00	6.98
6-May	53.2	46.4	9.8	561.9	0.14	7.12
7-May	68.5	46.2	17.4	579.3	0.01	7.13
8-May	72.5	48.0	20.3	599.5	0.00	7.13
9-May	71.1	42.1	16.6	616.2	0.00	7.13
10-May	63.1	44.3	13.7	629.8	0.00	7.13
11-May	81.2	46.9	24.1	653.9	0.00	7.13
12-May	74.1	49.9	22.0	675.9	0.00	7.13
13-May	60.5	46.7	13.6	689.5	0.00	7.13
14-May	79.4	49.9	24.6	714.1	0.00	7.13
15-May	76.2	59.3	27.7	741.9	0.39	7.52
16-May	71.9	55.1	23.5	765.3	0.06	7.58
17-May	69.4	48.9	19.1	784.5	0.00	7.58
18-May	72.3	45.9	19.1	803.6	0.00	7.58
19-May	68.1	47.2	17.7	821.3	0.00	7.58
20-May	58.1	50.5	14.3	835.5	3.71	11.29
21-May	70.5	46.2	18.3	853.9	0.00	11.29
22-May	69.1	46.5	17.8	871.7	0.00	11.29
23-May	65.0	54.0	19.5	891.2	0.00	11.29
24-May	57.7	51.9	14.8	906.0	0.05	11.34
25-May	53.1	48.8	10.9	916.9	0.20	11.54
26-May	68.9	51.2	20.1	937.0	0.20	11.74
27-May	81.8	47.5	24.6	961.6	0.00	11.74
28-May	75.7	53.5	24.6	986.2	0.00	11.74
29-May	76.4	53.2	24.8	1011.0	0.00	11.74
30-May	78.3	50.5	24.4	1035.4	0.00	11.74
31-May	78.4	58.3	28.3	1063.7	0.09	11.83
1-Jun	72.0	51.0	21.5	1085.2	0.00	11.83
2-Jun	61.8	55.2	18.5	1103.8	0.00	11.83
3-Jun	63.8	57.8	20.8	1124.6	1.35	13.18
4-Jun	73.6	61.3	27.4	1152.0	0.00	13.18
5-Jun	85.6	58.9	32.2	1184.2	0.01	13.19
6-Jun	89.8	64.6	37.2	1221.4	0.48	13.67
7-Jun	86.3	67.3	36.8	1258.2	0.30	13.97

Appendix B: Weather Data for the 2005 Late Pea Variety Trial

Date	High	Low	Daily Heat Units	Accumulated Heat Units	Rainfall	Accumulated Rainfall
18-Apr	77.3	41.1		Planted	0.00	0.00
19-Apr	82.9	44.2	23.5	23.5	0.00	0.00
20-Apr	86.9	55.2	31.1	54.6	0.00	0.00
21-Apr	72.4	47.7	20.0	74.7	0.00	0.00
22-Apr	56.3	47.4	11.9	86.5	0.02	0.02
23-Apr	71.1	47.0	19.1	105.6	0.16	0.18
24-Apr	56.3	42.8	9.6	115.1	0.01	0.19
25-Apr	61.9	39.9	10.9	126.0	0.01	0.20
26-Apr	71.4	37.9	14.6	140.7	0.00	0.20
27-Apr	71.0	53.1	22.1	162.7	0.11	0.31
28-Apr	66.7	47.3	17.0	179.7	0.00	0.31
29-Apr	62.5	44.3	13.4	193.1	0.00	0.31
30-Apr	74.5	53.5	24.0	217.1	0.23	0.54
1-May	64.5	45.5	15.0	232.0	0.67	1.21
2-May	62.5	43.1	12.8	244.8	0.10	1.31
3-May	60.5	36.9	8.7	253.5	0.01	1.32
4-May	56.6	42.2	9.4	262.9	0.01	1.33
5-May	61.7	35.1	8.4	271.3	0.00	1.33
6-May	53.2	46.4	9.8	281.1	0.14	1.47
7-May	68.5	46.2	17.4	298.4	0.01	1.48
8-May	72.5	48.0	20.3	318.7	0.00	1.48
9-May	71.1	42.1	16.6	335.3	0.00	1.48
10-May	63.1	44.3	13.7	349.0	0.00	1.48
11-May	81.2	46.9	24.1	373.1	0.00	1.48
12-May	74.1	49.9	22.0	395.1	0.00	1.48
13-May	60.5	46.7	13.6	408.7	0.00	1.48
14-May	79.4	49.9	24.6	433.3	0.00	1.48
15-May	76.2	59.3	27.7	461.0	0.39	1.87
16-May	71.9	55.1	23.5	484.5	0.06	1.93
17-May	69.4	48.9	19.1	503.7	0.00	1.93
18-May	72.3	45.9	19.1	522.8	0.00	1.93
19-May	68.1	47.2	17.7	540.4	0.00	1.93
20-May	58.1	50.5	14.3	554.7	3.71	5.64
21-May	70.5	46.2	18.3	573.1	0.00	5.64
22-May	69.1	46.5	17.8	590.9	0.00	5.64
23-May	65.0	54.0	19.5	610.4	0.00	5.64
24-May	57.7	51.9	14.8	625.1	0.05	5.69
25-May	53.1	48.8	10.9	636.1	0.20	5.89
26-May	68.9	51.2	20.1	656.1	0.20	6.09
27-May	81.8	47.5	24.6	680.8	0.00	6.09
28-May	75.7	53.5	24.6	705.4	0.00	6.09
29-May	76.4	53.2	24.8	730.2	0.00	6.09
30-May	78.3	50.5	24.4	754.6	0.00	6.09
31-May	78.4	58.3	28.3	782.9	0.09	6.18
1-Jun	72.0	51.0	21.5	804.4	0.00	6.18
2-Jun	61.8	55.2	18.5	822.9	0.00	6.18
3-Jun	63.8	57.8	20.8	843.7	1.35	7.53
4-Jun	73.6	61.3	27.4	871.2	0.00	7.53
5-Jun	85.6	58.9	32.2	903.4	0.01	7.54

6-Jun	89.8	64.6	37.2	940.6	0.48	8.02
7-Jun	86.3	67.3	36.8	977.4	0.30	8.32
8-Jun	91.7	68.1	39.9	1017.3	0.00	8.32
9-Jun	87.7	69.3	38.5	1055.8	0.00	8.32
10-Jun	85.6	70.9	38.2	1094.0	0.17	8.49
11-Jun	86.6	68.9	37.7	1131.7	0.00	8.49
12-Jun	86.6	68.5	37.5	1169.3	0.00	8.49
13-Jun	88.3	72.5	40.4	1209.7	0.00	8.49
14-Jun	91.5	75.1	43.3	1253.0	0.00	8.49
15-Jun	89.0	71.2	40.1	1293.1	0.00	8.49
16-Jun	87.6	65.1	36.3	1329.4	0.02	8.51
17-Jun	78.5	58.4	28.5	1357.9	0.00	8.51
18-Jun	79.4	53.6	26.5	1384.4	0.00	8.51
19-Jun	74.1	59.0	26.6	1410.9	0.00	8.51
20-Jun	69.0	52.4	20.7	1431.6	0.00	8.51
21-Jun	80.6	48.3	24.4	1456.0	0.00	8.51
22-Jun	77.5	60.8	29.1	1485.2	0.00	8.51
23-Jun	85.4	59.5	32.5	1517.7	0.00	8.51
24-Jun	87.0	62.8	34.9	1552.6	0.00	8.51
25-Jun	84.7	65.4	35.1	1587.7	0.00	8.51

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: $Y = a + bX + cX^2$, where Y is percent yield, X is tenderometer reading; a, b, and c are parameters to be estimated statistically.

Results and Discussion

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

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

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

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

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

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

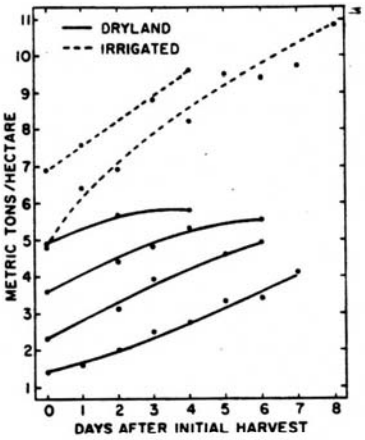

Fig. 1. Yield versus time of harvest for fresh peas in 6 typical experiments.

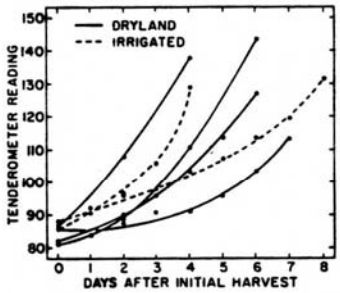

Fig. 2. Tenderometer of fresh peas as affected by time of harvest in 6 typical experiments.

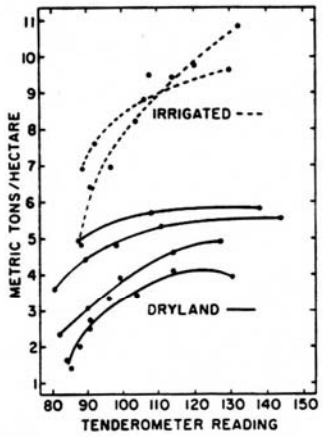

Fig. 3. Yield of fresh peas and associated tenderometer reading in 6 typical experiments.

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

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

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

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

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

The curves and data points for dryland and irrigated peas were

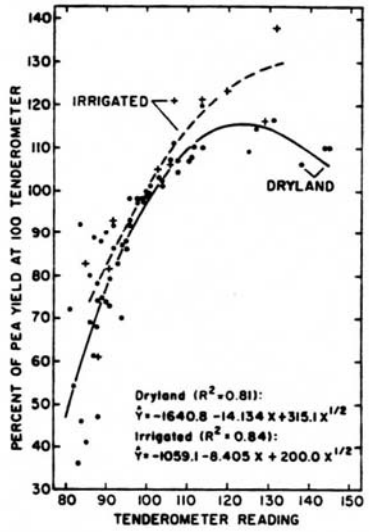

Fig. 4. Percent yield-tenderometer reading relationship for 'Dark Skinned Perfection' pea in irrigated and dryland experiments.

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

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

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

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

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

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

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

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

Norton et al. (4) and Sayre (7) point out that 1 scale is not applicable to all pea cultivars. Norton et al. (4) add that the use of a well-developed scale for 1 cultivar to adjust another cultivar may introduce less error than using a scale developed from only a few points. Information presented in Fig. 4 is consistent with earlier results (1, 2, 4, 7) showing a similar relationship between percent yield and tenderometer readings in the range of 90 to 110. Percent yields changed between 1 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 10 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.

Literature Cited

1. Hagedorn, D. J., L. G. Holm, and J. H. Torrie. 1955. Yield-quality relationships as influenced by maturity of canning peas. *WI Agr. Expt. Sta. Res. Bul.* 187, pp. 15.
2. Kramer, Amihud. 1948. Relation of yield to quality in the production of vegetables for canning. *MD Agr. Expt. Sta. Misc. Pub.* 64.
3. Lynch, L. J., and R. S. Mitchell. 1953. The definition and prediction of the optimal harvest time of pea canning crops. *Commonwealth Scientific and Industrial Research Organization, Australia, Bul.* No. 273, pp. 43.
4. Norton, Robert, A., Walter E. Bratz, and Thomas S. Russell. 1968. An analysis of pea varieties and selections for freezing and canning in northwestern Washington—1967. *WA Agr. Expt. Sta. Cir.* 438, pp. 16.
5. Ostle, Bernard. 1963. Statistics in Research. 2nd Edition. IO State Univ Press, Ames, IO.
6. Pollard, E. H., E. B. Wilcox, and H. B. Peterson. 1947. Maturity studies with canning peas. *UT Agr. Expt. Sta. Bul.* 328, pp. 16.
7. Sayre, Charles B. 1952. Tenderometer grades, yields, and gross return of peas. *NY Agr. Expt. Sta. Farm Research* 18(3):3-4.