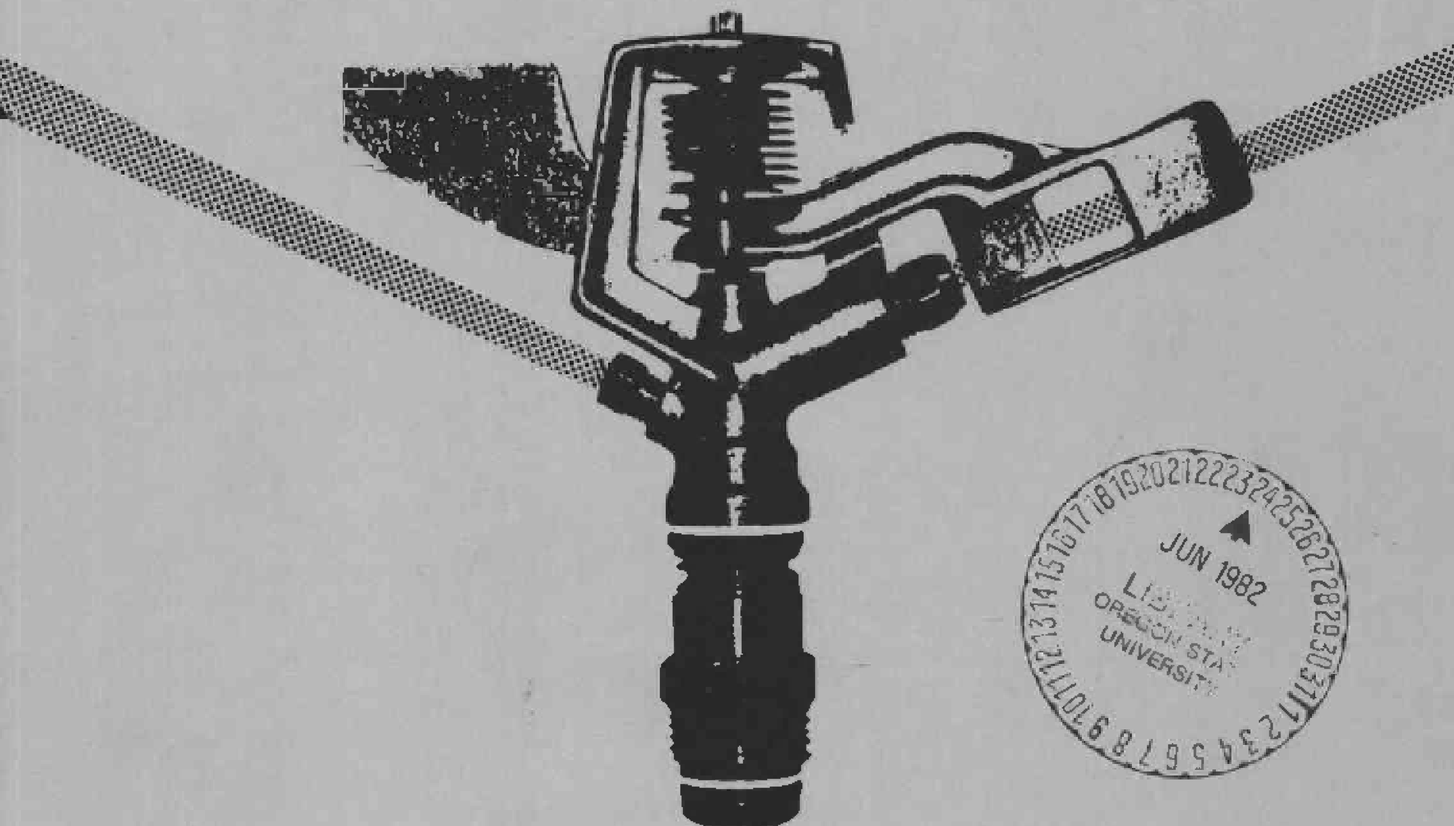
Irrigated Crop Research in Oregon's Columbia Basin



1982 Research Report

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HERMISTON STATION

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COLUMBIA BASIN AGRICULTURAL RESEARCH AND EXTENSION CENTER
HERMISTON, OREGON 97838

The Umatilla Irrigation Project was founded by passage of the "General Reclamation Act" signed by the President of the United States on June 17, 1902. Concurrent with the U.S. Reclamation Services's development of the Umatilla Irrigation Project in 1909, the Oregon Agricultural Experiment Station and the Division of Western Irrigation Agriculture, USDA, agreed to cooperatively establish local research programs (now the Columbia Basin Agricultural Research and Extension Center).

Operations of the Umatilla Experiment Station began in 1909 on a 40-acre tract.

On April 16, 1931, an executive order signed by President Herbert Hoover set aside the present tract to meet increased research demands.

This research center has conducted research on livestock and poultry production, and is now actively studying problems related to soil and water management as well as fruit, vegetable, and field crop production.

In October 1977, the center's capabilities were expanded when western Umatilla County Extension personnel moved to the center. Now research results are more directly available to Extension agents as are the grower's production problems better related to researchers.

Field trials in 1982 include potato yield and disease trials, insect studies, alfalfa yield trials, fall grazing crops, grape variety observations, corn and cereal yield trials, wheat, barley, and triticale breeding trials, water use patterns, cereal diseases, weather observations, lawn grass variety trial, and bean production.

CONTENTS

POTATO *(Solanum tuberosum L.)* EVALUATION TRIALS CONDUCTED IN NORTH CENTRAL OREGON 1978-1980

D.C. Hane and A.R. Mosley[1]

The potato variety program at Hermiston uses two approaches to identify superior potato cultivars. The Columbia Basin Agricultural Research Center conducts regional, state, and early variety production trials on location as well as tests of promising entries under commercial growing conditions in grower fields.

PROCEDURES

Trials are planted from late March through mid-April in a randomized block design with four replications (three in off-station plots). The soil type at the Research Center is an Adkins loamy fine sand. Soil type in commercial fields varies from loamy fine sand to sandy. All seed is hand cut, treated with fungicide and bagged for individual plots. 'Russet Burbank' and 'Norgold Russet' are included as check varieties. Each plot consists of one 25-foot row. Rows are on 34-inch centers and plants are spaced nine inches apart in the row. A five-foot border is maintained between replications.

Management practices suitable to the Hermiston area are used in the trials. Pesticides are used as needed. A per acre fertilizer mix of approximately 100 pounds of nitrogen, 150 pounds of phosphorous, 150 pounds of potash, 60 pounds of sulfur and needed minor elements is banded at planting. Some 200 to 275 pounds of additional N per acre is applied through the irrigation system during the growing season. Frequent sprinkler irrigations, generally three times per week, are required to supply needed water.

The climate in 1981 was generally good for potato production. A relatively hot period in late July and early August probably lowered yields and contributed to increased internal defects in tubers.

Since growing conditions change from year to year, as well as from location to location, promising lines are tested over a number of locations for more than one year. Tables 1 through 8 summarize yield and performance data for entries tested in the Hermiston area in 1981 and for the last few years.

RESULTS AND DISCUSSION

A number of factors must be kept in mind when evaluating new potato lines. For example, a line not suited for processing may be valuable for

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fresh market. A fresh market variety should mature early, yield and store well and produce oblong blocky tubers with "eye" appeal. A processing variety, on the other hand, should be mid-season to late and have elongated and blocky tubers with shallow, dispersed eyes. Processors also want storability, but high specific gravity and a long dormancy are also important. With either potato type a russet skin, high yield of U.S. No. 1 tubers, resistance to disease, and various physiological disorders are also significant.

As shown in the tables, many desirable characteristics are found in the potato lines tested. Unfortunately, most have one or more undesirable traits that make them unacceptable for commercial production. 'Lemhi', a recently released russet potato, is very attractive with good internal and processing qualities. Its susceptability to pressure bruising however, leads to storage problems which limits its commercial use to out-of-field directly to processing.

The fresh market variety testing program has identified desirable types among the 'Norgold' clones tested. Both 'Norgold 35' and 'Norgold 19' have performed well in the years tested. Though later in maturity than the standard Norgold, these two clones have a good tuber type which are generally larger in size than the Norgold strain now grown.

Continuation of these testing programs will aid in selecting cultivars with desirable characteristics for fresh market and processing varieties.

Table 1. Total yield, yield of U.S. No. 1 and No. 2 grade potatoes, specific gravity and average tuber weight of entries in the 1981 statewide variety trial at the Columbia Basin Agricultural and Extension Center, Hermiston, Oregon

Entry	Total yield	U.S. No. 1's		U.S. No. 2's	Specific gravity	Average tuber weight
	cwt/acre	cwt/acre	percent	percent		ounces
A74124-3	869	635	73	12	1.075	10.9
A7596-1	841	744	88	7	1.084	12.7
Targhee	810	710	88	5	1.084	9.5
A7403-3	806	672	83	7	1.078	19.0
A69657-4	806	624	78	6	1.087	9.8
A74404-3	803	704	88	4	1.081	8.5
A74212-1	768	684	89	3	1.078	9.5
Butte	767	703	91	2	1.086	7.4
RB 1978 Gen 1	754	457	61	21	1.083	9.4
A72545-2	715	655	92	2	1.075	11.8
A69870-3	710	666	94	1	1.082	8.6
A74104-8	700	581	83	5	1.072	10.7
A74393-1	683	635	93	2	1.083	9.1
A69870-6	670	621	93	1	1.080	10.0
WN630-5	670	577	86	5	1.081	13.1
49 1 118	640	518	81	8	1.079	8.3
Chiefton	632	586	93	4	1.071	9.4
ND561-1	619	540	87	4	1.078	11.1
AC67560-1	610	557	91	3	1.074	10.1
A72602-2	608	534	88	3	1.087	10.6
A75291-4	590	543	92	3	1.079	10.9
RB Local	576	420	73	16	1.086	8.8
Lemhi	568	469	83	8	1.079	11.3
T226-1	567	421	74	6	1.064	10.1
AK38-2	552	338	61	22	1.078	7.6
A75291-3	546	481	88	4	1.079	9.8
ALR4-1	530	446	84	2	1.092	7.7
A69173-2	469	407	87	3	1.084	8.4
ND451-2	439	404	92	1	1.072	11.2
A7487-5	430	357	83	3	1.079	9.2
Norgold	417	369	89	2	1.077	8.2
5% LSD	156	147			0.005	

Table 2. Total yield, yield of U.S. No. 1 and No. 2 potatoes, specific gravity and average tuber weight of entries in the 1981 Western Region Potato Variety Test at the Columbia Basin Agriculture Research and Extension Center, Hermiston, Oregon

Entry	Total yield	U.S. No. 1's		U.S. No. 2's	Specific gravity	Average tuber weight
	cwt/acre	cwt/acre	percent	percent		ounces
A72685-2	743	669	90	3	1.082	11.6
WC672-2	716	640	89	7	1.083	8.8
A72545-2	697	630	90	1	1.078	11.8
AD7377-1	669	564	84	10	1.075	10.7
WC521-12	564	526	93	2	1.096	8.8
Lemhi	561	514	92	4	1.085	10.0
Norchip	503	403	80	6	1.081	6.6
AD7267-1	501	392	78	10	1.070	10.6
AD74135-1	492	406	82	6	1.079	8.7
RB	489	321	66	14	1.084	8.6
5% LSD	148	133			0.005	

Table 3. Total yield, yield of U.S. No. 1 and No. 2 grade potatoes, specific gravity and average tuber weight of entries in the 1981 early variety trial at the Columbia Basin Agricultural Research and Extension Center, Hermiston, Oregon

Entry	Total yield	U.S. No. 1's		U.S. No. 2's	Specific gravity	Average tuber weight
	cwt/acre	cwt/acre	percent	percent		ounces
Norgold 19	565	504	89	3	1.078	8.4
Norgold M	524	446	85	5	1.078	9.0
Norgold 35	499	441	88	2	1.077	9.0
Norgold Neb.	478	434	91	0	1.081	7.7
Norgold L	476	426	90	2	1.077	7.9
Norgold 7	471	403	86	2	1.077	8.6
Norgold N.D.	443	384	87	2	1.081	7.3
Norgold 10	442	375	85	3	1.077	8.3
5% LSD	33	33			0.003	

Table 4. Total yield, yield of U.S. No. 1 and No. 2 potatoes, specific gravity and average tuber weight of entries grown at three off-station locations in North Central Oregon in 1981

Entry	Total yield	U.S. No. 1's		U.S. No. 2's	Specific gravity	Average tuber weight
	cwt/acre	cwt/acre	percent	percent		ounces
Location 1						
A74404-3	902	761	84	10	1.084	9.6
Nooksack	723	689	95	3	1.097	16.4
Targhee	705	654	93	3	1.085	11.8
AD7377-1	688	599	87	7	1.075	12.3
RB 1980 VTSC	623	506	81	4	1.084	10.5
Butte	538	431	80	8	1.086	10.4
Lemhi	526	437	83	5	1.092	9.9
RB 1978 VTSC	505	330	65	21	1.084	12.3
5% LSD	121	102			0.003	
Location 2						
A74404-3	689	586	85	4	1.079	7.6
RB 1980 VTSC	645	484	75	11	1.082	7.4
AD7377-1	617	578	94	2	1.079	8.6
Lemhi	564	426	76	6	1.087	8.1
Butte	558	461	83	6	1.085	7.5
Targhee	526	457	87	4	1.083	8.9
Nooksack	510	480	94	0	1.092	10.6
RB 1978 VTSC	490	373	76	9	1.083	7.7
5% LSD	83	72			0.003	
Location 3						
A74404-3	546	435	80	6	1.071	8.3
RB 1980 VTSC	519	306	59	13	1.079	6.1
Nooksack	487	429	88	8	1.085	11.0
AD7377-1	472	383	81	6	1.073	8.8
RB 1978 VTSC	449	256	57	16	1.079	6.7
Butte	444	361	81	3	1.082	7.4
Targhee	401	334	83	4	1.076	7.3
Lemhi	397	265	67	9	1.081	7.2
5% LSD	57	63			0.004	

Table 5. Average percent internal necrosis, hollow heart, and brown center in tubers of entries grown at three-off-station locations in North Central Oregon, 1981

Entry	Internal necrosis	Hollow heart	Brown center
	percent	percent	percent
A74403-3	3.5	.4	-
AD7377-1	.4	.4	-
Butte	.4	.4	-
Lemhi	-	1.3	-
Nooksack	-	.4	-
RB 1980 VTSC	3.5	3.5	5.3
Targhee	.9	.4	-
RB 1978 VTSC	3.1	4.0	7.1

Table 6. Total yield and comments regarding entries tested in the Early Maturing Potato Variety Trial during 1979, 1980 and 1981 at the Columbia Basin Agricultural Research and Extension Center, Hermiston, Oregon

Entry	Total yield 1979	1980	1981	Average	Comments[1]
	- cwt per acre -				
Norgold 35	480	559	499	513	Late, good grade, large
Norgold 19	420	-	565	493	Late, good grade, large
Norgold L	439	536	476	484	Scab, rough
Norgold M	407	522	524	484	Good grade, large, H.H.
Norgold 7	382	589	471	481	Late, large, H.H.
Norgold (Neb.)	405	437	478	440	Early, good grade, small
Norgold 10	355	432	442	410	Good grade, average to small
Norgold H	430	585	-	508	Late, good grade
Norgold (Ore.)	349	348	-	349	Early, good grade, small
Lemhi	460	621	-	541	Late, excellent grade, large, will not store
AVG	413	514	494	470	

[1] H.H. = hollow heart

Table 7. Total yield and comments regarding cultivars from the OSU Statewide Potato Variety Trial for 1978 through 1981 at the Columbia Basin Agricultural Research and Extension Center, Hermiston, Oregon

Entry	1978	1979	1980	1981	Comments[1]
	Total yield				
	- cwt per acre -				
Bison	285	404			
Centennial	338	333			
Nampa	329	373			
A70270-3	384	376	582		Late attractive tuber
A70383-24	449	443	810		Long russet, rough
A7273-3	628	588	725		R-O russet, deep eyes
A72545-2	402	551	-	715	Late, smooth, I.N.
A72602-2	317	418	662	608	Dark russet, thick skin
Butte	365	518	676	767	Attractive, light russet
Chiefton	420	548	729	632	Red skin, severe I.N.
Lemhi	329	529	692	568	Attractive dark russet, susc. to pressure bruise
Russet Burbank	551	421	660	576	Poor grade, rough, knobby
Targhee	406	396	789	810	Heavy russet, thick skin
A66107-51	-	527	840	-	Long, rough, knobby, deep eyes
A7346-11	-	397	467	-	Oblong light russet
WN701-14	-	379	480	-	Large dark russet, rough
ALR4-1	-	487	605	530	Oblong white or very light russet, scab
Norgold	-	400	407	417	Early, good grade
AC67560-1	-	-	643	610	Red skin, large, scab
A69870-3	-	-	653	710	R-O russet, thick skin, blocky, I.N., H.H.
A69870-6	-	-	724	670	R-O russet, deep eyes, I.N., H.H.
A7403-3	-	-	751	806	R.O russet, growth cracks, I.N.
WN630-5	-	-	692	670	Large, long white, scab, shatter
*AVG.	401	413	630	579	

*Average for all entries tested in year indicated.

[1] R-O = round to oblong; I.N. = internal necrosis; H.H. = hollow heart

Table 8. Total yield and comments regarding cultivars, tested in the Western Region Potato Variety Trial in 1979, 1980 and 1981 at the Columbia Basin Agricultural Research and Extension Center, Hermiston, Oregon

Entry	Total yield 1979	1980	1981	Comments[1]
	- cwt per acre -			
WC612-13	516	613	-	Round light russet, high S.G, shatter
AC67560-1	440	440	-	Red skin, large, low S.G., scab
Lemhi	582	645	561	Attractive dark russet, susc. to pressure bruise
WC521-12	535	714	564	Round light russet, high S.G., shatter
Russet Burbank	480	563	489	Long russet, poor grade
WC672-2	-	593	716	Round flat russet, scab
AD7267-1	-	623	501	Oblong russet, low S.G., shatter
AD7377-1	-	552	669	Oblong dark russet, deep eyes, growth cracks, low S.G.
A72685-2	-	-	743	Oblong russet, good grade
A725452	-	-	697	Oblong light russet, I.N.
Norchip	-	-	503	Small, growth cracks, scab
AD74135-1	-	-	492	Oblong russet, low S.G., shatter
*AVG.	486	542	593	

*Average for all entries tested in year

[1] S.G. = specific gravity; I.N. = internal necrosis

CORN SILAGE AND GRAIN VARIETY PERFORMANCE

F. V. Pumphrey[1]

Corn variety tests for silage and grain yields were conducted in 1981 on the Hermiston Research and Extension Center. The varieties in 1981 were entered by the companies listed in Table 1. The trials were conducted to determine silage yield, grain yield, and moisture content at harvest. Desirable and undesirable characteristics were noted.

TESTING PROCEDURE

Soil of the test area was Ephrata sand; however, the soil survey presently in progress is designating the soil as Adkins fine sand. The previous crop was winter wheat which had been fertilized with nitrogen and phosphorus.

Minimum tillage was used; rows were precision marked using subsoiling shanks. Before planting, fertilizer at 450 pounds per acre of 10-20-10 was incorporated into each row with a narrow rototiller. A total of 300 pounds per acre of additional nitrogen was applied in three applications after plant emergence and before pollination of the corn.

The silage trial consisted of four hand-planted replications and the grain trial consisted of five replications. Individual plots were two rows wide and 15 feet long. Rows were spaced 36 inches apart.

The tests were planted April 30 and May 1. Germination, emergence, and early growing conditions were excellent. Loss of stand to rodents and birds, mainly pheasants, was minimal. Plant populations at harvest were 36,000 plants per acre for the silage trial and between 29,000 and 30,000 for the grain trial.

Irrigation water was applied as needed via sprinklers. During the greater part of the growing season, sprinkling occurred three times weekly. Approximately 1.8 inches were applied weekly from mid-June to late August. Atrazine was applied to control weeds.

Climatic conditions were favorable for corn production. No frosts occurred in the spring after the corn was planted or before the silage trial was harvested September 12-15. Light frosts had occurred before the grain trial was harvested October 18 and 19. No severe, adverse winds caused lodging before harvest.

The corn in the silage trial was cut, weighed, and subsampled immediately for dry matter. The subsamples were oven dried at 70 degrees C. The corn grain trial was picked and weighed, and grain samples were obtained for moisture determinations.

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Table 1. Companies contributing varieties to the 1981 Corn Performance Tests at the Research and Extension Center, Hermiston, Oregon

Brand	Company	Address
Cenex	Cenex	St. Paul, Minnesota 55164
SS, CX	Crookham Company	Caldwell, Idaho 83605
DeKalb	DeKalb	DeKalb, Illinois 60115
Ferry Morse	Ferry Morse Seed Co.	Modesto, California 95352
Funk	Germain's, Inc.	Fresno, California 93777
Greenway	Greenway Seed Co.	Nampa, Idaho 83651
K S	Keltgen Seed Co.	Olivia, Minnesota 56277
NC+	NC+	Lincoln, Nebraska 68501
PX	Northrup King	Bloomington, Minnesota 55420
Pioneer	Pioneer Hi-Bred International, Inc.	Des Moines, Iowa 50308
Pride	Pride Seed Co.	Glen Haven, Wisconsin 53810
Trojan	Trojan Seed Corn	Nye, Montana 59601

Grain Trial

Grain yields, moisture content of the grain at harvest, plant height, and ear height information is presented in Table 3. Most varieties produced excellent grain yields. All varieties were above 25 percent moisture which is an undesirable high moisture content for grain.

No lodging, dropped ears, insects, or diseases were noted. Many varieties were unnecessarily tall and had high ear height for grain corn. Such varieties often are lodged badly after one or more wind storms.

Table 3. Corn grain yield, moisture content, plant and ear height for varieties in the 1981 Grain Corn Test of the Research and Extension Center, Hermiston, Oregon

Company	Variety	Grain yield 15.5% moisture	Moisture at harvest	Plant height	Ear height[1]
		bushels per acre	percent	feet	feet
Cenex	2108	164	31.4	9.1	4.1
Cenex	2114	192	35.4	9.6	4.6
Cenex	2157	199	31.9	10.0	5.2
Cenex	2203	199	33.9	9.3	4.7
Crookham	SS70	218	35.9	10.1	5.1
Crookham	SS304	185	30.6	9.5	4.6
Crookham	SS305	174	31.3	9.6	4.4
Crookham	SS605	186	35.4	10.4	5.5
DeKalb	XL25A	195	30.5	9.2	4.2
DeKalb	55A	192	31.6	10.1	5.3
DeKalb	72AA	211	36.0	10.0	5.5
Ferry Morse	2006	190	31.8	8.5	4.0
Ferry Morse	2015	209	31.5	8.5	3.8
Ferry Morse	2080	214	35.3	9.7	4.7
Funk	G-4323	184	34.4	10.0	5.0
Funk	G-4430	200	33.0	9.9	5.6
Funk	G-4507	209	35.8	10.1	5.7
Greenway	GX57	199	31.9	8.3	3.7
Greenway	60	176	35.1	9.5	4.6
Greenway	66	205	36.3	9.7	5.4
Keltgen	KS101	190	26.5	8.8	4.2
Keltgen	KS103	177	31.7	9.4	4.6
Keltgen	KS104	181	31.5	8.8	4.1
Keltgen	KS106	205	32.5	9.4	4.6
NC+	4155	197	31.7	9.4	4.7
NC+	4710	192	36.0	9.6	4.6
Northrup King	PX39	204	30.5	9.8	4.9
Northrup King	PX72	232	35.8	10.1	5.8
Northrup King	PX74	229	35.6	10.1	5.4
Pioneer	3541	202	34.0	9.3	4.4
Pioneer	3732	203	32.3	9.3	4.9
Pioneer	3780	176	29.9	8.8	4.5
Pioneer	3901	196	31.3	9.3	4.5
Pride	5578	186	31.1	10.2	5.2
Pride	6678	192	33.0	10.2	5.4
Pride	7715	224	35.0	10.3	5.3
Trojan	TXS115A	214	36.5	10.2	5.2
Trojan	1100	193	35.4	9.1	4.1
5% LSD		16			
C.V. %		7			

[1] Ear height above 5 feet is undesirably high.

RESULTS

Silage Trial

Data on green forage weight, percent dry matter, and silage yield at 70 percent moisture are presented in Table 2. Most green forage yields were above 35 tons per acre. Most of the varieties were well dented at the time they were harvested; the percent dry matter of each variety was above 25 percent. Most of the varieties produced more than 35 tons per acre of 70 percent moisture silage.

Table 2. Green weight, dry matter, and silage yields for varieties in the 1981 Corn Silage Test at the Research and Extension Center, Hermiston, Oregon

Company	Variety	Green forage	Dry matter		Silage 70 percent moisture
		tons per acre	percent	tons per acre	tons per acre
Cenex	2124	38.2	29.3	11.2	37.3
Cenex	2371	36.6	26.4	9.7	32.3
Cenex	2380	38.6	26.7	10.3	34.3
Crookham	SS70	38.8	27.3	10.6	35.3
Crookham	605	38.8	28.0	10.9	36.2
DeKalb	72AA	39.4	27.1	10.7	35.6
DeKalb	442	32.7	27.3	8.9	29.7
DeKalb	640	41.8	27.8	11.6	38.7
Ferry Morse	FM493	39.9	26.4	10.5	35.1
Ferry Morse	FM2080	37.7	29.1	11.0	36.6
Ferry Morse	FM3020	42.4	25.8	10.9	36.5
Funk	G-4315	31.3	31.6	9.9	32.9
Funk	G-4430	38.0	27.1	10.3	34.4
Funk	G-4507	42.8	26.2	11.2	37.4
Greenway	GX72	38.5	28.8	11.1	37.0
Keltgen	KS103	31.5	29.3	9.2	30.7
Keltgen	KS104	24.8	32.8	8.1	27.1
Keltgen	KS106	34.9	29.8	10.4	34.7
NC+	85	38.2	26.7	10.2	34.0
NC+	8331	38.2	29.5	11.3	37.6
Northrup King	PX72	41.3	26.9	11.1	37.0
Northrup King	PX74	39.5	28.0	11.1	36.9
Pioneer	3183	43.4	28.4	12.3	41.1
Pioneer	3360	40.8	27.5	11.2	37.4
Pioneer	3369A	40.9	28.8	11.8	39.3
Pioneer	X5387	41.8	25.2	10.5	35.1
Pride	X2151	43.2	26.1	11.3	37.6
Pride	7715	39.7	25.9	10.3	34.3
Pride	8811	38.7	28.5	11.0	36.8
Trojan	TXS115A	39.6	27.7	11.0	36.5
Trojan	1100	32.3	29.5	9.5	31.7
5% LSD		2.9			
C.V. %		6.2			

NITROGEN FERTILITY STUDIES CONCERNING FULL SEASON POTATOES *(Solanum tuberosum L.)* IN NORTH CENTRAL OREGON

D.C. Hane and A.R. Mosley[1]

Commercial potato growers in North Central Oregon have been applying 500 to 600 pounds of nitrogen per acre to raise a full season crop of potatoes. Recommendations from Oregon State University and other research sources indicate that this amount of nitrogen is excessive. To reconcile these differences, investigations relating to the nitrogen needs of potatoes grown in the Hermiston area have been conducted for three consecutive years. Objectives and procedures changed slightly during the three years so each year's data are presented separately. Final conclusions are based on the three years of results.

IRRIGATION RATE BY NITROGEN FERTILITY

The objectives in 1979 were (1) estimate the nitrogen requirements for a full season potato crop grown in the Columbia Basin of North Central Oregon, (2) determine the effect of water application rates on nitrogen requirements and (3) evaluate petiole nitrate nitrogen levels as a method of determining the nitrogen needs of the growing crop throughout the season.

PROCEDURES

The experiment utilized a split-plot design with irrigation rates constituting main plot and fertilizer rates based on petiole nitrate levels as subplots. Irrigation rates were (1) low, 67 percent of evapotranspiration (ET), (2) normal, 100 percent of estimated ET, (3) high, 133 percent of estimated ET. Maintaining petiole levels of (1) 10,000 ppm, (2) 20,000 ppm, and (3) 30,000 ppm was the basis for determining the amount of nitrogen to apply. A check plot with no nitrogen applied was also monitored for petiole nitrate levels.

Water was applied three times a week through a solid set sprinkler irrigation system. Blanket application of water to all plots before potato emergence provided a uniform moisture level in the soil. The water variables were imposed on May 20, (approximate time of 100 percent emergence).

A soil test, taken before planting, showed less than 50 pounds of available nitrogen per acre in the top two feet of the soil profile. At planting, 100 pounds of phosphorus, 300 pounds of potash and 66 pounds of sulfur per acre were banded near the seed pieces.

'Russet Burbank' potatoes were planted on April 25 and petiole sampling was begun on May 30 (five-to seven-leaf stage). Petiole samples were picked

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every seven days through the growing season and analyzed for nitrate nitrogen by a commercial laboratory.

Potato vines were chemically killed on September 13. Plots were harvested on October 3. All tubers were graded to determine total yield, yield of No. 1 and No. 2 tubers, culls, undersized and specific gravity.

RESULTS AND DISCUSSION

Water, 18.4, 27.3, and 36.3 inches, was applied in the low, medium, and high irrigation levels. Maximum tuber yield was where 27.3 inches of water (100 percent of estimated ET) were applied (Figure 1). The low irrigation rate had less yield than the high irrigation rate.

Maintaining petiole nitrate levels of 10,000, 20,000, and 30,000 ppm required a total of 160, 410, and 690 pounds of nitrogen (N) per acre, respectively. One-hundred pounds of the 690 pounds of N applied to the 30,000 ppm plots was put on at planting. The check plot received no nitrogen. Yield was increased by the addition of 160 pounds of nitrogen per acre and was further increased by 410 pounds of nitrogen per acre (Figure 2). Applying 690 pounds of nitrogen per acre did not increase yield above the yield produced where 410 pounds were applied. Quality, as indicated by yield of No. 1 tubers, was improved at 410 pounds of nitrogen per acre but was substantially reduced at 690 pounds per acre.

There was no significant interaction between fertility and irrigation indicating that, at least in this study, nitrogen fertility and irrigation acted independently of each other.

Petiole nitrate levels varied quite radically throughout the growing season (Figure 3). Though the actual levels of nitrate nitrogen in the petioles were not maintained at the desired levels, the actual positions of the treatments were in perspective. Initial petiole levels were lower than desired for the two higher nitrogen treatments even though the 30,000 ppm treatment received 100 pounds of nitrogen per acre at planting.

The 1979 data suggest water application be applied at or slightly above estimated ET to 'Russet Burbank' potatoes since too little water appeared to be more detrimental than high irrigation rates.

These 1979 data indicate that 400 pounds of nitrogen per acre is sufficient to raise a full season crop of 'Russet Burbank' potatoes. Since the trial was planted somewhat late and overall yields were relatively low, additional refinement requires further study.

The petiole results indicate several things. Some preseason nitrogen is beneficial in developing early plant growth and providing a reserve for the rapid initial growth. An expected or reference petiole nitrate curve could and should be developed for a particular nitrogen program. Petiole nitrate levels are being used to evaluate the relative fertility status of a potato crop but these data indicate this tool should be used with some caution and with backup information such as soil tests.

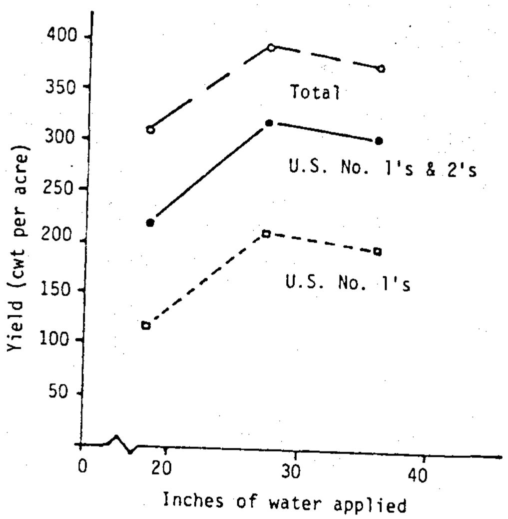

Figure 1. The effect of irrigation rates on the yield of 'Russet Burbank' potatoes, Hermiston, Oregon, 1979

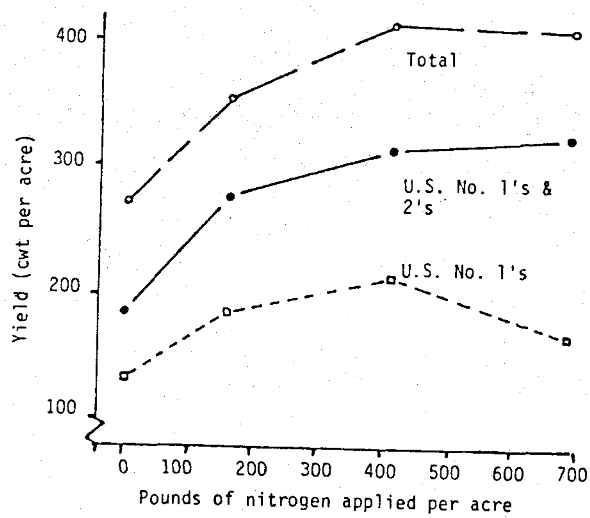

Figure 2. The effect of nitrogen fertility on yield of 'Russet Burbank' potatoes, Hermiston, Oregon, 1979

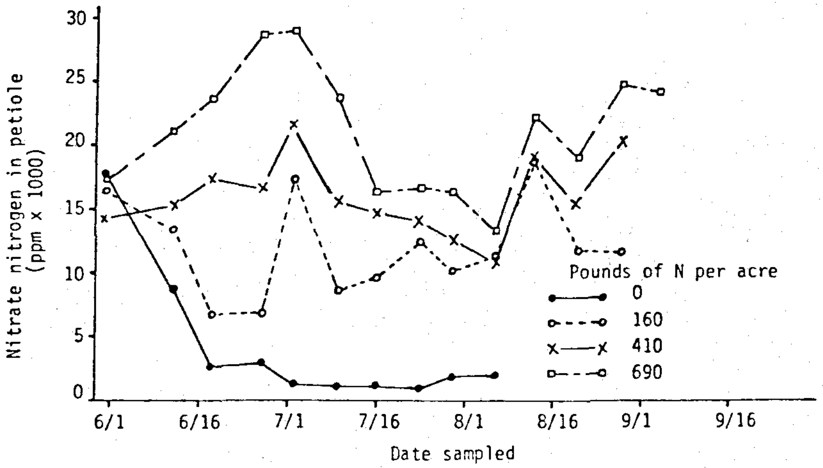

Figure 3. The effect of nitrogen fertility on nitrate levels in potato petioles, Hermiston, Oregon, 1979

NITROGEN FERTILITY WITH RUSSET BURBANK POTATOES

The nitrogen fertility trial in 1980 consisted of a randomized block design with four nitrogen fertility levels and four replications. Petiole nitrate levels were used as a guide for applying four nitrogen rates. Petiole nitrate levels were set at 15,000, 20,000, 25,000, and 30,000 ppm of nitrate nitrogen. The 25,000 and 30,000 ppm levels received 50 and 100 pounds of nitrogen per acre, respectively, just before planting. A soil test indicated less than 50 pounds of available nitrogen in the top two feet of the profile.

'Russet Burbank' potatoes were planted on April 11. Petiole sampling was begun on May 21 (5- to 7-leaf stage) and continued weekly through September 15. Application of nitrogen fertilizer was based on petiole nitrate levels with respect to the standards of 15,000, 20,000, 25,000, and 30,000 ppm.

Potato vines were chemically killed on September 22 and plots were harvested on October 2. Yield and grade information was then obtained for each plot.

RESULTS AND DISCUSSION

The 15,000, 20,000, 25,000, and 30,000 ppm treatments received 295, 405, 535, and 710 pounds of nitrogen per acre, respectively. Yield responses to nitrogen rates are shown in Figure 4. Increasing rates of nitrogen above 295 pounds per acre resulted in lower yields. No. 1 tuber yields were variable and the differences were not significant. The data indicate that reasonable yield potentials can be obtained with less than 350 pounds of nitrogen per acre.

Figure 5 shows another problem associated with high rates of nitrogen. Percent hollow heart and brown center in U.S. No. 1 tubers increased from eight percent at 295 pounds of nitrogen per acre to 21 percent at 710 pounds of nitrogen per acre. Further, specific gravity decreased at the two higher rates of nitrogen (Table 1). Tuber size tended to be smaller at the high rate of nitrogen, possibly because of delayed tuber set which would decrease the time for tuber growth.

The data in Figure 6 show that petiole nitrate levels were quite variable fro week to week. Precise petiole levels were difficult to maintain but respective positions of treatments were good. The petiole nitrate levels obtained with 295 pounds of nitrogen per acre are less than levels presently considered necessary for optimum potato yields but this was the best yielding treatment.

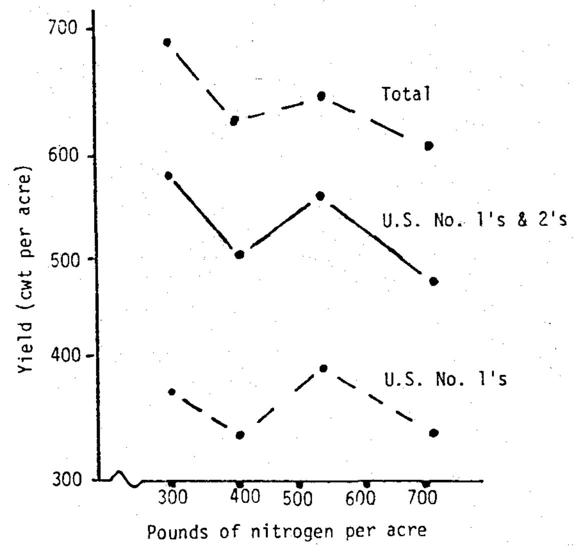

Figure 4. The effect of nitrogen fertility on yield of 'Russet Burbank' potatoes, Hermiston, Oregon, 1980

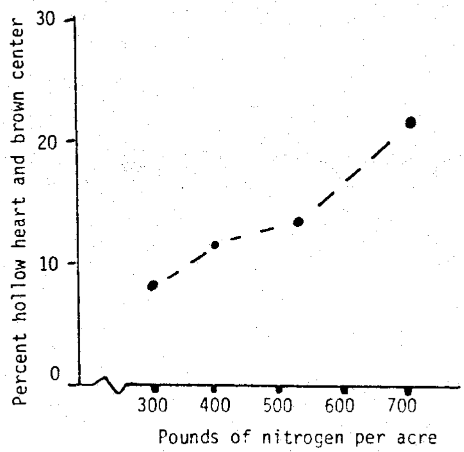

Figure 5. The effect of nitrogen fertility on percent hollow heart and brown center in 'Russet Burbank' potatoes, Hermiston, Oregon 1980

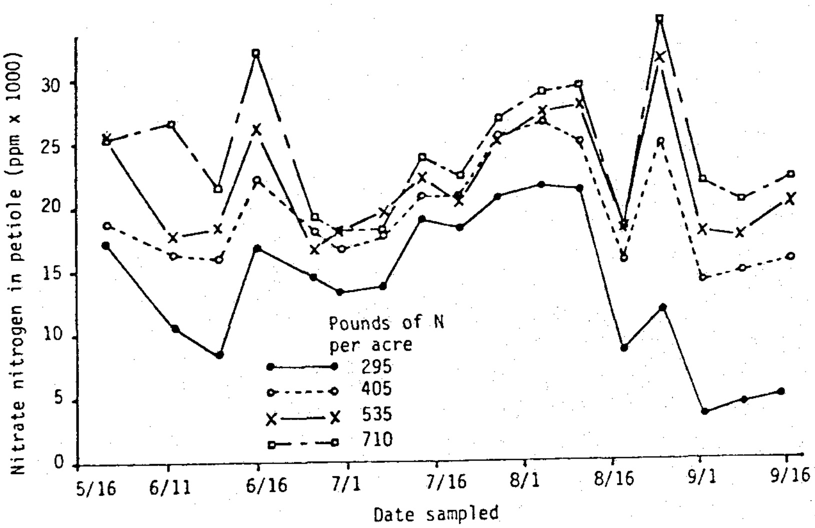

Figure 6. The effect of nitrogen fertility on nitrate levels in potato petioles, Hermiston, Oregon, 1980

Table 1. Total yield, yield and percent U.S. No. 1 and No. 2 grade potatoes, specific gravity and average tuber weight of R.B. potatoes grown at four levels of nitrogen fertility at the Columbia Basin Agricultural Research Center, Hermiston, Oregon, 1980

Nitrogen applied	Total yield	U.S. No. 1's		U.S. 2's	Specific gravity	Average tuber weight
pounds per acre	cwt per acre	cwt per acre	percent	percent		ounces
295	693	371	54	31	1.086	12.2
535	651	390	60	24	1.082	13.0
405	629	339	54	26	1.086	13.4
710	607	338	56	23	1.081	11.3
LSD	56	64			0.003	

VARIETY BY NITROGEN FERTILITY

Data from the 1979 and the 1980 trials reported in this paper indicate that 300 to 400 pounds of nitrogen per acre is the most effective for growing 'Russet Burbank' potatoes in the Hermiston, Oregon, area. Thus, the 1981 trial was designed to further study the 300 to 400 pounds of nitrogen application rates by varying the time of applications on 'Russet Burbank' and 'Lemhi' potatoes.

PROCEDURES

Four nitrogen rates as main plots and two potato varieties as subplots were studied in a split plot design. Treatments 1, 2, and 3 received 100 pounds of nitrogen per acre banded at planting and an additional 125, 215, and 300 pounds of nitrogen per acre, respectively, during the growing season. Treatment 4 received 300 pounds of nitrogen per acre broadcast and incorporated just before planting and an additional 100 pounds of nitrogen per acre was banded at planting. A crop growth curve guided the application of nitrogen during the growing season. Petiole nitrate levels were measured weekly.

RESULTS AND DISCUSSION

Differences between varieties at Treatments 1 and 2 were significant with regard to yield of U.S. No. 1 and No. 2 tubers (Figure 7). Fertility treatments did not differ statistically in terms of yield. Four hundred pounds of nitrogen per acre generally produced the best yields with both varieties regardless of application techniques; 225 pounds of nitrogen per acre was not sufficient for adequate yields. 'Lemhi' did respond well to the 325 pounds of nitrogen per acre, whereas, 'Russet Burbank' did not improve in yield until 400 pounds of nitrogen per acre were applied. These data indicate 'Lemhi' might require less nitrogen for optimum growth than 'Russet Burbank'.

Internal quality varied dramatically between varieties (Figures 8 and 9). 'Russet Burbank' was severely susceptible to internal brown spot (IBS), with 14 percent to 21 percent of the tubers affected. Internal defects greater than five percent result in price reductions. 'Lemhi' was much less susceptible to IBS, showing zero to three percent affected. There appears to be no difference in IBS in relation to the nitrogen rates studied. Percent hollow heart and brown center was nearly the same for both varieties and did not significantly change with nitrogen treatments.

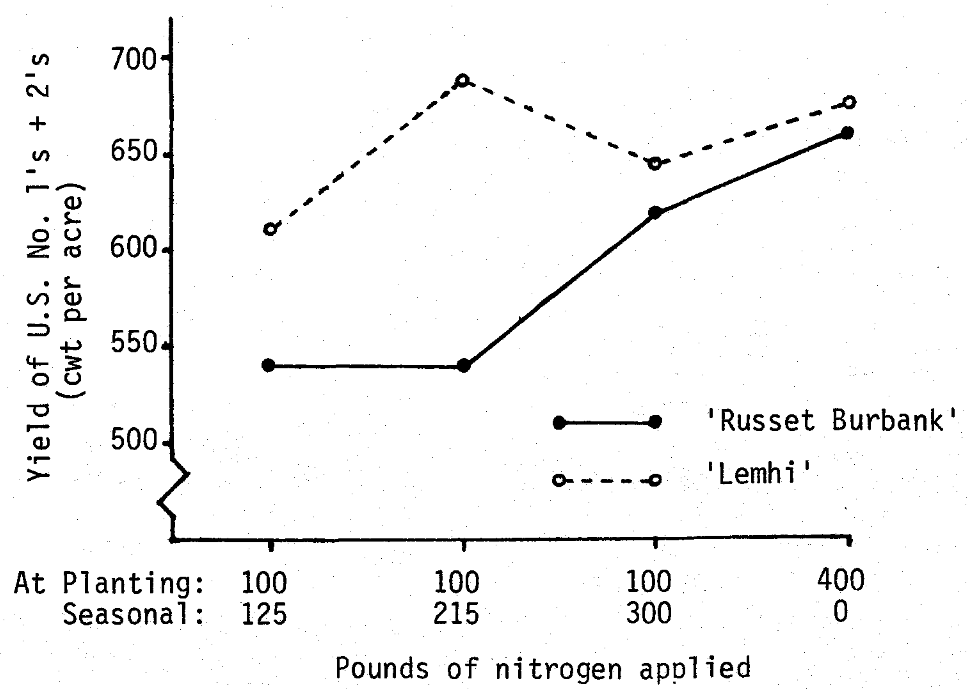

Figure 7. The effects of nitrogen fertility on yield of 'Russet Burbank' and 'Lemhi' potatoes, Hermiston, Oregon, 1981

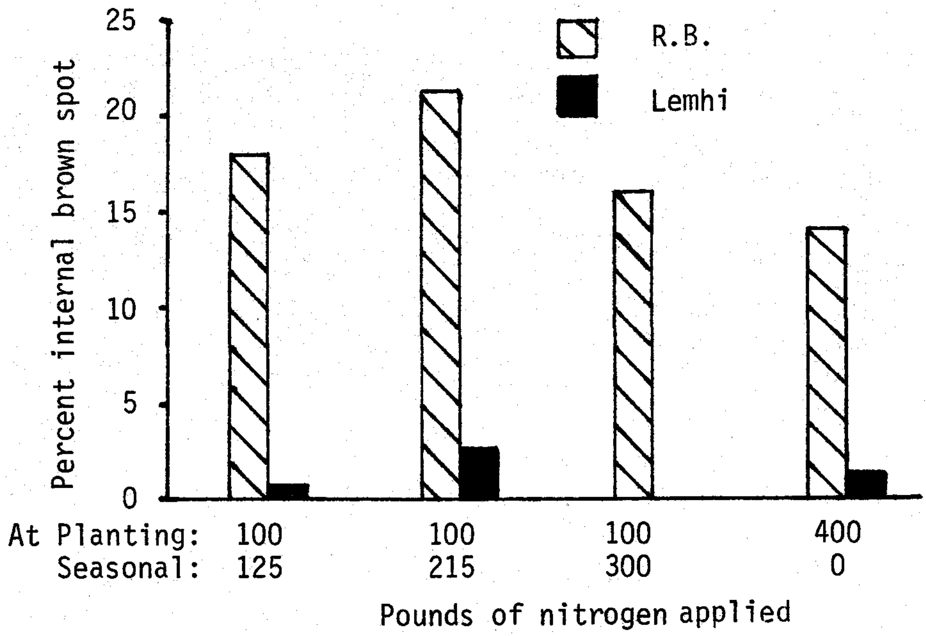

Figure 8. The effect of nitrogen fertility on internal brown spot of 'Russet Burbank' and 'Lemhi' potatoes, Hermiston, Oregon, 1981

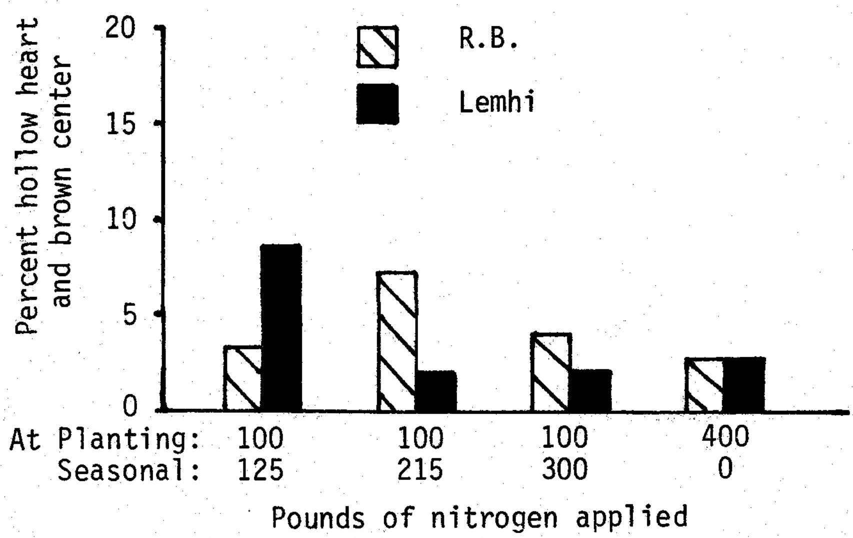

Figure 9. The effect of nitrogen fertility on hollow heart and brown center of 'Russet Burbank' and 'Lemhi' potatoes, Hermiston Oregon, 1981

Petiole nitrate, which initially was more than 24,000 ppm, dropped rapidly during early growth (Figure 10). Applications of 300 pounds of nitrogen per acre during the growing season maintained the nitrate level in the petioles several thousand ppm higher than did applying all the nitrogen preplant. The higher nitrate levels were not accompanied by higher tuber yields. Even though the nitrate concentration in petioles was less than 10,000 ppm during the middle part of the growing season where all the nitrogen was applied preplant, tuber yield was more than 30 tons per acre. The petiole nitrate levels that developed from the different rates and time of nitrogen application indicate a need for knowing what kind of nitrate curve to expect during the growing season for a given nitrogen management practice.

Petiole nitrate patterns were similar for the two varieties.

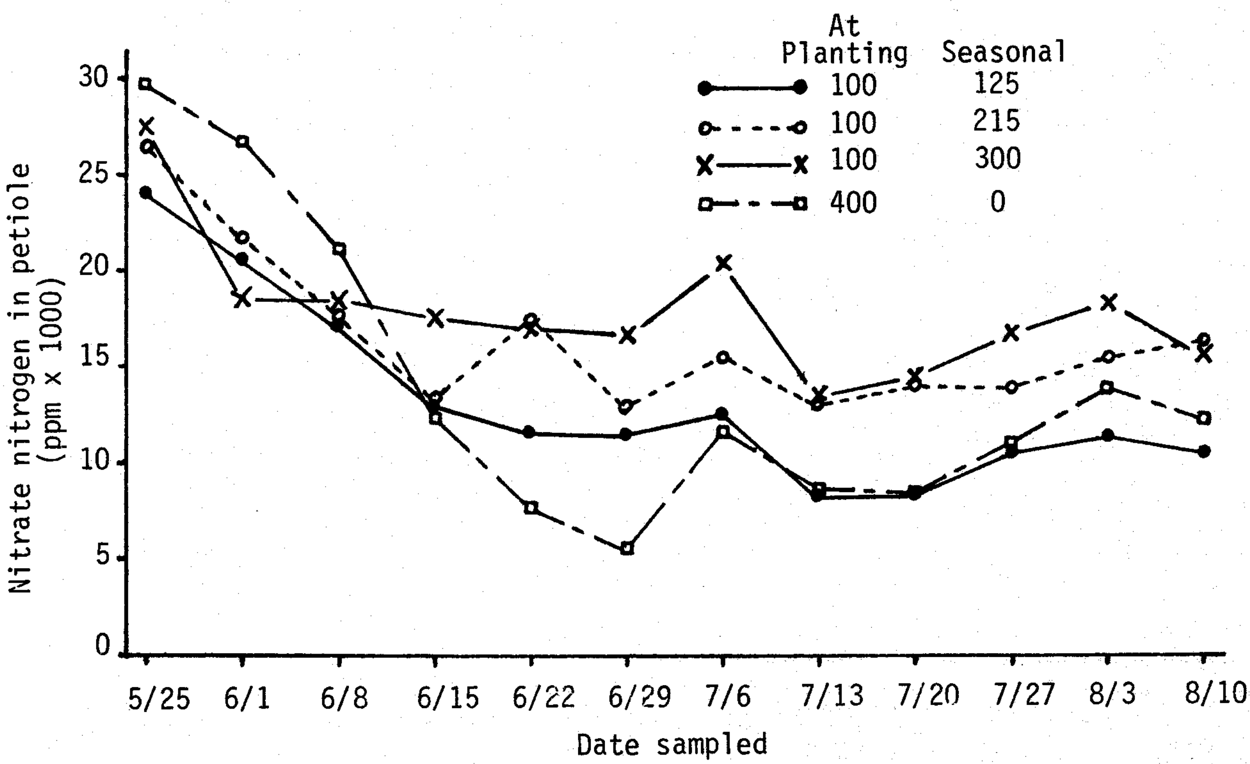

Figure 10. Petiole nitrate levels as affected by nitrogen fertility Hermiston, Oregon, 1981

CONCLUSIONS

Several points are evident from these data: (1) optimum production for a full season crop of potatoes in the lower Columbia Basin required 300 to 400 pounds of nitrogen per acre, (2) both preplant and banded nitrogen benefited yield, (3) hollow heart and brown center problems increased with increasing amounts of nitrogen, (4) tuber size and specific gravity were lowered by high rates of nitrogen, (5) petiole nitrate levels were affected by both the amount of nitrogen applied and the method applied, (6) petiole nitrate levels of 15,000 to 20,000 ppm during most of the growing season can produce tuber yields of 30 or more tons per acre, (7) petiole nitrate levels were higly variable and recommended levels did not always coincide with best yields and quality.

IRRIGATED WINTER WHEAT RESPONSE TO NITROGEN, SULFUR, AND PHOSPHORUS PLUS POTASSIUM FERTILIZATION IN NORTHEASTERN OREGON

F. V. Pumphrey and P. E. Rasmussen[1]

Irrigated winter wheat *(Triticum aestivum L.)* response to sulfur (S) and phosphorus (P) plus potassium (K) was evaluated from 1978 to 1981 as a part of many fertility experiments in Morrow, Umatilla, and Union Counties. Grain yield and soil test values for P and K were determined in all experiments and straw yield, plant height, and head density in some of the experiments.

PROCEDURES

Soil samples (0 to 12 and 12- to 24-inch depths) were taken before fall application of fertilizers and analyzed by the Oregon State University soil testing laboratory. All S, P, and K fertilizers were incorporated before seeding. 'Stephens' soft white winter wheat was grown in most of the experiments; 'Daws' was grown in the remainder. Irrigation was by either center pivot or wheel line and ranged in sufficiency from partial to complete elimination of moisture stress.

Three treatments in the 17 P + K experiments were: (1) no fertilizer applied, (2) 75 to 100 pounds of N per acre (as ammonium sulfate) broadcast in the fall before planting and 75 to 100 pounds of N (as ammonium nitrate) broadcast in the spring during tillering, and (3) same as number (2) application plus 22 pounds P (50 lbs P_2O_5) and 42 pounds K (50 pounds K_2O) per acre broadcast before planting.

Two experiments evaluated sulfur and phosphorus response in irrigated winter wheat. Four treatments in these experiments were: (1) no S or P, (2) S at 20 pounds per acre, (3) S at 20 pounds plus P at 11 pounds (25 lbs P_2O_5) per acre banded, and (4) S at 20 pounds plus P at 22 pounds (50 pounds P_2O_5) per acre broadcast. Sulfur and phosphorus in Treatment 3 were banded with the seed at planting. The effects of dates of planting were compared in one experiment and the timing of N application in the other experiment.

RESULTS

Six of the 19 experimental sites had 8 to 12 parts per million (ppm) available P in the top 12 inches of soil, six had 13 to 20 ppm, and the remainder had from 21 to 50 ppm (Table 1). Most of the sites had lower available P in the second than in the first foot of soil; nine had less than 8 ppm.

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Two soils had less than 200 ppm K, and four soils had between 200 and 250 ppm K in the top foot of soil. Four soils contained less than 200 ppm K in the second foot. Soil P and K levels in the top foot of soils were only weakly correlated ($r^2 = 0.36$). The sandy soils in Morrow and Umatilla Counties generally had much lower availble P and K than the finer textured soils in Union County. With one exception, the pH of the top foot of soil ranged between 6.0 and 7.5.

Significant grain yield increases to P plus K fertilization were obtained in only two experiments, H-78 and C-80 (Table 2). These sites had 11 and 12 ppm P and 228 and 211 ppm K, respectively, in the top foot of soil. Other sites with similar levels of P and K (C-78, F-78, E-80), however, did not show yield increases from P + K application. In all experiments, N application significantl increased grain yield. Average yield without N fertilization was 62 bushels per acre; with N fertilization the average yield was 101 bushels.

In several experiments, N-P-K application increased straw yield and head production over application of N alone without increasing grain yield (Table 2). In the experiments where straw yield was measured, an average of 91 pounds of straw produced one bushel of grain where the wheat received optimum N application. Non-fertilized wheat produced one bushel for 92 pounds of straw which indicates the capability of semidwarf soft winter wheats (primarily 'Stephens') to efficiently use N fertilization to produce additional grain.

Irrigated winter wheat did not respond to P at two sites in 1981 (Table 3) even though soil available P levels were less than 12 ppm (Table 1). Neither of the sites had received S or P application in the four previous crop years. At the A-81 site, S application increased grain yield of wheat seeded October 1 about 5 bushels per acre. Sulfur application appeared to increase grain yield of wheat seeded three weeks later (October 21) by five bushels per acre; however, grain yields from this seeding date were so variable that it was questionable as to whether this was a meaningful increase. The later seeding yielded nearly nine bushels per acre less than the earlier seeding. The October 1 and October 21 seeding dates averaged 91 and 82 pounds of straw per bushel of grain produced, respectively. Winter wheat at the B-81 site did not respond to S or P application. Applying most (93 percent) of the N in the spring increased yield about 13 bushels per acre above yields from application of 90 percent of the N in the fall before planting. Different timing of N application did not produce S or P responses.

Semidwarf wheats such as 'Stephens' have considerable ability in tillering capacity, kernels per head, and kernel size to compensate for some adverse conditions. For instance, in Experiment B-79, 'Stephens' suffered severe winter killing and reduction in heads producted (Table 2). In spite of the low number of heads and straw production, grain yields were nearly normal; 65 pounds of straw produced a bushel of wheat. In Experiment A-81, although fall stand establishment of the October 1 seeding was 30 percent less because of seed damage by insects than the October 21 seeding, head production was eight percent greater (Table 4) and grain yield was seven percent higher (Table 3). Treatments with lower stand and tiller density had higher head yield resulting in nearly identical grain yields.

Table 1. Location, soil texture, and soil test P, K, and pH values for experiment sites in Northeast Oregon, 1978-1981

Experiment		Extractable P		Exchangeable K		pH		Soil texture[2]
Identification	Location[1]	0-12	12-24	0-12	12-24	0-12	12-24	0-12
number	county	ppm		ppm				
A-78	UN	31	7	960	476	6.2	6.8	sil
B-78	UN	49	14	600	510	6.2	6.2	vfsl
C-78	UMA	14	5	256	232	6.6	7.8	fsl
D-78	UMA	15	6	320	268	6.8	7.5	fsl
E-78	MO	16	5	186	286	6.2	7.5	sil
F-78	MO	10	6	286	280	6.6	7.2	sil
G-78	UMA	19	4	320	192	7.5	8.0	fsl
H-78	UMA	11	6	228	232	7.2	6.7	ls
A-79	UN	32	20	536	421	6.3	7.1	sil
B-79	UMA	23	11	226	281	6.6	7.8	fsl
A-80	UN	24	26	534	367	6.0	6.6	sil
B-80	UN	26	21	659	367	6.4	7.0	sil
C-80	UMA	12	26	211	168	6.7	7.7	ls
D-80	UMA	16	20	234	211	6.9	7.2	fsl
E-80	UMA	8	18	273	296	6.9	7.9	sl
F-80	UMA	42	16	324	168	6.6	8.6	fsl
G-80	UMA	17	14	168	101	8.6	8.9	fsl
A-81	UMA	8	3	-	-	-	-	ls
B-81	UMA	10	5	-	-	-	-	vfsl

[1]County location: UN = Union, UMA = Umatilla, MO = Morrow

[2]Soil texture: sil = silt loam, vfsl = very fine sandy loam, fsl = fine sandy loam, ls = loamy sand, sl = sandy loam.

Table 2. Grain, straw, and head response of irrigated winter wheat to nitrogen and phosphorus plus potassium at 17 sites in northeastern Oregon, 1978 to 1980

Experiment	Grain yield			Straw yield			Heads		
	None[1]	N[1]	N-P-K[1]	None	N	N-P-K	None	N	N-P-K
number	bushels per acre			cwt per acre			number per square foot		
A-78	66	85	84	-	-	-	-	-	-
B-78	56	84	85	-	-	-	-	-	-
C-78	53	92	91	50	81	79	30	46	47
D-78	63	97	97	65	108	101	33	51	58
E-78	61	104	105	44	99	95	30	53	50
F-78	61	101	100	59	108	108	34	54	70
G-78	42	85	91	-	-	-	-	-	-
H-78	49	98	103*	51	99	106	29	53	59
A-79	71	135	129	60	105	105	30	43	47
B-79	40	92	90	26	60	59	13	22	22
A-80	109	130	134	140	154	-	-	-	-
B-80	84	124	123	-	-	-	-	-	-
C-80	48	96	107*	45	83	93	33	52	55
D-80	42	96	92	28	59	60	22	36	38
E-80	63	98	96	48	93	94	-	-	-
F-80	90	110	104	70	89	95	39	49	54
G-80	56	85	82	-	-	-	-	-	-

[1]None = no fertilizer; N = 75 to 100 N per acre before planting plus 75 to 100 N in the spring during tillering; N-P-K = 75 to 100 N per acre before planting plus 75 to 100 N in the spring during tillering plus 22 pounds P (50 pounds P_2O_5) and 42 pounds K (50 pounds K_2O) per acre broadcast before planting.

*Significant grain yield difference between N and N-P-K treatment.

Table 3. Grain yield response by irrigated winter wheat to sulfur and phosphorus at two sites in northeastern Oregon, 1981

Fertilizer applied[1]		Hermiston (A-81) Seeding date		Echo (B-81) Time of N application[2]	
Sulfur	Phosphorus	Oct 1	Oct 21	180F-20S	15F-185S
pounds per acre		grain yield in bushels per acre			
0	0	129	123	83	95
20[a]	0	134	128	83	98
20[a]	11[a]	138	124	85	96
20[a]	22[b]	138	128	81	96
STATISTICAL EVALUATION OF YIELD RESPONSE[3]					
Sulfur application		*	ns	ns	ns
Phosphorus application		ns	ns	ns	ns

[1]Fertilizer applied: a = banded with seed, b = broadcast and incorporated before seeding.

[2]Time of N application: F = Fall, S = Spring; rates in lbs/acre.

[3]Statistical evaluation: * = significant difference at P = 0.05, ns = not significantly different.

Table 4. Effect of sulfur and phosphorus application on fall stand, head production, and head yield of irrigated winter wheat (Experiment A-81)

Fertilizer applied[1]		Plants Seeding date		Heads Seeding date		Head yield Seeding date	
Sulfur	Phosphorus	Oct 1	Oct 21	Oct 1	Oct 21	Oct 1	Oct 21
pounds per acre		number per square foot				grams per head	
0	0	9.6	13.6	45	43	1.8	1.8
20[a]	0	8.9	12.8	43	39	2.0	2.1
20[a]	11[a]	9.0	12.3	44	34	2.0	2.3
20[a]	22[b]	8.5	13.0	40	42	2.2	1.9
STATISTICAL EVALUATION OF RESPONSE[2]							
Sulfur application		ns	ns	ns	ns	*	*
Phosphorus application		ns	ns	ns	ns	ns	ns

[1]Fertilizer applied: a = banded with seed, b = broadcast and incorporated before seeding

[2]Statistical evaluation: * = significant difference at P = 0.05, ns = no significant difference

CONCLUSIONS

Serious deficiencies of phosphorus and potassium for grain production do not exist in irrigated fields in northern Morrow, western Umatilla, and the central part of Union Counties. Small yield increases may be obtained from P and/or K fertilization where soil tests indicate less than 12 ppm P or 200 ppm K and growing conditions are favorable for producing more than 100 bushels of grain per acre.

Banding phosphorus and/or potassium fertilizers with or near the seed at planting time reduces the amount needed to be applied compared to broadcasting and incorporating the fertilizer preplant or applying these elements after the wheat has been planted. The rate of N plus K banded with the seed should not exceed 25 pounds per acre. Nitrogen and potassium fertilizers close to the seed in dry soil readily injure germinating seed. On the sandy soils, phosphorus and/or potassium applied to other crops in the rotation will probably be of more value than applying these elements to winter wheat.

WATER CONSUMPTION OF FREQUENTLY IRRIGATED WINTER WHEAT IN NORTH CENTRAL OREGON

F. V. Pumphrey, D. C. Hane and Earl M. Bates[1]

Water evaporation from a standard open pan is used to measure the evaporative potential of the environment in which plants live. Water consumed by a crop plus that evaporated from the soil as the crop grows have been related to pan evaporation to provide guidelines in scheduling irrigation water. The term coefficient of evapotranspiration is used to express their relationship.

Research has shown that the coefficient of evapotranspiration is not a constant throughout the growing season. Plant growth and physiological activity change during the growing season as do climatic factors such as temperature, wind, and humidity. Coefficients of evapotranspiration and seasonal water use curves for a crop are similar, but not constant, between geographical areas primarily because of differences in climate. Irrigated research at the Columbia Basin Agricultural Research and Extension Center has been directed toward developing coefficients of evapotranspiration. The coefficients of evapotranspiration for soft winter wheat (*Triticum aestivum* L.) have been associated with wheat growth stages as an aid to the utilization of the information by producers, consultants, and the Extension Service.

MATERIALS AND METHODS

Water was applied with sprinklers at rates varying from 140 percent down to 20 percent of the estimated water requirements for optimum wheat yields. Water applied was measured using catch cans maintained at the height of the growing wheat. Water in the catch cans was measured immediately after each irrigation. Irrigations were applied three times each week during most of the growing season. Twenty-six irrigations were applied in 1980 and 32 irrigations in 1981.

The soil on the Research Center is a loamy sand which holds 6.2 inches of available water in the upper four feet. Moisture content of the soil was determined each week using a neutron probe. The surface foot of soil was near field capacity and the next three feet were at field capacity during early spring tillering which was the time each experiment was started.

Precipitation and water evaporation from a standard Weather Service Class A evaporation pan were measured and recorded daily. These instruments were in a recommended Weather Service climate measuring station about 500 yards from the experiments.

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Water use (evapotranspiration, also referred to as consumptive use) by the wheat crop was considered to be the water used by the wheat in transpiration plus water evaporated from the soil. The equation ET = L+P+I (1) was used to sum the irrigation water applied, precipitation, and addition or loss of moisture in the upper four feet of soil.

$$ET = L+P+I \tag{1}$$

Where ET = weekly evapotranspiration

L = weekly change in soil moisture, 0-4 feet

P = precipitation during the week

I = irrigation water applied during the week

Weekly coefficients of evapotranspiration were calculated as the ratio of evapotranspiration to pan evaporation (Equation 2).

$$C = \frac{ET}{EP} \tag{2}$$

Where C = weekly coefficient of evapotranspiration

ET = weekly evapotranspiration

EP = weekly pan evaporation

Linear regression was used to associate grain yield response to water used by the wheat crop in evapotranspiration.

RESULTS AND DISCUSSION

Water available to the wheat crop Precipitation occurring from the start of spring growth to maturity was 2.5 inches in 1980 and 4.1 inches in 1981. Each year more than half the precipitation occurred between heading and hard dough growth stages. Temperatures each year were more favorable than normal for wheat production.

Irrigation water applied during the growing season varied from less than one-half inch at the outer edge of the distribution pattern to 22 inches adjacent to the sprinklers. The sum of water available to the wheat at the outer edge was less than 11 inches (6.2 from the soil + 2.5 or 4.1 inches precipitation in 1980 and 1981, respectively, + 0.5 inch irrigation water). Wheat in this area was moisture stressed and matured before all the moisture in the 3- to 4-foot soil depth was extracted. Also, the stressed wheat was too mature to utilize the later precipitation which was utilized by later maturing wheat.

Wheat, growing where the subsoil moisture was gradually depleted and the surface soil moisture was depleted as the grain matured, used 19 inches of water in evapotranspiration (approximately 5 inches from the soil + 2.5 or 4.1 inches precipitation + 9 to 11 inches irrigation water). As the amount of irrigation applied increased over 9 to 11 inches, the amount of water remaining in the soil after the wheat matured increased.

Grain yield and water consumption Grain yields increased steadily until appproximately 19 inches of water was consumed in evapotranspiration (Figure 1). Grain yields increased at the rate of 7.5 bushels per acre per inch of water consumed until yields of 135 to 140 bushels per acre were produced. Above this yield each additional inch of water increased grain yield only 0.8 bushels per acre. No reason is apparent as to why yields above 135 to 140 did not continue to increase at the rate of 7.5 bushels per inch of water.

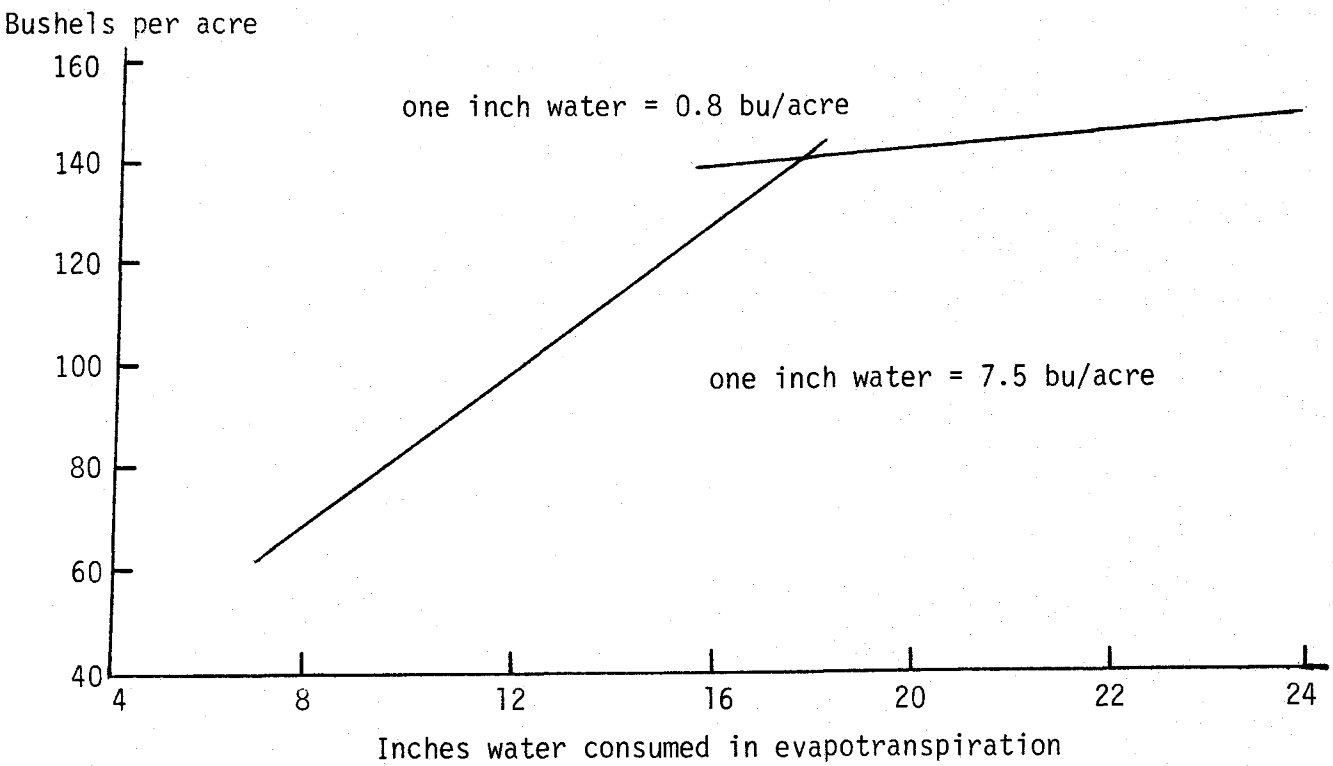

Figure 1. Inches water from irrigation water applied, precipitation, and soil moisture used (evapotranspiration) by frequently irrigated wheat to produce various grain yields. Columbia Basin Agricultural Research and Extension Center, Hermiston, Oregon. 1980 and 1981.

Evapotranspiration and pan evaporation Optimum wheat yields were 135 to 140 bushels per acre (Figure 1). Daily evapotranspiration of wheat producing optimum yields increased with increasing leaf area and plant physiological activity (Figure 2). Water use decreased rapidly after early dough growth stage. Water use was approximately 6 inches in May and 6 inches in June or an average of 0.2 inch per day. During June, average daily pan evaporation was 0.25 inch.

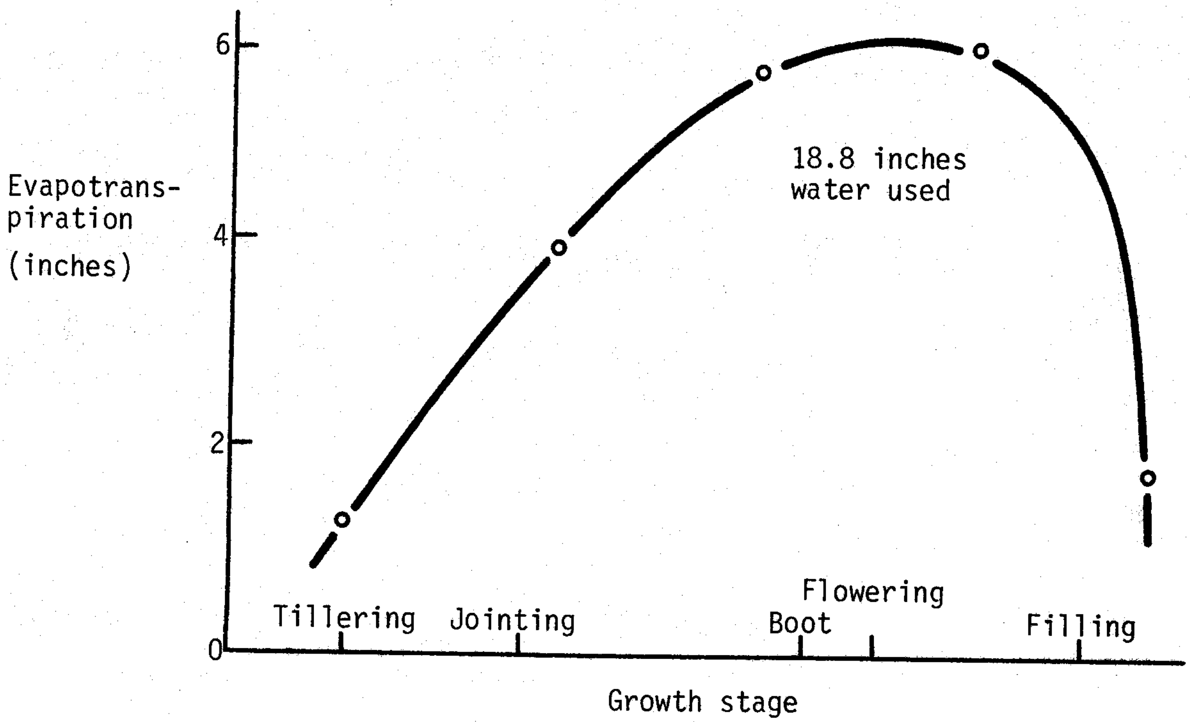

Figure 2. Water used by the wheat plant and evaporated from the soil (consumptive use) to produce a wheat crop of 100 or more bushels per acre.

Coefficient of evapotranspiration at the start of spring growth was 0.53 which means water use was about half of pan evaporation (Table 1). From boot through early dough, the wheat crop used 0.8 to 0.9 as much water as evaporated from a pan. As the kernels matured, the weekly coefficients of evapotranspiration dropped rapidly. The great change in the coefficients during the growing season requires that the coefficient used should be in accordance with the growth stage of the crop to obtain a reasonably accurate estimate of how much water to apply.

Calculating water to apply The irrigator, after obtaining daily pan evaporation, uses the coefficients as follows:

Step 1 pan evaporation X coefficient for growth stage of crop = water consumed by crop

Step 2 $\frac{\text{water consumed by crop}}{\text{efficiency of irrigation system}} = \text{water to apply}$

Water to apply can be calculated daily or for how many days that are included in the pan evaporation.

Table 1. Coefficient of evapotranspiration and growth stages of frequently irrigated winter wheat. Columbia Basin Agricultural Research and Extension Center, Hermiston, Oregon

Coefficient of evapotranspiration	Growth stage	Coefficient of evapotranspiration	Growth stage
0.53	early tillering	0.93	flowering
0.66		0.86	
0.70		0.83	
0.59	late tillering	0.80	early dough
0.61		0.81	
0.65	jointing	0.68	hard dough
0.75		0.44	
0.84	boot	0.31	kernels firm
0.88	head emergence		

CONCLUSIONS

The wheat crop not suffering from moisture stress uses less than 0.1 inch of water per day during early tillering. Daily water consumption increases gradually to more than 0.2 inch per day during head emergence, flowering, and early filling. Water use decreases rapidly after the soft dough stage of growth.

Over irrigation of winter wheat is most likely to occur during tillering and during the later stages of kernel maturity because little water is used during these growth stages. During the growth stages from boot through soft dough and with average weather, over irrigation is nearly impossible with pivot systems designed to apply 0.3 to 0.35 inches daily.

The use of daily pan evaporation information and coefficients of evapotranspiration for the various growth stages provides a method of estimating water use. Information needed is daily pan evaporation, growth stage of the crop, coefficient of evapotranspiration for each growth stage, and efficiency of the irrigation system. Periodically, weekly or once in two weeks, the soil should be examined to verify agreement between the water applied and water consumed by the wheat crop.

VAPAM APPLIED THROUGH CENTER PIVOT AND WHEEL LINE IRRIGATION TO CONTROL "EARLY DYING" DISEASE OF POTATOES CAUSED BY *Verticillium dahliae*

Mary L. Powelson[1]

Potato *(Solanum tuberosum* L.*)* vines may die several weeks prematurely when moisture and fertilizer conditions still favor continuous growth. This syndrome, called "early dying" disease, occurs in many potato-growing regions around the world and is especially important in the arid, irrigated regions of the western United States.

Verticillium dahliae Kleb., a soilborne fungus, is considered to be the primary fungal pathogen associated with the "early dying" disease in the irrigated circles of the Columbia Basin. Though other pathogens, notably *Colletotrichum atramentarium* (Berk and Br.) Taub., *Fusarium* spp., *Erwinia carotovora* (Jones) Holland, have been implicated, their role in the "early dying" disease syndrome has not been resolved.

Generally, "early dying" disease caused by *V. dahliae* becomes a yield-limiting factor on land where potatoes have been produced for several years. Yield reductions of up to 40 percent have been reported for this disease in the Columbia Basin production area. A definite relationship exists between number of cropping years to potatoes and the increase in incidence of plant infection by this pathogen and severity of "early dying" disease symptoms. In addition, there is an increase in the number of microsclerotia, the primary infective unit of *V. dahliae*, in fields cropped for several years to potatoes.

Vapam is a soil fumigant which is used to control a variety of soilborne pests such as weeds, nematodes, fungi, and insects. Several methods of Vapam application to the soil have been employed; however, because this fumigant is higly soluble in water, the most efficacious method of application is via sprinkler irrigation systems.

OBJECTIVES

The purpose of this study was to determine the effect of Vapam applied in water through the irrigation system on soil populations of *V. dahliae* and the incidence and severity of *V. dahliae* in potatoes.

METHODS

Vapam was applied through the irrigation system to the soil in one inch of water at two locations in the Washington Columbia Basin production area in the fall of 1978. At one location, Vapam was applied at 50 gallons per acre through a wheel line sprinkler. A 1,320 x 60 foot section was not treated and served as a check area. At a second location, Vapam was applied through a center pivot sprinkler at 50 and 75 gallons per acre. Check areas, 20 x 100

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feet, were covered with a plastic tarp before application to protect the soil from the treatment. Adjacent "run-off" areas were avoided during subsequent sampling.

Inoculum densities of *V. dahliae* propagules in the fumigated and nonfumigated soils were determined with an Anderson air sampler using the technique of Butterfield and DeVay (Phytopathology. 67: 1073-1078). Five soil samples, to a depth of seven inches, were taken from each treatment immediately after planting. The samples were air dried for two weeks, subsampled five times, and analyzed to determine the number of *V. dahliae* propagules per gram of air dried soil.

On August 1, 1979, 100 'Russet Burbank' plant samples were collected at random from both the treated and nontreated areas of the wheel line irrigated field. Three weeks later, 100 'Russet Burbank' plant samples were randomly collected from the treated and nontreated areas of the center pivot irrigated field.

Plants were brought back to the laboratory, and a four inch portion of the lower stem from each plant was washed in running water and surface sterilized for three minutes in a five percent commercial bleach solution. After removing the epidermis, the stem was cut into one-quarter inch segments which were plated onto water agar containing an streptomycin antibiotic. The stems were incubated in the dark at 22^{0} C for eight days and then examined for the presence of *V. dahliae*.

The terminal five inches of each plant were air dried at 28^{0} C for two months. After drying, the basal two inches of these stem portions were ground in a Wiley mill using a 40-mesh screen. From each stem, five 10 milligram samples were plated onto NPX medium using the Anderson air sampler. Plates were incubated in the dark at 22^{0} C for two weeks. The ground stem material was removed from the agar surface by gently washing in tap water. The number of *V. dahliae* colony forming units (CFU) per gram of stem tissue was determined.

For yield comparisons, the treated and nontreated areas in the wheel line irrigated field were machine dug by the grower. Yield data were not available for the center pivot irrigated trial.

A multiple t-test was used to determine if significant differences existed between treatments.

RESULTS

Levels of soilborne inoculum of *V. dahliae* were 102 and 94 propagules per gram of soil, respectively, in the nontreated areas at the wheel line and center pivot irrigated sites (Table 1). At the former location, Vapam at 50 gallons per acre reduced the number of viable *V. dahliae* propoagules by 85 percent. A similar reduction in soil population levels was achieved with the 50-gallon rate at the latter location. A further reduction (nine percent) was realized with the 75-gallon rate.

In the wheel line irrigated field, 95 percent of the vines were dead or chlorotic with less than 25 percent of the leaves still green on August 1. In the Vapam treated area, only 25 percent of the vines were showing similar type symptoms.

Severe symptoms (less than 10 percent of the leaves still green) on 99 percent of the vines were observed in the nontreated areas of the center pivot irrigated field on August 20. Vines in the 50 and 75 gallons per acre treated areas were exhibiting 25 and 10 percent severe "early dying" disease symptoms, respectively.

Stem isolations were made to determine incidence of plant infection by *V. dahliae*. In addition, internal stem populations of *V. dahliae* were determined as an estimate of severity of plant infection.

The incidence of stems infected with *V. dahliae* was not significantly reduced with the 50-gallon rate at either location (Figure 1 and 2). However, at 75 gallons per acre, the incidence of stem infection was significantly reduced ($p = 0.01$) when compared with the 50-gallon per acre rate and the non-treated area. In contrast, the 50-gallon per acre rate significantly reduced ($p = 0.01$) the internal stem populations of *V. dahliae* at both locations (Figure 1 and 2). No additional reduction in internal stem populations was achieved with the 75-gallon rate.

In the wheel line irrigated field, tuber yields were 29.0 and 22.5 tons per acre in the treated and nontreated area, respectively.

DISCUSSION

The inoculum for root infection and vascular invasion by *V. dahliae* comes from diseased plants from the previous crop which are decomposing in the soil and from residual microsclerotia that remain viable in the soil for a long time.

Major reduction in the amount of initial inoculum in soil usually requires approaches more drastic than crop rotation to nonsusceptible crops because of the longevity of the microsclerotium. Soil fumigation is one such means of reducing the amount of initial inoculum. In both fields where soil population levels of *V. dahliae* propagules were high before fumigation, Vapam at 50 gallons per acre significantly reduced the amount of initial inoculum.

Even with a significant reduction in the number of detectable microsclerotia following fumigation, plant infection by *V. dahliae* still occurred. The high incidence of plant infection is not surprising in that one inoculum unit is capable of causing infection.

As with many diseases, however, severity of attack often provides a better measurement of treatment effects. "Early dying" disease caused by *V. dahliae* is a quantitative disease. In other words, the amount of inoculum in the soil is related to severity of disease. The efficaciousness of a control practice may, therefore, be evaluated by measuring the reduction in amount of inoculum and severity of attack. The technique of assessing internal stem populations of *V. dahliae* provides a measure of disease severity, e.g., the higher the internal stem populations, the more severe the disease expression. By reducing the amount of initial inoculum, there should be fewer root infections; and hence, internal stem populations should be lower. A significant reduction in internal stem populations was observed with the 50-gallon per acre treatment at both locations. In addition, tuber yields were significantly increased (22 percent) over the nontreated area in the wheel line irrigated field.

Reduction in severity of symptoms was also visually evident when treatments were compared. In the nontreated areas at both locations, most of the vines were severely diseased at sampling time. In contrast, most of the vines grown on the treated areas were still green and just beginning to show symptoms. The difference in severity of visual symptoms between treated and nontreated areas was supported by the significant difference in internal stem populations of *V. dahliae*.

An epidemic of "early dying" disease caused by *V. dahliae* spans several successive years during which the primary inoculum increases or decreases depending on sanitation effects. If the increase in disease incidence and severity depends upon the inoculum from the previous seasons, then control measures should be aimed at reducing the amount of initial inoculum in the soil.

Table 1. Inoculum densities of *Verticillium dahliae* in Vapam fumigated and nonfumigated plots in the Columbia Basin production area, 1979

Location	Treatment	No. of miscrosclerotia/gm of soil
Wheel line irrigated field	Check	102
	50 gal/A	19
Center pivot irrigated field	Check	94
	50 gal/A	13
	75 gal/A	5

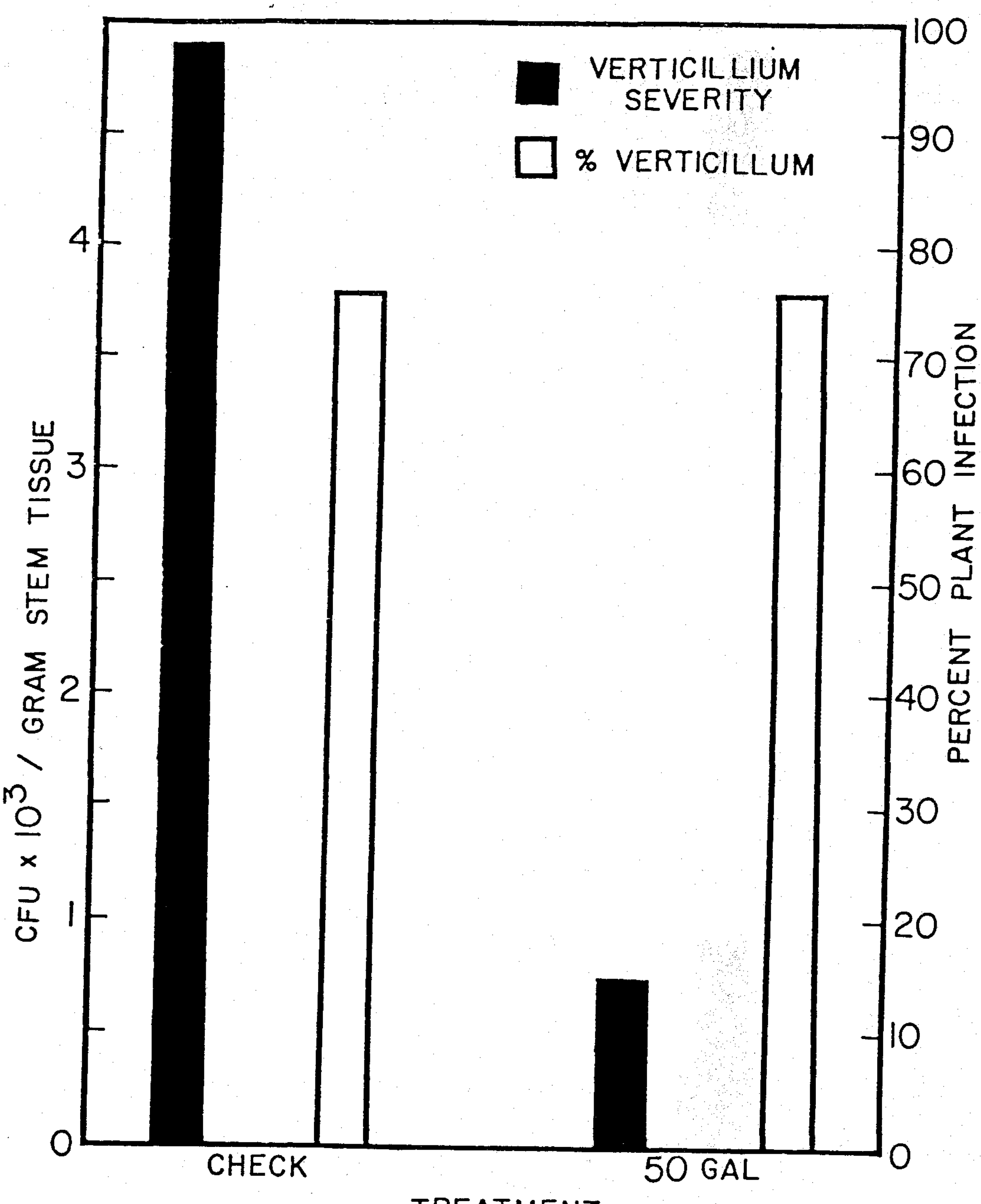

Figure 1. The effect of Vapam applied through a wheel line irrigation system at 50 gallons per acre on percentage of plants infected with *Verticillium dahliae* and internal stem populations (CFU) of *V. dahliae*, an indicator of *Verticillium* severity.

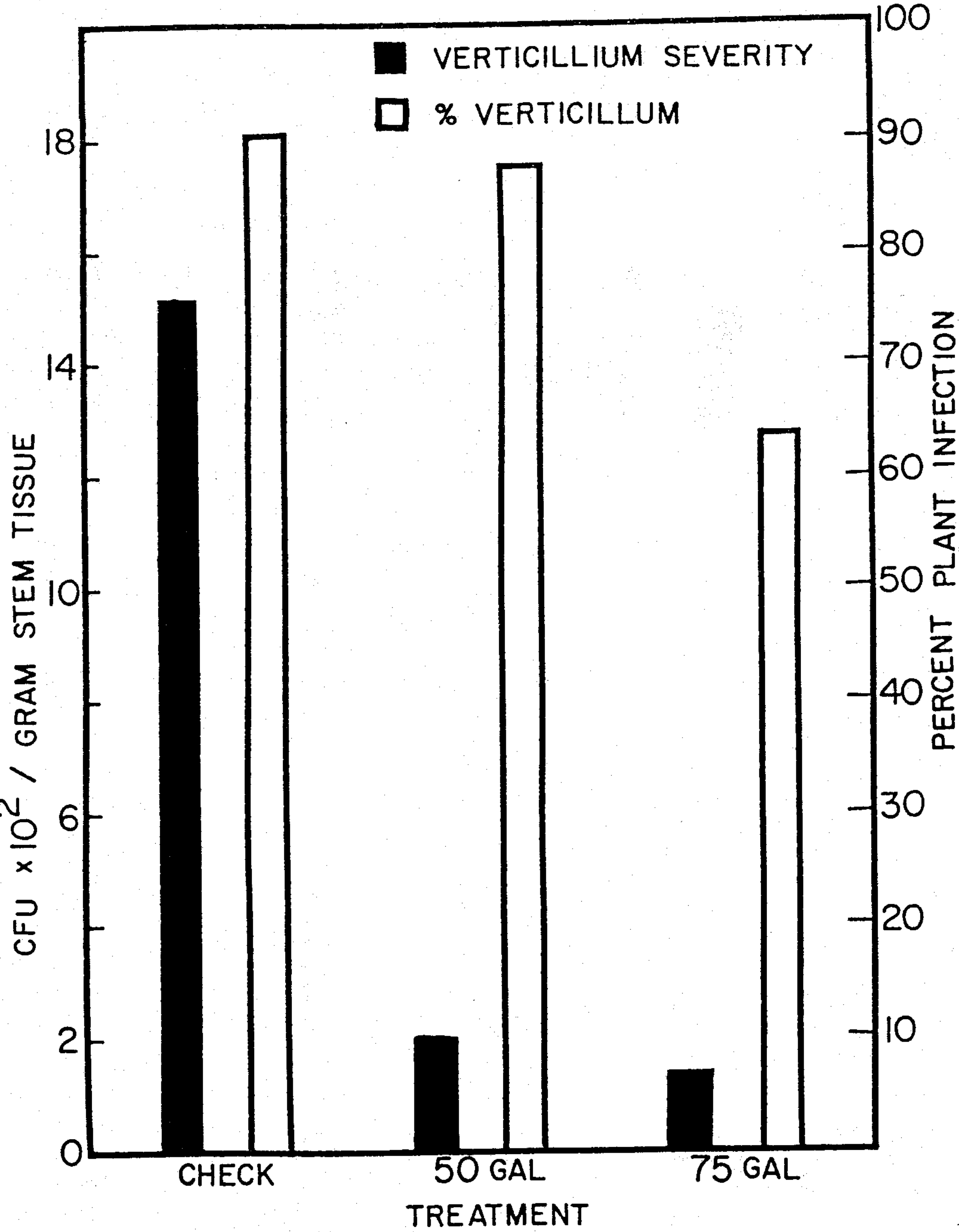

Figure 2. The effect of Vapam applied through a center pivot sprinkler irrigation system at 50 and 75 gallons per acre on percentage of plant infected with *Verticillium dahliae* and internal stem populations (CFU) of *V. dahliae*, an indicator of *Verticillium* severity.

CHARACTERIZATION OF SEVERE "EARLY DYING" DISEASE EPIDEMICS IN POTATOES

M. L. Kirkland and M. L. Powelson[1]

INTRODUCTION

"Early dying" disease of potatoes *(Solanum tuberosum* L.*)*, often considered to be synonomous with verticillium wilt, is characterized by a progressive yellowing and death of leaves which often lead to premature plant death. Verticillium wilt, or "early dying" disease as caused by verticillium, may result in yield reductions of up to 40 percent in varieties such as 'Norgold Russet' and 'Russet Burbank'.

In Oregon, the major pathogen associated with the disease is *Verticillium dahliae* Kleb., which overwinters in the soil as a microsclerotium, a small group of darkly pigmented, dormant cells. These cells are relatively long-lived; when stored under laboratory conditions, microsclerotia have remained viable for as long as 19 years. Microsclerotia have been found in small numbers in native Columbia Basin soils; however, major "early dying" disease epidemics do not generally occur until these low soil populations have been increased, primarily through repeated croppings to potatoes, to some threshold level as yet undefined. The fungus invades the roots and subsequently becomes established in the xylem, or waterconducting tissues, where it multiplies, thus enabling the pathogen to progressively colonize the plant's waterconducting system from the base of the stem to the tip of the stem. At death, the pathogen leaves the xylem and invades adjacent tissues where extensive microsclerotial development occurs, provided conditions are suitable. When the vines are tilled under and begin to decompose, the microsclerotia are then added to the soil.

OBJECTIVES

Seasonal development of "early dying" disease epidemics have not previously been described. Therefore, during the 1980 growing season, disease progress was monitored in an attempt to determine what characteristics could be used to define fields as having severe "early dying" disease problems.

METHODS

A single seed lot of 'Norgold Russet' was planted at three locations, one in the Klamath Basin (KF) and two in the Columbia Basin (RF and EF). Plot KF was in a field under solid-set irrigation and had been cropped approximately eight times to potatoes. Plot RF was in a field which had been cropped three times to potatoes. Plot EF was in a field which had never been cropped to potatoes. Both of these last two fields were under center-pivot irrigation.

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Potato croppings at KF and RF had primarily been in a yearly rotation with wheat, the 1979 crop having been wheat at both locations. Before the six year alfalfa cropping, EF was undeveloped desertland. Each plot consisted of 25 sampling units; each unit was a single row, 20 feet in length. Spacing of seed-pieces within a row was nine inches and spacing between rows was 34 inches. Plots were managed according to the standard farming practices of each locality.

Plots were sampled three to four times during the growing season by randomly pulling 5 to 10 potato stems from within each of 17 sampling units. No more than one stem was pulled from a single hill at a single sampling date. Individual stems were tagged and returned to the laboratory for analysis of *V. dahliae* incidence and severity. To determine the incidence, or presence of the pathogen within the plant, a one-inch segment of the main stem was removed from just above the soil line. The segment was surface sterilized by soaking it in a 0.5 percent solution of sodium hypochlorite for three minutes. The epidermis was removed and cross-sections of the segment were placed onto streptomycin-ethanol water agar (Nadakavukaren. 1959). The segments were then incubated at approximately 70^{o} for seven days and the presence of *V. dahliae* was determined using a dissecting microscope to scan segments for microsclerotia. Severity of plant infection, as indicated by internal stem populations of *V. dahliae*, was determined as follows: (1) the above-ground portion of the main stem was air-dried for at least three months, (2) a two-inch segment from within 4 to 6 inches of the stem tip was ground with a Wiley mill, and (3) using an Anderson air sampler, 10 milligrams of ground tissue was plated onto NPX medium (Huisman. 1974). These plates were then incubated at approximately 70^{o} F for 14 days and, again using a dissecting microscope, individual colonies of *V. dahliae* were counted. Each of these colonies was assumed to have arisen from a single propagule, or piece of the fungus which could act as a unit of inoculum. Incidence of "early dying" disease symptoms was visually estimated for each plot at each sampling date by determining the percent diseased hills. A hill was defined as "diseased" if at least one stem in that hill exhibited typical "early dying" disease symptoms.

Inoculum densities, or the amount of *V. dahliae* present in the soil before planting, were determined for plots RF and KF. Immediately before planting, 12 soil samples from within each plot were taken at a depth of 2 to 12 inches. These samples were returned to the lab and air-dried. After both four and six weeks of air-drying, five subsamples of 67 milligrams each were plated using the Anderson air sampler onto NPX medium and, following the same method as outlined above, the number of *V. dahliae* propagules per gram of air-dried soil was determined.

Tuber yield was determined by using a two-row potato digger to lift the tubers out of the soil. These were then bagged and weighed. Yield was determined by harvesting the eight sampling units from which stems had not been pulled.

1. early onset of "early dying" disease symptoms and of plant infection by *V. dahliae*.

2. rapid increase in the incidence of both "early dying" disease symptoms and plant infection by *V. dahliae*.

3. high levels of incidence of both "early dying" disease symptoms and plant infection by *V. dahliae* well before the expected harvest time.

4. rapid increase in severity of "early dying" disease symptoms as estimated by internal stem populations of *V. dahliae*.

5. high inoculum density of *V. dahliae* in the soil before planting.

6. low tuber yield at harvest.

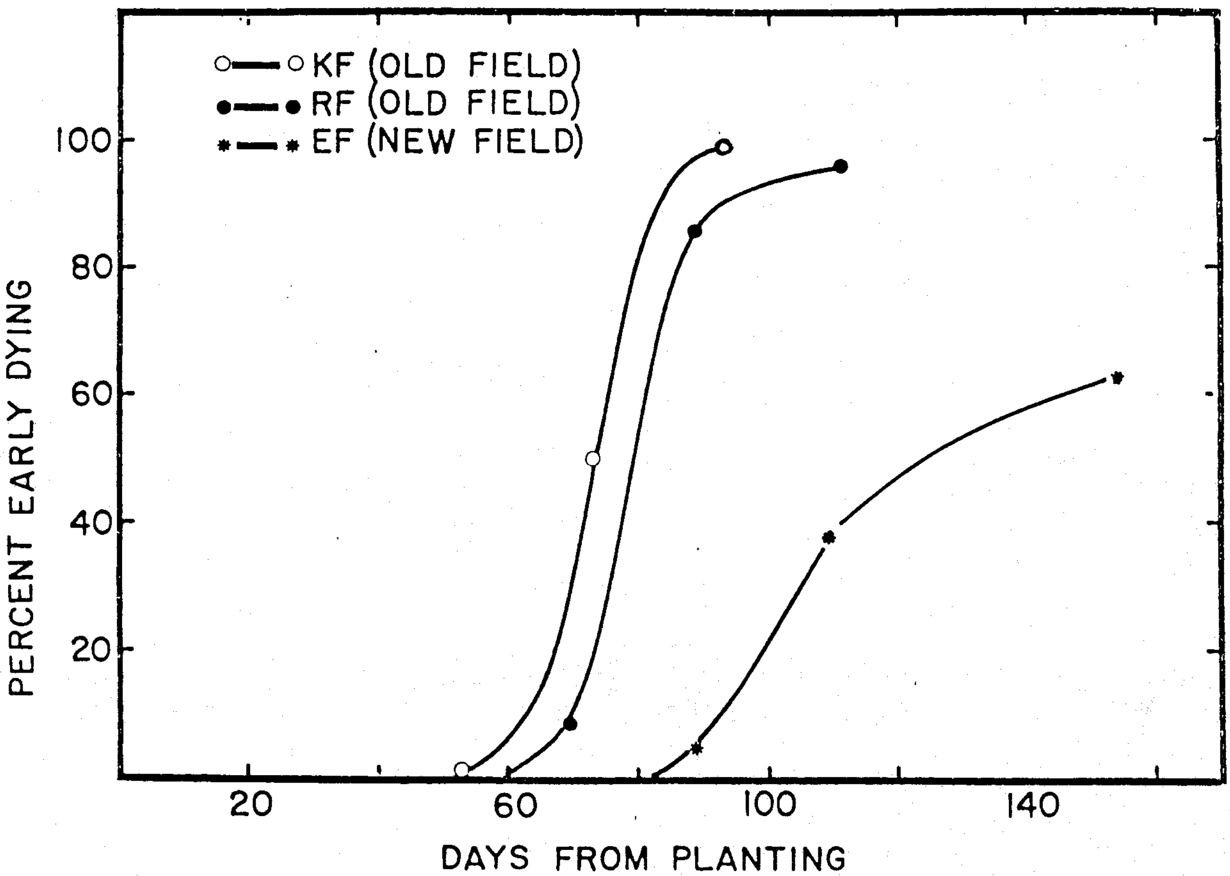

Figure 1. Potato "early dying" disease progress curves at three locations in Oregon in 1980.

RESULTS

Average tuber yields were 12.6 tons per acre at the KF plot, 8.2 tons per acre at the RF plot[2] and 23.0 tons per acre at the EF plot. "Early dying" disease progress curves, which represent disease development over time, for the KF and RF plots were similar to each other, but both differed from the curve for the EF plot (Figure 1). Symptom expression at the KF and RF plots was characterized by an early onset with 10 percent of the hills exhibiting "early dying" disease symptoms at 61 and 70 days, respectively, from planting and by a rapid build-up to 90 percent symptoms within approximately 25 days. However, at the EF plot 10 percent "early dying" disease symptoms did not occur until about 94 days from planting with a much slower build-up in disease to only 64 percent at 152 days from planting. The plants in the KF and RF plots were dead approximately 5 and 8 weeks, respectively, before expected regional harvest times. Conversely, in the EF plot, the plants were still predominantly alive at harvest time (152 days from planting). The KF and RF plots had severe "early dying" disease epidemics, whereas, the EF plot had a mild epidemic. The same trends existed for the frequency of potato plant infection by *V. dahliae* (Figure 2).

Using a standard transformation which employs certain laws of probability, the percent of stems infected was converted to a value indicating the actual number of infections per plant. Daily apparent infection rates (r), or the number of new infections occurring per plant per day, were then calculated for each plot. At the KF and RF plots, the daily apparent infection rate was significantly greater than at the EF plot (Figure 3), indicating there were more new infections per plant each day at the KF and RF plots than at the EF plot. Internal stem populations of *V. dahliae*, used to signify severity of plant infection, were converted to logarithms, a standard biological technique, to determine the daily growth rate (k), or increase in propagules of *V. dahliae* per plant per day. Increases in stem populations of *V. dahliae*, as indicated by daily growth rates, were significantly greater at the KF and EF plots than at the EF plot (Figure 4). In fact, it took 11.9 days for internal stem populations of *V. dahliae* to double in the EF plot, whereas, in the KF and RF plots it only took 5.6 and 4.7 days, respectively, for doubling to occur. Inoculum density for *V. dahliae* before planting was 14.38 propagules per gram of soil in the RF plot. At the EF plot, it was only 1.13 propagules per gram of soil.

CONCLUSIONS

By comparing the EF plot with the KF and RF plots, we noted several distinguishing characteristics and concluded that fields with severe "early dying" disease epidemics, when compared to fields without severe epidemics, could be characterized by:

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[2] The RF plot was on a sandy ridge. The total yield obtained by the grower for the remainder of the field was approximately 16 tons per acre.

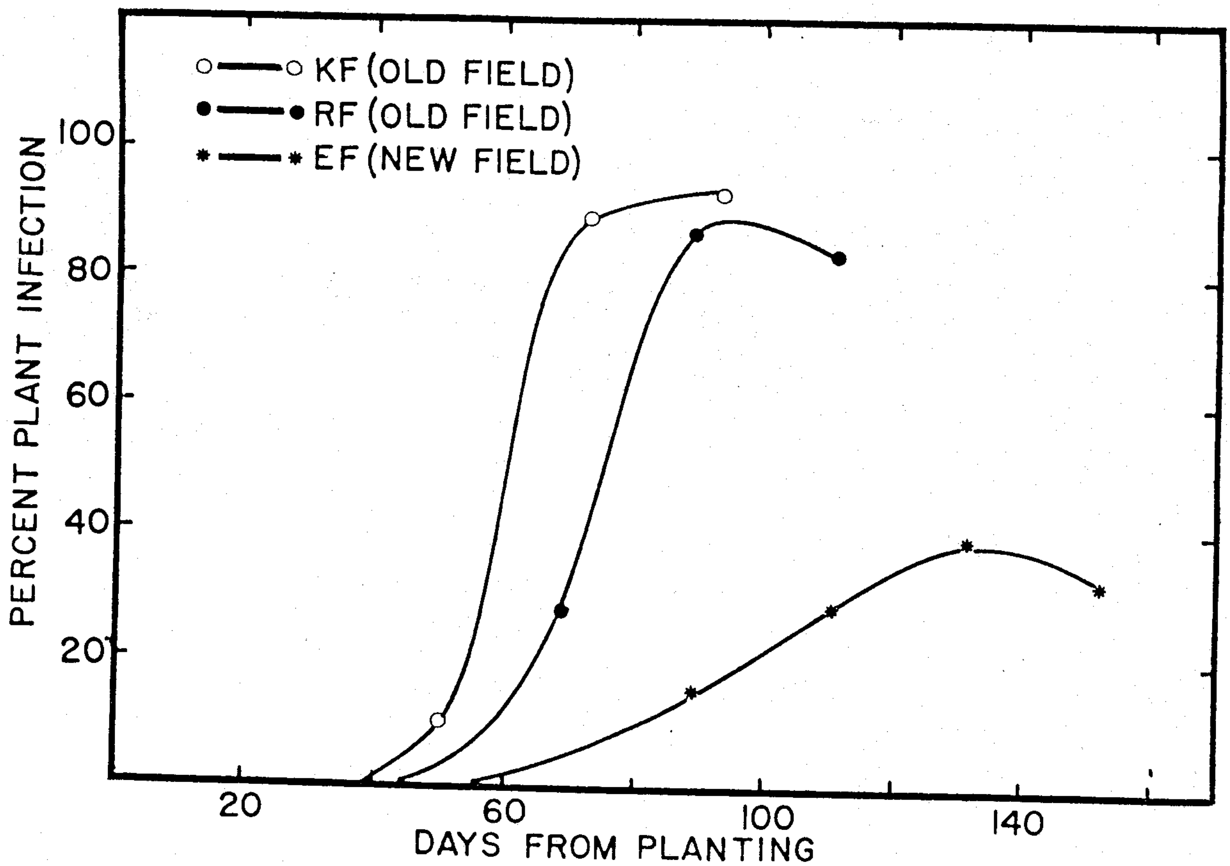

Figure 2. Development of potato plant infection by *Verticillium dahliae* at three locations in Oregon in 1980.

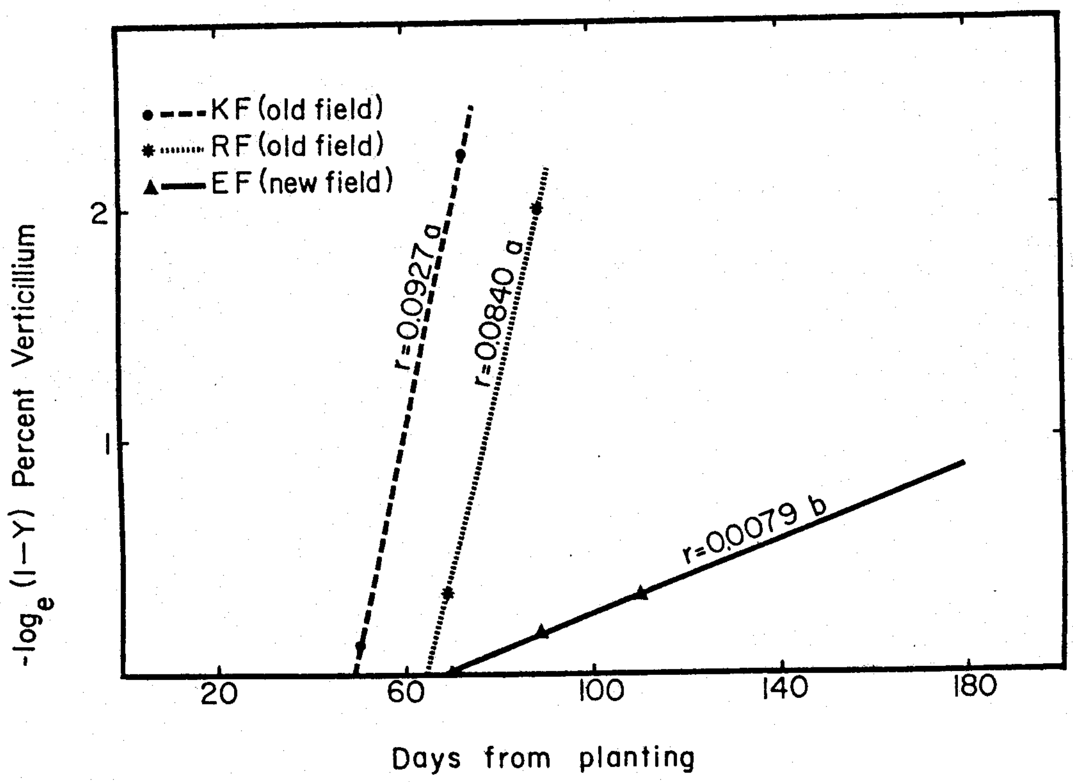

Figure 3. Daily apparent infection rates (r) for *Verticillium dahliae* at three locations in Oregon in 1980.

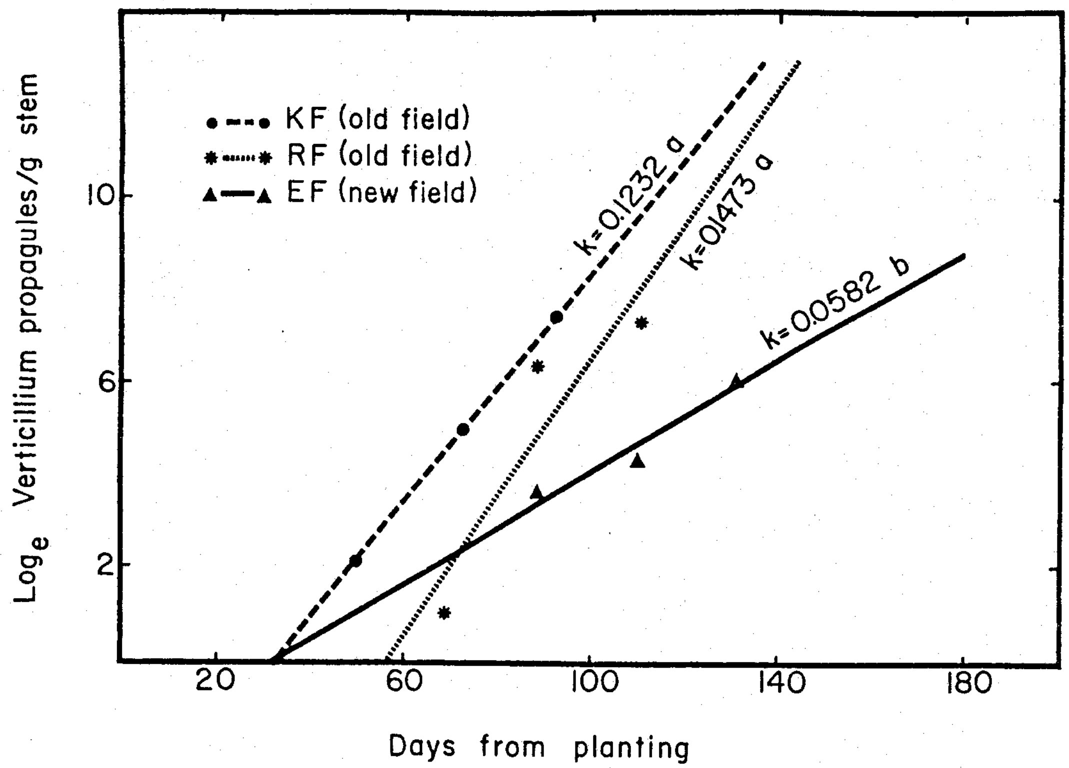

Figure 4. Growth rates for internal stem populations of *Verticillium dahliae* in potato at three locations in Oregon in 1980.

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2. Nadakavukaren, M. J. and C. E. Horner. 1959. An alcohol agar medium selective for determining verticillium microsclerotia in soil. Phytopathy 49: 527-528.

POTATO *(Solanum tuberosum L.)* SEED LOT TESTS

Luther A. Fitch and D. C. Hane[1]

Each year, commercial potato *(Solanum tuberosum L.)* producers in the Hermiston-Boardman area purchase and plant seed from as many as 100 seed lots produced by 50 or more seed growers in Montana, Oregon, Idaho, North Dakota, Minnesota, Nebraska, California, and the Canadian provinces of British Columbia and Alberta.

As might be expected, the lots have varied in the amount of seed-borne diseases and vigor. It has been difficult, however, for either commercial growers or seed producers to evaluate these differences without side-by-side comparisons. Starting in 1978, a seed lot test has been conducted annually at the Hermiston Research and Extension Center. Diseases and plant vigor of each seed lot have been observed and noted in these tests.

PROCEDURES

With guidance from the local Extension agent, growers select samples of approximately 300 whole, small (4 to 6 ounce) tubers representative of each lot they plant. These samples of seed are collected regularly from local growers and stored in a refrigerated box car until planting. Two plantings, representative of the median planting dates for early and for late plantings of potatoes are made each year. In 1980, these dates were April 1 and May 1 and in 1981, April 2 and April 27. Cultural practices which allow maximum expression of disease symptoms are used to grow the seed lots.

The lots are evaluated twice yearly under supervision of Oscar Gutbrod, certification specialist, and Paul Koepsell, Extension plant pathologist. After the second evaluation, a field day is held to allow seed growers, potato producers, and other interested parties the opportunity to receive the official evaluations and to view the seed lots tests.

The tests are also used to train roguing crews and supervisors who will be responsible for roguing potato seed fields later in the summer.

RESULTS

Visual but unmeasured differences have been noted in emergence and in general vigor of seed lots. The major differences, and those that have been definitively cataloged, have been in the area of diseases. The most evident disease has been blackleg caused by Erwinia species of bacteria. As much as 13 percent of the plants in some lots have shown symptoms of this disease.

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Mosaics, caused by single or complexes of potato viruses, are the next most frequent disease with from none to six percent of plants showing tuber perpetuated infection.

Total numbers of plants identified with the major diseases out of the more 25,000 individual tubers planted each year as follows:

YEAR	NUMBER OF DISEASED PLANTS		
	Leaf-roll	Mosaic	Blackleg
1978	32	73	403
1979	12	168	185
1980	5	149	219
1981	14	127	251

CONCLUSIONS

The Potato Seed Lot Tests have have provided a valuable service to the potato industry. These tests have aided seed growers and commercial producers to identify diseases and other weaknesses in specific seed lots, and have provided an important training opportunity for roguing crews, fieldmen, and farm managers on disease identification. Monitoring of the general quality of seed coming into this area for planting has been possible.

INSECTICIDAL CONTROL OF *(Limonius canus* LeConte*)* ON *(Solanum tuberosum L.)*

H. Harold Toba[1]

The two usual methods, depending on soil sample estimates, of applying insecticides for wireworm control on potatoes in the Pacific Northwest are preplant broadcast application for high wireworm populations and at-plant sidedress application for low populations. Against low populations, growers prefer to apply insecticides in the seed-piece furrow instead of at-plant sidedress because of the ease and lower cost of application. Furthermore, a need exists for a method to apply insecticides post-plant, particularly in fields suspected of having few or nor wireworms, so growers could forego any treatment before or at planting time but could apply insecticides if they subsequently find a damaging population of wireworms (Toba and Turner, 1981) (2).

A field test was conducted in 1981 at the Columbia Basin Agricultural Research and Extension Center, Hermiston, to evaluate the effectiveness of different insecticides and formulations, applied by four methods, in reducing wireworm damage to potatoes.

METHODS AND MATERIALS

The test was conducted in a solid-set, sprinkler-irrigated field in which the soil type was Ephrata sandy loam (Xerollic Camborthids) with an organic matter content of less than one percent. On March 19, five soil samples were taken at each of 10 sites in the test area (circa 2.5 acres) with a posthole digger to a depth of at least 18 inches to estimate the wireworm population. Four wireworms, identified as the Pacific Coast wireworm, *(Limonius canus* LeConte*)* were found in the 50 samples for a mean of 0.32 wireworms/ft^2.

The test was conducted in a randomized split-plot design with four replications (blocks). The main treatments consisted of four different methods of insecticide application: preplant broadcast, at-plant sidedress seed-piece furrow, and postemergence sidedress. Since wireworm populations are known to be spotty in distribution, each block was divided into two subblocks, each having seven insecticide subtreatments and an untreated check in a randomized complete block design. Each plot measured 38 feet long and 4 rows wide (34-inch row spacing).

On April 29, broadcast materials were applied; granules were broadcast with a hand-operated Cyclone ® grass seeder, and liquid formulations were diluted in water to a volume of one quart and applied at a rate of 25 gallon/acre and a pressure of 30 psi with a hand-held CO_2 boom sprayer consisting of four TeeJet ® (No. AL 80015) nozzles. The plots were rototilled to a depth of 4 to 6 inches within one hour after application. The weather was sunny and slightly windy.

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On April 29-30, 'Russet Burbank' potatoes were planted with a two-row planter. The at-plant sidedress and seed-piece furrow applications were made with applicators mounted on the planter. Sidedress applications were shanked 3 to 4 inches to each side and level with the seed pieces; granules were applied in one-inch bands with Gandy ® applicators, and liquid formulations were diluted in water to a volume of one pint and applied at a pressure of 40 psi with TeeJet (No. 4916-35) nozzles attached to the rear of the shanks. Furrow applications were made in the planter shoe level with and directly ahead of the seed pieces; granules were placed in one-inch bands, and liquid formulations were applied with TeeJet (No. 8004E) nozzles.

On June 1, postemergence sidedress applications were made two rows at a time with tractor-mounted Gandy and liquid applicators in a manner similar to that of at-plant sidedress. In one treatment, granules of a Temik-Phorate combination were applied over the rows, then incorporated into the soil with a Lilliston ® cultivator. The weather was sunny and calm.

On October 6-8, tuber samples were harvested from the two center rows of each plot (circa 15 ft/row). All tubers were washed and examined for wireworm feeding, and the percentages (by weight, of tubers injured and damaged) were determined. "Injured" was defined as any penetration of a tuber by a wireworm, and "damage" as any injury as severe as described in Section 51.1560 and 51.1564 of the U.S. Standards for Grades of Potatoes. Since significant differences in percentages of injured and damaged tubers in the untreated checks were noted between subblocks, the percentages were converted to percentages of check. These percentages were then transformed to arcsine √ percentage and analyzed by analysis of variance (split-plot design) and Duncan's multiple range test. Compounds that were not applied by all four application methods were not included in the analysis.

RESULTS AND DISCUSSION

Soil sampling may not always give a true estimate of the wireworm population in the field. According to Onsager and Foiles, 1970) (1), we expected about 22 percent tuber injury in the untreated checks, based on the population estimate of 0.32 wireworms/ft^2 from soil sampling. However, the actual mean tuber injury was 59 percent (range 11.4 - 87.7); therefore, the wireworm population in the test area could be considered moderately high.

On Table 1, means of methods shows that broadcast application was more effective than the other methods, and means of insecticides shows that Mocap 6EC and Lorsban 4E were more effective than Dyfonate 10G and Amaze 20G at two different rates. Also, individual insecticides differed in effectiveness depending on the method of application.

Conclusions on the performance of insecticides should not be based on this test only. For example, averages of past field tests have shown that broadcast and furrow applications were more effective than the other method, and Dyfonate was one of the most effective insecticides in controlling wireworms on potatoes.

Table 1. Percent control, based on percent of potato tubers damaged by wireworms, after insecticide application by four methods, Hermiston, Oregon, 1981

Compound	Broadcast		At-plant sidedress		Seed-piece furrow		Postemergence sidedress		Mean of compound
	Rate[1]	% Control[2]	Rate	% Control	Rate	% Control	Rate	% Control	
Mocap 6EC	4.0	97.5a[3], A[4]	2.0	83.9abc, AB	2.0	95.6a, A	2.0	65.1abcd, B	85.5a
Lorsban 4E	4.0	95.9a, A	4.0	81.9abc, A	2.0	94.3ab, A	3.0	71.7ab, A	86.0a
Amaze 6EC	6.0	99.1a, A	3.0	83.2abc, AB	3.0	89.7ab, A	3.0	47.4abcd, B	79.9ab
Mocap 10G	4.0	98.5a, A	2.0	90.0ab, AB	2.0	72.2ab, AB	2.0	56.3abcd, B	79.2ab
Amaze 6EC	4.0	99.7a, A	2.0	52.3 c, B	2.0	84.2ab, AB	2.0	77.1ab, B	78.3ab
Counter 15G	4.0	96.4a, A	2.0	85.9ab, A	2.0	37.4 d, B	2.0	84.4a, A	76.0abc
Phorate 15G	4.0	88.7a, A	2.0	92.4a, A	2.0	70.0abc, A	2.1	61.9abcd, A	78.2abc
Dasanit 15G	5.0	97.2a, A	3.0	88.1ab, A	3.0	42.5 cd, B	3.0	74.2ab, AB	75.5abc
Diazinon 14G	4.0	95.7a, A	1.9	77.6abc, AB	1.9	57.1 bcd, B	2.1	71.0abc, AB	75.4abc
Dyfonate 10G	4.0	97.2a, A	2.0	60.6 bc, B	2.0	70.5abc, AB	2.0	47.1 bcd, B	68.8 bc
Amaze 20G	4.0	92.1a, A	2.2	63.0abc, AB	2.2	69.4abc, AB	2.1	33.3 cd, B	64.4 bc
Amaze 20G	6.0	99.7a, A	3.0	58.8abc, B	3.0	39.1 cd, B	3.0	34.9 d, B	58.1 c
Mean of Method		96.5 A		76.5 B		68.5 BC		60.4 C	

[1] lb AI/acre

[2] Based on percent damaged in untreated check, which had a mean of 14.4% (range 2.3 - 39.0%)

[3] Means followed by the same small letter within a column are not significantly different (P = 0.05, DMRT)

[4] Means followed by the same capital letter within a row are not significantly different (P = 0.05, DMRT)

The following treatments, with the rates used and the percentage control obtained, were not included in Table 1 because they were not included in the analysis: Lorsban 15G as broadcast (6.0, 86 percent), as at-plant sidedress (4.1, 88 percent) and as furrow (2.9, 75 percent), Temik 15G + Dyfonate 10G as at-plant sidedress (3.0 + 2.0, 73 percent) and as furrow (3.0 + 2.0, 52 percent), Temik 7.5 percent + Phorate 7.5 percent as postemergence sidedress (3.2 + 3.2, 73 percent), and Temik 9 percent + Phorate 6 percent as postemergence sidedress (3.2 + 2.2, 79 percent) and as an over the row postemergence sidedress incorporated with a Lilliston cultivator (3.0 + 3.0, 31 percent).

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POTATO BRUISING: A COMPARISON OF THE POTATO *(Solanum tuberosum L.)* VARIETIES LEMHI AND RUSSET BURBANK, SEPTEMBER 1980

Luther A. Fitch[1]

The potato (*Solanum tuberosum L.)* variety 'Lemhi' was introduced into Oregon's irrigated Columbia Plateau on a very limited basis in 1979. Producers indicated that in spite of other excellent attributes it appeared to be unusually susceptible to black-spot bruising, a phenomenon well studied in the 'Russet Burbank' variety and generally associated with warm soil and tuber temperature and resulting low vigor (water content) of this variety at harvest.

METHODS

At approximately 11 a.m., samples were collected at random intervals from adjacent one half mile strips of Russet Burbank and Lemhi potatoes in a commercial center-pivot irrigated potato field.

Tubers were randomly selected from the harvester before they ascended the elevator chain to the truck bed. Pulp temperatures were taken with a soil thermometer.

The samples of both varieties were divided into three equal lots. One third were end-dropped nine inches, and one third were end-dropped 18 inches to a board surface. The remaining third received no treatment. All lots were placed in storage for approximately one month, then examined for splits and bruises.

RESULTS

Internal tuber temperatures were low (between 45^{o} F and 52^{o} F) and tubers were quite turgid both at harvest and at the time the tubers were end-dropped thus maximizing the probability of splits occurring and minimizing the probability of black-spot bruising.

On examining unpeeled potatoes from storage it was determined that number of splits per tuber were not significantly different between varieties on the harvester-run (no treatment) lots (Figure 1).

The Lemhi variety both split and bruised more severely than did Russet Burbank at both nine inch and the 19 inch drop (Figure 1).

Peeled harvester-run samples revealed small, initially undetected bruises (black-spot) to be five times more prevalent in Lemhi than Russet Burbank (Figure 2). Also, upon peeling, it was noted that Lemhi tubers had sustained deeper bruising and had more bacterial rot developing around the bruised and split areas.

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CONCLUSIONS

The potato variety Lemhi shows greater potential for black-spot bruising and greater potential for deterioration in storage when bruised than Russet Burbank.

Because of these characteristics it should only be planted for a direct-from-field processing (harvested and processed the same day) variety. Until further studies are made as to cultural conditions (if any) that can be used to offset this problem or strain biotypes that might be less susceptible, Lemhi should not be planted as a fresh-pack or long-term-storage variety for processing.

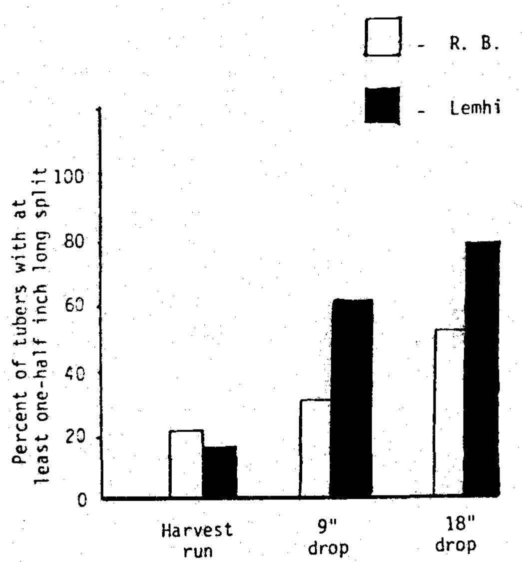

Figure 1. Comparison of 'Lemhi' and 'Russet Burbank' to susceptibility of harvester damage (splits).

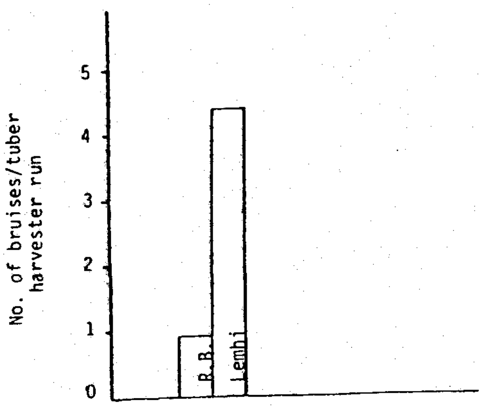

Figure 2. Comparison of 'Lemhi' and 'Russet Burbank' to susceptibility of harvester damage (bruises).

SCREENING FOR TOLERANCE TO BARLEY YELLOW DWARF VIRUS (BYDV) IN WINTER FEED WHEATS FOR EASTERN OREGON

Mathias F. Kolding[1]

Cereal workers at the Barley Yellow Dwarf Virus Workshop at Urbana, (1) Illinois, June 1-2, 1977, generally agreed that barley yellow dwarf virus (BYDV) is one of the most devastating cereal diseases in the United States and Canada. Though annual losses are estimated to range from one to three percent in wheat, barley, and oats, damage can reach 20 to 30 percent in some areas. Oregon also has considerable BYDV economic losses. For example, the high quality BYDV susceptible two-row barley *(Hordeum vulgare L.)* variety 'Hannchen' is no longer grown in Oregon's Klamath Basin and Willamette Valley, nor has it been replaced by a BYDV resistant two-row malting type. Yield losses from fall BYDV infections in eastern Oregon's winter wheat have not been measured. Though fall infected wheat fields appear to suffer drought stress earlier in the summer than uninfected fields, mild BYDV wheat symptoms, which tend to disappear after water and nitrogen applications, are sometimes confused with nutrient deficiencies.

Potter (6) reported that BYDV initially suppressed powdery mildew *(Erysiphe graminis* DC ex Merot*)* infections in barley, but subsequently the mildew infections were enhanced. He also referred to work by H.C. Smith who noted more *(Gaeumannomyces graminis* [Sacc] Arx and Oliver*)* take-all in BYDV infected wheat plants than in healthy plants. Gill (4) reported a 73 and 63 percent reduction in total seed weight per plant in the spring wheat *(Triticum aestivum L.)* cultivars 'Glenlea' and 'Neepawa' during an outbreak of barley yellow dwarf in western Manitoba, Canada. Losses in that 1978 Manitoba outbreak were calculated to reach 7 percent of the total yield, or 5,851,000 bushels.

In the past, Oregon's dryland winter wheat production area escaped fall BYDV. Most host plants ripened and dried out before wheat seedlings emerged in September and October. When spring viriliferous aphid flights arrived, the partially resistant winter wheat plants were also too large to suffer noticeable damage, and, as hot dry June weather appeared, aphids would move further north. With the advent of an enlarged irrigated crop acreage a changed BYDV-aphid-host complex emerged. Late summer lush, irrigated grass, corn and volunteer cereals, which do not dry or ripen until early September, act as a reservoir for aphid populations. In addition, aphid collections done by Fitch (2) suggest that fall aphid migrations may radiate from eastern Oregon residential areas.

The BYDV-aphid-plant host relationship is complex. For example, variants of the virus are transmitted better in specific aphid species, but they are also transmitted to some degree by other aphid species. Studies about the BYDV variants are giving better reasons why what was once thought a simple virus reacts symptomatically different in the same cultivar. Gill (3) suggests that the corn leaf aphid *(Rhopalosiphum maidis,* Fitch.*)* specific BYDV variant and

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the english grain aphid *(Macrosiphum avenae, L.)* specific and non-specific BYDV variants are either distantly, or else not related. BYDV variants are becoming better identified and so are their vectors. Jedlinski (5) recently identified the rice root aphid *(Rhopalosiphum rufiadominales, L.)* as a vector of barley yellow dwarf virus in Illinois, so now the BYDV aphid vectors number 18.

OBJECTIVE

The winter wheat BYDV screening trials are conducted to: (1) discover winter wheat cultivars resistant to natural BYDV infections, (2) evaluate susceptibility to other diseases associated with early fall planting, (3) select and increase resistant lines for further testings, (4) evaluate resistant winter wheat cultivars for plant type, winterhardiness, and disease resistance, (5) hybridize resistant types with adapted varieties and (6) release new resistant selections to growers and other breeders.

METHODS

Each fall, since 1974, introduced cultivars, advanced winter feed wheat selections, and heads from promising selections are hand planted at the Columbia Basin Agricultural Research and Extension Center at Hermiston, Oregon. An August 28 to September 3 date is chosen.

Plants are usually in the two-to three-leaf stage when September aphid flights begin. Aphids are observed briefly as to their distribution and density throughout the trial area. The one or two species in majority are recorded. No attempt is made to kill the aphids in the plot area. Autumn and spring BYDV intensity is recorded for the different entries. A cultivar's desirability and appearance during or after anthesis, however, determine if it is tagged for reevaluation the next fall. Head selections taken from promising lines both from within the BYDV trials and from other feed wheat trials are planted as whole heads. During the growing season, infected head rows are pulled and discarded. Seed from the remaining rows are planted into four-row, 15-foot long plots. The better lines are then increased for more extensive yield trials, or hybridized to adapted wheats.

RESULTS

Usually the oat bird-cherry aphid *(Rhopalosiphum padi L.)* appears as the dominant aphid species. The greenbug *(Schzophis graminum L.)* corn leaf aphid, and english grain aphid appeared in the test area, but no relative specie counts were attempted. Total fall aphid populations are usually more than 300 foot in the row when plants are in the two-to five-leaf stage.

Twenty-six winter wheat cultivars (Table 1) are in the 1981-82 BYDV reselect trial. The reselect trial is used to verify BYDV resistance through years. This year's entries were rated as tolerant or resistant for four years or more. Entries 1 through 13 were recovered from the Corvallis crossing block collection, or from the International Winter X Spring Screening Trial. Fourteen through 26 are selections from the Oregon feed wheat breeding project.

Table 1. 1982 Barley Yellow Dwarf Virus (BYDV) reselect trial: 1981 agronomic and leaf damage ratings of winter wheat *(Triticum aestivum L.)* cultivars grown more than one season at Hermiston, Oregon

Variety or selection	Leaf damage[1] February 3	Agronomic rating[2] April 10	Agronomic rating[2] June 18	Foliar disease[3] June 18	Date headed June	Leaf damage[1] December 3
1. Badia	2	8	6	0	25	2
2. Moldova	1	8	4	trace	18	1
3. Pillan	2	6	6+	0	16	2
4. Riebesel	1	8	5	trace	26	1
5. Sambo	2	8	5	trace	19	2
6. Talent	3	6	5	1	26	3
7. Zorba	2	6	7	0	21	2
8. Vorchiloskaja	3	5	6	1	17	3
9. Mx 75739	2	7	6	1	17	2
10. TJB 368/251	3	6	6	trace	20	3
11. TSN 75225	3	6	6	1	18	3
12. VA-103	1	7	5	trace	22	1
13. 1523-Dc	1	6	6	trace	26	1
14. FW73830-28	2	6	6	trace	18	2
15. FW73830-29	2	6	6	trace	19	2
16. FW73830-34	2	6	6	trace	20	2
17. FW74075-99	3	5	6+	trace	20	3
18. FW74075-104	2	6	6+	trace	19	2
19. FW76167-702	1	5	6	1	20	1
20. FW771011G	3	7	6	1	17	3
21. FW771249G	2	7	6	1	19	2
22. FW7713736	3	6	6	trace	21	3
23. FW771366G	2	6	6	trace	20	2
24. FW771369G	2	6	6	trace	20	2
25. FW771380G	3	4	6	1	22	3
26. FW771704G	3	5	6	2	16	3

[1] Leaf damage is used as an estimate of BYDV expression in the plot. 1 to 3 is considered as resistance. 4 to 6 is either segregating or questionable resistance. 7 to 9 as susceptible.

[2] Agronomic rating: 0 = dead, 1 to 3 less than a desirable plant type for irrigation, 4 to 5 acceptable plant type, but usually has some undesirable defect, 6 to 9 acceptable to superior agronomic type. 9 would be the "ideal."

[3] Foliar disease: Fungal diseases as leaf spots, septoria and mildew. 0 = none. 1 to 3 = no expected yield loss.

Table 2.[1] Yield, plant height, heading data, bushel weight, stripe rust *(Puccinia striiformis)*, leaf rust *(Puccinia recondita)*, plot rating and lodging of four winter wheats *(Triticum aestivum L.)*, and four winter feed wheat selections with better tolerance to barley yellow dwarf virus (BYDV) and other diseases associated with early planting at Hermiston, Oregon

Variety or selection			Yield per acre	Plant height	Date headed	Bushel weight	Stripe rust[2]	Leaf rust[2]	Plot rating[3]	Lodging
			bushels	inches	June	pounds	percent			percent
1.	C.I. 17596	Stephens	97	34	8	59	5-R	70-S	4	0
2.	C.O. 17419	Daws	105	38	9	59	0	60-S	4	5
3.	C.I. 13968	Nugaines	102	35	8	59	0	80-S	3	0
4.	C.I. 14586	Luke	100	38	16	60	0	90-S	2	80
5.	FW771555G	4079-1970/JJG/2/FW-127	108	43	10	56	0	5-S	5	5
6.	FW771607G	67-109/Froid/2/P-101/FW71002	104	38	16	59	0	5-MR	4	1
7.	FW73830-29	Rb/1523-Dc	108	44	23	60	0	0	5	0
8.	FW73830-34	Rb/1523-Dc	113	40	22	60	0	0	5	0

[1]These data are from the irrigated preliminary winter feed wheat trial planted September 23, 1980 and harvested July 30, 1981. This trial was planted on summer fallow fertilized with 300 pounds of 16-20-0 incorporated pre-plant and 300 pounds of 33-0-0 broadcast at early tillering the last week of March 1981. Disease and plot rating notes were recorded June 21, 1981.

[2]Rust of 0 to 100 is first column. The reaction type is in the second column where S = susceptable, MR = moderately resistant, and R = resistant.

[3]Plot rating is an overall score given the plot were 0 - 3 = undesirable, 4 - 6 = acceptable, 7 - 9 = superior

BYDV tolerant winter wheat selections are agronomically desirable but often lack desirable grain quality. Some yield better than the adapted varieties (Table 2). Though the BYDV tolerant selections are primarily used for crossing to adapted types, cultivars like FW73830-29, FW73830-34, (Number 7 and 8 in Table 2) and other sub-selections from the FW73830 series have good baking and milling quality. The selection FW73830-CP04, as an example, is now in breeders seed production as a potential new soft, white wheat variety.

In 1974, only three of 136-F-2 wheat plots survived what is surmised to be an attack of greenbug. Two of these, FW74715-GB and FW74714-GB, were kept as bulks and planted at various locations, dates, and depths until 1980. In 1980, 50 whole heads from FW74715 were planted in the BYDV trials at Hermiston. Six were kept and are now in increase plots in the 1981-82 Hermiston BYDV screening trial. FW74714 was planted in an early, thinly seeded plot August 21, 1981, and a later thinly seeded plot September 23, 1981. Approximately 120,000 plants emerged. During March, April, May, and June, desirable plants with no BYDV and other disease symptoms were marked. Fifty-two plants were saved from the earlier planting, and 20 from the later. These selections are now in increase plots at Ontario, Oregon.

Selections from two new crosses, FW79006 (Diplomat/McDermid) and FW79008, (Excelsior-2/Rb/Hy) are seemingly producing two types of BYDV resistant plants. On November 23, 1981 plants within the increase plots of FW9006 (with aphids still active) ranged from no BYDV symptoms to death of individuals. On the other hand, no aphids were found in several plots of the FW79008 sub-selections.

CONCLUSIONS

The barley yellow dwarf screening trials at Hermiston are identifying cultivars with tolerance or resistance to virus infections. These tolerant or resistant lines are probably more tolerant than the adapted varieties to other diseases associated with or enhanced by early fall planting such as stripe rust *(Puccinia striiformis* West*)*, leaf rust *(Puccinia recondita* Rob ex Desm. f. sp. tritici*)*, Powdery mildews *(Erysiphe graminis* DC ex Merat f. sp. tritici*)*, Septoria leaf and glume blotch *(Septoria spp.)*, root rots *(Fusarium spp.)*, Take-all *(Gaeumannomyces graminis* [Sacc.] Arx & Oliver var. tritici Walker*)* and possibly Western Beet Yellow Virus and Wheat Streak Mosaic.

There are now more than 100 crosses of resistance times adapted lines in bulk F-2 increase plantings awaiting selection for the 1982 head row screening trials which should produce superior adapted winter wheats.

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GREEN PEACH APHID (*Myzus persicae*) SURVEY[1]
FOR THE HERMISTON-BOARDMAN POTATO-PRODUCING AREA
OF OREGON'S COLUMBIA PLATEAU

Luther A. Fitch[2]

Approximately one million dollars per year are spent by the potato industry in the Hermiston-Boardman area to control green peach aphids--vectors of leaf-roll virus disease of potatoes. In 1976, an intensive two-year study of this insect vector was started by the OSU Department of Entomology under the direction of Richard Clarke. One facet of the study, a trapping program to monitor seasonal movement and buildup of aphid populations, was seen by the growers as a valuable seasonal guide. The grower association has funded this program under the supervision of the local Extension potato agent since.

METHODS AND MATERIALS

Yellow, four-gallon, plastic pans two-thirds full of water are positioned at 30 or more selected locations throughout the potato-growing area. The growing region was arbitrarily divided into four areas in 1978 to determine direction of invasion. Areas are delineated in (Figure 1). A few grains of Cu SO_4 are placed in the pan to control growth of algae. All aphids are collected and placed in numbered vials (containing 70 percent alcohol) to denote trap location. The remaining contents of the pan are discarded and the trap-pan refilled with fresh water.

Once all traps are collected, green peach aphids are removed from the vials and identified under a microscope. A report, sent to growers and service industry personnel, lists the weekly count of green peach aphids and other aphids by location.

RESULTS

Areas differed in numbers of aphids (Figure 1). The date of the largest aphid flights varies from year to year, and areas most geographically removed from urban centers showed slower buildup of populations.

The highest number of aphids found each year are in traps close to towns. Had it not been for traps located within 4 miles south and east of Boardman, counts in Area 1 would have been as low or lower than they were in Area 3. In like manner, the traps in the northwest corner and in the northeast corner of Area 3 accounted for most of the aphid populations in that area.

Trapping was continued later in the season in 1980 than in previous years. A sharp upswing in aphid numbers was noted in all areas in late

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[1]An Extension Service Project funded by Blue Mountain Potato Growers Association.

[2]County Extension agent, Oregon State University Extension Service, Hermiston Oregon 97838

September. According to insect specialists, the increased numbers are caused by the fall flight migrating to their overwintering peach tree hosts. This was verified by observations of winged peach aphids on peach tree leaves during and after the migration. The same upswing trend was seen earlier in September 1981 and was again accompanied by observations of winged aphids on peach trees.

In 1978, trap collections were not started until June 9, but at that time substantial numbers of green peach aphids were found in traps leaving the question as to how much earlier they might have been noted if traps had been out. Starting in 1979, traps were put out in May, but it was not until 1981 that any significant numbers were actually collected before early June. Those collected in May were somewhat randomly located and may have been indicative of an overwintering population of winged adults since the 1980-81 winter was unusually mild.

CONCLUSION

Green peach aphids appear to be perpetuated and disseminated from overwintering peach tree hosts. The spread from those overwintering centers appears progressive over time. Peak populations and peak movement of winged aphids correspond closely to time periods when grain fields with an understory of volunteer potatoes are being dried down for harvest, and when early harvested 'Norgold' potatoes are being killed down and readied for harvest. Another phenomenon that occurs at about this time which accounts for additional aphid movement is the natural maturation of winter annual broadleaf weed hosts such as mustards. It is, however, the flights of aphids from either volunteer potatoes, or from early harvested potato fields that are of prime concern, since these aphids may have fed on chronically infected plants and are thus the greatest potential vectors of leaf-roll virus.

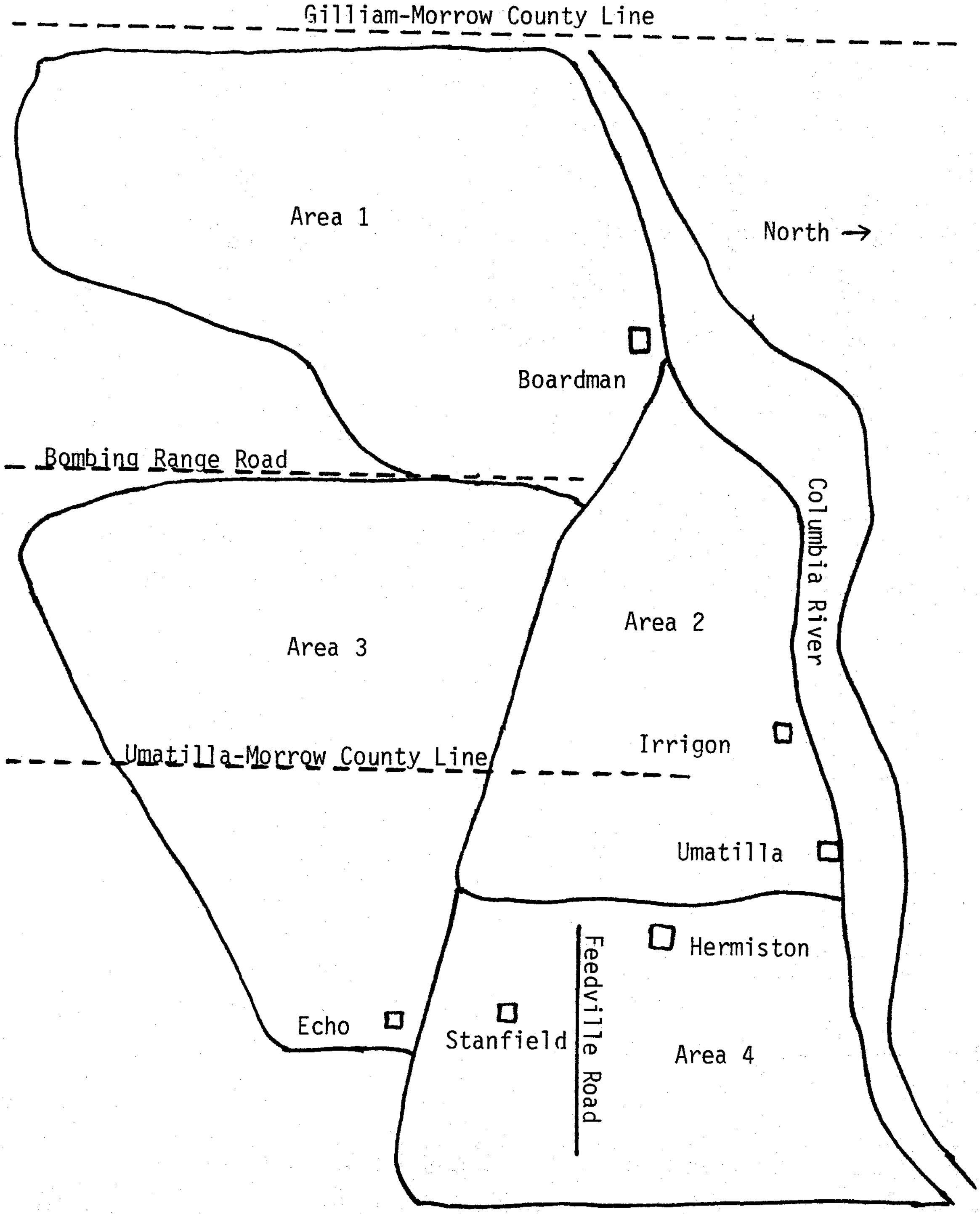

Figure 1.

Map Outline of Western Umatilla - North Morrow County Potato growing region showing the four area divisions used for aphid trapping.

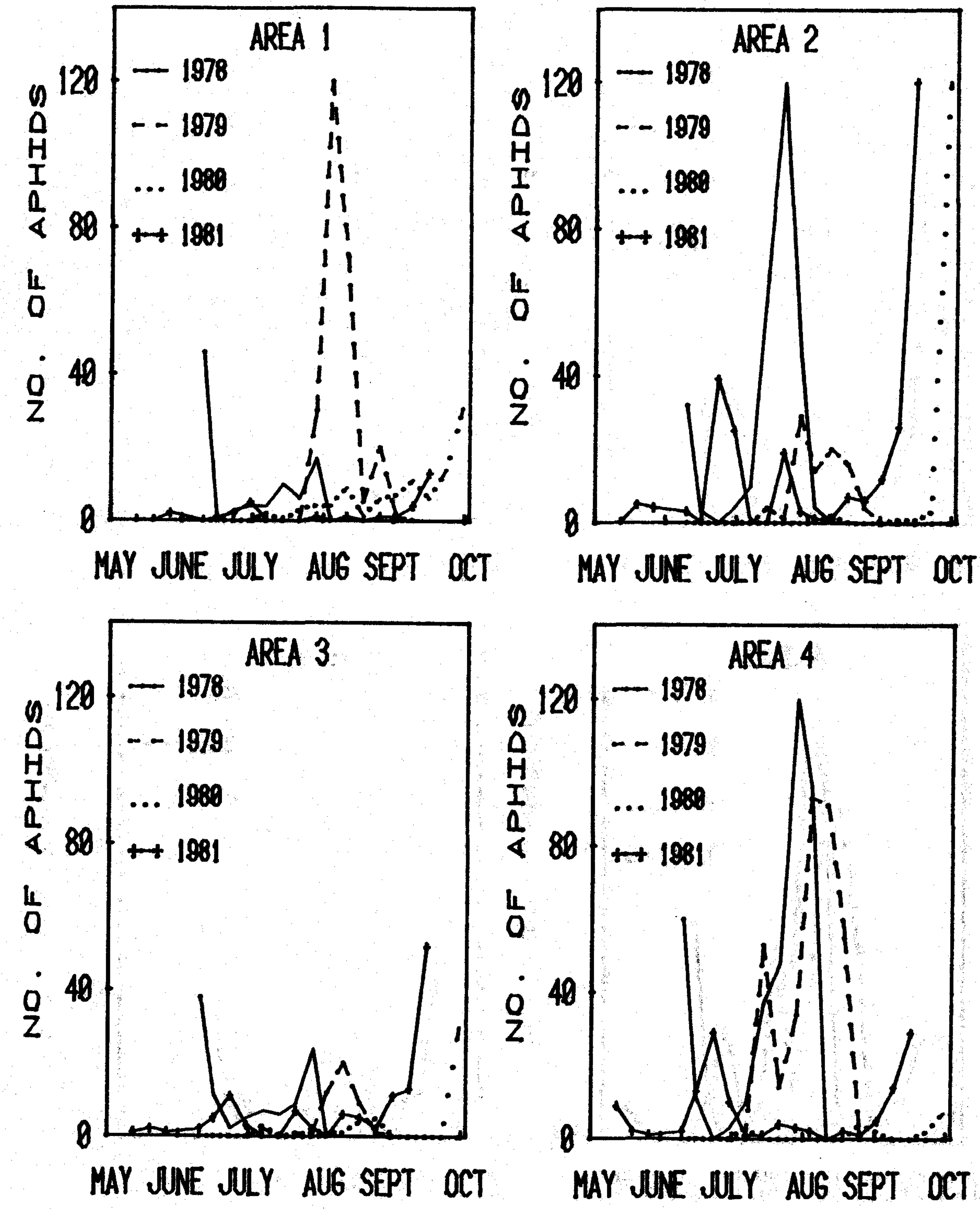

Figure 2. Numbers of Green Peach Aphids trapped from May to October in four Morrow and western Umatilla county areas during 1978 through 1981.

YIELD AND OIL CONTENT OF FIVE OIL SEED CROPS

F. V. Pumphrey[1]

Interest in alternate crops for eastern Oregon and in the production of vegetable oils in the Pacific Northwest prompted the Columbia Basin Agricultural Research Center to conduct oil seed crop investigations in 1980 and 1981. This work was in cooperation with other experiment stations in Oregon, Washington, and Idaho. The local investigations consisted primarily of variety testing of safflower (*Carthamus tinctorius* L.), sunflower (*Helianthus annus* L.), winter rape (*Brassica napus* L.), spring rape (*Brassica napus* L. and *B. compestris* L.), and spring mustard (*Brassica nigra* L., *B. Juncea* L., and *B. alba* L.) under irrigated production at Hermiston and dryland at Pendleton. Cultural practices considered to produce optimum yields with irrigation were used at Hermiston. Cultural practices, seed yields and oil content, and sunflower silage yields are reported here. Results of the dryland trials are found in a Special Report of the Columbia Basin Agricultural Research Center, Pendleton.

SAFFLOWER

Safflower is a full season, summer annual in the Pacific Northwest. Seeding should be as early in the spring as a seedbed can be prepared. Seedlings are frost tolerant and are poor competitors to weeds. Spines, which develop on the edges of the leaves and on the head, discourage any contact with the plant. Safflower is easily harvested with combines used for wheat and barley.

Cultural practices, seed yields, and oil content of safflower variety trials conducted in 1980 and 1981 are presented in Tables 1 and 2. Seed yields are similar to those from trials conducted intermittently during the last 30 years at Hermiston.

SUNFLOWERS

Sunflowers are grown primarily for oil which is extracted from the kernel of the seed. Secondary uses are for confection and for silage. Varieties have been developed for each of these uses.

Sunflower seedlings can withstand very light frosts; thus, planting is done just before the start of frost-free nights. A wide range in stand has little effect on yield as the head size can vary considerably to compensate for differences in stand. Weeds are readily controlled with herbicides. Rust, wilt, and mildew have been observed in Oregon but no disease of an epidemic nature have been observed. Insects, especially the sunflower head moth (*Homoeosoma electellum*), attack the head and may cause serious head

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damage and reduction in seed yield. Bird feeding on the heads can also cause losses. Experience with these trials indicates insect control and possibly bird control would be necessary for commercial production of sunflowers.

Cultural practices, seed yields, oil content of the seed and silage yields are presented in Tables 3, 4, and 5. Silage yields were several tons per acre lower than corn silage yields.

WINTER RAPE

Winter rape is a cool season winter annual crop planted from mid-August into September. Moderate fall growth and no fall bolting are desirable characteristics for winter survival. The seedlings provide little competition to weeds; however, weeds are reasonably controlled with herbicides. Spring growth starts with the first few warmer days in the spring and is followed soon with bolting and flowering.

Winter rape varieties are classified for human food or for industrial oils according to their erucic acid content. In these trials, erucic acid content was not measured.

Agronomic data are presented in Table 6. Seed yield and oil content of varieties grown in 1980 and 1981 are presented in Table 7. Seed yields of winter rape were much higher than yields from spring rape.

SPRING RAPE

Spring rape is a cool season plant. Seedling plants have moderate frost tolerance; thus, planting should be done when frost at night is still occurring. Plants grow rapidly and compete reasonably well with weeds. Shattering may be a problem at harvest time. Seed yields and agronomic data are presented in Tables 8 and 9.

SPRING MUSTARD

Mustard is a cool season plant; thus, cultural practices and climatic conditions which aid rapid growth and maturity before hot summer days promote seed yield in the mustard crop. Varieties have been developed for specialized uses in condiments and oils. Seed yields and agronomic data are presented in Tables 10 and 11.

SUMMARY

These results indicate minimal production problems for safflower, winter rape, spring rape, and spring mustard. Seed yields of winter rape were encouragingly good. Sunflower production problems center around the control of head-damaging insects and possibly birds consuming seed from the heads.

The economics of production of these crops was not favorable for a grower in 1980 and 1981. Price per pound of oil seed crops was in the range of 10 to 12 cents per pounds. The location in the Pacific Northwest where this price was obtained varied; thus, a grower could have had considerable cost in transporting the seed to a market where this price was being paid. Considerable increase in price per pound, increase in production per acre, or reduction in cost of production is needed to make these crops financially feasible for the grower.

Table 1. Agronomic and cultural information about Safflower Yield Trials, Research and Extension Center, Hermiston, Oregon, 1980-81

Observation	Comment
Seedbed preparation	- Rototilled, packed
Planting	- Date--April 6 and 16 Rate--25 lbs/acre Depth--one inch Row spacing--one foot
Weed control	- Treflan, 1 pint/acre preplant; hand weeded
Fertilization	- 250 lbs/acre of 10-20-10 worked into seedbed 140 lbs/acre N before first bloom
Irrigation	- Frequent sprinkler irrigated
Insects	- None
Diseases	- Traces of rust and sclerotinia wilt
First bloom	- July 10-16
Harvest	- Late September, early October
Weather	- Favorable for plant growth, above average

Table 2. Seed yield and oil content of safflower varieties grown under irrigation at the Research and Extension Center, Hermiston, Oregon, in 1980 and 1981

Variety	Seed yield		Oil content		Plant height
	pounds per acre		percent		inches
	1980	1981	1980	1981	1981
Sun Hi 317	2,870	3,410	39.3	38.5	41
Sun Hi 208	2,360	3,220	36.1	36.9	38
Sun Hi 112	1,970	2,870	37.4	37.1	37
Sun Hi 742	1,810	-	38.0	-	-
Sun Hi 541	2,400	3,510	41.2	42.0	41
Carmex 353	2,020	2,880	37.0	38.4	40
Cal West 74	2,430	3,210	40.7	39.3	38
UC-1	1,590	2,310	34.5	32.5	35
Sidwell	2,750	-	31.1	-	-
Gila	1,990	-	38.2	-	-
Hartman	-	2,060	-	34.9	41
5% LSD	-	360	-	-	-

Table 3. Agronomic and cultural information about the 1980 and 1981 Sunflower Variety Trials, Research and Extension Center, Hermiston, Oregon

Observation	Comment
Seedbed preparation	- Rototilled, packed
Planting	- Date--May 6, 1980 Rate--22,000 plants/acre April 22, 1981 Row spacing--1 foot Depth--1 inch
Weed control	- Treflan, 1 pint/acre preplant; hand weeded
Fertilization	- 200 lbs/acre of 10-20-10 worked into seedbed 120 lbs/acre N when plants 12-16" tall
Irrigation	- Frequent sprinkler irrigated
Insects	- Severe head moth damage, Sevin applied
Bird damage	- Severe, required covering the heads with paper bags
Plant height	- 7 to 9 feet in the seed varieties which is taller than desired for combining and resistance to lodging
Weather	- Favorable for plant growth, above average

Table 4. Seed yield and oil content of sunflower varieties grown under irrigation at the Research and Extension Center, Hermiston, Oregon, in 1980 and 1981

Variety	Seed yield	Oil content
	pounds per acre	percent
1980		
Sun Hi 372A	2,650	43.4
Sigco 894	1,890	45.8
DO 704XL	2,920	47.1
5% LSD	540	-
1981		
DO 844	2,860	45.6
DO 164	2,450	45.4
DO 704XL	2,370	43.2
Sigco 894	2,490	44.1
Sigco 432	3,270	42.0
Sigco 448	2,020	44.1
Cal West 904	2,430	46.3
ST 315	1,930	42.4
IS 7116	1,930	45.8
IS 907E	2,670	45.1

Table 5. Green weight and silage yields at 70 percent moisture of sunflowers grown under irrigation at the Research and Extension Center, Hermiston, Oregon, in 1980 and 1981

Variety	Green weight[1]	70% Moisture
	tons per acre	
1980		
Sungro 894	36.3	20.6
Sungro 372A	42.4	24.0
DO 716	33.2	18.8
1981		
Sungro 372A	25.0	26.8
Sungro 380A	24.9	26.6
ST 304A	25.0	26.8
ST 301A	24.6	26.4
ST 108	21.3	22.8
Sigco 894	22.9	24.5
Sigco 449	23.6	25.2
NK 254	22.4	24.0
5% LSD	2.1	-

[1]Average dry matter when harvested in 1980 was 17 percent and in 1981 was 32 percent; harvested mid-August.

Table 6. Agronomic and cultural information about the 1980 and 1981 Winter Rape Variety Trials, Research and Extension Center, Hermiston, Oregon

Observation	Comment
Seedbed preparation	- Rototilled, packed
Planting	- Date--Sept. 10, 1979 Rate--8 lbs/acre Sept. 14, 1980 Row spacing--1 foot Depth--one half inch
Weed control	- Hand weeded
Fertilization	- 200 lbs/acre of 16-20-0 worked into seedbed 140 lbs/acre of nitrogen from ammonium nitrate March 25
Irrigation	- Frequent sprinkler irrigated
Insects	- Fall and spring populations of flea beetles; serious infestation of cabbage seed pod weevil (*Ceutorhynchess assimilus*) in 1980
Diseases	- No serious disease problem
Plant height	- Over five feet; considerable plant lodging between blooming and maturity
Blooming	- Early bloom April 10, full bloom April 25-May 5
Harvested	- Hand cut June 18 to June 30; threshed early July
Weather	- Mild temperatures, above normal rainfall, and less than normal wind were favorable for cool season crops in 1980 and 1981. The density of plant growth and the amount of blooming and pod filling in the irrigated trial appeared to be near the expected maximum.

Table 7. Seed yield and oil content of winter rape varieties grown under irrigation at the Research and Extension Center, Hermiston, Oregon, in 1980 and 1981

Variety	Seed yield		Oil content	
	pounds per acre		percent	
	1980	1981	1980	1981
Dwarf Essex	4,505	5,150	44.2	44.5
Gorczanski	5,285	6,250	43.6	43.9
Norde	5,095	6,020	43.3	44.4
Brink	3,730	4,330	42.3	42.1
Raporo	4,330	5,920	40.7	40.7
Quinta	5,600	5,740	41.3	42.7
Primor	3,550	6,330	41.6	42.2
Sipal	4,400	5,070	41.9	42.9
Oleagineau	4,755	-	40.7	-
ORB 78-253	1,470	-	42.0	-
ORB 78-259	-	3,970	-	43.7
Bishop	-	5,990	-	40.7
Herkules	-	4,860	-	43.5
Jet Neuf	-	5,630	-	43.1
5% LSD	697	677	-	-

Table 8. Agronomic and cultural information about the 1980 Spring Rape Variety Trials, Research and Extension Center, Hermiston, Oregon

Observation	Comment
Seedbed preparation	- Rototilled, packed
Planting	- Date--April 7, 1980 Rate--6 lbs/acre Depth--one half inch Row spacing--1 foot
Weed control	- Hand weeded
Fertilization	- 200 lbs/acre of 16-20-0 worked into seedbed 120 lbs/acre of nitrogen applied in split application before and during blooming
Irrigation	- Frequent sprinkler irrigated
Insects	- Flea beetles
Diseases	- None
Harvest	- Varieties Candle, Torch, and Lear on July 19; others on July 21 and 22

Table 9. Seed yield and oil content of spring rape varieties grown under irrigation at the Research and Extension Center, Hermiston, Oregon, in 1980

Variety[1]	Seed yield	Oil content
	pounds per acre	percent
<u>Brassica napus</u>		
Altex	700	36.9
Midas	1,085	36.8
Tower	800	34.4
Regent	930	37.8
<u>Brassica campestris</u>		
Candle	760	33.7
Torch	930	35.7
Lear	640	32.6
5% LSD	353	-

[1]The <u>Brassica campestris</u> varieties matured approximately one week earlier than the <u>B. napus</u> varieties. The <u>B. campestris</u> varieties also lodged more.

Table 10. Agronomic and cultural information on Spring Mustard Variety Trials, Research and Extension Center, Hermiston, Oregon, in 1980 and 1981

Observation	Comment
Seedbed preparation	- Rototilled, packed
Planting	- Date--April 25, 1980 Rate--6 lbs/acre April 16, 1981 Row spacing--1 foot
Weed control	- Hand weeded
Fertilization	- 200 lbs/acre of 16-20-0 worked into seedbed 120 lbs/acre of nitrogen applied in split application before and during blooming
Irrigation	- Frequent sprinkler irrigated
Insects	- Flea beetles
Diseases	- None
Harvest	- August 13, 1980, and July 29, 1981

Table 11. Seed yield and oil content of spring mustard varieties grown under irrigation at the Research and Extension Center, Hermiston, Oregon, in 1980 and 1981

Variety	Seed yield		Oil content	
	pounds per acre		percent	
	1980	1981	1980	1981
Lethbridge 22A	1,150	1,930	35.9	39.2
Stoke	1,190	1,800	33.0	38.6
Domo	1,240	1,930	37.7	40.0
Commercial Brown	1,150	1,920	32.2	36.7
Sabre	920	1,270	28.7	28.8
Kirby	890	1,200	27.4	27.8
Blaze	1,100	-	33.3	-
Eklo	1,300	1,660	30.4	34.9
Gisilba	960	-	27.1	-
Commercial Yellow	780	-	27.4	-
Ochre	-	1,320	-	27.5
5% LSD	235	263	-	-

CHARACTERISTICS OF POTATO VARIETIES GROWN OR EVALUATED IN NORTH CENTRAL OREGON

D.C. Hane[1]

Atlantic (1976)[2]

Type: Medium maturity. Oblong, slightly netted tubers. Yield comparable to Russet Burbank (R.B.).
Strengths: Resistant to late blight, net necrosis, virus X, and golden nematode *(Heterodera rostochiensis Wn.)* Very good specific gravity (S.G.). Good fry color and texture. Stores well.
Weaknesses: Susceptible to hollow heart (H.H.) and internal necrosis.

Bison (1974)

Type: Medium maturity. Smooth round tubers.
Strengths: Resistant to certain races of late blight and moderately resistant to scab. Fair chip and baking qualities.
Weaknesses: Small tubers. Poor to medium yield. Low S.G.

Butte (1977)

Type: Late maturing. Long, cylindrical, well russeted tubers.
Strengths: Resistant to leafroll net necrosis and virus X. Greater nutritional value than R.B.
Weaknesses: Susceptible to blackleg and verticillium wilt. Short dormancy. Sugar accumulation.

Centennial (1976)

Type: Mid-late maturity. Oblong to long russeted tubers.
Strengths: Resistant to net necrosis. Long dormancy. High percent of No. 1 tubers.
Weaknesses: Susceptible to scab. Small tubers. Yields less than R.B. Sugar accumulation.

Chiefton (1966)

Type: Medium maturity. Red skin tubers. Fresh market variety.
Strengths: Resistant to late blight, virus A, and leafroll net necrosis.
Weaknesses: Susceptible to scab. Low yield and S.G.

Kennebec (1948)

Type: Medium-late maturing. Oval to oblong white skinned tubers.
Strengths: Resistant to late blight and net necrosis. High yield and percent No. 1's. Processes well.
Weaknesses: Susceptible to scab, verticillium wilt, and most viruses. Round, oversized tubers. Hollow Heart. Short dormancy and sugar accumulation.

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[1] Research assistant, Columbia Basin Agricultural Research and Extension Center, Oregon State University, Hermiston, Oregon 97838.

[2] Indicates year of release

Lemhi (1980)

Type: Late maturing. Long, cylindrical, russeted tubers.
Strengths: Resistant to net necrosis. High yield with good S.G. and high percent of No. 1 tubers. Slow sugar buildup in storage. Good fry quality.
Weaknesses: Very susceptible to pressure bruising. Susceptible to virus Y. Does not store well.

Monona (1965)

Type: Medium maturing. Round white. Chipping variety.
Strengths: Resistant to verticillium wilt and viruses X and Y. Good chip color.
Weaknesses: Low yields. Short dormancy.

Nampa (1973)

Type: Medium late maturing. Long cylindrical tubers with medium russeting.
Strengths: Resistant to virus X and medium resistance to leafroll net necrosis. High S.G.
Weaknesses: Yields less than R.B. in Hermiston areas. Poor texture. Sugar accumulation.

Nooksack (1973)

Type: Late maturing. Oblong russeted tubers.
Strengths: Resistant to growth defects and to leafroll net necrosis. High S.G. and percent No. 1 tubers. Very long dormancy. Slow sugar accumulation.
Weaknesses: Blank seed pieces because of fewer eyes. Warming of seed to break dormancy.

Norchip (1969)

Type: Medium maturity. Round, white tubers.
Strengths: High percent No. 1's and high S.G.
Weaknesses: Low yield. Short dormancy.

Norgold (1964)

Type: Early maturing. Oblong, russeted tubers.
Strengths: Resistant to leafroll net necrosis. High percent No. 1 tubers.
Weaknesses: Susceptible to verticillium wilt, blackleg, and hollow heart. Low S.G. Short dormancy. Sugar accumulations.

Pioneer (1963)

Type: Early maturing. Oblong, red skinned tubers.
Strengths: Resistant to leafroll net necrosis. High percent No. 1's. Stores well.
Weaknesses: Susceptible to early blight and scab. Yields generally less than R.B.

Russet Burbank (1876)

Type: Late maturing. Long russeted tubers.
Strengths: Long dormancy. Very good processing qualities. Stores well.
Weaknesses: Susceptible to leafroll net necrosis. Rough tubers. Low percent No. 1's. Dark end french fries.

Shurchip (1970)

Type: Medium maturing chipper. Round, white tubers.
Strengths: Resistant to verticillium wilt and common scab.
Weaknesses: Low yield.

Targhee (1973)

Type: Late maturing. Oblong, smooth, heavy russeted tubers.
Strengths: Resistant to verticillium wilt, common scab and virus X.
Weaknesses: Susceptible to leafroll net necrosis. Generally yields less than R.B. Tends to develop growth cracks and elephant hide. Sugar accumulation.

METEROLOGICAL DATA
COLUMBIA BASIN AGRICULTURE RESEARCH AND EXTENSION CENTER
HERMISTON, OREGON

T.P. Davidson[1]

Temperatures, Monthly Mean, Fahrenheit

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	38	38	46	52	60	63	69	73	63	50	43	37
1932-81	32	38	45	53	61	65	74	73	64	53	41	36

Temperatures, Monthly Mean Maximum, Fahrenheit

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	42	47	59	65	72	75	84	89	79	64	54	44
1932-81	40	46	56	66	75	82	90	88	80	67	51	44

Temperatures, Monthly Mean Minimum, Fahrenheit

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	33	29	33	39	47	52	55	56	47	36	33	31
1932-81	23	29	33	39	47	47	58	58	48	39	31	27

1981 Temperatures, Monthly Maximum and Minimum, Fahrenheit

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Max	51	63	68	82	87	90	99	100	92	77	68	58
Min	25	21	22	24	35	41	45	44	36	21	21	22

Precipitation, Inches

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	1.47	1.05	.49	.09	1.58	1.45	.57	.05	.56	.68	1.11	2.41
1932-81	1.23	.91	.72	.63	.67	.62	.21	.27	.41	.76	1.14	1.30

Total Precipitation in 1981, 11.51 Inches

Average Total Precipitation 1932-81, 8.87 Inches

Evaporation - Inches

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1981			3.32	5.72	8.11	8.82	11.01	9.51	6.17			
1932-81			3.27	5.30	8.07	9.61	11.22	9.62	6.23			

Wind Velocity - Miles Per Hour Average

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	1.6	2.3	3.1	2.1	4.1	4.4	3.6	2.4	2.3	1.9	2.1	2.6
1932-81	2.5	2.8	3.8	4.3	4.0	4.1	3.6	3.2	2.5	2.2	2.3	2.5

Frost Free Days

1981	April 14	October 4	173 Days
1932-81	April 23	October 10	170 Days

[1] Assistant professor Emeritus of Horticulture, Columbia Basin Agriculture Research and Extension Center, Hermiston, Oregon 97838.

Weather Extremes from 1932 through 1981

Temperature Extremes - Degrees Fahrenheit

	January	February	March	April	May	June
High	1971, 69	1972, 74	1960, 82	1934, 93	1951, 101	1951, 108
Low	1957, -31	1950, -29	1955, 8	1972, 19	1954, 22	1951, 37

	July	August	September	October	November	December
High	1939, 112	1961, 113	1944, 102	1943, 88	1934, 77	1941, 70
Low	1962, 39	1980, 38	1965, 27	1935, 7	1955, -12	1972, -11

Precipitation Extremes

Most precipitation per month, inches

Jan. 1970	Feb. 1940	March 1957	April 1974	May 1962	June 1948
3.06	2.70	2.72	2.13	2.20	2.19

July 1968	Aug. 1979	Sept. 1946	Oct. 1957	Nov. 1973	Dec. 1973
1.02	1.83	1.99	3.91	3.77	3.45

Most precipitation in a year, 1957, 13.99 inches
Least precipitation in a year, 1967, 4.43 inches

Most precipitation in a 24-hour period: October 2, 1957, 3.36 inches

Snow records from December 1946 through 1981

December 14, 1948, 7 inches in a 24-hour period
January 10, 1980, 12 inches on ground at 8:00 AM

Frost-Free Days

Latest frost in Fall 1937, November 4, 32° Fahrenheit
Earliest frost in Fall 1970, September 14, 30° Fahrenheit
Latest frost in Spring 1964, May 23, 30° Fahrenheit
Earliest last frost in Spring 1958, March 27, 29° Fahrenheit
Longest frost-free period in 1937, 211 days
Shortest frost-free period in 1970, 126 days