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Irrigated Crops Research in Central Oregon—1987

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CONTENTS

COVER: Malcolm Johnson and Steve James with 'Malcolm' wheat

As an Oregon State College employee, Malcolm established the Central Oregon Experiment Station in 1948 to address crop production problems in Central Oregon. He began with himself, a shovel and a pick-up working exclusively in grower's fields. Malcolm eventually established offices and permanent research plots on public land at Redmond and Madras in the early to mid-1960's. The Powell Butte field was added in the late 1970's. By the mid-1970's the station staff grew to two Ph.D. scientists, plus permanent support positions.

Malcolm's research is the basis for the crop fertilizer guides in Central Oregon. He worked with nitrogen, phosphate, potash, sulphur and pH. He was instrumental in showing the value of adding potash to volcanic soils, which initially are high in potash but which are depleted of potassium by continuous cropping.

In cooperation with George Carter at Klamath Falls, Malcolm began a program to select new potato varieties for the Oregon potato industry. Initially, 50 new selections were screened per year, but the program has grown to about 100,000 new selections per year. Over the years, Malcolm evaluated many new crops for their potential in Central Oregon's rugged environment. He assisted in cereal and other crop variety evaluations in statewide and regional programs. In 1985, the new wheat variety 'Malcolm' was released and named in his honor.

In 1987, an endowment scholarship fund was initiated to show appreciation to Malcolm's thirty-four years of service to Central Oregon and to assist Central Oregon students in their efforts to obtain an education in Agricultural Sciences at Oregon State University.

METEROLOGICAL DATA - 1986
Redmond*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1986 TOTAL
AIR TEMP. (°F)													
AVE. MAX. TEMP.	45	45	58	57	66	80	76	86	66	65	51	40	
AVE. MIN. TEMP.	27	27	31	26	37	45	42	48	37	32	31	25	
MEAN TEMP.	36	36	45	42	52	63	59	67	52	49	41	33	
AIR TEMPERATURE (No. of Days)													
MAX. 90 OR ABOVE	0	0	0	0	2	6	0	7	0	0	0	0	
MAX. 32 OR BELOW	1	3	0	0	0	0	0	0	0	0	0	8	
MIN. 32 OR BELOW	27	18	18	24	12	1	0	0	6	18	14	29	
MIN. 0 OR BELOW	0	0	0	0	0	0	0	0	0	0	0	0	
GROUND TEMP. (°F at 4")													
AVE. MAXIMUM	26	31	40	43	50	64	63	67	55	48	38	30	
AVE. MINIMUM	25	29	37	40	45	59	58	62	51	44	36	29	
MEAN TEMP.	26	30	39	42	48	62	61	65	53	46	37	30	
PRECIPITATION (inches)													
MONTHLY TOTAL	1.66	2.53	.49	T	.41	.10	.53	.07	1.24	.57	.75	.62	8.97
EVAPORATION (Ave. Inches Per Day)	--	--	--	--	.22	.30	.27	.32	.14	.08**	--	--	
WINDAGE (Ave. Miles Per Day)	65	68	64	71	74	63	67	51	50	41	70	52	

Growing Season:	**Last Date Before July 15**	**First Date After July 15**	**Total Number of Days Between Temp. Minimums**
Air Temp. Min. 32° or below	6/28	9/9	72
Air Temp. Min. 28° or below	6/28	10/2	95
Air Temp Min. 24° or below	5/22	10/11	141

METEROLOGICAL DATA - 1986
Madras*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1986 TOTAL
AIR TEMP. (^{o}F)													
AVE. MAX. TEMP.	42	44	57	59	69	84	80	90	68	65	48	38	
AVE. MIN. TEMP.	28	29	34	31	39	49	47	52	41	36	33	27	
MEAN TEMP.	35	37	46	45	64	67	64	71	55	51	41	33	
AIR TEMPERATURE (No. of Days)													
MAX. 90 OR ABOVE	0	0	0	0	3	12	3	19	1	0	0	0	
MAX. 32 OR BELOW	4	5	0	0	0	0	0	0	0	0	0	11	
MIN. 32 OR BELOW	25	15	9	19	12	0	0	0	0	5	14	28	
MIN. 0 OR BELOW	0	0	0	0	0	0	0	0	0	0	0	0	
GROUND TEMP. (^{o}F at 4")													
AVE. MAXIMUM	--	--	--	58**	69	85	84	88	69	64**	--	--	
AVE. MINIMUM	--	--	--	46	54	70	68	73	59	51	--	--	
MEAN TEMP.	--	--	--	52**	62	78	76	81	64	58**	--	--	
PRECIPITATION (inches)													
MONTHLY TOTAL	2.56	3.42	.69	.19	.50	.26	.86	T	1.34	.58	1.61	.78	12.79
EVAPORATION (Ave. Inches Per Day)	--	--	--	.19**	.24	.26	.31	.35	.16	.13**	--	--	
WINDAGE (Ave. Miles Per Day)	--	--	--	79	65	52	60	53	56	35**	--	--	

Growing Season:	Last Date Before July 15	First Date After July 15	Total Number of Days Between Temp. Minimums
Air Temp. Min. 32^{o} or below	5/22	10/11	141
Air Temp. Min. 28^{o} or below	5/22	10/11	141
Air Temp Min. 24^{o} or below	4/24	11/25	214

METEROLOGICAL DATA - 1986
Prineville*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1986 TOTAL
AIR TEMP. (°F)													
AVE. MAX. TEMP.	48	48	62	61	71	83	81	91	69	68	51	43	
AVE. MIN. TEMP.	29	29	30	26	37	44	40	44	35	29	29	23	
MEAN TEMP.	39	39	46	44	54	64	61	68	52	49	40	33	
AIR TEMPERATURE (No. of Days)													
MAX. 90 OR ABOVE	0	0	0	0	5	10	5	22	3	0	0	0	
MAX. 32 OR BELOW	0	0	0	0	0	0	0	0	0	0	0	0	
MIN. 32 OR BELOW	23	16	21	26	11	2	2	0	12	23	23	30	
MIN. 0 OR BELOW	0	0	0	0	0	0	0	0	0	0	0	0	
PRECIPITATION (inches)													
MONTHLY TOTAL	1.05	2.16	.79	.37	.62	.16	.40	.00	1.88	.55	.49	.15	8.62

Growing Season:	**Last Date Before July 15**	**First Date After July 15**	**Total Number of Days Between Temp. Minimums**
Air Temp. Min. 32° or below	7/5	9/10	65
Air Temp. Min. 28° or below	5/22	10/2	132
Air Temp Min. 24° or below	5/22	10/11	141

* No meterological data are recorded at the COES Powell Butte field. Redmond data are recorded at COES facilities. Prineville data are from KRCO, four miles NW of Prineville. Madras data are recorded at the North Unit Irrigation District offices, adjacent to the COES field.

** Missing data.

NA = Not available.

T = Trace precipitation, not affecting total.

EFFECT OF PLANT DENSITY ON WINTER SURVIVAL AND SEED PRODUCTION OF AN IMPERATOR TYPE HYBRID CARROT

J. Loren Nelson, Don Grabe, and Sean Currans[1]

ABSTRACT

Two experiments with identical treatments were conducted on one strip of eight-female rows of an Imperator type hybrid carrot on the Madras research site from August 1985 through September 1986. Plants were spring and fall thinned to six- and 12-inches between plants, and to a four-inch block in the spring for comparison to a non-thinned control. From 32.5 to 53.5 percent of the fall thinned plants had heaved compared to 1.1 percent or less for the control plants. The percent winterkill ranged from 14.2 to 21.7 for both fall-thinned treatments but was only 2.8 or less for the control. Obviously, fall thinning is not recommended. Plants of the spring treatments only of experiment I were harvested since treatments of experiment II appeared to be similar and resources were unavailable to handle them. Total seed yield from plants spaced six-inches apart was significantly higher than other treatments except the four-inch block. Individual plant productivity was greatest from plants spaced 12 inches apart but plant population was too low to maximize total yield compared to six-inch spaced plants. Plant spacing had little effect this year on the proportions of each seed size class comprising yield. On the average, the size distribution was 9, 61, and 30 percent for 1/13, 1/16, and 1/19 size seed respectively. The 1,000-seed weight within size class was not altered by plant density. Germination averaged about 90 percent and was not affected by plant spacing or seed size within plant spacings. Therefore, the four-inch block and six-inch spacing between plants produced the highest yield of quality seed.

Many growers produce carrot seed in central Oregon by the seed-to-seed method. Seed is planted in August so the carrot seedlings can make sufficient growth and be hardened for the

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winter. Winter survival varies from year to year. Up to 30 percent stand loss has occurred. As a result the stand in some fields has to be increased by transplanting carrots in the spring. However, questions have arisen about the correct plant density to which a stand should be restored as well as the number of plants to which a field should be thinned for yield of high quality seed. Therefore this study was undertaken to assess the effect of plant density on winter survival, seed yield and quality during the 1985-86 season. This study will be continued for 2-3 years.

METHODS

Plots for the study were in a small Imperator-type hybrid carrot seed production field on the Madras research site of the Central Oregon Experiment Station. This field had spring cereals in 1984 and was summer fallowed in 1985. A broadcast application of N-P-K:16-16-16 (414 pounds/acre) was incorporated into the seedbed before the formation of 30-inch wide beds. Planting began August 6, 1985, but only four female rows were sown because the beds were too soft. Approximately one inch of water by sprinkler was applied to firm the beds. On August 12, the other four female rows of the eight female and four male row pattern for the whole production field were planted. Irrigation was again applied after the entire field was planted and the soil was kept moist to ensure good germination and seedling emergence. Weeds were controlled by an application of Lorox (1 pound ai/acre) on September 20, 1985. Other commercially acceptable practices were conducted in 1986.

The study was located on the strip of four early (August 6) and four late (August 12) female rows because differences in carrot plant height were observed for the two sowing dates. The early and late rows, each with the same treatments, were designated as experiments I and II, respectively. Five treatments (carrots thinned to six- and 12-inches between plants on November 6, 1985 and March 14-17, 1986 plus removing every other four-inch block of plants in the spring) were compared to a non-thinned control. The same six treatments were replicated four times in a randomized complete block design for each experiment. Each treated plot was 18 feet long by 10 feet wide (four 30-inch wide beds). The two center rows 10 feet long were hand harvested September 10 and 11, 1986. The number of plants harvested were counted. All plants from one row were placed in a plastic lined tote box for drying. These plants were handled as the bulk portion of the plot. Plants from the other row were separated and the umbels were clipped and identified according to class (primary, secondary, and tertiary). The number of umbels in each class were counted. Samples were threshed with a belt thresher and scalped before a second threshing. An M-2B air screen machine was used to condition the seed. Sample identity was maintained from each row of a plot from harvest through conditioning and weighing. However, the total seed yield reported was the sum of seed from both rows.

Quality of bulk-harvested seed

A 40-gram working sample was obtained from each bulk seed sample with a Gamet Precision divider. Since the belt thresher did not accomplish complete debearding, each sample was further debearded to simulate that obtained by commercial debearders. This was done by hand rubbing the seed on a canvas-covered foam pad. The seed was further cleaned with hand screens and a laboratory blower.

Each sample was sized with hand screens into three size fractions: (1) over 1/13, (2) through 1/13 and over 1/16, and (3) through 1/16 and over 1/19. Each size fraction was weighed and the amount reported on a pounds/acre basis.

The 1,000-seed weight of each size fraction was determined. The germination percentage of each size fraction was determined in four replications of 100 seeds each at 20-30^{o} C for 14 days.

Quality of seed from various umbel orders

Seed from each umbel order was cleaned with hand screens and a laboratory blower. Further debearding was not necessary since the seeds were not sized. Germination tests were conducted on seed larger than a 1/19 screen opening. Germination tests were conducted as before, but with only two replications per sample. One thousand-seed weights were determined for each sample.

RESULTS AND DISCUSSION

Significantly more heaving and death occurred among plants spaced six- and 12-inches apart than control populations of 11 and 20 plants per foot of row during the 1985-86 winter (Table 1). Some plants had heaved about two inches above the soil surface. There was no apparent difference for either heaving or winterkill among plants in experiments I and II due to the six-day plant growth differential. At thinning time the leaves were about six- and three-inches tall on plants in experiments I and II, respectively. However, little variation in root diameter (one-half inch) and length (six-eight inches) existed among plants in both experiments. By November 7, 1985, the soil had cracked deeply in line with the carrot plants which exposed up to one quarter of an inch on two sides of the carrot root. The plants were covered with snow from November 11, 1985, to January 10, 1986, which provided good protection from cold temperatures.

Fall thinning of a carrot stand is detrimental and cannot be recommended. No comparisons were possible on fall vs spring thinning in either experiment I or II because of differences in stand, although plant height, earliness of flowering, number and size of umbels on fall thinned plants appeared to be similar to the same on spring thinned plants.

For the spring thinned treatments, total seed yield from plants six inches apart was significantly higher than all treatments except four-inch blocks (Table 2). However, individual plants were most productive at the 12-inch spacing but plant density was insufficient to maximize total yield. From observation of all treatments it appeared that profuse stem branching was inversely related to low plant population, but no quantitative data were collected. Control and S-4 inch block plants were observed to be about eight inches taller than the six to 12-inch spaced plants. The primary umbels on the two high density populations appeared to flower about a week before plants in other treatments. There were significantly fewer umbels per plant in control and S-4 inch block plants but primary umbels were significantly more numerous and contributed more to yield than the same on plants spaced six and 12 inches. It appears that the high total yield from six-inch spaced plants resulted from more tertiary umbels compared to more primary umbels on S-4 inch block plants.

There was no statistically significant difference in the number of secondary umbels among the four plant densities studied but percent seed yield by umbel class shows that the amount of seed from the secondary umbels increased from the highest to the lowest plant population.

<u>Quality of bulk-harvested seed</u>

The effects of plant density on seed yield of each size class are shown in Table 3. On the average, the 1/16 size class made up 61 percent of the yield, the 1/19 size was 30 percent of the yield, and the 1/13 size was nine percent (Table 4). There was a tendency for more 1/16 size seed to be produced at the 12-inch spacing with less for the 1/13 size. In general, however, plant spacing had little effect this year on the proportions of each size class making up the yield.

The 1,000-seed weight within size classes was affected significantly by plant spacing in only one instance. This would indicate that seed density within size classes was not altered by the density of planting.

Germination percentage averaged about 90 percent and was not affected by plant spacing or seed size within plant spacings.

<u>Quality of seed from various umbel orders</u>

Seed from the primary umbels was the heaviest with seed from the tertiary umbels the lightest (Table 5). Plant spacing did not alter this relationship. As in the bulk-harvested study, six-inch spacing produced lighter seed than four inch blocking.

Seed germination of the primary umbels averaged 65 percent, secondary umbels 62 percent, and tertiary umbels 74 percent (Table 5). Germination of the Control and four-inch blocking was higher than the six-inch and 12-inch spacing.

Since the germination percentages of these seed were considerably lower than of the bulk-harvested seed, no conclusions should be based on these data. On investigating the cause of the low germination of the umbel orders, it was found that the samples contained many empty and undersized seeds. In the bulk-harvested samples, these empty seeds were crushed during the hand-debearding, and the higher germination percentage was obtained because only filled seeds were planted. This conclusion is supported by the fact that the 1,000-seed weight of the bulk-harvested seed was higher than of the seed harvested umbel-by-umbel. We will have to modify our conditioning procedures next year to more closely simulate commercial conditioning results.

Nevertheless, because of the uniformly high germination of all seed sizes in the bulk-harvested samples, all umbel orders undoubtedly were producing good quality seed.

This study did not address the difference in effects that may exist among hybrids, open-pollinated varieties, or between the two types. Therefore, application of these results to other hybrids or open-pollinated varieties is not suggested.

Additional data will be collected in 1987 on plant density effects.

REFERENCE

Simpson, W.R., R.G. Beaver, W.M. Colt, and C.R. Baird. 1985. Carrot, Parsnip and Parsley Seed Production in the Pacific Northwest. A Pacific Northwest Extension Publication (Idaho, Washington, Oregon). PNW272.

Table 1. Effect of plant density on heaving and winter survival of carrot plants at Madras, Oregon, 1985-86

Treatment[1]	Plants: Heaved Exp. I	Heaved Exp. II	Dead Exp. I	Dead Exp. II
	%			
F-6" Space	53.5 a	32.5 a	21.7 a	20.8 a
F-12" Space	34.5 a	34.0 a	18.1 a	14.2 a
Control	.4 b	1.1 b	.6 b	2.8 b
Mean	29.5	22.5	13.5	12.6
CV (%)	60.6	71.8	69.4	41.8
LSD (5%)	30.9	28.0	16.2	9.2

1 Treatment: F-6 inch and F-12 inch space -- populations hand thinned November 6, 1985, to a carrot every six and 12 inches, respectively; control -- Exp. I & II populations averaged 20 and 11 plants per linear foot of row, respectively.

Table 2. Effect of plant density on carrot seed production at Madras, Oregon, 1986

Treatment[1]	Seed yield Total	Seed yield per plant	Umbels per plant	Umbels by class[2] P	S	T	Seed yield by umbel class[2] P	S	T
	(lb/a)	(oz.)	(no.)	%					
Control	1117c[3]	.2c	8.5c	14a	43a	44c	35a	54c	11b
S-4" Block	1305ab	.3c	12.3c	10b	44a	47bc	23b	63bc	15ab
S-6" Space	1389a	1.1b	43.3b	3c	41a	57a	6c	71ab	23a
S-12" Space	1135bc	1.9a	69.0a	1c	46a	52ab	3c	80a	16ab
Mean	1237	0.8	33.3	7	43	50	17	67	16
CV (%)	9	9.9	12.4	35	12	10	38	11	34

1 Treatment: control -- plants about one inch apart; S-Four-inch block -- plants removed from alternate four-inch row lengths on March 13-17, 1986 with about five plants in the four-inch block; S-six-inch and S-12 inch space -- populations thinned to a carrot plant every six and 12 inches, respectively, on March 13-17, 1986.

2 Class: P = primary; S = secondary; T = tertiary.

3 Values within a column with the same letter are not significantly different at the .05 level of probability using Duncan's multiple range test.

Table 3. Effect of plant density on carrot seed quality at Madras, Oregon, 1986

Quality component	Screen size	Plant Spacing				
		Control	S-4" block	S-6"	S-12"	LSD .05
		lbs/acre				
Seed yield	1/13	88	101	114	62	46
	1/16	580	681	741	620	52
	1/19	288	372	346	287	80
	Total	956	1154	1201	969	
		g/1000				
Seed weight	1/13	2.405	2.472	2.306	2.334	.081
	1/16	1.796	1.858	1.741	1.847	.074
	1/19	1.285	1.367	1.261	1.370	.108
	Mean	1.829	1.899	1.769	1.850	
		%				
Germination	1/13	91	89	92	91	5
	1/16	91	89	92	92	4
	1/19	87	85	89	88	8
	Mean	90	88	91	90	

Table 4. Effect of plant density on percentage of seed in each size category at Madras, Oregon, 1986

Screen size	Plant Spacing				
	Control	S-4" block	S-6"	S-12"	Average
	%				
1/13	9.2	8.8	9.5	6.4	8.5
1/16	60.7	59.0	61.7	64.0	61.3
1/19	30.1	32.2	28.8	29.6	30.2

Table 5. Effect of plant density on carrot seed quality by umbel order at Madras, Oregon, 1986

Quality component	Umbel order[1]	Plant Spacing				
		Control	S-4" block	S-6"	S-12"	LSD .05
		g/1000				
Seed Weight	P	1.599	1.682	1.600	1.644	.202
	S	1.444	1.604	1.437	1.447	.140
	T	1.396	1.541	1.299	1.444	.208
	Mean	1.480	1.609	1.445	1.512	
		%				
Germination	P	72	70	58	61	14
	S	65	68	61	54	9
	T	77	79	73	68	13
	Mean	71	72	64	61	

1 Umbel orders: P=Primary, S=Secondary, T=Tertiary

PRELIMINARY OBSERVATIONS ON WHITE LUPINE AT MADRAS AND REDMOND, OREGON, IN 1986

J. Loren Nelson[1]

ABSTRACT

Kiev Mutant, Ultra, and five selections (Nutriseed lines 4801, 4805, 5801, 5803, and 5805) of white lupine (*Lupinus albus* L.) were observed for adaptation in non-replicated single-row plots at Madras and Redmond in 1986. Both trials were planted April 25 and irrigated as needed throughout the summer. The two cultivars and 4801 at both locations, 4805 at Madras, and 5801 at Redmond exhibited the greatest rapidity of emergence and seedling vigor.

Lines 4801, 5801, and 5805 bloomed about one week before other lines and varieties. Pods were non-shattering on erect plants. Seeds were mature and ready for harvest on most plants of each line and variety by September 12. Lines 4801 and 4805 compared favorably with Ultra for seed yield and yield components on an individual plant basis. From a limited plant sample, lines 5801, 5803, and 5805 produced more seed than Ultra. Seed yields need to be determined in multiple row plots with interplant competition which is planned for 1987.

INTRODUCTION

Interest in sweet or low-alkaloid white lupine (*Lupinus albus* L.) seed for livestock feed has developed recently in the United States. The new varieties and experimental lines of this type of erect legume have large, flat, creamy white seeds with approximately 32-40 percent protein. They can be ground and fed directly to livestock without any detoxification treatment. Therefore, if this lupine is adapted and productive economically in central Oregon, our livestock producers may benefit from a local source of a high protein feed. For this reason, preliminary adaptation trials were initiated in 1986.

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ACKNOWLEDGMENTS: Seed of Kiev Mutant and Ultra were supplied by Dan Bruce, B-N-P Lentil Company, P.O. Box 146, Farmington, WA 99128. Seed of the Nutriseed lines were supplied by Dr. Kevin McVeigh, International Seeds, Inc., P.O. Box 168, Halsey, OR 97348.

MATERIALS AND METHODS

Rhizobia inoculated white lupine seed (cv. Kiev Mutant, Ultra, and Nutriseed lines 4801, 4805, 5801, 5803, and 5805) were planted April 25, 1986, in single-row, non-replicated 20-foot long plots in nurseries at Madras and Redmond. Two hundred and forty seeds of each entry were sown one-half inch deep with one inch between seeds and about two inches to the side and above a band of liquid 10-34-0 fertilizer applied at 140 pounds per acre. All plots were irrigated as needed. One-hundred seed weight of seed planted, rapidity of seedling emergence and vigor, date of flowering, and time of maturity were noted for all entries. Plants were pulled, bagged, and stored on September 12 and October 8. Plant height was measured when plants were taken from the field. In December, individual plant data were collected and for each variety and line an average value was calculated for the traits shown in Table 1.

RESULTS AND DISCUSSION

Madras Trial

Nutriseed 5805 and Ultra had the largest and smallest seed, respectively (Table 1). The other Nutriseed lines had intermediate seed sizes. One objective for sweet lupine improvement has been to increase the seed size. There may be difficulty with seed breakage of the large seeded lupines during planting with a conventional grain drill. Growers need to be aware of this potential problem.

Seedlings began to emerge about 10 days after planting. The poorly drained soil had crusted severely which appeared to present problems in obtaining a good stage. In white lupine the cotyledons emerge above the soil surface so during the emergence process there were large soil cracks and the seedlings actually lifted large sections (two-four inches in diameter) of soil. The largest seeded lines appeared to accelerate this problem. Ultra, Kiev Mutant, 4801, and 4805 exhibited the fastest emergence the first two weeks after planting. However there were more seedlings with superior vigor of the two varieties than any of the lines three weeks after planting. The first compound leaf was expanding on plants of each variety. There were only a few weak seedlings for lines 5803 and 5805 at this time but several more seedlings emerged later. After 21 days, plants of lines 4801, 4805, and 5801 were similar in vigor and stage of development as variety plants but there were only about one-half the number of plants. No laboratory germination values were available from any variety or line but differences as indicated existed among varieties and lines for field germination/ emergence. Generally it was very poor. There was some death of seedlings in all entries from root rotting. However, there was less in 4801 and 4805 but by June 27 many plants of 4801 exhibited wilt, leaf yellowing, and death. Root rot and stem vascular browning were prevalent. No identification of disease organism was made. Other lines did not show these symptoms. No root maggots, like those observed on seedlings at Redmond, were found. Poor soil drainage was probably a contributing factor to the death of many plants. By harvest time there were no plants of Kiev Mutant remaining, however, some of them were probably lost when the plot was weeded. The number of plants harvested reflect losses from low germination and poor emergence, disease, and mechanical damage (Table 2). Some plant samples were destroyed in storage by mice.

On June 12, flowering began on line 5805 with blossoms about to open on two 5801 plants. The first flower cluster (raceme) occurred on either node 12 or 13. On June 17, there were blossoms on six, five, and four plants of lines 4801, 5801, and 5805, respectively. No flowers were open at this time on other lines or varieties which were judged to be at least a week later. Flowers open from the base to the apex of each raceme with subsequently later maturation. A number of pod-bearing branches also formed on most all plants of each variety/line which produced predominantly one raceme per branch. An average of 3.4 to 6.8 branches occurred on Ultra and the lines (Table 2). The pods developed slowly. They became large, fleshy, and green then turned yellow. The earliest pods started to dry-down the first part of August. Most pods were sufficiently dry and mature for harvest on Ultra and all lines by the first week of September. Withdrawal of irrigation water at the proper time may be useful to aid seed maturation and pod/plant drying to advance harvest. No attempt was made to do this on the trial.

The data from a few individually spaced plants as shown in Table 2 have limited applicability to plant productivity in large fields of a dense population but the relative values shown indicate a possible potential, for example, lines 5801, 5803, and 5805. Therefore, replicated multiple-row plots of a few varieties/ lines are planned at Madras and Powell Butte in 1987 provided there are sufficient resources.

Redmond Trial

Seedlings of Kiev Mutant, Ultra, 4801, and 5801 started to emerge about two weeks after planting, four-five days later than seedlings of the varieties and 4801 at Madras. There appeared to be less difficulty for seedlings to emerge because of the light sandy soil and no surface crust. Generally, better stands were obtained than at Madras, however, the seedcorn maggot destroyed many seedlings which seemed to be the only cause of plant loss. Ground squirrels ate all the seedlings of line 4805 and most seedlings of 4801 before the two-strand New Zealand electric fence was installed on June 2 after which no other plants were lost.

Cone-shaped racemes had developed on the largest plants of 5801 and 5805 by June 9 and flowers began to open three days later. Plants of 4801 began to blossom on June 16. Several flowers were open on Kiev Mutant by June 17 but none were visible on Ultra. Plants of 5803 started to bloom June 18 before open flowers could be seen on any Ultra plants.

Thrip damage (disfigured leaves and flowers), leafhoppers, and lygus bugs were observed on plants June 24 with Glen Fisher, OSU Extension entomologist. The seriousness of thrips or lygus bugs on these plants is not known nor is information available on damage caused that may exceed the economic injury level on commercial size fields.

Pods/seed on all remaining plants of varieties and lines were sufficiently dry for harvest about September 20, nearly a week later than the same varieties/lines at Madras. No pod shatter nor lodged plants occurred. Mice destroyed many pods and ate nearly all of the seed from all samples while in storage so no data such as that in Table 2 were collected on Redmond plants. Nevertheless, there were more plants removed from the plots and they appeared to be more productive than those grown at Madras.

From limited observations, it appears that seed of white lupine will mature in central Oregon. However, production would probably be best on non-crusting, well-drained soils. It is suggested that growers experiment with only a few acres if a market can be identified for use of the seed.

Table 1. One-hundred seed weight of Kiev Mutant, Ultra, and five Nutriseed lines planted at Madras and Redmond, Oregon, 1986 compared to seed produced at Madras

Variety/line	100 Seed wt. (gms) from	
	Seed planted	Seed produced
Kiev Mutant	32.1	----[a]
Ultra	27.9	26.7
Nutriseed No. 4801	43.2	36.3
Nutriseed No. 4805	41.8	34.7
Nutriseed No. 5801	46.0	34.3
Nutriseed No. 5803	42.8	30.1
Nutriseed No. 5805	53.5	45.7

[a] No plants were available at harvest for seed data

Table 2. Performance of white lupines at Madras, Oregon, 1986

Variety/selection	Plants harvested	Avg. plant ht.	Avg. pod bearing branches	Avg. pods/ plant	Avg. pods/ raceme	Range avg. pods/ raceme	Avg. seeds/ pod	Range avg. seeds/ pod	100 seed wt.	Avg. seed wt./ plant
	---no.---	-in.-	---------------------no.---------------------						----gms----	
Ultra	11	11.6	4.3	10.7	3.2	1-7	2.8	1-6	26.7	8.8
Nutriseed No. 4801	9	13.5	3.4	5.6	1.7	1-3	3.2	1-4.5	36.3	7.9
Nutriseed No. 4805	48	19.7	4.3	7.5	4.0	1-7	3.0	1-5.3	34.7	7.7
Nutriseed No. 5801	9	17.7	6.8	17.6	1.9	1-7	3.1	1-7	34.3	18.5
Nutriseed No. 5803	4	14.6	5.8	17.6	3.1	1-8	2.8	1-4.8	30.1	15.0
Nutriseed No. 5805	3[a]	19.6	5.3	9.0	2.3	1-3	3.4	1-4.5	45.7	23.3

[a] All measurements except for average plant height and pod-bearing branches were from a single plant because of mouse damage to pods and seeds on the other two plants.

CONTROL OF RATTAIL FESCUE IN KENTUCKY BLUEGRASS GROWN FOR SEED

George W. Mueller-Warrant, USDA-ARS[1]

ABSTRACT

Control of rattail fescue (Vulpia myuros L.) in Kentucky bluegrass grown for seed was studied at furrow and sprinkler irrigated sites in central Oregon. Diuron appeared to be the best available material for control of rattail fescue and did possess adequate crop tolerance in central Oregon, but was unable to provide complete control of this weed. Ethiozine showed potential for post-emergence control of rattail, but crop tolerance may be questionable and further testing will be necessary.

Rattail fescue has been a serious problem in Kentucky bluegrass grown for seed production in central Oregon since its introduction more than 30 years ago. This annual weed is widely distributed in the Kentucky bluegrass producing regions of Oregon, and it often travels between fields floating on irrigation water or trapped in equipment. It can be mechanically removed from bluegrass seed, but even low levels of seed contamination may pose problems. The only herbicides registered for its control in central Oregon grown Kentucky bluegrass are dicamba and terbacil; both occasionally injure crops and/or fail to control all the rattail. Also, all previous herbicide testing has used sprinkler rather than furrow irrigation.

METHODS

Tests were conducted at two locations near Madras, Oregon, in the 1985-86 growing season, comparing several registered treatments with new materials on both a furrow and a sprinkler-irrigated site. Site 1 was on the Don Boyle farm north of Madras. The variety grown there was Monopoly bluegrass, and the site was furrow irrigated. The site had been harrowed and watered-up in advance of treatment. First treatments were applied October 11, 1985, when the rattail was at the one-two leaf growth stage. These treatments are listed as pre-emergence in the table, but were actually early post-emergence. Site 2 was on the Robert Jasa farm west of Madras. The variety grown there was America bluegrass, and the site was sprinkler irrigated. The thatch was quite heavy, and the

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site had not been harrowed until just before treatment. Also, since the site had not been watered before treatment, application of Nortron (ethofumesate) was delayed until after irrigation had begun. This stand was approximately five years old. Since no rattail had germinated by the October 11 treatment date, treatments were genuinely pre-emergence at this site. Spring-applied post-emergence treatments were made on April 10, 1986, at both sites. The test at Site 2 was severely affected by a broadcast application of dicamba plus diuron made to the entire area during the winter by the grower, and only a few plots still had rattail in them. There was also considerable crop damage at Site 2, from the superimposed effects of the grower's treatments and the experimental treatments. The only data that could be taken at Site 2 were rattail control rating in part of one replication, and little confidence can be placed in it.

RESULTS AND DISCUSSION

The unfortunate loss of the Site 2 test limits conclusions that can be drawn from these studies, especially since that site had the most significant weed pressure. Based on results at Site 1 and partial results at Site 2, diuron at 2.4 pounds/acre appeared to provide fairly good control of rattail fescue with adequate crop safety (Table 1). Good, but not necessarily excellent control was also achieved with terbacil, ethofumesate, chlorpropham, and prometryn. Dicamba appeared to be somewhat weaker on rattail fescue, and its use would probably be justified only if downy brome (cheatgrass) was also a problem. Ethiozine appeared to provide fairly good post-emergence control of rattail fescue, but did cause some crop injury, and needs to be studied in greater detail.

One rather surprising result was the severity of injury to bluegrass caused by use of 0.8 pounds/acre of terbacil. Damage from terbacil occurred only at the furrow irrigated site with the variety Monopoly, which was essentially destroyed. Whether the absence of terbacil injury at Site 2 was caused by differences in soil moisture, varietal tolerance, or both factors is unknown.

Herbicide tests will be conducted again in the 1986-87 growing season to look at bluegrass tolerance and rattail control. These tests will once again be conducted both on furrow and sprinkler irrigated sites, and will explore new herbicide chemistry not included in the 1985-86 tests.

Table 1. Response of rattail fescue and Kentucky bluegrass to herbicides

Herbicide Treatment	Lbs/Acre	Crop injury Apr 10 Site 1	Volunteer bluegrass control Apr 10 Site 1	Rattail fescue control ratings Apr 10 Site 1	Rattail fescue control ratings May 20 Site 1	Rattail fescue control ratings Apr 10 Site 2
		----------	----------	%	----------	----------
Untreated Check		0	0	0	0	0
PRE-EMERGENCE ONLY (10-11-85)						
Diuron	2.4	3	77	80	87	85
Terbacil	0.8	57	100	100	100	90
Ethofumesate	1.0	7	17	93	83	99
Dicamba	2.0	0	56	100	83	53
Chlorpropham	2.0	0	60	98	98	--
Prometryn	2.0	10	67	100	95	--
PRE-EMERGENCE (10-11-85) / POST-EMERGENCE (4-10-86)						
Diuron / Diuron + Ethiozine	2.4 / 0.8 + 0.5	2	83	100	50	60
Diuron / Diuron	2.4 / 1.6	3	91	100	60	--
Diuron / Ethiozine	2.4 / 1.0	5	85	100	99	--
Diuron / Ethofumesate	2.4 / 1.0	3	63	97	80	74
Dicamba / Diuron + Ethiozine	1.0 / 0.8 + 0.5	0	53	83	100	70
POST-EMERGENCE ONLY (4-10-86)						
Diuron + Ethiozine	0.8 + 0.5	0	32	67	66	--
Ethiozine	1.0	0	23	67	100	--
LSD (5%)		13	45	41	47	--

ENDOPHYTE CONTENT OF SEEDS HARVESTED FROM SPACE-PLANTED TALL FESCUE[1]

R.E. Welty and M.D. Azevedo[2]

INTRODUCTION

Endophytic fungi in tall fescue grass have recently been the subject of intense research. Interest was stimulated by the discovery that <u>Acremonium</u> <u>coenophialum</u> (<u>Epichloe</u> <u>typhina</u>) was associated with "fescue toxicosis" in cattle grazing plants infected with the fungus. The problem has also been incorrectly called "summer syndrome" because it is most severe in the summer months in Southeast USA.

The fungus is commonly referred to as an endophyte because it grows entirely within the grass host and rarely shows external signs or symptoms of infection. The only known mode of spreading the endophyte is by sowing infected seed. Resowing pastures with endophyte-free seed or with seed having low levels of endophyte (less than five percent) offers the least-expensive method of control. Seedborne infection can be reduced by seed-treatment fungicides, heat treatments, or storage.

In 1983, Oregon established standards for endophyte testing in seed lots of grasses and established a voluntary regulatory testing program. Seed lots containing five percent or less endophyte-infected seed are issued an endophyte tag by the Oregon Department of Agriculture for attachment to bags of Oregon-produced seed. In 1983-1985, 509 seed lots of tall fescue representing 11,813,887 pounds (5,358,744 kilograms) of seed were tested by ODA, and 94 percent were found to contain five percent or less endophyte. Levels of endophyte infection in seed of tall fescue from these seed lots are especially low when compared with seed lots from other production regions.

The studies reported here were done to determine if endophyte-free plants would remain free of endophyte when

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interplanted with endophyte-infected plants. Growers question if the percentage of endophyte-infected seeds can increase in seed fields planted with a variety that is endophyte-free or one that contains a low level of endophyte infection. The studies were done at seven experiment stations to provide information on the effects of location.

MATERIALS AND METHODS

Seedlings of G1-307 tall fescue infected with the endophyte fungus (*Acremonium coenophialum*) and endophyte-free Forager were grown in the greenhouse. Leafsheath tissue was removed from each plant, fixed, stained, and examined with the microscope for the presence of hyphae typical of the endophyte fungus. Twenty seedlings of Forager were interplanted with 10 seedlings of G1-307 at each of seven experiment stations - Redmond, Corvallis, Pendleton, Hood River, Medford, Klamath Falls, and Union. Seeds were harvested in 1984 (except at Redmond, Klamath Falls, and Union), 1985, and 1986 and assayed for endophyte.

For the endophyte assay, seeds were collected from each plant of each entry (G1-307 or Forager) and combined. For each sample, two grams of seed were thoroughly mixed, subdivided, and digested overnight in five percent NaOH and 0.1 percent trypan blue. The samples were stained with lactophenol and trypan blue, and up to 200 seeds per subsample were examined microscopically for the presence of endophyte hyphae in the seeds.

RESULTS AND DISCUSSION

Endophyte infection ranged from 83-99 percent in seeds harvested from endophyte-infected G1-307; seeds harvested from endophyte-free Forager were free of endophyte at all locations except Pendleton (Table 1). At Pendleton, endophyte infection in the bulked seeds was eight percent in 1984 and three percent in 1985. To determine which plants contained endophyte, 2 grams of seeds from each of the 20 plants of Forager (1985) were subsequently assayed. One plant was identified as contributing the endophyte-infected seeds in the bulked-seed sample.

In 1986, seeds from the endophyte-infected Forager plant, identified in 1985, were assayed for endophyte; 47 of 50 seeds (94 percent) contained the endophyte. Seeds from the remaining 19 Forager plants free of the endophyte in 1985 were bulked and 200 seeds were assayed as previously described. None of the seeds from these 19 plants contained endophyte.

These experiments were established to determine if endophyte-free plants became infected in the field when interplanted with endophyte-infected plants. No endophyte transmission occurred at six of seven locations. The results at Pendleton suggest this as a possibility, however, the rate of field transmission is very low. The study was not designed to test how transmission might occur.

In the spring of 1986, five studies were established at Pendleton with endophyte-free and endophyte-infected seedlings to evaluate mechanical transmission of the endophyte from infected to non-infected plants. Seed will be harvested for the first time in the summer of 1987.

In a related study at the Oregon State University Botany and Plant Pathology Field Laboratory in Corvallis, ten 50-foot rows of tall fescue were established. Paired rows were previously found to contain a similar level of endophyte infection. Thus, five paired comparisons could be made after one row was burned with a kerosene torch burner while the other row remained nonburned. Seeds were harvested in 1986 from single rows, bulked by row, and thoroughly mixed. Fifty seeds from each paired comparison (burned vs. nonburned) were digested, stained, and examined for the endophyte, as previously described. Endophyte infections in seeds from the five comparisons for nonburned vs. burned were 72 vs. 80, 26 vs. 40, 0 vs. 0, 0 vs. 6, and 88 vs. 92 percent, respectively. These results indicate the effect of burning on endophyte content of seeds is minimal. Since the sample size is small, the results are variable and may be misleading.

Table 1. The level of endophyte in tall fescue seed harvested from endophyte-infected plants of G1-307 and apparently endophyte-free plants of Forager. Seedlings were transplanted at seven locations in Oregon and harvested in three years

Experiment Station location	Percent endophyte in G1-307[a]			Percent endophyte in Forager		
	1984	1985	1986	1984	1985	1986
Hyslop	98	88	83	0	0	0
Pendleton	91	92	92	8[b]	3[b]	0[c]
Hood River	89	95	98	0	0	0
Redmond	--	96	95	-	0	0
Medford	95	94	94	0	0	0
Klamath Falls	--	95	96	-	0	0
Union	--	95	99	-	0	0

a Seeds from 10 plants were combined and 2 grams of seed sampled; seeds were examined for endophyte.

b Seeds from 20 plants were combined and 2 grams of seed sampled; 109-200 seeds were examined for endophyte.

c Seeds from 19 plants were combined and 2 grams of seed sampled; 200 seeds were examined for endophyte. Ninety-four percent of the seeds (47 of 50 examined) from an infected Forager plant contained endophyte.

ONION VARIETY EVALUATION AT MADRAS, OREGON

J. Loren Nelson[1]

ABSTRACT

Thirty-two yellow spanish onion varieties were evaluated in 1986 at the Central Oregon Experiment Station, Madras site. This was the third year of testing to identify high yielding early maturing varieties with acceptable characteristics for potential markets accessible to central Oregon growers. All varieties were rated for maturity, neck and top growth characteristics, total yield, yield by bulb size, and storability. The total yield of Yula was significantly higher than all varieties except Rocket in 1986. However, differences existed in yield distribution among bulb size classes. Two- and three-year averages are presented. Eskimo, Norstar, Simcoe, Rocket, Columbia, HXP 2610, and Progress appear to be the best possible varieties for future production in central Oregon. Others, such as Golden Cascade, Yula, and Foxy have more serious limitations, because of lateness, lower yield, and/or double bulbs although development of improved management practices may allow growers to take advantage of their superior traits. Several suggested onion production techniques are presented. No further onion variety tests are planned.

There continues to be only limited grower interest in dry onion production in central Oregon. Unfamiliarity with production practices, lack of suitable equipment, knowledge of buyers, price volatility, and no on-farm onion storage facilities are some problems encountered which have presented various degrees of difficulty and/or prevented adoption of onions as a viable new crop in the area. The fluctuating onion prices from year to year and the large U.S. onion production have deterred some growers from attempting to enter the market. Some people feel that onions could be marketed with potatoes from the area. However, certain changes for onion storage and equipment for grading and handling may be necessary. Three-year evaluation of onion varieties has given sufficient information for growers to begin production. This report gives 1986 trial results and two-three year averages for varieties tested.

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MATERIALS AND METHODS

Onions were planted April 25, 1986, at the Madras research site of the Central Oregon Experiment Station. Spring peas and spring wheat were grown in this field in 1984 and 1985, respectively. Wheat stubble was roto-tilled followed by a fertilizer application of 16-16-16 at 423 pounds/acre which was incorporated into the seedbed on September 16, 1985, by disk and harrow. A soil sample was taken from the 0-12-inch depth on March 11, 1986. The pH was 7.0. Ppm of P, K, nitrate, and ammonium-N and Zn were 55, 402, 4.1, 56.5, and .34, respectively. Liquid fertilizer (10-34-0) was banded at planting two inches below and to the side of the seed at 37.2 and 126.6 pounds/acre of N and P_2O_5, respectively. Ethion 8 granules at 10 pounds/acre were applied in-furrow with the seed for onion maggot control. Parathion and Metasystox (1 + .75 pounds ai/acre) were applied on June 28, July 13, August 2, and 16 for thrip control.

Each of the 32 varieties was replicated five times in a randomized complete block design. Each plot was two rows wide (14 inches between rows on a three-feet wide flat bed) and 23.5 feet long. Twelve live seeds per linear foot of row were planted. Onion seedlings were hand-thinned when they had two-four leaves to a final stand of four or six plants per foot of row dependent on mature bulb size.

Weeds were controlled by Dacthal (6 pounds ai/acre applied May, 1986), N-TAC herbicide (eight gallons/acre of material, or 15.2 and 12 pounds of N & S/acre on June 10) and hand weeding.

Each onion plot was side-dressed between the rows with solution 32 (122.5 pounds N/acre) on June 25.

The trial was irrigated with a solid-set sprinkler system when needed. The last irrigation was on August 25, 1986.

Maturity was rated on August 26, and September 2 and 8 as the plants with tops fallen over expressed as a percentage of total plants within a plot.

All varieties were scored for neck and top growth characteristics, including uniformity. The scale ranged from one to 10: one for poor uniformity and large or heavy necks and tops, 10 for the most uniform and refined or small diameter necks. The number of plants with bolts were recorded.

The bulbs were lifted on September 11 with a tilted blade. Eighteen feet of each row were harvested. The bulbs were hand topped on September 30, placed in mesh bags, and stored in a metal shed for additional curing. On October 20, all sacks were moved to a cooler which was maintained at $38^{\circ}F$.

On January 9, 1987, the onions were graded to determine size, yield, sprouted and rotted bulbs. The bulb size classes of 2 1/4, 2 1/4-3, 3-4, and 4+ inch were determined with a Kerian sizer. Split or double bulbs were picked from the grading belt by hand and were classed as number two's. After bulbs were sized and weighed by size class, each bulb was examined for symptoms of botrytis neckrot. Diseased bulbs were weighed to determine percent neckrot. Neckrot is reported as an average and as potential neckrot. Average neckrot is an average for the neckrot occurring in all bags for each variety. Potential neckrot represents the amount of neckrot from the sack with the most rot among the five replications. Weights for each size, including number two's, were used to calculate total onion yields. The least significant difference at both the .05 and .01 level of probability was calculated from appropriate statistical analyses.

RESULTS AND DISCUSSION

The average bulb yield for all varieties was 501 hundredweight (25.05 tons) per acre (Table 1). The total yield of Yula was significantly higher than all other varieties except Rocket. Neetco Nugget, Cima, FMX 222-W-8, XPH 77N76, Ringmaker, Foxy, Early Shipper 75, Yula, Maya, Simcoe, Golden Cascade, and 60-9 had some colossal jumbo bulbs (4+ inch), however, Golden Cascade, Maya, Yula, Early Shipper 75, and Ringmaker gave the greatest yield with Yula ranking first. Some of these varieties also had about 50 percent jumbo bulbs (3-4 and 4+ inches). However, most (22 varieties) had predominately medium size bulbs (2 1/4-3 inch). Other differences in the size distribution of bulbs can be observed.

Bulb size is an important trait to consider if the market demands a particular size, such as colossal jumbo's (4+ inches), jumbo's (3-4 inches), mediums (2 1/4-3 inches), or undersizes (1 1/2-2 1/4 inches). Growers need to realize that central Oregon weather hinders the production of large size bulbs.

All varieties had some number two bulbs except 327-2 (Table 1). The 21.1 percent two's for Yula would lower its total yield of marketable bulbs. This would also be the case for several other varieties.

HXP 2610 was the earliest maturing variety. Yula, Progress, Rocket, and Simcoe were next in earliness but the other varieties with maturity percentages in the twenties and thirties may be acceptable for the area. Some varieties in previous years were earlier than they were in 1986. The June 25 sidedressing of nitrogen may have delayed maturity. It is believed that this is particularly the case for Eskimo and Norstar because they were the earliest as shown by the two-year (1985-86) averages (Table 3). They were not grown at Madras in the 1984 test. The three year (1984-86) average maturity was the greatest for Simcoe, Rocket, Yula, Columbia, HXP 2610, and Progress (Table 4). These varieties plus Eskimo and Norstar, and possibly Granada, Topaz, and FMX 222-W-8 merit consideration for further experimentation for production in the area because of earliness. However, the high percentage of bolting in Granada and Topaz may be a problem in the relatively cool season of central Oregon (Table 2). Most varieties had acceptable neck and top-growth characteristics although the varieties with the highest scores (7-10) are probably the best candidates for commercial production since their bulbs will cure faster and enable growers to remove them from the field earlier. This will aid growers to avoid damaging frosts.

All varieties stored quite well in 1986-87 except Maya, Early Shipper 75, XPH 77N76, and Neetco Nugget which had greater than 10 percent rot, but the high potential rot in many other varieties may preclude their acceptability for storage (Table 1). Growers may consider marketing these varieties soon after harvest if other characteristics are acceptable. The early varieties appear to be best for longterm storage. These varieties possessed the best neck and top growth characteristics (Table 2).

Seven yellow spanish onion varieties were in common for the 1985 and 1986 tests. The two-year averages for yield, neckrot, and maturity are shown in Table 3. No statistical analyses were performed but it appears that all of these varieties were similar in total yield. The high percentage of neckrot for most of these varieties indicate that they may not be suitable for long-term storage when grown in our production area primarily because of lateness and poor weather to help cure the bulbs. Several differences in percentage of bulbs in various size classes can be observed. Eskimo and Norstar are the earliest and are good varieties to consider for commercial production. Granada and Topaz would require more precise management if they are grown.

The three-year (1984-86) averages give the best estimates of varieties with which growers may begin small scale production. Simcoe and Progress have been grown successfully in central Oregon. This experience, coupled with research data can be helpful for variety selection. Other varieties, Rocket, Yula, Columbia, HXP 2610, should also be considered based on earliness but other traits may limit their desirability, especially if growers cannot achieve higher yields, market the bulbs soon after harvest, or reduce storage losses. Experience by growers and experiment station tests show that the environment and management can affect results considerably. Therefore, it is suggested that the seedbed be prepared and the beds formed and treated with herbicide in the fall. Planting as early as possible in the spring (probably no earlier than a week before irrigation water is available) with an early cultivar will also help. It is critical to use the proper amount of nitrogen fertilizer and to stop irrigation at the correct time. Bulbs should be lifted by September 1 to 5 for adequate drying of the bulbs. Drying and curing can be aided by periodically turning the bulbs. Bulbs removed from the field by September 20-25 may have the greatest possibility to escape wet weather and frost damage.

Growers are advised to investigate all aspects of production and marketing before planting any onion acreage. However, experimentation with a few acres will help growers learn more rapidly how to manage the crop and to gain a better understanding of the risks involved. It is further suggested that growers consider providing their own storage and grading and packing the onions, which offer more options to the grower for marketing through established onion brokers and/or packer-shippers. Assistance is available from other growers, agribusiness, Extension and research personnel. The following references and attendance at grower meetings in central Oregon and other onion production areas will be helpful.

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Table 1. Results of the 1986 onion variety trial at Madras, Oregon, Central Oregon Experiment Station

Company	Variety	Total yield	Avg. neckrot	Potential neckrot	Storage sprout	Bulb yield by size and percent of total yield: >4 inch		3-4 inch		2 1/4-3 inch		<2 1/4 inch		2's		Maturity: 8-26	9-2	9-8
		cwt/a	%	%	%	cwt/a	%	cwt/a	%	cwt/a	%	cwt/a	%	cwt/a	%	%	%	%
American Takii	Eskimo	520	2.7	3.6	0.2	--	---	91	17.5	380	73.1	23	4.4	25	4.8	1	7	26
	Norstar	513	4.9	7.3	1.0	--	---	144	28.1	309	60.2	20	3.9	40	7.8	2	8	31
	60-9	420	4.8	9.5	1.0	2	.5	81	19.3	320	76.2	13	3.1	5	1.2	0	2	12
	60-12	463	4.1	11.2	0.7	--	---	114	24.6	329	71.1	17	3.7	2	0.4	0	8	36
	327-1	480	6.3	18.0	1.0	--	---	142	29.6	317	66.0	14	2.9	7	1.5	1	2	9
	327-2	448	3.9	6.2	0.8	--	---	109	24.3	328	73.2	10	2.2	--	----	0	4	24
ARCO	Golden Cascade	592	8.2	16.5	3.6	20	3.4	307	51.9	200	33.8	13	2.2	53	9.0	0	2	12
	Simcoe	426	2.3	4.1	0.5	1	.2	89	20.9	277	65.0	50	11.7	9	2.1	1	13	40
Asgrow	Granada	578	2.1	4.3	0.4	--	---	160	27.7	340	58.8	20	3.5	59	10.2	1	9	30
	Maya	556	11.2	25.3	4.0	24	4.3	260	46.8	188	33.8	15	2.7	69	12.4	0	2	8
	Rocket	611	1.5	2.4	0.2	--	---	168	27.5	399	65.3	24	3.9	21	3.4	2	12	46
	Topaz	516	7.6	27.1	3.0	--	---	116	22.5	356	69.0	27	5.2	17	3.3	2	11	29
	XPH 3246	392	3.6	11.1	7.6	--	---	14	3.6	304	77.6	63	16.1	12	3.1	0	1	3
	XPH 3272	512	1.1	4.1	0.9	--	---	116	22.7	329	64.3	21	4.1	47	9.2	0	0	5
	Yula	698	8.3	16.2	0.6	52	7.4	326	46.7	163	23.4	10	1.4	147	21.1	5	26	56
Crookham	Early Shipper 75	537	12.5	21.2	3.8	16	3.0	220	41.0	209	38.9	12	2.2	79	14.7	1	2	15
	Foxy	515	5.1	11.3	4.8	3	.6	202	39.2	222	43.1	21	4.1	68	13.2	0	2	14
	Golden Treasure	460	4.6	10.6	23.8	--	---	96	20.9	254	55.2	62	13.5	49	10.7	0	1	5
	Ringmaker	547	6.9	12.9	23.4	19	3.5	283	51.7	177	32.4	24	4.4	44	8.0	0	1	14
	Spartan Sleeper	424	3.3	6.9	1.4	--	---	64	15.1	319	75.2	30	7.1	12	2.8	0	0	2
	XPH 77N76	465	18.5	52.9	24.8	7	1.5	206	44.3	195	41.9	22	4.7	35	7.5	0	1	9
Ferry-Morse	Bronze Reserve	426	6.3	20.0	1.9	--	---	88	20.7	303	71.1	20	4.7	15	3.5	0	1	10
	Bullseye	501	7.4	22.7	7.4	--	---	213	42.5	252	50.3	22	4.4	13	2.6	0	1	4
	Columbia	471	1.8	3.2	1.9	--	---	147	31.2	295	62.6	17	3.6	12	2.5	1	7	27
	FMX 222-W-8	454	7.5	15.9	3.0	6	1.3	125	27.5	214	47.1	23	5.1	86	18.9	0	3	13
	Sweetheart	482	6.0	12.3	6.3	--	---	167	34.6	284	58.9	24	5.0	7	1.5	0	0	6
Harris Moran	HXP 2610	569	1.2	2.6	0.1	--	---	137	24.1	365	64.1	24	4.2	44	7.7	28	53	81
	Progress	531	2.5	4.8	1.7	--	---	109	20.5	362	68.2	34	6.4	27	5.1	7	27	48
Nickerson	NIZ 23-1028	558	5.8	16.8	1.5	--	---	144	25.8	228	40.9	29	5.2	157	28.1	0	2	10
Sun Seeds	Cima	464	3.3	9.3	4.5	7	1.5	185	39.9	201	43.3	19	4.1	52	11.2	1	2	14
	Olympian	362	5.6	20.6	13.0	--	---	32	8.8	201	55.5	54	14.9	74	20.4	0	2	10
B & K Prepack	Neetco Nugget	530	10.6	21.9	4.0	6	1.1	162	30.6	290	54.7	28	5.3	43	8.1	0	1	13
	Mean	501	5.7	----	4.8	5	---	150	----	278	----	25	----	42	----	2	7	21
	CV (%)	14	112.3	----	195.1	197	---	44	----	21	----	50	----	53	----	254	132	68
	LSD (5%)	89	7.9	----	11.6	13	---	83	----	72	----	16	----	28	----	5	11	18
	LSD (1%)	118	10.6	----	15.4	17	---	110	----	96	----	21	----	37	----	7	15	23

Table 2. Bolting, neck, and top growth characteristics of onion varieties grown at Madras, Oregon, 1986, Central Oregon Experiment Station

Company	Variety	Bolting	Neck score*	Top growth score*	Neck uniformity score*	Top growth uniformity score*
		%				
American Takii	Eskimo	--	9	10	8	8
	Norstar	--	9	10	9	9
	60-9	--	8	8	8	8
	60-12	--	7	8	7	6
	327-1	--	6	7	6	7
	327-2	--	7	8	7	8
ARCO	Golden Cascade	6	4	3	5	6
	Simcoe	6	8	8	6	7
Asgrow	Granada	12	5	6	7	7
	Maya	2	5	4	6	5
	Rocket	1	8	8	8	9
	Topaz	12	6	7	6	6
	XPH 3246	1	7	6	6	7
	XPH 3272	1	6	7	8	8
	Yula	--	5	5	7	7
Crookham	Early Shipper 75	1	5	5	5	6
	Foxy	1	5	5	5	6
	Golden Treasure	1	5	5	5	6
	Ringmaker	1	2	2	6	5
	Spartan Sleeper	1	4	6	6	6
	XPH 77N76	--	2	1	8	8
Ferry Morse	Bronze Reserve	--	7	8	6	7
	Bullseye	6	4	6	5	6
	Columbia	--	7	7	6	6
	FMX 222-W-8	2	5	6	3	4
	Sweetheart	3	5	4	5	5
Harris Moran	HXP 2610	2	8	7	6	7
	Progress	2	8	8	7	7
Nickerson	NIZ 23-1028	2	5	5	5	4
Sun Seeds	Cima	5	4	5	6	6
	Olympian	--	3	3	6	7
B & K Prepack	Neetco Nugget	1	4	5	5	5
	Mean	2	6	6	6	7
	CV (%)	135	21	21	28	25
	LSD (5%)	4	2	2	2	2
	LSD (1%)	5	2	2	3	3

* Score scale: 1-10, 1-large neck and top growth and poor uniformity and 10-small, refined neck and top growth and most uniform.

Table 3. Two-year averages from onion variety trials (1985-1986) at Madras, Oregon, Central Oregon Experiment Station

Company	Variety	Total yield	Avg. neckrot	Potential neckrot	Bulb yield by size and percent of total yield										Avg. maturity[c]
					> 4 inch		3-4 inch		2 1/4-3 inch		< 2 1/4 inch		2's		
		cwt/a	%	%	cwt/a	%	cwt/a	%	cwt/a	%	cwt/a	%	cwt/a	%	%
American Takii	Eskimo	502	1.8	3.6[a]	---	---	101	20.1	343	68.4	45	9.0	12.8	2.6	63
	Norstar	535	4.1	7.3[a]	1.0	0.2	189	35.3	283	52.9	42	7.8	20.2	3.8	63
Asgrow	Granada	545	4.0	14.5[b]	8.0	1.5	229	42.0	257	47.1	20	3.7	31.1	5.7	54
	Topaz	477	5.9	27.1[a]	---	---	155	32.5	286	60.0	27	5.7	8.8	1.8	54
Ferry-Morse	Bullseye	477	7.4	22.7[a]	3.0	0.6	217	45.5	226	47.4	23	4.8	7.9	1.7	13
	FMX 222-W-8	456	10.5	29.3[b]	6.0	1.3	165	36.2	213	46.7	26	5.7	46.4	10.2	40
	Sweetheart	458	7.5	19.0[b]	0.5	0.1	187	40.8	245	53.5	22	4.8	3.6	0.8	15

a The replicate with the highest percent neckrot occurred in 1986.
b The replicate with the highest percent neckrot occurred in 1985.
c Avg. maturity is the arithmetic average of the percent tops fallen-over September 6, 1985 and September 8, 1986.

Table 4. Three-year averages from onion variety trials (1984-1986) at Madras, Oregon, Central Oregon Experiment Station

Company	Variety	Total yield	Avg. neckrot	Potential neckrot*	Bulb yield by size and percent of total yield										Avg. maturity**
					> 4 inch		3-4 inch		2 1/4-3 inch		< 2 1/4 inch		2's		
		cwt/a	%	%	cwt/a	%	cwt/a	%	cwt/a	%	cwt/a	%	cwt/a	%	%
ARCO	Golden Cascade	535	6.7	18.8[b]	27.9	5.2	320	59.9	155	29.0	14	2.6	17.6	3.3	50
	Simcoe	416	1.4	6.1[a]	1.3	0.3	125	30.1	243	58.4	43	10.3	3.5	0.8	71
Asgrow	Maya	474	7.7	25.3[c]	14.7	3.1	271	57.2	148	31.2	13	2.7	27.2	5.7	23
	Rocket	466	2.3	15.1[b]	----	---	139	29.8	279	59.8	46	9.9	2.3	0.5	73
	Yula	576	9.3	37.8[b]	41.7	7.2	332	57.6	138	24.0	12	2.1	52.5	9.1	70
Crookham	Early Shipper 75	480	6.1	21.2[c]	18.7	3.9	256	53.3	157	32.7	19	4.0	29.3	6.1	40
	Foxy	475	3.6	12.1[b]	3.3	0.7	231	48.6	184	38.7	31	6.5	25.6	5.4	52
	Ringmaker	524	6.3	16.0[b]	30.9	5.9	321	61.2	137	26.1	19	3.6	16.4	3.1	49
	Spartan Sleeper	371	3.9	12.6[a]	----	---	74	19.9	229	61.7	64	17.2	4.4	1.2	21
Ferry-Morse	Bronze Reserve	390	3.8	20.0[c]	1.0	0.3	141	36.2	216	55.4	25	6.4	6.6	1.7	41
	Columbia	439	1.9	5.5[a]	6.7	1.5	134	30.5	255	58.1	39	8.9	4.0	0.9	67
Harris Moran	HXP 2610	464	2.2	12.3[b]	1.7	0.4	193	41.6	234	50.5	18	3.9	16.8	3.6	78
	Progress	463	1.8	5.3[a]	0.7	0.2	154	33.3	264	57.1	33	7.1	11.0	2.4	63
Sun Seeds	Cima	426	3.8	17.6[b]	4.3	1.0	198	46.4	184	43.2	20	4.7	20.1	4.7	35
	Olympian	403	6.5	27.2[b]	4.7	1.2	174	43.2	165	41.0	27	6.7	32.2	8.0	44

* Potential neckrot:

a Bulbs from the replicate with the highest percent neckrot occurred in 1984.
b Bulbs from the replicate with the highest percent neckrot occurred in 1985.
c Bulbs from the replicate with the highest percent neckrot occurred in 1986.

** Avg. maturity is the arithmetic average of percent tops fallen-over September 5, 1984, September 6, 1985, and September 8, 1986.

CONTINUED INVESTIGATION INTO THE EPIDEMIOLOGY AND CONTROL OF FUSARIUM BULB* ROT OF GARLIC

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ABSTRACT

As in past years, inoculum of Fusarium roseum culmorum placed into soil with garlic seed at planting in 1985, incited pre-emergence plant loss and extensive seasonal bulb rot in 1986; however, the importance of holdover soil-borne sources of the fungus remains uninvestigated. In uninfested field soil, about 10 and 30% loss to fusarium bulb rot by harvest occurred from two separate seed sources that had received hot water + formalin treatment. The extent of symptoms in fields in which these seed lots were produced was not a good indicator of disease occurence in the seed lot plantings. Furthermore, in identical test plantings in western Oregon and California, little fusarium bulb rot developed in either of these same seed lots. Bulbs infected at harvest, including those with and those without symptoms or signs of the fungus but considered intact enough to pass into seed lot storage, continued to decay for several months until bulbs and cloves were

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* Note: Previous reports have described this disease as "basal" rot; however, it recently became known that the onion basal rot organism (Fusarium oxysporum) may infect garlic and cause mild disease under certain conditions. Thus, to avoid future confusion, basal rot should be reserved for F. oxysporum diseases of all Allium species. We have switched to "bulb" rot for disease of Allium species caused by Fusarium roseum.

totally decayed, or until extensive drying caused the fungus to become inactive. Many bulbs and cloves were shown to harbor the inactive fungus, either anywhere on the clove if partial rot was present, or in the clove stem plate if no signs or symptoms were present. Fungal isolations from cloves indicated that 50% of seedborne fusarium could survive the standard commercially hot water + formalin seed treatment utilized for stem and bulb nematode. Benlate and Mertect seed treatments prevented fusarium bulb rot from developing in the field from seedborne sources, and reduced the disease developing from soil infestation.

INTRODUCTION

Fusarium basal rot was first identified in 1976 in the Salinas Valley of California, inciting extensive bulb decay in a commercial garlic field. The causal agent, *Fusarium roseum culmorum* also is able to attack roots and other underground seedling structures of wheat, barley, and oat, but the specialized strain which damages garlic can be much more damaging to garlic than the fungus generally is to cereals. Most *F. roseum culmorum* isolates from soil or cereals do not have the capacity to attack garlic in this manner. Garlic isolates may decay stem plates, covering leaf sheaths and cloves at all stages of garlic growth. Garlic seed growers and commercial growers have been concerned with the impact, spread, and control of this new disease. Losses have occurred every year in central Oregon since the disease was first noted. In 1983, losses in central Oregon garlic seed fields were widespread and disrupted the seed supplies to the commercial industry in California. In other years, losses in central Oregon have been less, but substantial in some fields. In most years, other parts of Oregon, California, and Nevada report less damage in the field than central Oregon.

Trials were established in 1984 and 1985 at the Madras field of the Central Oregon Experiment Station to investigate questions of epidemiology and control of this disease. These studies complement similar disease studies in California and in the Willamette Valley of Oregon. Results from previous trials in 1984-85 are reported in the Irrigated Crops Research in Central Oregon - 1986, Special Report 780.

The objectives of the 1985-86 central Oregon field research were:

1. To gather epidemiological evidence to help determine the role of seed and soilborne inoculum in fusarium disease spread and development. Various typical control measures were utilized to help in making these distinctions, as were

several different seed lots selected from fields with differing incidence of fusarium disease in 1984-85 (continuing objective).

2. Determining the effectiveness of various standard control measures on fusarium diseases (continuing objective).

3. To determine the post-harvest impact of fusarium on garlic seed held in storage (new objective).

MATERIALS AND METHODS

Bulbs from two different sources of a Basic American Foods virus-infected 'California Late' clone were collected at harvest in the summer/ fall of 1985, and stored in King City until treatment. Seed lots were selected on the basis of fusarium incidence, but also were chosen for the high probability of freedom of stem and bulb nematode *Ditylenchus dipsaci* infection. Trials 1 and 4 included seed labeled "Cassaca", from a field in California in which fusarium disease incidence was very high in 1984-85. Trials 2 and 3 included seed labeled "Nevada", from a field in Nevada in which no fusarium or very little fusarium symptoms were observed in 1984-85. Bulbs were cracked under commercial conditions, and hot water and formalin treatments for the stem and bulb nematode control, if done, were treated on the day of, or within 24 hours of cracking as described below. Previous studies indicated that this treatment for nematodes affected the incidence and severity of fusarium disease, perhaps making it worse.

All hot water and formalin clove treatments were made in King City, California, using 50-gallon, temperature controlled, experimental treatment tanks. Nematode eradicative treatments involving the University of California method of 30 minutes at 100 degrees F, followed by 20 minutes at 120 degrees F, both with 1% Formalin, followed by a 15-minute cold dip, and finally followed by drying at 90 degrees F were the standard treatment. Certain variations on this treatment with respect to temperature and time in Trial 1 are shown in Table 1. For additional treatments against fungal diseases such as penicillium seed rot, botrytis disease and fusarium disease, fungicides were added to the cold dip part of the seed treatments process. Formulations and rates of application were Benlate 50W and Mertect 340F as batch seed dips with 2 lbs a.i./100 lbs seed. In one trial, common household bleach (0.5% NaOCl) was added at a rate of 10 gal product/100 lbs seed in the same manner as fungicides. After treatment, all cloves were stored under ambient conditions until shipment to Madras, Oregon, in late September 1984.

F. roseum culmorum isolated from diseased garlic was grown in August and September 1985 on sterile barley. After air-drying, the decayed barley was ground and stored air dry. Twenty-five gm inoculum/plot was sprinkled by hand into open seedlines just before planting.

Cloves for individual treatments were counted by hand for each seedline and stored until planting. Clove weights were maintained as uniform as possible to reduce the influence of clove size. Seedlines were opened by hand using garden hoes. Individual trials were hand planted into two seedlines per bed, and then closed with a hoe. Plots were all single bed plots, 10 feet long, and separated by a 2-foot alley unless noted. All garlic was planted at 20 cloves per bed foot, on 36-inch beds center-to-center. All treatments were in randomized block design and data were analyzed by standard analysis of variance methods.

The field received 400 lbs/A 16-16-16 in September 1985. Residual nitrogen in the soil was about 8 lbs/Ac. In mid-April, 1986, 150 lbs/A of nitrogen as ammonium nitrate was applied. Standard chemical weed control was supplemented with some hand weeding. The field was watered by solid set sprinkler irrigation according to local requirements.

Notes were collected weekly during the season following emergence. After drydown of the crop, plants were dug from each plot on July 16, the soil was shaken from the roots and the plants were then laid on top of the plot bed section to dry further. Harvest data were collected on July 22. Plants were observed for disease, and bulbs weighed after roots below the stem plate and foliage higher than 2 cm above the bulb were removed. Bulbs were considered harvestable if stem plates and covering leaf sheaths were intact upon squeezing the bulb by hand. This harvestability criterion did not distinguish between non-infected and infected bulbs, but was developed to simulate commercial harvest practices in which only bulbs diseased enough to shatter during the harvest process are excluded.

After harvest, bulbs from Trials 3 and 4 were stored in open paper bags on wood pallets in a covered shed. No bulbs were layered greater than 10 cm deep in the bag. On August 29, 1986, stored bulbs were re-examined as follows: Class A bulbs had no apparent decay or signs of fusarium growth; bulbs were firm and intact on squeezing, and were not shriveled. Class B bulbs were "weighty", but had partial or general internal softness, sometimes with signs of fusarium growth somewhere on the bulbs. Class C bulbs were extremely light bulbs, usually with intact covering leaf sheathes, but sometimes with external signs of decay and deterioration of stem plate or leaf sheaths; almost always these were dry and brittle, and usually were slightly shriveled. There was no evidence of "nesting" of decay among bulbs within the stored lots.

Bulbs from classes A and B were weighed and counted. Cloves were hand cracked from bulbs of each class and graded into subclasses as below. Class C bulbs were cracked or cut across the bulb through all cloves and inspected for similar subclasses.

Subclass 1 included cloves which were visually with no signs, symptoms, or defects. Subclass 2 included cloves which were considered intact, viable cloves at the time of inspection, but which had signs of limited F. roseum infection somewhere on the clove. Subclass 3 included cloves some of which were possibly viable at that time, but which were partially-to-extensively decayed with fusarium and which were not considered likely to grow if planted. Subclass 4 included cloves which were fully decayed with F. roseum or with organisms such as penicillium or aspergillus.

Seed from most A and B subclasses was split into fractions, with some fractions then receiving standard hot water/formalin seed treatment in a small, lab bench batch process. Isolations onto potato dextrose agar (PDA) were made from both treated and untreated cloves, some without surface disinfestation with 0.05% sodium hypochlorite. Both treated and untreated cloves from most classes were planted in the field in October 1986, for disease evaluation in 1987. Reinoculations into symptomless cloves were made with isolations to verify isolate pathogenicity.

Additional cloves were separated into various parts, including stem plates, protective leaf, storage leaf, and first leaves for the next growth period, to determine the common locations of seedborne fusarium and other fungi.

RESULTS

Fusarium trials are summarized in Tables 1 through 4. Stand was reduced in some treatments where inoculum was added to the seed line and where no fungicides were utilized. Stands also were reduced when the cold dip treatment was eliminated and where the hot water treatment of 115F was extended for 2 hour (Trial 1, Table 1). Stand also was reduced in Trial 2 and 3 for both untreated seed and standardly treated seed. With the 'Nevada' seed lot, extensive seedborne fusarium disease was present where Benlate and Mertect were not utilized. For the 'Cassaca' seed lot, some seedborne fusarium was present, but less than with the 'Nevada' seed lot. As in past studies, inoculum added to the soil of the seed bed planting lines effectively killed most of the garlic (Trials 2 and 3), although both fungicides greatly delayed and reduced the amount of disease from this inoculum source. Fusarium bulb rot symptoms were noted early on some plants as stunted growth, although these plants generally died within a week or two. Disease symptoms continued to appear through the season. A few plants, pulled at various times, revealed stem and lower bulb decay, and usually a reddish color in the decay area (not purple, which is a normal response at certain times). No botrytis or other disease was seen, so all mid-season symptoms were assumed to be from fusarium bulb rot. At harvest, badly affected plants had pithy stem plates and usually some degree of leaf sheath and clove decay. Reddish discoloration was not always present at harvest.

For bulbs held in storage for 5 weeks, classes A and B were weighed and these weights are listed in Tables 3 and 4; Class C contributed no significant weight to the total (less than 0.01 kg, the lower limit of our field scales). Bulbs per class were counted. There was no evidence of "nesting" of decay within the stored lots, although it was evident that fusarium had been and still was actively rotting cloves within bulbs.

For 5.45 kg of class A bulbs from combined field treatments, subclass A1 included 5.27 kg (97%) of the cloves, and combined subclasses A2 + A3 included 0.18 kg (3%) of the cloves, which were found partially-to-fully decayed with _F. roseum_, usually just an occasional clove amongst good ones. Some class A bulbs had more extensive internal rot of numerous cloves, but exterior cloves and covering leaf sheaths were intact. No subclass 4 cloves were found among A bulbs at the date of inspection.

For 3.15 kg of Class B bulbs, all bulbs had several to all cloves in some process of decay to _F. roseum_ and/or other organisms. Subclass B-1 included 1.58 kg (50%) of the cloves, subclass B-2 included 0.6 kg (19%) of the cloves, subclass B-3 included 0.73 kg (23%) of the cloves, and subclass B-4 included 0.24 kg (8%) of cloves. Subclass B-4 cloves were apparently decayed with _F. roseum_, but other organisms such as penicillium or aspergillus frequently were present in addition; these cloves were almost always enough decayed to be considered non-viable.

Class C bulbs were cracked or cut across the bulb through all cloves. No cloves were found fully intact; bulbs were hollow shells except that clove protective sheaths usually were intact. Mycelium of _F. roseum_ generally filled the clove positions, with some occasional presence of penicillium and aspergillus.

Table 5 summarizes the percentage by weight of cloves within each class and subclass.

A summary of isolations from treated and untreated cloves from various subclasses is shown in Table 6. _F. roseum culmorum_ was reisolated in approximately equal proportions from both surface sterilized and on-surface sterilized seed. All subclasses contained F. roseum, but with increasing amounts when signs of the fungus were greater. Even symptomless cloves, however, still continued 25-28% infection before hot water/ formalin seed treatment. Following this treatment, incidence of recovery of F. roseum from cloves was reduced to 10-16%. Thus, hot water/formalin seed treatment reduced fusarium infection by about half. All F. roseum culmorum isolates tested were capable of decaying symptomless garlic cloves when either wound inoculated into these cloves from PDA or even if mycelium from PDA was smeared onto clove stem plates without wounding. Results from planting out in the field of cloves hot water/formalin-treated will not be available until next year.

Some bulbs from the various classes were inspected into September and October. In general, decay appeared to have progressed, but more slowly as bulbs dried. It appeared that once cloves/bulbs dried enough, fusarium activity stopped; however, F. roseum culmorum still was isolated from all clove subclasses.

At about 8-10 weeks after harvest, one hundred each of class A cloves with and without hot water/ formalin treatment were sectioned into three parts: 1) stem plate section; 2) storage leaf section, and 3) first leaf piece. The stem plate section and the storage leaf section were plated on PDA, while the first leaf piece was kept in a humid Tupperware dish. Results show that 22% of the untreated cloves had Fusarium growth, and in all but two cases the Fusarium grew from the stem plate section, not the storage leaf. Thirteen percent of the treated cloves contained Fusarium growth. No Fusarium growth was observed in the first leaf pieces.

DISCUSSION

As in past years, bulb rot was incited through the season when inoculum of the garlic strain F. roseum culmorum was artificially infested into the soil. Disease resulting from this source was extensive at all stages, including preemergence; but it remains unknown how important soilborne sources are actually important in the field. Potentially, F. roseum culmorum may remain active in soil and survive various crop rotations, in effect lying in wait for the next garlic crop. Further investigation will be required to determine this. Mertect and Benlate seed treatments (but not common household bleach) greatly reduced the amount of disease from soil sources, but the perhaps excessive amount of inoculum utilized in these tests still caused significant disease loss.

As for the last several years, the soil into which these plots were placed had no history of garlic production. Theoretically the F. roseum culmorum garlic strain could have been in the soil anyway, but the commercial seed lots planted around our plots have never had greater than a fraction of a percentage of loss to fusarium bulb rot. Presumably, then, this year's results showed that the fusarium pathogen could be brought in at high levels with infected garlic seed. Surprisingly, it proved difficult to relate the amount of disease on the seed crops grown in 1984-85 with the amount experienced in 1985-86 in our plots in central Oregon: plants grown from seed taken from the field with extensive fusarium losses in 1984-85 developed about 10% fusarium disease in 1985-86. Plants grown from the field with no observed fusarium in 1984-85 developed 30% or more fusarium disease by harvest in 1985-86. Storage losses continued following harvest. Several possible explanations for this apparent reversal expected in disease incidence exist: (1) our seed lots became mixed (we have excluded this possibility) (2) most badly infected seed decayed before harvest or before planting of the 1984-85 crop, whereas mildly infected seed passed through the system without decay (3) other seed health factors affected fusarium development on the two seed lots. It is notable that fusarium was very slight (about 1%) by harvest on the same seed lots grown in western Oregon and in California (data from other areas are not shown here). Thus, there seems additionally to be a strong environmental effect on disease expression. This fits with the general disease experiences in these areas: central Oregon has had greater losses to fusarium bulb rot than have other regions of western garlic production. These environmental factors are not understood but may involve growth stresses from overwintering cold or dryness which most other seed production areas do not experience to the same degree. Spring emergence tends to be a little lower in central Oregon than other locations, especially with known sources of reduced seed vigor. In these tests, the poor emergence when seed had been treated with higher temperatures and durations of hot water was not duplicated in western Oregon and in California, where emergence was equal for all hot water and time variations (data from other areas are not shown here).

F. roseum culmorum continued to be active during bulb drydown in storage; postharvest weights and bulb and seed clove condition were reduced significantly from the condition at harvest. Eventually, the disease became inactive on very dry bulbs and cloves, but the pathogen was found to be present on a significant number of cloves which would pass through into the next seed crop, either on cloves generally if partial rot was apparent, or inconspicuously in the stem plate of symptomless cloves. Standard hot water seed treatment alone eliminated only about one half of the clove infections. Why general surface contaminations of cloves with fusarium spores were not observed is uncertain. Mertect and Benlate each fully controlled the seedborne fusarium in field tests, thus incorporation of Benlate (which is registered for use against penicillium seed rot) is encouraged. Because seed lot infection levels may be obscure, fungicidal treatment of all seed to be planted in central Oregon is recommended. Seed treatment for fusarium control in plantings in other areas in which the disease is less likely to be severe is a less certain consideration: Overuse of Benlate or any fungicide may select for resistance in a fungus; and such resistance to Benlate already has been noted in certain cases with penicillium on garlic seed. Registration of Mertect and screening of other fungicides for efficacy against fusarium also are recommended.

It is further recommended that an investigation be initiated into the survival of the garlic strain of F. roseum culmorum in field soils, the amounts of the fungus in soil required to incite an economic level of disease, and the possible roles of alternate host crops (e.g. cereals).

Also, a general survey of seed lots for infection levels may prove useful.

Table 1: Fusarium Test #1, Madras, OR 1985-86
Cassaca Seed Source

Treatment Means and Stat Summary[a]

Treatment[b]	Stand[c] (# Emerged) 4/7/86	% Stand 4/7/86	% Plants with Bulb Rot Symptoms 6/18/86	Wt (Kg) Harvestable Bulbs 7/22/86
1. Untreated	177	89	9	4.94
2. St+Ben	170	85	3	5.32
3. St+(125deg)	175	88	1	5.87
4. St+(130deg)	176	88	2	5.54
5. St+(130deg-CD)	119	60	2	3.67
6. St+(2hr,110deg)+Ben	183	92	1	4.94
7. St+(2hr,115deg)+Ben	157	79	0	4.85
8. St+(2hr,115deg-CD)+Ben	115	58	2	3.65
X	159	80	2.4	4.85
CV	7.9	7.9	102.5	10.7
F-Test	**[d]	**	**	**
LSD .05	18.5	9.3	3.6	0.74

a. Means of 4 replications are rounded to nearest whole number (except for wts)

b. St = standard seed treatment: 30 min at 100F, followed by 20 min at 120F (both with 1% Formalin), followed by 15-min cold dip. St plus parenthetical variations indicate time and/or temperature variations of the hottest water part of the standard treatment, and -CD means the cold dip was eliminated. Mer = Mertect and Ben = Benlate added to cold dip treatment water

c. All plots planted 20 cloves/bed ft x 10 ft = 200 cloves/ plot

d. * & ** = significance at 5% and 1% levels, respectively

Table 2: Fusarium Test #2, Madras, OR 1985-86
Nevada Seed Source

Treatment Mean and Stat Summary[a]

Treatment[b]	Stand[c] (# Emerged) 4/7/86	% Stand 4/7/86	% Plants with Bulb Rot Symptoms 6/18/86	Wt (Kg) Harvestable Bulbs 7/22/86
1. Standard	154	77	46	2.54
2. St+Mer	191	96	2	4.45
3. St+Ben	190	95	5	4.57
4. St+FRC	145	73	55	1.95
5. St+Mer+FRC	188	94	20	3.31
6. St+Ben+FRC	187	94	17	4.13
X	176	88	24.2	3.49
CV	7.1	7.1	59.0	22.3
F-Test	**[d]	**	**	**
LSD .05	18.9	9.3	21.5	1.17

a. Means of 4 replications are rounded to nearest whole number (except for wts)
b. St = standard seed treatment = 30 min at 100F, followed by 20 min at 120 F (both with 1% Formalin), followed by 15-min cold dip. Mer = Mertect and Ben = Benlate added to cold dip treatment water. FRC = _Fusarium roseum culmorum_ garlic strain placed into planting furrows
c. All plots planted 20 cloves/bed ft x 10 ft = 200 cloves/plot
d. * & ** = significance at 5% and 1% levels, respectively

Table 3: Fusarium Test #3, Madras, OR 1985-86: Treatment Means and Stat Summary[a]
Nevada Seed Source

Column #	1	2	3	4	5	6	7	8	9	10
Treatment[b]	Stand[c] (# Emerged) 4/7/86	% Stand 4/7/86	% Plants with Fus Symptoms 6/18/86	Number of Harvestable Bulbs 7/22/86	Harvestable bulbs as % of Stand	Harvestable bulbs as % of seeded	Wt (Kg) Harvestable Bulbs 7/22/86	Wt (Kg) Post-Harvest 9/29/86	Wt (Kg) Loss In Storage	Storage Wt Loss As % of Harvest Wt
1. Un	154	77	30	85	54	43	3.38	2.45	0.93	28
2. St	155	78	36	69	42	34	2.58	1.83	0.74	29
3. St+Ben	184	92	2	150	81	75	5.34	3.61	1.73	33
4. St+Mer	175	88	2	142	81	71	5.00	3.37	1.63	33
5. Un+FRC	31	16	90	7	22	3	0.26	0.27	0.01	3
6. St+FRC	21	11	86	4	21	2	0.15	0.12	0.03	13
7. St+Ben+FRC	184	92	61	43	24	22	1.71	1.05	0.67	39
8. St+Mer+FRC	180	90	68	46	25	23	1.79	1.01	0.75	43
$\bar{X}$	136	68	47	68	44	34	2.53	1.71	0.81	28
CV	11.0	11.0	29.9	30.1	24.1	30.1	25.4	28.3	28.8	29.5
F-Test	**[d]	**	**	**	**	**	**	**	**	**
LSD .05	21.9	11.0	20.5	30.1	15.5	15.0	0.94	0.71	0.34	10.6

Column #	11	12	13	14	15	16	17	18	19	20
	Post-Harvest Class A		Post-Harvest Class B		Post-Harvest Class A		Post-Harvest Class B		Post-Harvest Class C	
Treatment[b]	Wt (Kg)	% Wt of Total	Wt (Kg)	% Wt of Total	Number of Bulbs	% of Total	Number of Bulbs	% of Total	Number of Bulbs	% of Total
1. Un	2.27	93	0.17	7	75	87	6	7	5	6
2. St	1.55	84	0.22	12	54	77	9	13	7	10
3. St+Ben	3.19	89	0.41	12	115	77	19	12	16	11
4. St+Mer	3.05	90	0.31	10	111	78	13	9	18	13
5. Un+FRC	0.22	83	0.04	14	6	89	1	11	0	0
6. St+FRC	0.08	84	0.05	27	2	73	1	18	1	9
7. St+Ben+FRC	0.82	78	0.23	22	27	61	9	20	8	19
8. St+Mer+FRC	0.77	77	0.24	23	30	64	10	22	9	19
$\bar{X}$	1.50	85	0.21	15.9	52	75.7	8.2	14.0	7.9	10.9
CV	30.8	14.7	46.9	83.2	34.3	16.4	46.3	63.8	55.6	57.8
F-Test	**	**	**	NS	**	NS	**	NS	**	**
LSD .05	0.68	18.4	0.14	NS	26.4	NS	6.0	NS	6.5	9.3

a. Treatment means of 4 replications are rounded to nearest whole number (except for wts)
b. St = standard seed treatment = 30 min at 100F, followed by 20 min at 120F (both with 1% Formalin), followed by 15-min cold dip. Mer = Mertect and Ben = Benlate added to cold dip water. FRC = *Fusarium roseum culmorum* garlic strain placed into planting furrows
c. All plots planted 20 cloves-bed ft = 200 cloves/plot
d. * & ** = significance at 5% and 1% levels, respectively

Table 4: Fusarium Test #4, Madras, OR 1985-86: Treatment Means and Stat Summary[a]
Cassaca Seed Source

Column #	1	2	3	4	5	6	7	8	9	10
Treatment[b]	Stand[c] (# Emerged) 4/7/86	% Stand 4/7/86	% Plants with Fus Symptoms 6/18/86	Number of Harvestable Bulbs 7/22/86	Harvestable bulbs as % of Stand	Harvestable bulbs as % of seeded	Wt (Kg) Harvestable Bulbs 7/22/86	Wt (Kg) Post-Harvest 9/29/86	Wt (Kg) Loss In Storage	Storage Wt Loss as % of Harvest Wt
1. Untreated	177	89	6.0	138	78	69	4.98	3.38	1.59	32
2. Standard	151	76	2.0	131	87	66	4.86	3.80	1.07	22
3. St+Ben	179	89	0	161	90	81	5.44	4.31	1.13	21
4. St+Mer	181	91	0	160	88	80	5.64	4.45	1.19	21
5. St+NaOCl	162	81	5.0	134	82	67	4.57	3.52	1.08	24
$\bar{X}$	170	85	2.6	145	84	73	5.10	3.89	1.21	24
CV	7.0	7.0	110.6	10.5	6.0	10.5	14.3	12.66	23.27	10.9
F-Test	*[d]	*	*	*	*	*	NS	*	*	*
LSD .05	18.4	9.2	4.4	23.3 NS	7.9	4.0	NS	0.75	0.43	4.0

Column #	11	12	13	14	15	16	17	18	19	20
	Post-Harvest Class A		Post-Harvest Class B		Post-Harvest Class A		Post-Harvest Class B		Post-Harvest Class C	
Treatment[b]	Wt (Kg)	% Wt of Total	Wt (Kg)	% Wt of Total	Number of Bulbs	% of Total	Number of Bulbs	% of Total	Number of Bulbs	% of Total
1. Untreated	2.84	84	0.49	15	103	75	24	18	11	8
2. Standard	3.65	96	0.15	4	121	93	9	6	1	1
3. St+Ben	4.16	97	0.15	3	151	94	10	6	0+	0+
4. St+Mer	4.27	96	0.18	4	150	94	9	6	1	0+
5. St+NaOCl	3.33	95	0.20	5	122	92	9	6	3	2
$\bar{X}$	3.65	94	0.23	6	129	89	12	8	3	2
CV	12.04	5.5	81.1	85.7	8.4	6.3	65.6	61.3	101.8	87.3
F-Test	**	*	NS	*	**	**	NS	*	**	**
LSD .05	0.68	8.0	NS	8.2	16.9	8.6	NS	7.9	4.8	2.9

a. Means of 4 replications are rounded to nearest whole number (except for wts)
b. St = standard seed treatment: 30 min at 100F, followed by 20 min at 120F (both with 1% Formalin), followed by 15-min cold dip. Mer = Mertect, Ben = Benlate and NaOCl = Sodium hypochlorite (common household bleach) added to cold dip treatment water.
c. All plots planted 20 cloves/bed ft x 10 ft = 200 cloves/plot
d. * & ** = significance at 5% and 1% levels, respectively

Table 5: Grade of garlic cloves, as a percentage of the weight fraction within fusarium bulb rot class and clove decay subclass following postharvest storage

Bulb Rot Class	Clove Decay Subclass Within Bulb Rot Class 1	2	3	4
A	97%	(3%)		0%
B	50%	19%	23%	8%
C	0%	0%	95%	5%

Table 6: Frequency of isolation of <u>Fusarium roseum culmorum</u> (FRC) from garlic cloves of different bulb rot classes and clove decay subclasses, with and without hot water + formalin seed treatment.

BULB ROT CLASS AND CLOVE DECAY SUBCLASS	STANDARD HOT WATER & FORMALIN SEED TREATMENT	SURFACE STERILIZATION	NUMBER OF CLOVES FROM WHICH ISOLATIONS WERE ATTEMPTED	% OF CLOVES WITH FRC RECOVERED
A1	-	-	20	25
A1	-	+	120	27
A1	+	+	140	13
B1	-	+	25	28
B1	+	+	25	12
B2	-	+	10	50
B2	+	+	10	20
B3	-	+	10	80
B3	+	+	10	50

PERFORMANCE OF FOUR FORAGE TURNIP VARIETIES AT MADRAS, OREGON, 1986-1987

J. Loren Nelson[1]

ABSTRACT

Forage turnips (cv. Purple Top, Rondo, Forage Star, Barive) were evaluated at the Madras site of the Central Oregon Experiment Station for root and top yield 67, 94, 123, and 158 days after planting on August 22, 1986. Maximum yield of fresh tops from 19.6 to 30.7 tons/Acre were obtained 67 and 94 days after sowing. The maximum of 14.8 to 17.9 tons/acre of fresh roots was not reached until the last harvest (January 27). However, maximum total yield of fresh biomass (34.4 to 40.6 tons/Acre) for all varieties was achieved November 23, 94 days from sowing. The contribution of leaf tissue to total yield declined with each harvest and the reverse relationship existed for the root role in productivity. Each component of dry matter yield was highest on December 23, 123 days after planting. Leaf tissue dry matter declined for Barive and Forage Star from November 24 to the end of the season. There was a slight increase during the same period for Rondo and Purple Top which had initiated some new leaf growth because of mild winter temperature. Maximum dry matter yield ranged from 2.4 to 3.2, 1.9 to 2.3, and 4.6 to 5.4 tons/ acre for tops, roots, and tops plus roots on December 23, 123 days from sowing. The highest percent dry matters obtained throughout the season were 13.88 and 10.83 for tops of Purple Top January 27 and roots of Forage Star November 24, respectively.

INTRODUCTION

Forage turnips (Brassica rapa L.) have been used as valuable supplemental fall and winter pasture on irrigated land in central Oregon. They are well adapted to cool climates. However, growers have observed that productivity declines

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with deferred planting from late July to September. Apparently the Purple Top variety has been planted most frequently but Rondo, Forage Star, and Barive are also available. No research data are available for these varieties grown in central Oregon.

The objective of this test was to determine the root and top yield of the four varieties listed above when harvested approximately 60-, 90-, 120-, and 160-days after planting.

MATERIALS AND METHODS

Non-treated seed of Purple Top, Rondo, Forage Star, and Barive fodder turnips was sown in 5 feet wide x 20 feet long plots replicated four times in a randomized complete block design at Madras, Oregon. Treflan (1 pound ai/acre) was impregnated on 16-20-0-15 (400 pounds/acre) and broadcast on the field for incorporation during seedbed preparation. Seed was planted 3/4-inch deep at 3 pounds/acre on August 22, 1986. The plot was irrigated as needed. Malathion (1.25 pounds ai/acre) was applied on September 8 for aphid control.

A 9.29 square foot sample was taken from each plot on October 28, November 24, December 23, and January 27, 1987, for 67, 94, 123, and 158 days after planting, respectively. Plant height was measured for the first two harvests. Plants were pulled from the soil by hand and the soil was brushed from the roots. All plants were topped and root and top weighed separately. Root diameter of the largest root for each variety was measured.

Green weight yields (tons/acre) were calculated for each variety. A top and root sample was oven-dried from which dry matter yields were determined. A top/root ratio on a green and oven-dry weight basis was calculated by dividing the top weight by the root weight.

Least significant differences at 5 and 1 percent levels of probability were calculated to test differences.

RESULTS AND DISCUSSION

Fresh Top, Root and Total Yield. The maximum top yield was obtained from 67 to 94 days after sowing (Table 1). However, the maximum root weight was not achieved until the January harvest, 158 days after planting. The maximum total yield (tops and roots) was obtained within 94 days. There was a higher percentage of the green yield comprised of leaf (tops) tissue 67 days after sowing than for subsequent harvest periods. The highest top/root ratios were for the early harvests. The total yield range of the four varieties was 34 to 40 tons per acre, for the November 24 harvest. Mitchell (4) reported a green weight yield range of 40-80 and 45-85 tons/acre for Purple Top and Barive, respectively, in the Columbia Basin of Washington. Heinemann (3) obtained 32.49 and 10.91 tons per acre fresh weight for roots and aerial parts, respectively, from Purple Top turnips planted August 1 at Prosser, WA.

Green Top Yield Among Varieties. Rondo produced significantly more fresh top yield than other varieties 67 days after planting but for subsequent harvests, Rondo was superior only to Purple Top and Barive.

Green Root Yield Among Varieties. For the first harvest, Purple Top and Barive produced more than Rondo and Forage Star. Ninety-four days after sowing, Purple Top surpassed only Rondo and Forage Star. However, for the next harvest the fresh root weight was similar for all varieties. The only significant difference among varieties in the last harvest was between Barive and Forage Star in favor of Barive.

Total Green Yield Among Varieties. For first harvest Barive was significantly lower in yield than other varieties. Rondo was the highest yielding but was also similar to Purple Top 67 days after planting.

Rondo was similar to Purple Top and Forage Star at all harvests except Forage Star in the first harvest.

Top/Root Ratio Among Varieties. Rondo had the highest ratio the first two harvests, followed by Forage Star and Purple Top for harvest one.

Dry Matter (DM) Yields. There was slightly higher top, root, and total yield for all varieties 123 days after planting than the other harvest periods (Table 2). Rondo and Forage Star were similar in top yield for all harvests and both had greater foliage yield than Barive. Purple Top was similar to Rondo and Forage Star for second and third harvests but lower than Rondo on the first and last harvest. Only one significant difference existed for root yield - Purple Top was superior to Rondo at second harvest. Root yields for all other varieties and harvests were similar. Only a few differences existed for total yield.

DM yields from Purple Top planted August 1 at Prosser, WA, were reported to be 2.97 and 1.43 tons/acre for roots and aerial plant parts (3). Evans (1) found at the same location and variety that total DM yield was 3.40, 3.42, and 1.62 tons/acre from plantings made July 10, August 2, and 31, 1976, respectively. Thus, he concluded that seeding at the end of August is a marginal situation in irrigated central Washington. His dry matter yields of Purple Top from

August 1-3 plantings by plant part were 2.64, 3.17, and 5.81, and 1.98, 2.50, and 4.48 tons/acre for top, storage root, and total, respectively, each in 1977 and 1976.

There was no difference in total yield among Purple Top, Rondo, and Forage Star for any harvest. Purple Top was higher than Barive 67, 94, and 123 days after sowing. Barive was also lower yielding than Forage Star at the first and third harvest. The trend was for Rondo and Forage Star to have the highest dry matter top/root ratios but all differences were not significant. For the first two harvests, Rondo and Forage Star were higher than Barive but Purple Top was similar to Forage Star and Barive. Rondo exceeded Purple Top for the first two harvests. Rondo and Forage Star were higher than Barive at the last two harvests.

Plant Height. All other varieties were taller than Barive (Table 3).

Root Diameter. Root diameter increased for Purple Top from first to second harvest but the largest diameter for the other cultivars was not achieved until the third harvest (Table 3).

Dry Matter (DM) Percentage of Tops and Roots. DM for tops of all varieties increased from October to January harvest (Table 3). No significant difference in percent DM occurred among varieties for the first or last harvest. Several differences existed for the other two harvests.

The percent DM change for roots from early to late harvest appeared to be insignificant. The difference between Rondo and Forage Star in harvest two of 1.93 percent was the only significant difference among varieties.

All varieties except Rondo had the highest percent root DM at the November harvest. Root DM of Forage Star and Barive declined from harvest two compared to Rondo which had a slight increase throughout the season. The percent DM for Purple Top showed an irregular pattern although it may not be significant.

The percent DM mean over all varieties for each harvest ranged from 8.48 to 13.06 and 8.45 to 9.75 for tops and roots, respectively.

Other Growth Characteristics. The root shape and portion of root formed above ground varied for the varieties tested. Purple Top has a globe shaped root with a considerable portion above ground. Evans (1) reported as above ground distribution of whole plant dry weight of 44, 36, and 80 percent for top, storage root, and total, respectively. Cattle may readily uproot the plant and consume virtually all of it. Less loss from broken roots would probably occur in light, sandy soils. Sheep may encounter greater difficulty in securing most of the root than cattle. Heinemann (3) found that Purple Top utilization was not complete nor efficient. In his study, the lambs left about 16.2 percent of the roots and the ewes about 8.6 percent. Presumably ewes and lambs could utilize Purple Top and Barive in a similar manner, but losses may be greater from the globe-shaped roots of Rondo and Forage Star which were set somewhat lower in the soil. Barive has a long oblong-shaped root set extra high above the soil surface so presumably utilization by livestock would be good.

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Table 1. Green top and root yield of four forage turnip varieties at Madras, Oregon, 1986-1987

Variety	Tops				Roots				Tops and roots				Top/root ratio			
	Days after planting				Days after planting				Days after planting				Days after planting			
	67	94	123	158	67	94	123	158	67	94	123	158	67	94	123	158
	tons/acre															
Purple Top	25.8	24.6	12.5	13.6	7.5	16.0	11.9	17.2	33.3	40.6	24.3	30.8	3.53	1.54	1.06	0.80
Rondo	30.7	28.0	17.6	18.7	5.1	12.5	9.4	15.6	35.8	40.4	27.0	34.3	6.17	2.26	1.47	1.20
Forage Star	25.9	25.5	15.1	17.3	5.8	12.7	9.1	14.8	31.7	38.2	24.2	32.2	4.69	2.01	1.72	1.17
Barive	17.9	19.6	8.8	12.4	8.0	14.8	10.4	17.9	25.9	34.4	19.2	30.2	2.29	1.34	0.85	0.69
Mean	25.1	24.4	13.5	15.5	6.6	14.0	10.2	16.4	31.7	38.4	23.7	31.9	4.17	1.79	1.27	0.97
CV (%)	9.6	8.3	14.4	8.1	11.9	11.3	18.2	9.9	7.2	8.8	14.4	7.1	16.93	7.72	38.29	10.91
LSD (5%)	3.8	3.2	3.1	2.0	1.3	2.5	3.0	2.6	3.6	5.4	5.4	3.6	1.13	0.22	0.78	0.17
LSD (1%)	5.5	4.6	4.5	2.9	1.8	3.6	4.3	3.7	5.2	7.7	7.8	5.2	1.62	0.32	1.12	0.24

Table 2. Dry matter yield of tops and roots for four forage turnip varieties at Madras, Oregon, 1986-1987

Variety	Tops: Days after planting 67	94	123	158	Roots: Days after planting 67	94	123	158	Tops and roots: Days after planting 67	94	123	158	Top/root ratio: Days after planting 67	94	123	158
	tons/acre															
Purple Top	2.1	2.4	3.1	1.9	0.6	1.6	2.3	1.7	2.8	4.0	5.3	3.5	3.62	1.57	1.36	1.16
Rondo	2.5	2.5	3.2	2.4	0.4	1.1	1.9	1.4	2.9	3.6	5.1	3.8	6.03	2.26	1.63	1.67
Forage Star	2.3	2.5	3.1	2.2	0.5	1.4	2.2	1.4	2.8	3.8	5.4	3.6	4.56	1.79	1.43	1.65
Barive	1.5	1.9	2.4	1.6	0.6	1.4	2.2	1.5	2.1	3.3	4.6	3.1	2.34	1.39	1.13	1.12
Mean	2.1	2.3	3.0	2.0	0.5	1.4	2.2	1.5	2.7	3.7	5.1	3.5	4.14	1.75	1.39	1.40
CV (%)	9.6	7.1	8.6	11.6	19.6	13.9	12.8	18.3	9.6	8.0	7.9	9.3	19.92	13.47	12.99	22.88
LSD (5%)	0.3	0.3	0.4	0.4	0.2	0.3	0.4	0.4	0.4	0.5	0.6	0.5	1.32	0.38	0.29	0.51
LSD (1%)	0.5	0.4	0.6	0.5	0.2	0.4	0.6	0.6	0.6	0.7	0.9	0.7	1.89	0.54	0.41	0.74

Table 3. Plant height, diameter of the largest root, and dry matter of tops and roots of four forage turnip varieties, Madras, Oregon, 1986-1987

Variety	Plant ht.		Diameter of largest root				Foliage dry matter				Root dry matter			
	10/28	11/24	10/28	11/24	12/23	1/27	10/28	11/24	12/23	1/27	10/28	11/24	12/23	1/27
	------cm------		------------mm------------				----------------------------%----------------------------							
Purple Top	46.0	39.0	60	76	72	70	8.36	9.93	11.55	13.88	8.30	9.83	8.72	9.63
Rondo	48.3	46.3	56	74	82	80	8.23	8.85	9.98	12.55	8.49	8.90	8.27	9.20
Forage Star	46.0	44.3	56	72	83	76	8.97	9.92	10.80	12.73	9.06	10.83	9.70	9.10
Barive	39.0	36.0	53	60	68	68	8.38	9.70	10.68	13.10	7.96	9.45	8.85	8.50
Mean	44.8	41.4	56	71	76	74	8.48	9.60	10.75	13.06	8.45	9.75	8.89	9.11
CV (%)	3.9	3.3	8	11	8	8	6.46	4.59	3.92	6.93	11.51	8.88	10.84	12.90
LSD (5%)	2.8	2.2	7	12	9	9	0.88	0.70	0.67	1.45	1.55	1.38	1.54	1.88
LSD (1%)	4.0	3.1	10	18	13	13	1.26	1.01	0.97	2.08	2.23	1.99	2.21	2.70

THE EFFECT OF pH AND POTASSIUM ON THE YIELD AND QUALITY OF ALFALFA HAY

PRELIMINARY REPORT

Steven R. James[1]

ABSTRACT

An experiment to study the effects of soil pH and potassium (K) on potatoes, winter wheat, and alfalfa was begun in 1979 at Powell Butte, Oregon. A wide range of soil pH and K levels was created by the addition of lime or elemental sulphur and potassium chloride. The trial area was seeded with Pioneer 532 alfalfa in 1984. One cutting was taken in 1984, three cuttings were taken each year in 1985 and 1986. The trial will be continued for one more year (1987).

The preliminary results after three years suggest that soil pH levels below 6.0 are detrimental to hay yield and quality. The pH treatments below 6.0 had lower yields, fewer nodules, and lower percent crude protein than plots with a pH above 6.0.

Soil K levels had less effect on yield and quality of alfalfa hay than soil pH levels. Increasing the soil K levels slightly increased hay yield but slightly decreased percent crude protein.

The production of hay is one of Oregon's principal farm commodity enterprises, ranking second in total value of production behind cattle/calves in 1985 (1). Approximately 52,000 acres of hay are grown annually in Deschutes, Crook, Jefferson, and northern Klamath counties. A soil fertility survey conducted in 1980 on central Oregon alfalfa fields indicated 42 percent of the fields were below a pH critical level of 6.5, and five percent of the fields were below the soil K critical level of 150 ppm (2). Fertilizing alfalfa with K was not practiced in central Oregon for many years because soil K levels were very high (800-1200 ppm) when lands were converted from rangeland to cropland. In 1980, surveyed fields averaged 367 ppm of K and many were lower, hence a downward trend in K fertility has developed in central Oregon alfalfa fields.

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An experiment to study the effects of soil pH and K on potatoes was begun in 1979 at Powell Butte, Oregon. A wide range of soil pH and K levels was created by the addition of lime or elemental sulphur and potassium chloride. After completion of the potato studies in 1983, the trial was seeded to alfalfa in 1984. The alfalfa experiment was designed to determine critical pH and soil K levels and aid in the fertilizer recommendations of lime and K.

MATERIALS AND METHODS

A relatively uniform Deschutes sandy loam site with a pH of 5.5 and soil K level of 168 ppm at the Powell Butte site of Central Oregon Experiment Station was chosen for the experiment in 1979. The experiment consisted of 20 treatments arranged in a completely random design replicated four times. Plots were sized 20 feet x 30 feet to facilitate tillage and reduce edge effects. Four different pH levels were artificially created on March 19, 1979, by an application of four tons/acre of lime, two tons/acre of lime, no amendment, and one and one-half tons/acre of elemental sulphur. These treatments were allowed to stabilize for one year with a crop of potatoes.

Five K levels were created within each pH level in May, 1980, by the application of 0, 100, 200, 400, and 800 pounds/acre of K as muriate of potash. The K treatments were repeated in April 1982, and May 1986.

The trial area was cropped as follows:

1979:	Potatoes
1980:	Potatoes
1981:	Winter Wheat
1982:	Potatoes
1983:	Winter Wheat
1984:	Alfalfa
1985:	Alfalfa
1986:	Alfalfa

The trial was seeded June 6, 1984, with 17 pounds/acre of Pioneer 532 alfalfa. The plots were treated with three pints/acre of Eptam 7-E before planting and two quarts/acre of 2,4-DB was applied July 5, 1984, after the plants had three trifoliate leaves. The trial was fertilized with 650 pounds/acre of 0-10-0-13 in 1984 and 1985; 455 pounds/acre of 0-10-0-13 was applied in 1986.

One cutting of hay was taken in 1984 on August 30. A 20-foot x 44-inch swath was harvested from each plot and a one-pound sample was taken from each plot for moisture determination and plant analysis. Three cuttings of hay were taken in both 1985 and 1986. Protein and plant nutrients were evaluated from the first cutting in 1984 (only cutting), the second cutting in 1985, and the third cutting in 1986.

The soil was sampled August 30, 1984, May 2, 1985, and September 11, 1986. Eight cores at a sampling depth of 0-8 inches were taken from each plot and analyzed for pH, phosphorus, potassium, calcium, and magnesium.

Ten plants including their entire root systems were removed from the center of each plot immediately after the first cutting was taken in 1984. The samples were refrigerated overnight and carefully washed the following day. The number of pink or presumably functioning nodules was recorded for each plant. Nodulation samples were not taken in 1985 and 1986.

RESULTS

Yield, soil analyses, plant analyses, and hay quality results are shown in Table 1, Table 2, and Table 3 for 1984, 1985, and 1986, respectively.

1984. Soil pH levels ranged from 5.2 to 6.5 in 1984. Hay yields from the first cutting of the new stand significantly increased for each increase in soil pH. Soil K had no effect on hay yield.

Soil pH also affected hay quality. pH levels over 6.0 increased percent crude protein significantly over pH levels under 6.0. Increasing the pH increased acid detergent fiber and total digestible nutrients, but decreased relative feed value. Soil K levels had little effect on hay quality in 1984.

Nodulation was also significantly increased by increasing the pH and soil K levels. Nodulation was increased nearly threefold when the pH level was greater than 6.0 as compared with pH levels less than 6.0. A soil K level of 321 ppm also significantly increased nodulation over a soil K level of 116.

1985. Hay yields increased as pH and soil K levels increased. The effect of higher soil K levels producing greater hay yields noted in 1985 was not observed in 1984 with seedling alfalfa. The three cuttings of hay taken in 1985 perhaps removed more K from the soil thus producing the yield response to increased soil K levels.

The effect of pH on percent crude protein was similar to the effect seen in 1984 except the 18.3 percent observed at the lowest pH level was surprisingly high and equal to the percent protein at the two higher pH levels. Soil K levels of 160 and 162 ppm produced the highest protein levels in 1985.

<u>1986</u>. Increasing the soil pH increased total hay yield, percent crude protein, and percent acid detergent fiber (ADF). These effects have been consistent in each of the three years. Increasing the soil K levels also increased yields except for the highest level of K (336 ppm). Percent crude protein decreased as soil K levels increased.

<u>Plant Analysis</u>. In each year of the study, as pH levels increased, plant K, Mg, Zn, and Mn decreased. The soil pH had no effect on plant P and Ca. Also, in each year higher soil K levels increased the uptake of K and decreased plant Mg. Soil K had no effect on plant P, Ca, Zn, and Mn except in 1986 when high K levels decreased the amount of Zn in the plant.

SUMMARY

The preliminary results after three years suggest that soil pH levels below 6.0 are detrimental to hay yield and quality. The pH treatments below 6.0 had lower yields, fewer nodules, and lower percent crude protein than plots with a pH above 6.0.

Soil K levels had less effect on yield and quality of alfalfa hay than soil pH levels. Increasing the soil K levels slightly increased hay yield but slightly decreased percent crude protein.

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Table 1. The effect of four pH treatments and five potassium treatments on the yield, quality, nodulation, and soil and plant nutrient levels of establishment year (1984) alfalfa grown at Powell Butte, OR

Treatment	Yield	Nodules /plant	Crude protein	ADF	TDN	RFV	Soil					Plant					
							pH	P	K	Ca	Mg	P	K	Ca	Mg	Zn	Mn
	ton/A	no.	%	%				ppm	ppm	meq	meq	%	%	%	%	ppm	ppm
pH-1	1.43	1.38	13.0	31.5	54.7	140	5.2	41.6	196	8.1	3.2	.27	2.3	1.4	.37	27.9	168
pH-2	1.69	1.38	13.3	32.3	54.7	137	5.8	35.1	184	8.5	4.1	.27	2.0	1.4	.33	23.0	69
pH-3	2.00	3.38	15.4	33.5	56.0	133	6.2	31.1	185	10.7	3.8	.27	2.1	1.4	.31	21.1	53
pH-4	2.22	3.96	15.4	33.9	55.8	132	6.5	32.2	168	12.0	3.6	.27	2.0	1.4	.27	18.5	45
LSD 5%	0.14	1.05	0.9	1.2	.8	4	0.1	3.0	21	0.3	.2	NS	.1	NS	.02	1.9	13
K-0	1.86	1.88	14.2	33.1	55.2	135	6.0	32.5	116	9.8	3.6	.27	1.7	1.4	.37	21.7	73
K-100	1.94	2.50	14.3	33.3	55.2	134	6.0	34.1	131	9.9	3.5	.27	1.9	1.4	.34	23.6	89
K-200	1.77	2.11	14.3	32.9	55.3	136	5.9	34.3	166	10.3	3.9	.27	2.1	1.4	.33	23.1	88
K-400	1.89	2.56	13.9	32.9	55.0	135	5.9	34.8	182	9.9	3.6	.27	2.2	1.4	.29	21.3	79
K-800	1.71	3.57	14.7	31.9	55.9	139	5.9	39.3	321	10.4	3.8	.27	2.6	1.3	.28	23.3	89
LSD 5%	NS	1.18	NS	1.3	NS	4	NS	3.4	24	0.4	.3	NS	.1	NS	.03	NS	14

Table 2. The effect of four pH treatments and five Potassium treatments on the yield, quality, and soil and plant nutrient levels of second year (1985) alfalfa grown at Powell Butte, OR

Treatment	Yield*	Crude protein	ADF	TDN	RFV	Soil pH	Soil P	Soil K	Soil Ca	Soil Mg	Plant P	Plant K	Plant Ca	Plant Mg	Plant Zn	Plant Mn
	ton/A	%	%				ppm	ppm	meq	meq	%	%	%	%	ppm	ppm
pH-1	5.7	18.3	36.0	57.3	125	4.78	39.3	169	8.9	4.1	0.37	2.5	0.9	0.41	11.6	92
pH-2	6.0	17.1	37.9	55.9	118	5.43	31.9	176	10.9	4.0	0.36	2.4	1.0	0.39	13.9	52
pH-3	6.0	18.4	37.6	56.9	119	5.73	25.0	183	12.2	3.2	0.34	2.2	1.0	0.38	12.7	41
pH-4	6.1	18.5	39.1	56.6	113	6.11	28.8	164	13.0	3.5	0.34	2.0	1.0	0.36	12.3	34
LSD 5%	0.3	1.0	1.1	.9	4	0.12	5.8	19	0.8	0.7	NS	0.2	NS	0.02	NS	13
K-0	5.7	17.6	37.7	56.3	119	5.65	29.2	147	11.1	3.9	0.35	2.0	1.0	0.42	13.7	55
K-100	5.9	18.9	36.7	57.5	122	5.57	32.0	160	11.0	3.8	0.34	1.9	1.0	0.42	13.2	48
K-200	5.9	19.0	37.9	57.3	118	5.44	28.1	162	10.9	4.0	0.36	2.2	1.0	0.40	12.2	59
K-400	6.1	17.4	38.2	56.1	117	5.41	31.8	168	11.4	3.3	0.36	2.4	0.9	0.38	11.6	51
K-800	6.2	17.4	37.8	56.1	118	5.50	35.1	229	11.8	3.3	0.34	3.0	0.9	0.31	12.5	62
LSD 5%	0.3	1.1	1.2	1.0	4	0.14	6.5	21	0.9	NS	NS	0.2	NS	0.03	NS	NS

* Total of three cuttings

Table 3. The effect of four pH treatments and five Potassium treatments on the yield, quality, and soil and plant nutrient levels of third year (1986) alfalfa grown at Powell Butte, OR

Treatment	Yield*	Crude protein	ADF	TDN	RFV	Soil pH	Soil P	Soil K	Soil Ca	Soil Mg	Plant P	Plant K	Plant Ca	Plant Mg	Plant Zn	Plant Mn
	ton/A	%	%				ppm	ppm	meq	meq	%	%	%	%	ppm	ppm
pH-1	4.2	21.2	28.7	61.6	150	5.35	44.1	187	8.2	3.1	0.34	2.5	1.3	0.37	22.8	104
pH-2	4.7	21.4	31.2	61.1	141	5.85	33.3	177	9.6	3.8	0.35	2.6	1.3	0.35	21.7	58
pH-3	5.0	21.8	30.8	61.4	142	6.14	31.4	190	10.4	3.5	0.34	2.4	1.4	0.33	19.6	41
pH-4	5.2	22.2	30.7	61.8	143	6.41	30.8	186	11.8	3.3	0.34	2.2	1.5	0.33	21.8	35
LSD 5%	0.3	0.7	1.2	NS	4	0.08	3.6	NS	.5	.2	NS	0.2	NS	0.02	2.2	13
K-0	4.7	22.2	29.2	62.2	149	6.01	34.6	96	9.9	3.4	0.37	1.7	1.5	0.42	23.4	56
K-100	4.8	22.0	30.5	61.7	143	5.93	33.6	124	9.8	3.3	0.35	2.0	1.4	0.38	21.3	54
K-200	4.6	22.3	29.2	62.3	148	5.91	36.0	172	10.2	3.6	0.33	2.4	1.4	0.35	22.1	68
K-400	5.0	21.2	31.1	60.9	141	5.93	33.2	197	9.8	3.3	0.34	2.8	1.3	0.33	19.8	55
K-800	4.7	20.5	31.8	60.2	138	5.89	37.0	336	10.3	3.5	0.32	3.2	1.2	0.27	20.7	64
LSD 5%	0.3	0.8	1.3	0.9	5	0.09	NS	29	NS	NS	0.02	0.2	NS	0.02	2.5	NS

* Total of three cuttings

DRY MATTER YIELDS OF TWENTY-TWO ALFALFA VARIETIES AT MADRAS, OREGON, 1982-1986

J. Loren Nelson and Steven R. James[1]

ABSTRACT

The five-year yield trial of 22 alfalfa varieties at Madras was completed in 1986. In the fourth year of full production (1986) W-37, Apollo II, W-45, Trumpetor, Vernema, DeKalb 120, Valor, WL 220, Greenway 360, Pacer, WL 312, and Blazer were significantly more productive than Vernal. For total production over the five-year (1982-86) stand life, W-37 was superior to all other varieties, but it is not available for farm use and cannot be recommended because it is susceptible to bacterial wilt. Total yield for most varieties was similar.

Growers have many improved varieties from which to select for production in the Madras area. They should also use pest tolerance information to assure proper varietal selection for their field conditions.

Alfalfa variety trials have been conducted for many years in central Oregon. The Central Oregon Experiment Station's Madras site is one of two test locations. It has an elevation of 2,440 feet, a 115-120 day growing season, and mild winters. Seed companies submitted varieties for the trial which they thought had the most potential for the area but they were restricted to a maximum of three varieties that were commercially available. This report presents yield information for the entire test period (1982-86).

MATERIALS AND METHODS

Non-coated uninoculated seed of 22 alfalfa varieties was planted June 3, 1982, at 18 pounds/Acre. Each plot was five feet wide by 20 feet long. Varieties were replicated four times in a randomized complete block design. Before seeding, 110 pounds S and 90 pounds P/Acre were incorporated into the seedbed. In the spring of 1983, a top-dress application of

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the same fertilizer was also made. Eighty pounds S and 70 pounds P/Acre were top dressed in the spring of 1984. A single superphosphate-gypsum formulation [0-12-0-11(S)] at 625 and 500 pounds/Acre was top-dressed March 14, 1985, and March 24, 1986, respectively.

During establishment of the trial, broadleaf weeds were controlled with 2,4-DB at two pounds/Acre when the alfalfa had three to four trifoliate leaves. The only other herbicide application on the nursery was on March 14, 1985, with Sencor (50 percent active) and Paraquat (2 pounds + 1 pint/Acre).

The trial was sprinkler irrigated as needed during the five-year period. No insecticides or fungicides were applied to the nursery in any year.

Three cuttings were taken each year except the establishment year when two cuttings were taken. A forage harvester with a sickle cutter bar was used. The center (three feet wide by 14 feet long) of all plots was harvested when Vernal was in the first flower stage. However, in 1986, all plots were cut when the early maturing varieties, such as Trumpetor and Vernema, started to flower. A green alfalfa sample of about one pound was taken from each plot and oven-dried for use in dry matter determinations.

RESULTS AND DISCUSSION

In 1986, the 12 highest yielding varieties were superior to Vernal (Table 1). The five-year total yield of W-37 was superior to all other varieties but it is not available for commercial use. W-37 would not be recommended because it is susceptible to bacterial wilt. The total yield for most varieties was similar. Growers have a number of good varieties from which to select; their achievement of similar yield results will depend upon the closeness to which their field environment and management practices match those of the test location. No specific examination for any pest was made on any variety during the five-year test, although occasional wilted plants, light infestations of spring black stem, downy mildew, alfalfa weevil, aphids, and leaf hoppers were observed in some years. These pest problems are believed to have had negligible effect on variety performance. Nevertheless, growers should know their local alfalfa pest problems and field conditions to select varieties with the appropriate resistance level. Characteristics for the varieties evaluated have been tabulated (Table 2). Growers can find additional information from the references.

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Table 1. Annual and five-year total dry matter yields of 22 alfalfa varieties at Madras, Oregon, 1982-1986

Variety[1]	Seed or varietal source[2]	1982[3]	1983	1984	1985	1986	5-Year total		Vernal
		--------tons dry matter/a---------							%
W-37*	WA-USDA	2.66	9.06	8.31	7.89	7.10	35.08	a[4]	123
Trumpetor	NK	2.48	8.77	8.23	7.39	6.60	33.35	b	117
Apollo II	AgPr	2.61	8.45	7.76	7.62	6.81	33.07	bc	116
DeKalb 120	DK	2.72	8.31	8.25	7.25	6.49	33.00	bc	116
Vernema	WA-USDA	2.71	8.43	7.96	7.21	6.52	32.62	bcd	115
Pacer	US	2.24	8.82	8.25	7.11	6.05	32.35	b-e	114
WL 220	WL	2.59	8.32	7.93	7.02	6.35	32.33	b-e	114
DeKalb 130	DK	2.34	8.55	8.10	6.79	5.83	32.22	b-e	113
Blazer	US	2.64	8.55	7.76	6.67	5.91	32.13	b-e	113
Greenway 360	GS	2.65	8.38	8.00	6.53	6.21	32.11	b-e	113
Valor	US	2.27	8.45	7.79	7.05	6.43	32.10	b-e	113
Armor	AgPr	2.58	8.26	8.15	6.88	5.64	31.80	b-e	112
W-45*	WA-USDA	2.63	7.45	7.81	7.11	6.78	31.47	b-e	110
RS 209	DK	2.64	8.11	7.96	6.84	5.52	31.28	cde	110
WL 312	WL	2.57	8.12	7.40	6.76	6.01	31.08	cde	109
532	P	2.35	8.58	7.81	6.83	5.39	31.08	cde	109
WL 314	WL	2.53	8.10	7.59	6.38	5.82	30.64	def	108
Cascade	CE	2.59	7.83	7.66	6.39	5.60	30.54	ef	107
545	P	2.62	8.23	7.51	6.32	5.48	30.35	ef	107
Saranac	NY	2.22	7.99	7.20	6.10	5.55	29.07	fg	102
Vernal	WI-USDA	2.30	7.74	7.26	6.28	5.22	28.48	g	100
581	P	2.44	7.15	6.84	5.80	4.68	26.37	h	93
Average		2.51	8.25	7.80	6.83	6.00	31.48		
LSD 5%		NS	0.76	0.68	0.59	0.56	1.70		
CV (%)		12.00	6.47	6.21	6.06	6.55	3.81		

1* Experimental lines not available for commercial use.

2 Entering or originating agency: AgPr=AgriPro (formerly NAPB), CE=CENEX, DK=DeKalb-Pfizer Genetics, GS=Greenway Seeds, NK=Northrup King, NY=New York, P=Pioneer, US=Union Seed, WA=Washington, WI=Wisconsin, WL=W-L Research, USDA=United States Department of Agriculture.

3 Establishment year - total of two cuttings, total of three cuts for each of the other years.

4 Yield values followed by the same letter within a column are not significantly different at the 5 percent level using Duncan's multiple range test.

Table 2. Year of release, winter hardiness, disease, insect, and nematode resistance levels for alfalfa varieties entered in 1982-1986 Madras Trial. (Tabulated from reference number one.)

Variety[1]	Agency[2]	Year	WH[3]	Diseases[4]									Insects[5]				Nematodes[6]	
				BW	FW	VW	PRR	AN	SBS	CLS	LLS	DM	AW	PA	SAA	LH	RKN	SN
Apollo II	AgPr	1981	MH	R	R	MR	HR	LR	LR		MR	LR			MR			MR
Armor	AgPr	1981	MH	R	R		R	MR										
Blazer	US	1978	H	HR	R		MR	LR	MR	MR				R	S	MR	S	R
Cascade	CE		MH	R	MR	S	MR	R						MR	R			
DeKalb 120	DK	1978	H	HR	R		R	LR	MR	MR				R	S	LR		R
DeKalb 130	DK	1980	MH	HR	HR	LR	MR	MR	LR	LR	LR	LR		R	R			R
Greenway 360	GS																	
Pacer	US	1975	MH	R	MR		LR	S	MR	LR				R	S	MR		LR
RS 209	DK		H	R	R		R	MR						MR	MR			
Saranac	NY	1963	MH	R	R	S	S	S		LR		R						
Trumpetor	NK	1981	MH	MR	R	MR	S	MR		MR		MR	S	MR	S			MR
Valor	US	1974	H	R	MR		S	LR	MR	MR		R		R	S	MR	LR	LR
Vernal	WI-USDA	1953	H	R	R	S	S	LR	LR	LR	LR	LR					R	MR
Vernema	WA-USDA	1981	MH	MR		MR	LR	S										R
W-37*	WA-USDA		MH	S		R												
W-45*	WA-USDA		MH			LR												
WL 220	WL	1977	H	R	HR	LR	MR	LR		LR	LR	LR		HR	MR			LR
WL 312	WL	1978	MH	R	HR	LR	MR	LR	LR	MR	MR	LR		R	R			MR
WL 314	WL	1981	MH	R	R	LR	LR	MR		LR		LR		HR	R			HR
532	P	1979	H	HR	R		LR	LR										
545	P	1977	H	R	MR		R	LR		R		R		S	R			MR
581	P	1977	MH	R			R			LR		R		LR	R			

1* Indicates experimental lines not available for commercial use.

2 Entering or originating agency: AgPr=AgriPro (formerly NAPB), CE=CENEX, DK=DeKalb-Pfizer Genetics, GS=Greenway Seeds, NK=Northrup King, NY=New York, P=Pioneer, US=Union Seed, WA=Washington, WI=Wisconsin, WL=W-L Research, USDA=United States Department of Agriculture.

3 WH=Winter hardiness; MH=moderately winter hardy or semi-dormant; H=winter hardy or dormant

4 Diseases: BW=bacterial wilt; FW=Fusarium wilt; VW=Verticillium wilt; PRR=Phytophthera root rot; AN=Anthracnose; SBS=Spring black stem; CLS=common leaf spot; LLS=Lepto leaf spot; DM=downy mildew.

5 Insects: AW=alfalfa weevil; PA=pea aphid; SAA=spotted alfalfa aphid; LH=leaf hopper.

6 Nematodes: RKN=root knot nematode; SN=stem nematode.

Resistance levels: S=susceptible (5% or fewer resistant plants);
LR=low resistance (6-14% resistant plants);
MR=moderate resistance (15-30% resistant plants);
R=resistant (31-50% resistant plants);
HR=highly resistant (more than 50% resistant plants).

POTATO VARIETY DEVELOPMENT
AT
CENTRAL OREGON EXPERIMENT STATION

1986 PROGRESS REPORT

S.R. James, A.R. Mosley, D.C. Hane, G.E. Carter, C.E. Stanger[1]

ABSTRACT

Seed increases, selection, and variety trials were conducted in 1986 at Central Oregon Experiment Station as a part of statewide, tri-state and regional variety development programs. High quality, relatively disease-free seed of 145 advanced selections was increased for statewide and regional trials. Three tuber units from each of 902 lines selected from 1984 seedling tubers were grown; 160 were retained for further statewide preliminary testing. More than 28,400 seedling tubers were grown; 547 were selected for further evaluation in 1987. Forty-one advanced lines were retained from statewide variety trials. Most of these selections were suited for long-term storage and processing. Seed of fresh market selection A74212-1 was increased and evaluated commercially in large scale on-farm trials. This selection yields better than Russet Burbank, has a greater percentage of No. 1 tubers, has a smooth, lightly russetted appearance, and has better internal quality than Russet Burbank. A74212-1 is a strong candidate for public release.

Potato production and handling are major agricultural enterprises in central Oregon. Approximately 30 percent and 10 percent, respectively, of Oregon's seed and commercial production are from the central Oregon region. For many years, potato growers have felt the need for new potato varieties with production, storage, handling, and processing characteristics superior to Russet Burbank. This need is becoming more critical and may be an important factor in determining whether some potato producers can continue production.

To successfully develop new potato varieties in Oregon it is necessary to (1) screen a large volume of new genetic material for adaptability at the earliest possible generation; (2) produce and store the progeny under uniform conditions; (3) diagnose and free

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infected potato clones of viruses; and (4) keep the progeny disease free so subsequent generations can be realistically evaluated for production and quality potential.

Central Oregon Experiment Station is ideally located and equipped to accomplish these objectives in cooperation with other state and regional experiment stations. Thousands of new clones can be screened and high quality, disease free seed produced of promising selections. The station also has the capacity to free clones selected at other research stations of viruses and maintain and increase disease-free seedstocks of these clones. The station also serves as an excellent short-season evaluation site. This report discusses 1986 activities at Central Oregon Experiment Station in these areas.

METHODS

Seed Increases. Powell Butte was the major seed increase site for regional, tri-state, and statewide potato variety trials. On May 22, 1986, 30 tuber units (six pieces each) of nine regional selections and 143 tri-state/statewide selections were planted. Individual seedpieces were planted 10 inches apart and tuber units were separated by 18 inches. Two rows were planted 36 inches apart and were bordered on either side by a blank row or a 10-foot alley for tractor access. The blank rows/tractor alleys provided space for sprinkler laterals, roguing, and spraying with minimal vine contact. Only 15 tuber units of the 108 statewide preliminary selections were planted.

Before planting, five and one-half pints/acre of Eptam 7-E were incorporated into the soil on May 16, 1986. An Iron Age assisted feed potato planter was used to band 800 pounds/acre of 10-20-20-5 (NPKS) fertilizer at planting time. All increases were hand planted.

The seed increase blocks were rogued for potato virus Y (PVY), potato virus X (PVX), potato leaf roll virus (PLRV), and other diseases each week. In addition to weekly roguing, one pound per acre of Orthene 75S and a 1 percent solution of Stylet spray oil were applied by ground sprayer at 250 psi.

All seed increases were sprayed with dinitro and diesel on September 5 (1.5 quarts/acre dinitro, 3 gallons/acre diesel) and September 10 (1.5 quarts/acre, 3 gallons/acre). All material was dug on October 13-15, 1986, and shipped to Klamath Falls for storage.

Selection Trials/Increases. Early generation material for which less than five total tubers existed were planted in a combination selection/increase trial.

Nine hundred and two clones selected from 1985 seedling tubers were planted May 19-20, 1986. Approximately 14 to 18 seedpieces of each line were planted as three or four units in the same spatial arrangement as the advanced selection seed increases. Each line was separated by "All Blue" potatoes, which were planted to reduce variety mixing at harvest. Fertilizer and weed control were the same as used for advanced seed increases.

The selection trials/increases were harvested on October 9, 1986, by lifting with a level bed potato digger. Selection was based on visual characteristics; selected lines were hand bagged and nonselected lines were left in the field.

More than 28,400 seedling tubers (small tubers produced from true potato seed) were planted from crosses made in Idaho, North Dakota, and Colorado. More than 16,000 of the seedling tubers were produced in Oregon and are unique to the Oregon program. Individual tubers were planted 27 inches apart in 36-inch rows on May 23-27, 1986. Fertility, herbicides, and management practices were identical to the seed increases above.

Variety Trials. Two variety trials were conducted at Powell Butte in 1986. Twenty-six advanced selections were grown in the statewide variety trial and 111 preliminary selections evaluated in the preliminary yield trial (PYT2).

Five days before planting, five and one/half pints/acre of Eptam was incorporated into the soil. The plots were planted on May 4, 1986, and 1,000 pounds/acre of 16-16-16-7 (NPKS) was banded to the sides and slightly below the seed pieces.

The variety trials were arranged in randomized block designs; the statewide trial had four replications, the PYT2 trial two replications. Seedpieces were placed nine inches apart in three-foot rows and each plot was separated by two hills of "All Blue" potatoes. The individual plots in the statewide trial were 25 feet long (27 seedpieces) and the PYT2 plots were 15 feet long (16 seedpieces). Vines were dessicated naturally by frost and eliminated with a flail mower before harvest. Both trials were harvested October 16, 1986, and graded one week later. A 10-pound sample from each plot was taken for french-frying, specific gravity determination, and internal defect grading.

Specific gravities were determined by weighing approximately 10 pounds of tubers in air and water. Sixteen tubers from each plot were cut and internal defects were recorded as percent of tubers with a given defect. Four tubers from each plot were stored for two months at 50°F for french frying. Four 1/4-inch square strips from each of four tubers were fried for four minutes at 350°F. Each strip was evaluated for color and dark ends. Color was scored from 0-4 based on the USDA Standard Color Chart for frozen french-fried potatoes.

RESULTS

Seed Increases. Seed of 1,050 clones/varieties was produced for statewide, tri-state, and regional testing. Flights of green peach aphids were extremely high in central Oregon in 1986. Despite this, only 0.04 percent of the tuber units planted were rogued for PVX/PVY and 0.01 percent were rogued for leafroll infection.

Because of the large numbers of varieties and the importation of material from other programs, it has been difficult to eliminate or minimize viral infection. Eye-indexing, ELISA testing, intensive roguing, and high pressure aphicide/oil spraying have kept viral infection low as compared with 80 to 90 percent infection in the early days of the program.

Selection Trials/Increases. More than 28,400 seedling tubers from 195 crosses were planted in 1986. These single-hill selections were dug on September 30, 1986, and evaluated by a team of researchers and processors from several western states. Five hundred thirty-eight clones were retained which included 9 selections made by private processing companies. The selections were based on visual criteria, such as relative yield, tuber size, shape, uniformity, and overall appearance.

Nine hundred two lines selected from the 1985 single-hill selections were planted at Powell Butte. This trial was harvested October 9, 1986, and 208 lines were selected for further evaluation. Each line was evaluated for yield, grade, specific gravity, fry color, and sugar end development. Forty-eight lines were dropped because of poor yield, tuber deformities, or poor processing quality. The remaining 160 lines will be evaluated at four Oregon locations in 1987.

Statewide Variety Trial. Yield and quality data for the 1986 statewide advanced yield trial are shown in Table 1. Every clone/variety produced more No. 1 tubers than Russet Burbank. Only 52 percent of the Russet Burbank production was graded as No. 1's because of growth cracks, second growth, and other tuber malformations. Additionally, 74 percent of the Russet Burbank tubers either had hollow heart or brown centers. Russet Burbank produced acceptable fries in 1986.

A74212-1, A081178-11, A081178-12, A081216-1, A081394-7, C0080152-1, C008177-2, and ND534-4 were kept for further evaluation in 1987. A081216-1 and C0080152-1 were entered in the 1987 tri-state trial. Selections A79141-3 and C008014-1 were dropped from the statewide trial but will enter the second year of regional testing in 1987. Selections A081178-11 and A081178-12 show outstanding potential as fresh market selections.

Fresh market selection A74212-1 was tested for the sixth year. Table 2 summarizes the performance of this selection at four Oregon locations for six years. This selection has consistently yielded greater than Russet Burbank and its smooth, tan, lightly russetted tubers are very attractive and well suited for the fresh market. Seed of A74212-1 is being increased by commercial growers and the Oregon Foundation Seed Project. Also, approximately one and one-half acres of this selection was grown commercially, packed, and marketed by a Klamath Basin grower. There

Table 1. Yield, grade, fry color, and internal quality of statewide potato variety trial entries at Powell Butte, 1986

Variety	Yield-cwt/a total	Yield-cwt/a no. 1	% RB[1]	Spec grav[2]	Fry color[3]	% HH[4]	% BS[4]	% BC[4]	Disposition
R. Burbank	512	268	100	1.084	1.30	36	5	38	KEEP
Lemhi	553	437	108	1.087	2.70	0	41	0	KEEP
Norgold	467	390	91	1.079	3.10	6	6	0	KEEP
A74212-1	590	482	115	1.087	3.50	0	13	0	KEEP
A7869-5	555	456	108	1.083	2.40	2	15	3	DROP
A79141-3	484	332	95	1.090	0.90	3	11	0	DROP
A7919-1	612	478	120	1.084	2.50	0	5	0	DROP
A7987-14	515	369	101	1.084	2.30	0	7	2	DROP
A07869-20	513	429	100	1.091	2.40	0	5	0	DROP
A07920-4	466	414	91	1.095	2.20	0	8	0	DROP
A079336-3	513	370	100	1.094	2.30	0	9	0	DROP
A080570-10	584	445	114	1.081	3.90	0	40	2	DROP
A080576-5	486	360	95	1.081	2.10	2	22	0	DROP
A081178-7	451	316	88	1.080	2.50	13	8	16	DROP
A081178-11	835	672	163	1.079	2.20	18	11	3	KEEP
A081178-12	554	507	108	1.082	3.40	0	3	0	KEEP
A081195-11	440	293	86	1.085	3.10	2	4	5	DROP
A081216-1	415	300	81	1.086	3.10	0	6	0	KEEP
A081388-1	593	423	116	1.076	2.10	10	8	2	DROP
A081394-7	365	294	71	1.105	2.40	0	7	0	KEEP
A081681-1	512	403	100	1.088	2.30	0	14	0	DROP
A081772-5	528	445	103	1.085	3.50	0	8	0	DROP
C008014-1	456	406	89	1.088	1.00	2	6	2	DROP
C0080152-1	586	495	114	1.090	1.70	0	17	0	KEEP
C008177-2	413	360	81	1.100	1.10	2	8	0	KEEP
ND534-4	422	358	82	1.069	2.20	0	0	2	KEEP
LSD 5%	60	69	-	0.005	0.80	8	10	8	-

1 % RB = Total yield/Total yield Russet Burbank x 100
2 Air/Water method
3 0 = Lightest; 4 = Darkest
4 HH = Hollow Heart
BS = Black Spot
BC = Brown Center

Table 2. Yield and internal quality of Selection A74212-1 at four Oregon locations

Location	Year	Total Yield[1] (cwt/a)	Total %RB[1]	No. 1 Yield (cwt/a)	No. 1 %	No. 1 %RB[1]	Specific gravity	Fry color	HH[2] (%)	BC/IBS[3] (%)	BS[4] (%)	Early/late
Powell Butte	1981	538	113	415	77	132	1.073	3.6	0	-	-	-
	1982	336	84	251	75	88	1.079	2.5	0	0	10	-
	1983	529	102	502	95	112	1.078	1.4	0	0	6	-
	1984	592	123	496	84	138	1.077	1.5	0	0	8	-
	1985	528	108	396	75	127	1.083	3.5	0	0	9	-
	1986	589	115	481	81	180	1.087	3.5	0	3	13	-
Hermiston	1981	768	102	684	89	150	1.078	3.6	0	3	0	-
	1982	899	110	734	82	118	1.077	2.7	0	0	0	61
	1983	832	112	707	85	119	1.076	3.8	0	0	15	82
	1984	723	118	674	93	135	1.077	3.5	0	2	14	68
	1985	938	123	786	84	147	1.070	3.0	1	0	0	-
	1986	794	107	568	71	111	1.080	0.8	0	1	4	-
Klamath Falls	1981	471	193	398	85	-	1.081	-	3	-	-	70
	1982	524	107	395	75	-	1.083	-	23	-	-	83
	1983	484	134	409	84	170	1.070	-	3	-	-	92
	1984	634	128	539	85	144	1.076	-	5	-	-	81
	1985	510	128	414	81	146	1.067	-	7	20	-	95
	1986	621	116	545	87	139	1.068	-	0	-	-	84
Malheur	1981	546	119	504	92	133	-	-	-	-	-	-
	1984	756	134	648	86	145	-	-	-	-	-	-
	1985	730	113	578	79	129	-	-	-	-	-	-
Powell Butte	Ave	519	108	424	81	130	1.080	2.7	0	1	8	-
Hermiston	Ave	829	115	696	84	134	1.077	2.8	0	1	6	70
Klamath Falls	Ave	540	134	450	83	159	1.074	-	7	-	-	85
Malheur	Ave	677	122	577	86	137	-	-	-	-	-	-
All Locations	Ave	636	119	531	83	140	1.077	2.8	2	2	7	85

1 % RB = Total yield/Total yield Russet Burbank x 100
2 HH = Hollow Heart
3 BC/IBS = Brown Center, Internal Brown Spot
4 BS = Black Spot

Table 3. Yield, grade, fry color, and internal quality of clones retained from the preliminary variety trial, Powell Butte, 1986

Variety	Yield-cwt/a total	Yield-cwt/a no. 1	% RB[1]	Spec grav[2]	Fry color[3]	% HH[4]	% BS[4]	% BC[4]	Usage[5]
R. Burbank	512	207	100	1.088	1.20	49	4	31	PR
Lemhi	559	342	109	1.094	2.00	0	42	0	PR
Norgold	444	315	87	1.077	2.20	0	3	0	FM
A81362-3	557	462	109	1.085	2.90	0	35	0	PR
A81727-9	303	244	59	1.078	3.20	0	0	7	PR
A081084-2	458	344	90	1.084	2.40	0	0	0	PR
A081509-1	499	384	98	1.089	2.00	0	7	0	PR
A081512-1	478	262	93	1.106	2.00	3	3	0	PR
A081522-1	462	296	90	1.093	1.60	6	0	0	PR
A081783-7	446	357	87	1.088	1.10	3	7	0	PR
A081794-9	418	325	82	1.088	1.20	0	0	0	PR,CH
A082023-1	460	384	90	1.075	1.50	0	0	0	PR
A082254-24	551	455	108	1.083	2.00	3	22	3	FM
A082260-4	392	312	77	1.068	0.70	0	0	0	PR
A082260-7	288	229	56	1.081	0.60	0	0	0	PR
A082260-8	546	466	107	1.089	1.50	4	13	0	PR
A082281-1	489	423	96	1.081	0.90	0	10	0	FM
A082283-1	590	460	115	1.090	0.10	0	37	0	PR
A082283-5	435	331	85	1.094	1.00	0	16	0	PR
A082283-9	429	288	84	1.089	1.70	0	28	0	PR
A082606-13	450	326	88	1.088	1.90	0	16	0	PR
A082611-7	565	389	111	1.089	1.70	0	10	0	PR
A082616-12	437	270	86	1.095	1.50	0	29	0	PR
A082616-18	583	382	114	1.097	1.00	0	13	7	PR
C0082136-2	338	303	66	1.095	1.00	7	0	0	PR
C0082063-3	397	386	78	1.091	2.90	0	4	0	PR
ND01062-1	490	308	96	1.095	1.60	0	16	0	PR
ND01496-1	559	412	109	1.093	0.01	0	3	0	CH
ND01567-2	436	209	85	1.075	2.90	4	36	0	PR
ND02061-2	414	293	81	1.066	2.30	0	3	0	FM
LSD 5%	77	100	-	0.010	1.20	9	15	7	-

1 % RB = Total yield/Total yield Russet Burbank x 100
2 Air/Water method
3 0 = Lightest; 4 = Darkest
4 HH = Hollow Heart; BS = Black Spot; BC = Brown Center
5 PR = Process; FM = Fresh Market; CH = Chipper

were no major problems encountered. Commercial scale testing will continue in 1987. A74212-1 is a strong candidate for public release.

Preliminary Yield Trial (PYT2). Of the 111 selections grown in the PYT2 in 1986, the 30 clones retained for further testing are shown in Table 3. These clones will be tested in the statewide trial in 1987. All of the clones yielded more No. 1 tubers than Russet Burbank. Most of the clones processed well, which reflects the direction of the Oregon potato variety development program.

SUMMARY

The number of lines grown and selected in 1986 are shown in Table 4. In each of the past five years, the number of new lines brought into Oregon from regional breeding programs has increased. Hermiston and Ontario experiment stations are also increasing the numbers of seedling tubers planted at those locations, but selections must be freed from virus infection if grown at those locations before they can be widely tested. These program increases should greatly enhance the prospect of identifying potato varieties better suited for commercial production and processing.

Table 4. The number of potato clones evaluated and selected for further testing at Powell Butte in 1986

Trial	Number of lines grown	Number of lines selected
Advanced Statewide	28	11
PYT2	111	30
PYT1	902	160
Seedling Tubers	28,403	547
Totals	29,444	748

THE PRESENCE OF ERWINIA CAROTOVORA IN SURFACE AND WELL WATER SOURCES IN CENTRAL OREGON

M.R. Cappaert and M.L. Powelson[1]

Blackleg and aerial stem soft rot of potatoes, caused by *Erwinia carotovora* subsp. *carotovora* and *E. c.* subsp. *atroseptica*, occur in seed fields of Central Oregon. The predominant symptom, however, is aerial stem soft rot. The presence of aerial symptoms suggests that inoculum sources other than the seed tuber are probably involved. *E. carotovora* has been reported to be present in rivers, oceans, aerosols, rain (2) and recently in irrigation water (5). Irrigation water has been implicated in the recontamination of pathogen-free seed stocks (5) and may serve as an inoculum source for aerial stem soft rot. The objectives of this research were to monitor the population size of the soft rot erwinias in irrigation water over time, and to examine subspecies distribution in a surface water source and a well water source in a major seed production region of Oregon.

MATERIALS AND METHODS

Irrigation water was monitored for soft rot erwinias beginning in May and then biweekly from late June to early September at two sites in Central Oregon in 1985 and 1986. Surface water samples were collected from a canal in four 1-liter sterile polyethylene jugs by submerging them below the water surface. Water, from a 35-m-deep well, was collected in four 1-liter jugs from spigots at a pump station. Water samples were processed within 48 hours. Each 1 liter subsample was processed four ways. (1) Direct plating: 0.2 ml aliquots of water were spread on triplicate plates of crystal violet pectate (CVP) medium (1). Surface water subsamples were also serially diluted, and 0.2 ml of each dilution plated on triplicate plates of CVP. (2) Direct enrichment: 50 ml of water from each jug were placed in a 100 ml sterile bottle which was then filled with double strength pectate enrichment medium (PEM) (6) and capped with parafilm. After a 96-hour incubation at 22 C, 0.2 ml aliquots were spread on duplicate plates of CVP. (3) Celite filtration: water samples were processed through a Celite filter to facilitate detection of the soft rot bacteria (4). A buchner funnel with two Whatman No. 1 filter papers was attached to a 2000-ml filter flask. Filtration was assisted with a water drawn vacuum. Before processing the water samples, a base layer of Celite was established by filtering 3-5 g Celite suspended in 25 ml of sterile water through the filter. Each 1 liter subsample was throughly mixed with ca. 25 g Celite and poured through the filter. The Celite layer was then removed and resuspended in 100 ml of sterile water. Aliquots (0.2 ml) of the suspension were spread on triplicate plates of CVP. With surface water subsamples two 10-fold serial dilutions were similarly plated. (4) Celite enrichment: Celite suspensions were mixed with an equal volume of double strength PEM and incubated for 96 hours at 22 C. Aliquots were spread on duplicate plates of CVP. Plates were incubated

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for 48 hours at 22 C. Number of colony forming units (CFU)/ml of soft rot erwinias was determined for direct water and celite filtered samples.

From each treatment up to five single *Erwinia*-like colonies were collected, purified, and stored on sugarless nutrient agar slants at 4 C for biochemical characterization.

Soft rot erwinias were identified based on biochemical properties. *E. c.* subsp. *atroseptica* differs from *E. c.* subsp. *carotovora* and the *E. chrysanthemi* in its ability to produce acid from -methyl glucoside and absence of growth at 36 C (3). *E. chrysanthemi* is separated from *E. c.* subsp. *carotovora* by phosphatase production in presence of NH_3 (3).

RESULTS AND DISCUSSION

Soft rot erwinias were recovered from both a surface water source and a well water source in 1985 and 1986 in Central Oregon (Tables 1 and 2). Surface water populations were consistently higher than those in well water. Populations in subsamples of surface water ranged from 1 to 700 cfu/ml and 1 to 25 cfu/ml in 1985 and 1986, respectively. In contrast, well water subsample populations ranged from 1 to 3 cfu/ml and 1 to 4 cfu/ml in 1985 and 1986, respectively. Population means, however, were lower. For both water sources, the highest populations occurred in August.

The predominant subspecies in both water sources was *E. c.* subsp. *carotovora* (Table 3). In 1985, 86% of all strains characterized were *E. c.* subsp. *carotovora*. The remaining strains, identified as *E. chrysantemi*, were recovered from six surface water samples and one well water sample. This is the first documentation of this species in water in Central Oregon. *E. c.* subsp. *carotovora* was predominant early and late in the season in surface water whereas *E. chrysanthemi* was more common in midseason. In 1986 *E. c.* subsp. *carotovora* was the principal soft rot erwinia recovered from water samples. One surface water sample and one well water sample yielded *E. chrysanthemi* and *E. c.* subsp. *atroseptica*, respectively.

Erwinia spp. are present in water sources used for irrigation of potatoes in Central Oregon. This water may serve as a viable inoculum source for aerial stem soft rot and contamination of pathogen-free seed stocks. The importance of waterborne inoculum of these pathogens in potato blackleg and aerial stem soft rot epidemiology is being investigated.

Table 1. Mean populations of Erwinia spp. in surface and well water irrigation sources near Powell Butte, OR, in 1985

	Surface Water (cfu/ml)				Well Water (cfu/ml)			
Sampling Date	Direct	Enriched	Celite filtered	Celite enriched	Direct	Enriched	Celite filtered	Celite enriched
May 23	0	0	0	>1	0	0	0	0
June 28	0	>1	0	>1	0	0	0	>1
July 15	18.74	>1	0.53	>1	0	0	0	0
July 30	0	>1	97.54	>1	0	>1	0	>1
Aug 14	0	>1	0.05	>1	0	>1	0	>1
Aug 26	574.58	>1	232.00	>1	0	0	0	0
Sept 10	4.59	>1	1.66	>1	0.83	>1	0.05	>1
Sept 25	0.42	>1	0	>1	0	>1	0	>1
MEAN	74.79		41.47		0.10		0.01	

'able 2. Mean populations of Erwinia spp. in surface and well water irrigation sources near Powell Butte, OR, in 1986

	Surface Water (cfu/ml)				Well Water (cfu/ml)			
ampling ate	Direct	Enriched	Celite filtered	Celite enriched	Direct	Enriched	Celite filtered	Celite enriched
ay 29	0	0	0	0	0	0	0	>1
une 26	0.42	>1	0.78	>1	0	0	0	0
uly 9	0	>1	0.11	>1	0	0	0	>1
uly 23	0.42	>1	0	>1	0	>1	0.60	>1
ug 5	4.59	>1	3.33	>1	0	>1	0	>1
ug 19	2.50	>1	0.73	>1	0	0	0	>1
ug 26	0	>1	2.19	>1	0	0	0	>1
ept 9	4.58	>1	1.93	>1	0	>1	0	>1
EAN	1.56		1.13		0		0.08	

Table 3. *Erwinia* species composition in surface and well water samples near Powell Butte, OR, in 1985 and 1986

Year/Date	Percent of strains					
	Surface Water			Well Water		
1985	Ecc[1]	Eca[2]	Ech[3]	Ecc	Eca	Ech
May 23	100	0	0	–[4]	–	–
June 28	100	0	0	100	0	0
July 15	89	0	11	–	–	–
July 30	66	0	34	0	0	100
Aug 14	50	0	50	100	0	0
Aug 26	12	0	88	–	–	–
Sept 10	90	0	10	100	0	0
Sept 25	96	0	4	100	0	0
1986						
May 29	–	–	–	100	0	0
June 26	94	0	6	–	–	–
July 9	100	0	0	100	0	0
July 23	100	0	0	100	0	0
Aug 5	100	0	0	100	0	0
Aug 19	100	0	0	67	33	0
Aug 26	100	0	0	100	0	0
Sept 9	100	0	0	100	0	0

1 *Erwinia carotovora* subsp. *carotovora*
2 *Erwinia carotovora* subsp. *atroseptica*
3 *Erwinia chrysanthemi*
4 – = no *Erwinia* sp. detected

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VARIETAL EVALUATION OF IRRIGATED CEREAL GRAINS IN CENTRAL OREGON

Frederick J. Crowe, Rod Brevig, and Steven R. James[1]

ABSTRACT

Nine different varietal evaluations were made of diverse cereal types. Improvements in hard red spring wheat seem to be forthcoming as new lines performed well in yield and protein. In Madras, several new soft white winter wheat lines yielded as well as currently released varieties. In Powell Butte, however, Malcolm and Dusty were top performers. The hard red winter wheat trial indicated real improvement in these cereals, but little material acceptable for central Oregon. With outstanding yields in the Powell Butte soft white spring wheat trial, Twin and Waverly continue to be good choices for growers. The Western Regional Spring Wheat nursery data indicate there may be improvement in soft white spring wheats in the offing. As for last year, the spring barleys compared at Powell Butte were similar in yield. The six-row barley varieties did best, while Menuet was the top two-row yielder. Of the spring barley varieties grown at Madras, Gus, Gustoe, Columbia, and Micah performed best in terms of yield. The Western Regional Winter Barley trial showed real promise for the future with some new lines yielding above 150 bushels/acre.

In a continuing effort to provide the growers of Central Oregon with current data on cereal production, nine replicated yield trials were established in 1986. Table 1 shows the various trials grown, their locations, and the number of lines investigated in each of the trials.

METHODS

Cereal plots (five feet wide x 20 feet long) were seeded at a rate of 100 pounds/acre with the various varieties using a Oyjord plot planter. Fertilizing was accomplished either with a Barber metered feed fertilizer spreader or by hand as the need arose. The plots were irrigated with an overhead irrigation system on either 40 x 40-foot spacing (Powell Butte) or 30 x 40-foot spacing (Madras). Harvest was accomplished with a Hege plot combine.

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Cultural data for the various experiments are listed in Table 2.

Table 1. Summary of cereal grain variety trials planted in central Oregon in 1986

Cereal type	Location	No. of lines
Hard Red Spring Wheat Elite	Powell Butte	28
Soft White Spring Wheat Elite	Powell Butte	14
Soft White Spring Western Regional	Madras	48
Spring Barley Variety Trial	Madras	16
Spring Barley Variety Trial	Powell Butte	16
Soft White Winter Wheat Elite	Powell Butte	24
Soft White Winter Wheat Elite	Madras	56
Hard Red Winter Wheat Elite	Madras	24
Winter Barley Western Regional	Madras	36

Table 2. Cultural data for 1986 variety trials at Madras and Powell Butte

Cereal type	Location	Amount nitrogen applied lbs/Ac	Date of planting	Date first irrig.	Date last irrig.	Date of harvest
HRSWE	Powell B.	250	3/19/86	5/5/86	7/29/86	8/28/86
SWSWE	Powell B.	150	3/19/86	5/5/86	7/29/86	8/28/86
WRSWN	Madras	150	4/8/86	5/12/86	7/23/86	8/21/86
SB	Madras	80	4/7/86	5/12/86	7/2/86	8/13/86
SB	Powell B.	110	3/19/86	5/5/86	7/15/86	8/27/86
SWWWE	Powell B.	152	10/28/85	5/2/86	7/22/86	8/28/86
SWWWE	Madras	152	10/24/85	4/24/86	7/18/86	8/12/86
HRWWE	Madras	250	10/24/85	4/24/86	7/18/86	8/13/86
WRWBN	Madras	80	10/24/85	4/24/86	6/24/86	8/5/86

RESULTS AND DISCUSSION

<u>Insects</u>: Aphid activity was light and only present at the end of seed maturity so no significant damage was considered to have occurred. There were some plants killed at the three to four leaf stage in the spring cereal trials in Madras from the Columbia Basin wireworm. The plants were scattered and again no significant reduction in yield was considered to have taken place.

Disease: There were no diseases that became apparent on any of the cereal trials at the Madras site in 1986. Also there were no diseases on the spring cereals at Powell Butte. There were some leaf and stripe rusts that showed up on the more susceptible varieties of wheat in the soft white winter wheat trial and there was also a low incidence of black chaff on this trial.

Hard Red Spring Wheat

As the selling price of soft white winter wheat continues to decline, the importance of other options for cereals in rotations becomes more apparent. By one estimate the hard red spring acreage in central Oregon was 5,000-7,000 acres in 1986. While still being only a third of the acreage of soft white winter wheat, this could change. One of the large Portland buyers of hard red spring wheat commented that the quality of hard red spring wheat coming out of Oregon has been consistently good this year. The reason noted for consistent quality was that growers were more carefully applying fertilizer so as to maximize quality (protein and test weights). See "Influence of Nitrogen Fertilizer Rate and Timing on Performance of Two Irrigated Hard Red Spring Wheat Varieties" in this publication for additional information.

Agronomic data for the elite trial planted at Powell Butte are shown in Table 3.

Table 3. Agronomic data for the hard red spring wheat elite trial grown at Powell Butte, 1986

Variety	Yield	Protein	Test wt.	Ht.	Hd. date	Lodging
	bu/Ac	%	lbs/Bu	in	# days	%
McKay	119.4	13.0	61.87	37	174	0
Shasta	101.1	13.0	63.33	37	169	0
Borah	101.7	13.9	62.11	36	172	30
NK 000751	124.6	13.1	64.07	35	171	0
906R	109.7	13.9	63.27	36	170	0
Wampum	110.0	13.1	64.62	36	169	0
ORS 8508	122.9	13.4	65.13	36	168	0
ORS 8509	131.2	13.7	63.78	32	169	0
ORS 8510	123.0	13.5	64.50	37	173	0
ORS 8511	126.7	13.6	63.60	33	168	0
ORS 8512	133.5	12.8	65.22	33	170	0
ORS 8514	109.0	13.1	62.31	35	176	0
ORS 8518	131.4	13.7	64.18	31	168	0
ORS 8519	115.0	13.3	65.15	34	168	0
Kodiak	108.7	13.2	59.24	23	169	0
ORS 8415	117.9	14.4	64.82	36	173	0
ORS 8417	124.4	13.3	62.17	34	174	0
Anza	110.6	12.3	63.94	34	173	0
ORS 8422	123.0	13.2	64.64	32	169	0
ORS 8425	108.2	13.8	64.21	33	169	0
ORS 8413	126.3	12.9	63.89	33	173	0
ORS 8416	125.5	13.1	64.53	37	173	0
AL 15	104.2	13.6	64.79	39	169	3
AL 16	97.5	14.4	63.02	35	169	8
AL 17	94.5	14.5	64.67	35	168	0
AL 18	92.8	14.3	61.02	36	177	0
AL 20	104.3	14.4	63.82	37	171	0
Yecora Rojo	100.7	14.5	62.91	25	169	0
LSD (5%)	11.3	.85	.65	2	2	17

As shown in Table 3, high yielders tend toward lower protein contents. However, in some of the varieties which yielded more than 120 bushels per acre, the protein content was very close to 14 percent. These results would indicate real promise in the near future for very good, hard red spring varieties being released.

Table 4. Agronomic data for several hard red spring wheat lines grown at Madras in the 1986 Elite trial, (protein was not available at time of printing)

Variety	Yield	Test wt.	Height	Protein
	bu/a	lbs/bu	in	(not yet available)
Shasta	94.5	61.5	31	
Borah	110.5	63.4	29	
NK000751	103.7	62.7	27	
906R	91.5	62.6	27	
ORS8508	85.5	64.4	30	
ORS8509	110.9	63.4	28	
ORS8510	99.0	64.5	32	
ORS8511	105.7	63.6	28	
ORS8512	112.5	64.2	29	
ORS8518	105.3	63.0	29	
ORS8417	111.3	60.7	36	
Yecora Rojo	87.8	61.2	19	
LSD (5%)	15.99	NA*	NA*	

* NA = data not available at time of printing.

Hard Red Winter Wheat

As indicated in Table 5 for the hard red winter wheat Elite trial, protein content still is unacceptably low for available varieties and new lines. At this time it is undetermined whether altered fertility regimes might elevate these protein levels. Yield levels have improved in advanced lines over standard varieties. Other wheat classes continue to be better choices in central Oregon.

Table 5. Agronomic data for several hard red winter wheat lines grown at Madras in the 1986 Elite trial

Variety	Yield	Test wt.	Ht.	Hd. date	Lodging	Protein
	bu/a	lbs/bu	in	days	%	%
Wanser	93.9	62.91	42	154	74	12.8
Stephens	110.8	59.56	35	156	0	12.2
Centura	84.7	63.19	38	154	83	13.4
Hatton	84.1	64.20	42	158	44	13.1
Batum	89.2	58.29	38	161	95	12.9
Federation	81.5	60.00	42	155	64	12.8
OR CR8313	113.4	63.21	34	150	14	12.7
OR CR8320	99.8	61.82	34	155	1	13.7
OR CR8414	99.1	61.73	37	155	10	13.2
TSN-B2	96.7	62.27	35	156	0	12.5
OR CR8511	112.9	62.72	34	156	50	13.3
OR CR8512	108.9	61.70	35	158	49	12.6
OR CR8513	117.3	62.54	34	155	10	13.3
OR CR8614	107.0	62.90	40	156	0	12.9
OR CR8615	103.7	62.50	28	155	0	13.0
OR CR8616	108.6	61.62	33	150	0	13.0
OR CR9617	114.4	62.95	32	161	3	12.6
OR CR8618	83.5	62.66	41	156	0	12.9
OR CR8619	121.3	63.10	32	153	23	12.9
OR CR8620	112.9	64.27	37	150	0	13.0
OR CR8621	105.0	63.74	35	156	3	12.9
OR CR8622	112.7	64.40	35	158	0	12.9
OR CR8623	103.9	61.06	31	150	0	13.5
OR CR8624	91.1	63.04	38	155	0	13.3
LSD (5%)	10.7	0.95	2	2	26	0.3

Soft White Winter Wheat

Soft white winter wheats have been the best performing wheats in central Oregon. Tables 6, 7, 8, and 9 show the results of the 1986 trials and some long-term agronomic data for established soft white winter wheats in Madras and Powell Butte.

Table 6. Agronomic data for selected soft white winter wheat lines grown at Madras in 1986

Variety	Yield	Test wt.	Height	Hd. date	Lodging
	bu/Ac	lbs/Bu	in	mo/day	%
Stephens	105.8	59.18	34	6/5	0
Hill 81	98.3	61.63	36	6/10	0
Malcolm	110.6	60.79	35	6/8	0
Dusty	118.8	61.59	35	6/10	0
ORCW8314	119.1	61.24	35	6/5	0
ORCW8417	98.1	62.20	36	6/8	0
ORCW8519	107.4	61.11	38	6/6	0
ORCW8521	98.4	61.45	38	6/3	1
ORCW8629	115.9	60.18	37	6/8	0
ORCW8632	113.2	60.08	34	6/3	0
ORCW8633	116.2	62.59	34	6/10	3
FW75336	116.8	60.81	35	6/6	0
Oveson	108.8	60.41	37	6/12	4
LSD (5%)	12.0	1.26	3	3	5

Table 7. Soft white winter wheat varieties grown at Madras 1979-1986 (1983 trials destroyed by hail)

Variety	Yield	Test wt.	Height[2]	Hd. date[3]	Lodging
	bu/Ac	lbs/Bu	in	mo/day	%
Stephens	112	56.2	35	6/16	9
Hill 81	106	57.0	37	6/20	6
Malcolm[1]	121	56.7	35	6/17	10
Dusty[4]	120	58.8	36	6/13	0
Daws[4]	108	57.0	36	6/22	20
Nugaines[4]	105	58.3	34	6/20	28
McDermid	98	55.8	35	6/20	24

1 1985, 1986 data only
2 1980, 1981 data missing
3 1979, 1980 data missing
4 1985 data missing

Table 8. Agronomic data for selected soft white winter wheat lines grown at Powell Butte in 1986

Variety	Yield	Test wt.	Height[2]	Hd. date[3]	Lodging
	bu/Ac	lbs/Bu	in	mo/day	%
Stephens	137.7	59.80	35	6/19	0
Hill 81	137.6	61.58	38	6/23	14
Malcolm	140.4	60.54	37	6/22	0
Dusty	144.5	61.60	37	6/22	0
ORCW8314	134.1	61.16	37	6/20	0
ORCW8417	136.8	63.53	38	6/19	12
ORCW8519	136.7	61.82	40	6/18	19
ORCW8521	135.0	61.77	43	6/20	0
Oveson	126.2	60.49	38	6/23	14
LSD (5%)	12.9	1.30	1	2	20

Table 9. Soft white winter wheat varieties grown at Powell Butte, 1979-1986

Variety	Yield	Test wt.	Height[3]	Hd. date[4]	Lodging
	bu/Ac	lbs/Bu	in	mo/day	%
Stephens	112	55.0	34	6/28	7
Hill 81	115	58.0	36	7/3	10
Malcolm	123	56.5	35	6/29	5
Dusty[1]	145	61.6	37	6/22	0
Daws	110	57.0	36	7/2	9
Nugaines	106	58.1	33	7/1	16
McDermid[2]	114	56.0	36	7/1	31

1 1986 data only
2 1985, 1986 data missing
3 1980 data missing
4 1985 data missing

Soft White Spring Wheat

To evaluate alternatives to winter wheat, soft white spring wheats have been included in the cereal trials in central Oregon for a number of years. The high yields gained in the Powell Butte trial in 1986 provides a basis for comparing the commonly available soft white spring wheats with those being bred at this time. The results of this trial indicate that Twin is still a good choice for growers in central Oregon.

Emphasis in breeding continues to be placed on high yielding, disease resistant, short-strawed varieties. While disease was not a problem again in 1986, leaf and stripe rusts have caused severe damage to some fields in past years. More disease resistance in new high yielding varieties is the goal in the future. Tables 10 and 11 show the results of the 1986 soft white wheat trials at Madras and Powell Butte.

Table 10. Soft white spring wheat grown at Powell Butte in 1986

Variety	Yield bu/Ac	Test wt. lbs/Bu	Height in	Hd. date mo/day	Lodging %
Twin	122.1	60.2	38	6/23	4
Owens	119.5	63.6	39	6/22	0
Waverly	120.3	62.9	37	6/22	0
Walladay	117.4	62.1	37	6/27	0
Edwall	109.0	62.1	38	6/23	0
ORS8413	117.6	64.2	35	6/23	0
ORS8501	117.3	64.6	39	6/21	0
LSD (5%)	8.6	.29	1	2	3

Table 11. Selected soft white spring wheat lines from the Western Regional Spring Wheat Nursery grown at Madras in 1986

Variety	Yield bu/Ac	Test wt. lbs/Bu	Height in	Hd. date mo/day	Lodging %
Twin	87.2	59.7	33	6/18	8
Owens	93.4	63.1	36	6/15	55
Waverly	92.3	60.7	37	6/19	30
Edwall	81.8	60.9	34	6/18	53
Penawawa	95.9	63.4	34	6/16	20
ORS8413	95.1	62.2	32	6/18	8
ID266	98.1	63.9	37	6/16	14
LSD (5%)	7.9	1.02	2	2	39

Spring and Winter Barley

Spring barley trials were planted at Madras and Powell Butte in 1986 to evaluate currently available commercial varieties. The varieties were selected from those presently available at the local suppliers and from two seed companies who wished to test their currently available varieties. Tables 12, 13, and 14 present the data from the 1986 trials and a long-term table of values for varieties grown at Madras.

Table 12. Agronomic data for spring barley grown at Madras in 1986

Variety	Yield bu/Ac	Test wt. lbs/Bu	Height in	Hd. date mo/day	Lodging %
Steptoe	126.9	50.05	38	6/13	99
Kombar	124.4	45.17	34	6/21	3
Gus	142.5	50.12	31	6/17	24
Gustoe	147.7	51.00	27	6/17	1
Columbia	140.6	47.78	33	6/21	0
Micah	135.7	49.27	31	6/21	1
Lindy	121.8	49.39	38	6/13	96
Piston	115.3	52.74	35	6/17	54
Menuet	123.1	54.15	37	6/17	40
Spirit	106.0	53.96	36	6/19	68
LSD (5%)	16.2	1.69	3	0	33

Table 13. Agronomic data for spring barley grown at Powell Butte in 1986

Variety	Yield bu/Ac	Test wt. lbs/Bu	Height in	Hd. date mo/day	Lodging %
Steptoe	136.4	50.29	39	6/16	0
Kombar	126.6	48.05	31	6/24	0
Gus	130.3	51.57	29	6/20	0
Gustoe	138.0	52.29	25	6/20	0
Columbia	130.1	51.36	31	6/25	0
Micah	128.3	50.84	28	6/25	0
Lindy	135.7	50.80	39	6/14	4
Piston	116.5	54.73	35	6/23	0
Menuet	127.3	56.50	35	6/24	0
Spirit	116.9	55.02	35	6/23	0
LSD (5%)	11.5	.97	1	1	3

Table 14. Spring barley varieties grown at Madras 1981-1986

Variety	Yield	Test wt.	Height[1]	Hd. date	Lodging[1]
	bu/Ac	lbs/Bu	in	mo/day	%
Gustoe[2]	145	49.4	30	6/20	0
Gus	140	48.2	32	6/21	25
Kombar	137	45.6	33	6/23	9
Micah[2]	137	48.3	32	6/20	0
Steptoe	120	47.4	36	6/17	65
Columbia[3]	139	47.3	33	6/18	0

1 1981, 1983 data missing
2 1981-1983 data missing
3 1981-1984 data missing

The Western Regional winter barley nursery was grown at Madras in 1986 in cooperation with Dr. Darrell M. Wesenberg at Aberdeen, Idaho. This is the first time that this trial has been included in the cereal trials in central Oregon. The reason we planted this trial was to again search for greater flexibility for the growers in our area for cereal crops. It was felt that a regional trial would give us the greatest exposure to these winter barley varieties in the three years allocated to this research. Data presented in Table 15.

Table 15. Agronomic data for selected varieties grown in the Western Regional Winter Barley Nursery in Madras in 1986

Variety	Yield	Test wt.	Height	Hd. date	Lodging
	bu/Ac	lbs/Bu	in	mo/day	%
Luther	128.8	50.3	40	6/6	0
Kamiak	112.5	51.2	40	5/31	13
Schuyler	133.9	51.5	38	6/4	0
Boyer	127.7	49.2	35	6/4	0
Wintermalt	117.7	50.2	41	5/31	38
Hesk	132.4	50.7	36	6/4	0
Mal	130.5	49.8	36	6/4	0
Scio	142.0	49.9	33	6/4	0
Showin	121.4	49.7	31	5/31	0
Steptoe	123.0	50.6	38	6/2	43
ORWF8328	152.0	50.3	34	5/31	5
ORWF8422	150.0	50.6	38	6/4	0
ORWF8417	156.0	49.4	35	5/31	0
LSD (5%)	20.1	1.9	3	2	12

SUMMARY

The primary objective of the cereals project in central Oregon is to evaluate potential new varieties for yield, test weight, maturity, height, lodging, winter hardiness, and disease resistance. Another important benefit is to provide current performance and agronomic data of released varieties under local growing conditions. The addition of hard red spring wheat, hard red winter wheat, and winter barley trials in the last two years represents a commitment on the part of the Central Oregon Experiment Station to assess alternatives in cereal production in central Oregon. The results of this work will enhance growers' profitability and reduce the overproduction of soft white winter wheat.

EFFECT OF INCREASING SULPHUR AND PHOSPHORUS FERTILITY ON PERFORMANCE OF TWO HARD RED SPRING WHEAT VARIETIES GROWN AT MADRAS IN 1986

Frederick J. Crowe, Neil Christensen, Rod Brevig,[1] and Steven R. James

ABSTRACT

When soil tests revealed a low residual level (1 ppm) of sulphur in the soil, a significant increase in yield, lodging, and protein, and decreased test weight occurred when supplemental sulphur was added with ammonium nitrate sulphate fertilizer.

Although soil tests also showed a low residual level (8-10 ppm) of phosphorus in the soil, no significant response in yield, test weight, lodging, or protein resulted when 25, 50, or 100 pounds/acre phosphorus were added in the form of triple super phosphate fertilizer.

The observation by growers and industry that sulphur often enhanced protein in hard red spring wheat led to the investigation of this nutrient in the cereal trials of the Central Oregon Experiment Station in 1986. Because phosphorus in addition to sulphur was at a low residual level in land recently acquired by the Central Oregon Experiment Station at Madras, phosphorus also was included in this test. This trial was designed to reveal which of the agronomic characteristics of hard red spring wheat were affected most by these nutrients and the possible interaction with other characteristics.

MATERIALS AND METHODS

Plots, five feet wide x 20 feet long at the Central Oregon Experiment Station Madras field, were planted with an Oyjord plot planter and harvested with a Hege plot combine. Hard red spring wheat varieties Yecora Rojo and Westbred 906R were selected as the most widely grown varieties in central Oregon. Preplant fertility treatments were applied to the specific plot areas by hand and rototilled into the top four to five inches of soil. Ammonium nitrate (34-0-0-0 N-P-K-S) was used

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as a nitrogen source without sulphur and ammonium nitrate sulfate (30-0-0-7 N-P-K-S) was used as a nitrogen source with sulphur present. Preplant nitrogen was applied at the rate of 200 pounds/acre nitrogen and sulphur at 46.7 pounds/acre sulphur. Phosphate was applied at 25, 50, and 100 pounds/acre phosphate rates with triple super phosphate (0-45-0-0 N-P-K-S) as the source of phosphorus. There were 16 treatments, which were replicated four times in a randomized complete block experimental design. There was an in-season treatment of 50 pounds/acre nitrogen applied to all plots by hand on June 24, 1986, which corresponded roughly to the flowering stage of the plants' development.

The planting date was April 9, 1986. The drill row spacing was eight inches, and the seeding rate was 100 pounds/acre for each variety. Plots were first irrigated May 8, 1986, and the final irrigation was on July 23, 1986. Harvest was on August 24, 1986.

RESULTS

Tables 1 and 2 show the results of added phosphorus and added sulphur with the effects on yield, test weight, lodging, and protein content on Yecora Rojo and Westbred 906R hard red spring wheats. The data on 906R were not included in the table on sulphur because the response in yield was greatly influenced by increased lodging and it was felt this obscured the influence of sulphur on the yield.

DISCUSSION

As shown in Table 1, there was no significant effect on any of the four listed agronomic characteristics from added phosphorus. Presumably, adequate residual phosphorus was present in the soil. As can be seen in Table 2, all of the listed agronomic characteristics were affected by added sulphur when sulphur was deficient in the soil.

Plots treated with sulphur could be identified early in the season (until approximately the jointing stage) because of a greener color and increased thriftiness of the plants. Increased vigor was also revealed by increased yield, decreased test weight, increased lodging, and increased protein. The large increase in protein revealed that the plant was better able to utilize the nitrogen available to it and convert this to higher protein. This higher protein is vital to a grower looking to market his hard red spring wheat with added value because of quality.

Table 1. Yield, test weight, lodging, and protein content of two hard red spring wheats with added phosphorus when soil test revealed residual 8-10 ppm of phosphorus

Phosphorus rate lbs/acre	Yield bu/ac	Test wt. lbs/bu	Lodging %	Protein %
0	91.6	62.8	30.9	14.2
25	91.5	62.9	20.3	14.2
50	92.8	62.8	28.1	14.2
100	91.8	62.7	37.2	14.2
LSD (5%)	5.0	.3	16.9	.16

Table 2. Yield, test weight, lodging, and protein content of Yecora Rojo hard red spring wheat with added sulphur when soil test revealed residual 1 ppm of sulphur

Sulphur rate lbs/ac	Yield bu/ac	Test wt. lbs/bu	Lodging %	Protein %
0	95.3	64.0	2.5	14.0
50	100.7	63.3	16.3	14.5
LSD (5%)	2.5	0.2	5.5	0.1

INFLUENCE OF SEEDING RATE ON PERFORMANCE OF TWO HARD RED SPRING WHEAT VARIETIES

Frederick J. Crowe, Rod Brevig, and Steven R. James[1]

ABSTRACT

Some hard red spring wheat growers in central Oregon have felt that a yield advantage could be realized by increasing seeding rates above 100 pounds/acre. For Yecora Rojo and Westbred 906R hard red spring wheats planted at the Madras site of the Central Oregon Experiment Station with 100, 125, and 150 pounds/acre of seed, no advantage in yield, test weight, lodging, or protein was found at the higher seeding rates.

MATERIALS AND METHODS

The hard red spring wheat varieties Yecora Rojo and Westbred 906R were selected as the most widely grown hard red spring wheat varieties in central Oregon. Plots were established in a well prepared seedbed using an Oyjord cone type plot seeder with shoe type openers and a seeding depth of one and one half to two inches in moist soil. The row spacing was eight inches. The seeding date was April 8, 1986.

Fertilization was accomplished with a Barber metered feed fertilizer spreader, which distributed 150 pounds/acre nitrogen uniformly over the plots in the form of 27-12-0-11 (N-P-K-S) on April 10, 1986, and 25 units/acre of nitrogen in the form of Ammonium Nitrate, 34-0-0-0, which was applied by hand on April 11, 1986. There was an additional in-season application of 50 pounds/acre nitrogen applied by hand and irrigated into the soil in the form of ammonium nitrate on June 23, 1986, which roughly corresponded to the flowering stage of plant growth. The last fertilizer was applied to enhance the protein content of the wheat.

Plots were first irrigated May 8, 1986, with the final irrigation occurring on July 23, 1986. Harvest was accomplished with a Hege plot combine on August 22, 1986.

There were six treatments which were replicated four times in a randomized complete block experimental design.

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RESULTS

The data in Table 1 show no differences in the yield, test weight, lodging, or protein content that can be attributed to changing the seeding rates.

Table 1. Yield, test weight, lodging, and protein content of two hard red spring wheats at three seeding rates

Seeding rate lbs/ac	Yield bu/ac	Test wt. lbs/bu	Lodging %	Protein %
100	98.4	63.3	12.5	14.0
125	94.5	63.1	25.6	14.1
150	98.5	63.4	19.4	13.9
LSD (5%)	5.6	.3	25.0	.2

The data in Table 2 indicate the measurable differences between Yecora Rojo and Westbred 906R hard red spring wheat when grown under the same conditions. Yecora Rojo maintained an advantage over 906R in yield, test weight, and lodging.

Table 2. Yield, test weight, lodging, and protein content of Yecora Rojo and Westbred 906R hard red spring wheat (data for three seeding rates are averaged)

Variety	Yield bu/ac	Test wt. lbs/bu	Lodging %	Protein %
Yecora Rojo	103.2	64.0	0.0	14.1
906R	91.0	62.6	38.3	14.0
LSD (5%0	4.6	.3	20.4	.1

DISCUSSION

In spring seeded hard red spring wheat no advantage could be shown for the two varieties tested by increasing the seeding rate above 100 pounds/acre. Other variables in seeding such as depth of seed placement, moisture content of the soil in the area of the seed, soilborne, seedborne, or seedling diseases could all have a bearing on the need to increase seeding rates to obtain optimum stands in specific instances. The purpose of this trial was to give empirical data useful to the growers in central Oregon in making one of the input decisions in raising hard red spring cereals.

EFFECT OF CERONE* ANTI-LODGING AGENT AND NITROGEN FERTILIZER RATES ON PERFORMANCE OF TWO IRRIGATED HARD RED SPRING WHEAT VARIETIES

Frederick J. Crowe, Rod E. Brevig, and Steven R. James[1]

ABSTRACT

Cereal plots received 150, 225, or 300 pounds/acre nitrogen at preplant. Cerone anti-lodging agent reduced lodging from 28 percent to 7.5 percent in Borah. Yecora Rojo hard red spring wheat did not lodge at the fertility levels and growing conditions that existed in this trial, and Borah lodging was comparable at each fertilizer rate. There was a total height reduction of 2.25 inches when Cerone was used. Cerone did not affect yield or test weight in this trial. There is an indicatication from the data in this trial that Cerone could have a negative effect on protein. Overall, protein went from 14.24 percent to 14.13 percent when Cerone was used, which was slight but statistically significant at the five percent confidence level. Increasing fertilizer preplant application above 225 pounds/acre of nitrogen resulted in no better or poorer crop responses.

MATERIALS AND METHODS

Well prepared seed beds were established in the spring of 1986 to receive plots five feet wide and 20 feet long which were seeded with an Oyjord plot drill with a drill row spacing of eight inches. On April 10 and April 11, plots received 150 pounds/acre nitrogen in the form of 27-12-0-11 (N-P-K-S) which was broadcast over the entire plot area using a Barber metered feed fertilizer spreader. An additional 75 or 150 pounds/acre nitrogen was applied by hand in the form of Ammonium Nitrate 34-0-0-0 (N-P-K-S) to bring treatment levels to 150, 225, or 300 pounds/acre nitrogen. On June 23, 1986, an additional 50 pounds/acre nitrogen was applied to each plot by hand and irrigated in. This fertilizer was in the form of ammonium nitrate and was applied to enhance the protein content of the

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* ACKNOWLEDGMENT: Union Carbide Agricultural Products Company, Inc. provided Cerone and partial support for this research.

wheat, and it was applied to correspond to the flowering stage of plant growth.

There were 12 treatments, replicated four times in a randomized complete block experimental design.

The hard red spring wheat varieties Borah and Yecora Rojo were used in the trial. Borah was used because of its good production record and tall growth habit making it subject to lodging at the fertility rates used in the trial. Yecora Rojo was used because it is the most widely grown hard red spring wheat variety in central Oregon.

The plots were planted April 8, 1986, as above, and were harvested August 21, 1986, with the use of a Hege plot combine. Plots were first irrigated May 8, 1986, and the final irrigation was on July 23, 1986.

Cerone has a relatively narrow window of growth development in which its optimal to apply, roughly from growth stage eight to 10 Feekes scale or from the time the flag leaf appears to when the boot is swollen before the awns appear. It took the wheat plants about four to five days in 1986 to go through these stages of plant development as the weather was hot during the day and warm during the night. To avoid wind, Cerone was applied June 7, 1986, at 8:45 p.m. with a Solo backpack sprayer with a five-foot hand held spray boom. Cerone was applied at 0.38 pound active ingredient/acre with two passes, one from each end of the plot. Borah was at a perfect Feekes growth stage 9 while Yecora Rojo had about 1 percent of the awns starting to show from the ligule of the flag leaf. Although it is not considered optimum to apply Cerone when the awns start to emerge, there was no indication in the data that the treatment had any damaging effect on the plants in this case.

RESULTS

Tables 1, 2, and 3 indicate how Borah and Yecora Rojo reacted to treatment with Cerone anti-lodging agent when subjected to three fertility regimes, in terms of yield, test weight, height, lodging, and protein content. Lodging was reduced from 28 percent without Cerone to 7.5 percent with Cerone. This change in lodging was totally reflected in Borah because Yecora Rojo did not lodge in this trial. The overall height reduction was 2.25 inches when Cerone was used. Protein was reduced from 14.24 percent to 14.13 percent for Cerone treatments. Neither yield or test weight was affected by the application of Cerone in this trial.

Table 1. Yield, test weight, height, lodging, and protein content of two hard red spring wheat varieties when Cerone anti-lodging agent was applied

Cerone	Yield	Test wt.	Height	Lodging	Protein
	bu/ac	lbs/bu	in	%	%
Untreated	98.8	62.2	31.25	28.3	14.24
Cerone	100.4	62.4	29.00	7.5	14.13
LSD (5%)	2.5	.3	.50	10.6	.10

Table 2. Yield, test weight, height, lodging, and protein content of Borah and Yecora Rojo hard red spring wheats (Cerone treatments averaged with untreated)

Variety	Yield	Test wt.	Height	Lodging	Protein
	bu/ac	lbs/bu	in	%	%
Yecora Rojo	104.3	63.5	26.5	0.0	14.5
Borah	94.9	61.1	33.7	35.8	13.9
LSD (5%0	2.5	.3	.5	10.6	.1

Table 3. Yield, test weight, height, lodging, and protein content of two hard red spring wheat varieties under three pre-plant fertility regimes (Cerone treatments averaged with untreated)

Pre-plant nitrogen	Yield	Test wt.	Height	Lodging	Protein
lbs/ac	bu/ac	lbs/bu	in	%	%
150	97.3	62.7	29.9	16.3	13.7
225	100.1	62.1	30.0	25.9	14.4
300	101.5	62.0	30.5	11.6	14.5
LSD (5%)	3.1	.4	.7	13.0	.1

DISCUSSION

This trial was designed to look at the feasibility of adding Cerone to the cultural practices used by growers to better utilize higher nitrogen rates in hard red spring wheat. Cerone proved to be useful for taller wheat prone to lodging, but of no use for the short stiff strawed variety.

For hard red spring wheat grown primarily for high protein content, the slight reduction in protein content with Cerone use might be of concern.

The data indicated no yield, test weight, or protein advantage in increasing pre-plant nitrogen from 225 to 300 pounds/acre nitrogen. This information would again indicate that extremely high rates of pre-plant nitrogen are not needed. These and other data indicate that return on investment may peak at about 200-225 pounds/acre nitrogen with 40-50 pounds/acre nitrogen added between boot and flowering.

INFLUENCE OF NITROGEN FERTILIZER RATE AND TIMING ON PERFORMANCE OF TWO IRRIGATED HARD RED SPRING WHEAT VARIETIES

Frederick J. Crowe, Rod Brevig and Steven R. James[1]

ABSTRACT

In 1986 trials, for 30 to 40 units of total nitrogen available before planting, increasing yields and protein contents were obtained for increasing preplant fertilizer applications from 150 to 200 pounds nitrogen/acre. Increasing later fertilization from 30 to 50 pounds/acre of nitrogen at either boot to flowering increased protein content but not yield. Nitrogen added between tillering and boot was divided in its effect. These studies and similar ones from 1985 may provide guidelines for central Oregon growers to optimize economic returns. Our studies confirm others that the timing of the final addition of nitrogen is important, because when added from tillering to boot the nitrogen is used by the plant to increase yield and to a lesser degree protein content of the grain. From the boot stage to the flowering stage there is little to no contribution to yield but a large contribution to protein. Of the two varieties used, Yecora Rojo showed a distinct advantage over 906R in yield, test weight, and lodging in this trial, but there were no differences between the two varieties in protein content.

Central Oregon irrigated wheat growers are attracted to the higher selling prices for high protein hard red spring wheats. In 1986, 5,000-7,000 acres of hard red spring wheat were produced in central Oregon. According to one of the central Oregon seed companies, average protein from producers' fields ran slightly more than 15 percent, with some fields exceeding 16 percent. Although these figures reveal strides have been made in predictably producing high protein hard red spring wheat in central Oregon, the hard red spring wheat elite variety trial reveals that improved varieties are in the wings to improve yields while maintaining quality (see "Varietal Evaluation of Irrigated Cereal Grains in Central Oregon" in this publication). The work begun in 1985 in establishing optimum levels of pre-planting fertility and post planting fertility was refined in 1986 as follows.

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METHODS

The hard red spring wheat (HRSW) varieties Yecora Rojo and Westbred 906R were selected as the most widely grown varieties in central Oregon.

Preplant and in-season fertilization of 906R and Yecora Rojo included three replant rates of nitrogen at 150, 175, and 200 units of nitrogen per acre and two in-season rates of 30 and 50 pounds/acre of nitrogen applied at three different stages of plant growth. There were 42 treatments overall, replicated four times in a randomized complete block experimental design. The first 150 pounds nitrogen/acre of preplant nitrogen was as 27-12-0-11 (N-P-K-S) mechanically broadcast over the entire area of the experiment.

If applied, the additional 25 or 50 pounds/acre nitrogen was in the form of ammonium nitrate applied by hand over the entire five-foot x 20-foot plot area at planting time. In-season fertilization was with ammonium nitrate 34-0-0-0 (N-P-K-S) sprinkled over the plots by hand and irrigated into the soil. In-season fertilization was at 30 or 50 pounds/acre nitrogen applied at tillering (Feeks scale 4), at boot (Feeks scale 9), and at flowering (Feeks scale 10.51). The application dates were May 23, 1986, for tillering, June 9, 1986, for boot, and June 23, 1986, for flowering. Residual total nitrogen was at 30-40 pounds throughout the area of the plots. The previous crop was winter wheat but the ground had been fallowed for two years before planting.

Plots were planted and harvested using a standard plot drill and a Hege plot combine, with a drill row spacing of eight inches. The seeding rate was 100 pounds/acre for each variety. The planting date was April 4, 1986. Plots were first irrigated May 8, 1986, and the final irrigation was on July 23, 1986. Harvest was on August 24, 1986.

RESULTS

Significant differences between treatments are apparent from the overall results of the trial shown in Table 1. The specific differences are shown in Tables 2 through 5.

Table 1. Yield and protein content of two hard red spring wheat varieties under different fertility regimes at Madras in 1986

Preplant nitrogen	In-season fertility	Yield	Protein
lbs/acre		bu/ac	%
150	0	84.9	12.5
175	"	91.8	12.9
200	"	96.6	13.5
150	30 N tillering	95.3	13.0
175	"	97.1	13.6
200	"	96.9	14.0
150	50 N tillering	93.7	13.5
175	"	97.7	13.9
200	"	100.3	14.0
150	30 N boot	91.8	13.2
175	"	95.6	13.6
200	"	93.5	14.1
150	50 N boot	92.6	13.9
175	"	92.9	14.2
200	"	98.6	14.4
150	30 N flowering	86.7	13.5
175	"	96.9	13.9
200	"	96.4	14.0
150	50 N flowering	91.7	13.7
175	"	94.0	14.2
200	"	97.4	14.2
LSD (5%)		5.88	.30

The data indicate several principles that should be most helpful to the growers in this area:

1. The best preplant fertilizer rate is from 175 to 200 units of nitrogen, when soil tests show 30-40 units of total nitrogen as residual nitrogen in the soil (Table 2.)
2. Additional fertilization is necessary to gain the desired protein levels. This can be added anywhere from boot to flowering and gain the desired effect (Table 3).
3. 50 units of nitrogen added from boot to flowering is better than 30 units of nitrogen (Table 4).
4. In-season nitrogen has to be added after boot to have the greatest impact on protein, because before this stage of development the plant will use the nitrogen to enhance yield with less of a positive effect on protein (Tables 1 and 3).

Table 2. Yield and protein content for two hard red spring wheat varieties at three fertility levels at planting

Preplant nitrogen lbs/acre	Yield bu/acre	Protein %
150	90.9	13.3
175	95.1	13.8
200	97.1	14.0
LSD (5%)	2.2	.1

Table 3. Yield and protein content for two hard red spring wheat varieties at two levels of fertility and at three stages of plant development

Postplant nitrogen lbs/acre	Yield bu/acre	Protein %
0	91.1	13.0
30 at tillering	96.5	13.5
50 at tillering	97.2	13.8
30 at boot	93.6	13.6
50 at boot	94.7	14.2
30 at flowering	93.3	13.7
50 at flowering	94.4	14.0
LSD (5%)	3.4	.2

Table 4. Yield and protein content of two hard red spring wheat varieties at three levels of fertility after planting

Postplant nitrogen lbs/acre	Yield bu/acre	Protein %
0	91.1	13.0
30	94.5	13.6
50	95.4	14.0
LSD (5%) for "0" vrs others	2.59	.13
LSD (5%) for "30" vrs "50"	NS*	.1

* NS = not significant

Varietal differences were apparent in this trial as Yecora Rojo performed significantly better than 906R in yield, test weight and lodging, with no difference in protein in this growing season and test (Table 5).

Table 5. Yield, test weight, lodging and protein content of two hard red spring wheat varieties

Variety	Yield	Test weight	Lodging	Protein
	bu/a	lbs/bu	%	%
906R	88.5	62.6	25.8	13.7
Yecora Rojo	100.3	63.9	3.6	13.7
LSD (5%)	1.8	.1	6.3	.1

DISCUSSION

In 1986, results reported above, 170-200 pounds/acre preplant nitrogen with 50 pounds/acre nitrogen added from boot to flowering provided greatest yield, good test weights, and greatest increase in protein in the two hard red spring wheat varieties tested. Levels of preplant nitrogen higher than 200 pounds/acre were not utilized.

In our 1986 Cerone trial (see "Effect of Cerone anti-lodging agent and nitrogen fertilizer rates on performance of two irrigated hard red spring wheat varieties", in this issue) we preplant fertilized at even higher levels of 225 and 300 pounds/acre of nitrogen in a deliberate attempt to induce lodging. We did not affect lodging, but results indicate yield and protein content responses leveled off at between 225 and 300 pounds/acre preplant nitrogen.

In 1985, (see "Influence of fertilizer rate and timing on yield, test weight, and protein content of three irrigated hard red spring varieties", Irrigated Crops Research in Central Oregon - 1986, pp 28-34), we found that 200 pounds/acre preplant of nitrogen was distinctly more effective than 100 pounds/acre preplant for increasing protein and yield, and that protein content continued to increase with later additional fertilizer applications even as high as 120 pounds/acre of nitrogen.

The primary reason for producing hard red spring wheats is the added return from higher protein content, which may vary from year to year in a region. Our 1985 and 1986 data may be sufficient to develop an economic analysis incorporating test weight and protein content (both factors which affect the price of hard red spring wheat), yield, fertilizer costs, and application costs. We tentatively suggest that greatest economic return from production of available hard red spring wheat would result from:

a. 200-225 pounds/acre of nitrogen as preplant (when residual nitrogen is 30-40 pounds/acre)

and b. 40-50 pounds/acre of nitrogen added between boot and flowering

EFFECT OF FLOATING ROW COVERS ON RADISHES, YELLOW SPANISH ONIONS, CABBAGE, CUCUMBER, WINTER SQUASH, AND SWEET CORN AT REDMOND, OREGON IN 1986

J. Loren Nelson and Marvin Young[1]

ABSTRACT

Reemay[2] was evaluated in replicated treatments on radish, yellow spanish onions, cabbage, cucumbers, and squash. Agryl P17[3] and Vispore[4] were used on sweet corn. Reemay increased plant height, percent edible bulbs, root and top weight, and maturity of radishes. The total dry bulb yield of plants under Reemay was significantly higher than yield of non-covered plants. Total yield, weight per head, and head diameter of cabbage were greater under cover than uncovered. Reemay plus mulch resulted in slightly more early yield of cucumbers but the total yield per plant for the season was similar for plants uncovered, covered without mulch, and covered with mulch. A trend existed for improved yield of winter squash with Reemay alone and in combination with mulch. Vispore and Agryl P17 row covers affected sweet corn similarly except 90-day plant height was greatest under Agryl P17. Covered plants had higher early yield and total yield of ears than non-covered plants. Additional research with row covers is needed to determine response of vegetables grown in central Oregon.

INTRODUCTION

The use of floating row covers over vegetable crops to enhance earliness and increase yields has expanded rapidly in the United States over the past few years. These covers are lightweight and require no support hoops. The cover material rests on the plant foliage and can be lifted up as

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2 Reemay is a registered trademark of E.I. DuPont de Nemours Company, Inc.

3 Agryl P17 is a registered trademark of International Paper Co.

4 Vispore is a registered trademark of Ethyl Visqueen Corporation.

ACKNOWLEDGMENTS: The able assistance of many Deschutes County Master Gardeners under direction of Ann McDonald made the study possible. Their names appear in Appendix I. They may be contacted for information on gardening in the area.

growth occurs. Some materials are sufficiently porous to allow water and pesticides to penetrate while others are not. Insects have also been excluded with some covers. Nelson, Brevig, and Young (3) observed that Vispore increased early yield and total yield of sweet corn in 1984 at Redmond. Reemay was also observed to have favorable effects on tomatoes and cucumbers at Madras in 1984. Therefore, interest increased in central Oregon to justify several small experiments with replicated treatments in 1986.

MATERIALS AND METHODS

All experiments were at the Redmond site of the Central Oregon Experiment Station on a sandy loam soil. A spring broadcast fertilizer application of 27-12-0 (312 pounds/acre) was incorporated during seedbed preparation. A light side-dressing of ammonium nitrate in each experiment was made from June 27-July 7. When weeding was necessary, the row covers were rolled-back. All treatments were arranged in randomized complete block designs.

Radishes (cv. Crimson Giant and Early Scarlet Globe). Seed was sown May 15. The treatments shown in Table 1 were replicated three times. The Reemay cover remained on plots until harvest on June 11 except for removal for hand-weeding.

Yellow Spanish Onions (Variety unknown). Sets were planted about three inches apart in each of all plots April 30. Each treatment (see Table 2) was replicated three times. Reemay was removed July 7. The plots were also hand-weeded at this time. Bulbs were lifted and left in the field to dry; then they were bagged and stored in a shed until grading by size and weight in November.

Cabbage (cv. Early Flat Dutch). Transplants were set three feet apart in rows 10 feet long. Treatments (Table 4) were replicated three times. Non-covered plants were dusted with Sevin (five percent) insecticide on July 17 and 29. Heads from all plants of each treatment were harvested August 13.

Cucumbers (cv. Burpee Hybrid II). Seed was planted May 28 in two hills spaced three feet apart for each plot. Each treatment (Table 6) was replicated twice. Reemay was removed July 7, 40 days after sowing.

Winter Squash (cv. Buttercup and Acorn type cv. unknown). Squash was handled in a manner similar to the cucumbers. Each type of squash was treated as a separate experiment. Table 7 shows the treatments for each.

Sweet Corn (cv. Golden Jubilee). Three seeds were planted in hills spaced eight-inches apart in two 20 feet long rows spaced 24 inches apart in the center of five feet wide plots on May 28, 1986. Polyethylene (Vispore) and polypropylene (Agryl P17) row covers were placed over each two-row plot for comparison with non-covered control rows. These three treatments were replicated four times. All row covers were removed June 28, 30 days after planting. Ammonium nitrate (100 pounds N/acre) was side-dressed four inches from each row at cover removal. Plant height was taken along with other data as shown in Tables 9 and 10.

RESULTS AND DISCUSSION

Radishes. No insect damage was observed on leaves of plants in any treatment. Only three bulbs of the control in replication three were found with maggots while one bulb under cover had some feeding damage. Therefore, no evaluation of the treatments for insect control could be made.

It was noticed that some radish leaves under Reemay had some brown areas which may have been caused by the covers' abrasive action. It is not as soft as some other materials such as Agryl P17. Wind accelerates any problems with abrasion on plants, especially the high-growing and delicate ones.

Both varieties responded dramatically to the floating row cover (Table 1). The percent edible bulbs under cover was more than 3.5 times greater than non-covered plants. Plant height and root and top growth of radish plants were also greatest under cover. Many bulbs of protected plants could have been harvested 21 days after planting rather than 27. Only two of the largest control bulbs were pithy or did not have a firm cortex region.

Diazinon and diatomaceous earth depressed radish growth. Rates may have been too high. Leaves were small, malformed, and yellowish on plants from the treatment of diatomaceous earth. However, top and root growth appeared normal on plants with Diazinon.

Yellow Spanish Onions. Reemay, diazinon, and diatomaceous earth each had no effect on maturity July 31 and August 11 (Table 2). On August 25, Reemay covered onions had significantly more mature plants than diazinon treated ones which may be just a chance occurrence but the same comparison was also significant for September 2. No report is known of diazinon delaying onion maturity. Maturity of covered plants and non-covered onions was similar on August 25. However, on September 2, for this same comparison, covered plants showed enhanced maturity. By September 12 the number of mature plants treated with diazinon were similar to covered onions but they exhibited greater maturity than control plants. Reemay increased earliness of yellow spanish onions although additional tests over more than one season are needed for substantiation. Mansour (2) reported increased earliness for green onions under Reemay but no reference to dry bulb onion response to floating row covers was found.

The total dry bulb yield of plants under Reemay was significantly higher than total yield of non-covered plants but similar to diazinon non-covered onions (Table 3). Although very little onion maggot damage was observed on mature bulbs of controls, there were differences in stands of onions between the treatments but timely monitoring of maggots was not done. Stands averaged 12, 23, 22, and 11 onion plants for the control, Reemay, diazinon, and diatomaceous earth treatments, respectively. It is highly probable that stand differences were from maggot damage but the exact number of sets planted was not determined either so some differences may be from unequal planting rates. The final plant population within rows was not uniformly spaced either which seriously reduces the reliability of yield values. The tendency is for larger bulbs in sparse plant populations. Therefore, further research is necessary.

Nevertheless, the percent double bulbs (two's) were extremely high from all treatments (Table 3). The percent of total yield for bulb sizes >4", 2 1/4-3", <2 1/4", as well as two's, among treatments was not significant. However, plants under Reemay had more 3-4" bulbs than the control and diazinon treatments. The weight of bulbs showed the same relationship. The average stand was the same for Reemay and diazinon treatments but no definition of plant uniformity was obtained. The weight of colossal jumbo bulbs (>4" in diameter) from covered and diazinon treated plants was similarly greater than the weight of control and plants with diatomaceous earth. The value of row covers on onions in this test appears questionable but further investigation is warranted from the data.

Cabbage. Total yield, weight per head, and head diameter were significantly greater from plants covered with Reemay than those not covered (Table 4). No insect damaged leaves or cabbage worms or butterflies were found in covered plants if no hole or tear existed in the Reemay cover. Damage occurred on all non-covered cabbage plants. Heads under cover could have been harvested two-three weeks earlier.

Cucumbers. Reemay cover plus mulch resulted in slightly more early cucumbers than control and cover without mulch (Table 5). There was also more fruit from plants under cover but no mulch on August 6 compared to control cover and mulch treatment. The number of fruit picked at each of the other harvest dates was similar regardless of treatment. Reemay alone or in combination with mulch did not help plants produce more total fruit per plant for the season than no cover or mulch (control). However, there was a trend toward increased productivity with cover alone and some additional increase when Reemay was used over mulch. More research needs to be done with more plants and replications to effectively define benefits from cover and mulch.

There was significantly more early yield (August 6 and 11) of cucumbers from plants under cover only and cover and mulch than the control (Table 6). Total yield per plant for the season was not significant among any of the treatments.

Winter Squash. A good stand of plants was not achieved. Consequently, the replication of treatments was not complete which prevented statistical analyses of the data. Some control plants were killed by frost on June 19. The leaves of covered plants had damage on the margins of the leaves touching the Reemay. Plants under cover appeared more vigorous than non-covered plants but none of them were as vigorous nor did they bloom and set fruit as expected.

There appeared to be a trend for increased yield of both winter squash varieties with cover and mulch (Table 7 and 8). However, further research is needed to determine the true effects.

Sweet Corn. Corn from cover treatments produced more ears and weight of ears, at least a week earlier, than the non-covered plants on September 3 harvest or 98 days after sowing (Table 9). The effect of Vispore and Agryl P17 cover was similar for number and weight of marketable ears on each harvest date and the total for the season. The number and weight of ears for the August 28 and September 10 harvest were similar for covered and non-covered plants. On the last harvest, September 17 or 112 days after sowing, non-covered plants produced significantly more ears than covered plants. The number and weight of ears increased from the first to the last harvest on non-covered plants but the greatest yield for covered plants was for the early harvest, September 3. Plant height 30 days after planting was significantly taller than control plants (Table 10). The margins of leaves touching the Vispore cover appeared to be burned. This was not the case for leaves under Agryl P17. No 90-day height difference occurred among non-covered plants and Vispore covered plants. Agryl P17 covered plants were taller than those not covered or under Vispore. Covered plants had similar root scores, and first internode diameters and lengths, but they were superior to non-covered plants for each of these parameters. Non-covered plants lodged from 50-60 percent.

Table 11 shows the daily maximum and minimum air temperature and heat units per day outside and under Reemay row cover. Heat units are temperature-time values expressed in degree days. They are calculated by subtracting the base temperature (minimum temperature for growth) from the average daily temperature. Base temperatures of 40 and 50^{o}F are usually used as the minimum temperatures for growth of cool and warm season vegetables, respectively. Accumulated daily heat units for varieties may be used for comparisons of relative maturity or time required from planting to harvest for some vegetables, such as peas and sweet corn. Reemay increased the daily maximum and minimum temperature, and heat units per day. Heat units under cover were much higher than over bare ground. The accumulated heat units under Reemay for each of three periods during the growing season ranged from 1.5 to 2.4 times the heat units without cover for the 50^{o}F base (Table 12).

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4. Wells, D.S. and J.B. Loy. 1985. Intensive vegetable production with row covers. HortScience 20:822-826.

APPENDIX I

List of Master Gardeners who worked on the Garden Research in 1986.

Name	Address	Phone No.
Anne McDonald	560 S.W. 35th Redmond, OR 97756	548-4952
Laurie Lefors	18460 Couch Mkt. Road Bend, OR 97701	382-7705
Clay/Patsy Vincent	63910 Quail Haven Dr. Bend, OR 97701	382-4580
Donna Cotton	20781 St. George Ct. Bend, OR 97702	389-5321
Jeanne Beaver	65280 85th Pl. Bend, OR 97701	382-0230
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Dick Uffelman	61135 Ladera Rd. Bend, OR 97702	382-5910
Glenda Swope	65336 73rd St. Bend, OR 97701	382-3669
Tom Gamm	4990 N.E. O'Neill Redmond, OR 97756	548-5277
June Nicholas	4563 S.W. 58th Redmond, OR 97756	548-1544
Carol Ulett	154 N.E. Franklin Bend, OR 97701	382-1821
James Powell	105 S. 12th Redmond, OR 97756	548-6588
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Table 1. Effect of Reemay row cover, Diazinon, and diatomaceous earth on (cv. Crimson Giant, Scarlet Globe) radishes at Redmond, Oregon, 1986

Treatment[1]	Cv[2]	Edible Bulb	Root wt.	Top wt.	Total wt.	Plant ht.
		%	gm			cm
No Cover	C	16.5	3.1	4.1	7.3	6.3
	S	21.7	3.5	3.0	6.5	6.0
Reemay	C	64.5	12.8	10.3	23.1	10.7
	S	81.1	13.8	7.5	21.3	11.0
Diazinon	C	1.9	1.7	4.1	5.4	6.7
	S	1.9	1.9	2.6	4.5	5.0
Diat. Earth	C	4.8	1.5	2.3	3.8	5.0
	S	0.0	0.4	1.1	1.4	4.0
LSD (5%)	C	20.5	2.4	2.0	2.9	2.5
	S	22.8	1.6	1.1	1.8	1.6

1 Treatment: Diazinon and diatomaceous earth applied in-furrow with seed.

2 Cv = cultivar: C - Crimson Giant and S - Scarlet Globe.

Table 2. Effect of Reemay Diazinon and Diatomaceous Earth on maturity of onions at Redmond, Oregon, 1986

Treatment	Maturity[1] 7-31	8-11	8-25	9-2	9-12
	%				
Control	10	10	27	27	36
Reemay	16	26	53	60	79
Diazinon	2	2	15	17	46
Dia. Earth	7	10	29	39	54
LSD (5%)	18	24	26	26	35

1 Maturity: Expressed as a percentage of plants with tops fallen-over to total plants in the treatment.

Table 3. Effect of Reemay, Diazinon, and Diatomaceous Earth on dry bulb yield of onions at Redmond, Oregon, 1986

Treatment	Total Yield	Dry bulb yield by size and percent of total yield >4 inch		3/4"		2 1/4-3"		<2 1/4"		Two's	
	lb.	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%
Control	6.01	.84	10	.93	13	.34	5	.03	0	3.87	71
Reemay	14.14	3.46	26	4.08	30	.51	3	.08	1	6.01	40
Diazinon	16.01	4.01	26	.96	6	.19	1	.07	1	10.78	66
Dia. Earth	8.22	.59	6	2.01	25	.24	3	.00	0	5.38	66
LSD (5%)	7.11	2.13	22	1.76	13	.75	6	.14	1	4.95	33

Table 4. Effect of Reemay row cover, Diazinon, and diatomaceous earth on cabbage (cv. Early Flat Dutch) at Redmond, Oregon, 1986

Treatment	Total yield	Wt./ head	Head dia.	Depth of head
	lb		in	
No cover	33.50b[1]	10.44bc	11.40b	6.95a
Polyester	48.75a	16.26a	13.08a	7.23a
Diazinon	32.25b	12.39b	10.95b	7.55a
Diat. Earth	18.67c	7.62c	10.37b	6.43a

1 Values with the same letter within a column are not significantly different at the 5% level of probability using Duncan's multiple range test.

Table 5. Effect of Reemay over cucumbers with and without black plastic mulch on average number of fruit per plant at Redmond, Oregon, 1986

Treatment	Harvest date 8/6	8/11	8/13	8/20	8/25	8/28	9/3	9/10	9/16	Total
	number									
Control[1]	.0	.0	.13	.25	1.00	1.88	2.75	1.63	9.38	17.00
Cover + No Mulch	.84	.71	.88	2.88	.75	2.04	5.42	2.79	6.09	22.38
Cover + Mulch	.50	3.50	.75	5.00	6.13	4.13	11.38	9.50	8.38	49.25
LSD (5%)	.58	3.44	1.32	9.44	14.23	9.64	28.70	16.42	19.00	85.91

1 Control: plants with no Reemay cover and black plastic mulch.

Table 6. Effect of Reemay over cucumbers with and without black plastic mulch on average yield per plant at Redmond, Oregon, 1986

Treatment	Harvest date 8/6	8/11	8/13	8/20	8/25	8/28	9/3	9/10	9/16	Total
	number									
Control[1]	.0	.0	.03	.17	.71	.76	1.58	.56	.45	4.27
Cover + No Mulch	.43	.41	.30	1.70	.55	.76	1.34	.86	.31	6.68
Cover + Mulch	.37	2.54	.30	3.66	3.30	.54	3.69	3.44	.81	18.66
LSD (5%)	.28	1.74	.68	9.04	7.27	2.59	7.70	5.40	1.99	30.75

1 Control: Plants with no Reemay cover and black plastic mulch.

Table 7. Effect of Reemay cover on acorn type winter squash with and without mulch at Redmond, Oregon, 1986

Treatment	No. of Plants	Good fruit No.	Good fruit Wt.	Good fruit Wt. /fruit	Bad fruit[2] No.	Bad fruit Wt.	Bad fruit Wt. /fruit
			lbs	lbs		lbs	lbs
Control[1]	1	1	2.8	2.8	0	.0	.0
Cover-no mulch	2	4	6.0	1.5	3	.4	.1
Cover + mulch	2	12	20.8	1.7	4	3.5	.9

1 Control = Plants not covered nor with mulch.
2 Bad Fruit = Small, immature, and frost damaged fruit.

Table 8. Effect of Reemay cover on 'Buttercup' winter squash with and without mulch at Redmond, Oregon, 1986

Treatment	No. of Plants	Good fruit No.	Good fruit Wt.	Good fruit Wt. /fruit	Bad fruit[2] No.	Bad fruit[2] Wt.	Bad fruit[2] Wt. /fruit
			lbs	lbs		lbs	lbs
Control[1]	2	14	54.2	3.9	9	13.1	1.5
Cover-no mulch	6	52	198.4	3.8	26	16.7	.6
Cover + mulch	1	26	81.8	3.1	2	.9	.5

1 Control = Plants not covered nor with mulch.
2 Bad Fruit = Small, immature, and frost damaged fruit.

Table 9. Effect of Vispore and Agryl P17 row covers on sweet corn (cv. Golden Jubilee) at Redmond, Oregon, 1986

Treatment	Number and weight of ears harvested: Aug. 28		Sept. 3		Sept. 10		Sept. 17		Total	
	no	lb	no	lb	no	lb	no	lb	no	lb
No cover	0	0.0	1	0.5	21	11.3	78	40.3	100	52.0
Vispore	8	4.6	94	54.3	12	5.7	16	7.9	130	72.3
Agryl P17	11	7.0	102	56.2	4	2.0	25	10.4	141	75.6
LSD (5%)	14	9.4	19	7.1	39	21.0	40	21.4	29	13.3

Table 10. Effect of Vispore and Agryl P17 row covers on sweet corn (cv. Golden Jubilee) at Redmond, Oregon, 1986

Treatment	Plant height[1] 30-days	Plant height[1] 90-days	Root score2	First Internode Dia.	First Internode Length
	---------in---------			-------in------	
No cover	19.8	99.3	4.3	.7	4.6
Vispore	37.8	98.1	7.5	.8	3.3
Agryl P17	37.0	107.8	9.0	.8	3.5
LSD (5%)	2.0	7.7	1.8	.03	0.6

1 Plant height 30- and 90-days after sowing. Covers removed 30-days after sowing.
2 Root score: 1 = shortest and lowest number of roots/plant; 10=longest and largest number of roots; from 18-30 plants/treatment.

Table 11. Daily maximum and minimum air temperature and heat units per day outside and under Reemay at Redmond, Oregon, 1986

Month	Day	Outside Reemay[1] Max.	Outside Reemay[1] Min.	Outside Reemay[1] H.U. 50°F	Under Reemay[2] Max.	Under Reemay[2] Min.	Under Reemay[2] H.U. 50°F
		------°F-----		degree days	------°F-----		degree days
May	16	57	27	0	102	32	17
	17	70	40	5	109	41	25
	18	77	49	13	96	48	22
	19	72	42	7	108	43	25.5
	20	76	39	7.5	80	41	10.5
	21	58	37	0	75	36	5.5
	22	54	21	0	97	29	13
	23	61	39	0	96	42	19
	24	71	41	6	106	43	24.5
	25	85	45	15	108	47	27.5
	26	88	50	19	104	52	28
	27	81	47	14	108	49	28.5
	28	82	47	14.5	109	49	29
	29	86	52	19	116	49	32.5
	30	93	54	23.5	122	54	38
	31	97	56	26.5	122	55	38.5
June	1	96	62	29	115	59	37
	2	93	56	24.5	105	54	29.5
	3	84	52	18	113	52	32.5
	4	83	50	16.5	108	52	30
	5	77	43	10	100	48	24

1 Outside Reemay: air temperature measured five feet above soil.
2 Under Reemay: air temperature measured six inches above soil.

Table 12. Effect of Reemay on air temperature for three periods at Redmond, Oregon, 1986

Treatment	Period	Heat units[1] 40°F Base	Heat units[1] 50°F Base	Mean air temperature[2] Max.	Mean air temperature[2] Min.	Mean air temperature[2] Mean
		degree days		----------°F---------		
No Reemay	5/16-6/5	458	268	78.1	45.2	61.7
	6/9-6/12	88	48	82.0	42.0	62.0
	6/17-6/19	46	22	72.7	37.7	55.2
Reemay	5/16-6/5	742	537	104.7	46.4	75.6
	6/9-6/12	157	117	114.8	43.8	79.3
	6/17-6/19	64	34	80.0	42.7	61.4

1 Heat units = $\frac{\text{Max.} + \text{Min.}}{2}$ - base temperature

2 Air temperature under no Reemay from weather station. Temperature under Reemay measured six inches above soil.

EFFECT OF PLANT PROTECTORS ON TOMATOES, PEPPERS, AND MUSKMELONS AT REDMOND, OREGON IN 1986

J. Loren Nelson and Marvin Young[1]

ABSTRACT

Wallo'Waters[2] (WoW) were evaluated on tomatoes (cv. Santiam), peppers (cv. Sweet Bananna), and cantaloupe (cv. Burpee's Sweet'n Early Hybrid). Transplants of tomatoes and peppers and seed of cantaloupe were placed in WoW on April 25, May 15, and June 5 for comparison with non-protected plants and seeds planted June 6. WoW protected plants from a low air temperature of 18^{o} F. No ripe tomatoes were obtained from non-protected frost damaged plants. Ripe tomato yield was greatest from plants set April 25 and May 15. Weight of peppers at the August 20 harvest for plants set in WoW on May 15 was significantly higher than the non-protected control. The total number and weight of peppers for the same comparison were also significant. Seedling emergence and establishment of muskmelons were poor under WoW so the purposes of treatment replication were not achieved. Further research needs to be conducted to determine the most effective way to use the Wallo'water protectors.

INTRODUCTION

Low air and soil temperatures with a short growing season seriously limit production of warm season vegetables in central Oregon. Area gardeners have used various kinds of materials and devices for frost protection and growth regulation. In recent years several commercial products have become available. One of these is the 6 mil clear polyethylene plastic cylinders which when filled with water are sufficiently rigid for free-standing. These structures, called Wallo'Waters (WoW) surround the plant for protection against frost and improvement of soil and air temperature. WoW have been previously described in Special Report 747

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2 Wallo'Waters is registered trademark of TerraCopia, Inc.
ACKNOWLEDGMENTS: The able assistance of many Deschutes County Master Gardeners under direction of Ann McDonald made the study possible. Their names appear in Appendix I. They may be contacted for information on gardening in the area.

(1). They were observed to provide excellent frost protection of tomato plants and improved early yield. Therefore, tests with replicated treatments to document these findings were conducted at Redmond in 1986. Besides tomatoes, peppers and muskmelon were chosen for evaluation in the Wallo'Waters.

MATERIALS AND METHODS

All experiments were established on a sandy loam soil at the Redmond site of the Central Oregon Experiment Station. Three-hundred twelve pounds per acre of 27-12-0 was broadcast on the field in the spring and incorporated during seedbed preparation. Tomato (cv. Santiam) and pepper (cv. Sweet Bananna) transplants and seed of cantaloupe (cv. Burpee's Sweet'n Early Hybrid) were placed in WoW on April 25, May 15, and June 5. These three dates of planting plus June 6 for plants and seeds not in WoW comprised the four treatments that were replicated four times in a randomized complete block design. Each vegetable was handled as a separate experiment. The WoW were set up a week in advance of planting into them so soil could be warmed. The cylinders of each WoW were filled with water about two-thirds full so the structure formed a tepee, the top being closed to give maximum protection and retention of heat within each unit. Tops of WoW were kept closed until plants could no longer be contained. Two stakes were placed inside each WoW when tops were opened to help support the plant top growth and prevent WoW collapse. All WoW were left on the plants throughout the season. Weeds were controlled by hand inside and outside the WoW as needed. On June 13, a light application of ammonium nitrate and muriate of potash was made around all plants and shallowly incorporated. Another similar application was made on July 7.

Only one tomato and pepper transplant in a WoW comprised a treatment of one replication in each experiment. Three-four muskmelon seeds were planted in each WoW. Plants were hand-watered when necessary.

Tomatoes were picked, counted, and weighed on the dates shown in Table 1. On September 15, tomato plants were pruned and gently enclosed within the WoW from which the stakes were removed. Tops of all WoW were closed for maximum protection. All green fruit from the control and branches that could not be inserted inside the WoW were picked on September 15.

Peppers were picked several times throughout the season when the fruit was yellow.

Cantaloupe vines were trained over the sides of the WoW when sufficient growth had occurred.

Data were analyzed statistically and significant differences determined at the five percent probability level.

RESULTS AND DISCUSSION

Tomatoes. Wallo'Waters prevented death to tomato plants. The unprotected plants (controls) were severely damaged and/or killed by several frosts. Consequently, no ripe fruit were obtained (Table 1). Perhaps ripe fruit from non-protected plants may have been produced if control plants had been replaced with aged transplants. However, some green fruit were produced for the control treatment. A good comparison of WoW with non-protected plants was not achieved.

There was no significant difference among WoW treatments for total yield (green plus ripe fruit). Transplants set April 25 in WoW gave the highest production of early tomatoes. For all harvest dates, the greatest yield of ripe tomatoes occurred from plants set April 25 and May 15. Therefore, the data suggest that setting transplants in WoW on April 25 can promote earlier harvest but plants in WoW on May 15 is sufficiently early to obtain a maximum yield of ripe tomatoes.

Peppers. No significant differences occurred among treatments for number of fruit harvested on any date but for total fruit harvested transplants set in WoW May 15 had more fruit than the unprotected plants (Table 2). Weight of fruit from August 20 harvest was significantly higher for plants set in WoW May 15 than non-protected plants. The total yield for the same treatment comparison was also significant. Further research is necessary to validate this finding.

Muskmelons. Germination was poor in the WoW. The soil seemed to dry fairly quickly under the protectors, evidently because of the elevated soil temperature. There may have been too little water entering the WoW from the sprinkler. When WoW are closed, hand watering is necessary. There did not appear to be sufficient movement of soil water into soil covered by WoW. Plants may have suffered from high temperature, and low moisture stress.

All of the fruit was immature and from two to four inches in diameter. Table 3 shows the number and weight of fruit produced.

Data were not analyzed statistically but it appears that the non-protected plants were more productive. It was difficult to train the vines over the WoW edges.

Table 4 gives the daily maximum and minimum air temperatures and heat units per day inside and outside the WoW. Heat units are temperature-time values expressed in degree days. They are calculated by subtracting the base temperature (minimum temperature for growth) from the average daily temperature. Base temperatures of 40 and 50°F are usually used as the minimum temperatures for growth of cool and warm season vegetables, respectively. Accumulated daily heat units for varieties may be used for comparisons of relative maturity or time required from planting to harvest for some vegetables, such as peas and sweet corn. The increase in number of heat units inside the WoW is shown in Table 5.

REFERENCE

1. Nelson, J.L., R. Brevig, and M. Young. 1985. Response of vegetables to floating row covers and plant protectors in Central Oregon. In Irrigated Crops Research in Central Oregon 1985. Oregon Agricultural Experiment Station. Special Report 747. pp. 82-86.

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Table 1. Production of tomatoes (cv. Santiam) from protected and non-protected plants at Redmond, Oregon, 1986

Treatment[1]	Ripe fruit: Early harvest[2] No.	Ripe fruit: Early harvest[2] Wt. (kg)	Ripe fruit: Early harvest[2] Wt./fruit (gm)	Ripe fruit: All harvests[3] No.	Ripe fruit: All harvests[3] Wt. (kg)	Ripe fruit: All harvests[3] Wt./fruit (gm)	Green fruit No.	Green fruit Wt. (kg)	Green fruit Wt./fruit (gm)	Total yield No.	Total yield Wt. (kg)
P - 4/25	18	1.5	84.0	50	3.5	71.3	10	.4	50.2	60	3.8
P - 5/15	8	.7	93.2	43	3.4	79.0	12	.5	39.9	55	3.8
P - 6/5	3	.3	78.0	23	2.0	89.5	21	1.2	48.6	44	3.1
NP - 6/6	0	---	----	0	---	----	23	1.7	54.4	23	1.7
LSD (5%)	8	.9	81.8	15	1.0	13.4	20	1.4	34.2	26	1.6

1 Treatment: P = transplants protected with clear polyethylene water-filled cylinders.
NP = non-protected plants (control).
4/25, 5/15, 6/5, 6/6 = month/day transplants set.

2 Early Harvest: total number and weight of ripe fruit picked on August 13 and 20.

3 All Harvests: Included ripe fruit picked August 13 and 20 plus August 25, 28, September 3, 10 and 15.

Table 2. Effect of Wallo'Water plant protectors on peppers at Redmond, Oregon, 1986

	Number and weight of fruit harvested														
	Aug 13		Aug. 20		Aug. 28		Sept. 3		Sept. 10		Sept. 22		Total	
Treatment[1]	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)
P - 4/25	7	161.1	14	253.8	10	148.3	8	120.7	14	192.9	12	78.0	63	954.8
P - 5/15	6	165.5	16	304.3	12	155.9	7	91.8	16	211.7	20	107.3	77	1036.5
P - 6/5	5	131.5	7	130.6	4	61.4	4	52.9	8	110.1	12	101.3	40	587.7
NP - 6/6	2	33.1	7	100.8	3	56.1	4	65.5	7	91.7	11	62.3	33	409.5
LSD (5%)	6	158.6	10	179.5	11	164.2	7	99.9	10	151.6	15	118.5	37	564.2

1 Treatment: P = transplants protected with clear polyethylene water-filled cylinders.
NP = non-protected plants (control).
4/25, 5/15, 6/5, 6/6 = month/day transplants set.

Table 3. Effect of Wallo'Waters on number and weight of muskmelon at Redmond, Oregon, 1986

	Number and weight of fruit September 22								Total		
	Rep. I		Rep. II		Rep. III		Rep. IV				
Treatment[1]	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	Wt./ Fruit (gm)
P - 4/25	6	862.4	5	1159.9	0	0	0	0	11	2022.3	183.8
P - 5/15	5	1529.4	0	0	0	0	0	0	5	1529.4	305.9
P - 6/5	0	0	0	0	3	1802.4	2	793.1	5	2595.5	519.1
NP - 6/6	6	2139.7	3	1096.9	4	2193.4	4	705.6	17	6135.6	360.9

1 Treatment: P = transplants protected with clear polyethylene water-filled cylinders.
NP = non-protected plants (control).
4/25, 5/15, 6/5, 6/6 = month/day transplants set.

Table 4. Daily air temperatures and heat units outside and inside Wallo'Waters at Redmond, Oregon, 1986

Month	Day	Outside WoW[1]			Inside WoW[2]		
		Max.	Min.	50°F	Max.	Min.	50°F
		-----°F-----		degree days	----°F-----		degree days
April	26	48	22	0	93	33	13
	27	55	42	0	101	42	21.5
	28	58	26	0	98	32	15
	29	53	31	0	101	32	16.5
	30	50	18	0	95	32	13.5
May	1	59	28	0	110	32	21
	2	73	40	6.5	89	42	15.5
	3	54	37	0	90	39	14.5
	4	52	21	0	94	32	13
	5	54	37	0	62	46	4
	6	46	28	0	89	32	10.5
	7	53	25	0	100	32	16
	8	56	25	0	100	32	16
	9	60	28	0	95	32	13.5
	10	56	32	0	88	32	10
	11	44	23	0	94	32	13
	12	53	26	0	102	32	17
	13	65	42	3.5	95	46	20.5
	14	57	23	0	108	32	20
	15	61	35	0	104	40	22

1 Outside WoW: air temperature measured five feet above soil.

2 Inside WoW: air temperature measured 12 inches above soil near center of WoW.

Table 5. Effect of Wallo'Water (WoW) on air temperatures for the two periods at Redmond, Oregon, 1986

Treatment	Period	Heat units1		Mean air temperature[2]		
		40°F Base	50°F Base	Max.	Min.	Mean
		degree days		--------°F----------		
No WoW	4/26-5/15	74	10	55.4	29.5	42.5
	5/16-6/5	458	268	78.1	45.2	61.7
WoW	4/26-5/15	506	306	95.4	35.2	65.3
	5/16-6/5	809	599	108.0	49.0	78.5

1 Heat Units = $\frac{\text{Max.} + \text{Min.}}{2}$ - base temperature

2 Air temperature: for outside WoW was from the weather station where thermometer is enclosed in protective shelter five feet above ground. Temperature was taken about 12 inches above soil near the center of the WoW.