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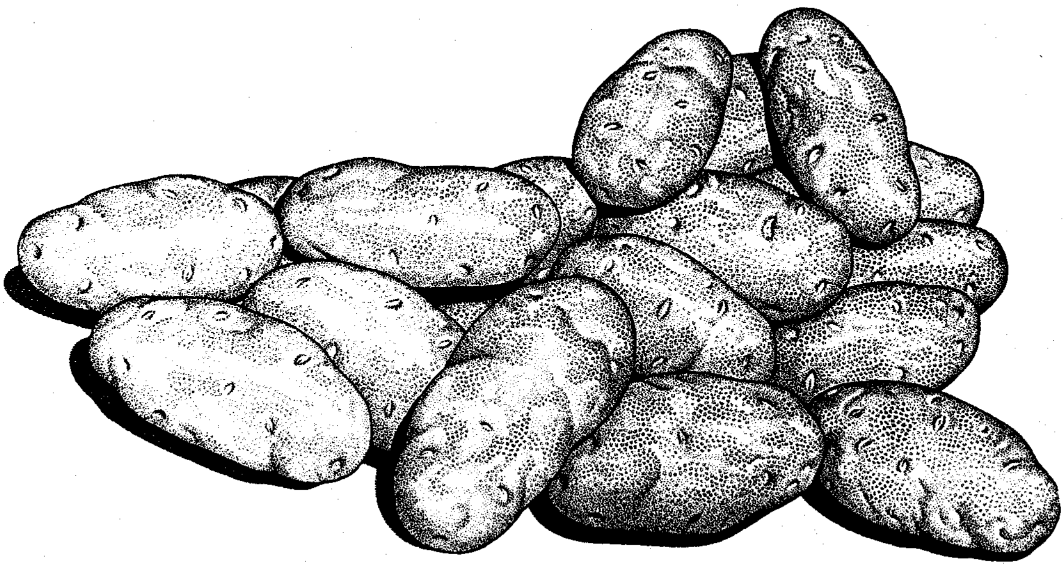

Special Report 876
May 1991

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Agricultural Experiment Station
Oregon State University, Corvallis

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CONTENTS

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INTRODUCTION

Our staff are pleased to share the results of the 1990 research programs at the Klamath Experiment Station (KES) with our clients, colleagues, supporters, and friends. The past year has been the culmination of a several-year project to upgrade our facilities, equipment, and programs. As we enter a period of budget uncertainties, we are very grateful that our needs have largely been resolved, and our facilities will meet our requirements in the years ahead with minimal attention. As an introduction to this report I would like to summarize the major changes and events of 1990 and recognize those individuals and agencies responsible for them.

The buildings at KES, owned by Klamath County, were recently appraised at a depreciated value of approximately $400,000. The majority of them were constructed in the 1940's and were in need of electrical service upgrades, roof replacements, siding, and interior remodelling. In 1988, the Klamath County Board of Commissioners and the lay person budget committee members approved a request for a temporary full-time employe and capital improvement funds to begin the process of upgrading facilities. That support was continued by the budget committee in 1989 and 1990. Additional capital funds were provided from the KES dwelling house account, from several OSU facility improvement grants, and from the proceeds of an auction of surplus equipment and crop sales. By the end of the 1990-1991 fiscal year all major objectives will be accomplished.

Three staff members at KES deserve special recognition for their roles in facility improvements. Jim Rainey has provided valuable guidance in planning projects and coordinating with outside contractors for jobs outside the scope of our staff. Dale Harris has done a major share of the actual work during the second and third years of the project. Rodney Lang has assisted in planning, acquisition of supplies and coordination of work parties, and has been closely involved with many projects.

Two significant projects completed since the beginning of this year are noteworthy. A headhouse building has been completely renovated and converted into a potato quality laboratory. KES now has the capability to test culinary quality of potential new potato varieties for french fry, microwave baked, oven baked, and boiled preparation methods. The new laboratory will be used extensively in the future.

The KES office building was constructed in 1957. A leaking roof, uninsulated windows and ceilings, and interior decorating needed attention. A new roof was installed and interior painting completed in 1989. In 1990, all windows were replaced, either with new insulated windows or with insulated walls. The exterior trim was painted. A storage area was converted to an office-computer room. Ceiling insulation, a drop ceiling, and new lighting was installed throughout the building. The changes have greatly improved the appearance, utilization and energy efficiency of our headquarters.

The overhaul and upgrading of several pieces of specialized equipment was also accomplished in 1990. Larry Johnson, Jerry Maxwell, and Jim Rainey were involved with refitting or fabrication of field and laboratory equipment. Randy Dovel and Greg Chilcote have made significant strides in bringing computer capabilities up to date. Our office efficiency has been improved with Betty Bragg's mastery of new software, a fax machine, and a state-of-the-art photocopier.

Research programs have been expanded in two areas. The OSU barley breeding program has selected the KES as the site for the major field activity. The introduction of sugarbeets as a major crop for the Klamath Basin has resulted in the initiation of a sugarbeet research project at KES. Both programs will be expanded in 1991.

The KES hosted three major events in 1990. In July, the annual summer meeting of OSU branch experiment station superintendents and campus-based administrators was held at Klamath Falls. In August, a tour of campus-based faculty and administrators included KES in their three-day agenda. The Annual KES field day on August 8 was held in conjunction with this event and was very well attended. All events provided opportunities for local growers to share ideas and concerns with OSU faculty from several disciplines. Betty Bragg played a key role in the organization of meals and social events for these functions.

I would like to extend a special note of appreciation to the KES Advisory Board and to the Klamath County Board of Commissioners for their continuing counsel and support of the KES, our facilities, and our programs. I extend this on behalf of the agricultural community, the faculty and administration of OSU, and the staff of KES.

We hope you will find this report useful. Any suggestions or comments that will help us better fulfill our mission are most welcome.

Ken Rykbost

Ken Rykbost, Superintendent
KLAMATH EXPERIMENT STATION

STAFF AT KES

Dr. Kenneth A. Rykbost...Superintendent, Associate Professor of Crop & Soil Science
Dr. Randy L. Dovel .... Assistant Professor of Crop & Soil Science
George E. Carter .... Associate Professor Emeritus
Betty Bragg .... Office Coordinator
Rodney D. Lang .... Biological Sciences Research Technician 2
Jerry W. Maxwell .... Biological Sciences Research Technician 3
James Rainey III .... Biological Sciences Research Technician 3
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Dale Harris .... Facility Maintenance (Klamath County)
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Weather and Crop Summary, 1990

K.A. Rykbost, J. Maxwell and G. Chilcote[1]

The Klamath Basin is situated in the rain-shadow of the Cascade Mountain Range at approximately 4,000 feet elevation. It experiences a high-desert climate with about 11 inches of annual precipitation. It is at risk of frost every month, and frequently has daily temperature fluctuations of 40° F. Agricultural production is dominated by livestock, forages, spring cereals, and potatoes. Although crops grown are fairly tolerant of weather extremes, minor changes in weather patterns from year to year significantly influence these crops and related diseases and pests. Frost damage poses the greatest environmental threat to crops and is a major reason for lack of crop diversity.

An official weather station is located at Kingsley Field, one-half mile east of the KES. It is at 4,090 feet elevation, 42° 10′ N latitude, and 121° 45′ W longitude. A station is also maintained at KES. Data from the two stations are very consistent with the exception that daily minimum temperatures are generally 1 to 3° F lower at KES. Climatological Data, Oregon, published by the National Oceanic and Atmospheric Administration, were used as the data base for a portion of the weather records (Tables 1 through 4). KES data were used for pan evaporation data for 1984 through 1988, to replace missing observations in other records, and as the base for all weather data for 1989 and 1990.

The 1990 growing season was characterized by unseasonably warm weather in early spring, cool and wet weather in late spring, near normal temperatures and precipitation through the summer, and a warm and dry fall. From April through October average air temperatures were 1° F above the mean for the decade of the 1980′s. Precipitation exceeded the 10-year mean for the period by 36 percent. The official weather station at Klamath Falls was one of few Oregon stations to report total precipitation in excess of long term averages for the calendar year. At Klamath Falls the frost-free season extended from June 11 through October 5, a 116-day season.

Weather records are summarized on a weekly basis from April 1 through October 27 (Tables 1-4). The 10-year period from 1980-1989 includes three of the warmest growing seasons on record at Klamath Falls. The accumulated departure of 1990 weekly mean temperatures from the 10-year average shows unseasonably warm weather during the first three weeks of April, a cool period from mid-May through mid-June, and a warm month of September. The average 1990 mean daily temperature for the 30-week period was 57° F, 1° F above the 10-year mean and 2° F above the mean in 1989.

Several periods of abnormal conditions affected crops during the growing season. A warm spell in late March and April advanced pastures and hay crops by about three weeks and allowed early ground preparation and planting of

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1/ Superintendent/Associate Professor, Biological Sciences Research Technician and Klamath County Research Technician, respectively, Klamath Experiment Station, OR.

spring cereals. Frosts in mid-May caused serious damage to the first cutting of alfalfa and several fields of sugarbeets. Cool and wet weather in late May and early June slowed recovery of alfalfa and pastures and delayed emergence and early development of potato crops. However, the moisture was beneficial for cereals, particularly in non-irrigated fields. Maximum air temperatures reached 90° F or above on 23 days between June 22 and September 11. Two extended periods of high temperatures in July and August caused some stress in most crops. Excellent harvest conditions prevailed through most of the fall.

Frosts occurred on eleven days between May 7 and May 19. This coincided with the emergence of sugarbeets planted during the first week of May and resulted in the need to replant about 25 percent of the crop. Earlier plantings survived these frosts in most cases. Alfalfa crops throughout the area suffered moderate to severe first cutting losses. A light frost on June 11 was followed by 15 weeks of frost-free weather at KES (Table 2). The delay of the first fall frost to October 6 is quite unusual for the area.

The major precipitation event of the year occurred in late May when over two inches of rain fell in a two-week period (Table 3). Although beneficial for pastures, cereals and sugarbeets, the rains delayed harvesting and regrowth of alfalfa, and provided ideal conditions for rhizoctonia damage to emerging potato crops. Above average precipitation in August and a lack of early frosts delayed ripening and harvesting of cereals. Dry weather in September and October provided ideal conditions for harvesting potato and sugarbeet crops, with the latter extending into the first week of November.

Total pan evaporation from mid-June through mid-September was slightly below the 10-year mean (Table 4). Evaporation losses were near normal except during the period of showers and cooler weather in August. This contributed to some difficulty in harvesting alfalfa and a delay in grain ripening.

Overall, the 1990 growing season was quite favorable for the large scale introduction of sugarbeets to the Klamath Basin. The loss of stands to frost injury was probably less than would be anticipated for April plantings but more than might be expected for May plantings. The only significant disease problem encountered was powdery mildew, which infected some fields in late August and early September. Early season flea beetle infestations and inadequate weed control were problematic in some fields and will require refinements in cultural practices in the future. Fall weather was undoubtedly better than can be anticipated in most years.

Potato yields were not as high as in the more favorable 1989 season. Rhizoctonia damage in June reduced stands and delayed early development. Heat stress in July caused extensive heat sprouts in some fields and reduced tuber set. August heat stress further delayed crop development and reduced tuber size in crops that were killed down early. Full season crops benefitted from the delay in fall frosts and achieved better yields and size. Overall crop quality was quite good.

Cereal crops were generally favored by weather conditions through early August. Spring frosts caused some loss to stands and vigor, but a lack of frost during flowering and early heading provided the potential for an excellent crop. Hail damage over an extensive area in August and again in mid-September caused a 30 to 50 percent yield reduction in some fields. Barley losses due to hail damage were estimated at 10,000 tons. Russian wheat aphids were observed in the Klamath Basin for the first time in 1990. Infestations were generally mild and yield losses were considered insignificant. However, several isolated fields did have sufficient infestations to require chemical control measures. Damage appeared to be more serious in non-irrigated fields which were more stressed by weather related factors. A careful monitoring of fields for this pest is advised for the future.

The first cutting of alfalfa was generally poor due to frost damage. August rains hampered harvest of third cuttings and reduced quality of some lots. Range and pastures were better than average early in the season but were adversely affected by heat in August and a lack of fall rains. Overall, 1990 was not a particularly good year for forages in the Klamath Basin.

Table 1. Weekly average maximum, minimum, and mean temperatures for 1990 and the 10-year period from 1980 to 1989, and the accumulated departure of 1990 weekly means from the 10-year average at Klamath Falls, OR.

Weekly Period		1980-1989 Weekly Average Max	Min	Mean	1990 Weekly Average Max	Min	Mean	1990 Accumulated Departure[1]
		° F						
April	1- 7	52	29	41	68	32	50	+ 9
	8-14	58	30	45	68	30	49	+13
	15-21	61	33	47	69	40	54	+20
	22-28	59	32	46	59	36	47	+21
	29- 5	61	34	48	66	33	50	+23
May	6-12	62	34	48	68	31	49	+24
	13-19	66	36	51	66	29	48	+21
	20-26	70	39	55	56	37	46	+12
	27- 2	69	41	56	55	37	46	+ 2
June	3- 9	69	43	56	71	37	54	0
	10-16	74	44	59	67	37	52	- 7
	17-23	77	46	62	81	49	65	- 4
	24-30	79	48	64	81	45	63	- 5
July	1- 7	79	46	63	77	45	61	- 7
	8-14	81	47	64	89	55	72	+ 1
	15-21	82	49	66	87	54	71	+ 6
	22-28	85	50	67	81	48	64	+ 3
	29- 4	84	49	66	88	48	68	+ 5
Aug.	5-11	86	50	69	93	52	73	+ 9
	12-18	83	47	65	83	50	66	+10
	19-25	82	47	65	71	44	58	+ 3
	26- 1	80	44	63	73	42	57	- 3
Sept.	2- 8	80	44	62	82	41	62	- 3
	9-15	74	39	57	84	39	61	+ 1
	16-22	69	37	53	77	38	58	+ 6
	23-29	69	37	53	77	44	60	+13
	30- 6	70	35	53	74	35	55	+15
Oct.	7-13	67	34	51	64	25	44	+ 8
	14-20	62	29	45	62	29	46	+ 9
	21-27	62	32	47	66	29	47	+ 9
Mean		72	40	56	73	40	57	

1/ Accumulated difference between 1990 and 10-year mean weekly temperatures

Table 2. Weekly minimum temperatures and percent of days with frost for 1990 and the 10-year period from 1980 to 1989 at Klamath Falls, OR.

Weekly Period		Weekly Minimum 1980-89	Weekly Minimum 1990	Frost Days/Week 1980-89	Frost Days/Week 1990
		------- °F ------		------ % ------	
April	1- 7	11	23	77	57
	8-14	17	23	67	71
	15-21	17	35	50	0
	22-28	21	25	57	28
	29- 5	22	23	36	43
May	6-12	22	24	47	71
	13-19	19	25	36	86
	20-26	24	32	17	28
	27- 2	27	27	19	28
June	3- 9	28	33	7	0
	10-16	29	29	3	14
	17-23	33	37	0	0
	24-30	31	43	1	0
July	1- 7	33	38	0	0
	8-14	35	49	0	0
	15-21	36	51	0	0
	22-28	40	40	0	0
	29- 4	39	45	0	0
Aug.	5-11	37	48	0	0
	12-18	34	46	0	0
	19-25	36	43	0	0
	26- 1	32	37	1	0
Sept.	2- 8	31	37	1	0
	9-15	29	35	11	0
	16-22	24	36	19	0
	23-29	26	39	24	0
	30- 6	20	20	26	28
Oct.	7-13	18	20	33	86
	14-20	20	18	76	57
	21-27	20	24	57	71

Table 3. Weekly and accumulated precipitation for 1990 and the 10-year period from 1980 to 1989 at Klamath Falls, OR.

Weekly Period		1980 - 1989 Weekly	1980 - 1989 Accumulation	1990 Weekly	1990 Accumulation
		Precipitation, inches			
April	1- 7	.13	.13	.00	.00
	8-14	.13	.26	.00	.00
	15-21	.15	.41	.39	.39
	22-28	.19	.60	.64	1.03
	29- 5	.19	.79	.00	1.03
May	6-12	.15	.94	.00	1.03
	13-19	.15	1.09	.00	1.03
	20-26	.11	1.20	1.31	2.34
	27- 2	.22	1.42	.97	3.31
June	3- 9	.27	1.69	.03	3.34
	10-16	.15	1.84	.03	3.37
	17-23	.06	1.90	.06	3.43
	24-30	.11	2.01	.00	3.43
July	1- 7	.03	2.04	.00	3.43
	8-14	.02	2.06	.07	3.50
	15-21	.17	2.23	.38	3.88
	22-28	.06	2.29	.00	3.88
	29- 4	.10	2.39	.00	3.88
Aug.	5-11	.03	2.42	.22	4.10
	12-18	.02	2.44	.49	4.59
	19-25	.11	2.55	.54	5.13
	26- 1	.21	2.76	.09	5.22
Sept.	2- 8	.12	2.88	.00	5.22
	9-15	.14	3.02	.00	5.22
	16-22	.40	3.42	.00	5.22
	23-29	.19	3.61	.42	5.64
	30- 6	.06	3.67	.00	5.64
Oct.	7-13	.21	3.88	.00	5.64
	14-20	.07	3.95	.09	5.73
	21-27	.33	4.28	.10	5.83

Table 4. Weekly and accumulated pan evaporation for 1990 and the 10-year period from 1980 to 1989 at Klamath Falls, OR.

Weekly Period		1980 - 1989 Weekly	1980 - 1989 Accumulation	1990 Weekly	1990 Accumulation
		---------- Pan Evaporation, inches			----------
June	10-16	1.94	1.94	1.97	1.97
	17-23	2.27	4.21	2.17	4.14
	24-30	2.16	6.37	2.07	6.21
July	1- 7	2.13	8.50	2.09	8.30
	8-14	2.29	10.79	1.95	10.25
	15-21	2.28	13.07	2.35	12.60
	22-28	2.29	15.36	2.14	14.74
	29- 4	2.18	17.54	2.32	17.06
Aug.	5-11	2.28	19.82	2.15	19.21
	12-18	2.16	21.98	1.74	20.95
	19-25	1.93	23.91	1.34	22.29
	26- 1	1.79	25.70	1.34	23.63
Sept.	2- 8	1.65	27.35	1.74	25.37
	9-15	1.52	28.87	1.60	26.97

Sugarbeet Variety Trial

K.A. Rykbost, and R.L. Dovel[1]

INTRODUCTION

Holly Sugar Corporation has introduced sugarbeets to the Klamath Basin. The beets are processed in Hamilton City, California. In 1990, approximately 1,000 acres were grown in the area. This is expected to increase to 5,000 acres in 1991 and possibly to 12,000 - 15,000 acres within three to four years.

Transportation of the crop by rail to the processing site will be a major cost factor in determining the feasibility of beet production in the basin. A high sugar content will be very important to the success of this venture. A limited number of commercially available sugarbeet varieties were evaluated at the Tulelake Field Station in 1988 and 1989 to determine yield and sugar content on organic soils typical of the southern portion of the basin. In 1990, an experiment was conducted at the Klamath Experiment Station to evaluate 12 varieties on sandy soils.

METHODS

The soil was fumigated with Telone II, shanked in at 18-inch spacing and 16-inch depth on April 25, at a rate of 15 gallons/acre (gpa). A broadcast application of 600 lbs/A of 16-16-16 fertilizer was disced in and the seedbed was compacted with a brillion roller on May 9. Twelve varieties were planted in a randomized complete block design with four replications on May 10. Seed was planted at approximately one-half inch depth at six to eight seeds/foot with a hand operated planet-junior type planter in 22-inch rows. Individual plots were two rows, 25 feet long.

Stands were hand-thinned to approximately eight-inch plant spacing on June 15. An application of Betamix herbicide on June 25 at 6 pints/A did not provide adequate weed control. Hand weeding was done periodically as needed. A flea beetle infestation was effectively controlled with an application of Diazinon on June 8. The crop received a total of 16 inches of irrigation water with solid-set sprinklers and approximately 4.5 inches of rainfall during the growing season. Ammonium-nitrate (75 lbs N/A) was broadcast and irrigated in on July 11.

Beets were hand-harvested on October 10 and October 25. At each date 12.5 feet of both rows were sampled. All beets from one row of each plot were weighed, placed in sample bags, and delivered to Holly Sugar Corporation for

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1/ Superintendent/Associate Professor, Assistant Professor, Klamath Experiment Station, OR.

determination of tare and sugar content. Beets from the second row were weighed and discarded. Tare weights were applied to field weights to calculate average yields from both rows.

Crop values were calculated for plots individually, using sugar price values, including sugar content incentive bonuses, as described in the Holly Sugar Corporation contract. All yield, sugar content, and crop value data were analyzed using MSU Stat software. The data was analyzed as a split-plot design. Harvest date was assigned as main-plots and varieties as split-plots.

RESULTS AND DISCUSSION

Plants emerged quite uniformly six days after planting. Minor flea beetle damage was the only early season problem observed. Crop vigor was excellent throughout the season until a minor powdery mildew infection occurred in mid-September. The first fall frost occurred on October 6. With a minimum temperature of 20°F persisting for two hours, the crop experienced severe desiccation during this frost. However, further foliage growth did occur.

Frost injury to emerging seedlings presents a risk of significant concern for this crop in the Klamath Basin. In 1990, approximately 30 percent of the commercial crop was replanted, with frost damage the most common reason. At this site, with seedlings emerging from May 16 on, there was no apparent damage although minimum temperatures of 25, 28, 27, 29, 28 and 27°F were observed on May 13, 14, 15, 16, and 18, and June 1, respectively. There were no noticeable differences between varieties in tolerance to these frosts.

Plant populations were very uniform for all entries (Table 1) and were not a factor in variety performance. First-harvest yields ranged from 20.9 to 26.5 tons/A, averaging 23.5 tons/A. A 15-day delay in harvest date resulted in a significant average yield increase of 1.7 tons/A. Only three entries; HH 59, Beta 1996, and ACH 177, failed to achieve a yield increase of at least 1.0 ton/A between harvest dates. Monohikari experienced the largest yield increase between dates of harvest and achieved the highest average yield. Average yields were not significantly different between Monohikari, Beta 1996, ACH 203, and HH 55. The yields of HH 50, HH 59, HH 44, ACH 190, and ACH 177 were significantly lower than those of the high yielding group.

Sugar contents ranged from a low of 16.0 percent to a high of 18.2 percent. On average, sugar content did not change between harvest dates. Sugar content declined in HH 55 and HH 59, increased in Monohikari, ACH 190, and Mar 865, and remained about the same in the other varieties. Monohikari clearly benefitted the most from delayed harvest, with substantial increases in both yield and sugar content.

The sugar yield parameter (Table 2) combines effects of yield and sugar content to provide a single measure of performance. Monohikari and Beta 1996 were significantly higher than all other entries except ACH 203, in total sugar produced, averaged over both harvests. Low sugar yield was clearly noted for HH 59 and ACH 190.

Crop values (Table 2) were derived from sugar yield and the sliding scale contract price for sugar. The scale provides significant incentives for high sugar content. Values shown are gross in-field figures which do not account for costs associated with production, harvesting, or transportation of the crop. Value of the crop increased significantly between harvest dates. Individual varieties responded quite differently. Monohikari achieved the greatest increase while several varieties experienced only minor changes in value.

The cost of producing, harvesting, and transportation of sugarbeets in the Klamath Basin for processing in Hamilton City, California has been estimated to range from $500 to $800/A. The results of this trial suggest that all varieties tested would have realized a profit for growers. The average result represents a net return to growers of nearly $400/A assuming costs in the $800/A range.

The only disease problem observed in this trial was powdery mildew. If sugarbeets become a major crop in the area, curly top virus is likely to become important. While the results of this trial indicated Monohikari and Beta 1996 were superior to all other entries, both of these varieties are quite susceptible to curly top virus. Disease susceptibility and disease pressure will be important considerations in variety selection for the region.

CONCLUSIONS

The initial experience with commercial scale sugarbeet production in the Klamath Basin was very encouraging. The average production from all contracted acreage was over 21 tons/A with an average sugar content slightly below 17 percent. The two best commercial fields produced 28.5 tons/A. This experiment demonstrated varietal differences of sufficient magnitude to justify expansion of variety testing. Monohikari produced high yields and sugar in both mineral (Klamath Falls) and organic (Tulelake) soils, in the absence of serious disease pressure.

The HH 55 variety represented the majority of commercial production in 1990. It performed reasonably well in both soil types. However, the importance of high sugar content for efficiencies in transportation, and the low sugar content observed in HH 55 in this trial, suggest that this probably is not the ideal selection for the Klamath Basin.

The commercial experience with sugarbeets has indicated several areas of cultural management which will require research. Weed control, planting date, water management, fertilization, particularly in relation to minor elements and sulfur, and plant population need investigation. The crop appears to hold considerable promise for the area.

Table 1. Summary of 1990 Sugarbeet Variety Trial at the Klamath Experiment Station. OR.

Entry No.	Variety	Plant Population (plants/A)	Yield First harvest	Yield Second harvest	Yield Average[1]	Sugar First harvest	Sugar Second harvest	Sugar Average[1]
			---------- tons/A	----------		------------ %	------------	
1	HH 55	32,200	24.9	26.4	25.6 efg	16.7	16.0	16.3 a
2	HH 50	33,500	22.4	24.1	23.2 abcd	17.1	17.2	17.1 bc
3	HH 59	32,400	21.3	21.4	21.3 a	17.5	16.8	17.1 bc
4	HH 44	32,900	21.8	23.5	22.7 abc	17.4	17.3	17.3 bcd
5	Monohikari	34,200	25.9	29.2	27.6 g	17.6	18.2	17.9 d
6	Beta 1996	34,800	26.5	27.2	26.9 fg	17.4	17.7	17.5 cd
7	ACH 190	34,600	20.9	23.9	22.4 ab	16.1	17.3	16.7 ab
8	ACH 191	33,900	23.5	25.1	24.3 bcde	17.2	17.3	17.2 bcd
9	ACH 203	29,100	25.5	26.5	26.0 efg	17.1	17.0	17.0 abc
10	ACH 177	34,500	22.0	22.5	22.3 ab	17.6	17.6	17.6 cd
11	Mar 865	33,300	23.6	26.2	24.9 def	16.7	17.4	17.0 abc
12	Mar 875	33,900	23.2	25.8	24.5 cde	17.7	17.3	17.5 cd
	Average	33,300	23.5	25.2	24.3	17.1	17.2	17.2
	CV(%)							
	Variety				8.6			4.4
	Harvest Date				10.1			2.4
	LSD(.05)							
	Variety				2.1			0.76
	Harvest Date				1.6			NS

1/ Means not followed by a common letter are significantly different at the 95 percent probability level.

Table 2. Summary of 1990 Sugarbeet Variety Trial at the Klamath Experiment Station, OR.

Entry No.	Variety	Sugar Yield: First harvest	Sugar Yield: Second harvest	Sugar Yield: Average[1]	Crop Value: First harvest	Crop Value: Second harvest	Crop Value: Average[1]
		cwt/A			$/A		
1	HH 55	82.8	84.4	83.6 bcd	1156	1163	1160 bc
2	HH 50	76.3	82.6	79.4 abc	1074	1163	1118 ab
3	HH 59	74.3	72.3	73.3 a	1052	1014	1033 a
4	HH 44	75.8	81.2	78.5 abc	1072	1147	1110 ab
5	Monohikari	91.0	106.6	98.8 f	1293	1530	1411 e
6	Beta 1996	92.1	96.1	94.1 ef	1305	1366	1335 de
7	ACH 190	67.0	82.4	74.7 a	923	1164	1043 a
8	ACH 191	80.8	86.5	83.6 bcd	1138	1222	1180 bc
9	ACH 203	87.1	89.3	88.2 de	1225	1252	1238 cd
10	ACH 177	77.3	79.1	78.2 ab	1099	1122	1111 ab
11	Mar 865	78.9	90.5	84.7 bcd	1104	1279	1191 bc
12	Mar 875	82.0	89.3	85.7 cd	1166	1263	1214 bc
	Average	80.5	86.7	83.6	1134	1224	1179
	CV (%)						
	Variety			8.8			9.3
	Harvest Date			9.7			9.8
	LSD(.05)						
	Variety			7.3			110
	Harvest Date			5.3			75

1/ Means not followed by a common letter are significantly different at the 95 percent probability level.

Alfalfa Variety Trial
Klamath Experiment Station

R.L. Dovel and J. Rainey[1]

INTRODUCTION

Alfalfa varieties were evaluated for persistence and yield to help producers identify appropriate varieties for production in the Klamath Basin. Yield and persistence will be monitored over a five-year period.

PROCEDURES

Plots were established in August 1986. The trial consists of 48 released and experimental alfalfa varieties arranged in a randomized complete block design with four replications. Soil samples from the plots were analyzed and the appropriate fertilizer applied prior to planting. A tank mix of EPTC and benefin was applied prior to planting at 3 and 1.2 lb active ingredient (ai)/A, respectively. Immediately after application the herbicide was disk incorporated. Seed was drilled to a depth of 1/4 inch at a rate of 20 lbs/A using a modified Kincaid drill. Plots were 5 x 30 feet with 5-foot borders and alleyways. Alfalfa was sprinkler irrigated with a solid set system.

The plants were allowed to grow uncut through the first growing season. Alfalfa was harvested in 1987, 1988, 1989, and 1990 when plants reached early bud. Plots were harvested using a flail harvester with a three-foot-wide head. All yields are reported on a dry weight basis.

RESULTS AND DISCUSSION

Many very good, high-yielding alfalfa varieties are currently available. Little difference in yield was seen between the majority of varieties grown. Varieties that yielded significantly higher than Vernal include eleven varieties averaging 6.4 tons/A or greater over the four years of this study. There was no significant decline in forage yield of any variety by the third year (Table 1). However, due to severe spring frost in 1990, yields declined from an average of 6.9 tons/A in 1989 to 4.9 tons/A in 1990. This is probably a temporary depression in yield as plant stands did not appear to be affected.

Most of the varieties tested are well adapted to the Klamath Basin; however, if stands are expected to last past three to four years, further testing is required.

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Acknowledgments: Appreciation is expressed to the following companies for financial support for this trial: Allied Seed, DeKalb Seed, North American Plant Breeders, Northrup King Co., Pioneer Hi-Bred International, Plant Genetics, Union Seed Co., W-L Research.

Table 1. Alfalfa Variety Trial Summary 1987-1990. Forage yield summaries of 48 alfalfa varieties from 1987 to 1990. Plots were established in the fall of 1986 at the Klamath Experiment Station, OR.

	Entry	Yield 1987	1988	1989	1990	Avg.
		tons/A				
1	PB 5444	6.5	6.8	7.1	4.9	6.3
2	PB 526	6.3	6.7	7.5	5.5	6.5
3	PB 532	5.9	6.6	7.3	5.0	6.2
4	PB 5432	6.5	6.7	7.2	5.3	6.4
5	Brute Brand	6.0	6.1	6.6	4.2	5.7
6	Max 85 Brand	6.0	6.7	6.9	4.8	6.1
7	Mission 123	6.3	6.0	6.7	4.9	6.0
8	Commander	6.5	6.7	7.2	5.0	6.4
9	Pike	6.3	6.3	7.1	4.2	6.0
10	Drummor	6.4	6.8	7.1	4.9	6.3
11	NK 83580	6.5	6.5	6.7	5.0	6.2
12	NK 83632	6.0	6.5	6.8	4.7	6.0
13	Phytor	6.4	6.5	7.0	4.1	6.0
14	Spreador II	6.0	6.1	6.7	5.0	6.0
15	WL 225	6.4	6.7	7.4	5.2	6.4
16	WL 315	6.6	6.8	7.5	5.3	6.6
17	WL 316	6.1	6.3	6.5	4.8	5.9
18	WL 320	6.7	6.8	6.5	4.9	6.3
19	83-2	6.0	6.4	7.1	5.1	6.2
20	GT 58	6.4	6.2	6.9	4.6	6.0
21	Apollo II	5.9	6.5	6.7	5.0	6.1
22	Arrow	6.6	6.6	7.0	5.4	6.4
23	Armor	5.8	6.2	7.0	5.4	6.4
24	Thunder	5.9	6.5	6.8	4.9	6.0
25	Peak	6.3	6.5	6.9	5.1	6.2
26	Blazer	6.0	6.4	7.0	4.6	6.0
27	Epic	6.1	6.6	7.3	5.3	6.4
28	Sparta	6.4	6.9	7.0	4.7	6.3
29	RS 3309	6.2	6.5	7.3	5.0	6.3
30	Excalibur	6.4	6.8	7.2	5.2	6.4
31	Centurion	6.7	6.5	6.9	4.7	6.2
32	Flint	5.8	6.2	6.8	4.9	6.0
33	York	6.0	6.4	6.8	4.8	6.0
34	Vortex	6.3	6.8	7.1	5.3	6.4
35	Sutter	5.6	5.9	6.3	4.6	5.6
36	Vector	6.7	6.7	7.0	5.1	6.4
37	DK 120	6.4	6.6	6.8	4.8	6.2
38	DK 135	6.0	6.5	6.8	4.7	6.0
39	Vernal	6.0	6.0	6.7	4.8	5.9
40	Guardian	5.9	6.5	6.9	5.2	6.1
41	Sentinel	5.9	6.2	6.3	5.0	5.8
42	Sentry	6.0	6.3	6.9	5.0	6.1
43	Atra 55	6.0	6.5	7.0	5.2	6.2
44	Ranger	6.5	6.7	7.0	5.1	6.3
45	Nomad	5.4	6.1	6.3	4.3	5.5
46	Rambler	6.2	6.5	6.9	4.4	6.0
47	Iroquois	6.3	6.9	7.4	5.5	6.6
48	Lahontan	6.0	6.2	7.0	4.6	6.0
	Mean:	6.2	6.5	6.9	4.9	6.1
	CV (%)	7.0	5.9	7.1	7.2	7.1
	LSD (0.05)	0.6	0.5	0.7	0.5	0.4

Pasture Grass Variety Trials

R.L. Dovel and J. Rainey[1]

INTRODUCTION

Irrigated pastures are grown on over 95,000 acres in Klamath County and provide summer grazing for over 100,000 cattle. The currently recommended grass variety for irrigated pastures is Alta tall fescue, which was released in the late 1940's. New cultivars developed since that time need to be assessed for adaptation to the Klamath Basin. The acquisition of new germplasm from forage breeding programs in New Zealand and Australia add further emphasis to the development of a forage variety screening program in the Klamath Basin.

Two variety trials were established in August, 1988 to examine the relative forage production of commercially available tall fescue and orchardgrass varieties. Another trial was established examining hybrids of bluebunch wheatgrass and quackgrass compared to a locally acquired selection of quackgrass. A substantial acreage of quackgrass is grown as hay or pasture in the Klamath Basin. The identification of a less weedy hybrid that is better adapted to both hay and pasture production could be very beneficial.

PROCEDURES

Trials were established on sandy mineral soil at the KES in August, 1988. All trials were arranged in a randomized complete block design with four replications. Soil samples were analyzed and appropriate fertilizer was applied prior to planting. Seed was drilled to a depth of 1/4 inch using a modified Kincaid plot drill. Orchardgrass was seeded at a rate of 15 lbs/A. Tall fescue varieties were seeded at 12 lbs/A. Quackgrass-bluebunch wheatgrass selections and crosses were seeded at a rate of 10 lbs/A. Plots were 5 x 20 feet with 3-foot wide alleyways. Plants were irrigated by solid set sprinklers.

The plants were allowed to grow uncut through the first growing season. Three harvests were taken in 1989 and 1990 when plants began to flower. Plots were harvested with a flail harvester. All yields are reported on a dry weight basis. Quality samples were collected in 1990 and analyzed for acid detergent fiber (ADF) and crude protein (CP).

RESULTS AND DISCUSSION

Tall Fescue

Tall fescue had the best seedling vigor of the grass species established in 1988. All varieties established well and tended to out-compete most weeds, with the notable exception of several mustard species. Average yield of tall

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fescue was higher than any other forage grass (Tables 1-3). It also appears that forage yield of this species is less dependent on N fertilization than orchardgrass. There was no significant difference in total forage yield between tall fescue cultivars in either 1989 or 1990. Tall fescue is the recommended grass species for irrigated pastures due to ease of establishment, forage production, weed suppression, and stand longevity. There was no difference in CP between tall fescue cultivars; however, ADF values of Tandem were significantly lower than all other varieties.

Quackgrass-Bluebunch Wheatgrass

All entries in this trial established well. They showed lower seedling vigor than tall fescue but were more vigorous than orchardgrass varieties. The local selection of quackgrass was the lowest yielding entry in the trial (Table 2). The highest yielding entry, RS MC87, is a cross of quackgrass and bluebunch wheatgrass, which may soon be released. This variety was bred for dryland conditions but yielded well in this irrigated trial. It has a more upright growth habit than quackgrass and a more bunch type growth habit similar to bluebunch wheatgrass. The yield of this variety was roughly equal to the average orchardgrass yield in an adjacent trial (Tables 2 and 3). Further testing is needed to confirm the adaptation of these new varieties to Klamath Basin dryland and irrigated sites; however, it is possible that RS MC87 will be a high-yielding variety for irrigated sites that also tolerates dryland conditions.

There was no difference in quality between entries in this trial. It is interesting to note that forage quality of all entries in this trial were superior to all timothy, tall fescue, and orchardgrass varieties tested at KES. Average ADF values were lower than improved species, indicating higher digestibility, and CP values were higher.

Orchardgrass Variety Trial

Although Orion produced significantly higher yields than all other entries in 1989, this trend did not continue in 1990 (Table 3). The only entry with consistently high yields in both years was Latar. Wana, a variety introduced from New Zealand, produced significantly less forage than any other entry in the trial in 1990.

There were slight, yet statistically significant, differences in forage quality between varieties. Latar, the highest yielding variety, had the highest ADF and lowest CP values. In contrast, Wana, the lowest yielding entry, had the lowest ADF and highest CP values. This indicates that differences in quality were probably due to differences in the stage of growth of these varieties at harvest.

Table 1. **Tall Fescue Variety Trial.** Summary of forage yield and quality of tall fescue varieties established in the fall of 1988 at the Klamath Experiment Station, OR.

Entry	Yield 1989	Yield 1990	Yield Avg.	Forage Quality ADF	Forage Quality Protein
	lbs/A			%	
Fawn	14,750	7,460	11,110	40.9	9.5
Alta	14,640	7,520	11,080	40.9	8.8
Kentucky 31	16,100	7,430	11,760	39.4	9.7
Tandem	15,480	5,810	10,640	38.2	9.1
Festorina	14,430	6,660	10,540	39.6	9.7
Johnstone	14,280	7,490	10,880	39.4	9.7
Forager	15,520	8,350	11,940	40.4	9.6
Phytor	15,420	7,450	11,440	40.0	8.7
Mean:	15,080	7,270	11,170	39.9	9.4
LSD (0.05)	(NS)	(NS)	(NS)		
CV (%)	8	18	12		

Table 2. **Quackgrass - Bluebunch Wheatgrass Variety Trial.** Summary of forage yields and forage quality of two quackgrass - bluebunch wheatgrass hybrids and quackgrass lines established in the fall of 1988 at the Klamath Experiment Station, OR.

Entry	Yield 1989	Yield 1990	Yield Avg.	Forage Quality ADF	Forage Quality CP
	lbs/A			%	
RS MC87	9734	7050	8393	36.9	12.5
RS E87	8263	6657	7461	37.1	13.5
RS Hoffman	8572	7003	7788	36.3	13.7
Klamath Basin Selection	6862	5064	5964	37.2	13.7
Mean	8358	6444	7401	36.9	13.4
CV (%)	15	18	16		
LSD (0.05)	1957	1859	1253		

Table 3. Orchardgrass Variety Trial. Summary of forage yield and quality of ten orchardgrass varieties established in the fall of 1988 at the Klamath Experiment Station, OR.

Entry	Yield 1989	Yield 1990	Yield Avg.	Forage Quality ADF	Forage Quality CP
	lbs/A			%	
Latar	11,740	9,302	10,520	42.4	9.5
Kara	9,277	7,180	8,229	41.6	10.1
Rancho	9,791	8,796	9,294	40.3	10.4
Able	8,751	7,150	7,951	39.8	11.0
Wana	8,421	5,874	7,148	39.0	13.3
Patomic	10,600	7,086	8,844	40.1	10.3
Benchmark	11,680	8,461	10,070	40.9	10.5
Comet	12,110	7,765	9,937	39.9	9.7
Orion	16,140	8,347	12,250	41.5	9.8
Crown	8,847	9,288	9,068	40.5	11.0
Mean:	10,740	7,925	9,331	40.6	10.6
CV (%)	13	14	14	2.4	6.6
LSD (0.05)	2,076	1,573	1,273	1.4	1.0

Timothy Variety Trial

R.L. Dovel and J. Rainey[1]

INTRODUCTION

Timothy is a short-lived perennial forage grass that is in high demand for high quality hay. The development of specialty markets in the race horse industry has driven prices to levels that are in excess of alfalfa hay prices. There is an increasing interest in timothy hay in the Klamath Basin yet little variety yield data is available for prospective producers. This trial was established to compare the relative yield potential of various commercially available timothy varieties in the Klamath Basin.

PROCEDURES

Plots were established in August 1988. The trial consists of ten commercially available Timothy varieties arranged in a randomized complete block design with four replications. Soil samples from the plots were analyzed and appropriate fertilizer applied prior to planting. Seed was drilled to a depth of 1/4 inch or greater using a modified Kincaid drill at a rate of 4 lbs/A. Plots were 5 x 20 feet with a 3-foot alleyway. Water was supplied with a solid set sprinkler system. Plants were allowed to grow uncut through the first growing season. Three harvests were taken in 1989 and 1990 when plants started heading. Plots were harvested using a flail harvester with a 3-foot wide cutting head. All yields are reported on a dry weight basis.

RESULTS AND DISCUSSION

Establishment was poor due to deep planting. Timothy should be planted no deeper than 1/4 inch. It appears that seedling vigor of the various varieties was not the same since some varieties established much better than others in spite of the depth of planting.

Although Richmond had the highest yields in 1989, it was not an outstanding yielding variety in 1990 (Table 1). Clair was the second highest yielding entry in 1989 and the highest yielder in 1990, averaging 180 lbs/A more than Richmond over two years. Due to the importance of stand persistence in this crop, more emphasis should be placed on the second year yields.

There was little difference in digestibility, as measured by acid detergent fiber (ADF), between the entries in this trial. However, there were substantial differences in crude protein (CP) between varieties. Average CP value ranged from 7.6 to 10.4 percent. The two varieties with the highest CP were Basho and Climax, while Clair had the lowest value (Table 1).

Continued testing is required to develop any valid conclusions on the yield potential of these varieties in the Klamath Basin. However, the average yield across two years was in excess of four tons/A. At current market prices this yield would result in comparable or superior net profits/A to alfalfa hay.

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Table 1. Timothy Variety Trial. Summary of forage yield and quality of ten timothy varieties established in the fall of 1988 at the Klamath Experiment Station, OR.

Entry	Yield 1989	Yield 1990	Yield Avg.	Forage Quality ADF	Forage Quality Protein
	-------- lbs/A		-----------	----- (%)	------
Clair	11,920	9,331	10,620	40.1	7.6
Drummond	8,393	6,268	7,331	40.2	9.2
Timflor	9,838	6,980	8,409	41.6	8.7
Mariposa	10,970	7,122	9,046	40.4	8.3
Richmond	12,210	8,666	10,440	41.4	7.5
Bounty	9,085	6,980	8,032	39.3	10.0
Basho	7,805	8,379	8,092	39.4	10.4
Climax	8,042	8,155	8,098	40.2	10.4
Champ	9,816	6,525	8,171	40.0	8.5
Salvo	11,000	8,075	9,539	40.1	9.1
Mean:	9,908	7,648	8,778	40.3	9.0
LSD (0.05)	1,777	954	972	1.1	1.3
CV (%)	12	9	11	1.8	9.7

Wetland Meadow Forage Management

R. L. Dovel and J. Rainey[1]

INTRODUCTION

Wetland meadows occupy over 95,000 acres in Klamath County and provide summer grazing for over 100,000 cattle each year. The major native species encountered in such sites include tufted hairgrass (*Deschampsia caespitosa*), Kentucky blue grass (*Poa pratensis*), meadow foxtail (*Alopecurus pratensis*), Nebraska sedge (*Carex nebraskensis*), *Carex nigricans*, and Lieburg bluegrass (*Poa lieburgi*). Many of these species are found throughout Oregon and the entire Northern United States in wetland meadows; however, little information on the productivity, quality, or management of many of these species is available.

Virtually all beef ranchers grazing wetland meadows in Southern Oregon practice set stock grazing. The species composition of many wetland meadows has been altered due to heavy continuous grazing. Less palatable species such as various rushes and sedges, meadow barley, mat muhly, and foxtail barley, have increased under heavy grazing pressure. This shift in species composition can adversely affect both forage production and forage quality. Forage produced in a sedge-dominated wetland meadow had protein levels of 13 percent on May 19; yet, by mid-June forage protein content had dropped to 8.7 percent which is below the nutrient requirements for steers and lactating cows. By September, forage protein content from the same pasture dropped to 6.9 percent, which is only marginally adequate for dry cows.

Animal performance on these meadows is also hampered by extreme variability in forage production with season and declining forage quality with age. Dry-matter production on these meadows reaches a peak in early July then declines rapidly through August and September. If meadows are stocked at rates high enough to efficiently harvest the vigorous early season growth and not allow rank dead vegetation to accumulate, then slow late-season forage production results in overgrazing and poor animal performance. Animal production and the condition of desirable native meadow species both suffer under such a system. Improved grazing management to prevent the accumulation of low-quality forage and to maintain desirable species in the sward could greatly increase the productivity of these wetland meadows and provide a more ecologically sound management alternative.

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Acknowledgments: Land and irrigation management were provided by the Rock Creek Ranch.

Intensive grazing management has improved overall productivity, efficiency, and profitability in New Zealand. The use of intensive grazing management has also allowed the maintenance of high-quality, highly palatable species in the sward, even with heavy utilization. One requirement for intensive grazing management is a knowledge of forage growth rates. Knowledge of growth rates in the spring and the time of onset of growth for different forage species is critical in strategic planning to reduce hay feeding.

Regrowth following clipping or grazing is dependent on various environmental and management parameters. The amount of forage left after grazing or clipping greatly affects regrowth. Residual dry matter (RDM) is not easily measured by the producer; however, height is closely related to RDM and is easily measured by cattlemen and ranchers.

A clipping study was initiated to determine the productivity and quality of the major forage species in three wetland meadow plant associations.

PROCEDURES

Three wetland meadow associations were identified along a moisture gradient. The bluegrass/clover association occupied the driest location and plants experienced moisture stress before the other associations. The mixed grass/sedge association was in an alternating flooded/dry situation which allowed growth of the grass species to continue when the bluegrass/clover associations were too dry to support active growth. The sedge association was almost continually flooded or very moist allowing growth to continue even when the grass/sedge association had ceased growth due to moisture stress. Thus, yields reflect not only the relative yield potential of the species present, but also the effects of the moisture regime in which they are growing.

Plots were established within a livestock exclosure. Three cutting heights (2, 4 and 6 inch) were imposed. The RDM left by each cutting height was determined by clipping a 1-m^2 quadrate to ground level. Plots were harvested and forage weighed monthly throughout the growing season. Forage quality was assessed by determining crude protein (CP) content and acid detergent fiber (ADF) content.

The relative forage production and quality of continuously grazed versus simulated rotationally grazed swards (clipped) was evaluated using exclusion cages. Accumulated forage mass was determined prior to protecting a section of continuously grazed sward with a 1-m^2 cage. After one week the cage was removed and the forage mass determined. This allowed an estimate of the pasture growth rate for that week. The cage was then moved to a previously unprotected site and the process repeated.

RESULTS AND DISCUSSION

The mixed grass/sedge association was the highest yielding association in the trial. This is probably due to having a more favorable location for growth (less prone to moisture stress) than the bluegrass/clover association and having a greater yield potential than the sedge species. It may also be that the flooded conditions often present in the sedge association locations impeded growth due to anoxia.

The bluegrass/clover and sedge associations produced similar yields at the two and four inch cutting heights. However, yields of the sedge association fell significantly below that of the bluegrass/clover association when cut at a height of six inches (Figure 1).

Cutting height significantly affected yields of all three plant associations in this study. Yields decreased as cutting height was raised (Figure 1). Raising the cutting height from two to six inches cut total forage yields in half in the sedge and mixed grass/sedge association. Reduction in total forage produced by the Bluegrass/clover association was not as drastic.

The majority of total forage produced for all associations was harvested in the June cutting (Figure 2). Growth rates declined as the season advanced and yields in the July and August cuttings were less than half that seen in June. This is due in large part to the onset of moisture stress as the season advanced. In 1988 and 1990 drought stress was delayed until the third cutting in the two wetter association locations, and yields remained fairly high (Table 1). Yields dropped sharply at the third cutting due to moisture stress. In contrast, in 1989 moisture stress was evident by the second cutting and yields declined dramatically. Increased irrigation and lower than normal temperatures in August allowed for some recovery and higher growth rates late in 1989.

Cutting height did not significantly affect forage quality (ADF or CP content). The bluegrass/clover association had the lowest ADF content throughout the trial (Table 2). The sedge association had ADF value significantly higher than the other two plant associations in 1988 but dropped to levels significantly lower than the other two associations in 1989 and 1990 (Table 2). This is probably due to the removal of dead material in the first year of cutting. The sedge association was only grazed down to a 6-8 inch level prior to initiation of this experiment, resulting in an accumulation of older material which was low in quality. An ADF content of 40 percent in grasses corresponds to TDN levels in excess of 59 percent. Cows nursing calves only require feed with a TDN content of 55 percent. Dry cows only require feed with 52 percent TDN to perform well. Pregnant yearling heifers require feed with 58 percent TDN to gain 1.8 lbs per day. Yearling cattle require higher energy levels which are marginally provided by the associations in this trial, to gain over 1 lb per day.

The bluegrass/clover association had crude protein contents averaging roughly 3 percentage points higher than the other two plant associations in 1988. This is due largely to the clover component. After initiation of this study, the bluegrass component of this association was allowed to grow to taller levels before utilization and became more competitive, thus reducing the CP content of the sward. This can be seen in the lower CP content of the bluegrass/clover association in 1989 and 1990 (Table 3).

The mixed grass/sedge association had significantly higher crude protein contents than the sedge association; however, the crude protein content of the sedge association did not drop below 9.0 percent until the September 15 sampling date. This falls below requirements for growing finishing steers and heifers. However, crude protein requirements for all animal classes in a cow-calf operation, including pregnant yearling heifers and lactating cows of average milking ability, are below 9.0 percent. Thus, the sedge association could serve as the sole source in a cow-calf operation without nitrogen supplementation. It is more realistic to expect the sedge component to make up only a portion of the diet and higher protein associations would effectively raise the protein level of the diet to levels significantly higher than minimum requirements.

CONCLUSIONS

Optimal yields were obtained using the two inch cutting height in all associations. The two inch cutting height did not appear to reduce stand vigor or persistence as indicated by high yields in the third year of the study. Set stocking on the same meadow in which the study was conducted resulted in cutting heights which were extremely variable between associations. The bluegrass/clover association was grazed to levels below 1/2 inch quite early in the season and little regrowth was allowed due to continuous grazing pressure. The mixed grass/sedge association was grazed to heights ranging from one to six inches due to spot grazing. The sedge association was not grazed to levels below six inches. This is typical of forage utilization patterns in the Klamath Basin under set stocking. The bluegrass/clover association was over utilized while the sedge association was under utilized. The use of rotational grazing could control utilization of the various associations and could allow more time for recovery between grazing episodes than seen in set stocking.

The quality of the sedge association was slightly lower than the other two associations, but was adequate to furnish minimum nutritional requirements for a cow-calf operation or even pregnant yearling heifers. In combination with other associations in this study the sedge association had adequate quality to produce acceptable gains in stocker calves. The increase in forage quality of the sedge association from 1988 to 1989 indicates that removing older growth through proper grazing management will significantly increase both digestibility and CP content of the sedge association.

Figure 1. Cutting height effect on total forage yield of wetland plant associations. Average of 1988-1990 data.

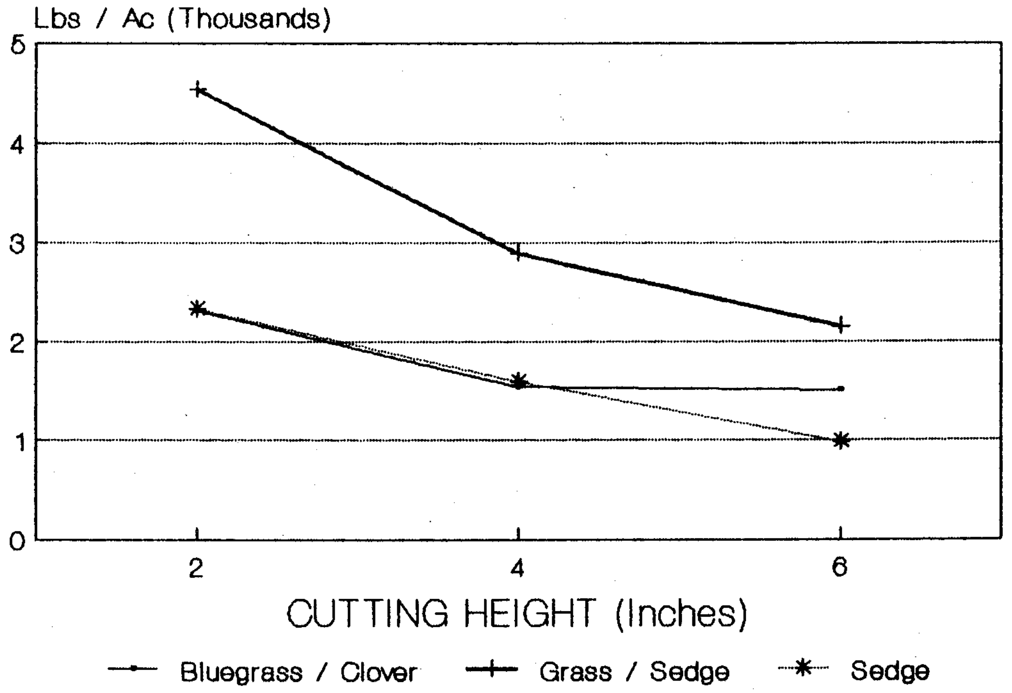

Figure 2. Average forage yields for wetland plant associations by cutting date. Average of 1988 and 1989 data.

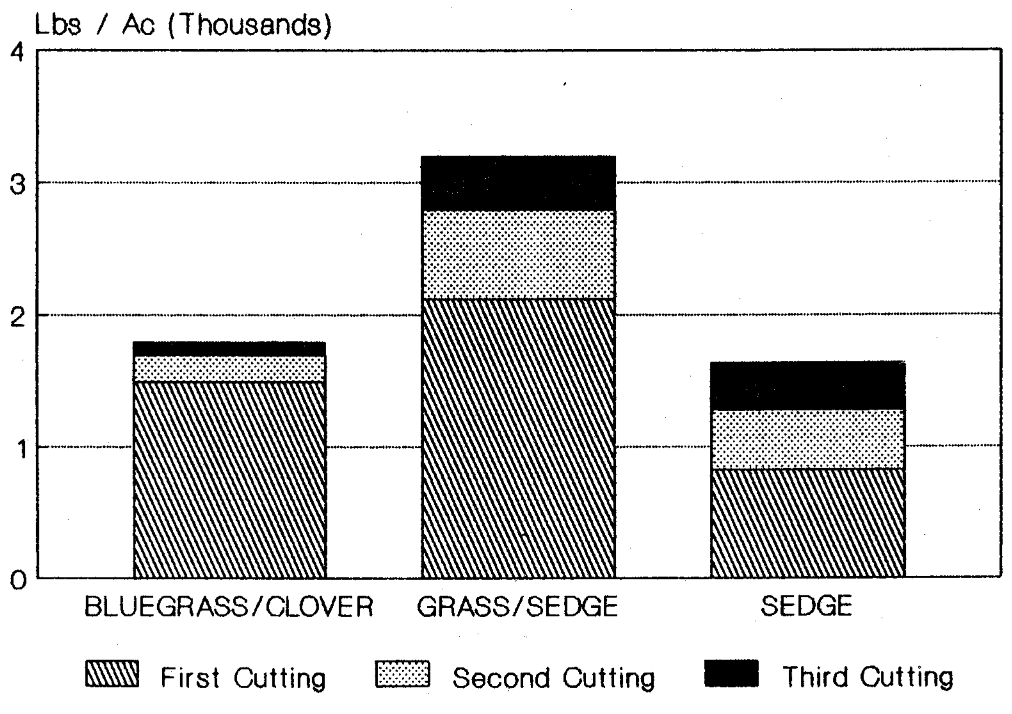

Table 1. Summary of Forage Yield - 1988-1990. Summary of forage yield of three wetland meadow associations in Klamath County, OR.

	Forage Yield			
	1988	**1989**	**1990**	**Avg.**
	---------- lbs/A ----------			
	----- **Bluegrass/Clover** -----			
First Cutting	1453	1582	1446	1494
Second Cutting	329	69	201	200
Third Cutting	70	83	125	93
Total Yield	1852	1734	1772	1787
	---- **Mixed Grass/Sedge** -----			
First Cutting	1689	1909	2757	2118
Second Cutting	1175	172	683	677
Third Cutting	200	590	405	398
Total Yield	3064	2671	3845	3193
	---------- **Sedge** -----------			
First Cutting	854	723	907	828
Second Cutting	739	205	425	456
Third Cutting	208	136	710	351
Total Yield	1801	1064	2042	1635

Table 2. **Summary of Acid Detergent Fiber 1988-1990.** Summary of acid detergent fiber content (ADF) of three wetland meadow associations in Klamath County, OR.

Association	Cutting	Year 1988	1989	1990	Avg.
		% ADF			
Bluegrass/Clover	1	33.4	31.8	32.2	32.5
	2	34.7	37.0	38.2	36.6
	3	37.6	39.9	42.1	39.9
	Mean	35.2	36.2	37.5	36.3
Mixed Grass/Sedge	1	36.0	34.0	35.9	35.3
	2	35.6	37.1	37.8	36.8
	3	40.1	37.9	36.2	38.1
	Mean	37.2	36.3	36.6	36.7
Sedge	1	41.2	32.3	32.4	35.3
	2	42.0	35.0	35.7	37.6
	3	41.5	36.7	35.8	38.0
	Mean	41.6	34.7	34.6	37.0

Table 3. **Summary of Crude Protein 1988-1990.** Summary of crude protein content (CP) of three wetland meadow associations in Klamath County, OR.

Association	Cutting	Year 1988	1989	1990	Avg.
		% CP			
Bluegrass/Clover	1	16.4	9.8	11.0	12.4
	2	16.1	10.2	13.5	13.3
	3	15.0	10.1	10.1	11.7
	Mean	15.8	10.0	11.5	12.5
Mixed Grass/Sedge	1	13.9	9.6	11.9	11.8
	2	11.2	14.8	16.0	14.3
	3	11.0	13.6	11.3	12.3
	Mean	12.0	12.7	13.1	12.6
Sedge	1	9.0	9.6	11.2	9.9
	2	9.6	11.7	13.5	11.6
	3	8.6	11.0	9.3	9.6
	Mean	9.1	10.8	11.3	10.4

Oat Hay Variety and Management Trial

R.L. Dovel, J. Rainey and G. Chilcote[1]

INTRODUCTION

Oat hay is of value in feeding both beef and dairy cattle. An increasing acreage of oat hay is being produced in the Klamath Basin. Little data have been collected locally on the relative hay yield potential of various oat varieties. Current varieties being grown for oat hay are those also being grown for grain production. A comprehensive variety trial examining the yield potential and quality of currently available varieties is needed to provide producers with a basis for selecting oat hay varieties.

Hay quality is affected both by variety and management. Management has greater impact on forage quality than variety selection. Currently, oat hay is generally cut at soft dough stage with the belief that seed set and grain formation will increase forage quality. This has not been found to be the case with other grass species. Delayed cutting and advanced maturity tends to lower forage quality; however, forage production does increase as the grass ages. This study was conducted to examine the effect of time of cutting on oat hay quality and yield, and to evaluate the relative yield potential of commercially available hay varieties in the Klamath Basin.

PROCEDURES

Twenty-two oat varieties and two barley varieties were grown in the variety trial in 1989 and 16 oat varieties and two barley varieties were grown in the trial in 1990. The trial was harvested at two distinct phenological stages, early boot and soft dough. Yield, crude protein (CP), and acid detergent fiber (ADF) were examined at both cutting dates.

The trial was established at the KES on fine sandy loam soil that was moderately deep but somewhat poorly drained. The plots were sprinkler irrigated weekly. The trial was arranged in a randomized complete block design with four replications. Seed was planted to the depth of 1 inch using a modified Kincaid plot drill. Seeding rate was 100 lbs/A. All plots were fertilized with 50 lbs N, 30 lbs P_2O_5 and 22 lbs S/A. Plots measured 5 x 20 feet with a row spacing of 6 inches. One-half of each plot was harvested at boot and soft dough growth stages. Growth stage was determined independently for each variety. Multiple harvests were made throughout the growing season to insure harvesting each variety at the appropriate phenological stage. Area harvested measured 3 x 8.5 feet. Plot weights were determined and subsamples taken for lab analysis of acid detergent fiber (ADF) and crude protein (CP).

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RESULTS AND DISCUSSION

Oat hay yields were quite variable across years. However, Winter Grey oats produced the highest amount of oat hay in both 1989 and 1990. Seed of several varieties which yielded well in 1989 was not obtained in 1990. The relative scarcity of seed from these lines would preclude their use on a commercial basis. The highest yielding varieties over the two-year period of this trial were Winter Grey, Montezuma, Corbit, and Park (Table 1). None of these varieties are currently grown for grain. They should only be planted for hay and have no dual-purpose potential. Cayuse, a variety commonly grown for grain in the Klamath Basin, ranked seventh in hay production over the two-year period and would be a viable dual-purpose variety. It is interesting to note that the two barley varieties included in the trial, Whitford and Westford, were among the lowest yielding entries. However, the barley varieties were also the earliest entries to be harvested (Table 2). If an early harvest is desirable, the use of one of these hooded barley varieties may be a viable option.

Only slight differences in crude protein content (CP) were seen between varieties. Crude protein decreased from an average of 13.3 percent when harvested at the boot stage to 8.9 percent when harvested at the soft dough stage (Table 4). Minimum CP levels required for pregnant yearling heifers is 8.9 - 9.0 percent and for pregnant mature cows is only 5.9 percent. The most common use for oat hay would be to winter feed reproductive stock. Clearly hay harvested at both stages has adequate protein levels for feeding both mature cows and pregnant heifers.

In general, forage quality declines over time. This was clearly seen in 1989 when ADF values of forage harvested at boot stage were significantly lower than for forage harvested at the soft dough stage (Table 3). Although there was no significant difference in ADF between the two harvested dates in 1990, the two-year average shows a clear decline in digestibility with time. Although quality decreased as harvest was delayed, ADF values of the hay harvested at soft dough stage still remained at acceptable levels to meet energy requirements for all but the most demanding livestock classes (i.e. growing, finishing steer calves and yearlings). Hay harvested at the boot stage was still not of sufficient quality to meet the needs of these higher demanding livestock classes. Hay harvested at the soft dough stage met the energy needs of pregnant yearling heifers above 700 lbs., dry and lactating beef cows, and bulls above 700 lbs.

SUMMARY AND CONCLUSIONS

It is interesting to compare the productivity and quality of oat hay with timothy hay. Averaged over two years, the Winter Grey oat variety, harvested at soft dough stage, achieved a yield of 6.8 tons/A of dry matter with ADF at 39.9 percent and CP at 8.6 percent. During the same two-year period the timothy variety Clair (see page 23) produced an average yield of 5.3 ton/A with 40.1 percent ADF and 7.6 percent CP. Clearly oat hay is a viable option as a forage crop for the region. The results over two years suggest that the gains in productivity by delaying harvest to the soft dough stage do not result in unacceptable losses in forage quality.

Table 1. Variety and Stage of Growth Effects on Oat Hay Yield. Summary of oat hay yields as affected by variety and stage of growth of spring oat varieties planted at the Klamath Experiment Station, OR.

		Forage Yield					
		1989		1990		Average	
Entry	Selection	Boot	Soft Dough	Boot	Soft Dough	Boot	Soft Dough
		tons dry matter/A					
1	Svea	2.3	6.3	3.2	4.6	2.8	5.4
2	Sierra	2.3	6.7	3.0	3.7	2.7	5.2
3	Cal Red	2.8	6.9	---	---	---	---
4	Cascade	2.8	5.5	---	---	---	---
5	Winter Grey	3.0	8.2	2.7	5.4	2.8	6.8
6	Kanota	3.1	6.7	3.1	2.0	3.1	4.9
7	Benson	1.4	5.3	3.1	5.0	2.3	5.2
8	Porter	2.1	5.7	---	---	---	---
9	Otana	2.3	6.5	2.6	4.3	2.5	5.4
10	Park	2.6	6.8	3.4	4.7	3.0	5.7
11	Ogle	1.6	4.9	2.6	4.3	2.1	4.6
12	Montezuma	2.9	7.9	2.7	3.8	2.8	5.9
13	Curt	1.6	5.4	---	---	---	---
14	Cayuse	3.0	6.3	3.1	4.5	3.1	5.4
15	Monida	2.7	6.0	3.3	4.2	3.0	5.1
16	Viking 765	2.5	6.6	3.3	4.3	2.9	5.5
17	Athabasca	3.2	6.0	---	---	---	---
18	Swan	1.6	4.9	2.8	4.1	2.2	4.5
19	Corbit	2.4	7.6	3.1	3.9	2.8	5.8
20	Moore	3.4	5.7	2.2	5.4	2.8	5.5
21	Stampede	2.3	7.5	---	---	---	---
22	Valley	2.7	5.3	3.2	4.6	3.0	4.9
23	Whitford	1.5	4.6	3.4	5.2	2.4	4.9
24	Westford	2.6	4.6	3.2	4.4	2.9	4.5
	Mean:	2.4	6.2	3.0	4.5	2.7	5.3
	CV (%)	31	19	20	19	25	20
	LSD (0.05)	1.1	1.7	0.8	1.2	0.7	1.0

Table 2. Variety and Stage of Growth Effects on Harvest Date. Summary of harvest date in Julian days (days from Jan 1) as affected by variety and stage of growth of spring oat varieties planted at the Klamath Experiment Station, OR.

		Harvest Date					
		1989		1990		Average	
Entry	Selection	Boot	Soft Dough	Boot	Soft Dough	Boot	Soft Dough
		Days from Jan. 1					
1	Svea	193	232	196	219	195	226
2	Sierra	188	230	191	217	190	224
3	Cal Red	205	240	---	---	---	---
4	Cascade	191	231	---	---	---	---
5	Winter Grey	205	249	214	227	209	238
6	Kanota	186	229	191	217	189	223
7	Benson	188	229	191	217	190	223
8	Porter	191	229	---	---	---	---
9	Otana	191	229	192	217	192	223
10	Park	191	231	195	217	193	224
11	Ogle	187	229	191	217	189	223
12	Montezuma	205	249	214	227	210	228
13	Curt	187	229	---	---	---	---
14	Cayuse	191	229	195	217	193	223
15	Monida	191	229	193	217	192	223
16	Viking 765	192	229	193	217	192	223
17	Athabasca	191	229	---	---	---	---
18	Swan	186	229	191	217	189	223
19	Corbit	190	229	194	217	192	224
20	Moore	191	229	193	217	192	223
21	Stampede	192	242	---	---	---	---
22	Valley	191	229	192	217	192	223
23	Whitford	186	222	191	205	189	214
24	Westford	195	226	192	205	194	216
	Mean	192	232	195	217	193	224
	CV (%)	0.8	1.0	0.6	0.8	0.7	0.7
	LSD (0.05)	2.2	3.2	1.6	2.4	1.3	1.6

Table 3. Variety and Stage of Growth Effects on Acid Detergent Fiber. Summary of acid detergent fiber (ADF) content of oat hay as affected by variety and stage of growth of spring oat varieties planted at the Klamath Experiment Station, OR.

		% ADF					
		1989		1990		Average	
Entry	Selection	Boot	Soft Dough	Boot	Soft Dough	Boot	Soft Dough
1	Svea	32.4	41.8	39.4	36.9	35.9	39.4
2	Sierra	33.6	37.5	36.3	34.9	34.9	36.2
3	Cal Red	40.2	41.6	--	--	--	--
4	Cascade	32.9	37.5	--	--	--	--
5	Winter Grey	36.8	42.6	39.7	37.1	38.2	39.9
6	Kanota	30.4	37.7	37.0	36.0	33.7	36.8
7	Benson	35.4	37.6	37.4	34.9	36.4	36.3
8	Porter	33.0	41.1	--	--	--	--
9	Otana	33.6	40.8	37.1	35.4	35.3	38.1
10	Park	34.3	39.4	39.3	36.3	36.8	37.8
11	Ogle	33.7	40.5	38.8	35.1	36.3	37.8
12	Montezuma	35.3	40.4	36.6	40.1	35.9	40.2
13	Curt	33.4	39.8	--	--	--	--
14	Cayuse	34.7	38.3	41.2	35.3	38.0	36.8
15	Monida	35.4	39.7	37.5	37.0	36.4	38.3
16	Viking 765	31.1	38.8	37.2	36.8	34.1	37.8
17	Athabasca	36.0	40.4	--	--	--	--
18	Swan	35.6	37.8	37.4	32.4	36.5	35.1
19	Corbit	33.4	39.0	38.4	37.8	35.9	38.4
20	Moore	37.6	36.1	39.6	35.0	38.6	35.5
21	Stampede	30.4	43.4	--	--	--	--
22	Valley	32.0	38.4	38.2	34.9	35.0	36.7
23	Whitford	30.6	36.5	40.2	36.4	35.4	36.4
24	Westford	36.6	40.4	38.7	40.8	37.6	40.6
	Mean	34.1	39.5	38.3	36.3	36.1	37.7
	CV (%)	5.5	5.0	5.9	6.0	5.7	5.4
	LSD (0.05)	2.6	2.8	NS	NS	2.0	2.0

Table 4. Variety and Stage of Growth Effects on Crude Protein Content. Summary of crude protein (CP) content of oat hay as affected by variety and stage growth of spring oat varieties planted at the Klamath Experiment Station, OR.

		% Crude Protein					
		1989		1990		Average	
Entry	Selection	Boot	Soft Dough	Boot	Soft Dough	Boot	Soft Dough
1	Svea	13.0	6.5	14.2	10.5	13.6	8.5
2	Sierra	12.7	8.1	15.1	9.9	13.9	9.0
3	Cal Red	9.7	7.1	--	--	--	---
4	Cascade	13.3	7.3	--	--	--	---
5	Winter Grey	9.1	7.1	12.4	10.2	10.8	8.6
6	Kanota	10.7	7.8	12.5	10.2	11.6	9.0
7	Benson	12.8	8.0	14.4	10.0	13.4	9.0
8	Porter	10.2	6.7	--	--	--	---
9	Otana	10.3	7.3	16.6	10.1	13.4	8.7
10	Park	12.1	7.8	14.0	10.8	13.0	9.3
11	Ogle	12.5	7.4	15.2	9.2	13.8	8.3
12	Montezuma	10.8	6.8	10.5	10.9	10.7	8.8
13	Curt	13.4	7.9	--	--	--	---
14	Cayuse	12.1	7.4	14.4	9.1	13.3	8.3
15	Monida	11.6	7.4	15.6	10.2	13.6	8.8
16	Viking 765	12.5	7.7	16.2	10.4	14.4	9.0
17	Athabasca	11.9	7.0	--	--	--	---
18	Swan	12.9	8.3	14.1	9.9	13.5	9.1
19	Corbit	11.5	7.3	14.4	9.9	12.9	8.6
20	Moore	12.0	7.5	14.5	9.9	13.2	8.7
21	Stampede	12.6	6.4	--	--	--	---
22	Valley	12.4	7.4	15.2	9.9	13.8	8.7
23	Whitford	16.0	7.8	14.0	9.8	15.0	8.8
24	Westford	14.0	9.4	16.3	11.5	15.2	10.5
	Mean	12.1	7.5	14.4	10.1	13.3	8.9
	CV (%)	5.5	11.1	6.8	6.9	8.1	9.2
	LSD (0.05)	2.6	1.9	1.4	1.0	1.1	0.8

Red-Skinned Potato Variety Development, 1990

K.A. Rykbost[1], H.L. Carlson[2], and J. Maxwell[1]

INTRODUCTION

Several producers in the Klamath Basin are interested in a growing market demand for red-skinned potatoes for both fresh and seed markets. In 1990, approximately 130 acres of Red LaSoda seed was produced in Klamath County. Seed for other varieties is imported from other areas. Red LaSoda produces very high yields but is light in color and is not attractive after storage.

Northwestern potato variety development efforts are primarily directed toward russet-skinned varieties. A systematic search for superior red-skinned varieties adapted to the Klamath Basin was initiated at KES in 1988. Objectives are to: 1) evaluate named and released red-skinned varieties; and 2) screen progeny from red-skinned crosses in hopes of selecting a new cultivar specifically adapted to the Klamath Basin.

I. SINGLE-HILL SEEDLING SCREENING

Procedures

The North Dakota State University potato breeding program provided first-generation mini-tubers from 24 crosses. In view of space limitations the tubers were preselected to reduce their numbers from 5,848 to 3,439. Preselection was done on the basis of color, shape, physical condition, and size of mini-tubers. Tuber size of material planted ranged from a few grams to approximately 10 grams.

The soil was fumigated with Telone II applied at 20 gpa on April 20. Aldicarb was banded in the seed furrow at planting at 3.0 lbs ai/A. Monitor was applied aerially on July 15 and August 9 at 0.75 lbs ai/A. Fertilizer applications included 600 lbs/A of 16-16-16 banded at planting and 50 lbs N/A applied as solution 32 on June 5. Weed control was achieved with Eptam applied at 3.5 lbs ai/A on June 5. A total of 14 inches of irrigation was applied with solid-set sprinklers.

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2/ Superintendent/Farm Advisor, University of California, Tulelake Field Station, CA.

Acknowledgment: The supply of tuber families from the North Dakota State University potato breeding program for single-hill, first-generation screening is gratefully recognized. Partial funding for variety development by the Oregon Potato Commission, the Cooperative State Research Service (CSRS), and the Agricultural Research Service (ARS) support this program.

Results and Discussion

Emergence and plant vigor was excellent in all families (Table 1). Less than two percent of the clones were removed for disease or wild plant types. At the field selection stage 142 clones were saved. After three months in storage, all clones were displayed and evaluated by three specialists and three growers. Fifty clones were retained for further evaluation. These clones exhibited superior skin color to several standard varieties stored in the same conditions. The parents used in crosses which contributed the highest number of clones selected were 1618-13R (17 clones) and 1408-8R (11 clones).

Five tubers from each clone selected were eye-indexed and examined for virus infection. Clean clones will be planted in 12-hill plots at KES in 1991. Tuber-unit planting will be used to assist in detection of virus diseases and variety mixing which may have occurred at harvest.

II. 12-HILL, SECOND GENERATION SEEDLING SCREENING

Procedures

Forty-three single-hill selections from 1989 were eye-indexed and grown in a greenhouse for disease evaluations. Thirty-nine virus-free clones were planted in tuber-units in 12-hill plots on May 29. Seed pieces were spaced at 12 inches with 24 inches between tuber-units. Cultural practices, timing of harvest and selection procedures were as described for single-hill plots.

Results and Discussion

Emergence was 100 percent in most clones. Plant type and vigor was observed at several growth stages. Two clones were removed for virus infection. Several others exhibited poor plant type and were discarded. At harvest, 24 clones were retained for storage evaluation (Table 2). Following three months in storage 13 clones were advanced for further evaluation in 1991. Eight of the clones are progeny of two crosses with Redsen and 1196-2R. All exhibit excellent skin color, shallow eyes, and smooth, round to oval tubers. Each of these parents were only used in one cross in the 1990 families evaluated as single hills. Further crossing of these parents seems desirable.

Thirty tubers of the thirteen clones have been eye-indexed and grown in a greenhouse for disease evaluation. Virus-free material will be tuber-unit planted in approximately 50-hill plots at KES in 1991.

III. MULTI-HILL, THIRD-GENERATION SEEDLING SCREENING

Procedures

Twelve 10-hill selections from 1989 were eye-indexed and grown in a greenhouse for disease evaluation. Two clones exhibited unacceptable virus infection and were discarded. Ten clones were tuber-unit planted in approximately 75-hill plots on May 29. Seed pieces were spaced at 12 inches with 24 inches between tuber units. Cultural practices were as described for single-hill plots. Tubers were dug with a one-row digger-bagger on September 28 and inspected by the selection team on October 1.

Results and Discussions

Emergence was excellent in all clones. Excessive tuber size was observed in all clones due to low population densities. Six clones were selected for advancement on October 1 (Table 3). On December 20, all tubers from the six clones were sorted and graded. Approximately 25-pound samples were selected for 1991 field plantings in Kern County, California and at Tulelake, California. Sixty tubers of each clone were eye-indexed and planted in a greenhouse for disease evaluation. Virus-free material will be grown for seed increase at Powell Butte and for further screening and selection at KES in 1991. Any selections which survive 1991 screening will be advanced to statewide trials in 1992.

IV. ADVANCED RED VARIETY TRIALS

Procedures

Eight named varieties and four numbered selections were planted at KES in a randomized complete block design with four replications on May 25. Individual plots were two rows, 23 feet long. Seed spacing was 8.7 inches in 32-inch rows, resulting in 60-hill plots. Fertilizer included 600 lbs/A of 16-16-16 banded at planting and 50 lbs N/A applied as solution 32 on June 5. Eptam was applied at 3.5 lbs ai/A on June 5 and incorporated with a rolling cultivator. Mertibuzin was applied aerially at 0.3 lbs ai/A on July 14. Standard cultural practices were followed for disease and insect control. The trial was irrigated with 16 inches of water with solid-set sprinklers during the season. Vines were desiccated with 1.0 pint/A of diquat applied on August 31. Tubers were harvested and field weights determined on September 24. Approximately 100-pound samples were stored from each plot and graded on November 1. Tubers were graded to USDA standard classes for size, No. 1's, No. 2's, and culls. The 10 largest tubers per plot were cut to examine for internal defects.

A second experiment was planted on organic soil in the Tulelake area on May 16. Eleven of the entries were the same and used the same seed source in both trials. The experiment at Tulelake was a randomized complete block design with four replications. Individual plots were two rows, 51 feet long. Seed was spaced at 9 inches in 36-inch rows. Similar cultural practices were followed. Vines were desiccated on September 10 and potatoes were harvested and graded on September 24.

Results and Discussion

Tuber yields and size distribution varied widely between selections (Tables 4 and 5). Red Pontiac produced the highest total yield and yield of U.S. No. 1's at both locations; however, tuber size was excessive. Viking also produced excessive size. Red LaSoda achieved high yields with acceptable size at KES, but tubers were large at Tulelake. A82705-1 produced relatively high yields at both locations but excessive size at Tulelake. Red Cloud produced intermediate yields at both locations. It has relatively deep eyes and only fair appearance (Table 6). As in 1988, Red Cloud exhibited only moderate yields in the most desirable size range (B's to 10 ounces).

Sangre, Red Norland, and Dark Red Norland have achieved relatively high yields of tubers under 10 ounces quite consistently. Sangre has a tendency for light russetting, but retains its color better in storage than several other reds and has excellent storage characteristics, including a long dormant period. Red Norland and Dark Red Norland are early maturing and produce smooth tubers with shallow eyes. Under local conditions skin color is quite similar for these selections and lighter than that of Sangre. However, both cultivars have been rated quite high in tuber appearance.

ND2224-5R and La 12-59 have been used as parents for crosses at North Dakota State University. Progeny from both parents have shown excellent appearance in screening trials at KES. Both are being considered for release. ND2224-5R was included in Western Regional trials in 1990. At Tulelake, ND2224-5R was the outstanding selection in both yield of appropriate size tubers and tuber appearance. At KES, its yield was only moderate in this trial and in the Western Regional trial. Tuber size was acceptable but tuber appearance was rated fair. La 12-59 was not outstanding at either location in yield or appearance.

AD81567-4R was only evaluated at KES. This California selection had a low yield and a very serious growth cracking problem. It is not worthy of further evaluation. NDTX8-731-1R was included in this trial only at Tulelake. It also produced a low yield and low appearance rating. In the KES Western Regional trial it achieved a relatively high yield, but tuber size was excessive.

Red-skinned cultivars and advanced selections have been evaluated at both locations over a three-year period. Most have failed to produce a combination of high yields of tubers under 10 ounces, smooth tubers with shallow eyes, and a bright skin color that is retained in storage. For local fresh market use the storage aspect is quite important since Klamath Basin crops do not mature early enough to fit an early market window. While a small but stable market niche has been maintained for Red LaSoda seed, this cultivar is not a good choice locally for fresh markets. Cultivars with much better appearance will be required to achieve a significant fresh market niche. To date the most likely cultivars to succeed appear to be Sangre, Red Norland, or Dark Red Norland. The numbered selection, ND2224-5R, appears to be worthy of further consideration. Further testing of Red Pontiac, Chieftain, Red Cloud, Viking, and A82705-1 does not seem to be justified.

CONCLUSIONS

The initial screening of large numbers of single-hill progeny from potato breeding programs is not labor intensive, but it does require an extensive land base. Land requirements increase dramatically in subsequent years as hill numbers are increased in second and third generation screening trials. The red-skinned selection program at KES has been modified in two ways to allow efficient use of limited land resources, while accommodating the maximum number of single-hill selections.

In 1990, preselection was used to reduce the number of mini-tubers by approximately 40 percent to match available land resources. Individual mini-tubers of each family were discarded on the basis of skin color, physical condition (shriveling, tuber size, and excessive sprouting), and to a lesser extent tuber shape. As a result of preselection the material planted achieved much higher emergence and better plant vigor than in the two previous years. A very high percentage of clones produced tubers with relatively good skin color and shape. At harvest, approximately four percent of the single-hills were selected. After three months in storage a further selection was made by comparing the progeny selected at harvest with stored samples of standard varieties. Approximately two-thirds of the original selections were discarded on the basis of color, eye depth, shape, tuber firmness, and sprouting. As a result of the three-stage screening process, only one percent of the original material provided will be advanced to the second stage of evaluation. However, based on observations of the second-generation selections in 1990, the quality of surviving progeny will be high.

The practices of preselecting mini-tubers prior to planting and reselecting single-hill progeny after approximately three months in storage should be given consideration for the much larger statewide program. Mini-tubers produced in greenhouse pots from true seed may not be completely representative of their field grown progeny. However, skin color, shape, and general appearance will be quite similar. These are the main characteristics on which single-hill selections are made. Excessively sprouted or shriveled mini-tubers are unlikely to produce vigorous plants and be selected at harvest. It is quite unlikely that a promising clone will be discarded in preselecting to eliminate 30 to 50 percent of the clones produced from true seed.

Reselecting single-hill clones after approximately three months in storage provides an additional observation on storability. Experience over three years at KES has shown that early sprouting, loss of firmness, and development of fusarium and other storage diseases may effect up to 20 percent of the clones. These undesirable attributes will eventually lead to discarding the clones. By eliminating them at the single-hill stage savings in eye-indexing, land requirements for multi-hill plantings, and overall effort will be realized.

Clonal selection programs typically retain two to three percent of single-hill progeny. If preselection and reselection procedures are incorporated it may be desirable to field-select a somewhat higher percentage. However, with a goal of eliminating, as quickly as possible, those clones with deficiencies, the incorporation of these practices in the variety selection program seem appropriate.

Table 1. First-year red-skinned seedling screening, Klamath Experiment Station, OR. 1990.

Family No.	Parentage	Clones provided	Clones planted	Stand %	Number selected Oct. 1	Dec. 20
NDO 3839	1382-6R x Mn 12945	221	143	97	7	2
NDO 3846	1408-8R x 3048-2R	278	169	85	13	8
NDO 3849	1660IB-8R x 1196-2R	286	204	96	17	6
NDO 3880	2139 7R x 1871- 3R	332	212	95	9	0
NDO 3892	2390-2R x 1196- 2R	180	88	98	2	1
NDO 3893	2390-2R x 2050- 1R	188	80	96	2	1
NDO 3991	Reddale x 1618-13R	463	233	97	8	6
NDO 3992	Reddale x 2611- 8R	243	99	98	0	0
NDO 3993	Reddale x 2840- 7R	194	102	97	2	0
NDO 3994	Redsen x La 12-59	205	136	99	8	4
NDO 4001	Ruby Red x 1618-13R	346	158	91	6	3
NDO 4006	Sangre x 1618 - 13R	198	131	93	7	3
NDO 4009	Viking x 2225 - 1R	188	109	96	6	2
NDO 4026	La 12-59 x 1618-13R	226	158	96	10	2
NDO 4030	Mn 12945 x 3049- 1R	279	175	97	12	5
NDO 4031	Mn 13035 x 1618-13R	410	239	95	6	3
NDO 4032	Mn 13053 x Sangre	263	159	89	3	0
NDO 4034	Mn 13053 x 2391- 5R	347	220	99	3	0
NDO 4035	Mn 13053 x 3170- 2R	248	171	95	3	1
NDO 4056	1408-8R x Reddale	68	36	83	2	1
NDO 4057	1408-8R x Sangre	125	78	87	7	2
NDO 4058	2050-1R x La 12-59	80	67	97	6	0
NDO 4062	2391-5R x Sangre	107	60	88	1	0
NDO 4063	2391-5R x Mn 13053	373	212	94	2	0
	Total	5848	3439		142	50

Table 2. Second-year red-skinned seedling screening, Klamath Experiment Station, OR. 1990.

Family No.	Parentage	Clones planted 1989	Clones selected 1989	Clones planted 1990	Clones selected 1990 Oct. 1	Clones selected 1990 Dec. 20
NDO 2438	Redsen x 1196-2R	266	11	10	7	4
NDO 2469	Viking x 1196-2R	281	6	5	3	1
NDO 2686	1196-2R x Redsen	225	10	10	7	4
NDO 3314	W806R x 2050-1R	82	2	2	1	1
NDO 3531	NDTX9-1068-11R x 2496-5R	248	6	5	2	1
NDO 3686	2428-2R x 2745-3R	144	3	2	2	1
NDO 3756	Red LaSoda X 2224-5R	132	1	1	1	1
NDO 3761	Red Pontiac x 1871-3R	92	2	2	0	0
NDO 3763	Ruby Red x 2224-5R	131	2	2	1	0
	Total	1601	43	39	24	13

Table 3. Third-year red-skinned seedling screening, Klamath Experiment Station, OR. 1990.

Family No.	Parentage	Clones planted 1988	Clones selected 1988	Clones planted 1989	Clones selected 1989	Clones planted 1990	Clones selected 1990
NDO 3432	Erik x NDTX9-1068-11R	160	3	3	2	1	1
NDO 3503	La 12-59 x NDTX9-1068-11R	220	13	11	5	5	2
NDO 3504	La 12-59 x 1196-2R	130	5	4	2	1	1
NDO 3573	1196-2R x La 12-59	150	5	5	3	3	2
	Total	660	26	23	12	10	6

Table 4. Tuber yield by grade for red-skinned selections, Klamath Experiment Station, OR. 1990.

Selection	Yield U.S. No. 1's				Yield			
	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Total
	cwt/A							
Red LaSoda	132	227	90	449	35	37	7	528
Red Pontiac	98	273	201	572	28	59	10	669
Chieftain	116	221	94	431	40	26	5	502
Red Norland	160	230	67	457	42	15	8	522
Dark Red Norland	147	184	38	369	75	15	12	471
Red Cloud	95	164	63	322	36	35	3	397
Sangre	181	199	62	442	85	12	6	545
Viking	63	154	223	440	18	101	11	570
A82705-1	143	212	92	446	49	14	4	513
ND2224-5R	120	172	38	330	56	12	5	403
La 12-59	108	221	90	419	48	26	6	499
AD81567-4R	93	112	35	240	39	72	16	367
Average	121	197	91	410	46	35	8	499
CV (%)	25	19	26	13	33	54	66	12
LSD (.05)	45	55	35	77	22	28	8	88

Table 5. Tuber yield by grade for red-skinned selections, Tulelake Field Station, CA. 1990.

Selection	Yield U.S. No. 1's 4-6 oz	6-10 oz	10-14 oz	>14 oz	Total	Yield B's	Culls	Total
	cwt/A							
Red LaSoda	151	96	109	117	473	13	52	538
Red Pontiac	97	110	142	194	543	12	37	592
Chieftain	193	78	50	29	350	30	18	398
Red Norland	164	108	80	31	383	20	12	416
Dark Red Norland	219	57	33	6	315	37	8	360
Red Cloud	132	78	101	48	359	11	42	412
Sangre	189	91	55	26	361	23	24	408
Viking	66	76	121	168	431	10	21	462
A82705-1	152	91	102	97	442	25	16	483
ND2224-5R	239	50	5	0	294	51	11	356
La 12-59	141	97	79	72	389	21	20	431
AD81567-4R	75	65	49	36	225	11	11	246
Average	152	83	77	69	380	22	6	425
CV (%)	15	19	33	29	13	33	183	11
LSD (.05)	33	23	37	29	70	11	NS	69

Table 6. Characteristics of red-skinned selections, 1990.

Selection	Vine Maturity[1]	H.H.[2] KES	H.H.[2] TFS	Appearance[3] KES	Appearance[3] TFS	Specific gravity	Yield B's + 4-10 oz KES	Yield B's + 4-10 oz TFS
							--- cwt/A ---	
Red LaSoda	3.5	5	15	2.1	2.0	1.070	294	260
Red Pontiac	4.0	15	5	1.9	1.8	1.066	400	219
Chieftain	4.0	3	10	2.9	3.5	1.065	377	301
Red Norland	1.8	3	25	3.4	4.0	1.063	432	292
Dark Red Norland	2.0	3	0	3.5	4.3	1.062	406	313
Red Cloud	3.3	0	5	3.4	3.3	1.074	295	221
Sangre	3.3	15	5	3.3	3.3	1.067	465	303
Viking	3.3	3	0	2.8	3.8	1.071	235	152
A82705-1	4.0	0	0	3.3	3.8	1.068	404	268
ND2224-5R	3.5	0	0	3.0	5.0	1.068	348	340
La 12-59	3.3	3	5	2.3	3.8	1.079	377	259
AD81567-4R	3.0	0	-	1.3	-	1.071	244	-
NDTX8-731-1R	-	-	0	-	2.8	---	-	151

1/ Vine maturity (Aug. 30): 1 - dead, 5 - green, vigorous
2/ H.H. - hollow heart: KES - % in 10 largest tubers/plot
TFS - % in 10 tubers of 10-14 oz/plot
3/ Appearance (Tubers): 1 - poor; 3 - acceptable; 5 - best

Potato Variety Screening Trials

K.A. Rykbost and J. Maxwell[1]

INTRODUCTION

Russet Burbank accounts for approximately 75 percent of Oregon potato production and nearly 90 percent of total production in Oregon, Washington, and Idaho. While this cultivar has many desirable characteristics and qualities, it is very prone to diseases, disorders due to physiological stress, and a number of pests. It requires a high level of management and high inputs in terms of irrigation, fertilizers, and pesticides to achieve optimum production. Even with careful management, poor quality crops can and do occur under stressful growing season conditions. Growers were clearly reminded of this fact in the 1990 season when heat stress in July and August resulted in serious tuber quality problems in the Columbia Basin and other production areas in the western states.

Regional efforts to find a suitable replacement for Russet Burbank and cultivars to fill other market niches have been ongoing for many years. The Oregon Potato Variety Development Program is an integral part of the total regional effort. Oregon presently screens about 80,000 first-generation seedlings. Clones surviving the first three levels of screening at Powell Butte, Hermiston or Ontario agricultural experiment stations are advanced to replicated yield trials. The KES participates in the program at this stage, conducting the Preliminary Yield trial, the Oregon Statewide trial, and the Western Regional trial, which is conducted at 13 locations in seven western states.

The Western Regional trial is the last stage of coordinated evaluation prior to varietal release. The KES has only participated in this trial since 1988. Several recently released cultivars have not been thoroughly evaluated at KES. An Early Russet trial was added to the KES program in 1989 to obtain additional local experience with new varieties and advanced selections from western regional and other variety development programs.

Screening large numbers of selections requires use of standard, uniform cultural management practices for any one trial. As Russet Burbank is the standard variety for the region, many trials are conducted using management practices for optimum performance of this cultivar. Russet Burbank requires low planting density to achieve appropriate tuber size due to high tuber numbers. Most selections produce fewer tubers than Russet Burbank. At low planting density the selections with a low tuber set often produce very large tubers which are more apt to exhibit physiological disorders such as knobbiness, growth cracks and hollow-heart. High nitrogen fertilization or irrigation rates required for realization of the full season yield potential of Russet Burbank will be excessive for earlier maturing or more efficient

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selections. Under management practices appropriate for Russet Burbank, selections with highly desirable qualities may be overlooked due to disorders, excessive size or lower yields. A study was initiated in 1988 to evaluate the effect of cultural management used in screening trials on the efficiency of the screening process.

While yield is a very important criterion in selecting lines for advanced testing, many other characteristics are also evaluated. At the Statewide trial level over 30 characteristics are routinely quantified at each trial location. At latter stages the list is expanded to include disease reactions and additional quality parameters. Poor performance in characteristics other than yield are often the basis for discarding selections during the advanced stages of testing. However, it is very important for new cultivars to be at least equivalent in yield to the varieties they are intended to replace. While this report emphasizes the yield component, the importance of other characteristics is not overlooked in the selection process.

PROCEDURES

All variety screening trials were conducted in a randomized complete block design. All trial areas were fumigated with Telone II applied at 20 gallons per acre (gpa) on April 20. Di-Syston was applied in the seed furrow at 3.0 lbs ai/A. Monitor was applied aerially at 0.75 lbs ai/A on July 15 and August 9. Herbicides included Eptam, applied at 3.5 lbs ai/A and incorporated with a rolling cultivator on June 5, and metribuzin applied aerially at 0.30 lbs ai/A on July 14. All seed was hand cut, treated with thiophanate-methyl fungicide, and suberized at least 10 days prior to planting. Standard foliar fungicides were applied aerially at labelled rates on July 15 and August 9. Vines were desiccated with diquat, applied with a conventional ground sprayer at 1.0 pint/A. Vines were shredded with a rotobeater several days prior to harvest. All trials were conducted in fields following a two-year rotation of potatoes and spring cereal grains. Agricultural gypsum was applied at 1.0 ton/A before secondary tillage. Cultural practices that varied between experiments are discussed separately for each experiment.

Potatoes were planted with a two-row assisted feed planter with 32-inch row spacing. All trials received 600 lbs/A of 16-16-16 fertilizer banded on both sides of rows at planting. Additional nitrogen was applied with a conventional ground sprayer as solution 32 in combination with Eptam. Trials received approximately 4.5 inches of rainfall and 15.5 inches of irrigation water during the growing season. Irrigation was applied twice weekly with solid-set sprinklers on a 40-foot x 48-foot spacing to replenish 60 - 90 percent of pan evaporation, depending on plant growth stage.

Potatoes were harvested with a one-row digger-bagger. Samples were tagged and stored until grading was done in late October or early November. Specific gravity was determined by the weight-in-air, weight-in-water method, using a 10-pound sample of U.S. No. 1's in the 6- to 10-ounce size portion. Internal defects were observed by cutting the 10 largest tubers from each plot. Yields of US No. 1's were not adjusted for surface blemishes such as scab, elephant hide or rhizoctonia, or for internal defects such as hollow-heart, brown-center or internal brown spot. Statistical analyses of data were performed with MSU Stat software.

Preliminary Yield Trial

Entries included five standard varieties and 81 numbered selections. The trial was planted on May 25 with two replications of 20-hills at 8.7-inch seed spacing. Fertilizer applied at planting was supplemented with 60 lbs N/A as solution 32. Final plant stands and vine vigor were rated on July 9 (Table 1). Senescence of vines was rated on September 8. Vines were desiccated on September 10. Tubers were harvested on September 25. All tubers from each plot were stored and graded on October 31. Data were not analyzed statistically.

Oregon Statewide Trial

The experiment was planted on May 18. Thirty-hill plots at 8.7-inch seed spacing were replicated four times. Cultural practices were the same as described for the Preliminary Yield trial. Tubers were harvested on September 26 and graded on October 30. All tubers were weighed at harvest. Approximately 60-pound samples from each plot were saved for grading.

Western Regional Trial

Official entries in this trial included Russet Burbank and Lemhi Russet as standards and 17 numbered selections. At KES, two additional named varieties, Cal-Ore and Calgold, were included. The experiment was planted on May 22. Individual plots were 30-hills at 8.7-inch spacing with four replications. Cultural practices were the same as those described for the Preliminary Yield trial. Plant emergence data were recorded on June 28 and July 9, vine vigor was rated on July 9, and vine maturity ratings were made on August 31. Vines were desiccated with 1.0 pint/A diquat, applied on September 10. Potatoes were harvested on September 28. All tubers were weighed in the field and approximately 60-pound samples were stored and graded on October 29.

Early Russet Trial

Eight selections were planted at 8.7-inch seed spacing on May 22. Individual plots were two rows, 27 feet long (74-hills) with four replications. Fertilizer banded at planting was supplemented with 50 lbs N/A applied as solution 32 on June 5. Other cultural practices were as described for the Preliminary Yield trial. Vines were desiccated with 1.0 pint/A diquat applied on August 31. Harvest occurred on September 24. Total plot weights were determined at harvest. Approximately 60-pound samples from each plot were stored and graded on November 1.

Seedling Screening Trial

Russet Burbank and five selections included in the 1989 Preliminary Yield trial were planted in two separate experiments on May 25. One experiment included 8.7-inch seed spacing and 150 lbs N/A, while the other included 12-inch seed spacing and 200 lbs N/A. The trials were separated by two rows. Both experiments included 30-hill plots and four replications. Vines were desiccated with diquat, applied at 1.0 pint/A on September 10. Potatoes were harvested on October 2 and graded on November 2.

RESULTS AND DISCUSSION

Preliminary Yield Trial

Emergence and early season vigor were delayed or reduced by cool, wet conditions in late May and early June. Some heat stress occurred in July and August. Considering a somewhat adverse growing season, crop yields, tuber type and internal quality was generally quite good. Very low incidence of tuber rot, nematode blemish, or internal defects other than hollow-heart was noted. In most cases the hollow-heart was observed in very large tubers. Most selections exhibited relatively smooth tuber type with minimal second growth and growth cracks.

The Russet Burbank standard produced a fairly typical yield, size distribution and grade (Table 2). Both Lemhi Russet and Russet Norkotah exceeded Russet Burbank in total yield of U.S. No. 1's and in yield of tubers over 10 ounces. Norgold Russet and Norchip were slightly below Russet Burbank in yield.

Nine of the numbered selections exceeded Russet Burbank in yield of No. 1's by 25 percent or more. The top five selections in yield of No. 1's at KES were CO086106-1, CO086149-4. AO86058-4, CO086042-2, and A8390-3, respectively. Averaged over four statewide locations their relative rankings in total yield of No. 1's were 2, 1, 12, 3, and 18, respectively.

A total of 27 selections were advanced to the Statewide trial for 1991. These included nine of the top ten and 17 of the top 20 in yield of No. 1's at KES. On the basis of a single year of observation, the breakdown of potential utilization of selections advanced includes one chipper, five fresh market, and 21 french fry selections. Several of the selections exhibited considerably higher solids and better fry color than Russet Burbank.

Oregon Statewide Trial

With the exception of two entries, No's 16 and 24, plant stands were excellent (Table 3). Standard varieties had slightly lower specific gravity and less hollow-heart than was observed in the Preliminary Yield trial. Russet Burbank slightly exceeded other standard varieties in total yield of No. 1's (Table 4). The early clone of A74212-1 achieved the highest yield at KES and ranked second averaged over four locations. Century Russet ranked fourth at KES and fifth at all locations in total yield of No. 1's. Entry numbers 7 - 14 are in various stages of advanced testing. All of them will be retained in the Statewide trial until disposition decisions are made at a regional level. Although CO08014-1 was disappointing in yield at KES it performed much better at the other three locations and has consistently shown excellent processing quality with good resistance to sugar ends under stress. AO82281-1 also performed well at the other locations.

One entry, ND02904-7, was advanced to the Tri-State trial for 1991. It was second only to A74212-1E in yield of No. 1's at KES. This is a fresh market line with Russet Norkotah as one parent. It has excellent appearance and has produced high yields in two years out of three at KES. Slightly flattened tubers and a tendency for elephant hide have been noted in this selection on more than one occasion.

Six additional entries were retained in the Statewide trial for further evaluation. AO85031-7 was perhaps the best overall candidate for processing, ranking first overall in yield of No. 1's with acceptable solids and fry color. Its performance in the 1989 Preliminary Yield trial was also quite outstanding.

Entries 17, 27, 31 and 35 were also retained. None of these were particularly impressive at KES in this trial. Entries 27 and 31 were well below Russet Burbank in yield.

Western Regional Trial

Mosaic virus infection was noted on a few plants in AC77101-1, ND1538-1 Rus, Cal-Ore and Calgold. NDTX8-731-1R exhibited significant levels of mosaic virus and Calgold showed potato leaf roll virus symptoms in several plants. Infected plants were not removed from the plots. Although plant stands were generally good, several selections had poor vigor throughout the season with Cal-Ore, Calgold and CO80011-5 the most noteworthy examples (Table 5).

The performance of Russet Burbank and Lemhi Russet was very similar to that observed in the Preliminary and Statewide trials (Table 6). Outstanding yields with very low percentages of No. 2's and culls were found in AO83177-6, A74212-1E and Century Russet. These selections produced a high percentage of tubers over 10 ounces and very few internal defects, including hollow-heart. The results for Century Russet and A74212-1E are consistent with their performance at KES and elsewhere. AO83177-6 has been consistently higher in yields than Russet Burbank in Oregon Statewide trials, but not by as large a margin as noted in this trial. It has marginal processing quality and has shown susceptibility to dark end under stress. It was discarded from the program at the regional level.

Several selections exhibited hollow-heart problems, including AC77101-1, CO7918-11 and Cal-Ore. Cal-Ore has consistently demonstrated a serious susceptibility to hollow-heart, even in small tubers. Excessive No. 2's and culls were noted in AC81198-11 and CO7918-11. As a result both selections achieved relatively low yields of U.S. No. 1's. Low yields were also found in Cal-Ore, TND329-1 and CO80011-5. TND329-1 and CO7918-11 were discarded at the regional level while AC81198-11 will remain in the trial in 1991.

Two red-skinned selections, NDTX8-731-1R and ND2224-5R, were included in the trial. ND2224-5R produced slightly lower yields than in the advanced red-skinned variety trial, but had better appearance in this trial. NDTX8-731-1R had higher yields but tuber size was excessive.

The remaining selections achieved lower yields of U.S. No. 1's than Russet Burbank. AO82283-1 has a nice yellow flesh color and has high solids, light fry color, and appears to be quite resistant to sugar ends. In Oregon trials it usually achieves higher yields than Russet Burbank. If a demand exists for a yellow-fleshed russet this would be a good candidate.

ND1538-1 Rus, CO82142-4, AO82611-7 and COO83008-1 were similar to Russet Burbank in yield. ND1538-1 Rus will be patented and released by North Dakota State University. It is an attractive russet with fresh market quality.

A082611-7 and C0083008-1 are less susceptible to sugar end than Russet Burbank and have demonstrated acceptable solids and light fry color in Oregon trials. Both exceeded Russet Burbank in yield of No. 1's in 1989 and 1990 Statewide trials. A082611-7 has a tendency for pointed ends and C0083008-1 for flattened tubers. C082142-4 is a Colorado selection that has not been tested previously in Oregon. All three selections are being retained for further evaluation in 1991. At KES, AC7869-17 has achieved lower yields than Russet Burbank in this trial in both 1989 and 1990. Flat tubers were noted in 1990. ND671-4 Rus was in this trial for the first time in 1990. It is an attractive, heavily russetted selection but was low in yield and solids. Both selections will be tested further.

The performance of Cal-Ore and Calgold was clearly influenced by virus infection. Although Cal-Ore produces a very attractive tuber, low yields and a very serious hollow-heart problem have been observed in all trials at KES. This selection will not be tested further. Calgold has achieved a market niche in Kern County, California. The Klamath Basin will serve as a seed source for this variety. A very light skin will limit the market potential of Calgold. It will not be evaluated further at KES.

Early Russet Trial

Final plant stands were acceptable for all entries (Table 7). Cal-Ore and Krantz were slightly slower to emerge and achieved the lowest emergence. Early season vigor was weak for Cal-Ore, Frontier Russet, Krantz and HiLite Russet. As in other trials Cal-Ore was affected by mosaic virus infection. Russet Norkotah demonstrated the earliest maturity and Century Russet had the latest maturity rating. A74212-1E was only slightly earlier in maturity than Century Russet. A low incidence of hollow-heart was noted in Krantz, Frontier Russet, HiLite Russet and Cal-Ore.

Century Russet achieved the highest yield, exceeding A74212-1E by 86 cwt/A of No. 1's. Both of these selections would have achieved considerably higher yields with a delay in topkilling. Frontier Russet and Krantz produced higher yields than Russet Norkotah. In this trial in 1989 Frontier Russet was well below Russet Norkotah and Krantz in yield of No. 1's. In both 1989 and 1990 HiLite Russet was nearly 100 cwt/A lower in yield of No. 1's than Krantz. C008014-1 achieved a yield equal to Russet Norkotah. It is being considered for release as a processing variety and has performed well in the Columbia Basin. Cal-Ore was significantly lower in yield of No. 1's than all other entries. As mentioned in the preceding section of this report, Cal-Ore will not be evaluated further at KES.

Seedling Screening Procedures Trial

Emergence, vine vigor and vine maturity varied between selections but were consistent for a given selection. In both 1988 and 1989 Russet Burbank achieved a higher yield and better tuber size at a low planting density and higher nitrogen rate (Table 9). In 1990, a combination of heat stress and rhizoctonia damage reduced tuber set. Under these conditions Russet Burbank achieved a higher yield, although smaller tuber size, at the higher planting density and lower nitrogen rate.

Four out of five numbered selections also produced the highest yield of No. 1's at the high planting density and lower nitrogen rate. One selection, AO85010-4, experienced a 93 cwt/A reduction in total yield of No. 1's at low density and high nitrogen rate. This was mainly due to a large increase in off-type tubers and growth cracks at the low planting density. AO85069-1 experienced a similar decline in yield of No. 1's. This selection produced only a slight increase in yield of No. 2's and culls. Yield loss was mainly due to lower tuber numbers associated with lower plant density. The effects of management practices on AO85010-13 and AO85010-14 were similar to those observed in Russet Burbank.

Yield declined about 50 cwt/A for both selections at the low density and high nitrogen rate. Only one selection, AO85035-1, achieved its highest yield at a low density and high nitrogen rate (Table 9).

In three years the performance of Russet Burbank and 15 numbered selections have been compared under low density and high nitrogen regimes, appropriate for Russet Burbank, and higher density, lower nitrogen rates appropriate for more efficient plant types or earlier maturing varieties. In two years out of three Russet Burbank performed best at a low density and high nitrogen rate. Only three selections out of 15 performed best under this regime. This clearly suggests that variety selection should be conducted using management practices that may not be optimum for Russet Burbank.

CONCLUSIONS

A number of attractive russet potatoes were identified in the Preliminary Yield trial. Many of them achieved higher yields, better solids, better fry color and better external and internal tuber quality than Russet Burbank. A total of 27 clones were promoted to the Statewide trial for 1991.

The Oregon Statewide trial included 26 numbered selections at this level of evaluation and eight selections that are at Tri-State or Western Regional trial levels. One selection was advanced to the Tri-State trial and six were retained for further testing in the Statewide trial.

Six out of 17 numbered selections in the Western Regional trial were supplied by Oregon, including the three highest yielding selections at KES. Century Russet will be officially released in 1991. An early selection of this seedling looks equally promising.

An early russet trial compared eight relatively new varieties or advanced selections. Cal-Ore was very poor and is not recommended for production. HiLite Russet has not achieved satisfactory yields in this trial in two years. However, its performance has been better in other trials discussed elsewhere. Frontier Russet and Krantz achieved higher yields than Russet Norkotah. This trial will be discontinued in 1991. Most of the appropriate entries are now being evaluated in management trials.

Three years of trials comparing cultural management regimes for seedling screening have shown that a large majority of selections achieve better performance at higher plant density and lower nitrogen fertilization rates than those considered optimum for Russet Burbank. Preliminary Yield and

Oregon Statewide trials at KES are now being conducted using this regime. While this will usually result in less than optimum performance for the Russet Burbank standard, it improves the likelihood of selecting clones which are capable of good performance under low-input management. This trial will not be continued.

The KES will continue to conduct Preliminary, Statewide and Western Regional trials as an integral part of the Oregon and regional variety development programs. A comparison of trial results over the four Oregon locations shows significant location effects in many cases. Each location has unique soil and climatic conditions that effect selection performance. Subjecting clones to this wide range of conditions enhances the data base for decisions on disposition of selections and improves the chances for advancing clones that are widely adaptable.

The routine testing of selections for culinary quality under various preparation methods has been incorporated into the KES program. Results of these tests will be covered as a separate report.

Table 1. Performance of entries in the Prelimany Yield Trial, Klamath Experiment Station, OR. 1990.

Entry No.	Selection	Stand %	Vigor rating[1]	Maturity rating[2]	Specific Gravity	H.H.[3] %	Comments[4]
1	Russet Burbank	98	3.0	2.5	1.090	15	Rough
2	Lemhi	90	4.0	3.0	1.095	55	Coarse
3	Norgold	100	4.5	1.0	1.074	20	
4	Norkotah	98	4.5	2.0	1.073	5	Nice
5	Norchip	95	3.5	2.0	1.081	10	
6	ND03640-1	98	4.0	2.0	1.080	10	
7	ND03640-2	100	4.5	3.0	1.075	5	
8	ND03640-3	95	3.0	2.0	1.070	0	
9	ND02955-1	95	3.5	1.5	1.078	0	Rough
10	ND02955-5	83	2.5	1.5	1.079	30	Small
11	ND02955-6	95	5.0	1.5	1.082	5	Discard
12	ND02667-5	88	1.5	1.5	1.074	0	IPS, GC, EH, YF
13	ND02667-7	95	3.0	2.0	1.068	0	No yield
14	ND02667-12	95	2.5	2.0	1.075	10	IPS, light YF
15	ND02667-13	100	4.0	1.0	1.084	0	Nice, smooth
16	CO086222-3	100	3.5	2.5	1.072	15	
17	CO086212-2	93	2.0	3.5	1.080	60	GC
18	CO086212-3	88	2.0	3.0	1.072	0	
19	CO086149-2	98	3.5	2.5	1.065	100	EH
20	CO086149-3	95	3.0	2.5	1.080	0	Nice type
21	CO086149-4	98	4.0	2.5	1.082	10	Skinning, YF, Nice
22	No Seed	--	-	-	-	--	
23	CO086106-1	98	5.0	2.5	1.083	0	Skinnning
24	CO086058-1	95	3.0	2.5	1.076	15	Flat, Ugly
25	CO086042-2	98	5.0	2.5	1.075	0	Nice type
26	A088011-2	85	2.0	1.0	1.072	0	Rot
27	A088011-5	100	2.5	2.5	1.090	5	Fair, Long
28	A088011-6	95	2.5	1.5	1.086	0	
29	A088011-8	100	3.5	2.5	1.081	0	
30	A086107-1	98	3.5	2.5	1.083	0	GC, Ugly
31	A086097-6	95	3.5	3.5	1.088	30	Flat, Fair
32	A086097-7	98	4.0	2.0	1.089	0	Poor
33	A086080-3	100	2.0	2.5	1.076	5	
34	A086078-3	98	2.5	3.5	1.083	15	
35	A086071-1	100	3.0	2.5	1.094	0	Smooth
36	A086058-4	98	3.5	2.5	1.072	10	Very white flesh
37	A086057-5	98	3.0	2.0	1.081	0	Coarse
38	A086049-1	95	2.5	3.0	1.088	20	Rot, Coarse
39	A086042-3	98	3.0	2.5	1.084	10	Ugly
40	A086034-1	95	2.0	2.5	1.078	20	Coarse
41	A086030-3	100	4.5	2.0	1.094	15	Poor
42	A086026-1	98	4.0	3.5	1.089	0	Like RB
43	A086024-2	98	3.5	2.5	1.085	30	
44	A086022-2	100	3.0	3.5	1.094	0	White flesh
45	A086019-1	93	3.0	2.5	1.088	40	
46	A086016-3	88	1.0	3.0	1.079	95	Discard
47	A086011-3	88	3.5	3.5	1.088	10	Discard
48	A086006-3	95	2.0	4.0	1.097	0	GC, Discard
49	A085130-3	85	2.5	2.0	1.074	10	Rough
50	A085027-2	98	2.0	2.5	1.091	30	

Table 1. (contd) Performance of entries in the Prelimany Yield Trial, Klamath Experiment Station, OR. 1990.

Entry No.	Selection	Stand %	Vigor rating[1]	Maturity rating[2]	Specific Gravity	H.H.[3] %	Comment[4]
51	A085027-4	100	1.5	3.0	1.096	50	Off-type
52	A085018-4	98	3.5	3.5	1.078	35	Ugly
53	A085018-6	98	5.0	2.5	1.083	15	Fair
54	A085017-4	98	2.0	3.0	1.078	5	Nice
55	A085017-6	95	3.5	3.0	1.087	30	GC, Ugly, Discard
56	A085014-1	100	3.5	2.0	1.076	0	
57	A084508-6	93	2.5	2.5	1.073	0	Nice
58	A084508-11	100	3.5	3.0	1.086	15	
59	A083247-1	100	2.0	2.0	1.075	0	
60	A083203-1	98	3.5	2.5	1.085	10	Coarse, Rough, GC
61	A083203-2	95	2.5	3.0	1.080	85	Discard
62	A083202-1	100	4.5	2.5	1.080	5	Discard
63	A083202-2	100	2.5	2.5	1.079	0	Rough
64	A080189-202	100	5.0	2.5	1.094	35	Discard
65	A080202-216	95	3.0	2.0	1.085	35	Discard
66	A083020-201	75	1.5	3.0	1.079	25	Discard
67	A083026-202	100	3.0	2.5	1.085	65	Skinning
68	A083081-206	100	3.0	2.5	1.087	15	
69	A083108-201	100	3.5	3.0	1.088	10	Discard
70	A083131-203	100	3.0	2.0	1.083	20	
71	A083139-203	95	3.0	2.0	1.090	0	
72	A083146-202	95	2.0	2.0	1.082	0	Ugly
73	A083221-204	90	3.5	3.0	1.081	25	Flat, Coarse
74	A083225-201	100	3.0	3.0	1.085	20	
75	A083338-201	100	2.0	4.0	1.095	10	
76	87 TR 2210-1	98	2.5	3.5	1.090	45	Flat
77	87 TR 2275-9	90	2.5	3.5	1.086	45	Y.F., Ugly
78	A077224-3	83	3.0	3.5	1.082	25	Y.F., Flat
79	A79180-10	83	3.0	2.5	1.091	10	
80	A79216-1	83	2.0	3.0	1.074	50	
81	A81478-1	95	2.0	3.0	1.084	5	Discard
82	A81480-6	95	2.5	4.0	1.084	20	IPS, Discard
83	A081775-3	98	2.0	2.5	1.083	0	
84	A82611-12	93	3.0	3.0	1.093	0	Fair
85	A82622-52	80	3.0	3.0	1.097	0	
86	A8390-3	90	4.0	2.0	1.083	40	Flat, Fair
87	A08478-1	98	4.0	2.5	1.085	5	GC, Discard

1/ Vigor rating - vine size - (1 - small, weak; 5 - large, robust)
2/ Maturity rating - vines Sept. 8 - (1 - dead; 5 - green, lush)
3/ H.H. - hollow heart - percent in 10 largest tubers/sample
4/ Comments - EH - elephant hide; GC - growth cracks;
IPS - internal purple spots; YF - yellow flesh

Table 2. Tuber yield by grade for entries in the Preliminary Yield Trial, Klamath Experiment Station, OR. 1990.

Entry No.		Selection	Yield U.S. No 1's 4-6 oz	6-10 oz	>10 oz	Total	Rank	%	Yield B's	2's	Total	Rank
			------------ cwt/A			-----------			---- cwt/A		----	
1		Russet Burbank	103	190	89	382	33	73	77	32	524	24
2		Lemhi	108	160	181	449	17	83	48	39	541	21
3		Norgold	97	185	79	361	40	82	60	14	441	49
4		Norkotah	79	172	170	421	20	87	52	11	486	32
5		Norchip	128	216	22	366	37	77	73	34	478	34
6		ND03640-1	131	198	31	360	41	77	83	19	465	39
7		ND03640-2	155	228	74	457	13	82	71	19	559	16
8		ND03640-3	89	147	38	274	67	67	102	27	411	64
9		ND02955-1	103	152	0	255	73	60	134	26	425	58
10		ND02955-5	96	120	27	243	76	77	62	6	314	80
11	*	ND02955-6	118	163	29	310	56	68	97	10	454	46
12		ND02667-5	59	152	28	239	78	65	87	26	365	72
13		ND02667-7	125	169	23	317	54	69	123	10	462	40
14	*	ND02667-12	108	186	84	378	34	74	100	23	508	26
15		ND02667-13	117	162	54	333	50	72	94	29	461	42
16	*	C0086222-3	97	163	160	420	21	84	52	29	502	28
17		C0086212-2	61	100	50	211	81	65	43	45	324	77
18		C0086212-3	49	92	7	148	85	72	53	0	206	86
19		C0086149-2	64	182	93	339	47	75	53	46	451	48
20	*	C0086149-3	129	202	121	452	16	81	87	18	559	17
21	*	C0086149-4	99	207	294	600	2	87	68	14	691	3
22	*	No Seed	-	-	-	-	--	--	-	--	-	--
23	*	C0086106-1	136	286	200	622	1	91	47	7	684	4
24	*	C0086058-1	99	199	50	348	44	75	48	32	462	41
25	*	C0086042-2	137	244	168	549	4	79	54	67	696	2
26		A088011-2	64	136	23	223	80	81	38	5	275	83
27		A088011-5	52	107	107	266	69	70	52	39	379	70
28		A088011-6	57	87	15	159	84	67	61	13	236	84
29		A088011-8	99	159	48	306	58	68	38	104	452	47
30		A086107-1	83	192	129	404	26	74	38	71	546	20
31	*	A086097-6	70	164	221	455	14	95	14	4	477	35
32		A086097-7	92	134	84	310	57	74	69	33	421	59
33		A086080-3	68	164	104	336	49	73	40	63	458	45
34	*	A086078-3	176	218	104	498	8	92	34	5	539	23
35		A086071-1	82	136	50	268	68	77	66	14	349	74
36	*	A086058-4	94	183	296	573	3	82	36	70	697	1
37	*	A086057-5	39	139	159	337	48	79	22	62	428	57
38	*	A086049-1	48	138	256	442	18	80	27	38	553	18
39		A086042-3	62	128	174	364	38	77	32	56	470	38
40		A086034-1	47	144	97	288	64	87	27	2	330	76
41	*	A086030-3	157	168	66	391	29	66	149	31	590	9
42	*	A086026-1	61	183	229	473	10	87	33	19	546	19
43		A086024-2	112	140	0	252	74	59	150	24	429	56
44	*	A086022-2	70	143	49	262	71	68	70	51	388	66
45		A086019-1	74	140	67	281	66	73	44	46	387	67

Table 2. (contd) Tuber yield by grade for entries in the Preliminary Yield Trial, Klamath Experiment Station, OR. 1990.

Entry No.	Selection	Yield U.S. No 1's 4-6 oz	6-10 oz	>10 oz	Total	Rank	%	Yield B's	2's	Total	Rank
		---- cwt/A ----						---- cwt/A ----			
46	A086016-3	38	53	52	143	86	66	27	39	218	85
47 *	A086011-3	83	213	167	463	11	83	63	29	561	15
48	A086006-3	79	169	36	284	65	66	42	79	433	53
49	A085130-3	60	106	203	369	36	81	22	51	458	44
50	A085027-2	84	142	116	342	45	78	45	25	437	51
51	A085027-4	54	109	77	240	77	75	48	18	320	78
52	A085018-4	56	172	191	419	22	74	46	63	566	13
53 *	A085018-6	167	235	50	452	15	70	113	61	647	5
54	A085017-4	49	151	51	251	75	91	24	0	276	82
55	A085017-6	95	175	126	396	28	73	48	61	541	22
56	A085014-1	108	210	32	350	42	74	89	31	476	36
57	A084508-6	69	160	161	390	31	90	25	13	431	55
58 *	A084508-11	87	203	95	385	32	77	76	26	498	29
59	A083247-1	91	122	17	230	79	60	104	34	385	69
60	A083203-1	109	174	115	398	27	68	49	116	589	10
61	A083203-2	44	165	203	412	24	69	20	127	594	8
62	A083202-1	109	225	153	487	9	76	53	77	645	6
63 *	A083202-2	117	203	140	460	12	75	49	74	614	7
64	A080189-202	86	165	89	340	46	70	51	50	483	33
65	A080202-216	71	201	77	349	43	70	39	82	496	30
66	A083020-201	74	86	20	180	83	65	76	10	278	81
67 *	A083026-202	111	219	94	424	19	84	72	8	507	27
68	A083081-206	73	147	83	303	60	72	44	49	418	61
69	A083108-201	118	115	55	288	63	67	90	32	432	54
70	A083131-203	85	96	13	194	82	56	136	11	348	75
71	A083139-203	114	197	5	316	55	77	73	11	413	63
72	A083146-202	91	160	72	323	53	83	48	18	391	65
73 *	A083221-204	67	181	265	513	6	89	17	21	578	12
74	A083225-201	121	123	19	263	70	68	79	22	385	68
75	A083338-201	124	159	13	296	62	67	136	0	439	50
76	87 TR 2210-1	104	167	53	324	52	86	42	11	378	71
77	87 TR 2275-9	96	210	109	415	23	80	38	47	522	25
78 *	A077224-3	85	203	102	390	30	79	57	41	495	31
79 *	A79180-10	92	193	215	500	7	89	44	18	564	14
80	A79216-1	63	159	76	298	61	84	38	7	355	73
81	A81478-1	30	114	115	259	72	82	14	36	316	79
82	A81480-6	51	181	178	410	25	86	28	26	475	37
83	A081775-3	66	190	116	372	35	86	37	25	435	52
84 *	A82611-12	106	151	46	303	59	72	92	19	420	60
85 *	A82622-52	78	199	87	364	39	88	27	21	413	62
86 *	A8390-3	128	243	150	521	5	89	36	20	588	11
87	A08478-1	76	184	70	330	51	72	56	36	461	43

* Advanced to the Statewide Trial for 1991

Table 3. Performance of entries in the Oregon Statewide Trial, Klamath Experiment Station, OR. 1990.

Entry No.	Selection	Stand %	Vigor rating[1]	Maturity rating[2]	Specific Gravity	H.H.[3] %	Comments[4]
1	Russet Burbank	98	4.8	3.3	1.085	0	Rough
2	Lemhi Russet	98	3.8	3.0	1.090	23	Rough
3	Norgold	89	3.8	2.0	1.073	10	
4	Norkotah	98	3.0	2.5	1.067	5	
5	Norchip	90	3.3	2.0	1.084	3	
6	Century Russet	96	3.8	3.5	1.081	0	Skinning, Rough
7	A74212-1E	98	4.5	3.0	1.079	0	Skinning
8	C008014-1	97	3.3	2.8	1.078	10	Skinning, Coarse, Flat
9	A082283-1	89	3.3	3.8	1.082	18	YF, Flat, Skinning
10	A082611-7	98	3.8	3.0	1.085	0	Nice, Smooth
11	C0083008-1	93	4.0	3.5	1.086	0	Flat
12	A083037-10	89	3.3	4.0	1.077	15	Flat
13	A083177-6	94	4.3	3.8	1.081	0	Skinning, IPS
14	A082281-1	92	3.0	4.0	1.083	20	Coarse, Ugly
15	A083196-15	88	3.8	2.5	1.080	28	Nice, Pointy
16	ND02845-1	82	3.0	4.5	1.074	3	Pink eyes, Skinning
17	ND02904-7	92	4.0	2.8	1.076	0	Nice, Flat
18	ND03057-2	97	3.8	2.0	1.066	0	
19	C0084206-2	95	2.8	2.5	1.074	0	White flesh, Nice
20	A084050-2	94	3.0	3.8	1.093	18	Round
21	A084134-1	96	2.3	2.8	1.094	30	
22	A084172-6	97	3.8	2.5	1.087	5	Mix, White-YF
23	C0084026-201	88	3.5	2.0	1.081	8	
24	C0084055-205	78	2.0	4.3	1.085	15	Skinning, Green
25	A084515-2	98	2.5	3.0	1.080	8	All IPS
26	A085004-3	97	4.0	2.8	1.084	30	
27	A085010-1	93	3.5	4.0	1.085	15	GC
28	A085010-10	98	3.8	3.0	1.090	3	IPS
29	A085027-1	97	4.0	3.0	1.083	10	Skinning
30	A085031-7	98	4.5	3.3	1.080	25	Flat, EH
31	A085066-2	95	4.3	2.3	1.073	3	Coarse
32	A085116-1	88	2.0	3.0	1.078	0	
33	A085164-2	98	3.0	3.3	1.087	5	Smooth, Pear shape
34	A085165-1	98	3.3	3.5	1.078	13	Smooth, Nice
35	A085165-2	97	3.3	2.5	1.084	40	Skinning, Ugly
36	A085205-2	93	3.3	3.8	1.087	8	Small, Nice
37	A085224-1	97	3.8	3.0	1.088	5	Crooked
38	A085257-2	93	3.3	3.0	1.095	15	Pointy, Poor
39	A085334-1	91	2.8	2.8	1.078	3	Flat, Skinning
40	C0085004-1	92	1.8	4.0	1.096	0	Skinning, GC
	Average	94	3.4	3.1	1.082	10	
	CV (%)	--	---	---	0.4	--	
	LSD (.05)	--	---	---	.006	--	

1/ Vigor rating - vine size - (1 - small, weak; 5 - large, robust)
2/ Maturity rating - vines Sept. 8 - (1 - dead; 5 - green, lush)
3/ H.H. - hollow heart - percent in 10 largest tubers/sample
4/ Comments - EH - elephant hide; GC - growth cracks;
IPS - internal purple spots; YF - yellow flesh

Table 4. Tuber yield by grade for entries in the Oregon Statewide Trial, Klamath Experiment Station, OR. 1990.

Entry No.	Selection	Yield U.S. No 1's 4-6 oz	6-10 oz	>10 oz	Total	Rank	%	Yield B's	2's	Total	Rank
		cwt/A					%	cwt/A			
1	Russet Burbank	108	204	93	405	19	72	83	63	563	8
2	Lemhi Russet	85	172	128	385	25	82	23	48	471	22
3	Norgold	81	214	93	388	24	86	33	20	450	9
4	Norkotah	84	172	118	374	27	82	52	23	454	27
5	Norchip	100	182	46	328	32	78	58	26	423	32
6	Century Russet	76	211	225	512	4	87	32	27	590	5
7	* A74212-1E	138	242	199	579	1	89	36	24	651	1
8	* C008014-1	73	179	84	336	30	81	36	31	413	33
9	* A082283-1	102	214	150	466	10	86	30	36	539	12
10	* A082611-7	101	172	185	458	11	85	49	24	539	13
11	* C0083008-1	65	177	154	396	21	83	28	32	476	21
12	* A083037-10	62	142	293	497	7	86	13	48	581	6
13	* A083177-6	73	196	177	446	13	84	34	40	534	14
14	* A082281-1	71	153	158	382	26	84	29	36	456	26
15	A083196-15	83	170	146	399	20	86	40	19	466	25
16	ND02845-1	67	157	81	305	35	77	26	27	397	34
17	**ND02904-7	83	225	266	574	2	93	25	7	617	4
18	* ND03057-2	119	196	102	417	17	79	69	30	526	18
19	C0084206-2	103	224	131	458	12	87	34	16	527	17
20	A084050-2	102	201	114	417	18	87	33	17	481	20
21	A084134-1	76	156	115	347	29	79	30	35	441	31
22	A084172-6	107	179	63	349	28	77	70	13	451	28
23	C0084026-201	79	188	179	446	14	82	32	54	544	11
24	C0084055-205	40	123	94	257	39	76	37	37	338	40
25	A084515-2	71	157	271	499	6	89	21	24	559	9
26	A085004-3	77	148	66	291	36	78	61	8	373	36
27	* A085010-1	57	134	130	321	33	72	25	52	448	30
28	A085010-10	128	259	148	535	3	84	48	36	638	3
29	A085027-1	81	175	213	469	9	86	31	25	545	10
30	* A085031-7	92	216	192	500	5	78	36	83	643	2
31	* A085066-2	61	142	133	336	31	86	28	18	392	35
32	A085116-1	47	135	65	247	40	71	36	39	347	38
33	A085164-2	97	225	71	393	23	84	53	11	468	23
34	* A085165-1	86	212	186	484	8	85	34	33	571	7
35	* A085165-2	70	207	149	426	16	81	45	45	529	16
36	A085205-2	105	145	11	261	38	73	90	2	356	37
37	A085224-1	85	155	73	313	34	67	98	34	468	24
38	A085257-2	51	166	175	392	23	76	32	51	512	19
39	A085334-1	49	129	257	435	15	85	34	40	530	15
40	C0085004-1	51	140	80	271	37	80	31	23	340	39
	Average	82	180	140	402	--	82	41	31	491	--
	CV (%)	32	22	38	18	--	--	40	85	15	--
	LSD (.05)	37	55	74	99	--	--	23	38	104	--

* Retained for future evaluation
** Advanced to Tri-State

Table 5. Performance of entries in the Western Regional Trial, Klamath Experiment Station, OR. 1990.

Selection	Stand 6/28	Stand 7/9	Vine vigor	Maturity rating	Specific Gravity	H.H. %
	------ % -----					
AC77101-1	88	91	3.3	3.0	1.079	55
AC7869-17	96	98	3.0	3.8	1.082	10
AC81198-11	88	92	2.8	4.3	1.083	10
A082283-1	83	88	3.3	4.3	1.088	38
A082611-7	95	99	4.3	4.0	1.090	5
Century Russet	98	99	3.8	4.0	1.087	5
C07918-11	83	90	2.8	3.5	1.078	65
C08011-5	73	83	1.5	3.8	1.074	0
TND329-1	86	96	2.8	2.8	1.060	3
NDTX8-731-1R	98	99	3.0	3.3	1.059	8
A74212-1E	93	98	4.3	3.8	1.081	0
A083177-6	91	93	4.5	4.3	1.089	3
C082142-4	95	98	2.8	3.5	1.084	35
C0083008-1	98	99	3.8	4.0	1.092	8
ND 671-4 Rus	90	98	3.5	3.0	1.067	23
ND 1538-1 Rus	93	98	3.8	2.0	1.073	15
ND 2224-5R	89	93	2.8	2.5	1.065	3
Russet Burbank	97	98	4.5	3.5	1.090	8
Lemhi Russet	88	95	3.0	4.0	1.090	65
Cal-Ore	83	84	2.5	3.8	1.082	43
Calgold	80	88	2.3	2.5	1.065	30

Table 6. Tuber yield by grade for entries in the Western Regional Trial, Klamath Experiment Station, OR. 1990.

Selection	Yield U.S. NO 1's 4-6 oz	6-10 oz	>10 oz	Total	Yield B's	No 2's	Culls	Total
	----------	----------	----------	cwt/A	----------	----------	----------	----------
AC77101-1	58	223	133	414	35	49	13	511
AC7869-17	43	160	150	353	26	45	22	446
AC81198-11	27	114	82	223	26	95	202	546
A082283-1	109	204	67	380	51	34	19	484
A082611-7	96	230	95	421	61	27	15	524
Century Russet	80	236	183	499	53	21	10	584
C07918-11	64	185	54	303	49	40	75	467
C08011-5	29	129	126	284	43	53	16	396
TND329-1	46	127	60	233	66	17	7	323
NDTX8-731-1R	78	204	160	422	21	19	29	511
A74212-1E	106	293	107	506	62	12	20	600
A083177-6	76	254	193	523	36	13	21	592
C082142-4	72	182	144	398	41	59	14	512
C0083008-1	78	222	99	399	28	16	25	468
ND 671-4 Rus	66	180	83	329	69	4	20	422
ND 1538-1 Rus	81	177	146	404	37	35	29	505
ND 2224-5R	104	166	26	296	75	8	12	390
Russet Burbank	101	212	103	416	73	47	28	564
Lemhi Russet	63	192	153	408	47	61	14	530
Cal-Ore	38	113	19	170	57	11	10	248
Calgold	92	123	115	330	35	25	26	414
Average	72	187	109	368	47	33	30	478
CV (%)	48	25	33	17	33	92	68	12
LSD (.05)	49	67	51	88	22	43	29	80

Table 7. Performance of eight selections in the Early Russet Trial, Klamath Experiment Station, OR. 1990.

Selection	Stand June 21	Stand June 28	Vigor rating	Maturity rating	Specific gravity	H.H. %
	-------- %	-------				
Russet Norkotah	81	92	4.3	2.5	1.070	3
Krantz	61	85	3.0	3.5	1.075	10
Frontier Russet	68	96	2.8	3.3	1.079	13
HiLite Russet	67	94	3.3	3.0	1.074	18
Cal-Ore	46	85	2.5	3.8	1.080	23
A74212-1E	76	91	4.0	4.0	1.080	0
Century Russet	81	97	4.3	4.5	1.081	0
C008014-1	72	91	4.5	3.5	1.083	3
Average	69	91	3.6	3.5	1.078	9
CV (%)	--	--	---	---	0.3	--
LSD (.05)	--	--	---	---	.005	--

Table 8. Tuber yield by grade for eight selections in the Early Russet Trial, Klamath Experiment Station, OR. 1990.

Selection	Yield U.S. No 1's				Yield			
	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Total
	------------------------			cwt/A	------------------------			
Russet Norkotah	81	173	68	322	87	12	6	427
Krantz	95	181	107	383	38	35	9	465
Frontier Russet	85	188	121	394	39	30	8	471
HiLite Russet	88	134	55	277	84	11	8	380
Cal-Ore	62	84	11	157	88	5	4	254
A74212-1E	106	207	88	401	71	12	5	489
Century Russet	114	236	137	487	57	16	8	568
C008014-1	97	172	50	319	50	29	14	412
Average	91	172	80	343	64	19	8	433
CV (%)	23	23	53	23	22	58	119	20
LSD (.05)	31	58	62	118	21	16	14	129

Table 9. Tuber yield by grade for Russet Burbank and five numbered selections under two cultural management regimes, Klamath Experiment Station, OR. 1990.

Selection	Yield U.S. No. 1's 4-6 oz	6-10 oz	>10 oz	Total	Yield B's	No 2's	Culls	Total
	cwt/A							
8.7-inch seed spacing, 150 lbs N/A								
Russet Burbank	150	167	56	373	85	24	14	496
A085010-4	57	141	154	352	19	34	40	445
A085010-13	106	138	32	276	51	76	97	500
A085010-14	96	181	151	428	50	28	12	518
A085035-1	98	156	55	309	64	38	18	429
A085069-1	70	123	253	446	21	32	10	509
Average	96	151	117	364	48	39	32	483
CV (%)	35	19	28	12	33	48	76	13
LSD (.05)	50	44	49	64	25	28	37	93
12.0-inch seed spacing, 200 lbs N/A								
Russet Burbank	87	164	75	326	60	34	9	429
A085010-4	54	102	103	259	18	70	71	418
A085010-13	74	117	27	218	48	70	108	444
A085010-14	106	151	116	373	42	14	6	435
A085035-1	105	166	80	351	56	34	8	449
A085069-1	56	111	184	351	14	18	32	415
Average	81	135	97	313	40	40	39	432
CV (%)	36	25	47	18	38	58	45	16
LSD (.05)	43	51	69	86	23	35	27	102

Culinary Quality Evaluations of Potato Selections

K.A. Rykbost and J. Maxwell[1]

INTRODUCTION

The evaluation of culinary quality of potato selections is a part of the total contribution of KES to the statewide and regional potato variety development programs. The development of standardized techniques to detect subtle differences in flavor and texture is beyond the scope of the KES program; however, the identification of obvious quality weaknesses in early generation selections is a worthwhile and attainable objective. Early elimination of selections with serious quality deficiencies will save time and resources in the total effort.

The evaluation of fry color has been a routine part of testing programs at other Oregon locations for several years. Equipment for french fry testing was installed in the KES potato quality laboratory in 1990. French fry color evaluations were conducted on all entries in the Preliminary, Statewide, and Western Regional variety trials.

The KES capability for evaluations of boiled, oven-baked, and microwave-baked potatoes is unique in the Oregon program. All entries in the Statewide, Western Regional, and Advanced Red-Skinned trials were evaluated. Only entries that were promoted from the Preliminary trial were tested.

PROCEDURES

During grading of field samples, 15-pound sub-samples of No. 1's, in the 6- to 10-ounce size fraction, were sorted and saved from one replication of each trial. Potatoes were stored at approximately 45° F and 95 percent relative humidity until cooking tests were conducted in late November and early December.

Five 10-ounce tubers were used for french fry tests. Potatoes were peeled with a Daisy Stripper electric peeler and cut in 3/8-inch fry strips with a Keen-Cut french fry cutter. Two center strips from each tuber were fried for 3.5 minutes at 375° F in Burger King frying oil. The fry color of each strip was scored by comparison with the standard USDA fry color chart.

For boiling tests, 6-ounce tubers were washed, peeled, and boiled whole. Four tubers of a single selection were cooked in one pot, with four pots used simultaneously. Tubers were placed in three quarts of cold water, brought to a boil, and boiled for 30 minutes.

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Oven-baking samples were 8- to 10-ounce tubers which were washed and punctured just prior to cooking. Four tubers of four selections were baked simultaneously on baking sheets for one hour at 400° F. After 30 minutes, samples were rotated from top to bottom shelves, or vice-versa, to achieve even heating.

Four 8- to 10-ounce tubers of each of two selections were baked simultaneously in a 700-watt microwave. Tubers were punctured prior to cooking, rotated from top to bottom shelf and turned over at ten minutes, and cooked at full power for a total of 20 minutes.

All quality ratings were done by one individual. In boiling tests, tubers were rated for sloughing, after-cooking darkening, flavor, and texture. Sloughing ratings were as follows: 1) deep sloughing through the vascular ring; 2) some sloughing of the surface not deeper than the vascular ring; 3) minor bubbling at the surface of at least three tubers; 4) none. After cooking, darkening was rated 30 minutes after completion of cooking. The rating scale ranged from 1 (severe darkening) to 4 (no discoloration). Flavor ratings were from 1 (poor) to 4 (excellent). Texture ratings were from 1 (soggy) to 4 (mealy). Texture and flavor were scored within five minutes of the completion of cooking. Total scores were calculated by adding scores for each parameter and cooking method. Higher total scores correspond to better overall quality.

Tests were conducted by method in sequence. All french fry tests were completed first, followed in order by boiling, oven baking, and microwave baking.

RESULTS AND DISCUSSION

Storage temperatures were approximately 45° F by the time fry tests were conducted in late November. This results in the buildup of reducing sugars in most selections and dark fry color was anticipated. In the USDA color chart rating system a color of 1 would be marginally acceptable for institutional grade product. Color ratings of 2 or darker are only acceptable for retail product. Fry color ratings presented (Table 1-3) were derived by multiplying the number of strips at a given color by the color designation (0.1 was used for 0 color), summing the total, and dividing by 10.

Russet Burbank fry color was light enough to indicate that with proper storage management, acceptable french fry quality was achieved in 1990 under the conditions of these experiments. Lemhi had lighter fry color than Russet Burbank in the Statewide and Western Regional trails. Several selections were better than or equivalent to Russet Burbank in fry color in each variety screening trial. As expected, Norkotah, Century Russet, and A74212-1E fried dark in every case.

Potato selections can vary widely in the time required for complete cooking. Differences were observed in these tests and in some cases over or under cooking of samples accounts in part for excessive sloughing and poor texture ratings. In refined quality evaluations, cooking times would need to be adjusted for individual selections. For the purposes of selection screening the additional effort is probably not justifiable.

Sloughing of tuber flesh from peeled tubers during boiling was observed in most selections in the Preliminary, Statewide, and Western Regional trials (Tables 1, 2, and 3), but was not common among red-skinned varieties (Table 4). The extent of sloughing was partially due to boiling whole tubers for a longer time. Frequently in home cooking, potatoes are cut into smaller pieces to reduce cooking time. This test may be invalid unless cooking times are adjusted to compensate for selection-specific cooking time requirements. In 1989 tests, moderate to serious sloughing was noted in about one-third of the selections. In the 1990 tests, serious sloughing occurred in about one-third of the russet-skinned selections.

Only one selection, the red AD81567-4R, exhibited an after-cooking darkening problem (Table 4). Most selections were either free of darkening completely or had slight darkening in one or more cooking tests. Cooking method did not appear to influence the expression of darkening.

Texture ratings were not consistent across cooking methods. Seven selections were rated poor in boiling tests, only two in oven baking tests, and none in microwave baking tests. The only selections to exhibit consistently poor to fair texture were the red-skinned selections AD81567-4R, ND2224-5R, and LA 12-59 (Table 4).

Potential flavor deficiencies were noted in two selections, ND02955-6 and CO086149-4, in the Preliminary Yield trial (Table 1). In the Statewide trial, poor flavor was observed in ND02845-1 in both baking tests. This selection did not demonstrate a flavor problem in 1989 tests. In the Western Regional trial, C07918-11 was rated poor for flavor when oven baked. In 1989, it rated poor in both baking tests and only fair in the boiling test. Both of these selections were discarded from programs after the 1990 season. The Cal-Ore and Calgold selections were also downgraded for flavor in both baking tests. Among red varieties, LA 12-59 and AD81567-4R demonstrated flavor deficiencies.

Russet Burbank had a rating of 36 or 37 in each trial. Lemhi was rated at 28, 31, and 35. Selections with a total score below 30 are probably deficient in more than one parameter and should be evaluated in more depth. On that basis, CO086149-4 from the Preliminary trial, three selections in the Statewide trials, and two of the red-skinned selections may require additional evaluation.

SUMMARY AND CONCLUSIONS

The results of these tests must be considered quite preliminary. However, they should be useful in identifying potentially serious quality deficiencies at an early stage in the variety screening processing. Follow-up testing of suspect selections with larger sample size, replicated tests, and several evaluators will be carried out in the future. Evaluations at other locations should also be conducted for those few selections which appear to have serious limitations.

Table 1. Culinary quality ratings of selections in the 1990 Preliminary Yield trial, Klamath Experiment Station, OR.

Entry No.	Selection	Slough	Darkening Boil	Darkening Oven bake	Darkening Micro bake	Texture Boil	Texture Oven bake	Texture Micro bake	Flavor Boil	Flavor Oven bake	Flavor Micro bake	Total score	Fry color
1	Russet Burbank	2	4	4	4	4	4	3	3	4	4	36	1.0
2	Lemhi	1	4	4	4	1	2	2	3	4	3	28	2.0
3	Norgold	3	4	4	4	4	4	2	3	3	4	35	4.0
4	Norkotah	4	4	4	4	4	3	4	4	4	4	39	2.6
11	ND02955-6	3	4	4	3	4	4	3	4	2	2	33	1.0
14	ND02667-12	1	4	4	4	4	4	2	3	4	3	33	2.0
16	C0086222-3	4	4	4	4	4	4	3	3	3	4	37	2.5
20	C0086149-3	2	4	4	4	3	3	3	4	1	3	31	1.3
21	C0086149-4	2	4	4	3	1	3	3	2	2	3	27	1.5
23	C0086106-1	2	4	4	3	4	4	3	4	3	2	33	1.0
24	C0086058-1	3	4	4	4	4	4	2	4	4	3	36	2.0
25	C0086042-2	3	4	3	3	4	4	3	4	4	3	35	2.4
31	A086097-6	2	4	4	4	4	4	3	2	4	4	35	2.0
34	A086078-3	2	4	3	3	4	3	3	3	3	3	31	2.0
36	A086058-4	2	4	4	4	4	4	3	4	4	3	36	2.0
37	A086057-5	2	4	4	3	4	4	4	4	4	4	37	1.5
38	A086049-1	2	4	4	4	4	4	2	3	3	3	33	2.7
41	A086030-3	2	4	4	4	4	3	3	3	3	4	34	1.2
42	A086026-1	2	4	4	4	2	3	3	2	3	4	31	2.4
44	A086022-2	3	4	4	4	4	3	4	3	4	4	37	0.1
47	A086011-3	1	4	4	4	2	4	3	3	4	4	33	1.0
53	A085018-6	1	4	4	4	4	2	3	3	3	3	31	2.2
58	A084508-11	2	4	4	4	2	4	3	3	4	4	34	3.0
63	A083202-2	2	4	4	4	3	4	4	3	3	4	35	3.7
67	A083026-202	3	4	4	4	4	4	3	3	4	2	35	1.5
73	A083221-204	2	4	4	4	4	4	3	3	4	3	35	1.4
78	A077224-3	3	4	4	4	4	3	2	4	4	3	35	3.0
79	A79180-10	4	3	4	4	4	4	3	3	4	4	37	3.0
84	A82611-12	3	4	4	4	3	2	3	4	3	4	34	1.5
85	A82622-52	2	4	4	4	4	4	4	3	4	4	37	2.5
86	A8390-3	1	4	4	4	3	3	3	4	4	4	34	1.0

Table 2. Culinary quality ratings of selections in the 1990 Statewide trial, Klamath Experiment Station, OR.

Entry No.	Selection	Slough	Darkening Boil	Darkening Oven bake	Darkening Micro bake	Texture Boil	Texture Oven bake	Texture Micro bake	Flavor Boil	Flavor Oven bake	Flavor Micro bake	Total score	Fry color
1	Russet Burbank	2	4	4	4	4	4	4	3	4	4	37	1.0
2	Lemhi	1	4	4	4	4	4	4	3	4	3	35	0.4
3	Norgold	1	4	4	4	4	2	3	3	3	4	32	3.0
4	Norkotah	1	4	3	3	4	3	3	4	3	4	32	3.0
5	Norchip	3	4	4	4	4	2	3	4	3	3	34	0.3
6	Century	2	4	4	4	4	4	3	4	3	4	36	4.0
7	A74212-1E	2	4	4	4	4	4	3	4	3	4	36	4.0
8	C008014-1	1	4	4	4	4	2	4	4	4	3	34	1.3
9	A082283-1	1	4	4	4	4	2	3	3	3	4	32	0.1
10	A082611-7	2	4	4	4	2	3	2	3	4	3	31	1.4
11	C0083008-1	2	4	4	4	4	3	4	4	3	4	36	0.5
12	A083037-10	2	4	4	4	4	2	4	3	3	4	34	3.0
13	A083177-6	1	4	4	4	2	4	3	3	3	4	32	1.0
14	A082281-1	1	4	4	3	1	4	3	2	3	3	28	3.0
15	A083196-15	1	4	4	4	1	4	3	3	3	2	29	2.2
16	ND02845-1	1	4	4	2	4	2	2	4	1	2	26	3.3
17	ND02904-7	1	4	4	4	4	2	2	4	3	3	31	1.6
18	ND03057-2	3	4	4	4	4	3	4	4	3	4	37	3.0
19	C0084206-2	2	4	4	4	3	2	3	3	3	2	30	2.3
20	A084050-2	1	4	4	4	4	2	4	3	4	4	34	2.7
21	A084134-1	3	4	4	4	3	4	4	2	4	4	36	1.0
22	A084172-6	1	4	4	4	4	4	3	1	3	3	31	1.9
23	C0084026-201	2	4	4	4	4	4	3	3	4	4	36	2.5
24	C0084055-205	2	4	4	4	4	4	4	3	4	4	37	2.3
25	A084515-2	2	4	4	4	4	4	3	2	3	4	34	3.6
26	A085004-3	1	4	4	4	1	2	3	3	4	4	30	0.5
27	A085010-1	3	4	4	4	4	3	3	3	4	4	36	3.4
28	A085010-10	1	4	4	4	1	3	3	2	4	4	30	3.0
29	A085027-1	1	4	4	4	4	4	3	4	4	4	36	2.0
30	A085031-7	2	4	4	4	3	3	4	3	4	4	35	2.4
31	A085066-2	2	4	4	4	4	2	3	4	1	4	32	1.0
32	A085116-1	2	4	4	4	4	4	4	4	3	4	37	2.6
33	A085164-2	1	4	4	4	3	4	3	4	4	3	34	1.0
34	A085165-1	2	4	4	4	4	4	4	3	3	4	36	2.5
35	A085165-2	1	4	4	4	4	2	4	4	3	3	33	1.5
36	A085205-2	1	4	4	4	2	2	4	2	3	4	30	1.5
37	A085224-1	1	4	4	4	4	4	3	4	4	4	36	0.8
38	A085257-2	1	3	4	4	2	2	4	2	4	4	30	2.0
39	A085334-1	2	4	4	4	4	3	3	4	2	3	33	2.5
40	C0085004-1	2	4	4	4	4	4	2	3	4	3	34	1.0

Table 3. Culinary quality ratings of selections in the 1990 Western Regional trial, Klamath Experiment Station, OR.

Entry No.	Selection	Slough	Darkening			Texture			Flavor			Total score	Fry color
			Boil	Oven bake	Micro bake	Boil	Oven bake	Micro bake	Boil	Oven bake	Micro bake		
1	Russet Burbank	1	4	4	4	4	4	4	4	3	4	36	1.5
2	Lemhi	1	2	4	3	4	3	4	3	4	3	31	0.5
3	Cal-Ore	4	3	4	4	2	2	4	3	1	2	29	2.7
4	Calgold	4	2	4	3	4	3	2	4	2	2	30	4.0
5	AC77101-1	1	4	3	4	1	4	4	3	3	4	31	3.0
6	AC7869-17	2	4	3	4	4	2	4	3	3	4	33	1.0
7	AC81198-11	1	4	4	4	4	4	3	4	4	4	36	3.0
8	A082283-1	1	4	4	4	4	3	4	4	4	4	36	0.3
9	A082611-7	1	4	4	4	4	2	3	3	3	4	32	2.3
10	Century	3	4	4	4	4	4	4	4	3	4	38	3.0
11	C07918-11	1	4	3	4	4	3	4	4	1	4	32	2.7
12	C08011-5	4	4	4	3	4	3	4	4	3	3	36	4.0
13	TND329-1	4	3	3	4	3	4	3	3	3	4	34	1.0
14	NDTX8-731-1R	2	4	4	4	2	4	3	4	3	4	34	4.0
15	A74212-1E	1	4	4	4	4	4	3	3	3	4	34	3.0
16	A083177-6	1	4	4	4	3	4	4	3	4	4	35	1.5
17	C082142-4	2	4	3	4	4	4	4	4	3	4	36	4.0
18	C0083008-1	1	4	4	4	3	3	4	4	4	4	35	2.1
19	ND671-4 RUS	2	4	4	4	4	4	3	3	4	3	35	3.0
20	ND1538-1 RUS	1	4	4	4	4	4	3	4	3	3	34	3.2
21	ND2224-5R	3	4	4	4	3	3	2	4	4	3	34	3.2

Table 4. Culinary quality of selections in the 1990 Advanced Red-Skinned Variety trial, Klamath Experiment Station, OR.

Selection	Slough	Darkening			Texture			Flavor			Total score
		Boil	Oven bake	Micro bake	Boil	Oven bake	Micro bake	Boil	Oven bake	Micro bake	
Red LaSoda	4	4	4	3	3	4	3	4	3	3	35
Red Pontiac	4	4	4	4	3	3	4	4	3	4	37
Chieftain	4	4	2	4	4	2	4	4	3	4	35
Red Norland	4	4	4	2	3	4	2	4	4	2	33
Dark Red Norland	3	4	3	4	4	4	3	4	4	4	37
Red Cloud	4	4	4	4	3	4	4	3	3	4	37
Sangre	4	4	4	4	3	2	3	3	4	4	35
Viking	3	4	4	4	4	4	4	4	4	4	39
AD81567-4R	3	2	1	4	2	1	3	1	3	2	22
A82705-1	4	4	4	4	4	4	3	4	3	4	38
ND2224-5R	4	4	2	4	2	2	3	3	2	4	30
LA 12-59	3	4	3	3	2	1	2	3	1	1	23

Effects of Planting Density and Nitrogen Rate on the Performance of New Potato Varieties and Advanced Selections

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INTRODUCTION

The development of variety-specific management practices for new varieties and advanced selections of interest to the regional potato industry is an important component of the KES potato research program. Although Russet Burbank still accounts for nearly 90 percent of potato production in the Northwest and 75 percent of Oregon's crop, interest is growing in other cultivars. Most new varieties will not achieve their genetic potential when managed under conditions that are optimum for Russet Burbank.

Studies were initiated in 1987 to evaluate the effects of plant population and nitrogen fertilizer rates on performance of new varieties and advanced selections. These two aspects of cultural management affect yield, tuber size distribution, and the manifestation of physiological disorders. In 1990, seven named varieties and three numbered selections were evaluated.

NEW VARIETIES OF INTEREST IN THE REGION

Russet Norkotah

This early-maturing, long russet has exceptional appearance and is a favorite for buyers in the fresh market chain. It has replaced Norgold Russet as the early fresh market russet in the Northwest. Over 26,000 acres of Norkotah were produced in Oregon, Washington, and Idaho in 1990, making it the third leading variety in these states. Under ideal conditions Norkotah produces a high yield with a high percentage of No. 1's and a high pack out. However, it is very susceptible to early blight, verticillium wilt, white mold and black dot. In 1990, several fields in the Columbia Basin died prematurely from a condition diagnosed as current season infection of potato virus Y. It has been suggested that Norkotah should be planted with seed from no more than three field-grown generations. Norkotah is not suitable for processing.

HiLite Russet

This patented russet is marketed by Northwest Potato Sales. It is a mid-season, blocky, medium russet with good appearance, a high percentage of marketable yield, and acceptable quality for fresh market or processing use. HiLite is very susceptible to early blight and white mold. Excessive water in late season has resulted in tuber rot problems in several instances. Skinning and bruising have occurred under high nitrogen fertilization rates.

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Frontier Russet

This new release from Idaho and cooperating states is an early to medium maturing, long russet with good quality for fresh market and processing use. It has long dormancy and is reported to be equivalent to Russet Burbank in storability. Frontier achieves a high percentage of No. 1's and is less susceptible to physiological disorders than Russet Burbank. Tubers are not as long as Russet Burbank and tend to be pointed when Frontier is subjected to stress. In 1990, a severe reaction to current season infection with potato virus Y was observed in the Columbia Basin.

Cal-Ore

This very attractive heavy russet is under patent to Calgene. In two years of evaluation at KES, yields have been low and a serious hollow-heart incidence has been noted, even in small tubers. Virus infected seed has undoubtedly influenced yield. Cal-Ore does not appear to be an acceptable variety for the Klamath Basin.

Sierra

Sierra is a heavily-russetted, blocky variety with a short dormancy and medium-late maturity. Although grower interest has been high in the Klamath Basin and Kern County, California, seed availability and quality will limit production. Sierra is slow to emerge, sets tubers quite late, but experiences rapid tuber bulking. When seed quality has been good Sierra has produced high yields with good fresh market acceptance. Specific gravity is very low and Sierra is unacceptable for processing. It appears to be quite tolerant of fungal foliar diseases common to the Klamath Basin.

Atlantic

Atlantic is the second leading chipping variety in North America. It produces a high yield of round, buff colored tubers with a slight netting, high specific gravity, and low sugar content. It's use is increasing in the Northwest. Atlantic is susceptible to internal tuber necrosis in sandy soils in the Atlantic coastal region but this problem has not been observed in the Klamath Basin. It is resistant to one or more races of cyst nematodes present in several eastern regions but is susceptible to corky ringspot caused by tobacco rattle virus, vectored by stubby-root nematodes.

Gemchip

This is a newly released selection with white skin, round to oblong tubers, intermediate specific gravity, and acceptable sugar content for chipping. In the Klamath Basin yields have consistently exceeded Atlantic yields. In 1990, several fields in the Willamette Valley experienced early vine death, low specific gravity, and high sugar content. The cause of this problem has not been determined. Gemchip performed well in one commercial field in the Klamath Basin in 1990.

A7411-2 (Ranger)

This long russet is scheduled for release in 1991. It produces high yields with good processing quality and is less susceptible to dark ends when grown under stress than Russet Burbank. On mineral soils in the Klamath Basin A7411-2 has consistently produced excessive length and thin, often crooked tubers. These characteristics make its acceptance for fresh market use highly questionable.

A74212-1E

This is a blocky, light russetted selection out of Century Russet that produces an earlier vine maturity and a smoother, blockier tuber type than Century. Preliminary results indicate that it may be even higher in yield than the original Century selection. The light netting of both selections may be inadequate in organic soils. This selection will be evaluated in the Western Regional trials in 1991. It produces intermediate specific gravity but a high sugar content and is considered unacceptable for processing.

Century Russet

This blocky to long, light russet will become the first official release from the Oregon program in 1991. It has consistently produced very high yields with a high percentage of No. 1's. Vine maturity is late and skin set is slow to develop. Century has good resistance to verticillium wilt but is quite susceptible to tuber infection with early blight. In 1990, current season infection with potato virus Y caused dramatic yield reductions in Century Russet in the Columbia Basin. Century is very susceptible to damage at harvest and fusarium infection in storage.

CO08014-1

This processing selection is a blocky, medium russet with intermediate specific gravity. It has a tendency for flat tubers and folded bud ends. Hollow-heart and internal brown spots have been noted on occasion. A decision to release will depend on processor evaluations over the next year or two.

Krantz

Krantz is a medium maturity, oblong, medium russetted selection for fresh market use. An erect plant habit and modest plant size may account for good tolerance to foliar fungal diseases under Klamath Basin conditions. Yields are intermediate but much more consistent than for Russet Norkotah. Tubers are less attractive than Russet Norkotah and may display growth cracks when grown under stress or allowed to get excessively large. Krantz has not achieved wide acceptance in the Northwest but several growers in the Klamath Basin remain interested in this variety.

Shepody

In 1990, Shepody was the second leading variety grown in the Northwest, with over 27,000 acres produced for early season processing. This long white variety has excellent processing quality and reportedly achieved good yields and quality in the 1990 season in the Columbia Basin and the Treasure Valley area of Oregon and Western Idaho. Serious quality problems were experienced in Russet Burbank crops in these areas in 1990. The Shepody acreage is expected to increase in 1991. Shepody is very susceptible to common and powdery scab. Although it is also susceptible to potato virus Y, foliar symptoms are not well expressed and yield reductions are minor compared with severe losses observed in Century Russet, Russet Norkotah, and Frontier Russet. Shepody seed supplies remain very limited in the Western Region.

CULTURAL MANAGEMENT STUDIES

Procedures

Plant population and nitrogen fertilization responses of 10 varieties or advanced selections were evaluated in two separate experiments. Split-plot designs with four replications were employed. Standard management practices were used for weed control, disease and pest management, and irrigation.

The variety by seed spacing experiment was planted on May 18. Main-plot treatments were seed spacings of 6.8, 8.7, or 12.0 inches in 32-inch rows. Individual plots were two rows, 30 feet long. Fertilization included 600 lbs/A of 16-16-16 banded at planting and 60 lbs N/A applied as solution 32 and incorporated with a rolling cultivator on June 5. Vines were desiccated with diquat applied at 1.0 pint/A on September 17 and potatoes were harvested on October 3. Field weight of all tubers from both rows was determined. Approximately 120-pound samples from each plot were stored and graded in late October. Internal tuber quality was evaluated by cutting the ten largest tubers from each plot.

The variety by nitrogen rate experiment was planted on May 21. Main-plot treatments were N rates of 130, 160, or 190 lbs N/A achieved by supplementing 800 lbs/A of 16-16-16 banded at planting with 0, 30, or 60 lbs N/A applied on June 5. Plots were four rows, 30 feet long with Russet Burbank spaced at 12 inches in the two outside rows and test varieties uniformly spaced at 8.7 inches in the center rows. Vines were desiccated on September 17 and tubers were harvested on October 4. Total weights from the center two rows were determined in the field. Approximately 120 lbs/plot were stored and graded in late November.

Results and Discussion

I. Variety response to seed spacing:

Plant vigor was very poor in Cal-Ore. A seed borne mosaic virus infection was partially responsible. A variety mix was also noted with some plots exhibiting over 50 percent mix with an unknown variety. Sierra also experienced poor plant vigor. Emergence was very slow and uneven. Some plants were still emerging in late July. It appeared that this seed lot may have been exposed to a sprout inhibitor during the previous growing season or in storage. Final stands for Sierra were less than 60 percent (Table 1) and a portion of the plants emerged too late to contribute to yield. All other selections produced good stands and typical crop vigor.

Yields and quality were generally good for all selections except Cal-Ore (Table 1). The high yield at 8.7-inch spacing for Cal-Ore was due in part to the variety mix observed. Sierra produced relatively high yields considering the poor stands that were obtained. A74212-1E achieved the highest yield of No. 1's followed by Gemchip and C008014-1. Russet Norkotah, HiLite Russet, Frontier Russet, Sierra, and A7411-2 were very similar in total yield of No. 1's.

The effects of seed spacing were mainly changes in tuber size distribution rather than in total yield of No. 1's or total yield (Table 1). A significant interaction was found between variety and spacing for yield of tubers greater than 10 ounces, and for total yield of No. 1's. The spacing responses for Cal-Ore and Sierra were clearly influenced by poor stands and other factors. All other selections demonstrated quite typical response to plant population.

Excessive tuber size was observed in most selections at the 12.0-inch spacing (Table 1). Norkotah, Frontier, Atlantic, Gemchip, and A74212-1E were most noteworthy in this regard. With the exception of Norkotah, the yields declined at the lowest plant population. Atlantic, Frontier, and C008014-1 achieved the highest yield of No. 1's at the highest planting density. HiLite, Gemchip, A7411-2, and A74212-1E produced their highest yields at the intermediate spacing.

The incidence of hollow-heart was less than 30 percent in all selections and was not influenced by seed spacing. A74212-1E did not exhibit any hollow-heart. Only one tuber out of 120 examined was hollow in A7411-2. C008014-1, Sierra, Atlantic, and Frontier had less than 10 percent hollow-heart while HiLite, Norkotah, Cal-Ore, and Gemchip ranged from 15 to 25 percent. With the exception of Cal-Ore most hollow tubers were in excess of 16 ounces. No other internal disorders were noted in more than a few tubers.

Specific gravity was generally high in this experiment (Table 1). Atlantic and A7411-2 had the highest readings while Norkotah and Sierra were low in specific gravity. The relative rankings were as expected. Plant population had no effect on specific gravity.

A multi-year summary of the influence of seed spacing on seven selections is presented (Table 2). The summaries represent four years of data for Russet Norkotah and three years for the other selections. The seed spacings have been converted to equivalent spacing in the more common 36-inch row. All data are derived from similar experiments conducted at KES from 1987 through 1990.

Multiyear varietal response to plant population has been expressed in economic terms by estimating the crop value and the cost of seed at three planting densities. Crop value estimates are based on net price to growers for fresh market russets in the Klamath Basin in mid-December 1990. While this estimate would be high for crops contracted for chipping or french fry production it represents a reasonable average of fresh market prices over the past three seasons. The prices used are as follows: U.S. No. 1's 4-6 oz. - \$5.00/cwt; U.S. No. 1's 6-10 oz - \$8.00/cwt; U.S. No. 1's >10-oz - \$13.00/cwt; B's - \$1.00/cwt; No. 2's - \$4.00/cwt; culls - \$0.75/cwt.

A net crop value adjusted for seed costs was calculated assuming an average of 2.0 ounces/seed piece and a price of $12.00/cwt for cut and treated seed. The approximate seed requirements for spacings of 6, 8, and 10.5 inches in 36-inch rows are 36, 28, and 20 cwt/A, respectively.

Tuber yield and size distribution response to plant populations vary quite widely between varieties. Shepody and Century Russet achieved maximum economic return at the high plant density. Both varieties produce a high percentage of large tubers at relatively high planting density. At low planting density excessive size develops. Shepody demonstrated a lower total yield and a higher percentage of No. 2's and culls at the lowest planting density.

Krantz and Sierra produced optimum returns at the intermediate spacing. Russet Norkotah and A7411-2 performed best at a plant spacing typically used for Russet Burbank. The results for Atlantic must be tempered by the fact that excessive size is undesirable in chipping potatoes and no price incentive is paid for tubers over 10 ounces. Based on a chip contract the high plant density would produce the highest return for Atlantic.

II. Variety Response to Nitrogen Rate:

Plant vigor and performance was about the same as in the seed spacing trial for all selections. Cal-Ore and Sierra achieved lower yields than in the companion study (Table 3). Most other selections were similar in average yields in both trials. In yield of No. 1's, A74212-1E, Gemchip, A7411-2, and C008014-1 ranked first to fourth, respectively. Yields of U.S. No. 1's were about the same for Norkotah, HiLite, and Frontier.

Most of the selections achieved the highest yield of No. 1's at the intermediate N rate. A7411-2 was the only selection to show an economical response to the highest N rate. Several selections had yield increases of 40 to 60 cwt/A of No. 1's in response to the N rate increase from 130 to 160 lbs N/A. Russet Norkotah, Cal-Ore, Sierra and A74212-1E showed no advantage for N rates above the 130 lbs N/A rate. The results for Cal-Ore and Sierra were undoubtedly influenced by poor seed quality. The statistical analysis did not find a significant interaction between N rate and variety for any of the yield parameters.

Internal quality was not influenced by N rate. An average of 15 percent hollow heart was observed in the largest tubers. Cal-Ore had the highest incidence at 30 percent. HiLite and Gemchip exhibited 23 and 26 percent, respectively. Sierra, A7411-2, and A74212-1E had less than 5 percent hollowheart. Internal purple pigmentation was observed in a few Frontier Russet tubers. This has been seen previously in this selection. No other internal disorders were noted.

Specific gravity was generally high with all selections quite consistent with results observed in the seed spacing trial (Tables 1 and 3). Atlantic, A7411-2, and C008014-1 had the highest specific gravity. Russet Norkotah, HiLite Russet, and Sierra were quite low. At the rates evaluated, N rate did not influence specific gravity.

A multi-year summary of N-rate response for seven selections is shown (Table 4). Russet Norkotah's response has been inconsistent from year to year. Commercial crops would be topkilled and harvested earlier than has been the case in this trial. Based on the need for early maturity the optimum N-rate appears to be 130 lbs/A. Past experience has shown that higher rates will be required in fields with a history of early dying or early blight. Norkotah demonstrated this need in one year of this trial.

Century Russet has consistently been difficult to topkill and is slow to develop an adequate skin set. Although yield responses have been obtained at higher N-rates they are accompanied by an increased risk to quality. This variety will achieve very high yields at low N-rates with less risk of tuber damage at harvest.

In two years, Krantz achieved optimum yields at 190 lbs N/A. This variety has a weak plant type and apparently requires higher nitrogen levels to achieve optimum performance.

Ranger has been inconsistent in response to N-rate. In each of three years maximum yield of No. 1's has occurred at a different rate. the differences in yield are minimal for the three year average. The intermediate rate is probably appropriate for this selection.

Sierra has consistently produced higher yields at low N-rates. Slow emergence, late tuber initiation, and late vine habit are characteristic of this variety. Forcing vine maturity by using lower N-rates appears to be advantageous for Sierra.

Both Shepody and Atlantic have consistently performed best at the intermediate fertilization rate. This is consistent with experience in other regions. Shepody is currently being used as an early processing variety in the Columbia Basin and Treasure Valley areas. Experience in the eastern United States and Canada suggests that excessive nitrogen may negate the maturity advantage that Shepody has over Russet Burbank and may also have a negative impact on important processing quality parameters.

SUMMARY AND CONCLUSIONS

To place the performance responses observed for new varieties and advanced selections in perspective they should be compared with Russet Burbank. While Russet Burbank has not been included in these management trials, extensive data are available from other experiments for comparison purposes. Optimum seed spacing for Russet Burbank in the area is approximately 12 inches in 32-inch rows or 10.5 inches in 36-inch rows. This is the common planting density used in commercial fields. Research during the past three seasons has shown Russet Burbank requires 180 to 240 lbs N/A for optimum performance. In commercial crops 200 lbs N/A would be the minimum rate with some growers exceeding this by substantial amounts. Using these relative relationships as a guideline the data obtained in these trials should allow the extrapolation of local observations to other regions which enjoy longer growing seasons or have different soil conditions.

The accumulated experience from these and other experiments at KES provides a substantial data base for assessing the adaptability of new varieties to local conditions. Cal-Ore has consistently shown inferior yields and high susceptibility to hollow-heart. Although poor seed quality has contributed to yield performance, this variety is clearly not competitive with several of the new russets. A7411-2 (Ranger) produces high yields but has shown shape and type limitations for fresh market use. It is not recommended for mineral soils in the Klamath Basin as a fresh market variety. CO08014-1 has only been evaluated at KES for a limited time. It appears to be too flat and not long enough under local conditions to fit expectations for traditional russet markets. Russet Norkotah, Krantz, Frontier Russet and HiLite Russet have all demonstrated satisfactory performance at KES and should be considered as appropriate russets for fresh markets served by the Klamath Basin. Atlantic and Gemchip have performed very well at KES and in limited commercial production in the area.

Table 1. Effect of seed spacing on performance of ten potato selections. Klamath Experiment Station, OR. 1990.

Selection	Seed Spacing (inches)	Yield US No. 1's				Yield			Stand	Specific Gravity
		4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Total	%	
		cwt/A								
R. Norkotah	6.8	76	192	88	356	76	22	463	96	1.073
	8.7	66	185	97	348	61	27	452	96	1.073
	12.0	61	186	157	404	46	21	483	99	1.073
HiLite R.	6.8	87	189	64	340	93	9	456	97	1.076
	8.7	60	237	93	390	59	14	470	97	1.080
	12.0	48	172	134	354	44	14	425	98	1.080
Frontier R.	6.8	74	182	125	381	37	28	450	96	1.085
	8.7	39	156	166	361	23	31	422	97	1.085
	12.0	29	138	199	366	18	27	414	97	1.083
Cal-Ore	6.8	95	141	39	275	75	19	377	82	1.088
	8.7	52	157	161	370	34	70	503	90	1.086
	12.0	52	140	67	259	37	44	359	89	1.087
Sierra	6.8	89	184	81	354	54	25	455	52	1.074
	8.7	61	199	103	363	33	34	453	54	1.076
	12.0	54	170	98	322	25	43	431	51	1.071
Atlantic	6.8	100	234	114	450	60	12	550	96	1.095
	8.7	79	229	90	398	41	17	481	97	1.094
	12.0	76	199	133	408	37	19	488	97	1.095
Gemchip	6.8	97	250	136	483	63	4	557	88	1.084
	8.7	71	277	184	532	26	19	591	92	1.085
	12.0	52	199	208	459	25	26	526	89	1.086
A7411-2 (Ranger R.)	6.8	98	175	84	357	90	59	523	99	1.090
	8.7	66	201	123	390	66	86	561	98	1.091
	12.0	54	157	131	342	42	85	505	100	1.092
A74212-1E	6.8	91	208	203	502	49	26	597	93	1.083
	8.7	71	263	238	572	35	33	672	92	1.084
	12.0	56	186	280	522	31	28	611	97	1.081
C008014-1	6.8	81	215	154	450	30	58	560	86	1.085
	8.7	67	217	149	433	16	54	512	85	1.085
	12.0	45	179	180	404	23	55	499	90	1.088
Variety Main Effect: (average of three spacings)										
R. Norkotah		67	188	114	369	61	24	466	97	1.073
HiLite R.		65	199	97	361	65	12	450	97	1.079
Frontier R.		47	158	163	369	26	29	429	96	1.084
Cal-Ore		66	146	89	301	49	44	413	86	1.087
Sierra		68	185	94	346	38	34	446	52	1.074
Atlantic		85	221	112	418	46	16	507	96	1.095
Gemchip		73	242	176	491	38	17	558	89	1.085
A7411-2 (Ranger R.)		73	178	113	363	66	76	529	99	1.091
A74212-1E		73	219	240	532	38	29	626	94	1.083
C008014-1		65	204	161	429	23	56	524	87	1.086
CV (%)		24	15	25	12	29	46	9	--	0.9
LSD (.05)		14	23	28	38	11	13	36	--	0.003
Seed Spacing Main Effect: (average of ten selections)										
	6.8	89	197	109	395	63	26	499	89	1.083
	8.7	63	212	141	416	40	38	512	90	1.084
	12.0	53	173	159	384	33	36	474	91	1.084
CV (%)		28	22	35	20	45	36	16	--	0.9
LSD (.05)		10	24	26	NS	11	7	NS	--	NS

Table 2. Multi-year summary of the effect of seed spacing on performance of seven potato varieties, Klamath Experiment Station, OR. 1990.

Variety	Seed Spacing[1]	Yield U.S. No. 1's				Yield			Crop Value	
		4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Gross	Net[2]
	inches	cwt/A							$/A	
R. Norkotah	6	112	171	123	406	66	27	17	3,714	3,282
(4 years)	8	107	179	152	438	56	24	21	4,111	3,775
	10.5	84	153	181	418	38	15	20	4,110	3,870
Century R.	6	133	199	182	514	72	31	25	4,838	4,406
(3 years)	8	122	168	191	481	68	35	26	4,665	4,329
	10.5	102	151	198	451	44	40	27	4,516	4,276
Krantz	6	111	164	112	387	51	33	25	3,525	3,091
(3 years)	8	73	128	155	356	37	50	25	3,660	3,324
	10.5	64	107	156	327	25	39	22	3,402	3,162
A7411-2	6	123	162	93	378	81	79	33	3,542	3,110
(Ranger R.)	8	110	179	126	415	61	81	28	4,026	3,690
(3 years)	10.5	76	143	163	382	46	86	33	4,058	3,818
Sierra	6	118	148	105	371	70	34	34	3,371	2,939
(3 years)	8	124	195	98	417	63	29	23	3,650	3,314
	10.5	105	146	96	347	57	50	32	3,222	2,982
Atlantic	6	124	196	122	442	68	24	24	3,956	3,524
(3 years)	8	122	189	114	425	52	25	36	3,783	3,447
	10.5	93	163	149	405	49	38	30	3,930	3,690
Shepody	6	76	128	203	407	34	77	33	4,410	3,978
(3 years)	8	75	129	187	391	33	62	37	4,147	3,811
	10.5	59	94	188	341	25	73	50	3,846	3,606

1/ Seed spacing equivalent in 36-inch rows.
2/ Gross crop value less seed costs based on 2-ounce seed pieces at a seed price of $12/cwt.

Table 3. Effect of nitrogen rate on performance of ten potato selections. Klamath Experiment Station, OR. 1990.

Selection	N-Rate lbs/A	Yield US No. 1's 4-6 oz	6-10 oz	>10 oz	Total	Yield B's	No 2's	Total	Stand %	Specific Gravity
		----------	----------	cwt/A	----------	----------	----------	----------		
R. Norkotah	130	108	161	90	359	72	16	451	94	1.073
	160	110	150	63	323	86	20	436	94	1.071
	190	96	181	78	355	84	19	465	92	1.071
HiLite R.	130	108	149	63	320	73	6	406	90	1.073
	160	89	203	102	394	61	4	463	91	1.075
	190	89	188	100	377	63	8	457	89	1.073
Frontier R.	130	69	155	118	342	52	49	450	92	1.082
	160	72	154	140	366	41	47	458	95	1.079
	190	77	156	96	329	47	45	424	91	1.083
Cal-Ore	130	88	137	63	288	69	29	403	80	1.089
	160	85	121	23	229	83	20	341	83	1.087
	190	85	125	15	225	91	9	332	85	1.086
Sierra	130	85	165	74	323	52	38	430	49	1.075
	160	72	147	82	301	42	32	405	42	1.075
	190	67	153	75	295	39	36	383	46	1.077
Atlantic	130	100	186	61	347	91	15	471	94	1.100
	160	115	194	82	391	82	10	506	97	1.095
	190	122	186	81	389	85	17	512	93	1.096
Gemchip	130	123	230	109	462	74	19	567	85	1.082
	160	105	254	150	509	52	20	590	89	1.083
	190	102	261	138	501	56	9	571	84	1.082
A7411-2	130	92	175	92	359	67	69	509	94	1.093
(Ranger R.)	160	107	206	114	427	63	46	544	97	1.091
	190	105	213	119	437	55	34	531	98	1.091
A74212-1E	130	98	252	184	534	54	13	611	86	1.083
	160	116	271	153	540	66	14	633	86	1.086
	190	126	240	178	544	63	15	637	88	1.084
C008014-1	130	76	171	124	371	38	53	469	81	1.085
	160	63	202	149	414	27	53	498	83	1.088
	190	69	215	130	414	31	44	494	81	1.087
Variety Main Effect: (average of three spacings)										
R. Norkotah		105	164	77	346	81	18	451	94	1.072
HiLite R.		95	180	88	364	66	6	442	91	1.074
Frontier R.		72	155	118	345	47	47	444	93	1.081
Cal-Ore		86	128	34	247	81	19	358	83	1.087
Sierra		74	155	77	306	45	35	406	46	1.075
Atlantic		112	189	75	376	86	14	496	95	1.097
Gemchip		110	248	132	491	61	16	576	87	1.082
A7411-2 (Ranger R.)		102	198	108	408	62	50	528	97	1.091
A74212-1E		113	255	172	539	61	14	627	87	1.084
C008014-1		70	196	134	400	32	50	487	82	1.087
CV (%)		20	16	33	11	21	54	9	--	0.9
LSC (.05)		16	24	28	33	11	12	34	--	0.003
Seed Spacing Main Effect: (average of ten selections)										
	130	95	178	98	371	64	31	477	85	1.083
	160	93	190	106	387	60	27	487	86	1.083
	190	94	192	101	389	61	24	481	85	1.083
CV (%)		22	18	20	10	15	63	11	--	0.9
LSD (.05)		NS	NS	NS	NS	NS	NS	NS	--	NS

Table 4. Multi-year summary of the effect of nitrogen rate on performance of seven potato varieties, Klamath Experiment Station, OR. 1990.

Variety	Nitrogen Rate lbs/A	Yield US No. 1's 4-6 oz	6-10 oz	>10 oz	Total	Yield B's	No 2's	Culls	Crop Value $/A
		----------	----------	cwt/A	----------				
R. Norkotah	130	108	177	111	396	52	20	12	3,540
(4 years)	160	92	152	112	356	55	22	19	3,289
	190	93	172	123	388	56	17	10	3,572
Century R.	130	127	186	173	486	56	30	16	4,560
(2 years)	160	118	174	195	487	59	19	21	4,668
	190	111	161	225	497	57	22	18	4,927
Krantz	130	70	126	149	345	32	35	25	3,486
(2 years)	160	72	143	170	385	34	36	26	3,912
	190	86	121	188	395	35	50	32	4,101
A7411-2	130	94	160	128	382	54	88	23	3,837
(Ranger R.)	160	99	165	128	392	60	85	27	3,899
(3 years)	190	98	168	128	394	57	77	26	3,883
Sierra	130	95	162	105	362	54	45	18	3,222
(3 years)	160	106	156	84	346	65	37	27	3,103
	190	89	137	104	330	50	44	23	3,136
Atlantic	130	110	153	108	371	68	32	34	3,400
(3 years)	160	107	175	125	407	64	19	29	3,722
	190	108	158	117	383	68	27	28	3,522
Shepody	130	58	122	178	358	32	65	47	3,907
(3 years)	160	57	129	208	394	27	64	42	4,336
	190	61	113	183	357	29	68	48	3,925

Effects of N, P, K and S Rates on Nutrient Status and Crop Performance of Russet Burbank

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INTRODUCTION

Klamath Basin potato production practices have changed significantly in the past two decades. Yield and quality improvements have been achieved by higher seed quality, more efficient irrigation management, and better control of diseases and pests. Soil fertility has been altered by acidification of mineral soils, changes in fertilizer formulations and practices, and perhaps by the increased use of soil fumigants for control of nematodes and related diseases. There is a growing trend toward fertility management based on soil and plant tissue analysis and consultant services. Consultants' recommendations are not based on calibration data derived in the local area, but on experience with potatoes in other areas in the Northwest which enjoy longer growing seasons, have different soil types, and use different irrigation management practices.

Optimum use of fertilizers, soil amendments, agricultural chemicals, and other inputs is increasingly critical, not only to maintain economic viability, but to minimize impacts of agricultural practices on soil and water resources. 'Best management practices' may become mandatory in the future in regions where agricultural practices are deemed at least partially responsible for surface or ground water quality problems. Several wells in the Klamath Basin have been identified with nitrate levels in excess of drinking water standards.

This study was initiated in 1988 to develop a current data base to evaluate Russet Burbank response to a range of N, P, K and S fertilization rates. Objectives were to: 1) determine effects on yield and quality; 2) correlate yield and quality performance with plant nutritional status; 3) determine whether fertility management influenced diseases; and 4) provide a basis for establishment of 'best management practices'.

PROCEDURES

Experiments were conducted during 1988, 1989, and 1990 on loamy sand soil typical of potato production soils in the northern end of the Klamath Basin. A two-year rotation of spring barley and potatoes was followed. This is a typical potato rotation on local mineral soils. Soil test sampling prior to planting has consistently shown very low organic matter content (0.5 percent), a soil pH of 6.0 to 6.5, low to medium S and Ca levels, and high to very high soil P and K levels.

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In 1990, Russet Burbank potatoes were planted on May 17. Twelve premixed fertilizer blends were shanked in on both sides of rows with a continuous belt applicator on June 4. Individual plots were four rows, 40 feet long. Treatments were arranged in a randomized complete block design with four replications. Standard cultural practices were followed. During the growing season a total of 20.5 inches of water was received from rainfall and solid-set sprinkler irrigation.

Petiole samples were collected from each plot on July 18, August 1, August 15, and August 28. Vines were desiccated with diquat applied at 1.0 pint/A on September 21. Tubers were harvested from 37 feet of the center two rows on October 5. Total weights were determined in the field. Samples of approximately 120 lbs/plot were stored and graded in early November. Specific gravity was determined by the weight-in-air, weight-in-water method, using 10 pound samples of U.S. No. 1 grade tubers in the 6 to 10 ounce size range. Internal defects were evaluated by cutting and inspecting the largest 10 tubers in each sample.

After one month in storage, 10 tubers from each plot were cut and 3/8-inch strips were french fried for 3-1/2 minutes at 375° F. Fry color was determined by visual comparison with the standard USDA fry color chart. A subsample of cut strips from the same tubers was dried and submitted for nutrient content analysis.

RESULTS AND DISCUSSION

Cool, wet weather in late May and early June delayed emergence and slowed early season growth. Rhizoctonia caused some root and shoot pruning; however, plants emerged quite uniformly in mid-June with excellent stands. Maximum air temperatures exceeded 90° F on 22 days during July, August, and early September. Mid-season foliage development was normal but some heat sprouting was noted. No killing frosts occurred prior to vine desiccation.

Premature senescence of vines was observed in plants receiving the two lowest N rates. Both early blight and early dying caused by verticillium wilt were involved in the senescence. Plants in the lowest N treatment were nearly dead by the end of August. Plants in the highest N treatment were still very vigorous at the time of vine killing.

Yields and Grade

Yields of U.S. No. 1's and total yields were slightly less than in 1988 and well below yields achieved in 1989. The combination of rhizoctonia damage and heat stress reduced tuber set. Tuber size was larger than in 1988 and tuber quality was about typical for Russet Burbank grown on mineral soils in the Klamath Basin.

Effects of N rates on yield and size followed trends observed in the previous two years (Table 1). Each increment of N above the 60 lb N/A minimum contributed to increased tuber size and total yield of U.S. No. 1's. The yield of 10-ounce tubers increased significantly from the low to high N rate. Total yield of No. 1's increased approximately 10 cwt/A for each increment in N but differences were not statistically significant. Increasing N rates also resulted in higher yields of No. 2's and culls. Considering the appearance and vigor differences observed in plants, yield responses to N rates were less than expected.

Early season plant uptake of P may have been restricted by cool and wet soil conditions. The minimum P rate produced the highest yield of No. 1's in both 1988 and 1989. In 1990, yield of No.1's and tuber size increased slightly up to the 180 lb/A rate of P_2O_5. K fertilization resulted in slight declines in tuber size and yield of No. 1's. This was in contrast to 1989 when increasing K rates produced small improvements in yield. The inclusion of S in the fertilizer blend resulted in a 40 cwt/A yield increase in No.1's and a slight reduction in yield of No. 2's and culls.

The 1988 to 1990 growing seasons represent an exceptionally good season (1989) and two average growing seasons for the Klamath Basin. The 1989 yields were significantly higher than in either 1988 or 1990 (Table 2). No significant interactions were found between year and treatment for any of the yield parameters.

Over three years the optimum N rate was 240 lbs/A. However, the range in yields between low and high rates was surprisingly small. The lowest P rate was optimum over three years. K Response was also minimal with the highest yield of No. 1's occurring at the 60 lb K_2O/A rate. A consistent yield increase was observed for S fertilization in each year. The 180-60-60-20 treatment, evaluated only in 1989 and 1990, achieved the highest yield of No. 1's in 1989 and was second highest in 1990.

Economic Analysis

To evaluate economic implications crop values were calculated, based on net price to growers for each size and grade component of total yield, for fresh market crops in the Klamath Basin. Prices fluctuate widely between years and over the storage season within a given year. For comparison purposes the prices prevailing in December 1990 were used (see page 74). Crop values were calculated for each replication of all treatments and were subjected to statistical analyses. To further compare economic effects of treatments the net return to grower after subtracting fertilizer costs was also determined. Fertilizer components were assigned prices of: \$0.30/lb for N; \$0.25/lb for P_2O_5 and K_2O; and \$0.10/lb for S.

Averaged over three years, individual nutrient responses showed optimum economic returns at 240 lbs N/A, 60 lbs P_2O_5/A, 60 lbs K_2O/A, and 40 lbs S/A (Table 3). The combination of 180-60-60-20, evaluated only in 1989 and 1990, ranked second and third in return over fertilizer costs in 1989 and 1990, respectively. The lowest economic returns occurred at 60 and 120 lbs N/A. The differences among other treatments were small.

Processing Quality

Although Klamath Basin crops are not presently used for french fry processing the effects of treatments on important processing quality parameters were evaluated. The response of specific gravity to fertilizer rates was consistent over three years and followed predictable trends (Table 4). Increasing N rates resulted in lower specific gravity. High P rates slightly increased specific gravity. Increasing rates of potassium chloride resulted in a slight reduction in specific gravity above the 60 lbs. K_2O/A rate. The substitution of potassium sulfate for potassium chloride increased specific gravity. It is interesting to note that specific gravity was well within acceptable limits for processing in all treatments each year.

Fry color was only evaluated in 1990. Storage temperature had been reduced below 45° F by the time tubers were sampled. This undoubtedly resulted in darker fry color for all treatments than would have occurred if evaluations had been made directly after harvest or out of 50° F storage. The majority of strips in all treatments were in the USDA 1 or 2 color ranges. No clear treatment effects were observed. All results would be considered unacceptably dark for institutional product.

Diseases and Disorders

Serious foliage disease symptoms were noted in each year at the two low N rates. Plants in the lowest rate were nearly completely dead by the time of vine desiccation. Pathogen cultures were not obtained; however, the main causes of plant death, based on visual symptoms, were verticillium wilt and early blight. Nitrogen stress is a well known contributing factor for both diseases. Plants in the high N rate treatments remained vigorous until they were desiccated each year. Other nutrient levels had no apparent affect on the incidence or severity of early blight or verticillium wilt.

Tuber soft rot was not a problem in any year. The highest incidence occurred at the high N rate in 1989. In this case, tuber rot accounted for about 1.5 percent of total yield. In all other cases rotted tubers accounted for less than 1.0 percent of total yield. No serious tuber rot problems were experienced in commercial crops in the Klamath Basin during the 1988 to 1990 seasons.

Internal tuber quality was observed each year. The only physiological disorder routinely detected was hollow-heart. In 1988, hollow-heart occurred in about 10 percent of the largest tubers, irrespective of fertility treatment. In 1989, the incidence was lower and only the low N rate treatment exhibited more than 5 percent. In 1990, the average incidence in very large tubers was 13 percent. Tubers had the highest incidence of hollow heart at 60 and 120 lbs N/A (23 and 20 percent, respectively). With the exception of more hollow-hear at low N rates, fertility treatments did not affect internal disorders of tubers.

Crop Nutrient Status

Petiole samples were analyzed for N, P, K, Ca, and Mg over four sampling dates in 1990 (Table 5). Treatments designed to evaluate S response were also tested for petiole S content. Based on sufficiency range data used in private laboratories currently making recommendations to growers in the Klamath Basin, petiole N levels were in the deficiency range at all but the highest N rate by August 1. At the high N rate, petiole N was adequate throughout the sampling period. A graph of petiole nitrate-N levels shows quite uniform declines over the six week sampling period with clear separation between N rates (Figure 1).

N applied did not influence petiole P or K levels. However, petiole Ca levels were significantly affected by N rate at the first and last sampling dates (Figure 2). At the high N rate, Ca level remained constant over six weeks at about 1.0 percent. At the low N rate, petiole Ca increased linearly from a low of 0.5 percent to a high of 1.7 percent. Intermediate N rates resulted in small increases in Ca levels as the season progressed. All Ca levels observed were within the sufficiency range.

N rates significantly affected petiole Mg levels at the first two sampling dates (Figure 3). Higher N rates corresponded to higher petiole Mg levels through August 1. By August 15, Mg levels were similar at all N rates. All Mg levels were within the sufficiency range.

Petiole phosphate - P content declined over time with relatively small but significantly different levels between P treatments. By late August, levels were below the sufficiency range at the two lowest P rates (Figure 4). P rate increases resulted in slight reductions in petiole Ca levels above the 120 lbs P_2O_5/A rate.

K rates did not significantly alter petiole K levels at any of the sampling dates. K levels remained well within the sufficiency range. Other nutrient levels were also unaffected by K rate.

The addition of S to the fertilizer blend did not change petiole S levels. During the first half of the sampling period the addition of S resulted in a 20 percent increase in petiole N levels. The addition of 1,000 lbs/A of gypsum prior to planting may account for the lack of treatment effects on petiole S levels. However, in the last two sample dates S levels were in the deficiency range.

In 1988, petioles were sampled on July 14 and August 8. In 1989, sampling was delayed until August 23 and September 7. Observations were very consistent with those obtained in 1990. In each year, N deficiencies were suggested for all but the highest N rate. In both 1989 and 1990, late season P deficiencies were indicated at rates below 180 lbs P_2O_5/A.

Crop Nutrient Content

Tuber tissue samples were analyzed in 1990 to estimate treatment effects on nutrient content. Total N in tubers ranged from 1.31 percent at the low N rate to 1.86 percent at the high rate (Table 6). As N rate increased K content of tubers declined. Increasing P and K fertilizer rates resulted in small increases in tuber content of P and K. No other treatment responses were found in tuber nutrient levels. All nutrient contents fall well within the ranges reported in standard references on potatoes.

Treatment averages of specific gravity, fresh weight total yield, and tuber nutrient contents were used to calculate percent dry matter, total dry matter production, and crop removal of nutrients. Crop N removal ranged from 125 lbs N/A at the low N rate to 185 lbs N/A at the high rate. The average N content for the nine treatments that received 180 lbs N/A was 167 lbs/A. A graphic depiction of the relationship between N rate and crop N content is presented using the 167 lb/A estimate for the 180 lb N/A rate (Figure 5). Crop removal of N increased by 22, 20 and 18 lbs/A for successive increments of N fertilization. This suggests an N-use efficiency of 33 percent over the range of rates evaluated. Consideration for N incorporated in other plant tissues and retained in the soil organic matter pool would raise the efficiency considerably. Extrapolation of the data to a zero fertilizer N rate indicates a crop accumulation of approximately 100 lbs N/A from other N sources including seed, precipitation, irrigation water, and mineralization of organic matter.

Although N rate influenced petiole levels of Ca and Mg, there was no effect on crop removal of these nutrients. A slight reduction in the tuber content of Mg as N rate increased was offset by higher total yield. Crop removal of K declined slightly as N rate increased.

P removal increased slightly as P rate increased. However, tuber content of P is low and continued use of high rates of P fertilizer will quickly build up soil P reserves. This is very evident in many areas where potatoes are grown in short rotations.

K crop removal was unaffected by K rate. Soil reserves of K were adequate to support a potato crop with no evidence of plant deficiency.

Adding S to the fertilizer blend resulted in slightly higher crop removal of both N and K which was associated mainly with increased yield rather than higher nutrient content in tubers.

SUMMARY AND CONCLUSIONS

Over three years, Russet Burbank achieved optimum yield and crop value at the highest N rate evaluated, 240 lbs N/A. Addition of S to the blend consistently produced yield responses. In the two years that it was evaluated, the combination of 180-60-60-20 resulted in an increase in total yield of No. 1's of 33 and 31 cwt/A compared with the 240-120-120 treatment. Commensurate increases in crop value minus fertilizer costs were 16 and 105 $/A.

Over the wide range of fertilizer rates tested, yield responses were relatively small. A minimum N rate of 180 lbs/A was required to maintain plant vigor. The additional yield obtained by increasing N rate to 240 lbs/A was minimal, even though plant tissue analysis indicated an N deficiency developed quite early in the season at rates less than 240 lbs/A.

Mineral soils of the Klamath Basin that test high in soil P and K do not require or respond to rates higher than 60 lbs/A of P_2O_5 or K_2O. Although late season petiole samples indicated P deficiencies at rates below 180 lbs P_2O_5/A, maximum yields were observed at 60 lbs/A. Petiole K levels were consistently in the sufficiency range and K rates had little effect on yields.

Efficient use of plant nutrients is important to growers for economic reasons and is becoming increasingly important in relation to environmental considerations. The Klamath Basin's irrigation and drainage system is closely entwined with two lakes and three wildlife refuges which support a large and diverse population of native and migratory birds. Algae and aquatic weeds are becoming increasingly problematic in the Basin's surface waters. The contribution of fertilizers to nitrogen and phosphorous loading of local aquifers is presently unknown. However, judicious use of these nutrients will be necessary in the future. This study has indicated that Russet Burbank potatoes can be grown economically with substantially less phosphorous and potassium fertilizer than is currently used in commercial practice. A nitrogen rate of 180 lbs N/A is required to maintain a healthy crop. Higher rates are unlikely to result in significant improvement in yield, quality, or cash return to growers.

Petiole sampling as a basis for fertility management is widely practiced in the Klamath Basin. Late season applications of N and P are frequently made through irrigation systems to correct deficiencies identified by petiole sampling. This study did not find a good correlation between plant nutrient status based on petiole samples, and crop response to imposed fertility treatments. Results suggest that supplemental nutrients needed to correct deficiencies may not improve crop performance. Petiole sampling programs have not been based on locally derived crop response data. The short growing season and unique climatic conditions experienced in the Klamath Basin undoubtedly impose limitations on crops that are not experienced in other major potato production areas in the Pacific Northwest. This study has raised a question about the validity of petiole sampling as a basis for fertility management under local conditions, at least when recommendations are based on experience or data derived in other growing areas in the Northwest.

Table 1. Effects of N, P, K and S rates on yield and grade of Russet Burbank, Klamath Experiment Station, OR. 1990.

Fertilizer Rate				Yield of U.S. No. 1's				Yield			
N	P_2O_5	K_2O	S	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Total
----- lbs/A -----				----- cwt/A -----							
N Response											
60	120	120	0	97	136	44	278	90	23	5	396
120	120	120	0	102	136	54	292	80	23	16	411
180	120	120	0	85	150	66	301	72	27	17	417
240	120	120	0	80	133	86	309	73	41	23	446
P Response											
180	60	120	0	94	133	58	290	81	23	16	410
180	120	120	0	85	150	66	301	72	27	17	417
180	180	120	0	89	152	77	318	78	30	14	440
180	240	120	0	81	151	74	306	61	39	15	421
K Response											
180	120	0	0	82	153	96	331	58	27	9	425
180	120	60	0	87	136	93	316	75	28	9	428
180	120	120	0	85	150	66	301	72	27	17	417
180	120	180	0	81	150	82	313	62	33	19	427
S Response											
180	120	120	0	85	150	66	301	72	27	17	417
180	120	120	40	89	161	95	345	73	23	10	451
180	60	60	20	107	155	78	340	73	25	9	447
Average				89	146	75	311	73	28	14	427
CV (%)				16	13	29	20	21	42	64	8
LSD (.05)				21	27	31	NS	22	17	12	49

Table 2. Effects of N, P, K and S rates on yield and grade of Russet Burbank, (three-year average), Klamath Experiment Station, OR.

Fertilizer Rate				Yield of U.S. No. 1's				Yield			
N	P_2O_5	K_2O	S	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Total
----- lbs/A -----				cwt/A							
N Response											
60	120	120	0	138	134	38	310	91	22	20	444
120	120	120	0	130	131	53	314	81	29	38	464
180	120	120	0	122	146	65	333	80	29	22	465
240	120	120	0	118	145	77	340	72	38	34	486
P Response											
180	60	120	0	124	151	79	354	73	33	24	484
180	120	120	0	122	146	65	333	80	29	22	465
180	180	120	0	116	137	65	318	71	36	42	468
180	240	120	0	124	150	75	349	72	31	27	480
K Response											
180	120	0	0	124	148	70	342	75	29	25	472
180	120	60	0	126	142	81	348	76	28	20	473
180	120	120	0	122	146	65	333	80	29	22	465
180	120	180	0	119	147	77	343	76	34	28	482
S Response											
180	120	120	0	122	146	65	333	80	29	22	465
180	120	120	40	133	155	71	359	82	22	23	487
180	60	60	20	143	159	72	374	74	25	30	504
Average 1988				144	133	53	331	78	23	23	455
Average 1989				146	156	78	379	80	38	45	545
Average 1990				89	147	75	311	73	29	17	427
CV (%) Year				31	31	20	25	34	93	113	13
CV (%) Treatment				17	15	35	10	24	45	59	7
LSD (.05) Year				20	23	7	42	13	14	16	30
LSD (.05) Treatment				18	18	20	29	15	11	13	28

Table 3. Economic implications of fertilization rates on fresh market Russet Burbanks in the Klamath Basin, OR.

Fertilizer Rate				Fertilizer cost	Crop Value				Crop Value - Fertilizer Cost			
N	P_2O_5	K_2O	S		1988	1989	1990	Average	1988	1989	1990	Average
lbs/A				$/A								
N Response												
60	120	120	0	78	2249	2774	2338	2454	2171	2696	2260	2376
120	120	120	0	96	2291	3069	2464	2608	2195	2973	2368	2512
180	120	120	0	114	2672	3181	2673	2842	2558	3067	2559	2728
240	120	120	0	132	2532	3558	2912	3001	2400	3426	2780	2869
P Response												
180	60	120	0	99	3133	3565	2513	3070	3034	3466	2414	2971
180	120	120	0	114	2672	3181	2673	2842	2558	3067	2559	2728
180	180	120	0	129	2351	3054	2874	2766	2222	2925	2745	2631
180	240	120	0	144	2801	3430	2803	3012	2657	3286	2659	2867
K Response												
180	120	0	0	84	2729	2997	3050	2925	2645	2913	2966	2841
180	120	60	0	99	2940	3155	2925	3007	2841	3056	2826	2908
180	120	120	0	114	2672	3181	2673	2842	2558	3067	2559	2728
180	120	180	0	129	2708	3425	2877	3003	2579	3296	2748	2874
S Response												
180	120	120	0	114	2672	3181	2673	2842	2558	3067	2559	2728
180	120	120	40	118	2703	3201	3139	3017	2585	3083	3021	2896
180	60	60	20	86	2872	3528	2971	3123	2786	3442	2885	3038
Average					2665	3245	2795	2902	--	--	--	--
CV (%)					11	12	12	10	--	--	--	--
LSD (.05)					421	543	499	246	--	--	--	--

Table 4. Effects of N, P, K and S rates on specific gravity and fry color of Russet Burbank, Klamath Experiment Station, OR.

Fertilizer Rate				Specific gravity				Fry
N	P_2O_5	K_2O	S					
-------- lbs/A			---------	1988	1989	1990	Average	Color[1]
N Response								
60	120	120	0	1.085	1.087	1.088	1.086	1.6
120	120	120	0	1.083	1.084	1.088	1.085	2.6
180	120	120	0	1.079	1.081	1.085	1.082	2.2
240	120	120	0	1.077	1.081	1.086	1.081	1.4
P Response								
180	60	120	0	1.080	1.081	1.086	1.082	1.5
180	120	120	0	1.079	1.081	1.085	1.082	2.2
180	180	120	0	1.081	1.082	1.086	1.084	1.8
180	240	120	0	1.082	1.084	1.089	1.085	1.8
K Response								
180	120	0	0	1.083	1.084	1.086	1.084	1.4
180	120	60	0	1.085	1.085	1.088	1.086	1.2
180	120	120	0	1.079	1.081	1.085	1.082	2.2
180	120	180	0	1.081	1.080	1.084	1.082	1.5
S Response								
180	120	120	0	1.079	1.081	1.085	1.082	2.2
180	120	120	40	1.082	1.084	1.087	1.084	1.6
180	60	60	20	1.080	1.084	1.086	1.083	1.6
Average				1.082	1.083	1.084	1.084	1.7
CV (%)				0.200	0.150	0.250	0.007	---
LSD (.05)				0.003	0.003	0.004	0.002	---

1/ Fry color based on 10 strip samples using two center strips from 5 tubers per replication. Strips were fried for 3-1/2 minutes at 375° F. Individual strips were compared with the USDA standard fry color chart. The number shown was derived by multiplying the number of strips at a given color by the color designation (0.1 was used for 0 color), summing the total, and dividing by 10.

Table 5. Effects of N, P, K and S rates on petiole nutrient levels in Russet Burbank, Klamath Experiment Station, OR. 1990.

Fertilizer Rate				NO_3 - N				PO_4 - P				K			
N	P_2O_5	K_2O	S	7/18	8/1	8/15	8/28	7/18	8/1	8/15	8/28	7/18	8/1	8/15	8/28
------ lbs/A ------				%											
N Response															
60	120	120	0	0.83	0.10	0.06	0.01	0.64	0.40	0.30	0.13	12.70	11.85	10.32	10.25
120	120	120	0	1.52	0.34	0.17	0.02	0.55	0.39	0.34	0.19	11.55	11.50	11.02	10.88
180	120	120	0	1.86	0.99	0.50	0.14	0.53	0.36	0.32	0.14	11.55	10.55	10.38	10.53
240	120	120	0	2.47	1.65	1.06	0.38	0.45	0.27	0.24	0.11	12.60	10.20	10.10	9.78
P Response															
180	60	120	0	2.11	0.96	0.47	0.13	0.48	0.27	0.25	0.12	12.13	10.13	10.10	9.95
180	120	120	0	1.86	0.99	0.50	0.14	0.53	0.36	0.32	0.14	11.55	11.50	11.02	10.88
180	180	120	0	1.88	0.98	0.46	0.10	0.53	0.40	0.34	0.19	11.50	10.67	10.82	10.77
180	240	120	0	1.97	1.07	0.53	0.15	0.55	0.43	0.38	0.23	11.85	11.40	10.95	10.77
K Response															
180	120	0	0	2.30	1.25	0.60	0.18	0.49	0.34	0.28	0.14	10.93	10.52	9.85	9.30
180	120	60	0	2.24	1.06	0.61	0.26	0.48	0.37	0.31	0.17	11.38	10.30	10.67	10.80
180	120	120	0	1.86	0.99	0.50	0.14	0.53	0.36	0.32	0.14	11.55	11.50	11.02	10.88
180	120	180	0	2.18	1.20	0.61	0.28	0.51	0.32	0.29	0.15	12.30	10.72	10.15	10.63
S Response															
180	120	120	0	1.86	0.99	0.50	0.14	0.53	0.36	0.32	0.14	11.55	11.50	11.02	10.88
180	120	120	40	2.21	1.26	0.71	0.21	0.53	0.36	0.31	0.18	11.45	10.93	10.18	10.65
180	60	60	20	2.23	1.23	0.60	0.26	0.48	0.29	0.24	0.11	11.15	10.38	10.70	10.00
Average				1.98	1.09	0.53	0.18	0.52	0.36	0.30	0.15	11.76	10.80	10.44	10.36
CV (%)				11	23	46	58	7	13	17	28	8	9	9	10
LSD (.05)				0.13	.036	0.35	0.15	0.05	0.17	0.07	0.06	NS	NS	NS	NS

Table 5. (contd)

Fertilizer Rate				Ca				Mg				S			
N	P_2O_5	K_2O	S	7/18	8/1	8/15	8/28	7/18	8/1	8/15	8/28	7/18	8/1	8/15	8/28
------ lbs/A ------				------ % ------											
N Response															
60	120	120	0	0.50	0.86	1.27	1.67	0.40	0.38	0.57	0.53				
120	120	120	0	0.84	0.82	1.12	1.36	0.49	0.49	0.62	0.55				
180	120	120	0	0.95	0.96	1.06	1.26	0.55	0.61	0.59	0.56				
240	120	120	0	1.03	1.04	1.06	1.07	0.63	0.69	0.61	0.67				
P Response															
180	60	120	0	0.93	1.04	1.12	1.21	0.57	0.67	0.61	0.66				
180	120	120	0	0.95	0.96	1.06	1.26	0.55	0.61	0.59	0.56				
180	180	120	0	0.87	0.96	1.07	1.15	0.54	0.55	0.59	0.54				
180	240	120	0	0.87	0.89	0.95	1.03	0.54	0.53	0.55	0.53				
K Response															
180	120	0	0	0.99	1.04	1.14	1.34	0.59	0.60	0.53	0.64				
180	120	60	0	0.94	0.89	1.09	1.14	0.56	0.56	0.63	0.53				
180	120	120	0	0.95	0.96	1.06	1.26	0.55	0.61	0.59	0.56				
180	120	180	0	1.00	0.98	1.01	0.94	0.60	0.65	0.57	0.55				
S Response															
180	120	120	0	0.95	0.96	1.06	1.26	0.55	0.61	0.59	0.56	0.30	0.23	0.19	0.11
180	120	120	40	0.88	0.89	1.04	1.16	0.53	0.56	0.58	0.50	0.32	0.25	0.19	0.12
180	60	60	20	0.84	0.87	1.01	1.12	0.57	0.61	0.55	0.61	0.30	0.30	0.25	0.14
Average				0.89	0.93	1.08	1.20	0.55	0.57	0.58	0.57	0.31	0.25	0.19	0.12
CV (%)				16	14	15	14	11	17	17	23	--	--	--	--
LSD (.05)				0.20	NS	NS	0.24	0.09	0.14	NS	NS	--	--	--	--

Table 6. Effects of N, P, K and S rates on tuber nutrient contents in Russet Burbank, Klamath Experiment Station, OR. 1990.

Fertilizer Rate				Tuber content					
N	P_2O_5	K_2O	S	N	P	K	S	Ca	Mg
lbs/A				%					
N Response									
60	120	120	0	1.31	0.28	2.21	0.16	0.039	0.13
120	120	120	0	1.49	0.30	2.01	0.15	0.037	0.12
180	120	120	0	1.61	0.27	1.96	0.16	0.037	0.12
240	120	120	0	1.86	0.26	1.90	0.17	0.039	0.11
P Response									
180	60	120	0	1.76	0.26	1.89	0.16	0.038	0.12
180	120	120	0	1.61	0.27	1.96	0.16	0.037	0.12
180	180	120	0	1.53	0.30	2.04	0.15	0.038	0.12
180	240	120	0	1.77	0.32	1.95	0.17	0.039	0.12
K Response									
180	120	0	0	1.69	0.28	1.83	0.16	0.039	0.12
180	120	60	0	1.54	0.27	1.94	0.17	0.039	0.12
180	120	120	0	1.61	0.27	1.96	0.16	0.037	0.12
180	120	180	0	1.63	0.26	2.00	0.15	0.037	0.11
S Response									
180	120	120	0	1.61	0.27	1.96	0.16	0.037	0.12
180	120	120	40	1.76	0.29	1.88	0.16	0.036	0.12
180	60	60	20	1.63	0.26	1.90	0.16	0.037	0.12
Average				1.63	0.28	1.96	0.16	0.038	0.12
CV (%)				13	7	6	--	---	--
LSD (.05)				0.30	0.03	0.18	--	---	--

Table 7. Effects of N, P, K and S rates on tuber nutrient removal in Russet Burbank crops. Klamath Experiment Station, OR. 1990.

Fertilizer Rate				Crop Nutrient Removal						Total
N	P_2O_5	K_2O	S	N	P	K	S	Ca	Mg	Dry Matter
lbs/A				lbs/A						
N Response										
60	120	120	0	125	27	211	15	4	12	9,540
120	120	120	0	147	30	198	15	4	12	9,870
180	120	120	0	154	26	188	15	4	12	9,600
240	120	120	0	185	26	189	17	4	11	9,930
P Response										
180	60	120	0	176	26	189	16	4	12	9,990
180	120	120	0	154	26	188	15	4	12	9,600
180	180	120	0	151	30	201	15	4	12	9,860
180	240	120	0	181	33	199	17	4	12	10,210
K Response										
180	120	0	0	168	28	182	16	4	12	9,940
180	120	60	0	156	27	197	17	4	12	10,160
180	120	120	0	154	26	188	15	4	12	9,600
180	120	180	0	162	26	199	15	4	11	9,950
S Response										
180	120	120	0	154	26	188	15	4	12	9,600
180	120	120	40	181	30	193	16	4	12	10,260
180	60	60	20	172	27	200	17	4	13	10,530
Average				163	28	196	16	4	12	9,990

Figure 1. Effect of N rate on Russet Burbank petiole N content Klamath Exp. Station, 1990

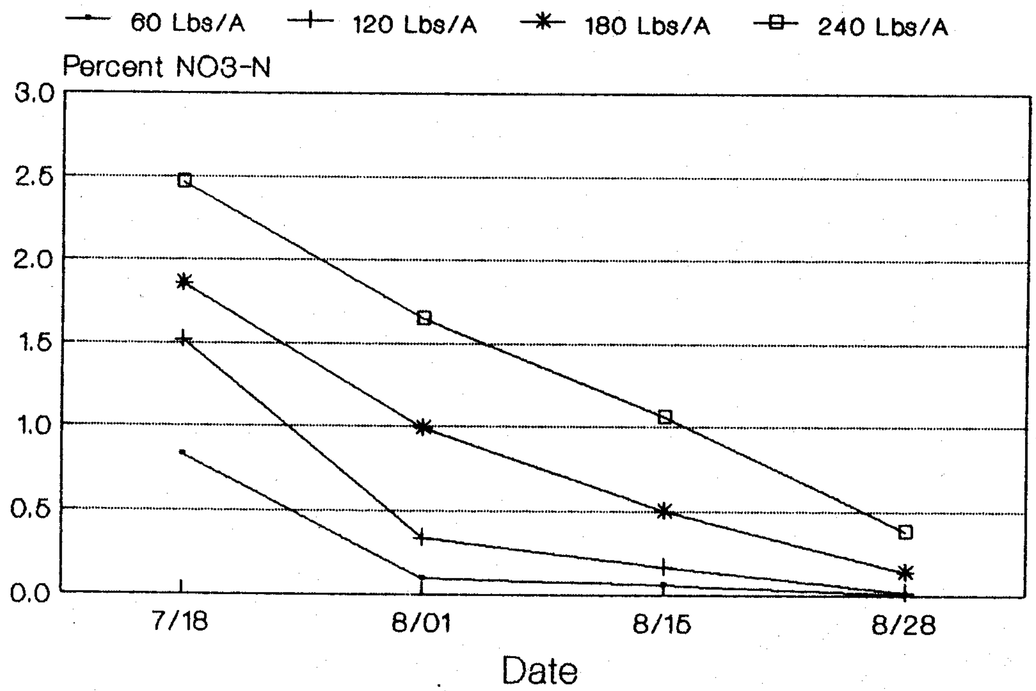


Figure 2. Effect of N rate on Russet Burbank petiole Ca content Klamath Exp. Station, 1990

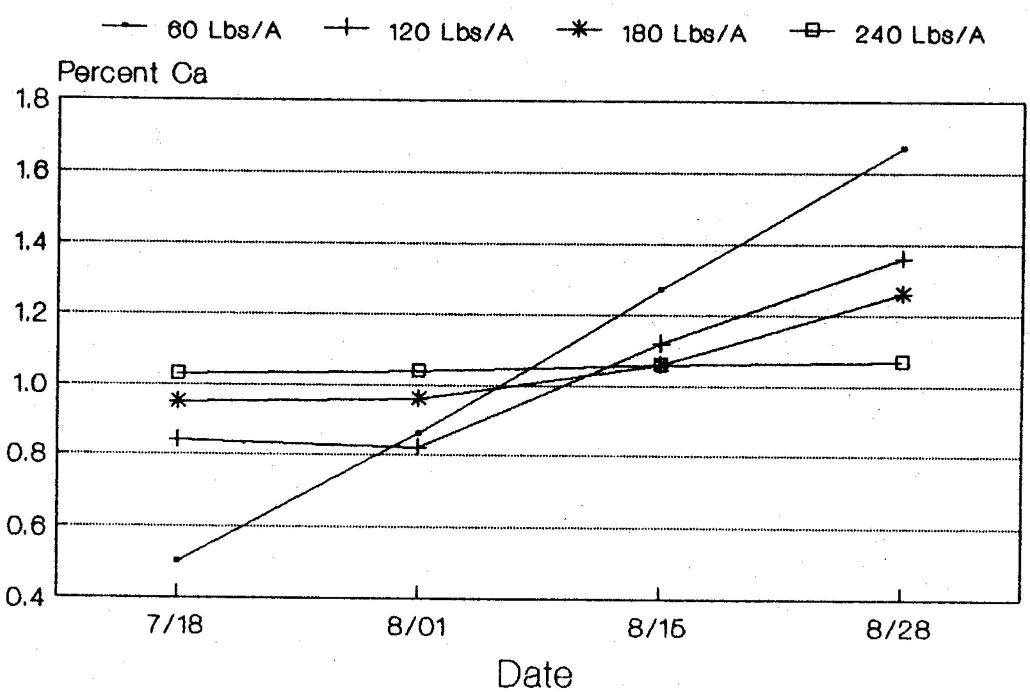


Figure 3. Effect of N rate on Russet Burbank petiole Mg content Klamath Exp. Station, 1990

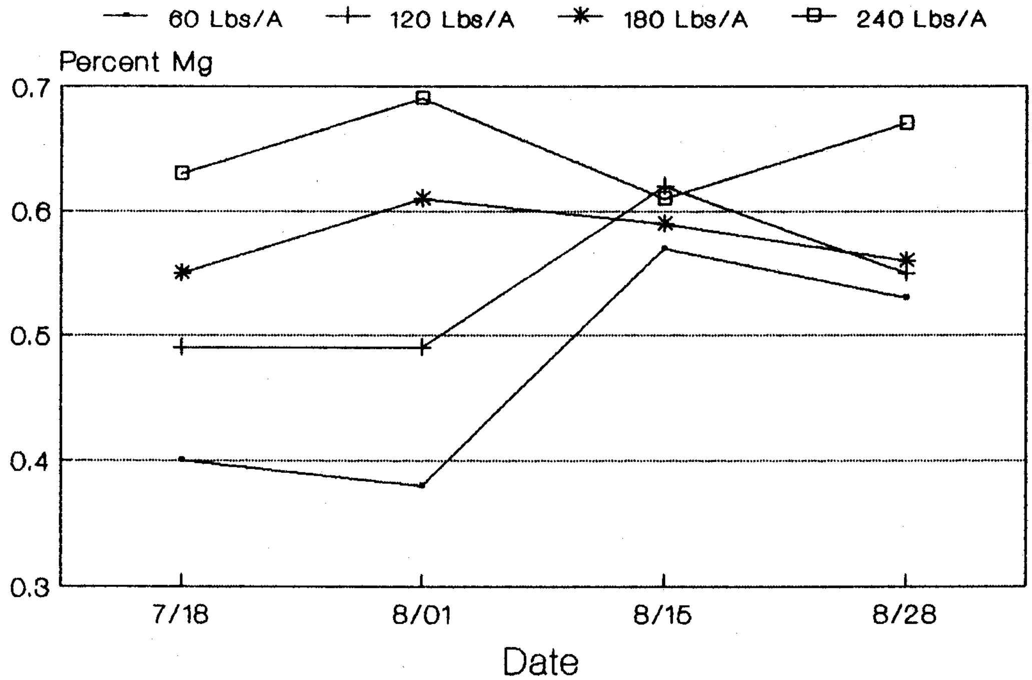


Figure 4. Effect of P rate on Russet Burbank petiole P content Klamath Exp. Station, 1990

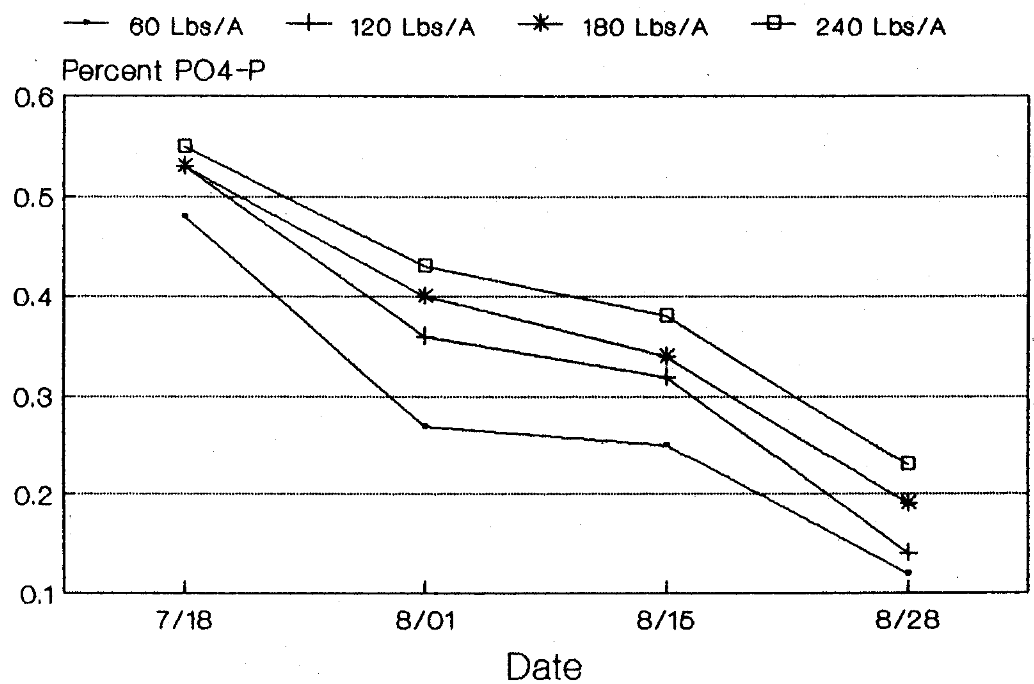
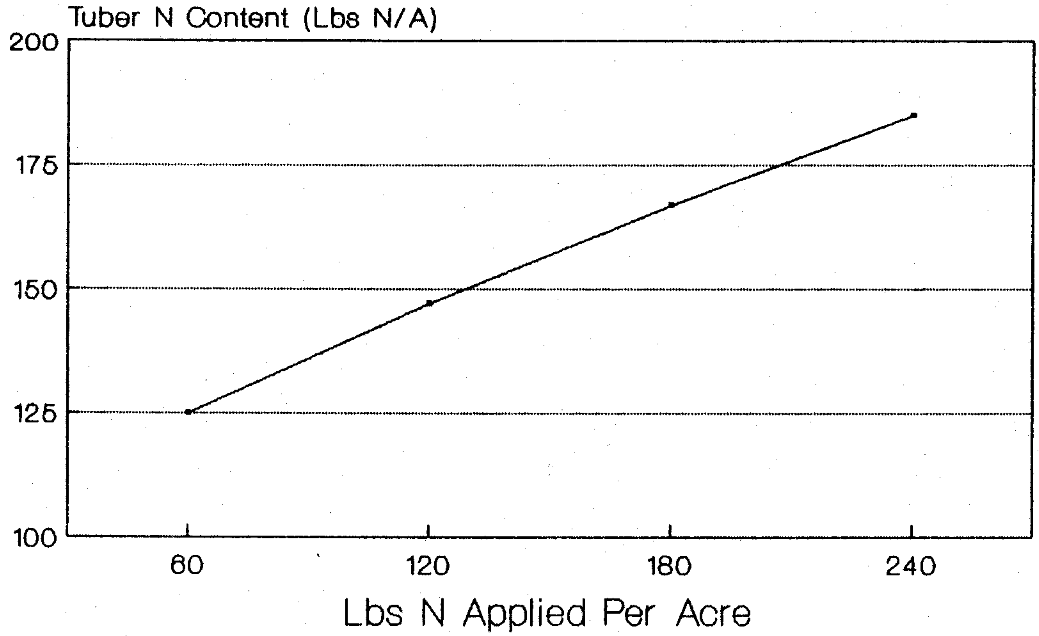


Figure 5. Effect of N rate on total N content of Russet Burbank tubers Klamath Exp. Station, 1990



Foliar Fertilization of Russet Burbank Potatoes

K.A. Rykbost and J. Maxwell[1]

INTRODUCTION

Soil analysis and plant tissue analysis from crops grown on mineral soils in the Klamath Basin frequently indicate marginal to serious deficiencies in boron, zinc, sulfur, and manganese. These nutrients can be provided from a wide range of commercially available sources. Growers are currently using several foliarly applied products but crop performance responses have not been documented.

This experiment was initiated in 1988 to determine the nutrient status of Russet Burbank potatoes grown on soils low in boron and zinc, and to evaluate effects on yield, quality, and nutritional status following foliar fertilization. In 1988 and 1989, most amendments evaluated produced small increases in yield and tuber size. The economic benefits in many cases were several times greater than costs for products and application. This experiment was repeated in 1990.

PROCEDURES

Russet Burbank potatoes were planted at 12-inch seed spacing in 32-inch rows on May 17. Fertilizer included 600 lbs/A of 16-16-16 banded at planting and 100 lbs N/A applied as solution 32 on June 5. Standard cultural practices were followed.

Foliar fertilizer products were applied to four-row plots, 40 feet long, with a hand-held plot sprayer. All amendments (Table 1) were applied at 30 gpa of solution in calm conditions during morning hours. The experiment was a randomized complete block design with four replications. Treatments were applied on July 13 and July 27.

Petiole samples were obtained from the center two rows of each plot on August 15, nearly three weeks after the second application of treatments. Vines were desiccated with diquat applied at 1.0 pint/A on September 21. Harvest areas included the two center rows, trimmed to 37-foot lengths to eliminate border effects. Potatoes were harvested on October 5. Total tuber weights were determined in the field. Approximately 120-pound samples were stored and graded on November 5. Crop values were calculated using fresh market net price to growers based on mid-December markets in the Klamath Basin (see page 74).

1/ Superintendent/Associate Professor, Biological Sciences Research Technician, respectively, Klamath Experiment Station, OR.

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RESULTS AND DISCUSSION

Soil samples collected in early spring indicated very high soil P, K, Mn, and Mg, medium Ca, and low S, Zn, and B. Soil pH was 6.0 and organic matter content was 0.5 percent.

Crop canopy was uniformly vigorous throughout the growing season. There were no visual effects of any of the treatments on foliage. Coded petiole samples were analyzed at a Leffingwell laboratory. As in previous years no measurable effects of any treatments on the nutrient status of plants occurred (Table 1). Petiole levels of N, K, Ca, and S were in close agreement with those observed in the experiment discussed in the previous section. Petiole P levels were about 30 percent lower than in the N, P, K, S experiment at the same sampling date. Based on sufficiency ranges used by consulting laboratories, P was deficient and S, Zn, and B were on the borderline of deficiency.

Yield, tuber size distribution and quality was very similar to that observed in the experiment discussed in the preceding section. All foliar treatments were slightly, but not significantly, higher in total yield of No. 1's than the control treatment (Table 2). Except for solubor, all treatments achieved higher yields of 10-ounce tubers. The Nutra-Phos 24 plus Nutra-Phos Super K and Nutra-Phos 24 plus Sorba-Spray CaB achieved the highest yields.

Effects of treatments on total yield of No. 1's and crop value over three years are summarized (Table 3). All foliar fertilizer treatments evaluated produced economical responses compared to the control. Typical costs for the treatments, including application costs, are approximately $25/A. Three-year average returns ranged from about $50/A to $175/A. An analysis over years showed a significant increase in total yield of No. 1's for the combination of Nutra-Phos 24 and Sorba-Spray Ca, compared with the control treatment. While other responses were not statistically significant the economic gains justify grower use of these products.

CONCLUSIONS

Several micronutrients are marginally deficient in soils of the Klamath Basin. The increasing use of plant tissue analysis and consulting services has heightened interest in crop nutrition and products that may alleviate real or perceived nutrient deficiencies. Three years of trials at KES have demonstrated small but economically justifiable responses to a number of foliar fertilizer products for Russet Burbank on mineral soils marginally deficient in sulfur, zinc, and boron. Foliar analysis of plant tissue following treatments has consistently failed to detect measurable effects on the nutritional status of plants.

Table 1. Petiole nutrient levels in Russet Burbank treated with several foliar fertilizers, Klamath Experiment Station, OR. 1990.

Treatment[1]	NO_3	PO_4	K	Ca	S	Zn	Mn	B
	%					ppm		
1	.98	.19	9.4	1.1	.22	23	80	35
2	.89	.17	8.8	1.1	.23	20	89	34
3	.94	.17	8.6	1.1	.23	23	84	33
4	.88	.17	8.8	1.1	.22	23	83	35
5	.83	.16	8.9	1.2	.18	24	90	35
6	.89	.16	8.8	1.2	.22	24	83	34
7	.89	.17	9.0	1.2	.20	25	87	33
8	.85	.16	9.0	1.2	.20	25	94	34
Average	.89	.17	8.9	1.1	.21	23	86	34
CV (%)	10	22	6	12	24	17	22	7
LSD(.05)	NS	NS	NS	NS	NS	NS	NS	NS

1/Trt. 1 - Control - water applied at 30 gpa July 13 and July 27.

Trt. 2 - Solubor (20% B) - applied at 1.25 lbs/A in 30 gpa water July 13 and July 27.

Trt. 3 - Tracite (1% Mn, 4% Zn, 1% Fe, 3.5% S) - applied in 30 gpa water July 13 and July 27.

Trt. 4 - Nutra-Phos 24 (24% P_2O_5, 20% Ca, 6% S, 12% Zn) - applied at 5 lbs/A in 30 gpa water July 13 and Nutra-Phos Super K (16% P_2O_5, 16% K_2O, 31% Zn) - applied at 5 Lbs/A in 30 gpa water July 27.

Trt. 5 - Nutra-Phos 24 at 5 lbs/A and Sorba-Spray Ca (6% N, 8% Ca) at 2 qts/A applied in 30 gpa solution July 13 and July 27.

Trt. 6 - Nutra-Phos 24 at 5 lbs/A and Sorba-Spray Ca B (3% N, 5% Ca, 0.5% B) at 2 qts/A applied in 30 gpa solution July 13 and July 27.

Trt. 7 - Nutra-Phos 24 at 5 lbs/A and Sorba-Spray ZBK (1% N, 6% K_2O, 1% Zn, 1% B) at 2 qts/A applied in 30 gpa solution July 13 and July 27.

Trt. 8 - Nutra-Phos 24 at 5.0 lbs/A and Sorba-Spray ZPK (16% P_2O_5, 9% K_2O, 1% Zn at 2 qts/A applied in 30 gpa solution July 13 and July 27.

Table 2. Effects of foliar fertilization on yield and grade of Russet Burbank, Klamath Experiment Station, OR. 1990.

Treatment	Yield of US No 1's				Yield			
	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Total
	cwt/A							
1	71	180	85	336	60	28	13	437
2	101	165	83	349	71	15	6	441
3	90	162	93	345	68	29	10	452
4	101	157	101	359	74	25	13	471
5	80	161	99	340	71	20	14	445
6	83	166	114	364	61	24	8	457
7	81	150	108	339	69	25	8	441
8	86	164	96	346	61	29	16	452
Average	87	163	97	347	67	24	11	449
CV (%)	15	13	26	10	25	36	67	7
LSD (.05)	19	NS	NS	NS	NS	NS	NS	NS

Table 3. Three year summary of effects of foliar fertilization on total yield of US No 1's and crop value of Russet Burbank, Klamath Experiment Station, OR. 1988 - 1990.

Treatment	Total Yield US No 1's				Crop Value			
	1988	1989	1990	Avg.	1988	1989	1990	Avg.
	cwt/A				$/A			
1	292	284	336	304	2203	2261	3081	2515
2	296	318	349	321	2289	2535	3038	2621
3[1]	246	324	345	305	1817	2564	3148	2509
4	318	295	359	324	2350	2212	3254	2606
5	355	317	340	337	2536	2471	3135	2714
6	309	267	364	313	2308	2044	3396	2582
7	325	321	339	328	2356	2439	3184	2660
8	322	296	346	321	2345	2366	3176	2629
Average	308	303	347	319	2275	2361	3177	2604
CV (%)	11	12	10	11	12	14	11	13
LSD (.05)	49	52	NS	28	404	NS	NS	NS

1/ In 1988 treatment was $ZnSO_4$, in 1989 and 1990 treatment was Tracite.

Control of Nematodes and Related Diseases in Potatoes

K.A. Rykbost[1], R.E. Ingham[2] and J. Maxwell[1]

INTRODUCTION

Three distinct nematode problems have been recognized as important for potato production in the Klamath Basin for many years. Root-lesion nematodes (*Pratylenchus spp.)* may cause sufficient direct damage to plants to reduce yields and quality. A more probable effect of this pest on local potato crops is the relationship between this pest and *Verticillium dahliae* to increase severity of potato early dying. Root-knot nematodes *(Meloidogyne chitwoodi* and *M. hapla)* are known to have been serious problems for local crops for over 50 years. Stubby-root nematodes *(Trichodorus spp)* serve as a vector for tobacco rattle virus (TRV) which causes corky ringspot (CRS). When inadequately controlled, both root-knot nematode and CRS infections can render potato crops unsalable.

With the availability of Telone and Temik, growers were able to achieve a satisfactory level of control of the nematode and related disease problems in mineral soils of the region. In 1989, Temik use on potatoes was suspended by the manufacturer of this product. In 1990, California suspended the use of Telone on all crops. The loss of these critical tools for pest control has resulted in a renewed urgency to develop alternative control measures or to overcome the problems or perceived problems which resulted in their suspension.

Two experiments were initiated in October 1989 to evaluate nematode control strategies. An off-station site was used to compare rates and application methods for Telone. A KES field with a history of root-knot, root-lesion, and stubby-root nematode infestations was used to compare products, rate, and timing of application.

I. EXPERIMENT I - MALIN SITE

Procedures

A sandy soil site east of Malin, Oregon was sampled at depths of 0 to 6, 6 to 12, and 12 to 24 inches on October 18 and 19, 1989. Individual plots were 16 feet wide and 50 feet long, arranged in a randomized complete block design with four replications. Fumigation treatments of Telone II at 15 gpa or 20

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gpa and of Telone C 17 at 27.5 gpa were applied on October 19 or 20. A five-shank V-ripper was used to inject fumigants at either 12-inch or 18-inch depth at a shank spacing of 18 inches. An experimental applicator was used to inject fumigants at 6- and 12-inch depths with 12-inch spacing between shanks.

Russet Burbank potatoes were planted on May 8. The crop was grown to maturity using standard cultural practices. Potatoes were harvested from 40-foot sections of the two center rows on September 27. Approximately 100-pound samples from each plot were stored and graded on November 5.

Results and Discussion

Pretreatment soil analysis failed to detect nematodes of root-lesion, root-knot, or stubby-root species. Chemical treatments were applied before soil samples were analyzed. The experiment was continued even though it was anticipated that treatment effects would be unlikely to occur. To minimize further efforts and expenditures no additional soil sampling was undertaken.

In organic soils, poor nematode control has been observed when a single depth of injection is used at 18-inch shank spacing. A modified fumigation applicator was evaluated in organic soils in 1989. Significantly better nematode control was achieved with injection at depths of 6, 12, and 18 inches and a 12-inch spacing between shanks. This study was undertaken to determine whether fumigant placement would also affect performance in mineral soils. Unfortunately, in the absence of nematodes, the impact of fumigant placement on nematode control could not be assessed.

Without exception, fumigation treatments resulted in small, but not statistically significant, improvements in yield of U.S. No. 1's and total yield (Table 1). Average yield of total No. 1's was 261, 264, and 275 cwt/A for Telone II - 15 gpa, Telone II - 20 gpa and Telone C 17 - 27.5 gpa, respectively. The response to placement favored the 18-inch by 12-inch combination. Net crop value after subtracting the cost of fumigation exceeded crop value for the untreated control in five of the nine treatments. The highest return occurred for Telone II at 15 gpa injected at 18-inch spacing and 12-inch depth.

II. EXPERIMENT II - KES SITE

Procedures

Twelve treatments were assigned in a randomized complete block design with four replications. Individual plots were 16 feet wide and 55 feet long. Soil samples (15 cores per plot) were collected on October 17, 1989 at depths of 0 to 6, 6 to 12, and 12 to 24 inches. Samples were double-bagged in plastic and delivered to the nematology laboratory within 72 hours. Additional soil samples were collected on April 18 and July 10, 1990 following the same sampling procedures.

Fall initiated treatments (Table 2) were applied at a depth of 16 inches with a V-ripper with 18 inches between shanks. Soil surface sealing was immediately accomplished with a weighted brillion roller. Spring fumigation treatments (Table 2) were applied with the same equipment and procedures on April 20. The field was plowed to a depth of 12 inches on May 8. The granular nematicides, Mocap and XRD-429, an experimental compound, were broadcast on the soil surface and immediately disc-incorporated to a depth of six inches on May 14. Treatments and their designation are shown (Table 2).

Russet Burbank potatoes were planted at 12-inch spacing in 32-inch rows on May 16. Fertilizer included 600 lbs/A of 16-16-16 banded at planting and 100 lbs N/A applied as solution 32 on June 5. Standard cultural practices were applied. The crop received a total of 20.5 inches of water from rainfall and solid-set sprinkler irrigation during the growing season. Vines were desiccated with 1.0 pint/A of diquat applied on September 21. Potatoes were harvested from 40-foot sections of the center two of six plot rows on October 8. Total weight was determined in the field. Approximately 120-pound samples were stored and graded on November 5 and 6.

Tubers were graded to USDA standards. Any visual evidence of external blemish due to root-knot nematodes resulted in including tubers in a nematode blemish category, regardless of size or other grade considerations. Ten tubers from each sample were cut longitudinally and inspected for evidence of CRS infection, either as diffuse internal brown spots or as characteristic brown arcs. Evidence of CRS was not used to downgrade tubers from No. 1 designation.

Following grading, tubers were stored under typical storage management conditions (40° F and 95 percent relative humidity) at KES. In mid-November 25 randomly selected tubers from each plot from 4 to 10 ounces in weight were delivered to Corvallis for analysis of nematode and CRS infections.

Root-knot nematode infections were determined by counting infection sites on peeled tubers. Tubers with six or more infection sites were considered to be culled by *M. chitwoodi*. CRS symptoms were evaluated by transverse slicing of tubers into 1/4 inch thick slices and individual inspection of slices for arcs or diffuse brown spots.

Results and Discussion

A. Crop Performance:

Young plants in plots treated with Mocap at 9 or 12 lbs ai/A exhibited moderate phytotoxicity symptoms. Symptoms were more severe at the 12 lbs ai/A rate and were not evident in the combination treatment of Telone II plus Mocap at 6 lbs ai/A. This effect was no longer evident by mid-July. In September vines were more vigorous in plots that received the high rate of Mocap. The untreated control plants began to show symptoms of early dying by mid-August and vines were nearly dead at the time of topkilling. Little early dying was observed in any of the treated plots.

Total yield was significantly lower in the control treatment than in the five treatments with highest yields (Table 3). Early dying was apparently responsible for this difference. Smaller and non-significant yield reductions were observed at the high rate of Mocap and for the XRD-429 treatment. Phytotoxic injury to young plants may account for the Mocap effect.

In routine grading of 120-pound samples nematode blemish was only scored on the basis of external visible symptoms on intact tubers. Extensive blemish occurred in each replication of the untreated control. A few tubers in each replication of the treatment with XRD-429 alone were blemished. Only two replications of the combination treatment with Telone II and XRD-429 contained tubers with visible blemish. No surface blemish was observed in any tubers from other treatments.

Yields of No. 1's were severely reduced by blemish in the control treatment (Table 3). The XRD-429 treatment was significantly lower in yield of No. 1's than seven other treatments. The C 17 formulation of Telone was apparently responsible for a reduction in tuber size. Yield of No. 1's was less for this treatment than for all other Telone treatments. Mocap at 9 and 12 lbs. ai/A reduced yields of No. 1's slightly, compared with the combination treatments of Telone and Mocap.

An economic interpretation of the data obtained with standard grading procedures would suffice to evaluate the situation where CRS infection does not occur. Gross crop values were calculated based on crop prices described on page 74 (Table 3). Nematode blemished tubers were valued as culls. In a commercial situation the crop from control plots would be unsalable except as culls. The level of blemish observed in the XRD-429 treatment would be borderline for fresh market use and the crop would be devalued to compensate for additional labor required to remove blemished tubers. This level of blemish would be unacceptable for processing usage.

Net crop value was calculated by subtracting the cost of fumigants, nematicides and their application. An arbitrary price was assigned for the experimental product, XRD-429. Within these confines, several treatments produced very similar economic returns. Telone C 17 was uneconomical due to reduced yield and size and a high cost for the product. The XRD-429 treatment was also low in return. The optimum treatment was the combination of Telone II applied in the fall and Mocap applied at 6 lbs. ai/A in the spring.

B. Nematode Populations:

Effects of treatments on populations of nematode species are illustrated separately for fall and spring initiated treatments (Figures 1-6). The data represent a summation of populations at the three depths sampled. Data are presented on the basis of a 2-inch diameter core from 0-24 inches. To convert to standard nomenclature of nematodes/250 cc of soil the population data should be multiplied by 0.21. The distribution of nematodes at the three sampling depths varied. Important differences will be discussed as appropriate.

Pretreatment populations of *Pratylenchus neglectus* were uniformly distributed through the 24-inch soil profile. The highest population was observed in the Telone II - 20 gpa treatment and the lowest in Telone II - 15 gpa plots (Figure 1). All fall applied fumigation treatments significantly reduced populations of *P. neglectus* and maintained them at low levels through mid-season.

Populations of *P. neglectus* declined during winter months in all untreated plots (Figure 2). Spring applied treatments achieved varying degrees of control. Mocap was ineffective in all but the surface layer. Spring applied Telone II very effectively suppressed populations. XRD-429 reduced populations by about 50 percent. Although total populations were similar for control and Mocap treatments the suppression by Mocap in the surface layer may account for the failure to observe early dying symptoms in Mocap treated plants.

Meloidogyne chitwoodi populations exhibited more variability at pretreatment sampling. High initial populations were observed in Telone C 17 and Telone II - 20 gpa plots (Figure 3). The highest concentration of *M. chitwoodi* occurred in the surface layer in most plots. However, distribution was uniform in Telone C 17 and Telone II plus XRD-429 plots. All fall fumigation treatments significantly reduced *M. chitwoodi* populations. A few nematodes were present in spring samples from Telone II - 15 gpa and Telone II - 15 gpa plus Mocap plots. All other fall treatments resulted in a total absence of viable nematodes in spring samples.

Spring populations of *M. chitwoodi* were higher than in the fall in control and Mocap - 9 lbs. ai/A plots (Figure 4). This is contrary to normal population trends. Populations were about the same for the XRD-429 plots and were about 50 percent lower in the other three spring initiated treatment areas.

Summer samples indicated much lower populations of *M. chitwoodi* in control plots than in the spring. This may be due to migration of nematodes into plant roots. Nematodes were not detected in either of the spring applied Telone II treatments. XRD-429 significantly reduced populations. Mocap appeared to provide some control in the surface layer but not at greater depths. All fall fumigated plots were devoid of *M. chitwoodi* at summer sampling.

Pretreatment populations of *Trichodorus spp.* were quite uniform throughout the site (Figures 5 and 6). The lowest population occurred in the control plots. Most of these nematodes were found at depths below six inches. A few nematodes were detected in spring samples in two out of three fall treatments with Telone II at 15 gpa. All other fall treatments reduced populations to undetectable levels. Summer sampling failed to detect *Trichodorus spp.* in any fall treated plots. Spring treatment with Telone II reduced populations significantly but not totally. XRD-429 and Mocap treatments alone did not control *Trichodorus* populations at any depth (Figure 6).

C. Nematode and CRS infections of tubers:

Based on grading of intact tubers, external nematode blemish was only observed in control, XRD-429 alone, and XRD-429 in combination with Telone II (Table 3). Peeled tubers revealed root-knot nematode infections in tubers from several additional treatments. A mean level of tuber infection was derived by averaging observations from the two detection methods (Figures 7 and 8). The largest discrepancy occurred in the Telone II - 15 gpa fall fumigation treatment. No surface blemishes were observed in grading but peeled tubers exhibited a 32 percent infection level with uniform infection in all replications. The Telone II - 25 gpa treatment had a 32 percent infection rate in one replication but no infections were observed in other replications, suggesting some unusual circumstance such as a mislabeling of samples. Mocap at 9 lbs. ai/A exhibited a 10 percent infection level in peeled tubers with infections found in each replication. Blemishes were not observed during grading of tubers from this treatment. The two combination treatments of Telone II plus Mocap were free of nematode culls in both grading methods.

Root-knot nematode infections were observed in tubers from several plots which were devoid of *M. chitwoodi* in soil samples obtained in July. This is not unusual and illustrates the difficulty in planning a control strategy for this pest. In general the infestation level observed at this site was much lower than levels found in many commercial fields in the region. While several of the treatments evaluated provided satisfactory control at this site, similar results are unlikely in fields with a much greater level of infestation.

CRS infection of tubers occurred to some degree in all treatments even though soil analysis suggested complete control of *Trichodorus spp.* in all fall fumigated treatments. Two distinct types of symptoms were observed. Characteristic brown arcs were observed in approximately 5 percent of all tubers examined. Diffuse brown spots were observed in nearly 25 percent of all tubers examined. It is interesting to note that the percentage of tubers infected with either symptom was nearly twice as high when 10 longitudinally-cut tubers per plot were examined than when 25-tuber samples were transversely sliced into approximately 15 slices.

Both CRS inspection methods produced highly variable results. In the longitudinally-cut samples, CRS arcs were observed in only one replication from six of the eight treatments where arcs were found. Diffuse brown spots were observed in all replications in only two treatments. Because of this variability differences between treatments were not statistically significant for longitudinally-cut samples. Measurements were more precise for transversely-sliced 25-tuber samples. A further refinement of the data was achieved by individual assessment of slices from the transverse sectioning method. Based on this analysis all fall fumigation treatments, Mocap at 12 lbs. ai/A, and spring applied Telone II plus Mocap, significantly reduced the incidence of diffuse brown spots compared with the control treatment. Telone C 17 significantly reduced the incidence of CRS arcs.

A mean level of tuber infection with CRS arcs and diffuse spots was derived by averaging observations from both inspection methods (Figures 7 and 8). The graphs clearly show inadequate control of nematodes and related diseases for XRD-429, Telone II at 15 gpa in fall or spring applications, and Mocap alone at 9 lbs. ai/A. The poor control observed for the Telone II - 25 gpa treatment may be in error for root-knot infections. However, CRS symptoms were observed in most samples from this treatment.

The best control of nematodes and related diseases was achieved with the three combinations of Telone II and Mocap or XRD-429, Telone C 17, and Telone II at 20 gpa. The main infection observed for each of these treatments was diffuse spots associated with CRS. Mocap at 12 lbs. ai/A was the only other treatment that provided a reasonable degree of control of infections.

The addition of CRS infections to the nematode control complex significantly alters the interpretation of experimental findings to commercial situations. Current seed certification standards and tolerances would not be met for any of the treatments evaluated. Tolerances for processing of french fries are less stringent but crops with more than 10 percent infections of root-knot nematodes and/or CRS would be devalued, if not rejected. On that basis, none of the treatments evaluated produced acceptable quality for french fry processing at full value. Fresh market standards are not as exacting and can vary from year to year depending on supply and demand. Some blending of lots can be done to achieve grade standards. However, if blending is necessary the price would be discounted accordingly. Infection levels in excess of 20 percent in total for root-knot nematodes and CRS would probably limit entire crops to cull status. This suggests that the treatments of Telone II at 15 gpa fall or spring applied, Telone II at 25 gpa, XRD-429 at 3 lbs. ai/A, and Mocap at 9 lbs. ai/A represent crop losses.

SUMMARY AND CONCLUSIONS

In the absence of detectable levels of root-lesion, root-knot, or stubby-root nematodes, fumigation resulted in a small increase in yield of No. 1's and total yield of Russet Burbank. The highest yield and economic return occurred for Telone II at 15 gpa, injected at 12 inches with 18-inch shank spacing. Telone C 17 was uneconomical due to its high cost. Multiple injection depths did not improve yields or returns. Although statistical significance was not observed, the results support local growers' experience which suggests fumigation is economically justifiable, even in the absence of nematodes.

At KES, pretreatment sampling found relatively low populations of *P. neglectus* (161 to 687/250 cc of soil), *M. chitwoodi* (39 to 211/250 cc), and *Trichodorus spp.* (10 to 25/250 cc). Soil sampling in July indicated complete control of *Trichodorus* and *M. chitwoodi* and 90 to 98 percent control of *P. neglectus* for all fall fumigation treatments. Spring fumigation was nearly as effective. Mocap reduced populations of *P. neglectus* and *M. chitwoodi* in the surface six inches only and was ineffective against *Trichodorus spp*. The experimental nematicide, XRD-429, was more effective against *M. chitwoodi* than Mocap, similar to Mocap in suppression of *P. neglectus* and ineffective against *Trichodorus*.

The control treatment experienced a significant yield reduction due to early dying and severe infections of root-knot nematodes and CRS. Only the combinations of Telone II at 15 gpa and Mocap at 6 lbs. ai/A completely prevented cullage from root-knot nematode infections. These treatments also provided the best control of CRS but still exhibited 10 percent infection levels. As has been observed in previous research, the absence of detectable nematode populations in soil analysis does not guarantee freedom from crop damage.

Under the conditions of this study none of the treatments evaluated achieved sufficient control of nematode pests and related diseases to allow marketing of the crop as seed. The best results obtained would have been marginal for processing as french fries. Fresh market quality was acceptable for six of the treatments, but at some sacrifice in price to grower.

The treatment of Mocap at 12 lbs. ai/A, the maximum labeled rate for this product, achieved marginally acceptable quality. A slight yield reduction occurred due to phytotoxic injury to young plants. At 9 lbs. ai/A, Mocap did not provide adequate control of tuber infections. The experimental compound, XRD-429, was ineffective against tuber infections.

Previous research, locally and elsewhere, has shown that Temik provides good control of stubby-root nematodes and CRS infection of tubers at populations higher than those observed at this site. None of the treatments evaluated appear to be capable of replacing Temik under high pest pressure. Similarly, at high populations of root-knot nematodes it appears doubtful that Mocap alone would achieve acceptable control.

Table 1. Effect of rate, placement and formulation of fumigants on yield, grade and economic returns of Russet Burbank, Malin, OR. 1990.

Treatment	Yield US No. 1's				Yield			Crop Value	
	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Total	Gross	Net[1]
	cwt/A							$/A	
Untreated Control	90	114	31	235	91	13	342	1909	1909
T II - 15 gpa 18" x 12"[2]	104	135	45	284	84	10	381	2305	2163
C17 - 27.5 gpa 18" x 12"	103	126	36	265	95	11	376	2133	1673
T II - 20 gpa 18" x 12"	93	136	46	275	84	14	375	2287	2107
T II - 15 gpa 18" x 18"	90	116	36	242	87	14	351	1993	1853
C 17 - 27.5 gpa 18" x 18"	97	132	56	285	95	10	392	2409	1949
T II - 20 gpa 18" x 18"	97	124	50	270	91	8	373	2247	2067
T II - 15 gpa 12" x 6 & 12"	101	110	47	258	82	15	357	2138	1998
C 17 - 27.5 gpa 12" x 6 & 12"	95	130	49	274	85	8	369	2266	1806
T II - 20 gpa 12" x 6 & 12"	96	122	30	248	90	9	349	1967	1787
Average	97	125	42	264	88	11	366	2165	1931
CV (%)	21	13	41	15	12	77	11	17	19
LSD (.05)	NS	24	NS	NS	NS	NS	NS	NS	NS

1/ Crop value less cost of fumigation at following prices:
Telone II - $8.00/gal; Telone C 17 - $16.00/gal
Application - $20.00/A.

2/ 18" x 12" - first number represents distance between injection shanks, second number or numbers represent depth of injection.

Table 2. Chemical treatments evaluated at Klamath Experiment Station, OR.

Designation	Product and application rate and date
Control	Untreated control
	<u>**Fall initiated treatments**</u>
T - 15	Telone II at 15 gpa, applied October 18, 1989
T - 20	Telone II at 20 gpa, applied October 18, 1989
T - 25	Telone II at 25 gpa, applied October 18, 1989
T - 15 + M6	Telone II at 15 gpa, applied October 18, 1989 and Mocap 10 G at 6 lbs ai/A, applied May 14, 1990
T - 15 + X3	Telone II at 15 gpa, applied October 18, 1989 and XRD-429 2 G at 3 lbs ai/A, applied May 14, 1990
T C 17	Telone C 17 at 27.5 gpa, applied October 18, 1989
	<u>**Spring initiated treatments**</u>
X 3	XRD-429 2 G at 3 lbs ai/A, applied May 14, 1990
M 9	Mocap 10 G at 9 lbs ai/A, applied May 14, 1990
M 12	Mocap 10 G at 12 lbs ai/A, applied May 14, 1990
T - 15 S	Telone II at 15 gpa, applied April 20, 1990
T - 15 S + M 6	Telone II at 15 gpa, applied April 20, 1990 and Mocap 10 G at 6 lbs ai/A, applied May 14, 1990

Table 3. Effect of fumigation and nematicide treatments on yield, grade, and economic returns of Russet Burbank, Klamath Experiment Station, OR. 1990.

Treatment[1]	Yield U.S. No. 1's				Yield					Crop Value	
	4-6 oz	6-10 oz	>10 oz	Total	B's	No 2's	Culls	Nema.	Total	Gross[2]	Net[3]
	cwt/A									$/A	
Control	14	35	15	64	11	11	6	268	360	807	807
T - 15	73	166	69	308	82	19	12	0	422	2760	2620
T - 20	92	156	70	318	77	19	15	0	429	2782	2602
T - 25	84	154	74	312	80	25	8	0	425	2800	2580
T - 15 + M 6	68	163	69	300	66	32	20	0	417	2746	2529
T - 15 + X 3	68	158	81	307	51	33	16	2	409	2852	2647
T C 17	83	154	39	276	86	31	12	0	405	2377	1917
X 3	51	128	58	237	63	18	38	30	378	2217	2152
M 9	72	155	64	291	67	30	14	0	402	2630	2517
M 12	69	145	64	278	58	27	8	0	371	2510	2361
T - 15 S	87	148	70	305	71	23	12	0	411	2702	2562
T - 15 S + M 6	71	163	58	292	74	27	14	0	407	2599	2382
Average	69	144	61	274	66	25	15	25	403	2482	2310
CV (%)	24	15	36	14	24	58	68	154	9	15	17
LSD(.05)	24	31	32	54	23	21	13	55	50	545	545

1/ see Table 2 for description of treatments

2/ gross value of crop based on prices detailed on page 74, adjusted for nematode blemish observed in grading of intact tubers and cull value for blemished tubers.

3/ crop value after adjusting for cost of materials and application at:
Telone II - $8/gal; Telone C 17 - $16/gal; application of fumigants - $20/A;
Mocap - $12/lb ai; XRD-429 - $20/lb ai; application of nematicides - $5/A.

Figure 1. Effect of fall initiated treatments on P. neglectus populations Klamath Exp. Station, 1990

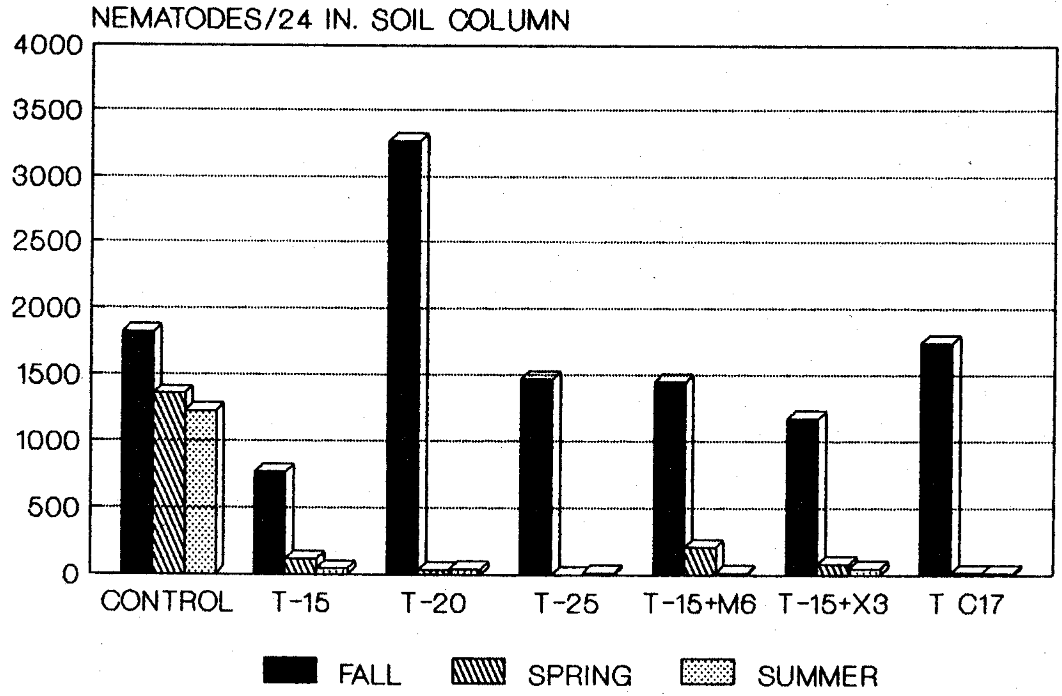


Figure 2. Effect of spring initiated treatments on P. neglectus populations Klamath Exp. Station, 1990

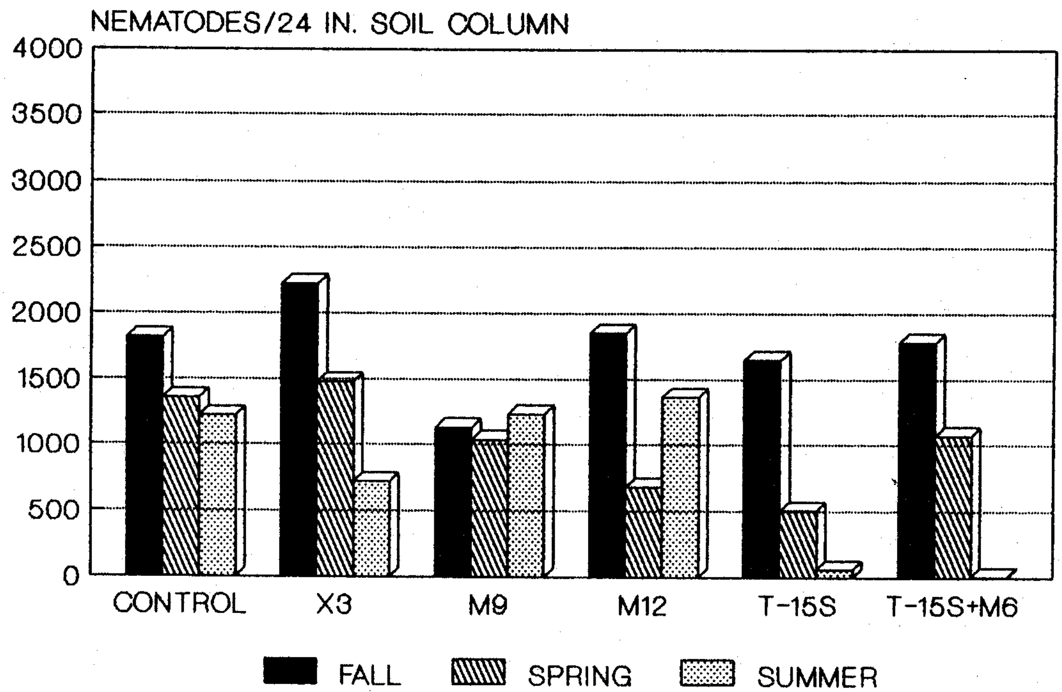


Figure 3. Effect of fall initiated treatments on M. chitwoodi populations Klamath Exp. Station, 1990

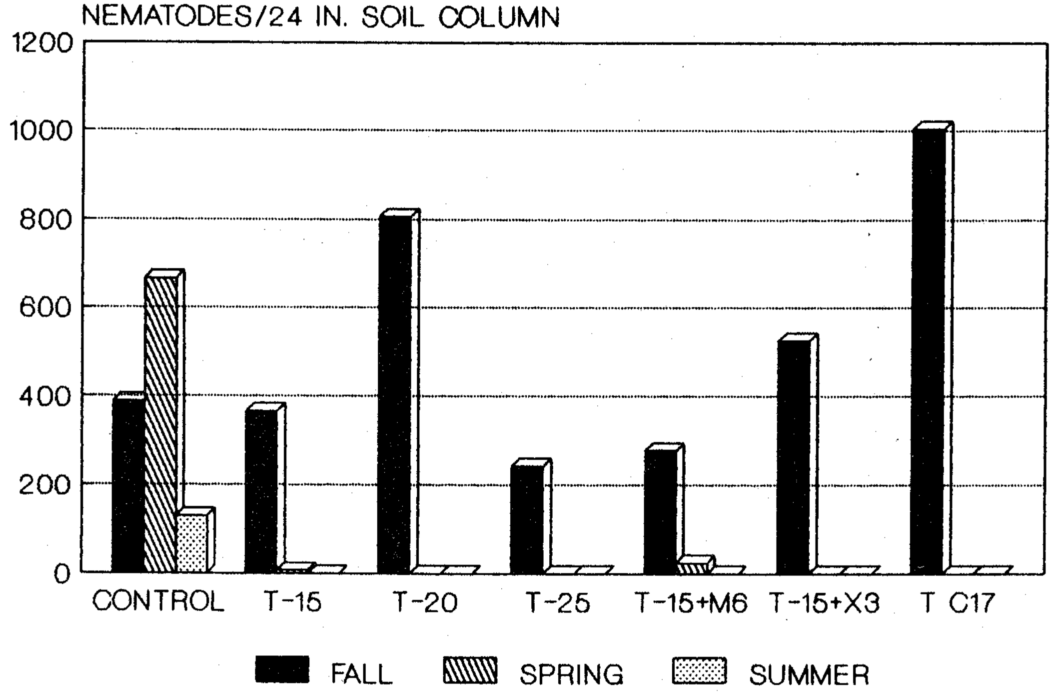


Figure 4. Effect of spring initiated treatments on M. chitwoodi populations Klamath Exp. Station, 1990

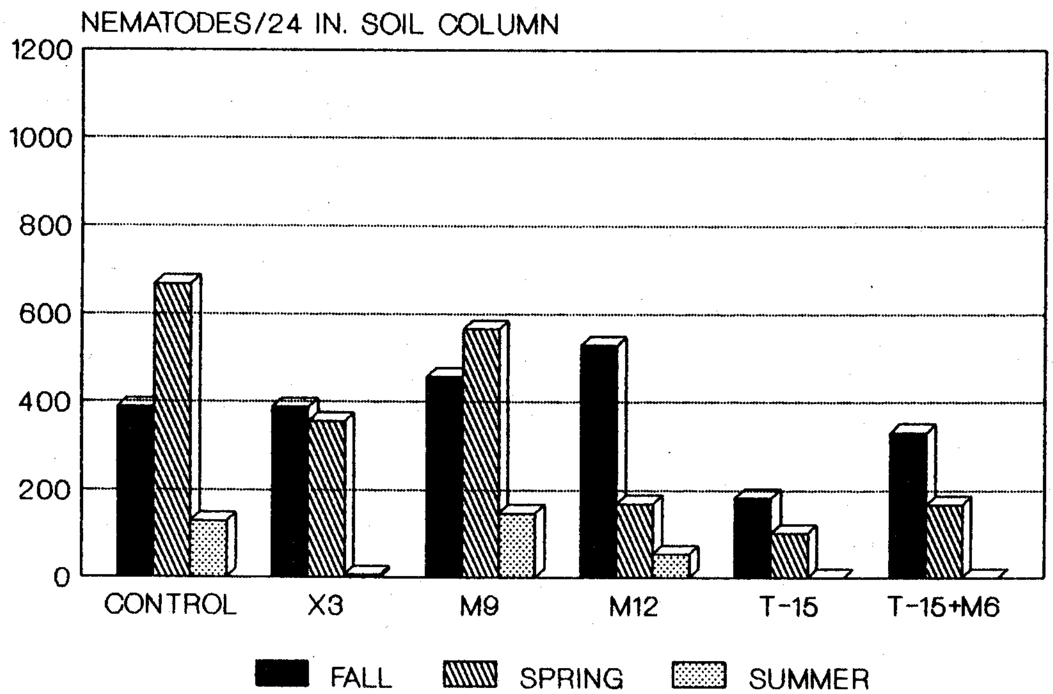


Figure 5. Effect of fall initiated treatments on Trichodorus populations Klamath Exp. Station, 1990

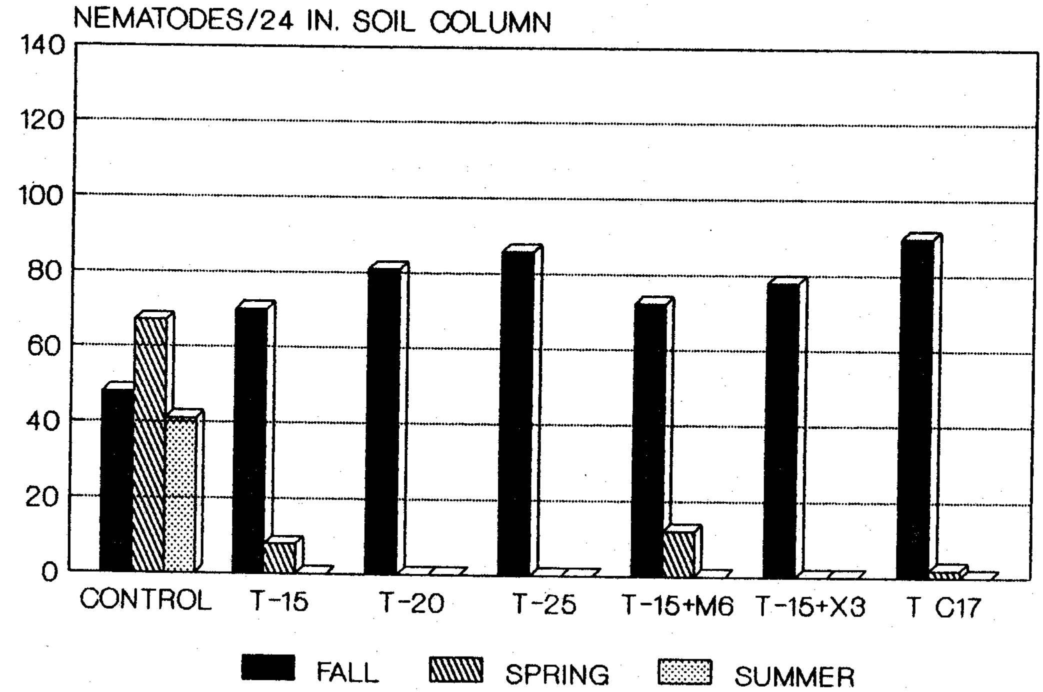


Figure 6. Effect of spring initiated treatments on Trichodorus populations Klamath Exp. Station, 1990

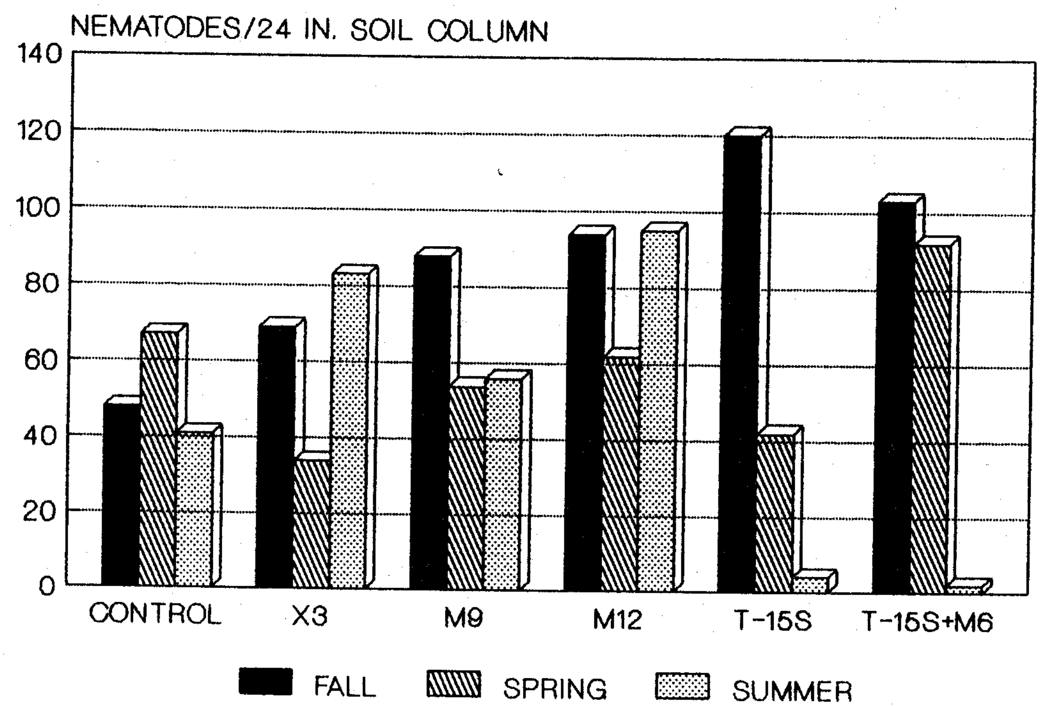


Figure 7. Effect of fall initiated treatments on root-knot nematode and CRS infections at the Klamath Exp. Station, OR.

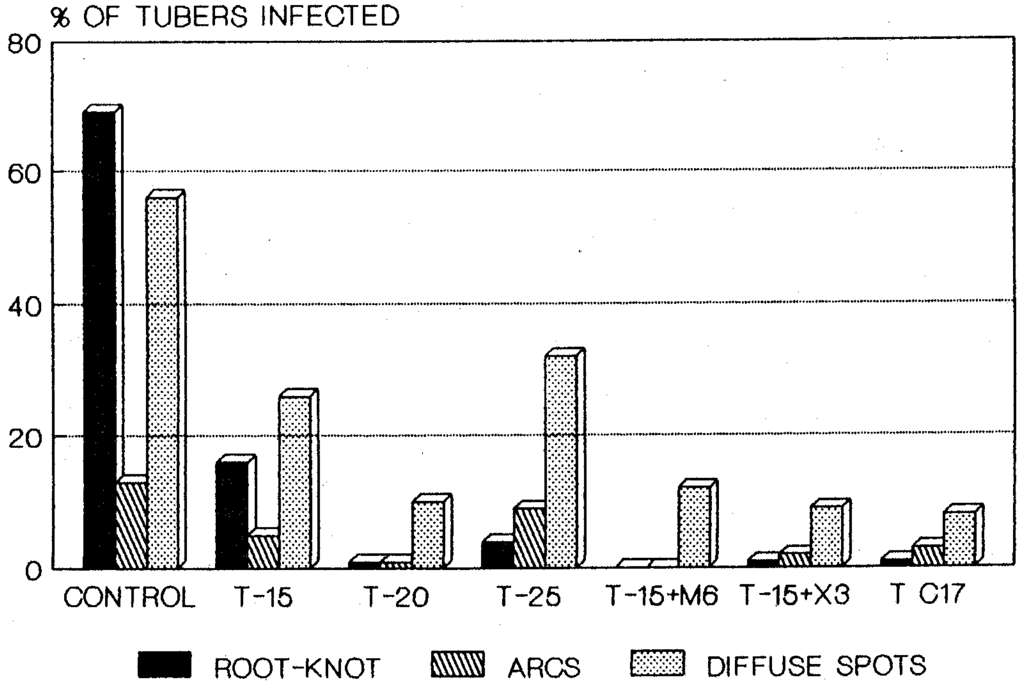
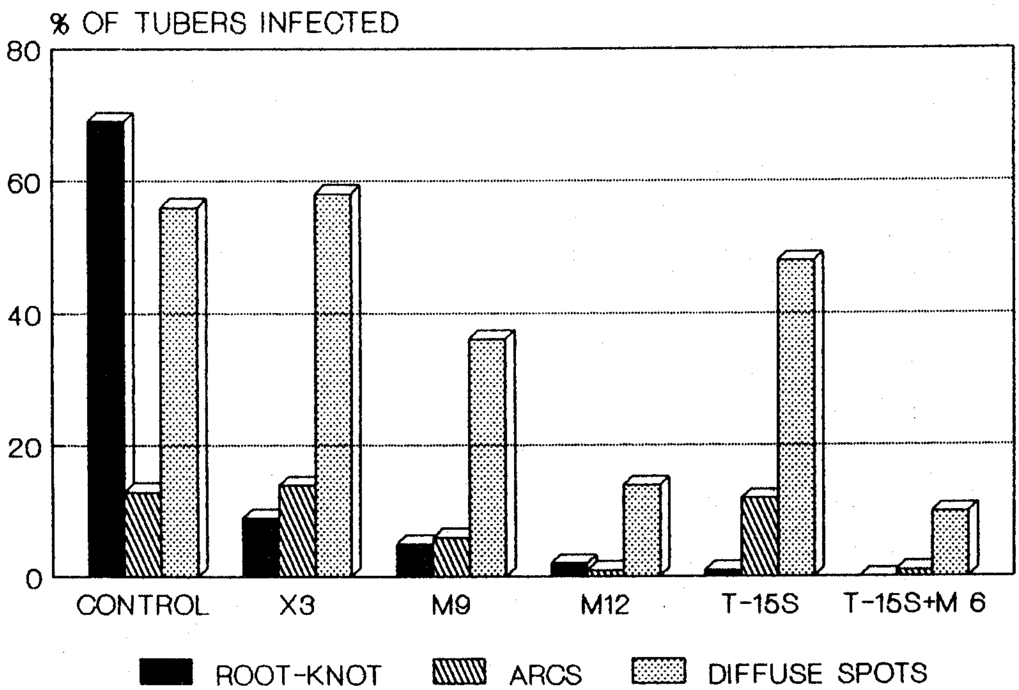


Figure 8. Effect of spring initiated treatments on root-knot nematode and CRS infections at the Klamath Exp. Station, OR.



Winter Small Grain Cover Crops Following Potatoes

R.L. Dovel, K.A. Rykbost, G. Chilcote, and J. Rainey[1]

INTRODUCTION

Soil loss due to wind erosion is a major obstacle to sustainable agriculture in the Klamath Basin. Light soils and high spring winds provide conditions for substantial soil loss in this region. The amount of crop residue left following potato harvest is minimal. Vines are often burned to reduce over-wintering pathogens. A cover crop is needed to protect the soil through the winter and especially during the spring when the highest erosive wind energy is received in the Klamath Basin.

A small-grain cover crop is one of the most effective methods for erosion control. The cost of erosion control could be minimized if the cover crop could also produce a marketable grain or forage crop. While small grains are an important component of cropping systems in the Klamath Basin, most of the grain planted is sown in the spring. This project was conducted to identify species and varieties of winter grains that are adapted to this region. Screening included both forage and grain yield as well as the ability to provide adequate soil protection.

Broadcast seeding of small grains prior to potato harvest has provided adequate cover following potatoes in other areas. This seeding method could reduce the cost of establishing the cover crop and allow establishment in years when weather would prevent the use of traditional planting methods. In this study drilled and broadcast plots were compared for early spring biomass, forage, and grain production.

PROCEDURES

Drilled Variety Trial

Two wheat varieties, four barley varieties, and one variety each of oats, cereal rye, and triticale were planted in mid-October for three consecutive years (1987-1989). Plots were 5 feet wide and 20 feet long. Seed was planted one inch deep with rows six inches apart at a rate of 30 seeds per square foot. Fertilizer was banded at planting at a rate of 50 lbs N, 60 lbs P_2O_5, and 44 lbs S/A. No chemical weed treatment was applied.Three harvests were made: one to monitor biomass accumulation and ground cover for the prevention of wind erosion; one when most of the cultivars were in the boot stage, to assess forage production; and one after complete grain fill to measure grain production.

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Broadcast Trial

Immediately adjacent to the trial described above an unreplicated trial including Rheidol rye, Hill '81 wheat, and Boyer barley was established by broadcast seeding immediately prior to potato harvest in the fall of 1988 and 1989. Seed was broadcast at approximately 80 lbs/A in 1988 and at 50, 100, and 150 lbs/A in 1989. Each entry was broadcast over an area measuring approximately 20 x 200 ft. Seed incorporation was accomplished by the potato harvesting operation. Harvest procedures and dates were identical in both trials. Four subsamples were taken from each plot and means given as an estimate of yield in broadcast seeded plots.

RESULTS

Drilled Variety Trial

All varieties except Winter Grey oats provided adequate ground cover to prevent early spring wind erosion in all three years. Rheidol rye produced the greatest amount of ground cover in 1989, while Flora triticale produced the most ground cover in 1990 (Figure 1). The prostrate growth habit of Flora tended to provide more ground cover with an equivalent biomass than more upright entries. There was a marked decrease in spring biomass accumulation of all barley varieties in 1990 due to poor winter survival. Winter Grey oats was eliminated from the study in 1989 due to very poor winter survival in 1988.

Rheidol rye produced the highest forage yield in two years (Figure 2). In the first two years of the study barley varieties tended to produce more forage than the two wheat varieties. However, wheat out yielded barley varieties in 1990, probably due to poorer winter survival of the barley varieties.

Hill '81 wheat consistently produced more grain than Weston, with yields similar to Scio, Hesk, and Boyer barley (Figure 3). Maury produced less grain than the other barley varieties; however, it is a hooded variety and would be used primarily for forage production. Grain yields of triticale were significantly lower than either wheat or barley in 1988 and 1990; however, 1989 triticale yields were very close to those of wheat and barley. Outstanding yields of winter triticale in other areas and an increasing demand by poultry producers warrant further consideration of this small grain as a winter cover/grain crop in the area.

Seeding Rate Effects on Broadcast Small Grains

Increasing seeding rates from 50 to 150 lbs/A increased early spring biomass accumulation of all three small grain species (Figure 4). However, increases in barley biomass were slight compared to those seen in wheat and rye. Increasing seeding rates also increased forage production with little difference seen between species (Figure 5). Barley grain yields increased as seeding rate increased up to 150 lbs/A (Figure 6). In contrast, grain yields of both wheat and rye were maximum at the 100 lbs/A seeding rate. This was due to increased lodging of wheat and rye at the highest seeding rate.

Comparison of Drilled and Broadcast Trials

Broadcast plots were seeded and incorporated by potato harvest one week prior to seeding drilled plots. Plants emerged earlier in the plots which were broadcast seeded than in plots which were drilled, and broadcast seedlings were larger than drilled seedlings at snow cover in December. Growth in early spring was more rapid in broadcast than in drilled plots, resulting in better ground cover by mid-March (Figure 7). Broadcast seeded plots produced more forage than drilled plots (Figure 8) and plants in the broadcast plots reached soft dough stage earlier than those in drilled plots. Broadcast seeding also produced similar or greater grain yields than drilled seeding and plants were slightly earlier maturing in broadcast plots (Figure 9).

Though these results are not replicated and comparisons are not statistically validated, it appears that broadcast seeding of small grains prior to potato harvest will result in similar or better levels of ground cover for erosion control and similar yields of forage or grain as drill seeding. Due to time constraints during potato harvest and unfavorable weather conditions in the fall, drill seeding of cover crops will not always be accomplished. Broadcast seeding prior to harvest is an alternative that should provide a more feasible means for establishment of a small grain cover crop following potatoes than drill seeding. Further study is underway to confirm the trends seen in this preliminary trial.

CONCLUSIONS

Both forage and grain yields of oats were significantly lower than any other small grain in the study due to poor winter survival. Therefore, the use of oats as a cover crop is not recommended where spring growth is important. In contrast, all other grain commodities produced adequate levels of ground cover in early spring and acceptable yields of both forage and grain. Depending on the objectives and management constraints of the producer, cereal rye, triticale, barley or wheat can produce adequate ground cover to prevent or reduce wind erosion in the early spring and provide a viable crop of either hay or grain.

Broadcast seeding of small grains prior to potato harvest has produced ground cover, forage, and grain yields which were equivalent or superior to drill seed plots. The use of broadcast seeding may prove to be an economically effective means of producing a cover crop following potatoes and may even provide adequate stands for hay or grain production at the discretion of the grower.

Figure 1. Ground cover of small grains following potatoes at the Klamath Experiment Station

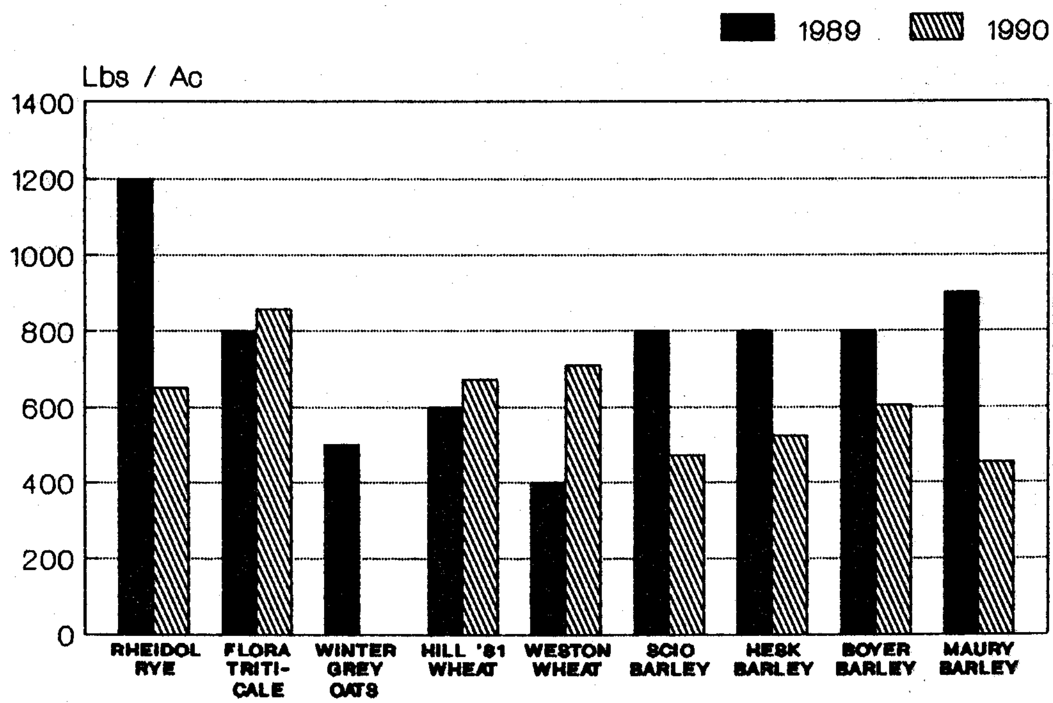

Figure 2. Forage production of small grains following potatoes at the Klamath Experiment Station.

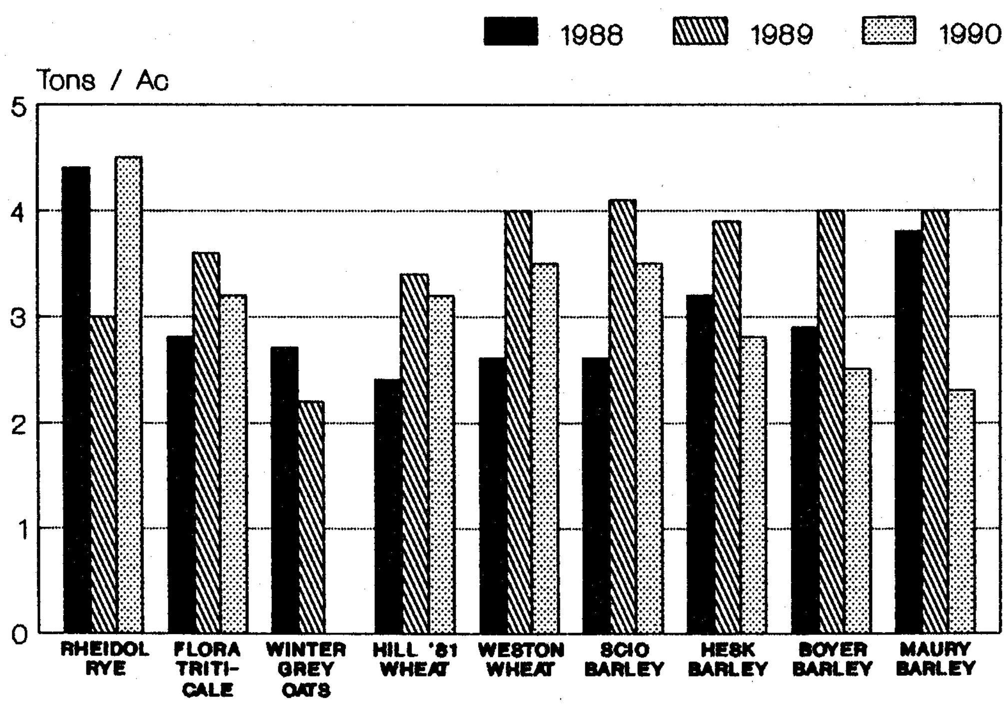

Figure 3. Grain production of small grains following potatoes at the Klamath Experiment Station.

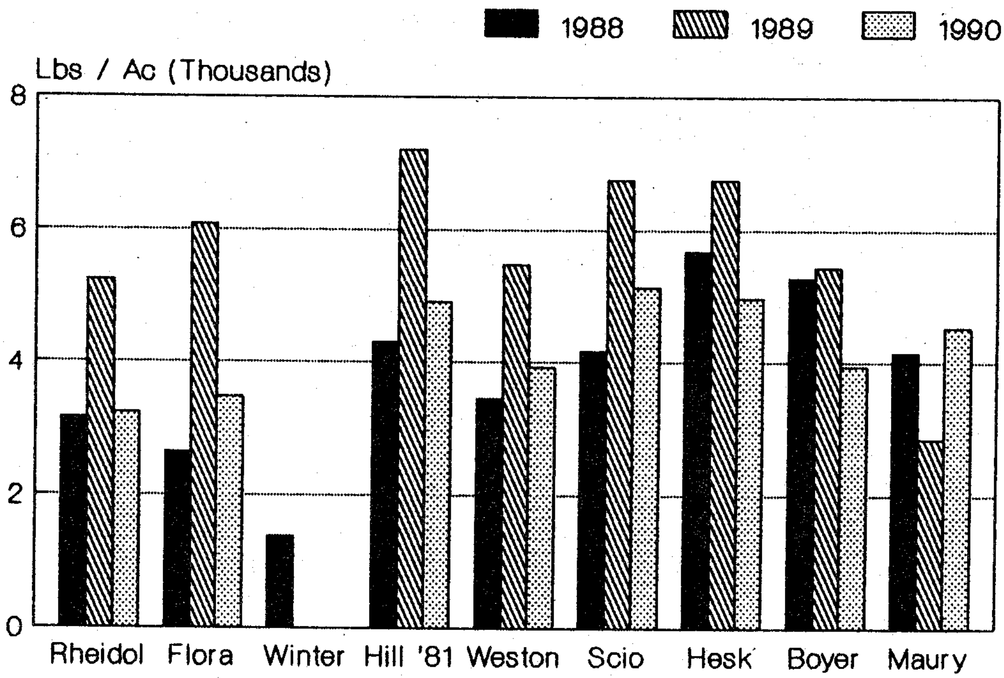

Figure 4. Seeding rate effect on ground cover of broadcast seeded small grains following potatoes - 1990

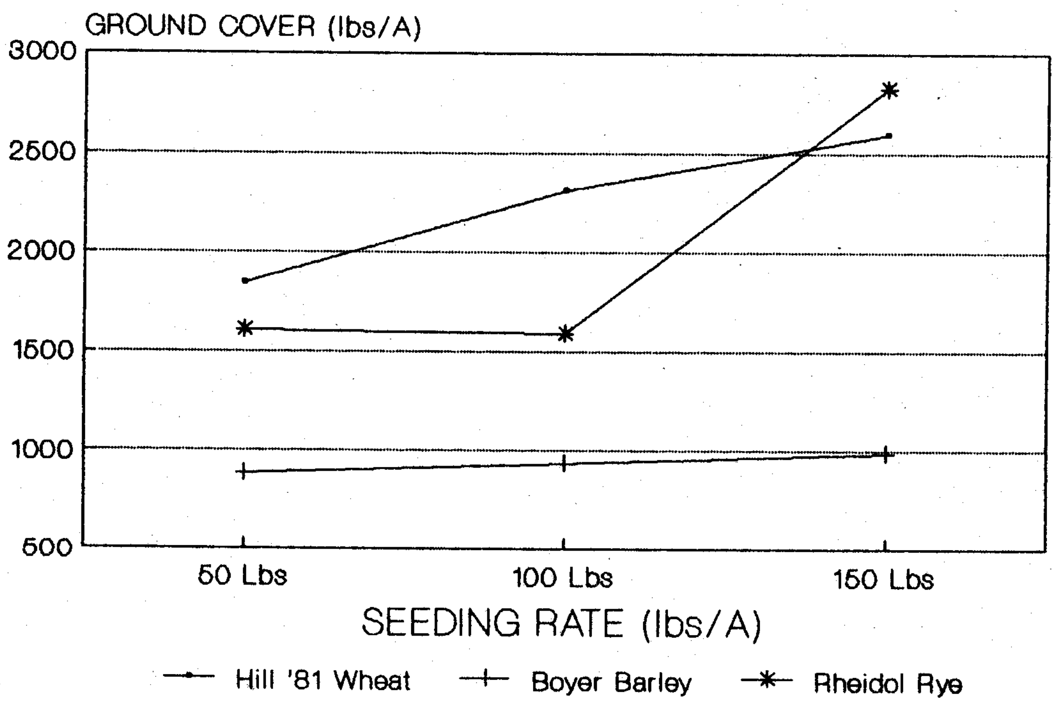

Figure 5. Seeding rate effect on forage production of broadcast seeded small grains following potatoes - 1990

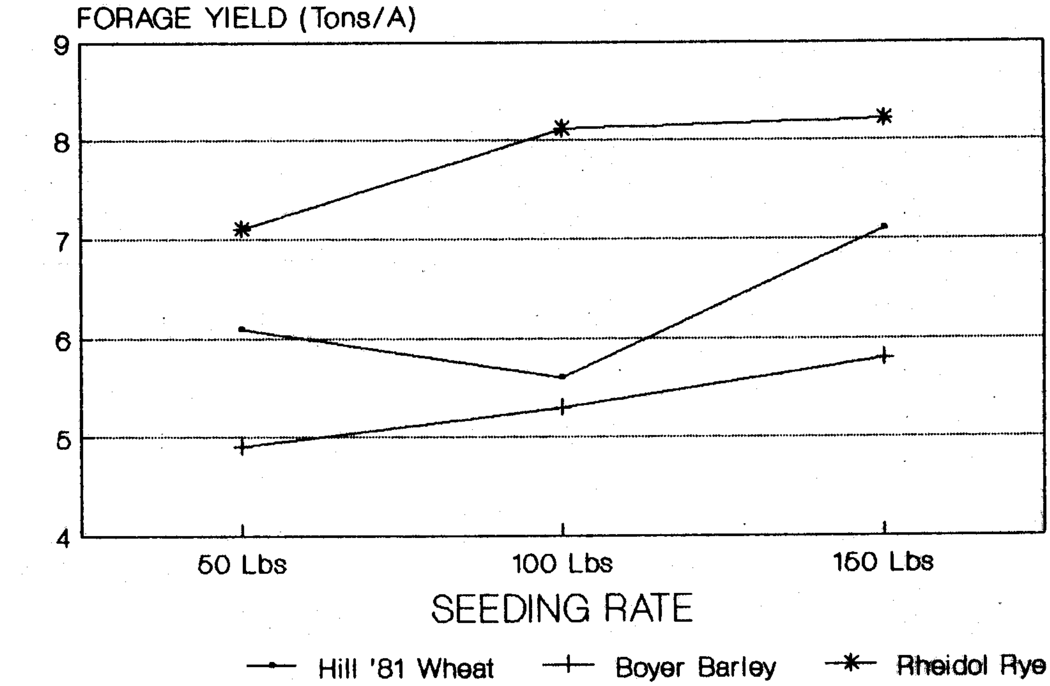

Figure 6. Seeding rate effect on grain production of broadcast seeded small grains following potatoes - 1990

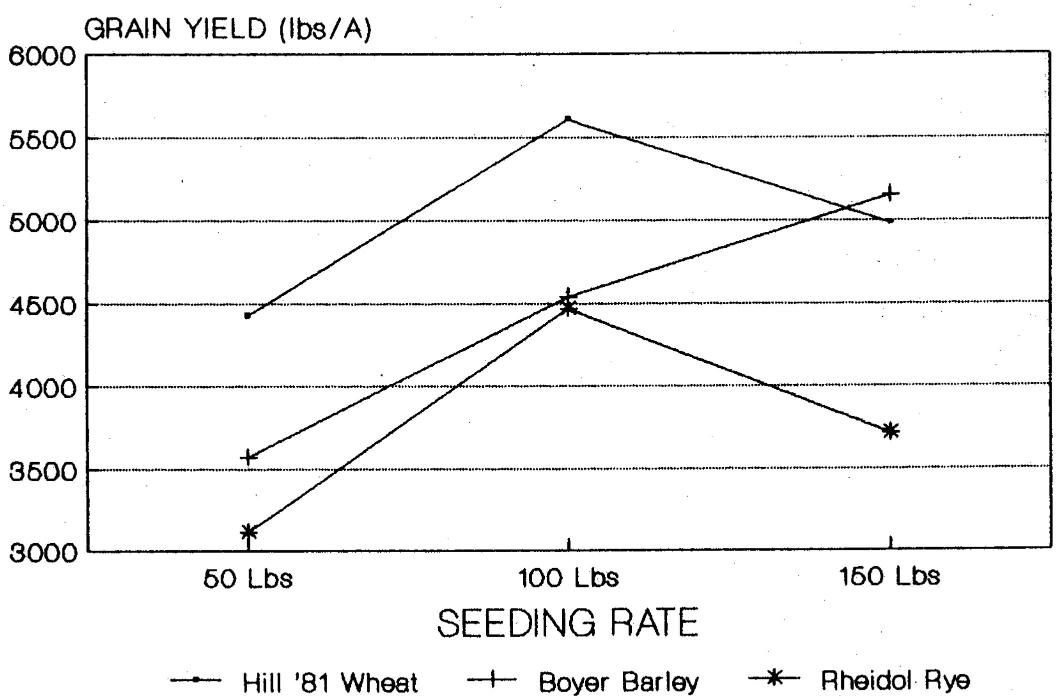

Figure 7. Seeding method effects on ground cover production of three small grain species following potatoes - 1990

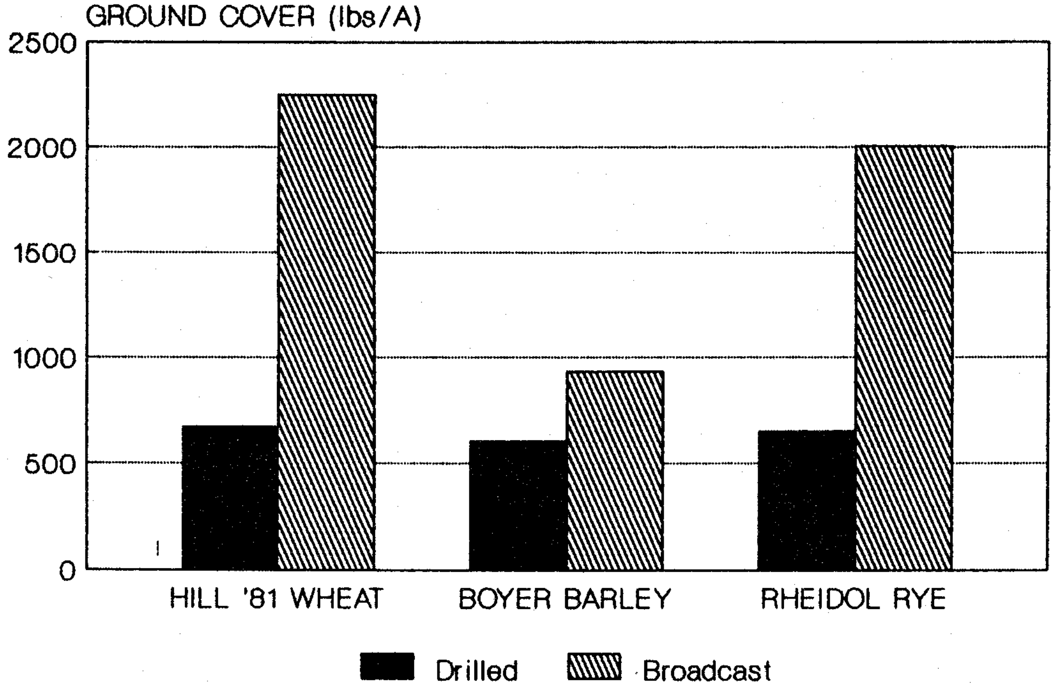

Figure 8. Seeding method effects on forage production of three small grain species following potatoes - 1990

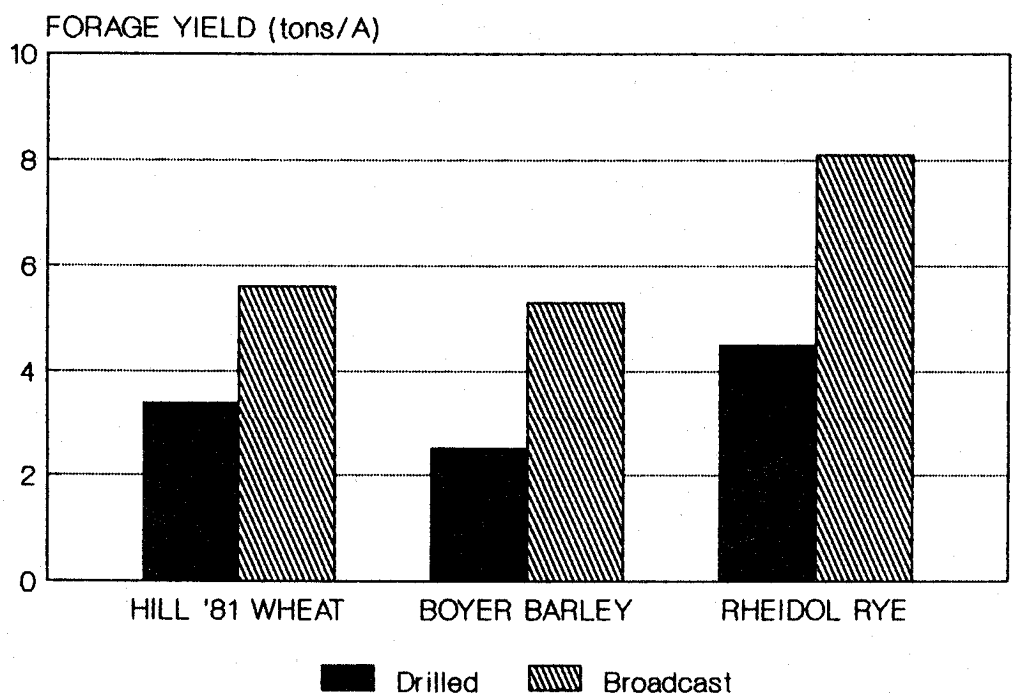

Figure 9. Seeding method effects on grain production of three small grain species following potatoes - 1990

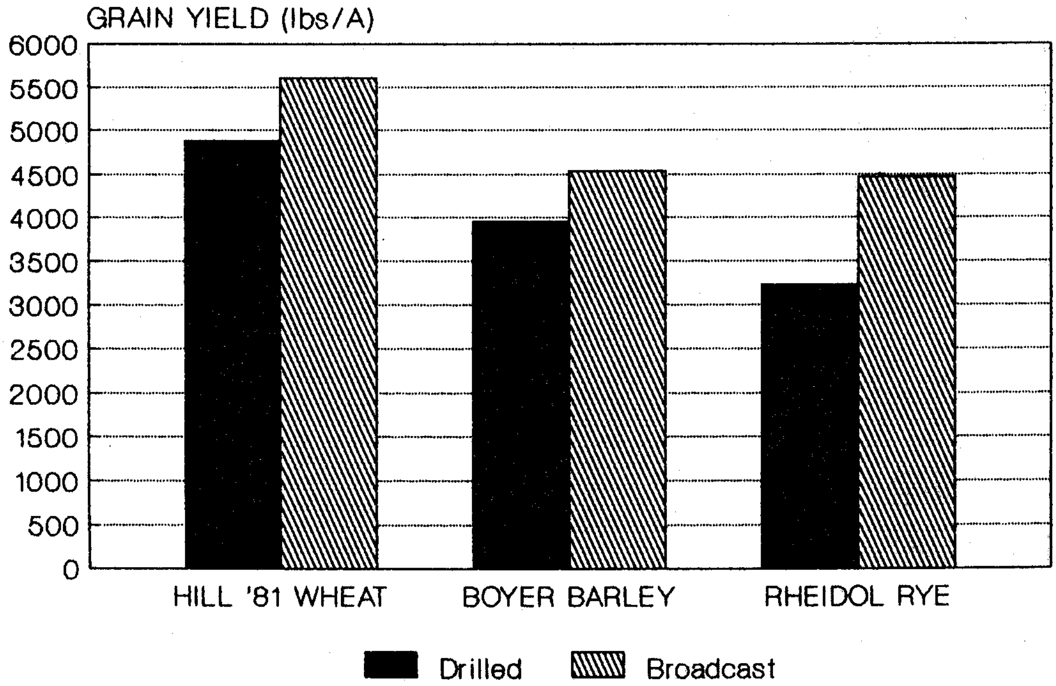

Table 1. Summary of Winter Grains Cover Crop Trial, 1988-1990. Observations of ground cover, forage yield, and grain yield of winter grains seeded as cover crops following potatoes at the Klamath Experiment Station, OR.

	Ground Cover		Forage Yield			Grain Yield		
	1988	1990	1988	1989	1990	1988	1989	1990
	--- lbs/A --		------ tons/A ------			------- lbs/A ------		
Cereal Rye								
Rheidel	1849	651	4.4	3.0	4.5	3160	5242	3232
Triticale								
Flora	1184	854	2.8	3.6	3.2	2644	6092	3477
Oats								
Winter Grey	599	---	2.7	2.2	---	1378	0	---
Wheat								
Hill 81[1]	674	672	2.4	3.4	3.2	4292	7211	4884
Weston[2]	476	709	2.6	4.0	3.5	3453	5468	3926
Avg. Wheat			2.5	3.7	3.4	3873	6340	4405
Barley								
Scie	842	470	2.6	4.1	3.5	4162	6767	5118
Hesk	834	524	3.2	3.9	2.8	5674	6770	4961
Boyer	866	603	2.9	4.0	2.5	5267	5421	3950
Maury[3]	952	452	3.8	4.0	2.3	4155	2854	4527
Avg. Barley			3.1	4.0	2.8	4815	5453	4639
Mean	920	617	3.1	3.6	3.2	3798	5092	4259
CV (%)	29	---	30	14	12	21	21	17
LSD(0.05)	296	(NS)	1.2	0.7	0.6	1003	1213	1067

1/ Soft white winter wheat
2/ Hard red winter wheat
3/ Hooded winter barley

1990 Barley Variety Trials

R.L. Dovel and G. Chilcote[1]

INTRODUCTION

Barley variety trials planted at the Klamath Experiment Station (KES) in 1990 included: the Western Regional Spring Barley trial in cooperation with Western State plant breeders; the Intermountain Spring Barley trial in cooperation with University of California research and extension personnel; and a collection of new and promising lines from the Oregon State University barley breeding program. The trial in cooperation with OSU was planted at KES and at two sites in the Lower Klamath Lake area.

PROCEDURES

All small-grain variety trials at the KES were on land planted in potatoes the previous year. Soils at the station include Poe, Fordney and Hosley series, all of which have a fine loamy to sandy texture and are moderately deep and somewhat poorly drained. The off-station trials were on very deep, poorly drained, lake bottom soils with high organic matter content. These fields are cropped continuously in spring cereals. All plots at KES were sprinkler irrigated, while only one organic soil test site was irrigated.

All trials were arranged in a randomized complete block design with either three or four replications. Trials at the KES were planted between April 25 and 27. Plots at the irrigated organic soil site were planted on May 26 and the dryland study was established on May 31. Seed was planted to a depth of one inch at a seeding rate of 100 lbs/A. All plots were fertilized with 100 lbs N, 60 lbs P_2O_5, and 44 lbs S/A at time of seeding. Plots measured 5 x 20 feet with a row spacing of six inches. At KES, Bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Chemical weed control at organic soil sites was achieved using a mixture of 2,4-D and Banvel. Plots were harvested using a plot combine with a five foot wide head. Grain yield was recorded for all plots. Test weight, percent plumps and percent thins were measured in only one replication.

RESULTS AND DISCUSSION

Western Regional Spring Barley Nursery

Yields in the Western Regional Barley Nursery were high in 1990, with the average yield exceeding the 1989 trial by more than 1,800 lbs/A (Table 1). There was no evidence of common root rot in the plots in 1990 while this disease, caused by *Cocleolebus spp.*, definitely lowered yields at KES in the previous year. Despite higher yields, test weights were lower in 1990 than in 1989. Steptoe had the lowest test weight in the trial (47.5 lbs/bu); however,

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Acknowledgments: Henzel Farms provided the off-station site and crop care.

it yielded well (6,364 lbs/A). Although there were no varieties that produced grain yields significantly higher than Steptoe, both OR 2 and OR 3 were slightly higher in yields (6,849 and 6,803 lbs/A, respectively). Good performance of these two varieties in trials on organic soils is also encouraging. The release of one of these lines as a feed barley is being considered. The highest yielding entry in 1990, WP 584118 (6,850 lbs/A), was one of the lowest yielding entries in the trial in 1989. Further testing is needed to determine the yield potential of this variety in the Klamath Basin.

OSU Spring Barley Variety Trials

Yields in the OSU Spring Barley Variety Trial at KES were comparable to those of the Western Regional Spring Barley Nursery. Both Lower Lake sites were lower yielding. The unirrigated trial received considerable hail damage with an estimated loss of 30 - 50%. The irrigated organic soil trial exhibited severe signs of stress shortly after emergence. Although plants did recover, yields were substantially depressed. It was not determined what caused the stress but both frost and herbicide injury are possible causes.

An experimental line from Idaho, 79 Ab10719-66LC, was the highest yielding entry at KES (Table 2). When averaged across all three sites it produced yields significantly higher than Steptoe but only slightly higher than Gustoe (Table 2-5). The OSU line, ORS 3, was only slightly lower yielding when averaged across all three locations and was the highest yielding line at the irrigated organic soil site. These two lines both show promise as feed varieties for the Klamath Basin. While the malting characteristics of ORS 3 are not appropriate for use in the United States malting industry, further testing is underway to determine if malting quality of this variety is appropriate for use in the export malt industry. The 2-row malting line, ORSM 8408, produced yields comparable to Crystal, the new 2-row malting standard, in all three locations. This selection is currently in plant scale malt testing.

Another malting variety that looked very promising is Russell. This 6-row malting variety produced yields equivalent to or superior to Steptoe at all three locations. This could be a commercially viable option if malt contracts are offered for this variety in the Klamath Basin.

The two leading commercially available varieties in this trial were Gustoe and Columbia. Gustoe has consistently out-yielded Steptoe in the Klamath Basin. Columbia has usually produced yields comparable to or superior to those of Steptoe. These higher yielding varieties require higher management levels (especially irrigation management) in order to realize superior yield levels.

Interest has increased recently in naked barley for use in human food products. Barley has a higher B-glucan content than oats. B-glucans have been reported to reduce blood cholesterol levels and the use of naked barley in health food products is possible. Several lines of naked barley were included in the trials. Nupana, Shonkin, Wanupana, and Washanupana were obtained from

Montana State University (MSU). Another line, called Hulless in these trials, was obtained from a local grower. The MSU lines are all 2-row varieties, Hulless is a 6-row barley. The yields of the 2-row varieties were 1,000-1,800 lbs/A lower than the average plot yield in all locations . In contrast, Hulless yield was about 300 lbs/A less than the average plot yield. However, yields of Hulless were up to 2,000 lbs/A lower than the highest yielding entries. Incentives would have to be substantial to make production of these lines economically attractive. Efforts to improve yield potential and marketability of naked barley are currently underway.

Intermountain Spring Barley Variety Trial

Yields in the Intermountain Spring Barley Variety Trial were slightly higher in 1990 than in 1989 and roughly equivalent to 1988. Grain yields ranged from 4,317 to 7,337 lbs/A in 1990 (Tables 6 and 7). Test weights averaged 52.8 lbs/bu, ranging from 50.0 to 56.5 lbs/bu with one exception. Hulless produced a test weight of 59.0 lbs/bu.

There were no numbered entries with higher yields than the two leading commercially available varieties in this trial (Gustoe and Columbia) during the last three years. However, when averaged over a three-year period, OSB 783063, ORSM 8424, and ORSF 8424 had yields which were equivalent to or superior to Steptoe, a commonly planted variety in the Klamath Basin.

Table 1. **1990 Western Regional Spring Barley Nursery.** Grain yield, test weight, percent thins, percent lodging, plant height and heading date of spring barley varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield lbs/A	Test Weight lbs/bu	Thins 6/64	Thins 5.5/64	Thins Pan	Lodge %	Height cm	Head Date Julian days
				-------	%	-------			
1	Trebi	3762	52.0	93.8	4.0	2.2	40	94	186
2	Steptoe	6364	47.5	90.7	5.0	4.3	15	112	183
3	Klages[1]	--	--	--	---	---	--	---	---
4	Morex	5007	50.5	93.3	5.1	1.6	28	117	183
5	ID 71966	5735	50.5	97.5	1.9	0.7	0	112	183
6	WA 944883	4654	50.0	74.1	13.1	12.8	30	99	191
7	BA 2601	6651	51.0	97.6	1.8	0.6	0	99	190
8	ID 8540	5240	53.0	98.1	1.4	0.6	10	112	183
9	MN 52	5623	52.0	96.8	2.4	0.8	23	109	183
10	ND 9866	6185	56.0	99.5	0.3	0.2	5	102	183
11	OR 1	5278	54.0	95.2	3.6	1.2	0	81	193
12	PB 107	3442	54.0	89.0	6.1	4.9	73	107	190
13	UT 502358	6721	52.0	97.9	1.5	0.7	0	89	191
14	WA 9029	4979	55.0	99.4	0.4	0.2	13	99	187
15	WP 584118	6850	51.0	99.1	0.8	0.1	0	79	189
16	BA 854026	4260	56.0	98.8	1.0	0.2	38	102	185
17	BA 865169	4744	55.0	98.9	0.9	0.2	23	104	190
18	ID 842974	4940	55.5	99.3	0.5	0.2	23	99	189
19	MT 851012	4065	53.0	96.2	2.3	1.5	58	104	186
20	MT 851195	5237	53.5	97.6	1.7	0.7	23	99	185
21	MT 860756	5261	50.0	94.6	3.5	1.9	40	99	187
22	ND 10277	5624	53.0	99.5	0.4	0.1	3	102	183
23	ND 10278	5778	53.0	99.7	0.2	0.2	0	99	183
24	OR 6	6010	55.0	92.0	5.5	2.5	0	112	183
25	OR 1209	6353	52.0	95.9	2.8	1.3	0	94	191
26	OR 2	6849	48.0	97.0	2.6	0.5	0	89	189
27	OR 3	6803	49.5	97.0	2.2	0.7	8	86	189
28	UT 1378	5985	50.0	95.2	2.6	2.2	5	109	186
29	UT 1705	6358	49.0	98.6	1.0	0.4	18	99	183
30	WA 903584	4157	48.0	81.8	10.0	8.2	40	94	187
	Mean	5480	52.0	95.3	2.8	1.8	18	100	187
	CV (%)	18	--	--	--	---	--	7	1
	LDS(0.05)	1056	--	--	--	---	--	10	1.3

1/ Contaminated seed, data discarded.

Table 2. 1990 Irrigated Mineral Soil OSU Barley Variety Trial. Grain yield, test weight, percent thins, percent lodging, plant height and heading date of spring barley varieties planted in mineral soil at the Klamath Experiment Station, OR.

Entry	Selection	Yield lbs/A	Test Weight lbs/bu	Thins 6/64	Thins 5.5/64	Thins Pan	Lodge %	Height inches	Head Date Julian days
				-------	%	--------			
1	Bearpaw	5817	53.0	98.7	1.1	0.2	13	39	188
2	OSB 753315	5819	53.0	97.6	1.7	0.7	5	41	183
3	Crystal	4790	52.0	88.0	7.6	2.6	43	38	186
4	Gustoe	6858	51.5	98.3	1.5	0.2	0	29	189
5	UK 227-90-5	5462	50.0	89.9	7.5	2.6	35	37	183
6	Nupana	3563	58.5	88.9	7.3	3.8	65	38	189
7	Russell	6491	52.7	98.6	1.1	0.3	0	42	183
8	Shonkin	3407	62.0	87.6	9.3	3.1	18	40	194
9	Steptoe	5872	51.5	98.1	1.2	0.7	20	42	183
10	Wanupana	4008	59.5	95.7	3.3	1.0	38	37	187
11	Washonupana	3421	53.0	86.1	7.2	6.7	45	33	187
12	ORSM 8623	5614	54.0	97.0	2.3	0.7	0	22	183
13	ORSM 8625	5527	53.0	97.7	1.5	0.7	0	25	186
14	B 2601	6000	51.0	98.7	1.0	0.3	0	37	191
15	B 1215	5605	54.0	99.6	0.3	0.2	8	37	188
16	FB 741209	5118	53.0	93.8	4.6	1.6	0	34	191
17	FB 78444-006	5836	51.0	94.6	3.6	1.8	0	43	186
18	MT 851005	4922	54.5	98.6	1.0	0.4	45	38	186
19	MT 851195	5119	51.0	96.9	2.2	0.9	15	39	184
20	MT 860219	5681	54.0	98.5	1.0	0.5	30	38	186
21	MT 860224	5079	55.0	95.9	2.2	1.9	30	37	187
22	ORSM 8408	5323	55.0	97.7	1.8	0.5	5	41	190
23	OR 1	5782	55.0	94.9	3.5	1.6	0	29	194
24	OR 2	6668	48.0	97.1	2.4	0.6	0	32	189
25	OR 3	6679	51.0	95.2	3.8	1.0	0	33	188
26	79Ab10719-66LC	7133	51.0	93.7	4.7	1.6	0	41	184
27	Hulless	4610	60.0	84.5	10.6	5.0	0	35	191
28	Columbia	6752	50.0	95.2	3.7	1.1	0	34	190
	Mean	5431	53.5	94.9	3.9	1.7	15	36	187
	LSD (0.05)	929	--	--	---	---	--	6.6	2
	CV (%)	12	--	--	---	---	--	5	0.7

Table 3. **1990 Unirrigated Organic Soil OSU Barley Variety Trial.** Grain yield, test weight, and percent thins of spring barley varieties planted in organic soil in the Lower Klamath Lake, OR.

Entry	Selection	Yield lbs/A	Test Weight lbs/bu	Thins 6/64	5.5/64	Pan
				--------	%	--------
1	Bearpaw	3816	44.5	92.6	5.5	1.9
2	OSB 753315	4549	46.0	84.2	11.3	4.6
3	Crystal	3861	48.0	95.1	3.5	1.4
4	Gustoe	4227	46.0	95.7	3.2	1.1
5	Klages	4126	49.0	95.6	3.3	1.1
6	Nupana	2774	56.0	93.7	4.3	1.9
7	Russell	4151	49.5	96.3	2.9	0.8
8	Shonkin	1988	54.0	53.7	30.3	16.0
9	Steptoe	4316	47.0	96.4	2.6	1.1
10	Wanupana	2883	55.5	89.8	8.1	2.1
11	Washonupana	2805	52.0	82.7	8.4	8.9
12	ORSM 8623	2943	50.0	97.1	2.1	0.8
13	ORSM 8625	3149	48.0	94.1	4.4	1.5
14	B 2601	2926	47.5	92.7	5.1	2.2
15	FB 78444-006	4230	45.5	91.4	5.9	2.7
16	MT 851005	3469	47.5	95.9	2.9	1.1
17	MT 851195	3388	50.0	97.4	1.9	0.7
18	MT 860219	3912	48.5	96.2	2.3	1.4
19	MT 860224	4015	51.0	97.8	1.6	0.6
20	ORSM 8408	3843	47.5	95.1	3.4	1.5
21	OR 1	3719	47.0	93.1	4.9	2.0
22	OR 2	4067	47.0	89.6	7.5	2.9
23	OR 3	4227	48.0	85.1	10.8	4.2
24	79Ab10719-66LC	4789	47.5	87.4	8.9	3.8
25	Hulless	2983	56.5	53.0	26.2	20.8
26	Columbia	4497	43.0	95.3	3.2	1.5
	Mean:	3678	48.9	89.9	6.7	3.4
	LSD (0.05)	700	--	--	---	---
	CV (%)	14	--	--	---	---

Table 4. 1990 Irrigated Organic Soil OSU Barley Variety Trial. Grain yield, test weight, and percent thins of spring barley varieties planted in organic soil in the Lower Klamath Lake, OR.

Entry	Selection	Yield	Test Weight	Thins 6/64	Thins 5.5/64	Thins Pan
		lbs/A	lbs/bu	--------	%	--------
1	Bearpaw	3465	49.0	95.2	3.5	1.2
2	OSB 753315	3292	50.0	91.8	6.2	2.1
3	Crystal	3268	50.0	95.1	3.6	1.3
4	Gustoe	5013	49.0	97.6	1.7	0.7
5	Klages	4301	50.0	95.5	3.6	0.9
6	Nupana	2362	58.0	95.1	3.3	1.6
7	Russell	4489	50.0	97.4	1.9	0.7
8	Shonkin	1105	55.5	45.5	31.2	23.3
9	Steptoe	4167	48.0	98.0	1.4	0.5
10	Wanupana	2006	60.0	95.0	3.8	1.3
11	Washonupana	2160	56.0	92.3	6.6	1.2
12	ORSM 8623	3096	50.5	96.9	2.1	0.9
13	ORSM 8625	2934	51.0	96.2	2.7	1.2
14	B 2601	4108	51.5	93.6	4.2	2.2
15	FB 78444-006	4449	49.0	93.2	4.9	1.9
16	MT 851005	2797	51.0	97.5	1.8	0.7
17	MT 851195	2993	50.0	93.5	4.9	1.6
18	MT 860219	3299	52.0	97.4	1.8	0.7
19	MT 860224	4045	54.0	98.2	1.3	0.5
20	ORSM 8408	3320	51.0	95.7	3.2	1.2
21	OR 1	4082	48.0	87.8	8.1	4.2
22	OR 2	4098	51.0	95.5	3.2	1.3
23	OR 3	5368	48.0	82.7	13.0	4.3
24	79Ab10719-66LC	5162	50.0	95.7	3.3	1.0
25	Hulless	3264	58.0	74.9	18.2	6.9
26	Columbia	4036	47.0	98.1	1.2	0.7
	Mean:	3567	51.4	92.1	5.4	2.5
	LSD (0.05)	1232	--	--	---	---
	CV (%)	24	--	--	---	---

Table 5. 1990 OSU Spring Barley Varieties - Observations of grain yield over 3 locations - Irrigated mineral soil (IMS), Unirrigated organic soil (UOS), Irrigated organic soil (IOS), OR.

Entry	Selection	IMS	UOS	IOS	Avg.	Rank
		----------------	lbs/A	----------------		
1	Bearpaw	5817	3816	3465	4366	13
2	OSB 753315	5819	4549	3292	4553	10
3	Crystal	4790	3861	3268	3973	17
4	Gustoe	6858	4227	5013	5366	3
5	UK 227-90-5	5462	4126	4301	4630	9
6	Nupana	3563	2774	2362	2900	24
7	Russell	6491	4151	4489	5044	5
8	Shonkin	3407	1988	1105	2167	26
9	Steptoe	5872	4316	4167	4785	8
10	Wanupana	4008	2883	2006	2966	23
11	Washonupana	3421	2805	2160	2795	25
12	ORSM 8623	5614	2943	3096	3884	18
13	ORSM 8625	5527	3149	2934	3870	19
14	B 2601	6000	2926	4108	4345	14
15	B 1215	5605	--	--	--	--
16	FB 741209	5118	--	--	--	--
17	FB 78444-006	5836	4230	4449	4838	7
18	MT 851005	4922	3469	2797	3729	21
19	MT 851195	5119	3388	2993	3833	20
20	MT 860219	5681	3912	3299	4297	15
21	MT 860224	5079	4015	4045	4380	12
22	ORSM 8408	5323	3843	3320	4162	16
23	OR 1	5782	3719	4082	4528	11
24	OR 2	6668	4067	4098	4944	6
25	OR 3	6679	4227	5368	5425	2
26	79Ab10719-66LC	7133	4789	5162	5695	1
27	Hulless	4610	2983	3264	3619	22
28	Columbia	6752	4497	4036	5095	4
	Mean:	5415	3376	3283	3892	--
	LSD (0.05)	929	699	1232	560	--
	CV (%)	12	14	24	17	--

Table 6. 1990 Intermountain Regional Spring Barley Trial. Grain yield, test weight, percent thins, percent lodging, plant height and heading date of spring barley varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield lbs/A	Test Weight lbs/bu	Thins 6/64	Thins 5.5/64	Thins Pan	Lodge %	Height inches	Head Date (Julian days)
				-------	%	--------			
1	Steptoe	5221	51.0	96.0	2.6	1.4	68	35	183
2	Klages	4311	54.0	90.3	5.8	3.9	48	39	192
3	Advance	6114	51.0	89.7	7.3	3.0	10	37	183
4	Gustoe	7337	53.0	95.7	3.2	1.1	0	30	189
5	Columbia	6611	52.0	97.0	2.2	0.9	0	36	191
6	ORSF 8405	6237	51.5	93.8	4.4	1.8	25	39	184
7	Teton	5416	51.0	90.5	5.7	3.8	43	40	183
8	Cougbar	5200	52.0	87.7	8.5	3.8	25	43	185
9	ORSM 8413	6641	52.0	91.7	5.8	2.5	0	30	187
10	ORSM 8424	6293	52.5	81.8	11.9	6.3	0	38	190
11	ORSF 8423	6365	53.5	96.4	2.5	1.1	3	32	189
12	PH584-11	7297	52.0	97.8	1.8	0.5	0	31	188
13	ORSM 8618	5265	56.0	93.4	4.6	2.0	50	35	190
14	ORSM 8423	6887	53.0	87.0	9.6	3.4	0	33	191
15	Medallion	6470	52.0	90.5	7.5	2.0	0	33	190
16	B 1202	4671	53.0	99.0	0.7	0.3	43	38	185
17	Micah	5207	50.0	71.4	18.3	10.3	40	31	191
18	PH585-6	6694	52.0	96.5	2.5	1.0	0	32	189
19	MT 140523	5821	55.0	98.7	1.0	0.3	10	38	187
20	Triumph	4580	55.0	95.4	3.1	1.6	50	39	190
21	OSB 783063	7403	49.0	82.7	12.5	4.8	0	32	190
22	ORSM 8408	5973	56.5	98.2	1.2	0.6	13	43	190
23	OR 1	6371	52.0	96.1	3.0	0.9	3	32	193
24	Crystal	5976	54.0	98.7	0.9	0.4	18	39	187
25	ORSF 8635	5829	50.0	80.8	12.8	6.4	5	33	190
26	ORSF 8435	5626	51.5	75.5	13.3	11.2	45	43	184
27	OSB 763128	5314	51.5	93.2	4.8	2.1	20	40	185
28	OSB 74289-5K	5830	52.0	96.5	2.5	0.9	40	38	184
29	BA 4039	6314	55.0	99.0	0.6	0.3	15	38	186
30	MT 83533	5139	52.0	91.4	5.2	3.4	48	37	187
31	Harrington	5679	53.5	93.6	3.8	2.6	20	39	187
32	Bearpaw	4732	54.0	92.0	5.1	3.0	58	38	187
33	Excel	4836	51.0	96.2	2.5	1.3	40	41	183
34	WA 8771	4502	52.0	90.5	5.9	3.6	50	36	187
35	585-6	6803	53.0	98.2	1.3	0.5	0	34	190
36	B 1603	4317	54.0	94.5	3.7	1.8	35	40	183
37	B 1215	5525	56.0	98.4	1.1	0.5	25	40	187
38	Hulless	4544	59.0	83.1	10.9	6.0	38	38	191
	Mean	5772	52.8	82.1	4.6	2.3	23	37	188
	CV (%)	15	--	--	---	---	--	--	---
	LSD(0.05)	1214	--	--	---	---	--	--	---

Table 7. **Intermountain Regional Spring Barley Variety Trial Summary.** Two and three-year summaries of spring barley varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield 1990	Yield 1989	Yield 1988	Avg. 2-year	Rank	Avg. 3-year lbs/A	Rank
		-----------	lbs/A	----------				
1	Steptoe	5221	4473	5333	4847	23	5009	11
2	Klages	4311	4703	4704	4507	26	4573	17
3	Advance	6114	5046	6350	5580	12	5837	6
4	Gustoe	7337	5473	7122	6405	1	6644	1
5	Columbia	6611	5740	7131	6176	3	6494	3
6	ORSF 8405	6237	4911	--	5574	13	--	--
7	Teton	5416	4767	4620	5092	20	4934	13
8	Cougbar	5200	5758	4782	5479	17	5247	10
9	ORSM 8413	6641	4351	5990	5496	15	5661	8
10	ORSM 8424	6293	5454	6413	5874	6	6053	5
11	ORSF 8423	6365	4643	--	5504	14	--	--
12	PH584-11	7297	4652	--	5975	5	--	--
13	ORSM 8618	5265	4439	4870	4852	22	4858	15
14	ORSM 8423	6887	4552	7100	5720	9	6180	4
15	Medallion	6470	5010	5601	5740	8	5694	7
16	B 1202	4671	5218	4751	4945	21	4880	14
17	Micah	5207	4346	5271	4777	25	4941	12
18	PH585-6	6694	5596	--	6145	4	--	--
19	MT 140523	5821	--	--	--	--	--	--
20	Triumph	4580	5096	4516	4838	24	4731	16
21	OSB 783063	7403	5342	6831	6373	2	6525	2
22	ORSM 8408	5973	5309	--	5641	11	--	--
23	OR 1	6371	5219	--	5795	7	--	--
24	Crystal	5976	5012	--	5494	16	--	--
25	ORSF 8635	5829	4834	--	5332	18	--	--
26	ORSF 8435	5626	5739	--	5683	10	--	--
27	OSB 763128	5314	--	5433	--	--	--	--
28	OSB 74289-5K	5830	4487	6022	5159	19	5446	9
29	BA 4039	6314	--	--	--	--	--	--
30	MT 83533	5139	--	--	--	--	--	--
31	Harrington	5679						
32	Bearpaw	4732						
33	Excel	4836						
34	WA 8771	4502						
35	585-6	6803						
36	B 1603	4317						
37	B 1215	5525						
38	Hulless	4544						
	Mean:	5772	5007	5713	5500	--	5512	
	LSD (0.05)	1214	1197	1253				
	CV (%)	15	17	16				

Spring Wheat Variety Trials in the Klamath Basin, 1990

R.L. Dovel and G. Chilcote[1]

INTRODUCTION

In 1990, spring wheat variety trials were conducted at the KES in cooperation with plant breeding and evaluation programs at Oregon State University, the Tulelake Field Station (University of California at Davis) and Western Region evaluation programs. Cold-tolerant, short-season cultivars are needed in the Klamath Basin due to a short growing season with the possibility of frost throughout the growing season. Entries evaluated included soft white (SW), hard white (HW), and hard red (HR) selections. In general there is little disease or insect pressure on small grains in the Klamath Basin. However, the introduction of the Russian wheat aphid could greatly alter that situation.

PROCEDURES

All small-grain variety trials at the KES were on land planted in potatoes the previous year. Soils at the station include Poe, Fordney and Hosley series, all of which have a fine loamy to sandy texture and are moderately deep and somewhat poorly drained. The off-station trials were on very deep, poorly drained, lake bottom soils with high organic matter content. All plots at KES were sprinkler irrigated, while only one organic soil test site was irrigated.

All trials were arranged in a randomized complete block design with either three or four replications. Trials at the KES were planted between April 25 and 27. Plots at the irrigated organic soil site were planted on May 26 and the dryland study was established on May 31. Seed was planted to a depth of one inch. The seeding rate for wheat trials was 80 lbs/A. All plots were fertilized with 100 lbs N, 60 lbs P_2O_5, and 44 lbs S/A at time of seeding. Plots measured 5 x 20 feet with a row spacing of six inches. At KES, Bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Chemical weed control at the organic soil sites was achieved using a mixture of 2,4-D and Banvel. Plots were harvested using a plot combine with a five foot wide head. Grain yield was recorded for all plots. Test weight was measured in only one replication.

RESULTS AND DISCUSSION

Western Regional Spring Wheat Nursery

Yields were average; however, there was a high degree of variability in the trial making it difficult to clearly distinguish the top yielders. Test weights were down from the very high levels of 1989 (averaging almost 65 lbs/bu) averaging only 57.1 lbs/bu (Table 1).

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Acknowledgments: Henzel Farms provided the off-station site and crop care.

Penawawa, a SW variety recently released by Washington State University, was the highest yielding variety over a three-year period (Table 2). However, it has not outyielded Fieldwin and Blanca, current standard SW varieties, in the Intermountain Spring Wheat Variety Trial.

Klasic, a HW wheat variety, yielded comparably to Penawawa in 1990 and shows great promise for this area if the HW wheat market continues to be strong.

The highest yielding variety in 1990 was ID 405, a SW variety from Idaho. Further testing will be required to determine if this variety is consistently a superior-yielding variety in the Klamath Basin.

Intermountain Regional Spring Wheat Variety Trial

The Intermountain Spring Wheat Variety Trial was planted at KES for the third consecutive year in 1990. This trial is conducted in cooperation with the Tulelake Field Station (TFS) and University of California extension personnel in Siskiyou and Shasta counties. The average yield in 1990 was 4,735 lbs/A with an average test weight of 59.4 lbs/A (Table 3). This is almost 1,000 lbs/A higher than the 1989 average (Table 4). Klasic, a HW variety planted widely in California, was the highest yielding variety in the trial. Over the three-year period that this trial has been conducted at KES, Klasic has ranked 11th. Over that same period another HW variety, ORS 8413, was the number one ranked variety. If the HW market continues to develop these two varieties could be viable alternatives to HR varieties currently being planted.

The highest yielding HR variety in 1990 was WB 926 (Table 3). Over a three-year period it has outyielded both Yecora Rojo and WB 906 (Table 4). However, it was ranked slightly lower than Spillman, another HR variety, over the three years of the trial. These two varieties are very promising HR lines for the Klamath Basin.

Yields of all SW varieties ranked lower than expected in 1990. The SW lines are usually the top-yielding varieties: however, in 1990 several HR lines significantly outyielded them. Over a three-year period Treasure has been the leading SW variety, followed by Fieldwin, then Blanca. All of these lines are well adapted to the Klamath Basin (Table 4).

OSU Hard White Spring Wheat Variety Trial

The advent of HW wheat as a viable market class offers another option for producers in the Klamath Basin. This was the first year for this trial to be planted at KES. Two standard HR varieties were included for comparison as well as Klasic, the standard HW variety in California. Yields of several lines were promising; however, further testing is required before any conclusions as to the adaptation of these lines to the Klamath Basin can be made (Table 5).

Table 1. 1990 Western Regional Spring Wheat Nursery. Observations of grain yield, test weight, lodging, plant height, and days to 50% heading of spring wheat varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Grain Class	Yield lbs/A	Test Wt. lbs/bu	Lodge %	Height inches	Heading date Julian Days
1	McKay	HR	5229	61.0	0	35	191
2	Federation	SW	3830	57.5	0	43	193
3	Owens	SW	4757	52.0	5	36	191
4	Penawawa	SW	5236	55.0	0	34	190
5	WA 7075	HR	3629	55.5	0	35	190
6	Wakanz	SW	5145	62.0	0	33	192
7	WA 7176	SW	4520	56.0	0	35	190
8	WA 7496	SW	4667	57.5	0	30	190
9	OR 487316	SW	4422	59.0	0	30	193
10	ID 367	HR	5215	58.5	28	35	190
11	ID 415	SW	5527	62.0	0	36	191
12	ID 417	SW	4390	57.5	0	33	188
13	ID 419	HR	4913	56.5	0	34	191
14	ID 420	HR	5606	62.5	0	32	191
15	UT 580646	HR	5190	48.0	0	33	194
16	UT 613960	HR	5708	58.0	0	36	190
17	UT 2464	HR	6027	62.0	0	37	194
18	OR 487335	HR	3889	54.0	0	36	191
19	OR 487456	HR	3169	54.0	0	31	187
20	OR 487457	HR	5026	62.0	0	26	191
21	OR 487400	HR	4741	65.0	0	34	192
22	Klasic	HW	5285	62.0	0	31	189
23	Serra	HR	4492	59.5	0	31	188
24	WA 7668	HR	5283	61.5	43	37	190
25	OR 487462	HR	3635	52.5	0	34	189
26	ORS 8427	SW	4672	62.0	0	35	190
27	OR 487380	HW	3564	53.0	0	23	189
28	OR 487279	HW	3924	57.0	0	30	189
29	OR 487453	HW	4905	62.5	0	32	193
30	UC 784	HR	4497	50.0	0	25	186
31	UC 786	HR	4520	51.5	0	26	190
32	UC 785	HR	4491	62.0	0	24	191
33	UT 1601	HR	4950	55.0	0	34	191
34	UT 613945	HR	5421	59.5	23	37	191
35	UT 2534	HR	4405	49.0	0	36	190
36	ID 392	SW	4541	54.0	0	34	193
37	ID 405	SW	7454	55.0	0	38	194
38	ID 408	SW	4974	60.0	0	32	191
39	ID 409	SW	5094	56.0	0	33	191
40	ID 412	HR	3990	55.0	0	34	190
41	LEWIEM 01	SW	4519	54.5	0	34	192
42	LEWIEM 05	SW	3898	55.0	5	38	194
43	LEWIEM 04	SW	5230	63.0	3	35	192
44	OR 487381	HR	5686	46.0	0	31	192
	Mean		4779	57.1	2	33	191
	LSD (0.05)		1782			7.5	1.5
	CV (%)		27			6.3	0.6

Footnotes: HR = Hard Red, SW = Soft White HW = Hard White

Table 2. Summary of Western Regional Spring Wheat Nursery, 1988-1990. Three year summary of spring wheat planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield 1990	Yield 1989	Yield 1988	Yield 2-yr Avg	Rank	Yield 3-yr Avg -lbs/A-	Rank
		lbs/A						
1	McKay	5229	4514	4926	4872	10	4890	3
2	Federation	3830	4348	3921	4089	19	4033	9
3	Owens	4757	5142	4600	4950	7	4833	4
4	Penawawa	5236	5570	4486	5403	1	5097	1
5	WA 7075	3629	4352	5814	3991	20	4598	6
6	Wakanz	5145						
7	WA 7176	4520	5053	4621	4787	11	4731	5
8	WA 7496	4667	4216	4458	4442	14	4447	8
9	OR 487316	4422	4245	5030	4334	18	4566	7
10	ID 367	5215	4590	5046	4903	9	4950	2
11	ID 415	5527	4284	--	4906	8		
12	ID 417	4390	4419	--	4405	16		
13	ID 419	4913	3880	--	4397	17		
14	ID 420	5606	4801	--	5204	3		
15	UT 580646	5190	4763	--	4977	5		
16	UT 613960	5708	4854	--	5281	2		
17	UT 2464	6027	4255	--	5141	4		
18	OR 487335	3889	2929	--	3409	21		
19	OR 487456	3169	3468	--	3319	22		
20	OR 487457	5026	3884	--	4455	13		
21	OR 487400	4741	5201	--	4971	6		
22	Klasic	5285	4263	--	4774	12		
23	Serra	4492	4325	--	4409	15		
24	WA 7668	5283						
25	OR 487462	3635						
26	ORS 8427	4672						
27	OR 487380	3564						
28	OR 487279	3924						
29	OR 487453	4905						
30	UC 784	4497						
31	UC 786	4520						
32	UC 785	4491						
33	UT 1601	4950						
34	UT 613945	5421						
35	UT 2534	4405						
36	ID 392	4541						
37	ID 405	7454						
38	ID 408	4974						
39	ID 409	5094						
40	ID 412	3990						
41	LEWIEM 01	4519						
42	LEWIEM 05	3898						
43	LEWIEM 04	5230						
44	OR 487381	5686						
	Mean:	4779	4425	4767	4410	--	4215	--
	LSD (0.05)	1782	743	1427				
	CV (%)	27	21	9				

Table 3. 1990 Intermountain Spring Wheat Nursery. Observations of grain yield, test weight, lodging, plant height, and days to 50% heading of spring wheat varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield lbs/A	Test Wt. lbs/bu	Lodge %	Height inches	Heading date Julian Days
1	Yecora Rojo	4638	56.0	0	25	186
2	Fieldwin	4772	59.0	45	38	194
3	Klasic	6141	64.0	0	28	185
4	WB 906R	4589	53.0	18	34	190
5	Blanca	4215	60.0	55	35	192
6	Edwall	4366	53.5	15	36	193
7	ORS 8413	5336	62.5	0	33	192
8	Serra	3437	58.0	25	31	190
9	Treasure	5034	60.0	73	36	194
10	ID266	4584	62.5	43	36	191
11	Sterling	4125	61.5	20	36	193
12	Waduel	3692	60.0	25	36	190
13	Spillman	5285	51.0	28	36	191
14	WB 926	6073	62.0	13	36	189
15	WB Sprite	4533	59.5	90	35	192
16	ORS 8410	5460	57.0	0	33	191
17	UC 748	5031	64.0	0	26	189
18	UC 785	5446	54.5	0	27	193
19	UC 786	5585	60.5	0	23	192
20	UC 850	5397	60.0	60	35	193
21	UC 852	4523	63.0	8	33	193
22	WB Rambo	4624	63.0	40	32	191
23	ID 312	4155	61.0	68	35	190
24	W 2501	5366	60.0	45	33	191
25	W 2502	4239	54.4	40	33	190
26	OR 4870235	4885	60.5	61	32	190
27	OR 4870249	3800	58.0	3	31	189
28	OR 4870279	5029	59.0	0	34	190
29	ID 379	4702	59.5	30	33	190
30	ID 366	4168	60.4	73	36	190
31	Nomad	5447	63.5	0	33	192
32	PH984-034	4989	64.0	0	30	189
33	Grandin	4353	53.5	0	37	190
34	Vance	4097	61.0	83	36	194
35	ID 372	4883	62.0	48	34	190
36	Federation	3459	56.5	13	43	194
	Mean:	4735	59.4	28	33	191
	LSD (0.05)	1855			4.5	1.4
	CV (%)	28			9	1

Table 4. Summary of Intermountain Regional Spring Wheat Variety Trial, 1988-1990. Three year summary of spring wheat planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield 1990	1989	1988	2-yr Avg	Rank	Yield 3-yr Avg	Rank
		------ lbs/A			------		-lbs/A-	
1	Yecora Rojo	4638	3173	2390	3906	17	3400	13
2	Fieldwin	4772	3860	6328	4316	8	4987	3
3	Klasic	6141	3320	3143	4731	2	4201	11
4	WB 906R	4589	3283	4558	3936	16	4143	12
5	Blanca	4215	4408	6070	4312	9	4898	5
6	Edwall	4366	3879	--	4123	13	--	--
7	ORS 8413	5336	4040	7374	4688	3	5583	1
8	Serra	3437	--	--	--	--	--	--
9	Treasure	5034	4338	5697	4686	4	5023	2
10	ID 266	4584	4098	5830	4341	7	4837	7
11	Sterling	4125	3791	6126	3958	15	4681	8
12	Waduel	3692	3904	2496	3798	18	3364	14
13	Spillman	5285	4016	5390	4651	5	4897	6
14	WB 926	6073	3453	4278	4763	1	4601	9
15	WB Sprite	4533	3745	5416	4139	11	4565	10
16	ORS 8410	5460	3692	5668	4576	6	4940	4
17	UC 748	5031						
18	UC 785	5446						
19	UC 786	5585						
20	UC 850	5397						
21	UC 852	4523	--	--	--	--		
22	WB Rambo	4624	3629	--	4127	12		
23	ID 312	4155	3868	--	4012	14		
24	W 2501	5366	3243	--	4305	10		
25	W 2502	4239	3347	--	3793	19		
26	OR 4870235	4885						
27	OR 4870249	3800						
28	OR 4870279	5029						
29	ID 379	4702						
30	ID 366	4168						
31	Nomad	5447						
32	PH984-034	4989						
33	Grandin	4353						
34	Vance	4097						
35	ID 372	4883						
36	Federation	3459						
	Means:	4735	3741	5055	4272	--	4580	--
	LSD (0.05)	1855	728	907				
	CV (%)	28	19	13				

Table 5. 1990 Hard White Spring Wheat Variety Trial. Observations of grain yield, test weight, lodging, plant height, and days to 50% heading of spring wheat varieties planted at the Klamath Experiment Station, OR.

Entry	**Selection**	**Yield lbs/A**	**Test Wt. lbs/bu**	**Lodge %**	**Height inches**	**Heading date Julian Days**
1	OR 4880351	5799	63.0	0	32	194
2	OR 4880352	5706	64.0	0	33	194
3	OR 4880376	6743	64.5	0	34	194
4	OR 4880384	5276	63.0	0	32	191
5	OR 4880388	3950	64.0	0	30	191
6	OR 4880391	5701	61.0	0	26	192
7	OR 4880392	5133	60.0	0	31	189
8	OR 4880403	5766	61.5	0	32	193
9	ORS 8413	5766	61.5	0	32	193
10	Klasic	4949	60.0	0	31	189
11	Yecora Rojo	5832	62.5	0	28	187
12	Spillman	4489	61.0	0	35	190
	Mean:	5499	62.2	0	31	191
	LSD (0.05)	2095			7.4	1.6
	CV (%)	26			7	1

Oat Variety Screening in the Klamath Basin

R.L. Dovel and G. Chilcote[1]

INTRODUCTION

Variety trials were established in three locations in the Klamath Basin in 1990. A large trial (36 entries) was established at the KES in cooperation with regional testing programs (Uniform Northwestern States Oat Nursery). Two smaller trials (16 entries) were established on organic soil sites in the Lower Lake area.

PROCEDURES

All small grain variety trials at the KES were on land planted in potatoes the previous year. Soils at the station include Poe, Fordney and Hosley series, all of which have a fine loamy to sandy texture and are moderately deep and somewhat poorly drained. The off-station trials were on very deep, poorly drained, lake bottom soils with high organic matter content. All plots at KES were sprinkler irrigated, while only one organic soil test site was irrigated.

All trials were arranged in a randomized complete block design with either three or four replications. Trials at the KES were planted between April 25 and 27. Plots at the irrigated organic soil site were planted on May 26 and the dryland study was established on May 31. Seed was planted to a depth of one inch at a seeding rate of 100 lbs/A. All plots were fertilized with 100 lbs N, 60 lbs P_2O_5, and 44 lbs S/A at time of seeding. Plots measured 5 x 20 feet with a row spacing of six inches. At KES, Bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Chemical weed control at the organic soil sites was achieved using a mixture of 2,4-D and Banvel. Plots were harvested using a plot combine with a five foot wide head. Grain yield was recorded for all plots. Test weight was measured in only one replication.

RESULTS AND DISCUSSION

Oat yields at KES were similar to those observed in 1989 and 1987. However, several varieties which were high-yielding in the previous three years were ranked lower in 1990. These include Border, Ogle, and 82Ab248. Despite lower yields in 1990, Border is the second and 82Ab248 is the third highest yielding variety over a four-year period (Table 1). There is interest in the release of 82Ab248 for use in this area. Although yields of Border and 82Ab248 are similar over a four-year period, Border is susceptible to crown

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1/ Assistant Professor, Research Technician, respectively, Klamath Experiment Station, OR.

Acknowledgments: Henzel Farms provided the off-station site and crop care.

rust and 82Ab248 would be a good crown rust resistant alternative. Border has also had lower test weights than 82Ab248 (34.0 and 38.2 lbs/bu, respectively) over the past four years (Table 2). Both of these varieties have consistently outyielded Cayuse in this trial. Several other varieties have yielded quite well over a four-year period and have better test weight and are more lodging resistant than 82Ab248 (Tables 1-3). Performance of varieties at the organic soil sites was similar to that seen at KES on mineral soil (Table 4).

In addition to yield, test weight is an important factor in oat variety selection. Border has had lower test weights than Cayuse over the last four years (34.0 and 37.2 lbs/bu, respectively) while test weights of 82Ab248 were slightly higher than Cayuse (38.2 and 37.2 lbs/bu, respectively). Varieties which have had high test weights include 80Ab5322 (39.8 lbs/bu), 80Ab988 (39.5 lbs/bu), and Calibre (39.5 lbs/bu) (Table 2).

Although Border and 82Ab248 are higher yielding than Cayuse, they show no increase in lodging resistance (Table 3). High yielding varieties which show increased lodging resistance include 81Ab5792, 80Ab5322, and 82Ab1142, which has recently been released as Ajay. Ajay is a semi-dwarf variety that yields quite well at higher levels of fertilization without lodging. This would be an excellent oat variety in high N situations such as following potatoes or alfalfa.

Table 1. **Summary of Northwestern States Oat Nursery Yields, 1987-1990.** Grain yields of spring oat varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Yield 1990	1989	1988	1987	Avg. 2-year	Rank	Avg. 3-year	Rank	Avg. 4-year	Rank
		------- lbs/A			-------	lbs/A		lbs/A		lbs/A	
1	Park	3831	4210	1373	3225	4021	18	3138	14	3160	16
2	Cayuse	4049	4765	1625	3757	4407	14	3480	9	3549	10
3	Otana	3593	3859	1587	3717	3726	23	3013	18	3189	15
4	Appaloosa	3530	4926	1433	4630	4228	16	3296	12	3630	8
5	Border	4390	5760	1836	4258	5075	5	3995	2	4061	2
6	Monida	3779	5312	1405	3513	4546	12	3499	8	3502	11
7	Ogle	4267	3881	1746	4433	4074	17	3298	11	3582	9
8	Calibre	3836	4010	1534	4016	3923	21	3127	15	3349	14
9	Dumont	3773	4264	1567	4113	4019	19	3201	13	3429	13
10	81Ab5792	5063	5605	1788	4019	5334	1	4152	1	4119	1
11	Riel	3555	4041	1721	4674	3798	22	3106	16	3498	12
12	80Ab988	4725	4982	1486	4178	4854	7	3731	5	3843	6
13	80Ab5807	4865	5172	1293	4058	5019	6	3777	4	3847	5
14	Valley	3428	3774	1214	--	3601	24	2805	19	--	--
15	80Ab5322	4423	5071	1541	4456	4747	11	3678	6	3873	4
16	82Ab248	3801	5855	1731	4605	4828	8	3796	3	3998	3
17	82Ab1178	4105	5397	1360	4212	4751	10	3621	7	3769	7
18	82Ab1142	3978	4889	1333	--	4434	13	3400	10	--	--
19	Robert	3589	4363	1182	--	3976	20	3045	17	--	--
20	Trucker	3414	3085	1124	--	3250	25	2541	20	--	--
21	Minimax	4479	4166	--	--	4323	15				
22	NPB 871742	5171	5051	--	--	5111	4				
23	83Ab3119	5429	5047	--	--	5238	2				
24	83Ab3250	5242	5208	--	--	5225	3				
25	83Ab3725	4897	4627	--	--	4762	9				
26	NPB 871754	5226									
27	NPB 88301	4945									
28	NPB 88304	5268									
29	86Ab664	3134									
30	86Ab1867	5330									
	Mean:	4304	4693	1494	4117	5706		4339		4706	
	LSD (0.05)	1309	953	441	566	1031		683		579	
	CV (%)	22	16	21	11	18		20		18	

Table 2. Summary of Northwestern States Oat Nursery Test Weights, 1987-1990. Test weights of spring oat varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Test Weight 1990	1989	1987	Avg. 2-year	Rank	Avg. 3-year	Rank
		-----	lbs/bu	-----	lbs/bu		lbs/bu	
1	Park	34.5	41.0	32.0	37.8	15	35.8	13
2	Cayuse	32.5	41.0	38.0	36.8	19	37.2	9
3	Otana	40.0	42.0	34.0	41.0	4	38.7	4
4	Appaloosa	27.0	40.0	39.0	33.5	25	35.3	14
5	Border	31.5	42.5	28.0	37.0	17	34.0	16
6	Monida	38.0	44.0	33.0	41.0	3	38.3	6
7	Ogle	34.0	39.0	30.0	36.5	20	34.3	15
8	Calibre	39.0	45.5	34.0	42.3	1	39.5	3
9	Dumont	38.5	41.0	30.0	39.8	9	36.5	10
10	81Ab5792	32.5	42.0	33.0	37.3	16	35.8	12
11	Riel	37.0	43.0	35.0	40.0	8	38.3	5
12	80Ab988	38.5	41.0	39.0	39.8	10	39.5	2
13	80Ab5807	39.0	42.0	33.0	40.5	7	38.0	8
14	Valley	35.0	43.0	--	39.0	13	--	--
15	80Ab5322	38.0	43.5	38.0	40.8	5	39.8	1
16	82Ab248	31.5	44.0	39.0	37.8	14	38.2	7
17	82Ab1178	28.0	42.0	38.0	35.0	23	36.0	11
18	82Ab1142	31.0	42.0	--	36.5	21	--	--
19	Robert	32.5	41.0	--	36.8	18	--	--
20	Trucker	37.0	44.5	--	40.8	6	--	--
21	Minimax	27.0	41.0	--	34.0	24		
22	NPB 871742	34.0	37.5	--	35.8	22		
23	83Ab3119	36.0	42.0	--	39.0	12		
24	83Ab3250	40.0	42.0	--	41.0	2		
25	83Ab3725	36.0	42.0	--	39.0	11		
26	NPB 871754	34.0						
27	NPB 88301	28.0						
28	NPB 88304	27.0						
29	86Ab664	28.0						
30	86Ab1867	40.0						
	Mean:	34.2	41.9	34.6	38.4		37.2	

Table 3. Summary of Northwestern States Oat Nursery Lodging, 1987-1990. Percent lodging of spring oat varieties planted at the Klamath Experiment Station, OR.

Entry	Selection	Lodging 1990	1989	1988	1987	2,3,4-year Average and Rank 90-89	Rank	90-88	Rank	90-87	Rank
		---------- %	---------			%		%		%	
1	Park	53	2	85	10	28	3	47	2	38	2
2	Cayuse	35	0	58	0	18	11	31	7	23	10
3	Otana	45	37	70	5	41	1	51	1	39	1
4	Appaloosa	38	0	50	15	19	9	29	9	26	8
5	Border	23	0	68	23	12	12	30	8	29	5
6	Monida	35	7	65	5	21	5	36	4	28	6
7	Ogle	0	0	40	0	0	17	13	14	10	12
8	Calibre	48	0	58	15	24	4	35	5	30	4
9	Dumont	70	0	30	5	35	2	33	6	26	7
10	81Ab5792	10	0	13	5	5	16	8	17	7	14
11	Riel	5	16	0	0	11	14	7	18	5	15
12	80Ab988	0	0	85	15	0	17	28	10	25	9
13	80Ab5807	15	0	45	0	8	15	20	12	15	11
14	Valley	0	0	33	--	0	17	11	16	--	--
15	80Ab5322	23	0	13	0	12	13	12	15	9	13
16	82Ab248	38	0	70	10	19	10	36	3	30	3
17	82Ab1178	0	0	1	0	0	17	0	19	0	16
18	82Ab1142	0	0	0	--	0	17	0	19	--	--
19	Robert	40	0	9	--	20	6	16	13	--	--
20	Trucker	40	0	35	--	20	8	25	11	--	--
21	Minimax	0	0	--	--	0	17				
22	NPB 871742	0	0	--	--	0	17				
23	83Ab3119	0	0	--	--	0	17				
24	83Ab3250	18	22	--	--	20	7				
25	83Ab3725	0	0	--	--	0	17				
26	NPB 871754	3									
27	NPB 88301	0									
28	NPB 88304	0									
29	86Ab664	38									
30	86Ab1867	5									
	Mean	19	3	41	6	13		23		20	

Table 4. Summary of Oat Yield in Klamath County, 1990. Summary of 1990 oat yields across three locations in Klamath County, OR.

		Yield (Rank)						
Entry	Selection	Mineral Soil Irrigated	Organic Soil Unirrigated	Organic Soil Irrigated	Average Organic Soils		Average All Sites	
		lbs/A					lbs/A	
1	Cayuse	4049	3229	2959	3094	(12)	3412	(12)
2	Monida	3779	3723	3077	3400	(6)	3526	(9)
3	Appaloosa	3530	3193	3457	3325	(9)	3393	(13)
4	Border	4390	3312	3830	3571	(4)	3844	(5)
5	Ogle	4267	3563	4043	3803	(3)	3958	(4)
6	Sierra	--	2701	2367	2534	(15)	--	
7	80Ab988	4725	4327	3659	3993	(1)	4237	(1)
8	80Ab4725	--	3617	2173	2895	(14)	--	
9	80Ab5322	4423	3707	4100	3904	(2)	4077	(2)
10	80Ab5807	4865	3814	2634	3224	(10)	3771	(6)
11	81Ab5792	5063	3161	2903	3032	(13)	3709	(7)
12	82Ab248	3801	3692	2959	3326	(8)	3484	(10)
13	82Ab1142	3978	3699	3065	3382	(7)	3581	(8)
14	82Ab1178	4105	2830	3432	3131	(11)	3456	(11)
15	83Ab3250	5242	3692	3215	3454	(5)	4050	(3)
16	Dane	3865	2233	2034	2134	(16)	2711	(14)
	Mean:	4578	3406	3119	3263		3658	
	LSD (0.05):	1309	801	489				
	CV (%)	22	16	11				

Management of Semidwarf and Conventional Height Oat Varieties in the Klamath Basin

R.L. Dovel and G. Chilcote[1]

INTRODUCTION

Oats are planted on over 10,000 acres in the Klamath Basin. Oats are well adapted to the organic and some lacustrine soils in the county with oat yields exceeding that of barley or wheat in some areas. Increased interest in the production of food quality oats has resulted in recent shortages of this commodity.

Despite the importance of this crop to Oregon, the effects of management parameters such as fertilization, seeding rate, and planting date on oat grain yield and quality have not been investigated. Varieties currently being planted in the area are conventional height genotypes. The advent of high yielding, semidwarf, lodging resistant varieties provides an opportunity to more intensively manage these new varieties than has been possible with more lodging-susceptible conventional varieties. Little information is available about the value of intensive management practices for oats because lodging has been a yield limiting factor at both high levels of N fertilization and high seeding rates. The development of semidwarf cultivars of wheat has lead to the efficient use of high levels of N fertilization and other intensive management practices that contribute to increased grain yields. Similar benefits could result from productive semidwarf oat cultivars.

Quality oats for both food and feed command a premium price. Test weight is currently used to assess feed and milling quality. In general, test weight declines with increasing nitrogen fertilization rates; however, other management practices such as early planting and appropriate planting rate and row spacing increase both yield and test weight. Increasing yield while lowering test weight would not be economically advantageous to the producer. Thus, a study of the effects of N fertilization and seeding rate on oat yield and quality of both conventional and semidwarf varieties was undertaken in 1989 and 1990.

PROCEDURES

The effects of N fertilization and seeding rate were examined using a factorial design with four levels of N, three seeding rates, and four oat varieties. The experiment was arranged in a randomized complete block design with four replications. Nitrogen as ammonium nitrate was applied at 0, 40, 80, and 120 lbs/A. A split application of 80 lbs N as ammonium nitrate at planting and 40 lbs N at flowering was also included. Seeding rates were 20, 30, and 40 seeds/square foot. Two conventional height oat varieties, Monida and Cayuse, and two semidwarf oat varieties, Ajay and NPB 86801 were seeded. The semidwarf line NPB 86801 will soon be released as Minimax. Seed was planted at one-inch depth in six-inch rows.

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Data collected included time to 50 percent heading, percent lodging, plant height, grain yield, and test weight. Plants/ft^2 and tillers/plant were determined in 1990. Oat quality parameters yet to be assessed include groat fraction and groat protein concentration.

RESULTS

There was no difference in grain yield, test weight or lodging across years. Nitrogen fertilization affected grain yield of conventional and semidwarf varieties differently. Grain yields of semidwarf lines increased with increasing N fertilization to the 80 lbs N/A rate (Figure 1). In contrast, grain yields of Monida and Cayuse tended to decrease as N application rates increased, largely due to increased lodging of the two conventional varieties with increasing N fertilization (Figure 2). Semidwarf lines did not experience significant lodging at any N fertilization level. The effect of lodging was also apparent in grain test weights (Figure 3). Increasing nitrogen fertilization decreased test weights of all varieties, except Ajay, which was unaffected.

No difference was observed in grain yield between the split N application and either the 80 or 120 lb N applications. Late season N application generally does not affect yield but should result in higher groat protein contents.

The highest yields were obtained with Ajay at N rates of 40 lbs/A or above. Resulting yields were more than 100 lbs/A greater than in the best conventional variety/N combination.

Although both Monida and Cayuse produced higher yields than MiniMax when no N was applied, there are few instances where this practice is followed. The addition of 30-50 lbs N/A banded at seeding, a common practice, would result in the highest yields obtained in this study when planting Ajay and MiniMax.

Seeding rate did not significantly affect yield; however, seeding rate affected lodging of conventional and semidwarf varieties differently (Table 1). Increasing seeding rates increased lodging in both conventional height varieties, yet had little or no effect on lodging of the two semidwarf varieties. Although seeding rate affected lodging of conventional varieties, the increased lodging was not sufficient to significantly reduce yield.

Since identical seeding rates were used for all varieties, the numbers of plants per square foot reflects the relative seedling vigor of the various varieties in the trial. Ajay and Cayuse had more plants/ft^2 than Monida or Minimax (Table 2). Minimax had the lowest plant population in the trial. The varieties also had significantly different tillers/plant with Ajay having more tillers than any other variety. This, combined with the excellent seedling vigor of Ajay, resulted in the highest number of tillers/ft^2 which directly affects grain yield (Table 2).

Nitrogen fertilization did not significantly affect plants/ft^2, tillers/ft^2, or tillers/plant (Table 3). It is interesting to note that seeding rate did not affect tillers/ft^2. As plants/ft^2 decreased due to decreasing seeding rate, tillers/plant increased (Table 4).

CONCLUSION

Both semidwarf varieties responded quite differently to N fertilization than did conventional varieties. The lodging and yield responses were similar to those seen in short statured wheat or semidwarf barley varieties. MiniMax yielded less than conventional varieties at very low N levels (no N fertilization), but was equivalent to or superior when receiving some N fertilization. Ajay was equivalent to or superior to conventional varieties at all N fertilization levels. Due to the lodging resistance and high yield potential (even at low N levels) of Ajay this could be a very good variety selection. It appears that the use of semidwarf varieties in high N situations would be advisable.

Seeding rate did not affect yield in this trial. However, due to increased lodging of conventional varieties at higher seeding rates, a seeding rate of 30 plants/ft^2 is advisable.

Figure 1. Effect of N fertilization on oat yield of semi-dwarf and conventional oat varieties at KES - 1989-1990

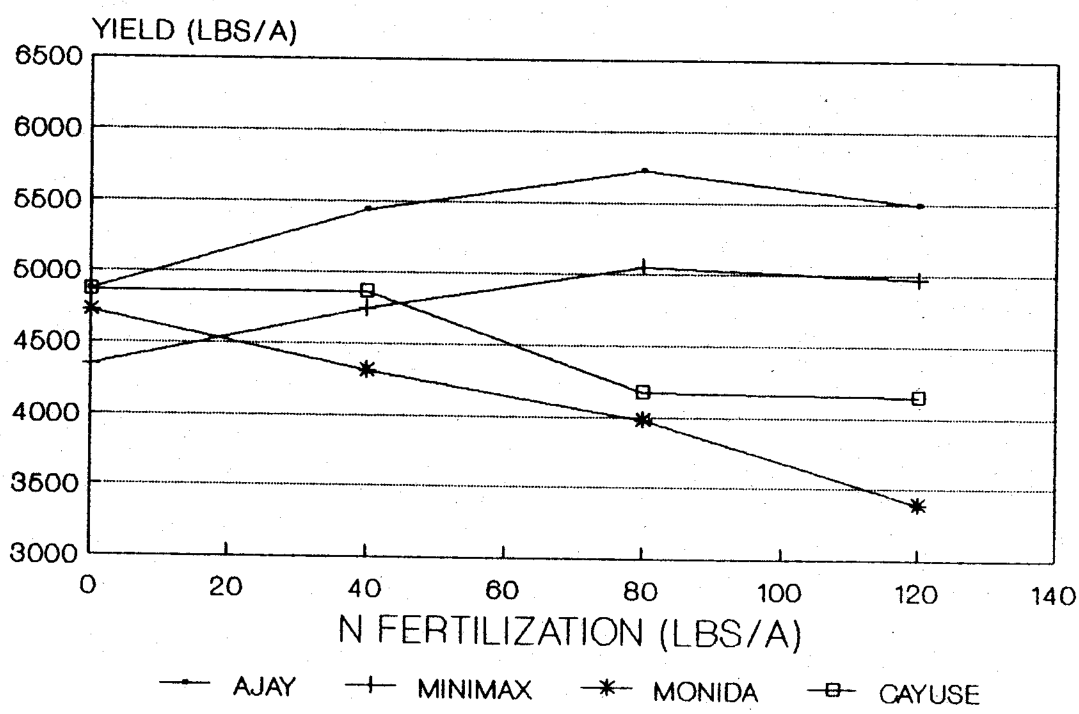

Figure 2. N fertilization effects on lodging of semi-dwarf and conventional oat varieties at KES - 1989-1990

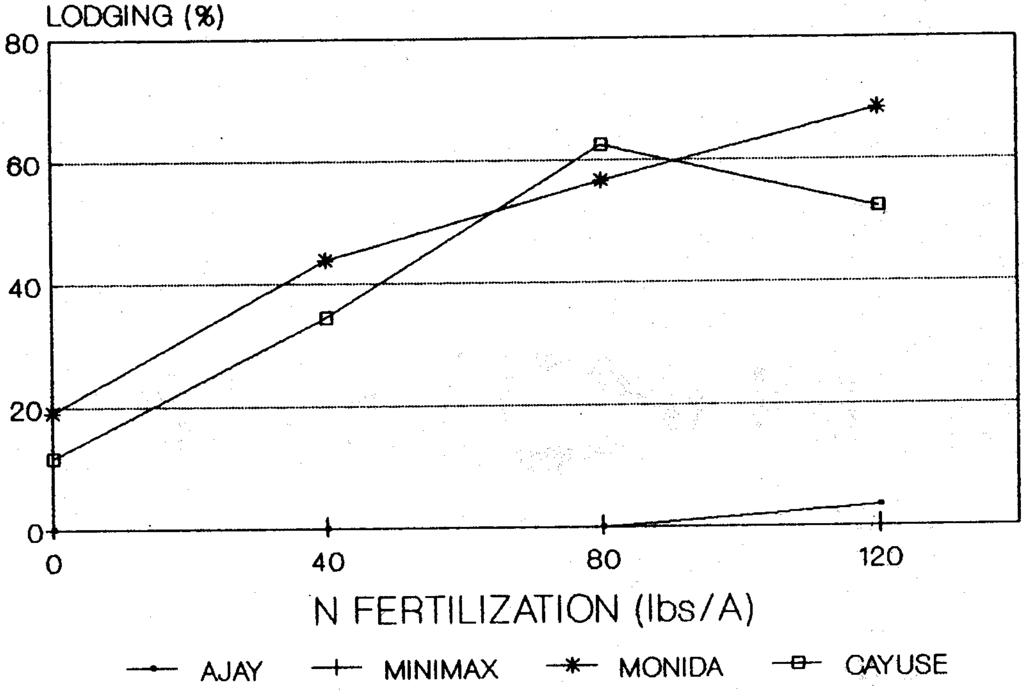

Figure 3. N fertilization effects on test weight of semi-dwarf and conventional oat varieties at KES - 1989-1990

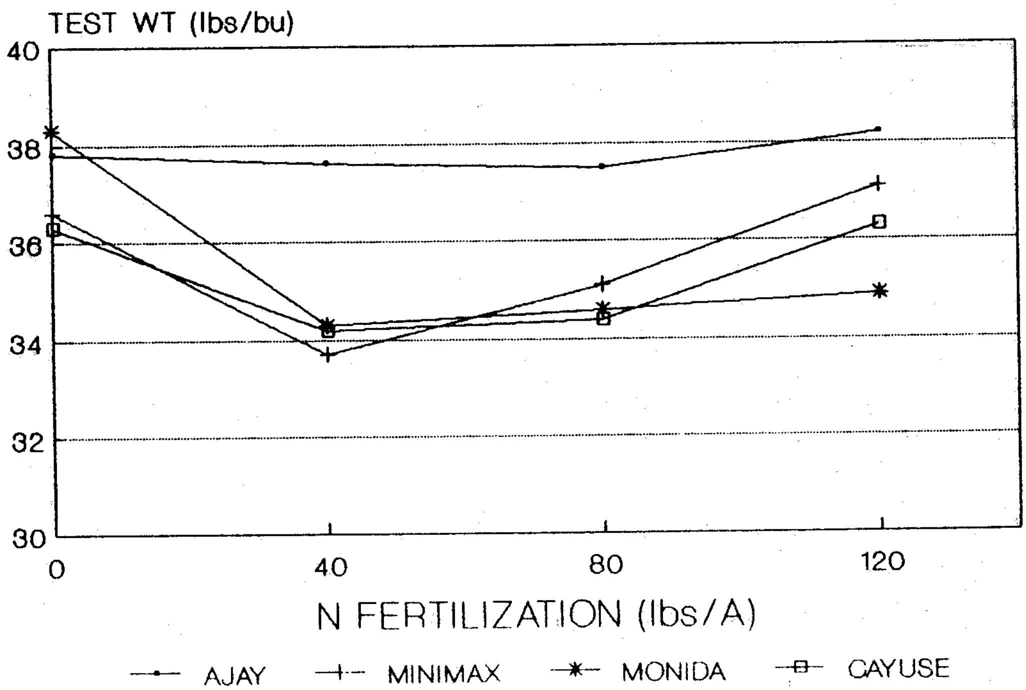

Table 1. Effect of Seeding Rate on Oats, 1989-1990. Effect of seeding rate on oat grain yield, test weight, lodging, and plant height averaged across 1989 and 1990. Significant interaction of seeding rate and variety examined in Table 2, Klamath Experiment Station, OR.

Seeding Rate seed/ft²	Yield lbs/A	Test Wt lbs/bu	Lodging %	Height cm
20	4758	36.1	19.8	99.2
30	4666	35.6	24.5	99.8
40	4607	35.7	27.6	99.0
LSD (0.05)	NS	NS	4.5	NS
SR * Variety Interaction	NS	NS	Sig	NS

Table 2. Effect of Seeding Rate and Variety on Lodging. Effect of seeding rate on lodging of various spring oats averaged across 1989 and 1990 at the Klamath Experiment Station, OR.

Seeding Rate seed/ft²	Ajay	Minimax	Monida	Cayuse
	------------ Lodging % ------------			
20	0.0	0.0	38.3	41.0
30	0.5	0.0	54.3	43.3
40	1.8	0.0	63.3	45.3
LSD (0.05)	0.5	NS	5.8	NS

Table 3. Variety Effect on Oat Plant and Tiller Density. Varietal effects on plants/ft², tillers/ft², and tillers/plant of spring oats planted in 1990 at Klamath Experiment Station, OR.

Variety	Plants /ft²	Tillers /ft²	Tillers /plant
Ajay	30	62	2.2
Minimax	24	44	1.9
Monida	27	48	1.8
Cayuse	29	53	1.9
Mean:	28	52	2.0
LSD (0.05)	2.2	3.8	0.14

Table 4. Nitrogen Fertilization Effect on Oat Plant and Tiller Density. Nitrogen fertilization effects on plants/ft^2, tillers/ft^2, and tillers/plant of spring oats planted in 1990 at Klamath Experiment Station, OR.

Nitrogen lbs/A	**Plants /ft^2**	**Tillers /ft^2**	**Tillers /plant**
0	28	52	1.9
40	28	52	2.0
80	27	54	2.0
120	29	51	1.9
120 (80+40)	26	52	2.0
LSD (0.05)	NS	NS	NS

Table 5. Seeding Rate Effects on Oat Plant and Tiller Counts. Seeding rate effects on plants/ft^2, tillers/ft^2, and tillers/plant of spring oats planted in 1990 at Klamath Experiment Station, OR.

Nitrogen lbs/A	**Plants /ft^2**	**Tillers /ft^2**	**Tillers /plant**
20	21	49	2.3
30	28	53	1.9
40	33	54	1.7
LSD (0.05)	2.0	3.3	0.1

Variety and N effects on Spring Wheat Grain Yield and Quality

R.L. Dovel[1], H. Carlson[2], G. Chilcote[1]

INTRODUCTION

The Klamath Basin has a unique environment characterized by a short growing season and cool night temperatures. Many varieties that perform well throughout the rest of the state yield poorly in the Klamath Basin. The development and adoption by the milling industry of Klasic, a hard white spring wheat (HWSW) variety, has resulted in the development of an important and growing grain class. Klasic has repeatedly produced higher grain yields than Yecora Rojo, the most widely planted hard red spring wheat (HRSW) in the region; however, yield levels of Klasic are much lower than several experimental lines of HWSW currently being tested. Grain quality of several of these lines looks quite promising; however, no information concerning management effects on grain quality or yield of these lines exists. Little information is available on the management of Klasic for yield or grain quality in the Klamath Basin. Since HWSW prices are dependent on quality (mainly protein content), research is needed to compare the yield potential and grain quality of Klasic and experimental HWSW lines to that of Yecora Rojo under a wide range of management conditions to determine the relative profitability of HWSW.

The greatest single management impact on grain quality is N fertilization. Increasing levels of N fertilization increase grain protein content. Research has shown that late season application of N can affect grain protein content more than preplant or early season N application. The application of 30 lbs N/A to Yecora Rojo at heading increased grain protein content from 12.8 to 14.5 percent in one study at Ontario. Addition of N in excess of 30 lbs N/A did not increase grain protein levels. Soil type may influence the effectiveness of late season N application in increasing grain protein concentration. Recent research using Yecora Rojo on lake bottom soil in Siskiyou county indicates that late season N application may not be effective on organic soils.

It is evident in hard red winter wheat (HRWW) and HRSW that there is a significant difference between varieties in their ability to produce high quality grain at low soil N levels. Some varieties are much more sensitive to N management than others. It is reasonable to assume that the same variability exists between HWSW varieties. Comparing promising HWSW varieties under a

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number of N management systems would allow the detection of varieties in which grain quality is less sensitive to N fertilizer inputs, thus allowing lower N inputs while maintaining grain quality.

It is desirable due to environmental and financial constraints to use a minimum of N fertilizer to achieve high grain yields with adequate quality. Nitrogen applied at heading has been shown to be incorporated primarily in the grain. Also a higher percentage of late applied N is recovered in the plant than preplant applied N. This has not been examined in the Intermountain Region and may not hold true on the organic soils in the area. Research is needed to develop N management systems to optimize grain yield, grain quality and N use efficiency on the two major soil types, mineral and organic, in the Klamath Basin.

PROCEDURES

Factorial experiments were established on an organic soil at the Tulelake Field Station (TFS) and a mineral soil at the Klamath Experiment Station (KES). The experiments were arranged in a split-split-plot design with four replications. Timing of N application was the sub-plot, variety was the sub-sub-plot and nitrogen fertilizer applied at 30, 70, 110, and 150 lbs N/A was the main plot. Nitrogen was applied either as a preplant or a split application. The preplant treatments received all fertilizer N broadcast prior to planting. Nitrogen was applied to plots receiving split applications as 0, 40, 80, and 120 lbs N/A prior to planting, followed by an additional 30 lbs N/A at heading.

Yecora Rojo, the most commonly planted HRSW in the region, was included in the study as a reference to assess relative white wheat production and quality responses to N management. The HWSW varieties in the study included Klasic and five promising experimental lines developed at OSU.

Soil samples were collected prior to and after application of preplant fertilizer. Tissue samples were taken at the later boot stage and leaf nitrate levels were determined using a specific ion electrode, to correlate grain protein response to late season N application. Upon harvest, grain yield and test weight were recorded. Grain protein contents were determined by infrared reflectance.

RESULTS

At KES, variety had a significant effect on grain yield, test weight, lodging, height, and heading date. Only ORS 8413 and Fieldwin yielded significantly higher than Klasic (Table 1). However, the other HWSW entries produced yields comparable to Klasic. Spillman yielded virtually the same as Klasic. Yecoro Rojo was the lowest yielding entry in the trial. Fieldwin, 4870235 and 4870279 had higher test weights than Klasic. With the exception of 4870249, all HWSW entries had higher test weights than either HRSW entry. In general lodging was not a problem in this trial, however, Fieldwin lodged more than any other entry.

Nitrogen fertilization significantly affected yield and plant height at KES. Yield increased with increasing N fertilization up to 110 lbs N/A (Table 2). Height increased slightly with high fertility rates (Table 2).

Timing of N fertilization did not significantly affect any yield parameter except bushel weight at KES. Split application of N resulted in a 0.4 lbs/bu increase in bushel weight (Table 3).

In the Tulelake study, the soft white variety, Fieldwin, significantly out-yielded Klasic (Table 4). On average, the varieties did not respond to preplant or split nitrogen applications (Tables 5 and 6). The lack of response to split applied Nitrogen is consistent with previous observations on the TFS. Apparently sufficient late season N is mineralized in the high organic matter soils on the station.

Nitrogen fertilization rate did not affect grain CP content in either location. However, plots at KES which received split application of N had higher CP than those receiving only one application (Figure 1). In contrast timing of N application had no effect on grain CP content at TFS (Figure 2). This is apparently due to late season N mineralization in the high organic matter soils at the TFS.

Protein levels of Klasic were lower than all experimental HW lines except ORS 8413 at both locations. Spillman had similar grain protein levels as Yecora Rojo at the KES and higher levels than Yecora Rojo at the TFS. As expected Fieldwin, the only soft white entry in the trial, had the lowest CP content at both locations.

Critical data on flour milling quality is not yet available. This trial will be repeated during the 1991 season.

Table 1. **Wheat variety development and grain yield** averaged over Nitrogen treatments at the Klamath Experiment Station, OR.

	Varieties	Heading Days From 1/1/90	Height Inches	Lodging %	Bushel Weight lbs/bu	Yield lb/A	Yield T/A
1	4870235	190.0	30	1.6	63.4	5400	2.70
2	4870279	189.9	28	0.0	62.2	5700	2.85
3	4870249	189.9	27	0.0	60.7	5404	2.70
4	ORS 8413	190.8	29	0.0	61.4	6014	3.01
5	Klasic	188.1	24	0.0	61.5	5614	2.81
6	Fieldwin	192.9	34	2.5	63.6	6169	3.08
7	Yecoro Rojo	187.2	22	0.0	60.8	5311	2.66
8	Spillman	190.1	32	0.3	60.0	5608	2.80
	LSD (0.05)	0.4	2	1.5	0.6	351	0.18

Table 2. **Effect of Nitrogen rate on wheat development and grain yield** averaged over varieties and application timing at the Klamath Experiment Station, OR.

Nitrogen Rate lbs/A	Heading Days From 1/1/90	Height Inches	Lodging %	Bushel Weight lbs/bu	Yield lb/A	Yield T/A
30	189.8	28	0.0	62.1	5346	2.67
70	189.8	28	0.5	61.5	5632	2.82
110	189.8	29	0.8	61.6	5874	2.94
150	190.1	29	0.9	61.5	5759	2.88
LSD (0.05)	NS	1	NS	NS	393	.20

Table 3. Effect of preplant vs split N application on wheat development and grain yield at the Klamath Experiment Station, OR.

	Heading Days From 1/1/90	Height Inches	Lodging %	Bushel Weight lbs/bu	Yield lb/A	Yield T/A
All Pre-plant	189.9	28	0.6	61.5	5598	2.80
Split Application	189.9	28	0.5	61.9	5708	2.85
LSD (0.05)	NS	MS	NS	0.3	NS	NS

Table 4. Wheat Variety Development and Grain Yield averaged over nitrogen treatments at the Tulelake Field Station, CA.

	Varieties	Heading Days from 1/1/90	Height Inches	TKW[1] Grams	Bushel Weight lbs/bu	Yield lbs/A	Yield T/A
1	4870235	177.3	32	37.2	60.8	4798	2.40
2	4870279	177.1	30	39.3	59.6	5221	2.61
3	4870249	177.0	29	37.1	59.2	4880	2.44
4	ORS8413	177.1	32	32.1	56.9	4862	2.43
5	Klassic	177.4	24	38.6	59.2	5122	2.56
6	Fieldwin	176.8	38	33.6	58.7	5652	2.83
7	Yecoro Rojo	177.1	24	37.7	59.3	5080	2.84
8	Spillman	177.1	38	39.1	56.1	4646	2.32
	LSD (0.05)	0.25	0.9	2.6	1.26	248	0.12

1/ Thousand kernal weight

Table 5. Effect of Nitrogen Rate on Wheat Development and grain yield averaged over varieties and application timing at the Tulelake Field Station, CA.

Nitrogen Rate lb/A	Heading Days from 1/1/90	Height Inches	TKW Grams	Bushel Weight lbs/bu	Yield lbs/A	Yield T/A
30	177.1	30	36.9	58.8	4865	2.43
70	177.2	31	36.9	58.8	5140	2.57
110	177.0	31	37.6	59.0	5223	2.61
150	177.1	31	36.0	58.4	4902	2.45
LSD (0.05)	NS	NS	NS	NS	NS	NS

Table 6. Effect of Preplant vs Split N Application on wheat development and grain yield at the Tulelake Field Station, CA.

	Heading Days from 1/1/90	Height Inches	TKW Grams	Bushel Weight lbs/bu	Yield lbs/A	Yield T/A
All preplant	177.1	31	36.6	58.6	5038	2.52
Split Application	177.1	31	37.1	58.8	5027	2.51
LSD (0.05)	NS	NS	NS	NS	NS	NS

Figure 1. Effect of time of N fertilization on protein content of spring wheat at the Klamath Experiment Station.

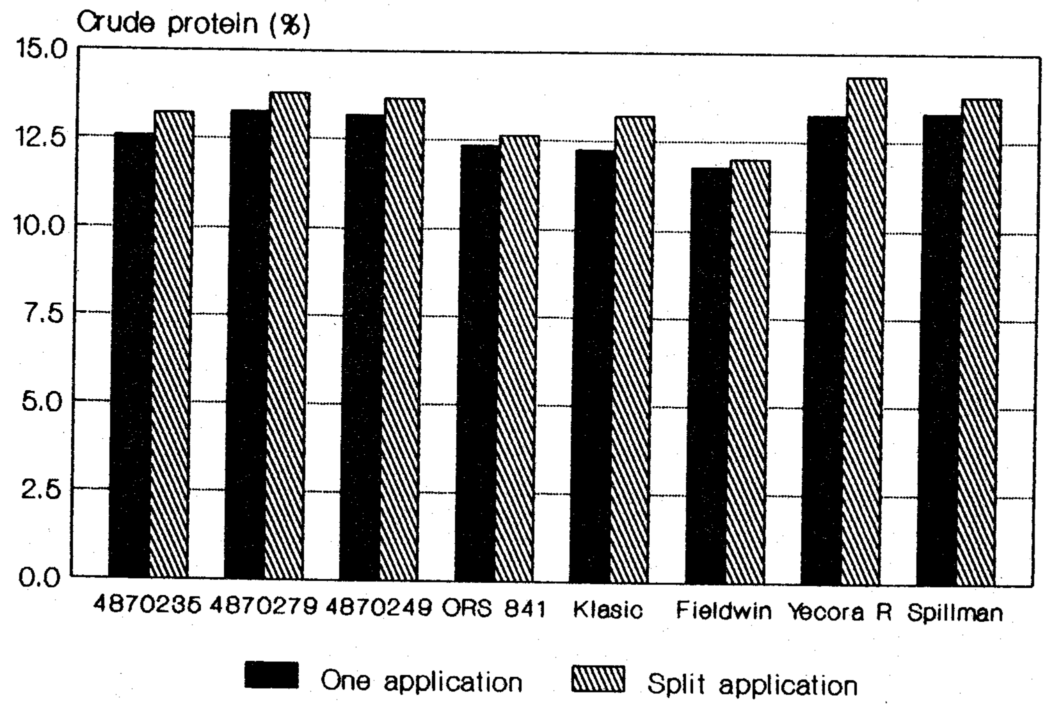

Figure 2. Effect of time of N fertilization on protein content of spring wheat at the Tulelake Field Station.