Special Report 964
June 1996

Malheur County Crop Research Annual Report, 1995

Agricultural Experiment Station
Oregon State University

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Front Cover: Erik Feibert and Monty Saunders examine drip irrigated onions at the Malheur Experiment Station, September 1995.

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1995 RESEARCH

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Department of Agriculture
Department of Environmental Quality
Department of Economic Development

MALHEUR EXPERIMENT STATION
SPECIAL REPORT - 1995 RESEARCH
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1995 WEATHER REPORT

J. Mike Barnum, Erik Feibert, and Clint Shock
Malheur Experiment Station
Oregon State University
Ontario, Oregon

Introduction

Daily observations of air temperature and precipitation have been recorded at the Malheur Experiment Station since July 20, 1942. Installation of additional equipment in 1948 allowed for evaporation and wind measurements. A recording soil thermometer was added in 1967. A biophenometer, to monitor growing degree days, and pyranometers, to monitor solar and photosynthetic active radiation, were added in 1985.

Since 1962, daily readings from the station have been reported to the U.S. Department of Commerce, Environmental Science Service Administration, National Weather Service. Each day the 8:00 a.m. air temperature, preceding 24-hour air and soil temperature extremes, and 24-hour accumulated precipitation are recorded and transmitted to radio station KSRV in Ontario. KSRV then conveys this information, along with their own daily readings, to the U.S. Weather Station in Boise, Idaho. During the irrigation season (April -October), evaporation, wind, and water temperature are also monitored and reported.

On June 1, 1992, in cooperation with the U.S. Bureau of Reclamation, a fully automated weather station, connected by satellite to the Northwest Cooperative Agricultural Weather Network (AgriMet) computer in Boise, Idaho, began transmitting data from Malheur Experiment Station. The automated station monitors air temperature, relative humidity, dew point temperature, precipitation, wind run, wind speed, wind direction, solar radiation, and soil temperature at 8-inch and 20-inch depths. Stored data is dumped and transmitted to the Boise computer every 4 hours. The database may be accessed via computer modem. During the irrigation season, daily Malheur County crop water-use estimates, which are based on data from this automated weather station, are also available by modem.

1995 Weather

Total precipitation for the year exceeded the 10-year and 53-year station averages by 43.5 percent and 32.8 percent , respectively (Table 1). With the exception of February, monthly precipitation totals from January through July were above both the 10-year and 53-year means (Table 2). Compared to the long term averages, January and December were abnormally wet (Figure 1). Precipitation accumulation for the fall/winter period October 1, 1994, through March 31, 1995, was 150 percent of the 53-year mean (Table 3).

Snowfall totals for January, February, March, October, and November were below the long-term means. Total snowfall accumulation for December was 149 percent of the 53-year average (Table 4). Annual snowfall for 1995 totaled 75 percent and 78 percent of the 10-year and 53-year averages, respectively (Table 5).

Mean monthly maximum air temperatures from April through August were consistently below the long term station means (Table 6). Mean monthly minimum air temperatures for the same period ranged from 1°F above to 4°F below the 53-year monthly means.

From March through August, monthly mean 4-inch soil temperatures tended to be slightly above the long term means (Table 7). From May through August mean monthly 4-inch soil temperature ranged from 1°F to 4°F above the 29-year monthly mean.

Monthly pan-evaporation totals for April through August ranged from 0.67 inches to 1.42 inches below the monthly mean totals for the past 10 years (Table 8). Mean 1995 daily pan-evaporation from March 1 through August 31 was approximately 0.27 inches per day. Monthly wind-run totals for April 1 through October 31 ranged from 2,449 miles for April to 1,532 miles for September (Table 9). The average daily wind-run over the irrigation season (April through October) was 63 miles per day. The average daily wind-run for the calendar year was 61 miles per day. Total pan-evaporation for the season was 9 percent under the 10-year mean and 5 percent over the 48-year mean (Table 10). Total wind-run for the season exceeded the 10-year mean by 4 percent and 48-year mean by 27 percent. The below-average evaporation figure for 1995 resulted from the occurrence of above-average precipitation amounts and below-average air temperatures throughout most of the irrigation season.

Seasonal estimates of crop water-use for those crops commonly grown in northeastern Malheur County, measured by the Bureau of Reclamation - AgriMet weather station at MES, estimated that crop water requirements for 1995 were below the average requirement for the past 4 years (Table 11).

The last spring frost ($\leq$32°F) occurred 10 days earlier than the 20-year mean date of April 26; the first fall frost occurred on September 22, 12 days earlier than normal. Table 12 shows the dates of the last spring and first fall occurrences of minimum air temperatures equal to or below threshold levels of 24, 28, 32, and 36 degrees Fahrenheit for the past 20 years. Table 13 shows the number of days between the last spring occurrence and the first fall occurrence of those threshold temperatures.

Total cumulative growing-degree-days ($\geq$50°F and $\leq$86°F) for the year were 11 percent below the 10-year mean (Table 14). Although cumulative growing degree days at the end of March were near to the 10-year mean (Figure 2), below-average temperatures from April through September reduced the overall growing-degree-day accumulation.

Record weather events recorded over the 53-year history for the Malheur Experiment Station are listed in Table 15.

Table 1. Annual precipitation totals for 1986 through 1995 and 10-year and 53-year mean annual precipitation totals at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	10 yr mean	53 yr mean
	inches											
Total	8.64	9.81	7.58	9.15	7.21	9.25	8.64	13.3	10.05	14.01	9.76	10.55

Table 2. Daily and monthly precipitation totals for 1995 and 10-year and 53-year mean monthly precipitation totals at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	inches											
1		0.02			0.04							0.01
2		0.08			0.48							
3			0.14		0.02	0.08	0.03					
4			0.20						0.03	0.18		0.06
5			T		0.10				0.04			
6	0.06		T	0.03	0.48	0.08						0.32
7	0.29			0.27	0.02	0.01		T			0.02	0.10
8	0.09			0.13				0.02			0.01	
9	0.20		0.12				0.17				0.07	T
10	0.03		0.03		T		0.09				T	0.11
11	0.10	0.06	0.03	0.06	0.21					0.06	T	0.05
12	0.19	0.07	0.05	0.02	T		0.03			0.11		0.45
13	0.57	0.01	0.20	0.03			0.46				0.11	T
14	0.19	T	0.13	T							0.02	0.10
15	0.06		0.09								0.03	0.22
16	0.02				0.06	0.06		0.02			T	0.23
17		0.03				0.46		0.09			0.02	
18	T	0.01	0.11			0.44				0.09	0.02	
19	0.19		0.32			0.38	0.02					
20	0.01		T	0.25		0.09						
21			T	0.12								
22			0.02							0.01		
23			0.14								T	
24											0.01	
25											0.02	T
26	0.12									0.12	0.03	0.03
27											T	0.01
28	T			0.06							0.48	0.02
29	0.03			0.01			0.05		T			0.15
30				0.18			0.25				0.04	0.41
31	0.52											0.29
1995 total	2.67	0.28	1.58	1.16	1.41	1.60	1.10	0.13	0.07	0.57	0.88	2.56
10 year mean	1.22	0.85	1.09	0.97	1.04	0.94	0.28	0.29	0.30	0.60	1.18	1.01
53 year mean	1.32	0.94	0.97	0.80	1.00	0.82	0.22	0.43	0.50	0.71	1.20	1.33

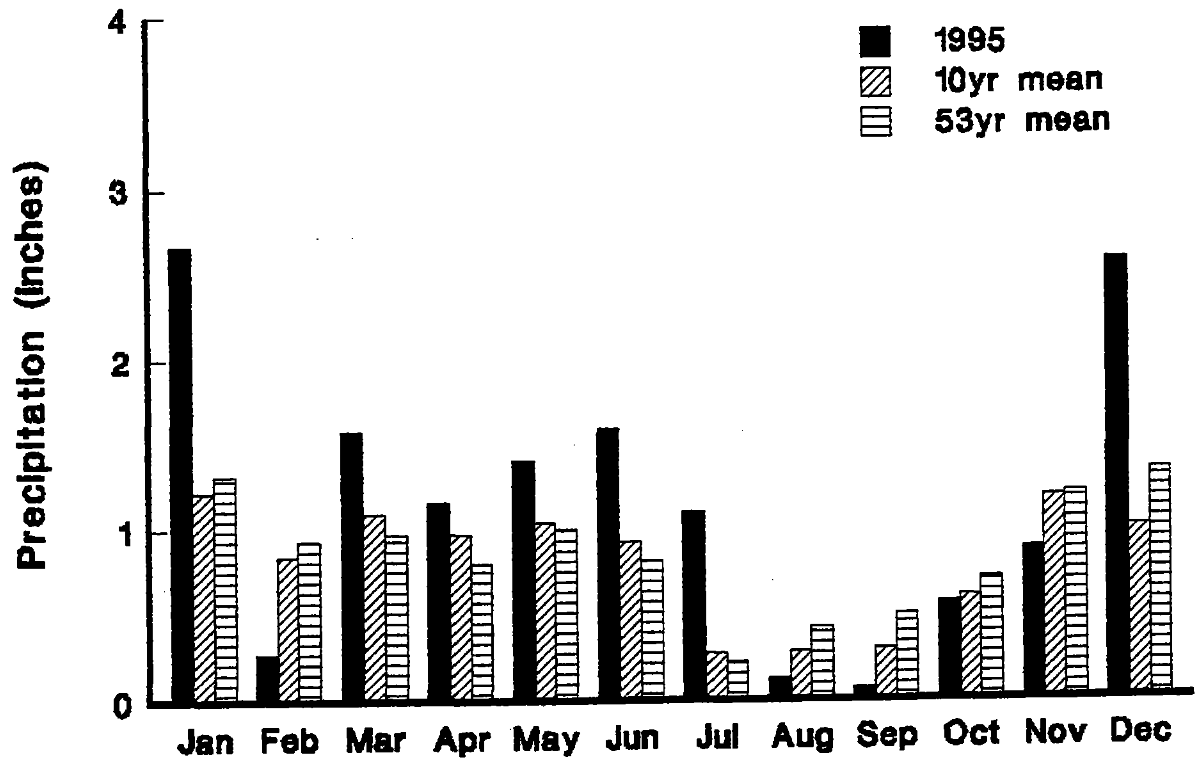

Figure 1. A comparison of the monthly precipitation for 1995 to the 10-year and 53-year monthly precipitation averages at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Table 3. Monthly fall and winter (October through March) precipitation totals from January 1986 through December 1995, and 10-year and 53-year mean monthly and mean seasonal precipitation totals for that six month period at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Month	1986	1986 / 87	1987 / 88	1988 / 89	1989 / 90	1990 / 91	1991 / 92	1992 / 93	1993 / 94	1994 / 95	1995	10-year mean	53-year mean
	inches												
Oct	-	0.12	0	0	0.86	0.49	1.01	0.95	0.80	1.23	0.57	1.22	1.32
Nov	-	0.22	1.40	2.45	0.24	0.69	1.71	1.15	0.64	2.46	0.88	0.85	0.94
Dec	-	0.22	1.46	1.48	0.01	0.29	0.43	1.51	0.60	1.49	2.56	1.09	0.97
Jan	0.96	1.24	1.25	0.88	0.44	0.59	0.58	2.35	1.20	2.67	-	0.60	0.71
Feb	2.29	0.77	0.14	1.27	0.35	0.44	1.36	1.02	0.57	0.28	-	1.18	1.20
Mar	1.24	1.37	0.26	2.17	0.72	0.88	0.25	2.41	0.05	1.58	-	1.01	1.33
Fall[1]		0.56	2.86	3.93	1.11	1.47	3.15	3.61	2.04	5.18	4.01	3.16	3.23
Spring[2]	4.49	3.38	1.65	4.32	1.51	1.91	2.19	5.78	1.82	4.53		2.79	3.24
Total		3.94	4.51	8.25	2.62	3.38	5.34	9.39	3.86	9.71		5.95	6.47

Table 4. Daily and monthly snowfall totals for 1995 and 10-year and 53-year mean monthly snowfall totals at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Day	Jan	Feb	Mar	Oct	Nov	Dec
	inches					
1						
2						
3						
4						
5						
6	0.5					2.5
7	4.0					0.5
8	T					
9						
10						
11		T				
12		1.0				
13		1.0				
14		T				
15						
16						
17						
18	T					
19						
20						
21						
22						
23						
24						
25						
26						T
27						T
28					T	T
29						1.5
30						4.0
31						
1995 total	4.5	2.0	0	0	0	8.5
10 year mean	7.8	3.1	0.6	0.1	2.2	6.3
53 year mean	7.8	2.8	0.7	0.1	2.1	5.7

Table 5. Annual snowfall totals for 1986 through 1995 and 10-year and 53-year mean annual snowfall totals at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	10 yr mean	53 yr mean
	inches											
Total	13.0	15.5	34.8	25.1	5.7	7.5	15.5	36.0	32.0	15.0	20.0	19.2

Table 6. Daily maximum and minimum and monthly mean maximum and minimum air temperatures for 1995 and the 10-year and 53-year mean monthly maximum and minimum air temperatures at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Day	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	inches																							
1	24	1	48	38	52	24	69	43	65	33	86	52	89	57	85	47	91	48	68	40	51	24	59	47
2	21	2	57	34	49	26	57	36	58	45	85	52	92	59	94	56	95	50	68	36	48	13	60	30
3	20	0	58	31	47	31	62	33	63	42	83	53	83	52	95	60	93	54	69	36	46	13	51	25
4	11	0	50	31	50	36	70	37	66	45	83	51	79	52	95	63	93	58	59	41	47	14	50	24
5	23	9	51	32	50	31	74	39	65	48	85	53	82	52	96	60	91	53	61	29	45	16	49	23
6	29	19	52	29	47	24	68	37	57	47	62	39	89	58	100	62	84	50	61	30	54	32	30	17
7	33	23	44	28	45	23	55	41	56	48	58	36	90	56	96	60	86	53	63	35	54	38	29	17
8	35	26	48	34	54	25	63	36	66	49	70	39	92	57	74	43	77	46	67	30	46	34	37	16
9	42	31	53	31	52	34	52	34	64	43	75	51	94	60	77	43	77	47	65	30	51	36	30	16
10	46	38	54	29	60	44	55	30	72	48	71	42	88	62	85	47	80	47	68	34	49	27	33	28
11	54	35	53	27	60	44	59	33	70	49	82	48	89	58	90	51	84	47	63	37	47	27	38	30
12	46	32	32	15	60	41	59	37	63	40	83	49	88	60	82	46	88	47	65	36	49	35	52	32
13	46	32	33	26	57	40	65	38	62	43	87	56	67	48	88	45	90	49	59	27	50	37	65	37
14	44	32	34	20	56	42	53	32	64	40	83	54	76	51	76	42	92	47	60	29	52	42	47	28
15	50	32	33	23	60	43	54	25	70	43	79	51	85	58	86	46	90	47	66	29	51	45	47	29
16	48	31	38	24	56	32	55	30	75	50	70	54	89	57	93	53	92	52	69	28	53	37	43	32
17	45	26	39	24	56	30	61	35	74	52	80	54	93	58	66	50	91	53	72	33	49	39	44	24
18	39	26	45	31	63	34	61	42	77	44	73	48	93	62	74	44	87	51	68	33	52	34	39	24
19	38	31	51	35	55	38	60	34	74	44	69	46	96	66	77	43	89	52	62	29	60	33	41	22
20	41	31	65	32	56	40	56	37	75	43	63	40	94	59	85	45	84	55	62	28	48	30	38	22
21	40	35	62	35	62	34	51	36	81	47	69	43	94	59	91	54	79	42	57	29	53	30	35	23
22	39	22	61	33	52	31	62	39	82	53	73	50	95	60	96	58	67	30	57	34	47	30	35	20
23	40	23	61	34	52	36	66	38	78	52	78	53	90	61	96	63	73	32	59	24	53	29	39	16
24	37	26	63	33	49	29	70	39	78	45	85	53	93	61	95	55	80	37	60	23	50	27	28	17
25	43	32	64	34	48	28	75	46	79	47	89	57	93	57	87	51	77	46	64	32	51	35	23	20
26	41	33	65	42	50	29	70	37	80	48	92	60	95	60	89	50	77	43	60	36	50	36	25	21
27	48	31	62	36	54	29	M	M	75	44	95	62	91	58	89	51	75	50	65	35	53	28	26	22
28	46	29	54	27	57	28	74	40	77	47	85	55	95	62	88	46	74	45	59	29	45	30	26	21
29	41	32			56	27	66	42	83	48	84	49	100	63	89	52	71	43	60	28	41	34	33	23
30	45	35			56	26	57	42	87	52	84	49	79	48	81	47	69	38	62	32	56	37	32	26
31	45	37			63	29			90	55			79	47	86	46			53	23			34	27
1995 mean	39	26	51	30	54	33	62	37	72	46	79	50	89	57	87	51	83	47	63	31	50	31	39	24
10 yr mean	33	16	42	22	55	32	66	38	74	46	83	53	90	57	89	54	80	46	67	35	46	26	36	18
53 yr mean	34	19	43	25	54	31	64	37	74	45	82	52	91	57	89	55	80	46	65	36	47	28	37	22

Table 7. Daily maximum and minimum and monthly mean maximum and minimum 4-inch soil temperatures for 1995 and the 10-year and 29-year mean monthly maximum and minimum 4-inch soil temperatures at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Day	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	inches																							
1	34	34	41	39	53	39	64	45	70	50	86	69	89	69	90	69	87	68	68	58	52	41	49	46
2	32	32	43	40	51	39	54	44	57	52	85	68	92	72	91	70	88	69	71	57	51	37	49	40
3	30	30	50	39	48	39	62	40	61	49	85	55	81	70	93	75	86	71	70	56	49	36	44	37
4	32	31	47	38	51	42	67	46	68	49	81	67	82	69	94	76	83	71	61	53	48	35	40	37
5	29	29	48	38	47	40	66	50	67	54	84	67	87	67	94	76	86	70	63	50	45	35	42	36
6	30	30	48	39	45	37	66	54	55	51	67	55	91	70	95	77	85	69	64	49	47	42	36	36
7	31	31	43	39	47	36	58	52	52	50	64	54	89	73	93	78	84	69	62	51	48	42	35	35
8	31	31	45	39	51	37	58	48	61	50	74	54	92	74	83	70	81	67	67	52	46	44	35	35
9	31	31	46	38	42	40	54	44	64	53	76	64	91	74	87	69	83	67	62	51	46	44	35	35
10	32	31	48	38	46	43	55	42	74	53	87	62	85	72	87	68	83	67	65	53	45	41	35	35
11	32	32	44	38	46	44	63	41	72	58	79	61	93	72	87	71	84	67	59	53	47	40	35	35
12	32	32	38	37	55	46	62	48	65	51	85	65	91	74	86	69	85	68	58	51	46	44	44	35
13	33	31	36	36	53	45	60	48	65	50	85	67	74	64	86	69	85	68	58	47	47	44	46	42
14	34	34	35	35	49	46	52	42	62	51	82	69	83	63	81	66	86	68	61	46	50	47	42	38
15	42	33	34	34	52	47	59	42	75	51	79	66	89	64	86	65	84	67	62	47	50	49	40	37
16	40	35	34	34	55	43	63	41	76	55	71	63	92	70	87	69	84	67	62	48	51	46	42	38
17	39	35	34	34	57	42	65	44	80	61	80	63	93	72	74	66	82	68	62	51	50	46	43	37
18	35	35	38	34	55	41	63	48	78	60	71	60	95	74	80	64	83	68	60	50	50	46	37	36
19	35	34	44	36	52	45	62	47	79	59	71	58	92	76	82	64	84	69	60	48	51	43	37	36
20	39	36	51	40	52	45	61	47	82	62	68	54	95	76	84	65	82	69	59	46	45	40	35	35
21	41	36	52	41	51	43	54	44	83	61	72	53	94	76	86	66	80	64	55	46	48	40	35	35
22	38	35	53	42	50	41	59	43	82	64	75	57	94	77	87	70	76	60	55	48	43	40	35	35
23	35	35	55	42	43	40	64	45	87	64	85	62	93	76	89	73	74	59	57	45	48	42	35	34
24	35	35	55	43	47	39	71	48	80	63	89	64	93	76	88	74	76	58	56	44	47	41	34	34
25	38	35	54	42	47	38	74	54	80	62	92	68	93	76	87	72	74	60	59	47	48	44	34	33
26	37	35	57	44	47	38	69	53	80	62	93	72	94	75	88	71	74	62	55	47	45	43	33	33
27	43	36	55	44	46	39	M	M	78	61	96	74	92	76	86	70	75	65	61	48	46	38	31	31
28	43	36	54	40	54	40	72	54	82	61	89	72	94	79	88	70	73	63	60	46	40	38	31	31
29	38	36			58	41	68	54	85	63	87	70	95	76	87	69	72	62	58	46	43	39	32	31
30	41	38			60	41	59	51	87	65	88	70	79	66	84	69	72	59	57	46	46	42	32	32
31	40	37			62	41			88	69			87	66	86	69			54	43			32	32
1995 mean	36	34	46	39	51	41	62	47	73	57	81	63	90	72	87	70	81	66	61	49	47	42	38	36
10 yr mean	32	31	38	34	51	41	63	50	73	59	82	67	89	75	87	74	77	65	63	52	44	39	34	32
29 yr mean	33	31	38	34	51	41	62	48	74	58	82	67	90	75	88	74	77	64	61	51	44	39	34	33

Table 8. Daily and monthly pan-evaporation[1] totals for April through October 1995 and 10-year and 48-year mean monthly pan-evaporation totals for the same period at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Day	Apr	May	Jun	Jul	Aug	Sep	Oct
	inches						
1	0.17	0.21	0.21	0.29	0.29	0.26	0.14
2	0.17	0.13	0.34	0.40	0.36	0.32	0.23
3	0.17	0.24	0.29	0.20	0.42	0.23	0.14
4	0.17	0.21	0.29	0.36	0.37	0.22	0.06
5	0.23	0.16	0.32	0.26	0.36	0.29	0.16
6	0.15	0.07	0.24	0.32	0.42	0.30	0.12
7	0.02	0.15	0.16	0.37	0.44	0.28	0.15
8	0.16	0.16	0.41	0.32	0.28	0.30	0.12
9	0.22	0.12	0.27	0.28	0.29	0.22	0.15
10	0.20	0.12	0.18	0.25	0.27	0.22	0.10
11	0.15	0.24	0.37	0.42	0.34	0.26	0.06
12	0.10	0.25	0.35	0.48	0.30	0.25	0.09
13	0.10	0.26	0.36	0.07	0.48	0.26	0.10
14	0.09	0.18	0.33	0.17	0.20	0.26	0.11
15	0.17	0.17	0.18	0.30	0.28	0.24	0.11
16	0.17	0.31	0.16	0.42	0.32	0.26	0.08
17	0.20	0.27	0.34	0.37	0.16	0.22	0.15
18	0.27	0.40	0.20	0.36	0.31	0.24	0.08
19	0.34	0.38	0.14	0.30	0.24	0.40	0.20
20	0.25	0.34	0.25	0.38	0.26	0.34	0.11
21	0.14	0.31	0.25	0.38	0.27	0.39	0.14
22	0.31	0.47	0.08	0.36	0.30	0.20	0.17
23	0.27	0.47	0.26	0.37	0.25	0.22	0.12
22	0.19	0.28	0.30	0.43	0.28	0.20	0.14
25	0.28	0.26	0.29	0.41	0.34	0.20	0.11
26	0.31	0.38	0.31	0.32	0.35	0.26	0.06
27	M	0.49	0.45	0.45	0.33	0.22	0.14
28	0.38	0.33	0.52	0.37	0.29	0.22	0.09
29	0.18	0.34	0.45	0.46	0.23	0.22	0.08
30	0.04	0.29	0.28	0.37	0.32	0.22	0.12
31		0.38		0.25	0.27		0.11
1995 total	5.60	8.37	8.58	10.49	9.62	7.72	3.74
10 year mean	6.27	9.11	9.84	11.91	10.54	7.49	4.30
48 year mean	5.54	7.59	8.79	11.09	9.47	6.18	3.07

[1] Total water evaporation from a standard 10-inch-deep by 47½-inch-diameter pan over 24 hours.

Table 9. Daily and monthly wind-run[1] totals for 1995 and 10-year and 48-year mean monthly April through October wind-run totals at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	----	----	----	----	----	----	miles	----	----	----	----	----
1	45	26	58	32	49	44	27	23	31	65	127	124
2	44	49	35	145	64	80	36	49	27	67	48	79
3	46	26	40	59	92	96	56	55	23	31	26	50
4	57	27	73	23	33	66	91	64	42	113	26	62
5	51	15	80	79	50	90	45	37	66	65	37	95
6	9	20	80	65	184	127	41	42	51	33	33	21
7	15	14	27	41	151	79	63	51	50	72	41	57
8	56	57	30	98	79	141	40	110	94	67	30	33
9	184	130	67	108	34	59	48	39	33	38	44	12
10	199	45	157	135	44	24	71	31	26	24	120	37
11	108	93	129	38	47	107	84	81	40	38	61	57
12	32	77	43	20	119	51	108	47	31	60	32	223
13	36	196	85	53	106	65	109	137	28	53	21	220
14	92	70	87	116	70	58	37	44	23	35	18	33
15	42	77	154	100	32	37	37	32	32	30	13	63
16	41	94	69	39	49	65	45	78	29	26	38	99
17	84	35	35	77	68	61	49	58	38	50	30	95
18	24	27	37	91	133	65	42	78	47	51	57	20
19	20	23	66	214	109	51	55	33	77	110	52	35
20	29	31	106	53	31	48	43	26	121	41	25	14
21	38	43	172	183	48	81	41	34	104	67	37	20
22	32	27	57	150	120	36	56	30	52	146	23	13
23	24	30	156	94	125	32	61	26	38	67	31	31
24	32	24	78	40	45	27	71	88	30	40	34	38
25	41	38	143	60	39	27	56	79	45	24	27	14
26	39	33	112	110	113	26	39	43	81	60	63	29
27	28	59	59	M	132	65	78	52	45	71	88	59
28	14	94	96	111	57	124	43	35	43	36	78	32
29	20		66	62	43	81	53	41	113	29	29	27
30	83		33	53	28	36	102	58	72	89	37	45
31	43		33		63		47	27		64		34
1995 total	1608	1480	2463	2449	2357	1949	1774	1628	1532	1762	1326	1771
10 year mean	*	*	*	2168	2367	1926	1861	1617	1504	1480	*	*
48 year mean	*	*	*	2083	1870	1507	1438	1272	1204	1207	*	*

[1] Total wind movement in miles over 24-hour period measured at approximately 24 inches above ground level.
* Prior to 1990, wind-run data for period between November 1 and March 31 were not recorded at this station.

Table 10. Monthly and seasonal (April through October) pan-evaportation[1] and wind-run[2] totals for April 1986 through October 1995 and 10-year and 48-year mean monthly and mean seasonal totals for the 7-month irrigation season (April 1 through October 31) at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Pan evaporation								
	----------	----------	----------	inches	----------	----------	----------	----------
1986	5.80	8.31	10.91	12.00	11.61	5.05	3.95	57.63
1987	8.13	9.55	9.51	11.46	11.08	8.30	4.92	62.95
1988	5.69	8.76	11.17	13.35	11.25	7.01	4.80	62.03
1989	5.79	8.74	10.78	12.84	9.73	6.65	3.76	58.29
1990	7.03	10.07	10.05	12.12	7.88	8.54	3.70	59.39
1991	6.44	8.42	10.12	12.88	11.15	8.36	5.23	62.60
1992	6.40	11.44	9.80	10.49	11.46	6.70	4.15	60.44
1993	4.92	9.28	7.60	10.03	9.51	7.86	4.38	53.58
1994	6.90	8.14	9.90	13.41	12.09	8.69	4.34	63.47
1995	5.60	8.37	8.58	10.49	9.62	7.72	3.74	54.12
10 yr mean	6.27	9.11	9.84	11.91	10.54	7.49	4.30	59.45
48 yr mean	5.54	7.59	8.79	11.09	9.47	6.18	3.07	51.72
Wind run								
	----------	----------	----------	miles	----------	----------	----------	----------
1986	2308	2321	1792	2130	1740	1413	1544	13248
1987	2354	2432	1898	2161	1938	1620	1311	13714
1988	1889	2599	2357	2014	1879	1604	1294	13636
1989	1929	2620	1872	1707	1481	1465	1311	12385
1990	1832	2506	1824	1556	1276	1357	1427	11778
1991	2693	2677	2184	1680	1358	1316	1786	13694
1992	1797	2237	1711	1671	1580	1583	1158	11737
1993	1943	2060	2008	2138	1604	1505	1273	12531
1994	2490	1865	1669	1780	1686	1648	1929	13067
1995	2449	2357	1949	1774	1628	1532	1762	13451
10 yr mean	2168	2367	1926	1861	1617	1504	1480	12924
48 yr mean	2083	1870	1507	1438	1272	1204	1207	10581

[1] Inches of water evaporated from a standard 10-inch-deep by 47½-inch diameter evaporation pan over 24 hour period.
[2] Total wind-run in miles over 24 hour period measured at 6 inches above the evaporation pan.

Note: Due to a accidental draining of the evaporation pan at this station, the value reported for August 1990 is from the Parma Experiment Station, University of Idaho, Parma, Idaho.

Table 11. Crop water use at Ontario, Oregon. Average calendar dates defining the water use period for those crops commonly grown in the Ontario area and their calculated water use for 1995 and their average use from 1992 through 1995. (This information was developed by the U.S. Bureau of Reclamation using evapotranspiration data generated via the AgriMet weather station located at the Malheur Experiment Station, Oregon State University, Ontario, Oregon.)

Crop & parameter[1]	Mean dates defining crop water use period			Mean length of water use period	Annual calculated crop water use	
	Water use starts	Full canopy occurs	Water use ends		1995	Mean 1992-95
	date			days	acre inches	
Alfalfa (4 cuts)	Mar 14	May 12	Oct 10	211	37.2	39.7
Pasture	Mar 11	May 2	Oct 10	213	29.4	31.4
Lawn or turf	Mar 11	Apr 17	Oct 10	213	35.6	38.1
Winter grain	Mar 9	May 22	Jul 13	126	18.9	22.1
Spring grain (early)	Mar 22	Jun 21	Jul 22	122	19.9	22.8
Spring grain (late)	Apr 5	Jun 19	Aug 3	120	23.0	24.5
Sugar beet (early)	Apr 7	Jul 3	Oct 10	186	*	33.4
Sugar beet (late)	Apr 20	Jul 12	Oct 5	168	29.0	31.9
Onion (early)	Mar 26	Jul 6	Aug 18	145	25.5	28.3
Onion (mid)	Apr 22	Jul 17	Sep 3	134	28.0	28.1
Onion (late)	May 6	Jul 26	Sep 8	125	*	26.6
Potato (Shepody)	May 2	Jul 3	Aug 29	119	22.7	25.0
Potato (Russet, early)	May 4	Jun 23	Sep 10	129	24.1	27.5
Potato (Russet, late)	May 19	Jul 14	Sep 18	122	23.1	25.4
Bean (early)	May 25	Jul 5	Aug 28	95	25.1	20.1
Bean (late)	Jun 8	Jul 8	Sep 4	88	17.5	18.4
Field corn (early)	May 7	Jul 18	Sep 15	132	24.3	26.9
Field corn (late)	May 22	Jul 28	Sep 18	119	23.0	25.5
Sweet corn (early)	May 7	Jul 18	Aug 25	110	19.8	22.0
Sweet corn (late)	May 22	Jul 25	Sep 4	105	19.1	21.1
Mint	Apr 6	Jun 14	Aug 18	134	30.8	26.9
Apple	Apr 15	May 30	Oct 3	170	32.9	36.4

[1] Conditions on which evapotranspiration calculations are based.

Table 12. Annual and 20-year mean dates for last occurrence in spring and for first occurrence in fall when the minimum recorded daily air temperature between January 1, 1976, and December 31, 1995, was equal to or below a threshold temperature at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

	Last spring date and first fall date when minimum temperature was ≤ threshold							
	Spring				Fall			
Year	≤24°F	≤28°F	≤32°F	≤36°F	≤24°F	≤28°F	≤32°F	≤36°F
1976	Apr 2	Apr 3	Apr 23	Jun 26	Oct 19	Oct 18	Oct 5	Sep 9
1977	Mar 31	Apr 15	Apr 20	May 5	Nov 3	Oct 11	Sep 22	Sep 22
1978	Mar 15	Mar 16	Apr 23	May 25	Oct 26	Oct 23	Oct 14	Sep 19
1979	Feb 7	Mar 19	Mar 20	Mar 26	Nov 10	Nov 2	Oct 27	Oct 10
1980	Mar 17	Mar 26	Apr 13	Apr 16	Oct 23	Oct 17	Oct 17	Sep 22
1981	Mar 18	Apr 14	Apr 14	May 7	Oct 22	Oct 22	Oct 1	Nov 23
1982	Apr 20	Apr 21	May 5	Jun 8	Oct 19	Oct 19	Oct 5	Oct 2
1983	Feb 6	Apr 11	Apr 27	May 14	Dec 2	Oct 16	Sep 20	Sep 10
1984	Mar 5	Apr 7	May 7	May 16	Oct 16	Sep 25	Sep 25	Sep 23
1985	Mar 26	Apr 20	May 13	May 13	Oct 9	Sep 30	Sep 30	Sep 18
1986	Feb 14	Feb 21	May 23	Jul 5	Nov 10	Oct 12	Oct 12	Sep 21
1987	Mar 30	Apr 20	Apr 21	May 2	Nov 18	Oct 11	Oct 11	Sep 27
1988	Mar 13	Apr 10	May 2	May 7	Nov 26	Oct 31	Oct 30	Sep 23
1989	Mar 5	Mar 30	May 19	May 25	Oct 29	Oct 16	Sep 13	Sep 13
1990	Mar 25	Mar 25	May 8	Jun 2	Oct 1	Oct 8	Oct 7	Oct 4
1991	Mar 16	Apr 8	Apr 30	May 9	Oct 30	Oct 30	Oct 4	Oct 4
1992	Feb 6	Apr 8	Apr 24	Apr 25	Nov 11	Oct 7	Sep 14	Sep 9
1993	Mar 12	Mar 12	Apr 20	Jun 12	Oct 30	Oct 27	Oct 11	Sep 17
1994	Mar 24	Mar 28	Apr 15	Jun 8	Nov 8	Oct 28	Oct 6	Oct 6
1995	Mar 7	Apr 15	Apr 16	Jun 7	Oct 23	Oct 13	Sep 22	Sep 22
Mean	Mar 12	Apr 2	Apr 26	May 19	Oct 30	Oct 16	Oct 4	Sep 25

Table 13. Annual and 20-year mean number of consecutive days during the year from January 1, 1976, through December 31, 1995, that the minimum recorded daily air temperature was greater than a threshold temperature at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Year	Number of days minimum air temperature was greater than threshold			
	≤24°F	≤28°F	≤32°F	≤36°F
1976	200	198	165	75
1977	217	179	155	140
1978	225	221	174	117
1979	276	228	221	198
1980	220	205	187	159
1981	218	191	170	200
1982	182	181	153	116
1983	299	188	146	119
1984	225	171	141	130
1985	197	163	140	128
1986	269	233	142	78
1987	233	174	173	148
1988	258	204	181	139
1989	238	200	117	111
1990	190	197	152	124
1991	228	205	157	148
1992	278	182	143	137
1993	232	229	174	97
1994	229	214	174	120
1995	230	181	159	107
Mean	232	197	161	130

Table 14. Monthly cumulative degree days (lower threshold = 50°F, upper threshold = 86°F) for the past 10 years (1986 - 1995) at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	0	16	101	220	558	1197	1847	2643	2939	3097	3111	3111
1987	0	0	43	318	741	1288	1929	2578	3064	3287	3316	3318
1988	0	5	56	236	554	1139	2050	2741	3117	3426	3446	3446
1989	0	0	13	197	469	1018	1751	2332	2721	2838	2852	2852
1990	2	9	88	327	588	1085	1819	2454	3039	3077	3077	3077
1991	0	13	29	153	365	754	1530	2248	2684	2878	2879	2879
1992	0	13	119	321	803	1377	2016	2720	3105	3279	3283	3283
1993	0	0	23	104	527	885	1349	1873	2281	2533	2539	2539
1994	0	2	94	283	652	1175	1969	2743	3252	3396	3398	3398
1995	0	29	61	167	460	893	1573	2161	2633	2734	2737	2747
Mean	0	6	63	240	584	1102	1807	2481	2911	3090	3100	3100

Note: One degree day is accumulated for each one degree of the average daily (24-hour) temperature that is above the lower threshold temperature and below the upper threshold temperature.

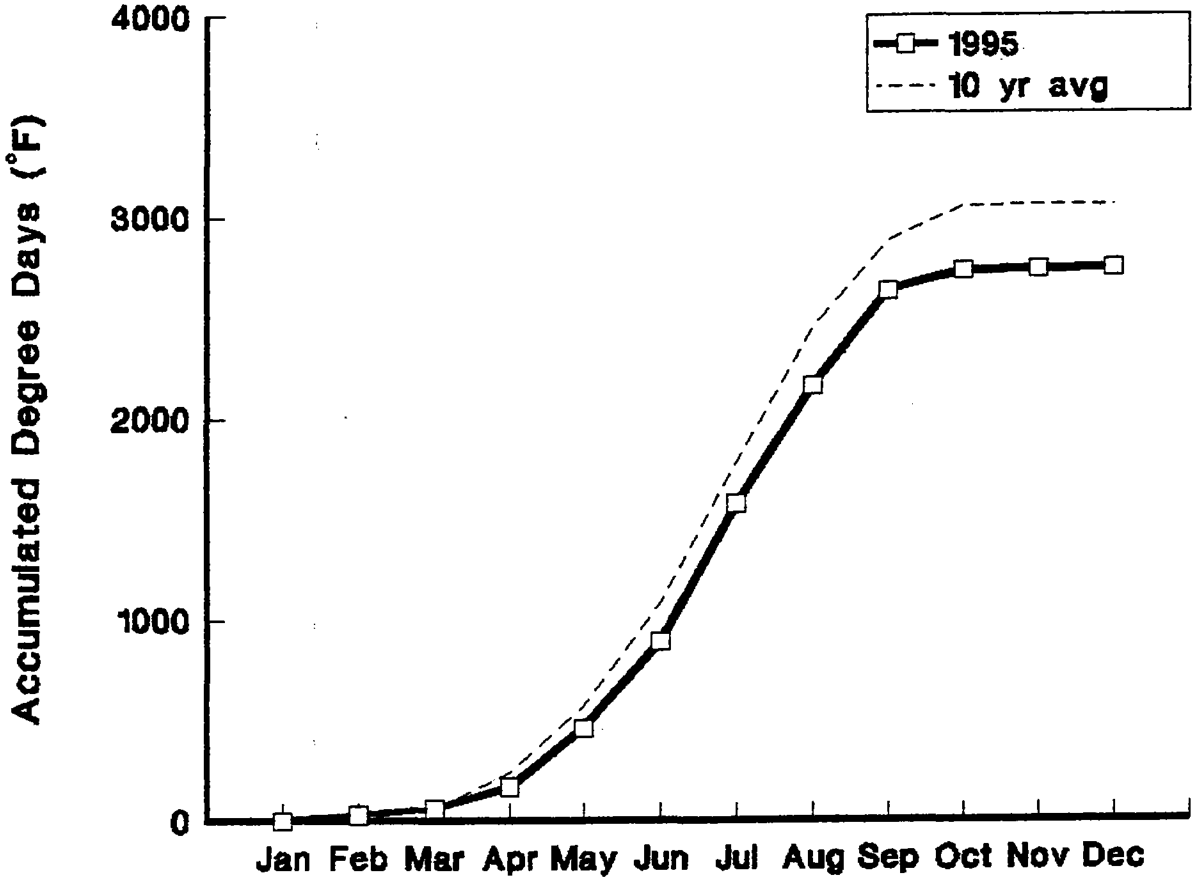

Figure 2. A comparison of the cumulative degree days for 1995 to the 10-year average at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Table 15. Record weather extremes recorded at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Event	Measurement	Date
Greatest annual precipitation	16.87 inches	1983
Greatest 24-hour precipitation	1.52 inches	Sep 14, 1959
Greatest annual snowfall	40 inches	1955
Greatest 24-hour snowfall	10 inches	Nov 30, 1975
Earliest first winter snowfall	1 inch	Oct 25, 1970
Highest air temperature	108°F	Aug 4, 1961
Total days maximum air temperature >=100°F	17 days	1971
Lowest minimum air temperature	-26°F	Feb 21 & 22, 1962
Total days minimum air temperature <=0°F	35 days	1985
Lowest 4-inch soil temperature	12°F	Dec 24-26, 1990

1995 RESULTS FROM A FORAGE ALFALFA VARIETY EVALUATION TRIAL ESTABLISHED IN THE FALL OF 1992

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Purpose

The purpose of this trial, which includes 7 public and 28 proprietary alfalfa cultivars, is to identify high-yielding alfalfa forage cultivars with good stand persistence in the Treasure Valley. It is expected that this trial will be maintained through 5 harvest seasons until the fall of 1997.

Procedure

In mid-September 1992, following a crop of winter wheat, the trial area was cross-disked and cross-ripped. Because soil test results showed very low phosphorus levels, 970 pounds of P_2O_5 per acre and 205 pounds of N per acre as 11-52-0 were applied prior to final seed bed preparation. The fertilizer was incorporated into the soil profile during ensuing secondary tillage operations which included disking, rototilling, and land-planing. A preplant application of benefin (Balan DF) at 1.5 lb ai/ac in 20 gallons of water per acre was applied by ground rig and rototilled into the top 4 inches of the soil profile. The field was bedded on 60-inch centers, and the beds were firmed with a rubber-tire roller. Individual plots measuring 5 feet wide by 22 feet long and separated at each end by 3-foot-wide bare soil alleys were arranged in a randomized complete-block design with four replications and seeded on September 16. Seed was drilled approximately ¼-inch to ½-inch deep into dry soil with a seven-row disk-opener plot drill. The seeding rate was 20 pounds per acre. To promote rapid germination and assure stand establishment, three 4-hour long sprinkler irrigations were applied over the trial area between September 17th and 20th. No cuttings were taken during the establishment year.

For each crop year, yield data for each cutting is collected by harvesting a 3-foot by 22-foot-long strip through the center of each plot with a flail forage harvester and weighing the freshly cut green forage. Forage moisture content is determined by drying samples from eight randomly selected plots. Plot yields are converted to 88 percent dry matter, which is typical of hay produced in the area. Additionally, in each crop year Near Infrared Reflectance Spectroscopy (NIRS) analysis is utilized to evaluate forage quality (crude protein and acid detergent fiber) of each entry within one replication for the second and third cuttings. Tissue samples for the NIRSanalyses, taken immediately prior to the second and third cuttings, are collected by randomly selecting 20 mature stems from each plot within the first replication.

Procedures pertaining to the annual maintenance and management of this trial during the 1993 and 1994 crop years are discussed in previous MES annual reports. All plots were harvested four time in 1993 and five times in 1994. In both years forage quality measurements were taken from the second and third cuttings.

On January 24, 1995, in preparation for the up-coming harvest season, a dormant application of metribuzin (Sencor 75 DF) at 0.93 lb ai/ac in 30 gallons of water per acre was broadcast applied over the trial area.

Four cuttings were taken during the 1995 harvest season. NIRS analysis was utilized to evaluate forage quality for the second and third cuttings.

Results and Discussion

The mean 1995 total-season yield at 88 percent DM was 8.5 tons per acre (Table 1). Third-year total-season yields ranged from 9.0 tons for Lobo, AP 8950, and ABI 9151 to 7.9 tons per acre for Maxi-Leaf. The total-season yields for Lobo, AP 8950, and ABI 9151 were significantly greater than the total-season yield for 1-T-11.

Forage quality values (ADF and CP) for 1995, derived from samples taken from one replication for the second and third cuttings, are presented in Table 2. The mean ADF over both cuttings was 35.2 percent. Differences in mean ADF values over the two cuttings among cultivars were not significant. The mean CP over both cuttings was 19.1 percent. Differences in mean CP values over the two cuttings among cultivars were not significant.

The mean three year-yield at 88 percent DM for the trial was 31.2 tons per acre (Table 3). Three year-total yields ranged from 33.4 tons for Lobo to 28.5 tons for PSS 393. The total yield for Lobo was significantly greater than the total yield for WL 320.

The three-year mean forage quality values (ADF and CP) of each cultivar for the second and third cuttings are presented in Table 4.

Information obtained from the participating seed companies and/or literature produced by the Certified Alfalfa Seed Council pertaining to winter hardiness and insect and disease resistance is presented in Table 5.

Table 1. Third-year forage yield of 35 alfalfa cultivars at Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Cultivar	Yield by cutting and cutting date 1st 5/17	2nd 6/23	3rd 7/27	4th 8/31	Total
	t/ac*				
Lobo	2.6	2.3	2.2	1.9	9.0
AP 8950	2.7	2.3	2.1	1.9	9.0
ABI 9151	2.5	2.4	2.2	1.9	9.0
Achieva	2.7	2.3	2.0	1.8	8.9
WL 320	2.7	2.3	2.0	1.9	8.9
Archer	2.5	2.4	2.2	1.9	8.9
Asset	2.7	2.2	2.0	1.8	8.8
PGI 2152	2.7	2.2	2.0	1.9	8.8
Garst 630	2.6	2.2	2.0	1.8	8.7
3 J 15	2.7	2.2	2.1	1.7	8.7
Excalibur II	2.5	2.3	2.1	1.8	8.7
WL 323	2.6	2.2	2.1	1.7	8.7
Vernema	2.7	2.3	1.9	1.7	8.6
Hyland	2.5	2.3	2.0	1.8	8.6
Sutter	2.4	2.3	2.0	1.8	8.6
5683	2.4	2.2	2.1	1.9	8.6
Perry	2.6	2.2	2.0	1.7	8.5
Wrangler	2.6	2.2	2.0	1.7	8.5
1-A	2.5	2.2	2.1	1.8	8.5
5472	2.4	2.2	2.1	1.8	8.5
Ovation	2.7	2.1	2.0	1.8	8.5
PSS 393	2.5	2.2	1.8	1.8	8.4
Washoe	2.4	2.3	2.0	1.7	8.4
Lahontan	2.5	2.1	2.1	1.8	8.4
DK133	2.5	2.2	2.0	1.7	8.4
ABI 9160	2.3	2.2	2.0	1.9	8.4
Blazer-XL	2.5	2.1	1.9	1.8	8.3
Crystal	2.4	2.2	2.0	1.8	8.3
WL 322 HQ	2.3	2.2	2.0	1.8	8.3
1-T-11	2.4	2.1	2.0	1.7	8.2
Future	2.5	2.1	1.9	1.7	8.2
CUF-101	2.2	2.4	2.0	1.6	8.1
WL 317	2.4	2.0	1.9	1.7	8.1
5364	2.4	2.0	1.9	1.7	8.0
Maxi-Leaf	2.3	2.0	1.9	1.6	7.9
Mean	2.5	2.2	2.0	1.8	8.5
LSD(0.05)	0.4	0.2	0.2	0.2	0.7
C.V. (%)	10.0	7.7	5.3	5.9	5.4

*Yields are repored at 88 percent dry matter.

Table 2. Percent acid detergent fiber (ADF) and percent crude protein (CP) by cutting from one replication of second and third cuttings of 35 alfalfa cultivars at Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

	Cutting and cutting date					
	2nd (6/23)		3rd (7/27)		Mean	
Cultivar	ADF	CP	ADF	CP	ADF	CP
	%					
Lobo	34.4	18.2	38.6	17.4	36.5	17.8
AP 8950	35.1	17.3	37.1	19.0	36.1	18.1
ABI 9151	34.4	17.6	34.3	20.2	34.3	18.9
Achieva	34.9	19.8	37.4	18.9	36.1	19.3
WL 320	33.5	19.6	32.1	22.0	32.8	20.8
Archer	34.9	18.7	38.8	17.7	36.9	18.2
Asset	35.1	18.0	36.3	19.9	35.7	18.9
PGI 2152	31.5	20.1	36.0	18.6	33.7	19.4
Garst 630	36.5	17.9	34.1	21.2	35.3	19.5
3 J 15	32.1	20.4	35.6	19.4	33.8	19.9
Excalibur II	34.4	19.7	38.0	18.3	36.2	19.0
WL 323	29.4	22.2	37.7	18.3	33.6	20.3
Vernema	30.7	20.9	40.2	17.2	35.4	19.0
Hyland	38.1	16.4	37.5	18.3	37.8	17.4
Sutter	33.7	18.6	37.4	18.2	35.6	18.4
5683	34.5	19.0	35.4	19.8	34.9	19.4
Perry	33.1	20.7	35.3	20.3	34.2	20.5
Wrangler	32.5	21.4	34.7	20.6	33.6	21.0
1-A	35.2	18.4	38.0	18.1	36.6	18.2
5472	34.0	18.9	34.9	20.5	34.5	19.7
Ovation	36.1	18.5	34.5	20.1	35.3	19.3
PSS 393	33.3	19.9	41.7	15.7	37.5	17.8
Washoe	34.2	18.4	37.6	18.3	35.9	18.3
Lahontan	36.6	18.2	38.2	17.9	37.4	18.0
DK133	31.9	21.9	35.0	19.9	33.4	20.9
ABI 9160	34.4	18.9	37.3	18.3	35.9	18.6
Blazer-XL	39.3	16.2	36.5	18.9	37.9	17.6
Crystal	36.3	17.8	33.1	21.2	34.7	19.5
WL 322 HQ	32.9	19.7	31.9	22.0	32.4	20.8
1-T-11	36.7	17.3	34.4	21.1	35.6	19.2
Future	36.9	17.1	32.4	21.8	34.6	19.5
CUF-101	33.5	18.6	36.7	18.3	35.1	18.5
WL 317	36.0	17.5	32.2	21.7	34.1	19.6
5364	34.3	18.5	34.8	20.3	34.5	19.4
Maxi-Leaf	34.5	19.0	35.4	19.1	35.0	19.1
Mean	34.4	18.9	36.0	19.4	35.2	19.1
LSD(0.05)					NS	NS
C.V. (%)					7.3	8.4

Table 3. Seasonal and 3-year forage yield totals of 35 alfalfa cultivars at Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Cultivar	Seasonal yield by year 1st 1993	2nd 1994	3rd 1995	Three year total
	t/ac*			
Lobo	13.5	10.9	9.0	33.4
Archer	12.9	10.9	8.9	32.8
Achieva	12.7	11.1	8.9	32.6
AP 8950	12.7	10.8	9.0	32.5
PGI 2152	13.1	10.6	8.8	32.4
DK133	13.2	10.8	8.4	32.4
5683	12.7	10.8	8.6	32.0
Garst 630	12.7	10.5	8.7	31.9
Excalibur II	12.6	10.6	8.7	31.9
Blazer-XL	12.9	10.6	8.3	31.9
ABI 9151	12.4	10.4	9.0	31.8
1-A	12.7	10.6	8.5	31.8
Asset	12.5	10.2	8.8	31.6
WL 323	12.2	10.7	8.7	31.6
Sutter	12.4	10.6	8.6	31.6
WL 320	12.2	10.4	8.9	31.5
5472	12.2	10.7	8.5	31.5
ABI 9160	12.3	10.7	8.4	31.4
Hyland	12.3	10.5	8.6	31.3
3 J 15	12.1	10.3	8.7	31.1
Lahontan	12.5	10.1	8.4	31.1
Crystal	12.5	10.3	8.3	31.1
Wrangler	12.4	10.1	8.5	31.0
Ovation	11.9	10.4	8.5	30.7
WL 317	12.3	10.3	8.1	30.7
WL 322 HQ	11.9	10.4	8.3	30.5
1-T-11	12.2	10.2	8.2	30.5
Future	11.8	10.3	8.2	30.4
Washoe	11.8	10.0	8.4	30.3
Vernema	11.7	9.9	8.6	30.2
Maxi-Leaf	12.2	9.8	7.9	29.9
Perry	11.7	9.6	8.5	29.8
CUF-101	12.0	9.4	8.1	29.6
5364	11.8	9.8	8.0	29.5
PSS 393	11.6	8.5	8.4	28.5
Mean	12.4	10.3	8.5	31.2
LSD(0.05)	1.2	0.7	0.7	1.8
C.V. (%)	7.0	4.9	5.4	4.1

*Yields are reported at 88 percent dry matter.

Table 4. Mean percent acid detergent fiber (ADF) and percent crude protein (CP), by cutting, from one replication of second and third cuttings of 35 alfalfa cultivars over three years at Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

	Cutting					
	2nd		3rd		Combined	
Cultivar	ADF	CP	ADF	CP	ADF	CP
	%					
Perry	31.1	21.9	30.9	20.7	31.0	21.3
Wrangler	31.1	22.0	30.5	21.5	30.8	21.8
Vernema	31.8	21.1	33.6	19.1	32.7	20.1
PSS 393	32.9	20.4	34.1	18.8	33.5	19.6
Washoe	31.9	21.0	36.0	18.0	34.0	19.5
Lahontan	33.6	20.7	35.9	18.2	34.7	19.4
CUF-101	33.0	19.5	34.8	18.5	33.9	19.0
1-A	33.4	20.0	33.5	19.5	33.5	19.8
1-T-11	32.5	20.8	31.9	20.8	32.2	20.8
Asset	33.1	20.1	32.8	20.6	32.9	20.3
Achieva	32.7	21.1	33.4	20.1	33.1	20.6
Hyland	34.4	19.4	34.1	19.3	34.3	19.4
Garst 630	33.3	20.6	31.7	20.9	32.5	20.7
Maxi-Leaf	32.0	21.1	31.5	20.7	31.7	20.9
Future	33.4	20.3	31.2	21.4	32.3	20.8
DK133	32.1	21.9	31.9	20.9	32.0	21.4
Blazer-XL	35.7	18.9	33.1	19.6	34.4	19.3
3 J 15	31.2	21.6	31.9	20.8	31.6	21.2
4 J 19	31.4	21.7	32.9	20.2	32.2	21.0
Lobo	31.9	20.9	33.8	19.3	32.9	20.1
Crystal	33.8	19.9	31.4	20.8	32.6	20.4
Sutter	32.3	20.3	34.6	18.4	33.4	19.3
PGI 2152	32.0	20.7	33.2	19.7	32.6	20.2
5472	32.8	20.4	33.8	19.4	33.3	19.9
5364	32.8	20.5	32.9	19.8	32.8	20.2
5683	32.2	20.8	32.8	19.6	32.5	20.2
WL 317	31.9	21.0	31.3	21.0	31.6	21.0
WL 320	30.8	22.1	31.7	21.4	31.2	21.8
WL 322 HQ	30.7	22.4	31.2	21.4	30.9	21.9
89-30	32.5	21.2	31.7	20.7	32.1	21.0
WL 323	30.6	22.1	33.8	19.8	32.2	20.9
AP 8950	31.2	21.4	33.3	19.9	32.3	20.7
ABI 9160	31.9	21.4	33.1	19.7	32.5	20.5
ABI 9151	32.3	20.1	33.3	19.6	32.8	19.8
Archer	32.1	21.2	34.9	19.1	33.5	20.2
Mean	32.3	20.9	32.9	20.0	32.6	20.4

Table 5. Disease and insect resistance levels for the 35 alfalfa cultivars included in the 1992-1997 alfalfa forage evaluation trial at Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995. Data presented in this table was derived from information provided by participating seed companies and/or the Certified Alfalfa Seed Council.

Cultivar	Source	Year of release	FD	Pathogen or insect BW	VW	FW	AN	PRR	SAA	PA	SN	APH	RKN
Perry*	USDA/U.Neb	1979	3	R	S	R	LR	MR	MR	R	-	-	-
Wrangler*	USDA/U.Neb	1983	2	R	LR	R	LR	HR	HR	HR	-	-	-
Vernema*	USDA/WSU	1981	4	MR	MR	-	LR	LR	MR	-	HR	-	-
PSS 393	Price & Sons	(nr)	6.5	-	-	-	-	-	-	-	-	-	-
Washoe*	USDA/UNV	1965	5	R	-	-	LR	R	R	R	R	-	-
Lahontan*	USDA/UNV	1954	6	MR	S	LR	-	LR	MR	LR	R	-	S
CUF-101*	USDA/UC	1976	9	-	-	HR	-	MR	HR	HR	LR	-	MR
1-A	Candy Co.	1992	3	-	-	-	-	-	-	-	-	-	-
1-T-11	Candy Co.	1992	5	-	-	-	-	-	-	-	-	-	-
Asset*	Allied Seed	1990	4	HR	R	R	R	HR	R	R	-	MR	-
Hyland*	Oasis Seed	1993	3	HR	R	HR	R	HR	R	HR	R	MR	-
Garst 630	ICI Americas	1985	4	HR	MR	R	MR	R	MR	R	R	-	-
MaxiLeaf*	Ray Brothers	1993	4	R	LR	MR	R	R	-	-	-	-	-
Future*	Ray Brothers	1987	3	HR	MR	MR	LR	R	MR	-	MR	-	-
DK 133*	Delkalb Plant Genetics	1991	4	HR	R	HR	HR	HR	R	R	MR	R	-
Blazer-XL*	Union Seed	1991	3	R	R	HR	HR	HR	HR	R	R	R	-
3 J 15	Union Seed	(nr)	3	HR	R	HR	HR	HR	HR	R	R	-	-
Excalibur II	Allied Seed	1993	4	HR	R	HR	HR	HR	HR	R	R	R	-
Lobo*	SeedTec	1991	6	MR	MR	HR	HR	R	HR	R	R	-	R
Crystal*	PGI/MBS	1990	4	HR	R	HR	R	HR	LR	R	MR	MR	-
Sutter*	PGI/MBS	1987	7	R	LR	HR	LR	HR	HR	R	R	-	-
PGI 2152	PGI/MBS	1992	5	HR	R	HR	R	R	HR	R	MR	-	-
5472*	Pioneer Hi-Bred	1989	4	HR	MR	HR	MR	MR	R	HR	R	-	-
5364*	Pioneer Hi-Bred	1989	4	R	MR	R	MR	MR	HR	HR	R	-	-
5683*	Pioneer Hi-Bred	1988	7	MR	S	R	S	R	HR	R	R	-	-
WL 317*	W-L Research	1988	3	HR	R	HR	R	HR	HR	HR	R	-	MR
WL 320*	W-L Research	1985	4	R	MR	HR	MR	R	R	R	MR	-	-
WL 322 HQ*	W-L Research	1991	4	HR	R	HR	MR	R	HR	HR	LR	-	LR
Ovation*	W-L Research	(nr)	4	HR	HR	HR	HR	HR	MR	R	MR	R	-
WL 323*	W-L Research	1993	4	HR	R	HR	HR	HR	MR	R	R	R	-
AP 8950	ABI	(nr)	4	MR	MR	HR	MR	R	HR	HR	R	-	R
ABI 9160	ABI	(nr)	5	MR	MR	MR	-	R	R	R	R	-	R
ABI 9151	ABI	(nr)	5	MR	MR	HR	MR	R	-	-	MR	-	-
Archer*	America's Alfalfa	1988	5	MR	LR	HR	MR	R	-	-	MR	-	-

*Information confirmed by the National Alfalfa Variety Review Board.
(nr) Not released or no release date available.

FD = Fall Dormancy, BW = Bacterial Wilt, VW = Verticillium Wilt, FW = Fusarium Wilt, AN = Anthracnose, PRR = Phytophthora Root Rot, SAA = Spotted Alfalfa Aphid, PA = Pea Aphid, SN = Stem Nematode, APH = Aphanomycese, RKN = Root Knot Nematode.

Fall Dormancy: 1 = Norseman, 2 = Vernal, 3 = Ranger, 4 = Saranac, 5 = DuPuits, 6 = Lahontan, 7 = Mesilla, 8 = Moapa 69, 9 = CUF 101.

Disease and Insect Resistance: >50% = HR (Highly Resistant), 31-50% = R (Resistant), 15-30% = MR (Moderately Resistant), 6-14% = LR (Low Resistance), 0-5% = S (Susceptible).

ONION VARIETY TRIALS

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Ontario, Oregon, 1995

Purpose

To evaluate commercial and experimental lines of different varieties of yellow, white, and red onions for bulb yield and quality.

Procedures

Sugar beets and wheat had been grown in the field during 1993 and 1994, respectively. The wheat stubble was shredded and the field deep-chiseled, disked, irrigated, and moldboard-plowed in the fall. The Owyhee silt loam soil containing 1.2 percent organic matter and with a pH of 7.3. Before plowing, 100 lbs/ac of P_2O_5, and 60 lbs N/ac were broadcast. After plowing, the field was bedded and left until spring without further tillage.

Onion seed was received from 14 companies; American Takii, Aristogenes, Asgrow, Bejo, Crookham, Ferry Morse, Dakota Seeds, Harris Moran, Nippon Noran, Petoseed, Rio Colorado, Rispen Seeds, Shamrock, and Sunseeds. Seventy-seven onion varieties were planted April 5 and 6 in plots 4 rows wide and 27 feet long. The onions were planted on 22-inch single-row beds. Each variety was planted in five replications. Seed for each row was prepackaged using enough seed for a planting rate of 12 viable seeds per foot of row. Seed was planted using 12-inch- diameter cone-seeders mounted on a John Deere Model 71 flexi-planter unit equipped with disc openers.

The onions were furrow-irrigated during the growing season. The first irrigation was applied on April 8 to supply the soil with moisture for seed germination and seedling emergence and growth.

On May 12 through May 16 the seedling onion plants were thinned by hand to a plant population of four plants/linear foot of row (3-inch spacing between individual onion plants). On May 20, 210 lbs N/ac as NH_4SO_4 was sidedressed. Nitrogen was shanked on each side of every row. On June 12, lay-bye herbicides were applied, and the onions were cultivated for the final time. Karate insecticide was applied at 2-week intervals during June, July, and August for thrip control. Because of hail damage on June 16 and 19 and again on July 29, Ridomil fungicide was applied in combination with the insecticide.

Bulb maturity ratings for each plot were taken on August 11, 18, 28, and September 4 and 15. Maturity ratings were recorded as percent of growing bulbs, with necks collapsed and leaves laying on the ground. All pests were controlled and were not a negating factor in varietal performance.

The onion bulbs were flail-topped and lifted on September 15 and field-dried for five days. On September 20, onion bulbs from the two center rows of each four-row plot were placed in small slatted wooden boxes. The boxed onions were put in storage boxes (4 x 4 x 6 feet) and left in the field for one week for further air drying. The boxes were placed in storage on September 27 and 28.

The onion bulbs were removed from storage and graded from December 19 through December 27. Bulbs were graded according to their diameter and quality. Size categories were 2¼ to 3-inch, 3 to 4-inch, and 4-inch and larger. Split bulbs were graded as No. 2s. Bulbs rotted by *Botrytis* neckrot and bacterial organisms were weighed and the percent of rotten bulbs was calculated.

Results

Because of higher than normal outside temperatures and humidity occurring during the storage season, significant amounts of storage rot occurred this year.

Varieties are listed by company in alphabetical order and according to rank for total bulb yield for each company's varieties (Table 1). Average bulb yields were 782 cwt/ac with 57.5 percent colossal-sized bulbs, 40.2 percent jumbo's, and 1.4 percent No. 2's. Average neckrot for all varieties was 20.2 percent.

Statistical data are included at the bottom of the tables and should be considered when comparisons are made between varieties for yield and quality performance potential. Differences equal to or greater than LSD (0.05) values should exist before one variety is considered superior to another.

Table 1. Yield and quality of commercial and experimental onion cultivars evaluated in 1995 trials. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

				Yield by market grade								Maturity ratings					Bolters[1]
Company	Variety	Total yield	Storage rot	> 4 inch		3 - 4 inch		2 1/4 - 3 inch		No. 2's		8/11	8/18	8/28	9/4	9/15	
		cwt/ac	%	cwt/ac	%	cwt/ac	%	cwt/ac	%	cwt/ac	%	%					
American Takii	T-405	808	15.5	376	46.5	428	53.0	3.2	0.4	1.0	0.11	0	5	20	45	75	0
	Condor	796	11.5	448	56.3	344	43.2	2.5	0.3	1.2	0.15	0	15	30	50	78	3
	9002	724	11.8	392	54.1	326	45.0	2.4	0.3	3.7	0.53	0	10	18	30	60	0
Aristogene	AX-1514	1061	31.6	898	84.7	161	15.1	2.1	0.2	0	0	0	3	15	25	58	5
	Bravo	1057	39.3	943	89.3	109	10.3	3.0	0.3	1.1	0.09	0	0	12	17	40	14
	El Padre	1025	39.9	858	83.8	164	16.0	2.6	0.3	0	0	0	0	5	10	25	16
	AX-1632	1022	25.7	833	81.6	182	17.8	3.0	0.3	2.9	0.28	0	5	15	35	60	3
	Seville	981	29.0	876	89.2	100	10.3	2.7	0.3	2.5	0.25	0	0	10	20	40	6
	Madrid	968	37.7	700	72.4	255	26.3	7.9	0.8	5.9	0.60	0	0	5	18	35	2
	Capri	946	26.9	743	78.4	200	21.2	1.9	0.2	1.6	0.16	0	2	12	25	50	5
	Maritime	876	16.6	635	72.5	232	26.5	1.8	0.2	1.6	0.85	10	45	65	80	85	11
	AX-2661	817	12.3	469	57.4	339	41.5	3.1	0.4	6.1	0.73	2	10	25	45	70	6
	AX-3102	814	19.9	447	54.9	362	44.4	1.8	0.2	3.2	0.39	0	0	5	15	45	9
	Envoy	776	15.8	477	61.5	283	36.4	9.1	1.2	6.8	0.87	10	40	65	80	90	4
Asgrow	Viper	928	13.0	687	74.1	234	25.2	2.7	0.3	3.5	0.37	10	40	65	75	80	7
	Viceroy	861	9.6	627	72.8	229	26.6	3.7	0.4	1.4	0.16	5	40	70	80	90	1
	Regiment	850	12.4	662	77.8	187	22.0	1.0	0.1	0.7	0.08	30	65	80	85	90	11
	Fury	673	8.4	361	53.6	306	45.4	4.5	0.7	2.2	0.32	40	70	85	93	95	0
Bejo Seeds	Redwing	711	8.8	301	42.2	408	57.4	2.5	0.4	0	0	0	25	50	60	75	1
	BGS-77	679	12.6	285	42.0	386	56.9	6.6	1.0	1.2	0.18	0	10	15	40	65	0
	Daytona	669	11.7	277	41.4	382	57.0	5.3	0.8	5.4	0.8	0	2	10	20	55	0
	Gladstone	636	25.3	213	33.4	412	64.7	10.7	1.7	1.4	0.2	0	3	6	15	40	2
	Santana	603	9.5	220	36.6	374	62.0	7.2	1.2	1.2	0.2	2	30	50	65	88	0
	Prince	547	0.9	137	25.1	393	71.8	16.2	2.9	1.0	0.2	25	70	95	98	100	6
	Sundance	540	1.1	126	23.3	375	69.4	17.1	3.2	22.8	4.1	10	55	85	95	98	0
Crookham	Celebrity	949	35.9	724	76.2	212	22.3	0.4	0	13.2	1.4	0	2	10	20	45	4
	Sweet Perfection	933	31.0	701	75.2	223	23.8	1.6	0.2	7.6	0.8	3	20	55	65	75	9
	Sweet Amber	929	31.4	754	81.2	160	17.3	6.3	0.7	8.3	0.9	2	15	35	60	65	7
	XPH-94378	894	32.5	584	65.3	298	33.3	4.2	0.5	7.7	0.9	0	0	5	15	40	7
	XPH-94385	831	37.6	553	66.6	268	32.2	1.9	0.2	8.5	1.0	0	0	10	25	45	2
Dakota Seed	Dakota BII	970	41.9	752	77.6	200	20.7	2.9	0.3	14.4	1.4	0	0	15	30	45	25
	Cherokee	886	26.3	688	77.6	188	21.2	1.3	0.2	9.1	1.1	0	2	15	30	50	4
	Cuzco	856	33.0	558	65.2	286	33.3	6.6	0.8	6.0	0.7	0	0	3	15	45	1
	Klondike	761	33.1	375	49.3	356	46.8	4.6	0.6	25.5	3.3	0	3	7	20	45	0
	Mohawk	560	1.5	117	20.9	412	73.6	11.5	2.0	19.2	3.4	20	50	75	90	98	0
	Laramie	463	0.6	28	6.1	420	90.7	13.5	2.9	1.3	0.3	30	80	95	98	100	1
	Buckskin	416	1.8	34	8.1	249	60.0	29.6	7.1	103.4	24.8	40	55	85	98	100	0
Ferry Morse	Caesar	843	23.6	531	63.1	307	36.4	1.3	0.2	2.7	0.3	0	5	20	40	60	4
	Augustus	804	31.8	540	67.2	250	31.1	3.3	0.4	10.1	1.2	0	2	5	15	35	4
	Oro Grande	800	21.8	480	60.0	312	39.0	4.4	0.5	3.8	0.5	2	30	45	60	75	6
	Fablus	774	16.4	492	63.5	279	36.2	1.4	0.2	1.6	0.2	5	10	30	55	70	15

Table one continued on next page

Company	Variety	Total yield	Storage rot	Yield by market grade								Maturity ratings					Bolters[1]
				> 4 inch		3 - 4 inch		2 1/4 - 3 inch		No. 2's		8/11	8/18	8/28	9/4	9/15	
		cwt/ac	%	cwt/ac	%	cwt/ac	%	cwt/ac	%	cwt/ac	%	%					
Harris Moran	HMX-3630	861	34.8	586	68.1	268	31.2	3.4	0.4	2.7	0.3	0	0	5	15	30	9
	HMX-0628	814	11.8	501	61.6	299	36.7	2.2	0.3	11.7	1.4	15	45	75	85	93	3
	HMX-0627	562	12.2	186	33.0	355	63.2	15.9	2.6	6.5	1.2	20	40	55	60	85	4
	White Ivory	462	6.4	49	10.6	358	77.7	17.3	3.7	37.4	8.0	0	10	20	35	75	0
Nippon Noran	Tenschin	579	1.9	128	22.2	443	76.5	6.8	1.2	0.5	0	35	80	98	100	100	0
Petoseed	Quest	1093	42.5	1008	92.2	83	7.6	2.3	0.2	0	0	0	2	15	25	50	12
	Vision	982	32.0	786	80.1	189	19.1	2.3	0.2	5.3	0.6	0	2	10	30	60	2
	Shasta	955	39.8	754	79.0	197	20.6	3.5	0.4	0.1	0	0	2	10	20	55	32
	Apex	821	20.6	432	52.8	377	45.8	5.6	0.7	5.8	0.7	0	10	25	35	60	0
	Teton	776	15.5	501	64.6	271	35.0	3.6	0.5	0	0	5	20	45	60	85	6
	Pinnacle	668	6.5	261	39.1	401	60.0	5.8	0.9	0	0	5	15	25	50	75	0
	Diamond	604	27.8	179	29.7	411	68.1	9.3	1.5	4.2	0.7	0	5	10	15	45	2
	PSX-81791	585	4.7	156	26.6	391	66.8	9.2	1.5	30.2	5.1	3	10	20	45	75	0
	Fuego	496	2.4	101	20.3	360	72.6	11.8	2.4	23.1	4.6	0	15	25	45	80	1
Rio Colorado	Challenge	800	20.2	535	67.0	245	30.6	3.9	0.5	15.8	2.0	5	25	35	55	65	6
	Discovery	733	14.7	403	55.0	310	42.3	6.7	0.9	13.4	1.8	15	65	80	85	85	1
	Rio Seco	727	5.3	387	53.3	329	45.3	3.2	0.4	7.3	1.0	65	80	95	95	95	1
Rispen Seeds	Golden Security	955	34.0	737	77.2	209	21.9	1.4	1.5	6.8	0.7	0	3	10	25	50	12
	Victory	932	31.6	720	77.3	201	21.6	2.2	0.2	8.3	0.9	0	10	30	50	65	2
	Bellringer	860	38.3	645	75.0	206	23.9	2.4	0.3	6.9	0.8	0	0	5	15	35	6
Shamrock	SSC-0617	885	26.9	632	71.4	243	27.4	4.9	0.6	5.2	0.6	0	5	15	35	60	11
	SSC-0199	789	18.1	477	60.5	262	33.2	5.1	0.6	44.9	5.6	0	3	15	35	60	9
	SSC-3360	763	14.1	471	61.7	254	33.3	4.3	0.6	34.4	4.5	15	40	60	75	80	0
	Impala	692	7.9	301	43.6	340	49.2	8.3	1.2	42.8	6.0	20	60	80	90	95	2
Sunseeds	Winner	968	33.6	807	83.5	161	16.5	0	0	0	0	0	7	20	45	70	24
	Valdez	923	38.5	788	85.3	131	14.2	2.0	0.2	2.9	0.3	0	3	8	20	45	5
	Vaquero	901	32.4	732	81.2	168	18.6	0.8	0.1	1.2	0.2	0	2	10	20	60	0
	Tesoro	783	10.0	420	53.6	357	45.6	4.5	0.6	1.7	0.2	15	55	70	75	88	6
	Bullring	728	13.4	457	62.8	265	36.3	4.1	0.6	2.5	0.3	5	45	70	80	85	3
	Snow White	723	44.2	383	52.9	303	42.0	5.4	0.7	32.1	4.3	0	0	3	8	25	9
	Sunex 1440	722	4.3	309	42.8	411	56.8	1.3	0.2	1.2	0.2	3	15	40	70	90	2
	Valient	709	15.2	439	61.9	264	37.1	4.8	0.7	1.7	0.3	2	30	50	65	85	9
	Brahma	671	6.5	312	46.7	352	52.3	4.6	0.7	2.1	0.3	20	50	75	85	90	1
	Mambo	643	5.4	307	47.7	301	46.7	7.1	1.1	29.0	4.4	0	10	18	30	70	2
	Blanco Duro	620	37.1	244	39.4	370	59.7	2.8	0.5	3.1	0.5	0	0	7	15	40	8
	Tango	445	1.5	85.4	19.2	334	75.0	22.0	4.9	4.2	0.9	5	30	45	60	85	0
Mean		782	20.2	482	57.5	285	40.2	5.4	0.9	9.3	1.4	-	-	-	-	-	-
LSD (0.05)		33	7.5	30	3.2	30	3.3	5.7	0.9	11.1	1.6	-	-	-	-	-	-
CV (%)		3.3	13.3	5.0	2.0	8.3	2.9	37.4	36.5	42.6	39.5	-	-	-	-	-	-

[1]Number of bolting onion bulbs per 1440 onion plants.

STRATEGIES FOR CONTROLLING ONION THRIPS (Thrips tabaci) IN SWEET SPANISH ONIONS

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Many of the products used in this study are not presently registered for use on onions. If in doubt, read the label or consult a company representative or county agent.

Objectives

The purpose of this project was to compare the efficacy of new insecticides on onion thrips control and to determine if rotating different classes of insecticides that result in better thrips control. There is a continuing need to screen new insecticides to determine if they are effective in controlling onion thrips. Because of the number of generations per year, thrips rapidly build up resistance to insecticides. Rotating between different classes of insecticides is one method of reducing resistance.

Materials and Methods

The trial was conducted on the Skeen Farm south of Nyssa. The plots were four double rows 25 feet in length and each treatment was replicated four times. The first part of the trial consisted of a one-time application of 14 different treatments. Thrips counts were made just prior to spraying and at 7 and 14 days after treatment. Normally there would be a count made 3 days after treatment but inclement weather during this time delayed entry into the field. Some of the plots that were showing effective control after 14 days were evaluated again at 21 days after treatment.

The treatments were made with a CO_2 pressurized plot sprayer set to deliver 26.8 gal/ac of water. The center two rows of each plot were used for evaluation. The number of thrips on 15 onion plants in each plot were counted to determine control.

The different products and their application rates for the efficacy trial are listed in Table 1. The synthetic pyrethroids were evaluated with and without a surfactant, with crop oil concentrate, and a 2X surfactant rate.

The second part of the trial consisted of Warrior, Vydate, Guthion and Lannate in various sequences to determine which applications would give the best season-long control. Insecticide applications were made at approximate two week intervals and thrips counts were made just prior to spraying. Three applications were made during the growing season.

Table 1. Insecticides and rates used in the efficacy trial for onion thrips count, Nyssa, OR. 1995.

Treatment		Applications rates	
Product	Formulation	Active ingredient/ac.	Product volume/ac
Fipronil	80% DG	.025 lb	.4 g
Fipronil	80% DG	.05 lb	.8 g
Spinosad	80% DG	20 g	.74 g
Spinosad	80% DG	40 g	1.5 g
Spinosad	80% DG	80 g	3.0 g
Mustang	1.5 EC	0.03	2.6 oz
Mustang	1.5 EC	0.04	3.2 oz
Warrior	1.0 EC	0.03	3.8 oz
"Y"	-	0.07	1.0 oz
Diazinon	4 EC	0.5	1.0 qt

The sequence trial was initiated on June 20 with subsequent applications on July 1st and July 14th. The following products were utilized.

Table 2. Insecticides and rates used in the sequential application evaluation for onion thrips control. Nyssa, OR. 1995.

Treatment		Application rates	
Product	Formulation	Active ingredient/ac	Product volume/ac
Warrior	1.0 EC	0.03	3.8 oz
Vydate	2 WSL	1	2.0 qt
Guthion	2 EC	0.5	1.0 qt
Lannate	2.4 WSL	0.9	1.5 qt

Each treatment received 4 oz/ac of Breakthrough silicon surfactant and 4.0 oz/ac Leffingwell ZKP as a buffering agent.

The sequential applications were made according to the schedule in Table 3.

Table 3. Date of application and materials used in the sequential application trial for onion thrips control. Nyssa, OR. 1995.

1st Treatment	2nd Treatment	3rd Treatment
6/20/95	7/1/95	7/14/95
Vydate	Vydate	Warrior
Vydate	Warrior	Warrior
Vydate	Warrior	Warrior
Vydate	Lannate	Warrior
Vydate	Warrior	Lannate
Guthion	Warrior	Lannate
Guthion	Warrior	Warrior
Warrior	Warrior	Warrior
Warrior	Warrior	Warrior
Warrior	Vydate	Lannate
Warrior	Guthion	Lannate
Warrior	Guthion	Warrior
Warrior	Lannate	Guthion

Results and Discussion

EFFICACY TRIAL

The results of the efficacy trial are shown in Table 4. Although there were significant differences among treatments in thrips populations at 21 days after treatment, all treatments were beginning to lose effectiveness.

Table 4. Onion thrips control results from the insecticide efficacy trial. Nyssa, OR. 1995.

Treatment					Thrips counts		
	a.i./ac	Break-through	COC	Buffer	7 DAT	14 DAT	21 DAT
Fipronil	0.25	4 oz	4 oz		5.4	4.3	13.4
Fipronil	0.5	4 oz	4 oz		5	3.4	17.1
Spinosad	20 g	-	-	-	11.6	14.5	-
Spinosad	40 g	-	-	-	7.7	6.9	-
Spinosad	80 g	-	-	-	10.2	8.2	-
Mustang	0.03	4 oz	-	-	1.8	4.2	-
Mustang	0.04	4 0z	-	-	0.9	2.4	7.8
Mustang	0.04	8 oz	-	-	0.9	3.3	-
Warrior	0.03	-	-	-	1.1	1.2	5.9
Warrior	0.03	4 oz	-	-	1.5	1.6	-
Warrior	0.03	4 oz	4 oz	-	2.3	1.7	5.4
"Y"	0.07	4 oz	4 oz	-	8.8	11	-
Diazinon	0.5	4 oz	4 oz	4 oz	9.3	8.7	14.9
Check	-	-	-	-	11	12.2	18.9
	LSD				4.5	4	6.6

Spinosad showed very little thrips control in this trial. Although other tests have shown it to be active against other types of thrips, it does not appear to have much activity on the onion thrips.

Fipronil provided fair to good control of onion thrips. While the activity is not as good as the synthetic pyrethroid materials, it could have a place as a rotation chemical since it is not advisable to use all synthetic pyrethroids during the growing season because of resistance buildup. The lower rate of Fipronil (0.25 lb a.i./ac) was as effective as the higher rate. Fipronil should be considered for further evaluation.

Although not statistically significant, the higher rate (3.2 oz) of Mustang consistently gave better control than the 2.6 oz rate. The addition of twice the recommended rate of silicone surfactant (8 oz of Breakthrough) did not increase efficacy.

Warrior had the overall highest control rate of the materials tested. The addition of a silicone surfactant and the addition of the surfactant plus crop oil concentrate did not increase control.

Compound "Y" was not effective against onion thrips.

The organo-phosphate diazinon performed as expected based upon past experience with this class of compounds. Thrips resistance to these materials is apparently still high.

SEQUENCE TRIAL

Vydate by itself gave poor thrips control, even when applied back to back (Table 5). Guthion also gave poor control, except for the third application when it kept the thrips population suppressed. Guthion would not be a good choice to apply at the last application if the thrips population was high. Lannate appeared to do a good job in the last spray sequence, probably due to higher temperatures which are necessary to make Lannate effective. Lannate was not as consistent as Warrior, which gave excellent control at each application.

Table 5. Average onion thrips counts after sequential insecticide applications. Nyssa, OR. 1995.

Treatment 1		Treatment 2		Treatment 3		Average Season Control
Treatment 1	Ave thrips count	Treatment 2	Ave thrips count	Treatment 3	Ave thrips count	
Warrior	2.5	Warrior	3.63	Lannate	4.63	3.58
Warrior	2.95	Lannate	4.13	Guthion	4.28	3.78
Warrior	2.95	Warrior	4.28	Warrior	4.78	4
Warrior	3.2	Vydate	5.9	Lannate	3.45	4.18
Vydate	11.93	Warrior	2.68	Warrior	5.1	6.57
Guthion	14.8	Warrior	4.03	Lannate	4.73	7.85
Warrior	4.83	Guthion	13.18	Lannate	5.95	7.98
Warrior	4.05	Guthion	17.98	Warrior	2.93	8.32
Guthion	17.1	Warrior	2.85	Warrior	5.48	8.48
Vydate	16.25	Warrior	2.95	Lannate	7.98	9.06
Vydate	16.15	Lannate	14.53	Warrior	3.65	11.44
Vydate	17.95	Vydate	24.83	Warrior	4.05	15.58
LSD						3.43

The first four treatments in Table 5 are shown graphically in Figure 1 and appear to be acceptable although a straight Warrior-Warrior-Warrior sequence is not recommended because of the quick resistance buildup to the synthetic pyrethroids. The other three treatments performed well and provide a mix of insecticide classes to reduce resistance buildup.

Figure 2 shows the next five treatments, none of which were very acceptable because of the high thrips population which was approaching the yield reduction threshold.

Figure 3 depicts the last three treatments which had unacceptably high thrips averages throughout the season.

Conclusions

1. The synthetic pyrethroid materials (Warrior, Mustang) gave excellent thrips control.

2. Adding a silicone surfactant to the synthetic pyrethroids did not increase control, even at twice the normal surfactant rate.

3. Adding a crop oil concentrate to the synthetic pyrethroids did not increase control.

4. The Rhone-Poulenc material "Fipronil" gave moderately good control and could possibly serve as a chemical to rotate with the synthetic pyrethroids if registered.

5. Neither Spinosad, compound "Y", nor diazinon performed better than the check.

6. The following four treatments were the best combinations for season-long control of thrips.

	1st application	2nd application	3rd application
a.	Warrior	Warrior	Lannate
b.	Warrior	Lannate	Guthion
c.	Warrior	Warrior	Warrior
d.	Warrior	Vydate	Lannate

Figure 1. Sequence Thrips Trial. Nyssa, OR. 1995

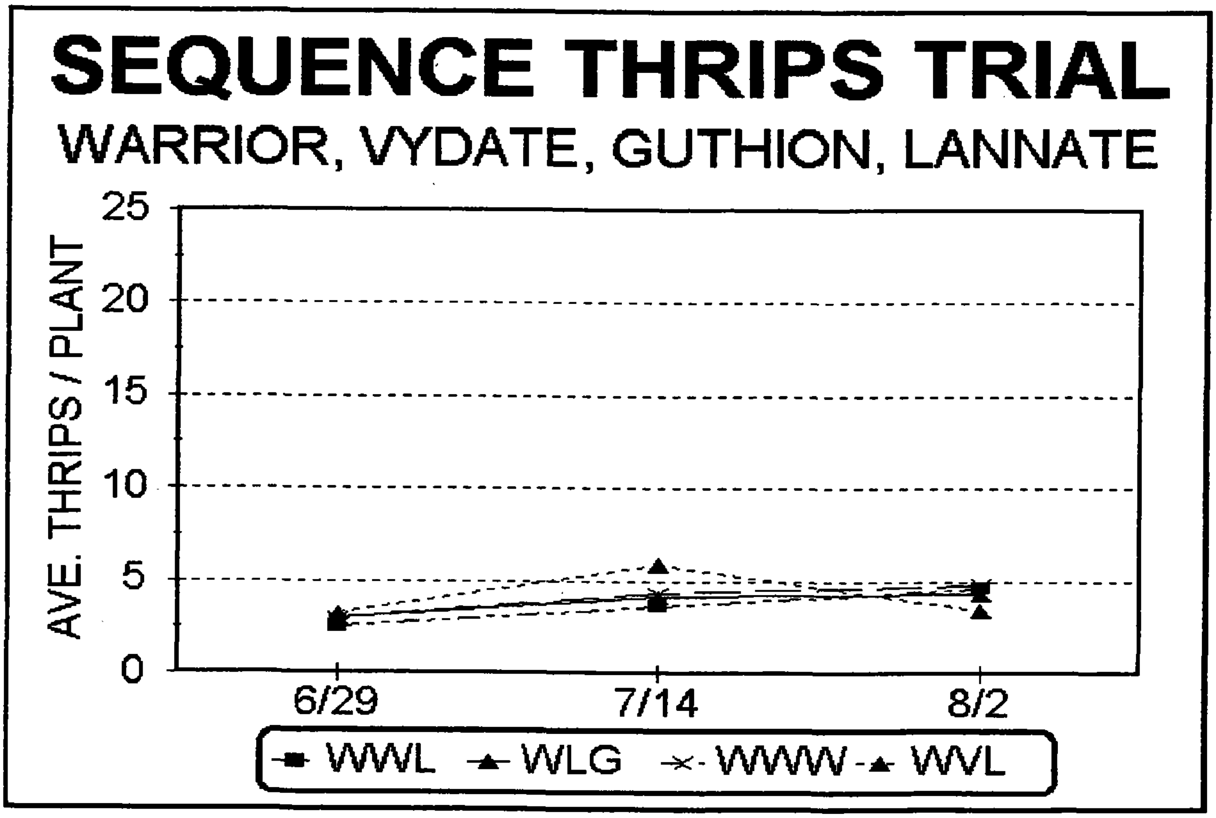


Figure 2. Sequence Thrips Trial. Nyssa, OR. 1995.

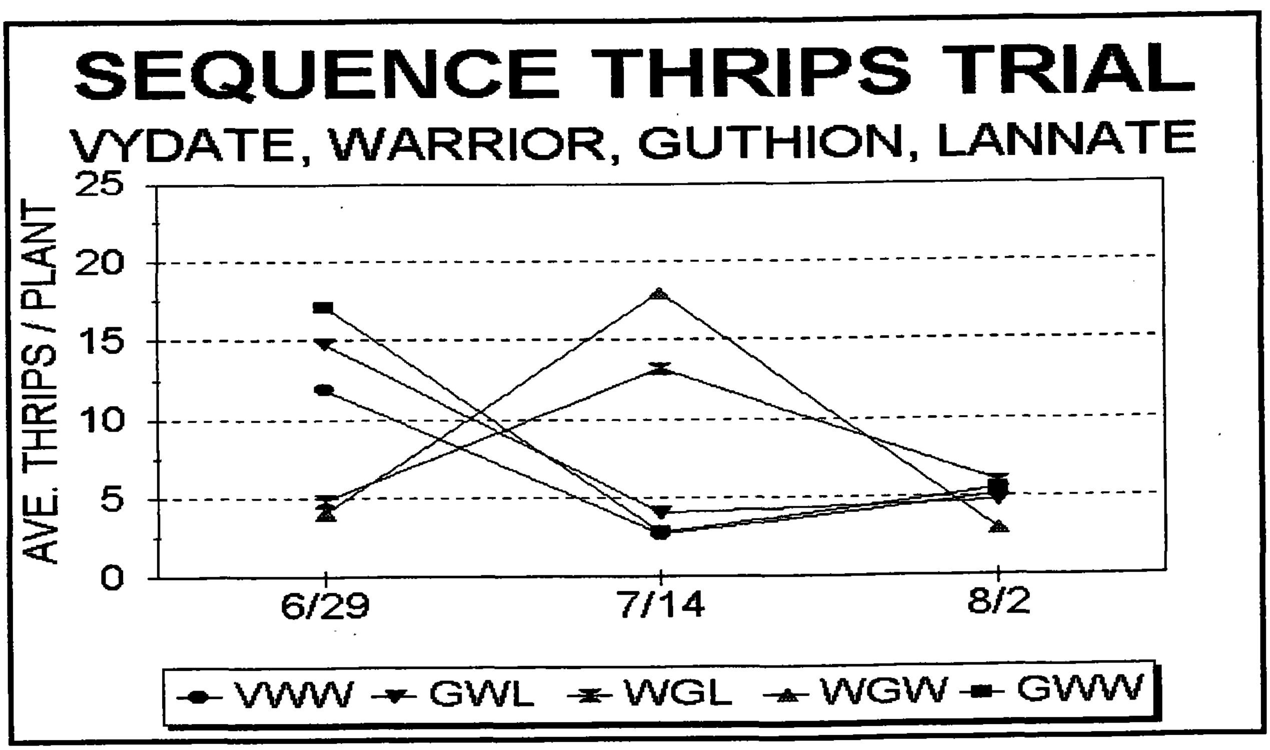
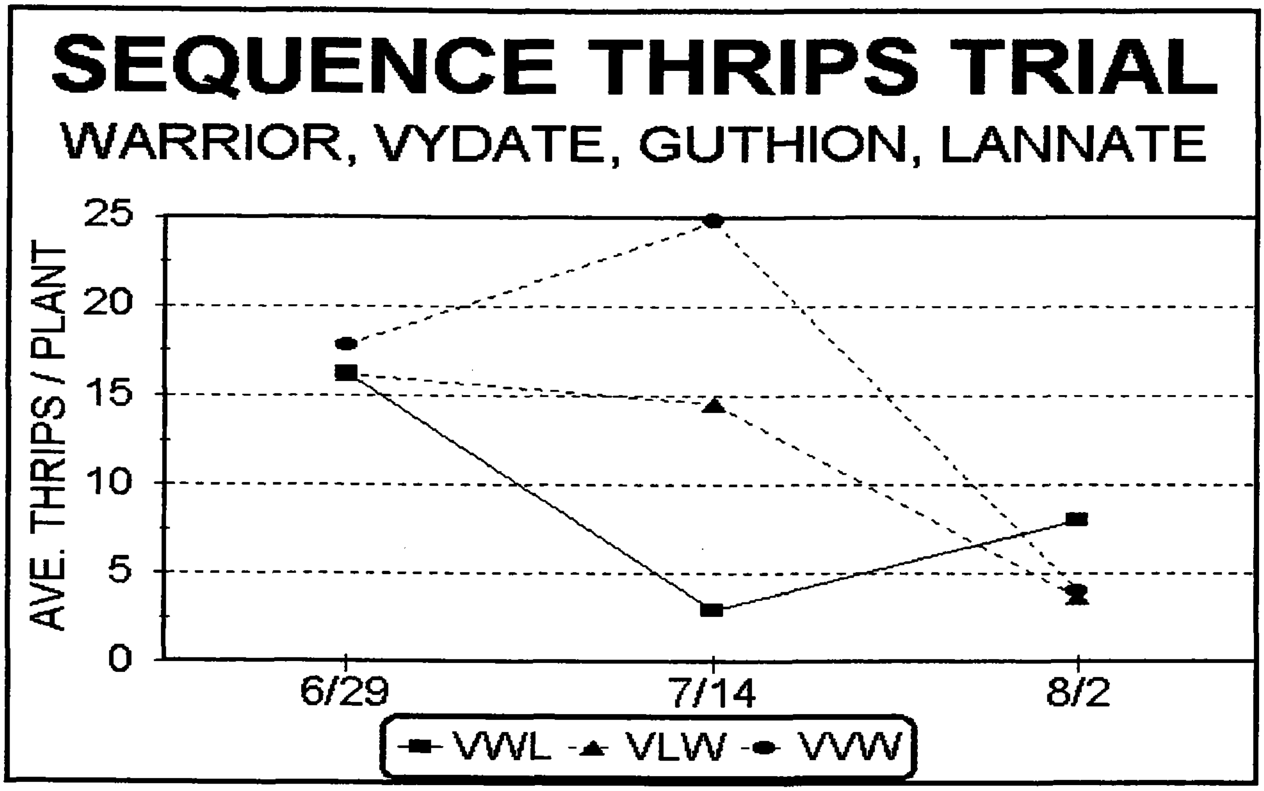


Figure 3. Sequence Thrips Trial. Nyssa, OR. 1995



THRIPS EFFECTS ON FOURTEEN SWEET SPANISH ONION VARIETIES

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Objectives

Onion thrips were either controlled or left untreated to examine the economic importance of thrips. Fourteen different varieties were tested to examine the susceptibility of varieties to thrips.

Materials and Methods

The trial was conducted on the Malheur Experiment Station near Ontario. The fourteen varieties were planted in 23 foot rows spaced 22 inches apart. Each plot consisted of eight rows with four contiguous rows of each plot sprayed to keep thrips populations low and four adjoining rows unsprayed. The trial was a split plot design with four replications in a completely randomized block design. The sprayed treatments received four applications of Warrior insecticide at 0.03 ai/ac. The unsprayed plots were not treated and all thrips counts made in the center two rows of these plots.

The plots were planted on April 17 using a cone seeder mounted on a John Deere model 71 flexi-planter equipped with disc openers. Seed for each row was prepackaged using enough seed for a planting rate of 12 seeds per foot of row. The onions were thinned to a population of 4 plants per foot of row when the onions were in the flag leaf stage. Weed control was with Dacthal applied on April 14 at a rate of 4 lbs a.i./ac. A post emergence application of Buctril at 12 oz/ac, Goal at 12 oz/ac and Poast at 20 oz/ac was made on June 12. A second post emergence application of 12 oz Buctril, 5 oz Goal and 16 oz Poast was made on June 16. Prowl at 48 oz/ac was also made at that time and incorporated by cultivation. The onions were sidedressed on June 6 with 180 pounds of osmocote time release nitrogen.

Irrigation was every 4-5 days except that problems during the first part of the growing season kept the onion field dryer than would normally be recommended. The plants were under stress during this time which may have caused some yield reduction. The yield reduction would have been uniform across sprayed and unsprayed plots.

Thrips counts were made on June 27, July 7 and July 20 by counting the total number of thrips on fifteen plants in each plot. The counts were made in only two replications on July 20 because of the extremely high counts and the time involved in making the counts.

The onions were harvested on September 27 and graded on October 24. The onions were graded by size but no attempt was made to separate number 1's and 2's.

Results

The average thrips counts for each reading date are given in Table 1. There was a seasonal trend in thrips populations among varieties, with Pinnacle having among the lowest average number of thrips and Valient among the highest.

Table 1. Thrips populations among 14 sweet Spanish onion varieties during the growing season in plots without thrips control. Malheur Experiment Station, Ontario, Oregon. 1995.

	Average thrips/plant			
Variety	6/27	7/7	7/20	Season average
Valient	38.5	91.3	233.8	121.2
Tango	16.5	72.5	263.1	117.4
Valdez	14.9	81.2	239.8	112
Bullring	20.5	87.7	227	111.7
Vega	18.9	92.8	221.3	111
Oro Grande	16	77.3	232.2	108.5
Vacquero	27.3	101.7	182.3	103.8
Blanco Duro	14	84.7	206	101.6
Sweet Amber	20.4	77.9	197.7	98.7
Winner	15	76.6	190.6	94.1
Apex	23.8	70	156.2	83.3
Cache	25	68.6	153.3	82.3
Bravo	16	85.7	132	77.9
Pinnacle	25.5	53.8	119.8	66.4
LSD (0.05)	12.4	ns	ns	

Since only two replications were counted on the last date, differences in thrips population may be due to field location or factors other than variety. It appears that some varieties have high thrips populations early compared to other varieties but lower populations later in the summer.

Total yield losses without thrips control ranged from 10.6 percent for Vacquero to 38.6 percent for Tango (Table 2). The thrips damage to Tango onions is consistent with growers' belief that red onions are more sensitive to thrips damage than yellow varieties, although the yellow varieties varied widely in the amount of yield reduction. Since there is usually a premium paid to growers for the larger onion sizes, the economic importance of thrips on size reduction is greater than that of yield. Failure to control thrips caused a jumbo loss of 139 cwt/ac or 29.9 percent (Table 3).

Table 2. Effect of thrips on yield in 14 varieties of sweet Spanish onions. Malheur Experiment Station, Ontario, Oregon. 1995.

Variety	Total yield		Yield loss without thrip control	
	Sprayed	Unsprayed	Difference	
	---- cwt/ac ----		cwt/ac	%
Vacquero	551.6	493.2	58.4	10.6
Oro Grande	488.6	418.4	70.2	14.4
Blanco Duro	456.6	372.9	83.7	18.3
Sweet Amber	618.8	501.5	117.3	19. 0
Pinnacle	363.6	292.1	70.7	19.4
Apex	503.1	398.2	104.9	20.9
Cache	561.5	436.4	125.1	22.3
Vega	635.3	493.3	142	22.4
Bravo	782. 0	597.1	184.9	23.6
Valdez	621.3	474.3	147. 0	23.7
Bullring	471.6	354.8	116.8	24.8
Valient	463.3	336.8	126.5	27.3
Winner	642.6	458.7	183.9	28.6
Tango	242.2	148.8	93.4	38.6
LSD (0.05) variety	41.2	15.8		
Mean insecticide	528.8	412.7	116.1	22
LSD (0.05) insecticide	17.4			
LSD (0.05) var x insecticide	ns			

Table 3. Effects of thrips on jumbo/colossal sized onion bulbs of 14 varieties of Spanish type onions. Malheur Experiment Station, Ontario, Oregon. 1995.

Variety	Colossal/Jumbo Yield - Cwt/ac			
	Sprayed	Unsprayed	Difference	
	---- cwt/ac ----		cwt/ac	%
Vacquero	523.2	430.8	92.4	17.7
Sweet Amber	587.3	455.6	131.7	22.4
Oro Grande	445.8	339.9	105.9	23.8
Vega	599.7	446.3	153.4	25.6
Bravo	756.2	562	194.2	25.7
Apex	459.2	338.3	120.9	26.3
Winner	589.3	417.9	171.4	29.1
Valdez	586.8	413.7	173.1	29.5
Cache	518.6	361.6	157	30.3
Blanco Duro	395.7	272.2	123.5	31.2
Bullring	426.1	282. 0	144.1	33.8
Valient	405.5	259.8	145.7	35.9
Pinnacle	287.7	167.4	120.3	41.8
Tango	160.1	48. 0	112.1	70. 0
LSD (0.05) variety	16.1	14.7		
Mean overall insecticides	481.5	342.5	139. 0	28.9
LSD (0.05) insecticide	18.2			
LSD (0.05) var x insecticide	ns			

NITROGEN FERTILIZATION FOR DRIP-IRRIGATED ONIONS

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Introduction

Nitrogen fertilizer applied through subsurface drip irrigation tape has the potential to be more efficient than nitrogen fertilizer applied broadcast, sidedressed, or water run in a furrow irrigated field. Crop nitrogen applications with drip irrigation could be reduced compared to furrow irrigation as a result of the higher application efficiency. Onion production with subsurface drip irrigation has been tested at the Malheur Experiment Station since 1992. The optimum N fertilization practices for subsurface drip irrigated onions is unknown. The objective of this trial was to determine the optimum N rate for drip irrigated onions to maximize yield and quality. The trial would need to be repeated several years to develop production guidelines.

Procedures

The trial was conducted on a Owyhee silt loam previously planted to wheat at the Malheur Experiment Station, Ontario, OR. The experimental site had reduced topsoil due to leveling operations several decades ago and had received little chemical fertilizer during the last decade. A soil sample taken from the top foot on March 8, 1995 showed a pH of 7.8, 1.2 percent organic matter, 17 meq per 100 g of soil of cation exchange capacity, 6 ppm nitrate-N, 7 ppm ammonium-N, 20 ppm phosphorus, 429 ppm potassium, 10640 ppm calcium, 469 ppm magnesium, 434 ppm sodium, 1.1 ppm zinc, 8.5 ppm iron, 9 ppm manganese, 1.7 ppm copper, and 0.4 ppm sulfate-S.

On April 5, the field was goundhogged following the broadcast application of 200 lb of phosphate as 0-46-0 and 15 lb of zinc as zinc sulfate. The field was made into 64-inch beds (88-inch centers) and 8 mm black polyethylene drip tapes were laid in a single pass on April 6. In each bed three drip tapes were spaced 24 inches apart and buried 4 inches deep. Each drip tape serviced 3 onion rows. The beds were remade on April 12 using a bed harrow and roller. Onions (cv. Vision) were planted in 9 single rows spaced 8 inches apart in each bed on April 13. Onions were planted with nine Beck Precision Planters (Mel Beck Precision Planters, Nyssa, OR) mounted 8 inches apart on a tool bar. Onions were planted at 200,000 plants/ac (3.21 inches/seed).

The seven N rates ranged from 0 to 300 lb N/ac in 50 lb N/ac increments. The nitrogen for each treatment was split into five equal amounts (Table 1). The N treatments were applied as uran on May 24, June 9, June 16, June 29, and July 7. Treatments were replicated five times and were arranged in a randomized complete block design.

Individual plots were 3 beds wide and 40 feet long. Fertilizer solutions were applied through the drip lines with a venturi injector unit (Mazzei injector Model 287) in each plot.

The trial was drip irrigated for 12 hours on April 19, 8 hours on April 22, and 11 hours on April 27 in order to assure uniform emergence. At each pre-emergence irrigation, the wetting front reached just beyond the 2 onion rows that were 8 inches to each side of each drip line. Onions started emerging on May 1.

Soil water potential in each plot was monitored by two granular matrix sensors (Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) placed 8 inches below, and one sensor placed 18 inches below one of the onion rows that was 8 inches to the side of a drip tape. The sensors were connected to a datalogger. The datalogger was programmed to read the sensors 8 times per 24 hours and, if necessary, irrigate the trial. The trial was irrigated to maintain a constant average 8-inch soil water potential of -20 kPa by applying 0.06 inch of water up to 8 times in the 24 hour period. The irrigations were controlled by a solenoid valve connected to the datalogger. The pressure in the drip lines was maintained at 10 psi by a pressure regulator in each plot. Drip tape flow rate was 0.3 gal/min/100 ft at 10 psi with emitters spaced 12 inches apart (Turbulent Twin-Wall, Chapin Watermatics, Watertown, NY). The amount of water applied was measured by a water meter read daily. Irrigations were terminated on September 11. Onion evapotranspiration (Et_c) was measured by an AgriMet weather station at the Malheur Experiment Station.

Ten plants from the border rows in each plot were sampled for nutrient analyses on June 28, July 18, August 2, and August 23. The plants were washed, the roots were analyzed for nitrate-N, phosphate-P, K, and sulfate-S, and the leaves were analyzed for micronutrients by Tremblay Consulting of Jerome, Idaho. Ten plants from the border rows in each plot of three replicates were sampled, weighed fresh, dried, weighed and analyzed for nitrogen content on September 2. When the plant tissue indicated P deficiency in onions in some of the plots, phosphoric acid at 3 lb P/ac was applied on August 11, August 16, and August 30 to all of the plots.

The field was sprayed with Roundup at 1.5 pint/ac (10 oz ai/ac) on April 25 to kill emerging weeds. Post-emergence weed control was obtained by the application of Buctril at 10 oz/ac (3.3 oz ai/ac) and Poast at 16 oz/ac (2.9 oz ai/ac) on May 20 and by the application of Goal at 10 oz/ac (1.9 oz ai/ac), Buctril at 12 oz/ac (4 oz ai/ac), and Poast at 16 oz/ac (2.9 oz ai/ac) on May 30, June 10, and July 5.

The onions were lifted on September 25. On September 29 the onions in the central 30 feet of the middle bed in each plot were topped, bagged, and placed into storage. The onions were graded out of storage on December 14. Bulbs were graded according to their diameters: small (<2.25 inches), medium (2.25-3 inches), jumbo (3-4 inches), and colossal (>4 inches). Split bulbs were graded as Number Two's regardless of diameter. Marketable onions were considered perfect bulbs in the medium, jumbo, and colossal size classes. Bulb counts for all replicates of the 100 lb N/ac treatment were made during grading in order to determine the actual plant population.

The soil was sampled in one foot increments down to six feet in each plot before planting and after harvest and analyzed for nitrate and ammonium. The N balances were calculated by subtracting the post harvest accounted nitrogen (crop N uptake plus available soil N after harvest) from the nitrogen supply (available soil N in spring plus fertilizer N plus N from irrigation water plus N from organic matter mineralization). Nitrogen contribution from the irrigation water was estimated to be 2.3 lb N/ac-inch/ac of water infiltration. Nitrogen contribution from organic matter mineralization was estimated by anaerobic incubation at 104 °F for 7 days.

Results and Discussion

Onion emergence was excellent. Onion growth and development continued until irrigation was cut off in early September. The crop suffered hail damage on June 16, June 19, and July 29. Environmental conditions were poor for onion bulb curing; there were several small rainfall events followed with very slow drying. Storage conditions were warmer and more humid than the ideal, especially in November.

The root nitrate concentrations were consistent with the N rates (Figure 1). The estimated critical root nitrate concentrations were very close to the root nitrate profile for the 100 lb N/ac treatment (Figure 1). In spite of low soil nitrate and ammonium levels at planting, and in spite of low nitrate concentrations in the onions receiving no nitrogen fertilizer, onion yields were not very responsive to nitrogen fertilization (Table 1). The limited of response of onion yield to the N rates could have been caused by N supplied from N mineralization.

Water applications over time exceeded crop evapotranspiration (Figure 2) resulting in 37 acre-inches of applied water (irrigation plus precipitation) and 27 acre-inches of Et_c. Soil water potential at 8-inch depth remained close to -20 kPa except for a brief period in late August (Figure 3). Datalogger programming problems made it necessary to manually operate the irrigations during parts of the season. The soil water potential oscillations could have been less if the automated irrigation system had run continuously.

By mid December, nitrogen fertilizer was associated with lower total marketable yields out of storage. Increased N fertilizer rates were detrimental in the 1995 drip irrigated onion trial, leading to both increased storage rot and decreased marketable onion yield by mid December (Tables 1 and 2). Trials need to be repeated several years in different fields and different environmental conditions to provide recommendations for growers.

The results of the adjoining trial to determine the optimum plant population for drip irrigated onions indicated that plant populations above 125,000 plants/ac are detrimental to onion yield and quality. The plant population used in this trial (204,930 plants/ac) was probably excessive, contributing to high storage rot at all N rates. Due to the high plant populations used in this trial, the detrimental effects on N fertilizer alone on onion storage quality in 1995 are difficult to determine. Nitrogen fertilizer rates for drip irrigated onions need further examination at plant populations closer to 125,000 plants per acre.

It is difficult to determine the exact causes of high losses in storage in this trial. The 1995 crop was late maturing and had an late irrigation cut off date. The three hail occurrences hurt the crop and may have further delayed maturity. The warmer and more humid storage conditions in November also was a complicating factor in bulb decomposition.

N mineralization supplied substantial amounts of available-N during the season (Tables 3 and 4). N balances were negative for all treatments and increased with increases in N rate (Tables 3 and 4). A negative N balance indicates a probable loss of N through leaching or volatilization. Since water applications plus rainfall were higher than crop water use, the substantial N losses could have been due to leaching. Substantial rainfall events during the 1995 season made it difficult to maintain wet soil for optimum onion production yet avoid soil nitrate leaching. Since water applications were uniform for all plots, the N balances emphasize the losses of N fertilizer and the importance of avoiding over application of N fertilizer.

Figure 1. Onion root nitrate concentration over time for onions subjected to seven N rates applied through the drip irrigation tape. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

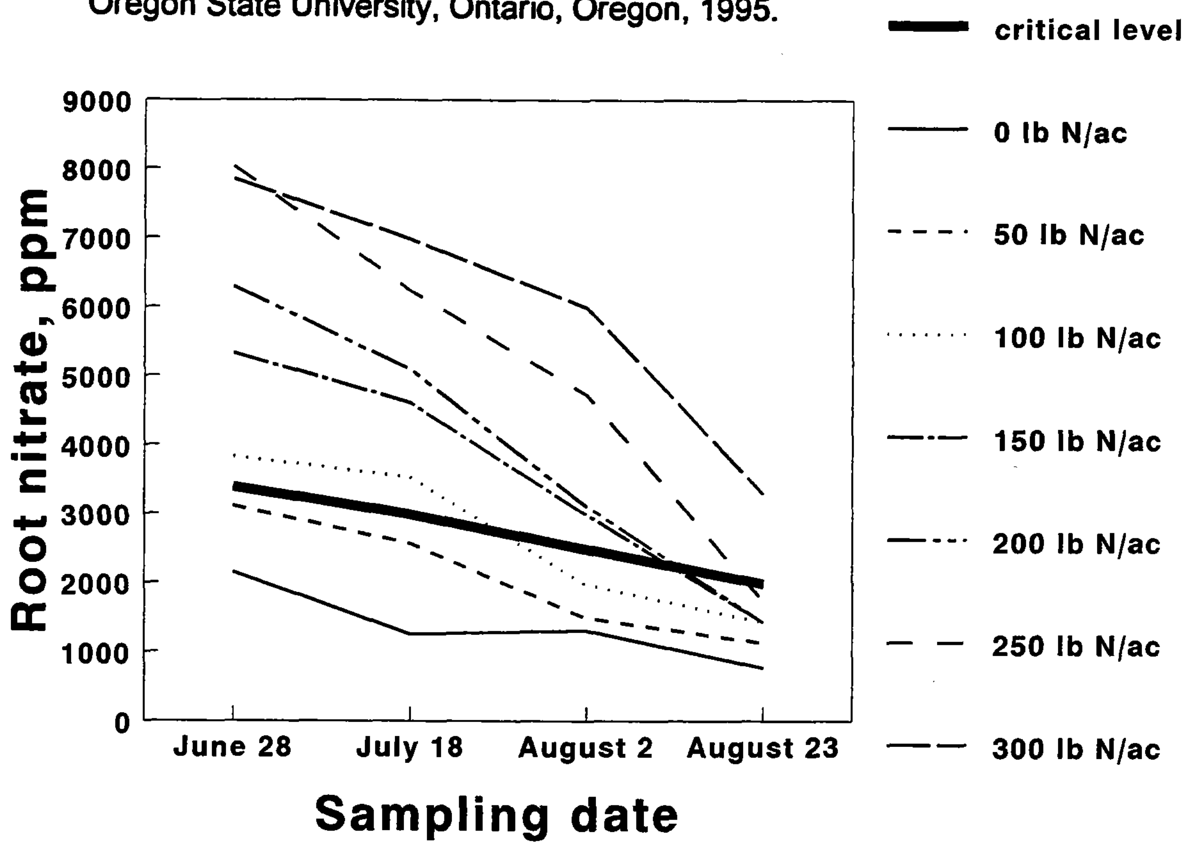

Table 1. Onion yield response to N rates under drip irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

N rate	N per application	Yield by market grade					Total yield	Marketable	Rot
		#2	Small	Medium	Jumbo	Colossal		medium to colossal	
lb N/ac	lb N/ac	------- cwt/ac -------					cwt/ac	---- cwt/ac ---	
0	0	3.8	51.6	201.0	619.4	8.6	884.4	587.0	258.5
50	10	9.9	46.2	190.9	666.0	5.4	918.4	541.3	342.5
100	20	7.3	49.2	187.0	704.8	11.0	959.3	474.9	456.5
150	30	25.5	25.5	169.0	720.9	10.4	951.3	306.6	628.7
200	40	16.3	32.2	165.1	759.5	9.3	982.3	376.7	585.9
250	50	13.9	33.0	164.5	706.1	6.0	923.5	353.3	551.9
300	60	26.1	28.4	154.5	742.9	13.1	965.0	332.3	612.5
LSD (0.05)		ns	16.8	30.5	86.8	ns	ns	117.3	139.6

Table 2. Onion market grade distribution response to N rates under drip irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

N rate	Market grade distribution by weight					Marketable	Rot
	#2	Small	Medium	Jumbo	Colossal	medium to colossal	
lb N/ac	---------- % ----------					--- % ---	
0	0.4	5.8	22.8	70.0	1.0	66.3	29.3
50	1.1	5.0	20.8	72.5	0.6	59.2	37.0
100	0.8	5.1	19.5	73.5	1.1	50.4	46.6
150	2.7	2.7	17.9	75.5	1.1	31.9	66.4
200	1.6	3.3	16.8	77.4	0.9	38.6	59.4
250	1.5	3.5	17.7	76.6	0.7	38.4	59.7
300	2.7	2.9	16.0	77.0	1.4	34.4	63.5
LSD (0.05)	ns	1.8	3.4	4.9	ns	12.5	13.1

Figure 2. Cumulative water applied (includes precipitation) and onion evapotranspiration. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

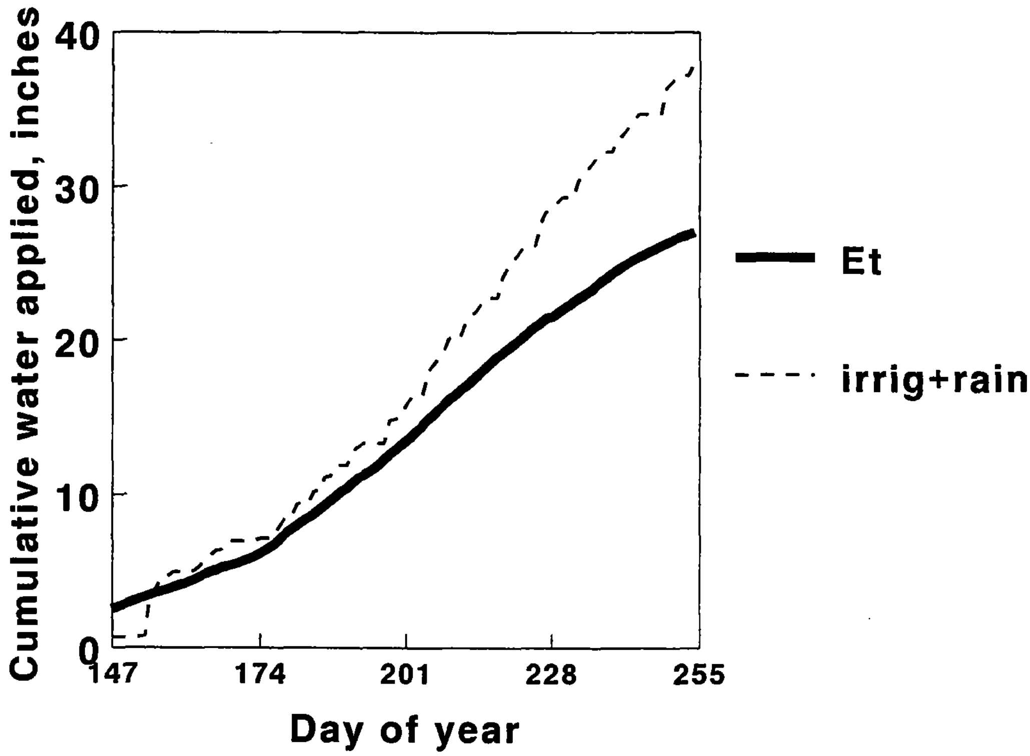

Figure 3. Soil water potential over time at 8-inch depth for drip irrigated onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

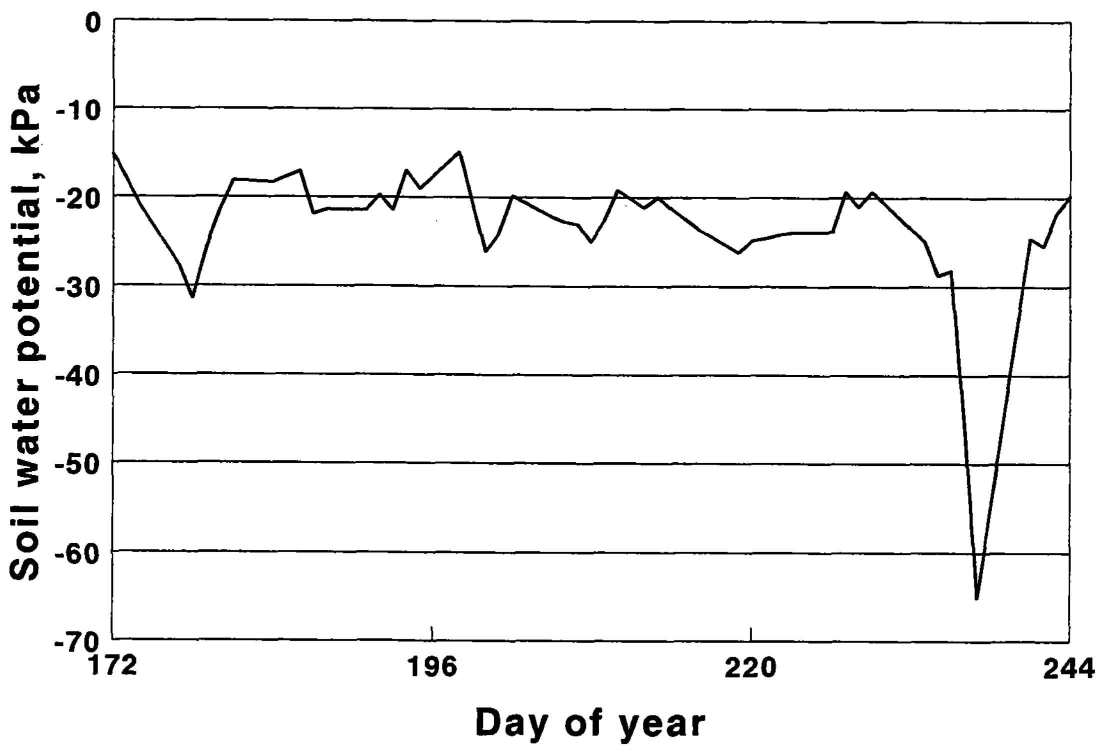

Table 3. Influence of N rate on seasonal available nitrogen accounting in onions and in the soil profile. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

N rate	N supply				Fall nitrogen accounting			Balance*
	Pre-plant soil available N (0-6')	Fertilizer N	N in irrigation water	Estimated N mineralization	Fall soil available N (0-6')	Plant N recovery	Accounted N	
lb N/ac	——— lb/ac ———							
0	276.7	0	78.8	115.5	169.5	160.7	330.2	-140.8
50	276.7	50	78.8	115.5	166.8	149.5	316.2	-204.8
100	276.7	100	78.8	115.5	170.2	163.1	333.2	-237.8
150	276.7	150	78.8	115.5	170.4	166.8	337.3	-283.8
200	276.7	200	78.8	115.5	164.7	181.2	345.9	-325.2
250	276.7	250	78.8	115.5	198.0	172.0	370.0	-351.1
300	276.7	300	78.8	115.5	209.6	169.9	379.5	-391.6
LSD (0.05)					ns	ns	ns	-50.9

* based on the difference between N supplies and fall N accounting.

Table 4. Influence of N rate on seasonal available nitrogen accounting in onions and in the top two feet of soil. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

N rate	N supply				Fall nitrogen accounting			Balance*
	Pre-plant soil available N (0-2')	Fertilizer N	N in irrigation water	Estimated N mineralization	Fall soil available N (0-2')	Plant N recovery	Accounted N	
lb N/ac	——— lb/ac ———							
0	76.2	0	78.8	115.5	45.5	160.7	206.2	-64.3
50	76.2	50	78.8	115.5	43.0	149.5	192.4	-128.1
100	76.2	100	78.8	115.5	57.2	163.1	220.3	-150.2
150	76.2	150	78.8	115.5	66.7	166.8	233.6	-186.9
200	76.2	200	78.8	115.5	51.7	181.2	232.9	-237.6
250	76.2	250	78.8	115.5	61.5	172.0	233.4	-287.1
300	76.2	300	78.8	115.5	66.4	169.9	236.3	-334.3
LSD (0.05)					17.3	ns	28.3	-28.3

* based on the difference between N supplies and fall N accounting.

PLANT POPULATION FOR DRIP-IRRIGATED ONIONS

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Summary

Onions were grown with subsurface drip irrigation with narrow row spacings on wide beds at 8 plant populations. Plant populations varied from 75,000 to 250,000 plants per acre. A plant population of 125,000 plants/ac maximized onion yield and economic return.

Introduction

The improved water application efficiency with subsurface drip irrigation allows for narrower onion row spacings and higher per acre yields. Onion production on narrow row spacings (8 inches apart) on wide beds (88 inches between centers) with subsurface drip irrigation has been tested at the Malheur Experiment Station since 1993. The optimum plant populations for drip irrigated onions was not known. The objective of this trial was to determine the optimum plant population for wide bed, drip-irrigated onions to maximize onion yield and quality and economic return to the grower.

Procedures

The trial was conducted on a Owyhee silt loam previously planted to wheat at the Malheur Experiment Station. The experimental site had reduced topsoil due to leveling several decades ago. The site has received little chemical fertilizer during the last decade. A soil sample taken from the top foot on March 8, 1995 showed a pH of 7.6, 1.3 percent organic matter, 18 meq per 100 g of soil of cation exchange capacity, 6 ppm nitrate-N, 5 ppm ammonium-N, 23 ppm phosphorus, 432 ppm potassium, 6344 ppm calcium, 436 ppm magnesium, 418 ppm sodium, 1 ppm zinc, 2.3 ppm iron, 10.7 ppm manganese, 0.9 ppm copper, and 0.5 ppm sulfate-S. On April 5, the field was groundhogged following the broadcast application of 200 lb of phosphorus as 0-46-0 and 15 lb of zinc as zinc sulfate.

The field was made into 64-inch beds (88-inch centers) and 8 mm black polyethylene drip tapes were laid on April 6. In each bed three drip tapes were spaced 24 inches apart and buried 4 inches deep. Each drip tape serviced 3 onion rows. The beds were remade on April 12 using a bed harrow and roller. Onions (cv. Vision) were planted on 9 single rows spaced 8 inches apart in each bed on April 13. Onions were planted with nine Beck Precision Planters (Mel Beck Precision Planters, Nyssa, OR) mounted 8 inches apart on a tool bar.

Onions were planted at 8 seeding rates in order to achieve the 8 plant populations (Table 1). The 8 plant populations were arranged in a randomized complete block design with 5 replicates. Plots were 3 beds wide and 40 feet long.

The trial was drip irrigated for 12 hours on April 19, 8 hours on April 22, and 11 hours on April 27 in order to assure uniform emergence. At each pre-emergence irrigation, the wetting front reached just beyond the 2 onion rows that were 8 inches to each side of each drip tape. Onions started emerging on May 1. Onions were irrigated by the same method as described in the preceeding report "Nitrogen fertilization for drip-irrigated onions," but with an independent set of controls.

Uran nitrogen fertilizer was applied at 25 lb N/ac on May 11, May 22, June 9, July 3, July 14, and July 19 (total of 150 lb N/ac). Fertilizer solutions were applied through the drip tape via venturi injectors (Mazzei injector Model 1078). Plants were sampled from the field for nutrient analyses on June 28, July 18, August 2, and August 23. The plants were washed, the roots were analyzed for nitrate-N, phosphate-P, K, sulfate-S, and the most recently developed nearly fully expanded leaves were analyzed for micronutrients by Tremblay Consulting of Jerome, Idaho. Phosphoric acid at 3 lb P/ac was applied on August 11, August 16, and August 30 after plants became marginally P deficient.

Weeds were controlled and onions were harvested and graded as in the nitrogen rate trial for drip irrigated onions above. Bulb counts for each plot were made during grading. Gross economic returns were calculated by crediting medium onions with $2.50/cwt, jumbo onions with $5.00/cwt, and colossal onions with $10.00/cwt.

Results and Discussion

Onion emergence in the irrigation trial was excellent. Onion growth and development continued until irrigation was cut off in early September. The crop suffered hail damage on June 16, June 19, and July 29. Environmental conditions were poor for onion bulb curing; there were several small rainfall events followed with very slow drying. Storage conditions were warmer and more humid than the ideal, especially in November.

Actual plant populations were close to the planned treatment levels (Table 1). Total yield increased with plant population up to 125,000 plants/ac (Table 2). The highest colossal onion yield was achieved with the lowest plant population of 75,000 plants/ac. The yield of Jumbo onions increased with plant population up to 125,000 plants/ac.

Plant populations higher than 125,000 plants/ac resulted in a significant increase in storage rot. Plant populations higher than 125,000 plants/ac resulted in an increase in the proportion of storage rot and in a decrease in the proportion of marketable onions (Table 3). When plant populations are high, water is retained between plants.

Evaporation of free water from leaf surfaces is hampered since air circulation is reduced between plants. Retention of water on the leaves and bulbs favors the development of disease organisms. Disease development is also favored with high plant populations because an excessive amount of tops covered the bulbs after lifting, hindering the curing process.

Gross returns increased with plant population up to 125,000 plants/ac then decreased with further increases in plant population (Table 2). It is difficult to determine the exact causes of high losses in storage in this trial. The 1995 crop was late maturing and had a late irrigation cut off date. The three hail occurrences hurt the crop and may have further delayed maturity. The warmer and more humid storage conditions in November also was a complicating factor in bulb decomposition.

Conclusions

A plant population of 125,000 plants/ac maximized total yield, jumbo onion yield, the proportion of marketable onions, and gross economic returns with subsurface drip irrigation. Plant populations higher than 125,000 plants/ac resulted in significant increases in storage rot.

Table 1. Planned and achieved onion plant populations. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Plant population	In-row seed spacing	Plant population counted
plants/ac	inches	plants/ac
75,000	8.55	76,547
100,000	6.40	101,020
125,000	5.13	133,072
150,000	4.28	143,649
175,000	3.67	180,147
200,000	3.21	204,138
225,000	2.85	222,626
250,000	2.57	261,063
LSD (0.05)		7,759

Table 2. Effect of plant population on onion yield. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Plant population	Yield by market grade						Rot	Marketable medium to colossal	Gross return
	#2	Small	Medium	Jumbo	Colossal	Total yield			
plants/ac	------ cwt/ac ------						---- cwt/ac ----		US. $/ac
75,000	73.3	1.1	3.6	462.0	211.1	751.0	223.6	476.9	4,430.00
100,000	52.5	3.7	16.4	632.9	138.6	844.1	309.8	499.9	4,591.50
125,000	23.0	5.7	37.3	743.1	158.5	967.6	320.0	628.9	5,393.75
150,000	48.3	7.9	55.7	767.8	87.9	967.6	514.0	430.4	4,857.25
175,000	28.7	15.3	103.5	820.9	39.2	1007.6	501.3	485.2	4,755.25
200,000	26.5	38.8	181.4	733.5	17.1	997.3	542.0	426.6	4,292.00
225,000	30.5	52.4	213.3	700.0	23.7	1019.8	576 .0	409.1	4,270.25
250,000	42.3	89.2	304.8	583.3	17.3	1036.9	567.3	410.9	3,851.50
LSD (0.05)	27.5	21.5	51.2	125.0	62.8	53.2	109.3	ns	

Table 3. Effect of plant population on onion market grade distribution. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Plant population	In-row seed spacing	Market grade distribution by weight					Rot	Marketable medium to colossal
		#2	Small	Medium	Jumbo	Colossal		
plants/ac	inches	——— % ———						
75,000	8.55	9.8	0.1	0.5	61.4	28.2	29.6	63.6
100,000	6.40	6.1	0.5	2.0	74.9	16.5	37.0	59.0
125,000	5.13	2.4	0.6	3.9	76.9	16.3	33.2	64.9
150,000	4.28	5.0	0.8	5.8	79.4	9.1	53.1	44.5
175,000	3.67	2.9	1.5	10.3	81.5	3.9	49.8	48.1
200,000	3.21	2.6	4.2	19.1	72.5	1.7	54.7	42.4
225,000	2.85	3.0	5.1	21.0	68.6	2.3	56.6	40.0
250,000	2.57	4.1	8.6	29.5	56.1	1.6	54.9	39.5
LSD (0.05)		3.1	2.5	6.4	12.1	7.9	11.3	11.7

WEED CONTROL AND CROP TOLERANCE OF ONIONS TO HERBICIDES APPLIED POSTPLANT PREEMERGENCE AND AS MULTIPLE POSTEMERGENCE APPLICATIONS TO SEEDLING ONIONS

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Purpose

Several different herbicides were applied singly and in tank-mix combinations at various rates and timing of applications to identify herbicide treatments which were most effective for weed control and crop safety.

Procedures

Seed of Vision variety of yellow sweet Spanish onions was planted on April 16 in silt loam textured soil. The soil was mold-board plowed and bedded in October of 1994. Stephens wheat was the crop before planting onions. The soil pH was 7.3 and had 1.2 percent organic matter. On April 5 the beds were harrowed with a spike-tooth bed-harrow and the onions planted in double rows 2 1/4 inches apart on single beds spaced 22 inches apart. Individual plots for all treatments were four rows wide and 25 feet long. All treatments were replicated three times in blocks using a randomized complete block experimental design.

After planting, the trial area was watered by furrow irrigation to furnish soil moisture for seed germination and plant emergence. Prowl preemergence herbicide treatments were applied at rates of 1.0, 1.5, and 2.0 lb ai/ac on May 2, when the onion seedlings were about 0.5 inch below the soil surface. On May 2 the air temperature was 58°F when spraying, and the wind was blowing from the west at 2 to 3 mph. The skies were overcast, and the soil was moist on the surface.

On May 18 the early postemergence applications were applied to flag leaf onions in this trial to compare preemergence treatments with early postemergence treatments for weed control and crop tolerance. The early postemergence treatments consisted of Prowl, Dual, or Frontier herbicides tank-mixed with Buctril, Nortron, and Prism herbicides and applied to onions with a fully developed flag leaf.

Weed species in the plots treated with postemergence applied herbicides were redroot pigweed, lambsquarters, kochia, hairy nightshade, and barnyardgrass. Broadleaf weed species ranged in size from cotyledon leaf weeds to weeds with 4-true leaves. Barnyardgrass had one to three leaves. Buctril, Nortron, and Prism rates were 0.15, 0.25, and 0.05 lb ai/ac, respectively. Prowl rates were 1.5 and 2.0 lb; Dual rate was 2.0

lb; and Frontier was 1.17 and 2.34 lb ai/ac. Prowl, Dual, and Frontier herbicides were soil activated with 1.41 inches of rain water which fell on six different days from May 3 to May 16. The most rainfall occurring in a single 24-hour period was 0.48 inches which fell on May 2 and again on May 6. On June 1 the onions previously treated with preemergence and early postemergence were sprayed with a final postemergence treatment containing Buctril, Goal, Nortron, and Prism at rates of 0.15, 0.05, 0.25, and 0.05 lb ai/ac, respectively.

In a second trial, herbicide treatments were begun as repeat applications to seedling onions in the flag leaf and 1-true leaf stage of growth. The treatments applied to onions with flag leaves were applied on May 18. The flag leaves were fully developed on all plants, and about 20 percent of the onions had a true leaf about 1 inch long. On May 18, when these treatments were applied, the air temperature was 74°F; soil temperature at 4 inches was 68°F. Wind was blowing at 2 to 3 mph from the west, and the skies were mostly clear. The first herbicide treatments applied to onion plants with 1 true leaf were made on May 24. On May 24 the air temperature was 76°F; the soil temperature at 4 inches was 73°F. The skies were partly cloudy, and wind was 2 mph from the northwest.

The weed species in the postemergence trials included kochia, redroot pigweed, hairy nightshade, lambsquarters, annual sowthistle, and barnyardgrass. When the onions were flag leaf, the weeds were small, ranging in size from cotyledon to four true leaves. The plants with four true leaves had rosettes 1-inch across. When the onions had one true leaf, the weeds had grown to a height of 2 to 4-inches with pigweed, nightshade, and annual sowthistle measuring 2-inches across rosettes. The larger barnyardgrass was three leaves and one tiller. Each trial received a total of 3 applications. The second and third applications were applied 10 and 24 days after the initial application.

All herbicides were applied with a single bicycle wheel plot sprayer. The spray boom had four nozzles with a nozzle centered over each row of the plot. Spray nozzles were Teejet fan size 6502. Spray pressure was 42 psi, and water as the herbicide carrier was applied at 19.5 gal/ac. Each plot was 4 rows wide and 25 feet long. Treatments were replicated three times using a randomized strip-type experimental design.

Results and Discussion

Postplant preemergence applications of Prowl gave good weed control without causing injury to the emerging onion plants. Weed control improved as the rate of Prowl was increased from 1.0 lb to 1.5 lb to 2.0 lb ai/ac. Prowl at 1.5 lb ai/ac controlled about 90 percent pigweed, lambsquarters, kochia, and barnyardgrass, 75 percent control of hairy nightshade, and 15 to 20 percent control of sow thistle. Prowl tank-mixed with Buctril/Nortron/Prism and applied postemergence to flag leaf onions controlled all weeds that emerged with the onions (Table 1). Two repeat applications of Buctril/Nortron/Prism applied 10 and 24 days after the initial application and the soil residual from Prowl kept the onions free of weeds until harvest. Seedling onions were tolerant of Frontier applied with Buctril/Nortron/Prism to flag leaf onions. Frontier did give residual weed control similar to Prowl. Dual applied to flag leaf onions caused injury to the onion plants. Injury symptoms began to show three to four weeks after Dual was applied. Onions with three or more leaves are tolerant to Dual applied at 2 lb ai/ac.

The better treatments in the postemergence trials included tank-mixes containing Prowl/Buctril/Nortron and Poast applied to the flag leaf onions at the respective rates of 1.5, 0.15, 0.25, and 0.1 lb ai/ac. Herbicides applied at the flag leaf gave better weed control than did herbicide applications delayed until onions had one true leaf. Repeat applications of these herbicides without Prowl as new weeds emerged gave season long weed control. Goal tank-mixed with Buctril/Nortron and applied to onions with true leaves can improve control of pigweed too large for control with Buctril. Prism herbicide gave excellent control of barnyardgrass applied alone or in tank-mix combination with Buctril/Nortron. Upbeet caused severe onion injury and did not control weeds effectively. Onion tolerance was not adequate with the emulsifiable formulation of Tough. Onions were more tolerant to the wettable powder formulation of Tough, but Tough treatments were consistently inferior to the Buctril/Nortron tank mixes (Tables 2 and 3).

Table 1. Percent crop injury and weed control from herbicides applied as postplant preemergence and postemergence applications to onions with a flag leaf. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Crop injury			Percent weed control: Pigweed			Lambsquarters			H. Nightshade			Kochia			A. Sowthistle			Barnyardgrass		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		%			%																	
Prowl	1. 0	Pre	0	0	0	85	90	85	90	85	85	65	70	70	85	85	85	0	0	0	85	95	90
Prowl	1. 5	Pre	5	5	5	90	90	90	90	90	90	70	80	80	90	95	90	15	20	15	90	100	100
Prowl	2. 0	Pre	10	10	5	90	95	95	85	90	90	70	85	85	90	95	95	20	20	15	95	100	95
Prowl[1]	1. 5	Post	0	5	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Prowl[1]	2. 0	Post	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Dual[1]	2. 0	Post	40	60	30	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Frontier[1]	1. 17	Post	5	10	5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Frontier[1]	2. 34	Post	10	15	5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Untreated check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] Herbicide tank-mixed with Buctril, Nortron, and Prism.

Evaluated June 12.

Table 2. Crop tolerance and weed control ratings for herbicides applied as repeat applications beginning when onion plants were flag leaf. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

		Crop injury			Percent weed control: Pigweed			Lambsquarters			H. Nightshade			Kochia			Sowthistle			Barnyardgrass		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	%			%																	
Buctril + Prowl + Poast	0.1 + 1.5 + 0.1	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Buctril + Prowl + Poast	0.15 + 1.5 + 0.1	5	0	0	100	100	100	100	100	100	100	100	100	99	100	100	100	100	100	100	100	100
Buctril + Prowl + Nortron + Poast	0.1 + 1.5 + 0.25 + 0.1	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Buctril + Prowl + Nortron + Poast	0.15 + 1.5 + 0.25 + 0.1	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Buctril + Goal + Prowl + Poast	0.1 + 0.03 + 1.5 + 0.1	0	5	5	100	100	99	100	100	100	100	100	100	100	100	99	100	100	100	100	100	100
Buctril + Goal + Nortron + Prowl + Poast	0.1 + 0.03 + 0.25 + 1.5 + 0.1	10	0	5	100	100	100	100	100	100	99	100	100	99	100	100	100	100	100	100	100	100
Tough ec + Poast	0.5 + 0.1	20	40	65	100	100	100	100	100	100	96	95	95	85	85	85	100	100	100	100	100	100
Tough ec + Poast	1. 0 + 0.1	80	80	80	99	90	90	99	100	99	99	100	99	99	95	95	99	99	99	99	99	99
Tough wp + Poast	0.5 + 0.1	10	10	10	100	100	100	100	100	100	100	90	90	98	85	85	100	100	100	100	100	100
Tough wp + Poast	1. 0 + 0.1	10	15	35	99	95	95	99	95	99	85	90	90	90	85	85	99	95	90	99	95	90
Tough ec + Buctril + Poast	0.25 + 0.15 + 0.1	30	40	60	100	100	100	100	100	100	100	100	100	98	98	98	98	99	99	99	99	99
Tough wp + Buctril + Poast	0.25 + 0.15 + 0.1	5	0	5	100	95	95	100	100	100	80	95	95	90	85	85	95	98	95	95	98	98
Upbeet	0. 0156	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upbeet + X-77	0.0156 + 0.25%	35	35	35	40	10	40	30	20	20	30	30	30	60	50	50	35	40	30	0	0	0
Upbeet + Buctril	0.0156 + 0.10	15	15	15	40	40	60	60	60	70	40	40	50	60	50	60	75	80	85	0	0	0
Upbeet + Buctril	0.0156 + 0.15	40	40	40	80	60	60	80	70	80	75	75	60	80	80	80	85	90	85	0	0	0
Prism + COC	0.045 + 1%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100
Prism + COC	0.094 + 1%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100
Buctril + Prism	0.15 + 0.045	0	0	0	85	85	90	100	100	100	100	100	100	90	95	100	98	98	100	100	100	100
Buctril + Prism	0.15 + 0.094	5	0	0	80	85	85	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COC = Crop oil concentrate = MorAct

X-77 = non-ionic surfactant

Evaluated June 12.

Table 3. Crop tolerance and weed control ratings for herbicides applied as repeat applications beginning when onion plants had 1-true leaf. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent weed control																		
		Crop injury			Pigweed			Lambsquarters			H. Nightshade			Kochia			Sowthistle			Barnyardgrass			
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
	lb ai/ac	%			%																		
Buctril + Prowl + Poast	0.1 + 1.5 + 0.1	0	0	0	98	98	98	99	99	99	99	99	99	99	99	99	100	100	100	100	100	100	
Buctril + Prowl + Poast	0.15 + 1.5 + 0.1	5	0	0	98	98	99	99	99	99	99	100	99	99	100	98	100	100	100	100	100	100	
Buctril + Prowl + Nortron + Poast	0.1 + 1.5 + 0.25 + 0.1	0	0	0	98	100	98	99	100	100	99	100	100	98	98	100	100	100	100	100	100	100	
Buctril + Prowl + Nortron + Poast	0.15 + 1.5 + 0.25 + 0.1	5	5	5	98	98	99	99	99	99	99	99	99	99	99	98	100	100	100	100	100	100	
Buctril + Goal + Prowl + Poast	0.1 + 0.03 + 1.5 + 0.1	0	0	0	98	98	98	99	99	98	98	99	99	98	99	95	100	100	100	100	100	100	
Buctril + Goal + Nortron + Prowl + Poast	0.1 + 0.03 + 0.25 + 1.5 + 0.1	5	5	0	98	98	98	99	99	99	99	98	98	98	98	98	100	100	100	100	100	100	
Tough ec + Poast	0.5 + 0.1	30	15	15	99	99	96	99	99	99	99	99	96	90	95	95	100	100	100	100	100	100	
Tough ec + Poast	1. 0 + 0.1	15	15	70	95	100	98	95	100	99	90	90	98	95	99	95	100	100	100	100	100	100	
Tough wp + Poast	0.5 + 0.1	0	0	0	90	90	95	90	95	98	90	90	95	80	85	85	95	98	98	100	100	100	
Tough wp + Poast	1. 0 + 0.1	5	5	5	99	99	99	99	99	99	95	98	98	90	95	90	99	100	100	100	100	100	
Tough ec + Buctril + Poast	0.25 + 0.15 + 0.1	5	5	10	95	98	99	98	98	99	9	98	99	95	95	99	100	100	100	100	100	100	
Tough wp + Buctril + Poast	0.25 + 0.15 + 0.1	5	5	5	60	80	85	75	85	85	80	85	75	70	90	80	95	99	99	100	100	100	
Upbeet	0. 0156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Upbeet + X-77	0.0156 + 0.25%	60	60	40	20	10	10	30	20	30	10	10	10	65	60	60	40	45	50	0	0	0	
Upbeet + Buctril	0.0156 + 0.10	30	30	30	20	20	25	30	20	25	10	10	15	35	25	30	95	95	95	0	0	0	
Upbeet + Buctril	0.0156 + 0.15	70	65	40	30	30	30	40	45	45	20	30	30	40	50	50	60	60	60	0	0	0	
Prism + COC	0.045 + 1%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100 100	100	100	
Prism + COC	0.094 + 1%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	
Buctril + Prism	0.15 + 0.045	0	0	0	80	85	85	95	95	95	90	95	95	90	90	85	90	95	100	100	100	100	
Buctril + Prism	0.15 + 0.094	0	0	0	85	85	90	90	90	90	95	95	95	90	90	90	95	100	100	100	100	100	
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

COC = Crop oil concentrate = MorAct

VAPAM FUMIGANT TREATMENTS IN SUGAR BEETS AND ONIONS

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Purpose

Sugar beets and onions were treated with the fumigant Vapam to test seedling vigor and yield.

Procedures

Vapam at 22 and 44 gallons per acre and two herbicides (Roneet 3 lbs/ac in sugar beets and Ramrod 4 lbs/ac in onions) tank-mixed with 22 gallons of Vapam per acre were applied March 31 and mechanically incorporated in fall-bedded soil. Before application, the fall-bedded soil was harrowed with a spike-tooth bed-harrow. Vapam and Vapam/herbicide were applied to the flattened beds in 11-inch bands. The fumigant and herbicide were incorporated to a depth of 3 inches of soil with a tractor power driven row tiller. After incorporation, the tilled beds were rehilled leaving the Vapam treatments in a 3-inch layer at the base of each bed. Spacing between beds was 22 inches. The rehilled beds were left 14 days before sugar beets (variety WS-PM9) and onions (variety Petoseed Vision) were seeded on April 18. After planting, the crops were furrow irrigated April 19 to promote moisture for seedling emergence and growth.

To apply the fumigant and herbicide/fumigant tank-mixes, the required amount of chemicals was mixed with water and sprayed in 11-inch bands using a single bicycle wheel plot sprayer with fan Teejet nozzles, size 8006. Spray pressure was 42 psi, and total spray volume was about 45 gallons per acre for all treatments (fumigant/water and herbicide). For the lower volume of fumigant, water made up the extra volume for total spray solution.

Postemergence herbicides were applied to control weeds escaping fumigant and soil active herbicides in treated plots and weeds present in untreated check plots. Postemergence herbicides used in sugar beets and onions were Betamix Progress + Poast at 0.25 and 0.1 lb ai and Buctril/Nortron/Poast at 0.15 + 0.25 + 0.1 lb ai. Two applications were applied to each crop. The initial application was applied to sugar beets at two true leaves and onions with one true leaf. The second application was applied 14 days later. Each plot was 4 rows wide and 25 feet long. Each treatment was replicated four times, and treatments were arranged using a randomized complete block experimental design.

The onions were lifted on September 21 and were hand-topped, boxed, and placed in storage on September 26. Onions were removed from storage on December 21 and 22 and graded to determine bulb yield by bulb size and measure the storage quality by determining the amount of rot occurring in storage (Table 1). Bulbs were evaluated subjectively for pinkroot at harvest.

The sugar beets were harvested on October 13. Root yields were determined by harvesting all roots from the two center rows of each four row plot. Percent sucrose, conductivity, and root NO_3N was measured from two-eight root samples taken from each plot and analyzed by Amalgamated Sugar Company at the Nyssa, Oregon tare laboratory. Percent extraction and estimated recoverable sugar per acre and ton of beets were calculated (Table 2).

Results

Vapam at both rates caused some initial injury to the emerging sugar beets and onions. Crop injury stunting from Vapam may have resulted from the high percent soil moisture causing the Vapam to remain active in the soil for a longer period of time. Initial weed control was excellent for all treatments, resulting in 80 to 95 percent control of redroot pigweed, kochia, lambsquarters, artemisia, hairy nightshade, and barnyardgrass. Roneet or Ramrod tank-mixed with Vapam did improve initial weed control but did not persist longer than normal to control later germinating weeds. Weeds escaping the Vapam or Vapam/Herbicide tank-mix were controlled with the postemergence applied herbicides. After the initial injury (stunting) from Vapam treatments, the crops in the treated area made more rapid growth and appeared more vigorous than the crops in the untreated area. Ramrod tank-mixed with Vapam increased the control of weeds.

Vapam treatments did not affect sugar beet root yield or lbs/ac of recoverable sugar. Percent sucrose and percent extractable sugar were lower and conductivity and root NO_3 N were higher in the 44 gal/ac treatment of Vapam. The yield of recoverable sugar/ac was similar for all treatments. Sugar yield in lb/ton of sugar beet roots was less for the Vapam 44 gal/ac treatment.

Even with the early Vapam injury to the seedling onions, harvested bulb yields were higher the 22 gal/ac rate of Vapam. Bulb yields were about 100 cwt/ac higher in the Vapam 44 gallon treatments compared to the yield in the untreated check, but the yield increase was below the 131 cwt/ac required for statistical significance. Bulb yield increases from Vapam treatments may have been due to more rapid early growth and no competition from early weed populations. Bulbs were larger in the untreated check plots, indicating wider spacing between onion plants because some onion plants were accidentally removed with weeds when hand weeding. The percent storage rot (4.4 percent) was low for all treatments, and differences between treatments were not significant. Pinkroot ratings taken at time of harvest did not show that Vapam reduced pinkroot infection. Pinkroot was on all onion bulbs regardless of treatment.

Table 1. Crop tolerance and percent weed control from Vapam and Vapam/Roneet tank-mix treatments applied preplant in March to sugar beets. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Crop injury				Percent weed control: Pigweed				Lambsquarters				Kochia				Artemisia				H. nightshade				Barnyardgrass			
Treatments	Rate		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	gal/ac	lb/ac	%				%																							
Vapam	22	--	15	10	15	10	85	90	90	85	90	80	85	80	80	80	85	85	85	80	85	85	80	85	80	80	85	90	90	90
Vapam	44	--	25	20	20	25	98	95	95	95	95	98	98	98	90	95	90	95	95	90	90	95	90	95	95	90	98	95	95	98
Vapam + Roneet	22	3. 0	35	30	30	30	100	100	100	100	98	98	98	100	98	95	95	98	90	95	95	95	100	100	100	100	100	100	100	100
Untreated check	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated May 12.

Ratings: 0 = no chemical effect. 100 = all plants killed.

Table 2. Root yield, sugar yield, and root quality from Vapam and Vapam/Roneet tank-mix treatments applied preplant in March to sugar beets. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Sugar beet yield and quality							
Treatments	Rate		Root yield	Sugar content	Gross sugar	Conductivity	Nitrate-N	Extraction	Recoverable sugar	
	gal/ac	lb/ac	tons/ac	%	lb/ac	μ mhos	ppm	%	lb/ac	lb/ton
Vapam	22	--	41. 64	16. 31	13,540	778	228	84. 49	11,440	275. 7
Vapam	44	--	42. 74	15. 94*	13,630	829*	305*	83. 73*	11,410	266. 9*
Vapam + Roneet	22	3. 0	41. 32	16. 14	13,330	780	212	84. 42	11,250	272. 6
Untreated check	--	--	40. 93	16. 50	13,480	751	188	84. 87	11,440	280. 2
Mean			41. 66	16. 22	13,490	784	234	84. 38	11,390	273. 8
LSD (0.05)			2. 82	0. 55	836	59	72	0. 86	751	11. 4
CV (%)			6. 5	3. 2	5. 9	7. 2	29. 7	0. 98	6. 3	4. 0
Significance			ns	s	ns	s	s	s	ns	s

Table 3. Crop tolerance and percent weed control from Vapam and Vapam/Ramrod tank-mix treatments applied preplant in March to onion ground. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

							Percent weed control																					
			Crop injury				Pigweed				Lambsquarters				Kochia				H. nightshade				Barnyardgrass			
Treatments	Rate		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	gal/ac	lb/ac	%				%																			
Vapam	22	--	10	15	15	10	80	85	80	85	85	80	80	80	75	85	80	80	75	85	80	80	85	90	90	90
Vapam	44	--	25	30	30	25	95	90	90	90	98	95	95	95	95	90	90	90	90	85	90	90	95	95	98	95
Vapam + Ramrod	22	4.0	10	10	15	10	100	100	100	100	85	85	85	85	100	100	100	100	98	95	98	98	100	100	100	100
Untreated check	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated May 12.

Ratings: 0 = no chemical effect. 100 = all plants killed.

Table 4. Onion bulb yield and grade from Vapam and Vapam/Ramrod tank-mix treatments applied preplant in March to onion ground. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Bulb yield (cwt/ac)								
Treatments	Rates		Storage rot		2 1/4 - 3 inch		3 - 4 inch		> 4 inch		Total
	gal/ac	lb/ac	cwt/ac	%	cwt/ac	%	cwt/ac	%	cwt/ac	%	cwt/ac
Vapam	22	--	37	4.2	46	5.1	654	72.9	158	17.6	897
Vapam	44	--	32	4.2	51	6.5	596	76.6	97	12.5	778
Vapam + Ramrod	22	4.0	35	4.4	56	6.9	589	73.4	117	14.6	802
Untreated check	--	--	35	5.1	25	3.6	461	66.3	168	24.1	695
Mean				4.4	44		575		135		794
LSD (0.05)				2.3	24		146		52		131
CV (%)				16	17		8		12		5

WEED CONTROL IN PEPPERMINT AND SPEARMINT

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Introduction

Peppermint and spearmint crops have been removed from the Prowl (pendimethalin) label. Mint growers are left without a soil active herbicide with residual activity to control many species of summer annual broadleaf and grassy weeds. The purpose of these studies are to evaluate experimental herbicides in small replicated plots and to compare registered herbicides for weed control and crop tolerance in field strip plots. Observations were taken on herbicide performance from different rates, tank-mixes, and timing of applications. Our objective is to find herbicide treatments that will control summer weeds with the same effectiveness as Prowl.

Procedures

Herbicides evaluated in the replicated trial included Command EC and two slow release formulations of Command identified as PL 95-087 and PL 95-014. Each formulation was applied at 0.5 and 1.0 lb ai/ac. The experimental FMC herbicide F 6825 was included at rates of 0.187, 0.25, and 0.5 lb ai/ac. Prism was tank-mixed with all treatments for grass control at the rate of 0.094 lb ai/ac. These herbicide treatments were applied to 3-year old spearmint. The field was located near Nyssa, Oregon. The field was rotary corrugated in the fall for furrow irrigation. Buds of mint were starting to emerge when herbicides were applied. Soil surface was in excellent tilth. Soils were silt loam texture with 1.1 percent organic matter and a pH of 7.3. Herbicides were applied on March 7. Air temperature was 50°F, soil temperature at 4-inches 36°F, skies were clear, and the wind was calm. Spray equipment was a single bicycle wheel plot sprayer, 8.5 foot boom, and 10-inch spacing between 8002 teejet fan nozzles. Spray pressure was 42 psi using a water volume of 34 gal/ac. Spray pattern was broadcast double overlap. Weed species present when herbicides were applied included downy brome, prickly lettuce, blue mustard, tansy mustard, and tumbling mustard. Downy brome was tillering, prickly lettuce had 4 leaves with 2 inch wide rosettes, and the mustard species were 2 inches tall and 2 to 3 inches across rosettes.

The strip plots were applied to peppermint and spearmint in fields located near Nyssa, Oregon, New Plymouth, Idaho, and Nampa, Idaho. All these sites were on two and three year old mint. Herbicides included Command, Sinbar, Stinger, Karmex, Buctril, and Gramoxone. Fusilade and Assure II were applied at certain sites to evaluate for control of downy brome. Treatments were two and three way tank-mixes applied at varying rates. Herbicide treatments were applied using a Rear's manufactured pull type sprayer equipped with a fifteen foot spray boom and teejet fan nozzles size 8002 spaced ten inches apart spraying herbicides in a broadcast double overlap pattern. Spray pressure was 35 psi and water volume 28 gal/ac. The sprayer was pulled with a 4-wheel recreational vehicle. Each treatment consisted of plots 30-feet wide for the length of the field. Herbicides, rates, and results are included in separate tables for individual sites, because the time of application and weed species varied between locations.

Results

The emulsifiable formulation of Command herbicide was slightly more active than the encapsulated formulations of Command. Weed control was better from the emulsifiable concentrate formulation at the 0.5 lb ai/ac. Symptoms of chlorosis from Command on crop and weedy plants in plots adjacent to Command treated plots were about equal between the two formulations indicating drift from Command vapors can still occur from the encapsulated PL 95-087 and PL 95-014 formulations. Mint and weedy plants in plots adjacent to the encapsulated treated plots may have outgrown the symptoms sooner, but the initial symptoms were as pronounced as those on plants adjacent to plots treated with the emulsifiable concentrate formulation. Weed control was excellent for both formulations at the one pound ai/ac rate. Command controlled all mustard species of weeds and persisted in the soil to give preemergence control of pigweed, lambsquarters, kochia, barnyardgrass, and green foxtail. It was less active on prickly lettuce giving only partial control of that species. The FMC herbicide F 6825 did not perform well in this trial. At the lower rates it did not control the annual weeds effectively, and spearmint was injured at the higher rate. F 6825 did show good activity for control of yellow nutsedge. Prism was compatible with Command and controlled downy brome. Prism did not control downy brome when tank-mixed with F 6825.

The outstanding treatment applied on grower fields in strip applications was the tank-mix combination of Karmex, Sinbar, and Gramoxone (0.8, 1.0, and 0.33 lb ai/ac respectively). A crop oil concentrate (MorAct) was added to the preceding tank-mix at the rate of 1 quart per acre. Both spearmint and peppermint were tolerant to the tank-mix treatments. No herbicide injury was observed in the crop, and weed control was excellent. Gramoxone with Sinbar and Karmex gave excellent control of all emerged weed species including downy brome and persisted to control spring and summer germinating annual weeds and even weeds germinating postharvest. Stinger was very active on prickly lettuce and gave excellent control when used in combination with Karmex and Command. Command was compatible with Karmex, Stinger, and Sinbar tank-mixes. Command vapor drifted to adjacent fields for a distance of 300 feet or more causing severe chlorosis to wheat, but the wheat recovered with normal color and growth. Fusilade tank-mixed with other herbicides did not give complete control of downy brome. Downy brome was severely injured initially, but some plants recovered and continued to grow. This did not occur with Gramoxone tank-mixes. Buctril tank-mixed with Karmex was also effective on emerged species of mustards and prickly lettuce. Karmex plus Sinbar did not control all prickly lettuce. Stinger added with Karmex and Sinbar gave excellent control of prickly lettuce from both contact and preemergence activity. Results from these studies show that Karmex tank-mixed with Sinbar and Gramoxone or other herbicides including Command and Stinger in tank-mix combinations can effectively control both winter and summer annual weeds. If Prowl is relabeled, Prowl/Karmex combinations with Gramoxone, Sinbar, or Stinger may be very effective and useful combinations in both established and new plantings of spearmint and peppermint.

Table 1. Crop tolerance and weed control ratings from spring applied herbicides to established stands of spearmint. Froerer Farms, Nyssa, Oregon, 1995.

					Percent weed control																
		Crop injury			P. lettuce			Downy brome			Yellow nutsedge			Tumbling mustard			Blue mustard		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	— % —									%								
Command + Prism	0.5 + 0.094	0	0	0	85	90	90	100	100	100	40	45	40	98	100	100	98	100	100
Command + Prism	1.0 + 0.094	0	0	0	93	95	95	100	100	100	75	85	70	100	100	100	100	100	100
PL 95-087 + Prism	0.5 + 0.094	0	0	0	80	85	80	75	75	70	25	25	30	98	95	95	98	98	98
PL 95-087 + Prism	1.0 + 0.094	0	0	0	85	85	85	100	100	100	65	65	65	100	100	100	100	100	100
PL 95-014 + Prism	0.5 + 0.094	0	0	0	90	95	95	75	70	75	30	40	40	100	98	98	98	100	100
PL 95-014 + Prism	1.0 + 0.094	0	0	0	95	93	95	100	95	100	65	65	65	100	100	100	100	100	100
F 6825 + Prism	0.187 + 0.094	30	35	35	85	90	90	25	35	30	45	50	50	85	80	85	80	85	85
F 6825 + Prism	0.25 + 0.094	40	35	40	85	90	95	20	25	30	90	85	85	90	80	80	85	80	85
F 6825 + Prism	0.5 + 0.094	50	45	45	100	100	100	25	25	20	95	90	90	100	100	100	100	100	100
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Herbicides applied on March 7. Evaluated on June 2. MorAct crop oil concentrate added to all treatments at rate of 1 qt/ac.

Ratings: 0 = no control. 100 = all plants killed.

All weeds emerged except yellow nutsedge when herbicides applied. Dense stands of yellow nutsedge emerged in May.

Table 2. Crop tolerance and weed control ratings from herbicides applied in November to established spearmint. George Mc Celland, New Plymouth, Idaho, 1995.

					Percent weed control																		
		Crop injury			P. lettuce			Blue mustard			Pigweed			Lambsquarters			Kochia			Green foxtail		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	— % —											%									
Command + Stinger	1.0 + 0.125	0	0	0	100	100	100	100	100	100	98	96	98	95	98	95	98	98	98	99	95	95
Karmex + Sinbar	0.8 + 1.0	0	0	0	85	90	80	100	100	100	95	98	95	100	99	100	95	95	95	98	95	98
Karmex + Stinger	0.8 + 0.125	0	0	0	100	100	100	100	100	100	90	90	85	95	90	90	90	93	85	90	95	90
Karmex + Stinger + Sinbar	0.8 + 0.125 + 0.5	0	0	0	100	100	100	100	100	100	95	98	98	100	100	100	98	95	95	99	100	99
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Herbicides applied November 7, 1994. Evaluated May 27, 1995.

Rating: 0 = no control. 100 = all plants killed.

Prickly lettuce and blue mustard emerged when treatments applied. Pigweed, lambsquarters, kochia, and green foxtail controlled by preemergence herbicide

Table 3. Crop injury and weed control ratings from herbicides applied in March to established spearmint. Froerer Farms, Nyssa, Oregon, 1995.

					Percent weed control																	
		Crop injury			P. lettuce			Pigweed			Kochia			Blue mustard			Downy brome			Barnyardgrass		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	— % —			%																	
Karmex + Gramoxone	0.8 + 0.33	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Karmex + Sinbar + Gramoxone	0.8 + 1.0 + 0.33	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Karmex + Stinger + Fusilade	0.8 + 0.125 + 0.1875	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	85	80	80	100	100	100
Karmex + Buctril + Fusilade	0.8 + 0.5 + 0.1875	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	80	80	80	100	100	100
Karmex + Command	0.8 + 0.5	5	10	5	98	98	98	100	100	100	100	100	100	100	100	100	70	75	70	100	100	100
Karmex + Command + Fusilade	0.8 + 0.5 + 0.1875	10	10	5	98	98	98	100	100	100	100	100	100	100	100	100	80	85	80	100	100	100
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Herbicides applied March 2. Evaluated June 14. MorAct crop oil concentrate added to all treatments at rate of 1 qt/ac.

Ratings: 0 = no control. 100 = all plants killed.

Prickly lettuce, blue mustard, and downy brome emerged when herbicides applied. Pigweed, kochia, and barnyardgrass control from preemergence herbicide activity.

Soil texture sandy loam, 1.0 % organic matter, pH 7.1.

Table 4. Crop injury and weed control ratings from herbicides applied in November and March to established peppermint. Robert McKellep, Meridian, Idaho, 1995.

						Percent weed control																	
			Crop injury			P. lettuce			Pigweed			Kochia			Mustard sp.			Downy Brome			Barnyardgrass		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		— % —			%																	
Karmex + Stinger + Sinbar	0.8 + 0.125 + 1.0	11-9	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	80	80	85	100	100	100
Karmex + Stinger	0.8 + 0.125	11-9	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	60	50	60	100	100	100
Command + Stinger	1.0 + 0.125	11-9	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	85	85	85	100	100	100
Karmex + Command + Stinger	0.8 + 0.05 + 0.125	3-8	5	10	5	100	100	100	100	100	100	100	100	100	100	100	100	85	85	85	100	100	100
Karmex + Sinbar + Gramoxone	0.8 + 1.0 + 0.33	3-8	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Karmex + Command	0.5 + 1.0	3-8	5	5	10	100 1	100	100	100	100	100	100	100	100	100	100	100	80	85	85	100	100	100
Untreated check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Herbicide applied November 9, 1994 or March 9, 1995. Evaluated May 11. MorAct crop oil concentrate added to all treatments at rate of 1 qt/ac.

Ratings: 0 = no control. 100 = all plants killed.

Prickly lettuce and mustard species (blue mustard, tumbling mustard, and shephard's purse) emerged when herbicides applied. Pigweed, kochia, downy brome, and barnyardgrass controlled by preemergence activity.

Soil texture clay loam, 1.2% organic mustard and pH 6.9. Furrow irrigated.

Table 5. Crop injury and weed control ratings from herbicides applied in March to established spearmint. Robert McKellep, Nampa Idaho, 1995.

					Percent weed control																
		Crop injury			Pigweed			Kochia			Lambsquarters			Barnyardgrass			Green foxtail				
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
	lb ai/ac	— % —			%																
Command + Karmex + Stinger	0.5 + 0.8 + 0.125	0	0	0	100	100	100	100	100	100	100	100	100	98	95	98	100	100	100		
Sinbar + Command	1.0 + 0.5	0	0	0	100	100	100	100	100	100	100	100	100	99	100	99	100	100	100		
Sinbar + Command	1.0 + 1.0	10	10	5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
Command	1. 0	5	10	5	100	100	100	100	100	100	100	100	100	90	85	90	100	100	100		
Command	2. 0	20	25	20	100	100	100	100	100	100	100	100	100	100	99	99	100	100	100		
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Herbicide applied November 9, 1994 or March 9, 1995. Evaluated May 11. MorAct crop oil concentrate added to all treatments at rate of 1 qt/ac.

Ratings: 0 = no control. 100 = all plants killed.

Prickly lettuce and mustard species (blue mustard, tumbling mustard, and shephard's purse) emerged when herbicides applied. Pigweed, kochia, downy brome and barnyardgrass controlled by preemergence activity.

IMPROVED NITROGEN AND IRRIGATION EFFICIENCY FOR POTATO PRODUCTION

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Summary

Management alternatives for reducing N fertilizer and irrigation water application rates were tested for furrow irrigated potatoes in replicated half acre plots. Potato yield, grade, and quality were maintained with a reduction of N fertilizer application below commercial and university recommendations, with a reduction in applied water using surge irrigation, and with the combination of both practices. Nitrogen fertilizer costs were reduced and the risks of nitrate leaching were reduced without sacrificing gross income.

Introduction

Previous small plot research at the Malheur Experiment Station has demonstrated the effectiveness of using greatly reduced nitrogen fertilizer inputs for optimum potato production. The N rates achieving maximum potato yield in these experiments were substantially lower than the Oregon or Idaho fertilizer guide recommendations, irrespective of whether the potatoes were irrigated by sprinklers or furrow.

Irrigation scheduling according to soil water potential measurements and water applications according to evapotranspiration calculations have also thoroughly tested here.

Surge irrigation is a tool that can be used to improve the water application efficiency of furrow irrigation. In surge irrigation, water is applied to an irrigation furrow intermittently during an irrigation set, whereas in continuous-flow (or conventional) irrigation, water is applied to the furrow during the entire irrigation set. With surge irrigation, a switch valve, commonly referred to as a surge valve, is used to repeatedly cycle water from one half of the field to the other half. Total water application can be reduced substantially with the use of surge irrigation. Previous research at the Malheur Experiment Station with wheat and onions has demonstrated the effectiveness of surge irrigation in reducing water applications while maintaining crop yield and quality equivalent to conventional furrow irrigation.

The reduced water applications with surge irrigation could result in a reduction of nitrate leaching and the need for applied nitrogen. This trial compared potato production with conventional and reduced N inputs under either conventional furrow irrigation or surge irrigation in field scale plots. Plots were 0.5 acres each with 600-foot long irrigation runs. The intent was to investigate the interaction between reduced nitrogen fertilizer and reduced water inputs on crop yield and quality. Further studies not reported here examined the fate of nitrogen and water moving across the field.

Procedures

The 1995 trial was conducted on a Greenleaf silt loam previously planted to wheat at the Malheur Experiment Station. The field was fumigated with 19 gals/ac of Telone II and bedded into 36-inch hills in the fall of 1994. A soil sample taken from the top foot on May 1, 1995 showed a pH of 7.6, 1.4 percent organic matter, 19 meq per 100 g of soil cation exchange capacity, 4 ppm nitrate-N, 7 ppm ammonium-N, 14 ppm phosphorus, 178 ppm potassium, 1748 ppm calcium, 256 ppm magnesium, 340 ppm sodium, 0.7 ppm zinc, 4.4 ppm iron, 4.1 ppm manganese, 0.7 ppm copper, 13 ppm sulfate-S and 0.7 ppm boron.

The experimental design had the irrigation and nitrogen fertilizer treatments as main plots with a half acre per plot replicated three times (Table 1), These main plots were 12 rows wide and 600 feet long. The top, middle, and bottom down the 600 feet of irrigation run in each main plot were handled as separate parts of the field for sampling purposes, and seven potato varieties as split-plots within the sampling areas (Table 2). The seven varieties were planted in 50 foot long rows in the top , middle, and bottom of each plot within the sampling area.

The Oregon fertilizer guide recommended 270 lb N/ac (210 lb N/ac based on the preplant soil analyses plus 60 lb N/ac for 3 tons of wheat residue) and the Idaho fertilizer guide recommended 255 lb N/ac (210 lb N/ac based on the preplant soil analyses plus 45 lb N/ac for 3 tons of wheat residue) for this site. A potato processing company and a soil fertility lab each recommended 300 lb N/ac based on the residual soil nitrate and ammonium and the cropping history. Consequently 300 lb N/ac was used as the recommended nitrogen fertilizer rate.

Table 1. Irrigation and N management treatments used to demonstrate the possibility of reduced inputs. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Treatment	Irrigation type	Pre-emergence N (May 19) lb N/ac	Post-emergence "water run" N lb N/ac	Total N applied lb N/ac
1	Alternating furrow	200	100**	300
2	Alternating furrow	120	30***	150
3	Alternating surge	200	100**	300
4	Alternating surge	120	30***	150

**July 13 ***July 31

Two-ounce seed pieces of Shepody potatoes were planted May 3 at 9-inch spacing except for small areas planted to six other varieties in three parts of each main plot. On May 19, Thimet 20G at 3 lbs ai/ac was shanked-in along with urea for the pre-emergence nitrogen (Table 1). The urea was applied to both sides of the hill (Figure 1). The shanks were adjusted to place the urea in bands located at the same depth as the seed piece and offset 9 inches from the hill center. The hills were remade with a Lilliston cultivator. The herbicides Prowl at 1 lb ai/ac and Dual at 2 lbs ai/ac were broadcast on the entire soil surface on May 23 and incorporated with the Lilliston. A late blight and insect control program consisting of weekly aerial applications of fungicide and insecticide mixes was initiated on July 14 and continued through August 26.

Gated pipe was arranged to permit all 12 plots to be irrigated simultaneously. A Waterman Model LVC-5 surge valve automatically oscillated water from three of the surge irrigation plots to the other three surge irrigation plots. The valves on the gated pipe were adjusted to deliver the same flow rate to all furrows in the surge and conventional irrigation systems.

Six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) were installed in the top foot of soil and three GMS were placed in the second foot of soil in each plot. The GMS in the top foot of soil were offset 6 inches from the hill top and centered 8 inches below the hill surface and the second foot GMS were placed in the hill center and centered 20 inches below the hill surface. Half of the first foot sensors were located on the wheel traffic side of the potato hill and the other half were located on the non-wheel traffic side of the hill. Sensors were read five times per week from June 10 to September 4 at close to 8 AM. Irrigations were started when the average soil water potential in the first foot of soil dried to -50 kPa. All the surge plots or all the conventional furrow irrigation plots were irrigated separately as needed to maintain the soil water potential wetter than -60 kPa.

At each irrigation, every other furrow was irrigated, with the irrigated furrows alternating from irrigation to irrigation. Seventeen irrigations were used from June 12 to September 1. Irrigation durations were 24 hours from June 12 through July 17 and 12 hours from July 17 through September 1.

Petiole samples were collected from Shepody plants in top, middle and bottom of each plot every two weeks from June 21 to August 16, and analyzed for nitrate. Tubers from 40 feet in the top, middle and bottom of each plot were harvested on September 26 and evaluated for yield and grade. A subsample was stored and analyzed for tuber specific gravity and stem-end fry color in early November.

The soil was sampled in one-foot increments down to six feet in each plot before planting and after harvest and analyzed for nitrate and ammonium. The N balances were calculated by subtracting the post harvest accounted nitrogen (crop N uptake plus available soil N after harvest) from the nitrogen supply (available soil N in spring plus fertilizer N plus N from irrigation water plus N from organic matter mineralization). Nitrogen contribution from the irrigation water was estimated to be 1.4 lb N/ac-inch/ac of water infiltration. Nitrogen contribution from organic matter mineralization was estimated by anaerobic incubation at 104 °F for 7 days.

Results and Discussion

Conventional furrow irrigated plots required 15 irrigations totaling 304 hours and surge irrigated plots required 21 irrigations totaling 388 hours. The actual duration of water applications with surge irrigation would be half of that for conventional irrigation. Actual water applications were 304 hours for conventional irrigation and 194 hours for surge irrigation (a 36 percent reduction in applied water). Soil water potential at 8-inch depth remained drier during the season in the surge irrigated plots than in the furrow irrigated plots (Figure 2). Since the depth of the water in the furrows during surge irrigation oscillates, the amount of time during which the irrigation can effectively wet the hill is reduced in surge irrigation compared to conventional furrow irrigation.

There was no significant difference in tuber yield or grade between treatments over all varieties (Tables 2 and 3, Figure 4). There was no significant difference in tuber specific gravity or fry color between treatments over all varieties (Table 4). The varieties responded similarly to the treatments. COO83008-1 had the lightest frying tubers averaged over all treatments. Ranger Russet, AO82611-7, and COO83008-1 had the highest tuber specific gravity.

Petiole nitrate levels over time did not differ between the furrow and surge irrigated plots (Figure 3). Petiole nitrate remained in the excessive range (Jones and Painter, 1974) after July 20 in the high N plots. Petiole nitrate became inadequate on July 27 and deficient on August 3 in the low N plots.

Tuber yield was just as high with 150 lb N/ac as with 300 lb N/ac. Perhaps the banding of the N fertilizer after planting improves the fertilizer use efficiency compared to broadcast applications. When broadcast applications are used, substantial amounts of N can be lost to leaching, lost to volatilization, or be located in tops of the potato hill that are inaccessible to the roots. Alternating furrow irrigation also reduces the amount of water applied and could reduce nitrate leaching, leaving more N available to the plants and greater residuals for the following year.

Rainfall events during the 1995 season provided substantially more water at several times in June and July than the crop required, and estimated nitrogen balances for the season were understandably negative (Tables 5 and 6). Reduced N application was associated with lower calculated nitrate leaching losses.

Conclusions

Nitrogen fertilizer savings were achieved with either conventional or surge irrigation of potatoes without compromising tuber yield or grade. Banding of the nitrogen fertilizer after planting may result in better uptake efficiency and reduced losses compared to broadcast applications. Potatoes were grown with surge irrigation with tuber yield and quality comparable to conventional furrow irrigation and with substantially less water applied during the season. Further research to determine the appropriate furrow or hill shape to be used with surge irrigation could result in more effective wetting of the hills and in a reduction of the number of irrigations necessary.

Literature cited

Jones, J.P. and Painter, C.G., 1974. Tissue analysis: A guide to nitrogen fertilization of Idaho Russet Burbank Potatoes. University of Idaho, College of Agriculture, Cooperative Extension Service, Agricultural Experiment Station, Current information series # 240, June 1974.

Table 2. Influence of reduced N application and surge irrigation on the tuber yield and grade of seven potato varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

Variety	Irrigation type	N rate	Potato yield by market grade										
			US Number One				US Number Two				Marketable	Undersize	Total yield
			4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total			
		lb N/ac	cwt/ac										
R. Burbank	Furrow	300	103.6	142.5	137.8	383.9	3.3	2.9	10.4	16.6	400.5	61.5	462.0
	Furrow	150	101.9	154.4	112.4	368.7	1.8	5.1	17.0	23.9	392.6	53.8	446.4
	Surge	300	79.5	146.5	102.9	329.0	3.0	5.6	13.0	21.6	350.5	59.2	409.7
	Surge	150	106.4	157.9	104.8	369.2	3.0	3.3	8.3	14.7	383.9	57.8	441.7
	Average		97.9	150.3	114.5	362.7	2.8	4.2	12.2	19.2	381.9	58.1	440.0
Shepody	Furrow	300	20.6	57.6	285.0	363.2	0.5	3.0	31.8	35.3	398.6	14.7	413.3
	Furrow	150	24.0	65.4	290.9	380.3	0.2	1.2	6.0	7.4	387.7	14.2	401.9
	Surge	300	20.9	59.9	300.1	380.9	0.9	2.6	18.8	22.3	403.2	14.7	417.9
	Surge	150	26.9	68.6	284.9	380.5	0.3	2.1	9.9	12.3	392.8	10.7	403.5
	Average		23.2	63.0	290.0	376.1	0.5	2.2	16.6	19.2	395.3	13.5	408.9
F. Russet	Furrow	300	79.8	108.1	139.2	327.1	0.3	3.5	9.0	12.8	339.9	59.4	399.3
	Furrow	150	55.3	117.5	132.9	305.8	0.1	0.9	5.3	6.4	312.1	44.5	356.7
	Surge	300	67.2	96.8	141.3	305.3	0.3	0.5	8.5	9.3	314.6	62.6	377.3
	Surge	150	92.6	129.0	106.7	328.4	0.6	2.5	7.1	10.2	338.6	59.9	398.5
	Average		73.7	112.9	130.1	316.6	0.3	1.8	7.5	9.7	326.3	56.6	382.9
R. Russet	Furrow	300	40.0	89.7	147.4	277.1	3.0	4.2	10.0	17.2	294.3	28.3	322.6
	Furrow	150	41.3	97.7	161.3	300.3	0.5	7.5	9.3	17.3	317.6	27.0	344.6
	Surge	300	51.9	95.6	167.9	315.4	1.3	2.4	15.1	18.8	334.2	29.3	363.5
	Surge	150	50.4	108.3	128.5	287.3	1.7	2.6	8.7	13.0	300.3	28.7	329.0
	Average		45.9	97.8	151.3	295.0	1.6	4.2	10.8	16.6	311.6	28.3	339.9
AO 82611-7	Furrow	300	62.6	116.1	187.6	366.3	1.6	2.6	9.8	14.0	380.2	38.4	418.6
	Furrow	150	56.5	119.1	186.5	362.0	0.6	3.0	6.8	10.4	372.4	32.5	404.9
	Surge	300	56.7	104.9	199.3	360.8	2.8	5.9	12.7	21.3	382.2	32.5	414.7
	Surge	150	57.3	103.1	149.7	310.1	0.4	2.6	9.4	12.5	322.5	31.3	353.8
	Average		58.3	111.3	182.8	352.4	1.4	3.6	9.7	14.7	367.1	33.8	401.0
COO 83008-1	Furrow	300	38.6	98.2	219.2	356.1	0.8	1.6	2.8	5.2	361.2	19.7	381.0
	Furrow	150	33.0	98.5	224.5	356.0	0.7	2.3	8.5	11.5	367.5	16.6	384.1
	Surge	300	24.4	77.9	276.0	378.2	0.4	1.5	10.6	12.5	390.7	14.0	404.7
	Surge	150	38.7	111.3	206.3	356.3	0.2	1.5	5.8	7.6	363.9	15.5	379.4
	Average		33.2	96.3	232.6	362.1	0.5	1.8	7.3	9.6	371.7	16.1	387.8
NDTX 8-731-1R	Furrow	300	56.5	114.1	228.5	399.1	0.0	0.0	0.0	0.0	399.1	29.9	429.0
	Furrow	150	54.2	146.1	238.7	439.0	0.0	0.0	0.0	0.0	439.0	28.3	467.3
	Surge	300	44.8	114.6	245.8	405.2	0.0	0.0	0.0	0.0	405.2	35.3	440.5
	Surge	150	59.1	121.0	227.2	407.2	0.0	0.0	0.0	0.0	407.2	31.7	438.9
	Average		54.2	123.6	234.2	412.0	0.0	0.0	0.0	0.0	412.0	31.3	443.4
All varieties	Furrow	300	58.6	104.1	188.7	351.5	1.5	2.7	11.4	15.6	367.1	37.2	404.3
	Furrow	150	52.4	112.8	190.0	355.2	0.6	3.0	7.9	11.5	366.7	31.2	397.9
	Surge	300	50.4	99.6	201.0	351.0	1.4	2.9	11.7	16.0	367.0	35.6	402.6
	Surge	150	61.6	114.2	172.6	348.4	0.9	2.1	7.0	10.0	358.5	33.7	392.1
LSD (0.05) Trt			7.8	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
LSD (0.05) Variety			8.9	14.2	27.4	29.2	1.2	1.6	5.1	6.1	30.0	6.3	27.2

Table 3. Influence of reduced N application and surge irrigation on the tuber market grade distribution of seven potato varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995 Ontario, OR, 1995.

Variety	Treatment: Irrigation	Treatment: N rate	US Number One: 6-10 oz	US Number One: >10 oz	US Number One: total	US Number Two: 4-6 oz	US Number Two: 6-10 oz	US Number Two: >10 oz	US Number Two: total	Marketable	Undersize
			%								
R. Burbank	Furrow	300	30.5	30.3	83.0	0.7	0.6	2.2	3.5	86.6	13.4
	Furrow	150	34.5	25.1	82.5	0.4	1.1	3.8	5.2	87.8	12.2
	Surge	300	35.3	24.6	79.6	0.6	1.4	3.2	5.3	84.9	15.1
	Surge	150	35.8	23.6	83.3	0.7	0.8	1.9	3.4	86.7	13.3
	Average		34.0	25.9	82.1	0.6	1.0	2.8	4.4	86.5	13.5
Shepody	Furrow	300	13.8	69.4	88.3	0.1	0.6	7.1	7.8	96.1	3.9
	Furrow	150	16.4	71.8	94.3	0.0	0.3	1.3	1.7	96.0	4.0
	Surge	300	14.4	71.6	91.1	0.2	0.7	4.4	5.3	96.4	3.6
	Surge	150	17.1	70.5	94.2	0.1	0.5	2.5	3.1	97.3	2.7
	Average		15.4	70.8	92.0	0.1	0.5	3.8	4.4	96.4	3.6
F. Russet	Furrow	150	33.4	36.1	85.2	0.0	0.2	1.2	1.4	86.6	13.4
	Surge	300	25.1	38.0	80.7	0.1	0.1	2.3	2.5	83.2	16.8
	Surge	150	32.3	27.0	82.6	0.1	0.6	1.8	2.5	85.1	14.9
	Average		29.6	33.8	82.5	0.1	0.5	1.9	2.4	84.9	15.1
R. Russet	Furrow	300	28.3	44.4	84.8	1.2	1.5	3.1	5.8	90.6	9.4
	Furrow	150	27.6	45.5	85.3	0.1	2.8	2.9	5.9	91.2	8.8
	Surge	300	27.1	45.5	87.0	0.3	0.7	4.0	5.0	92.1	7.9
	Average		28.9	43.7	86.0	0.6	1.5	3.2	5.2	91.2	8.8
AO 82611-7	Furrow	300	27.9	44.4	87.4	0.3	0.6	2.4	3.3	90.7	9.3
	Furrow	150	29.8	45.2	89.5	0.1	0.5	1.5	2.2	91.7	8.3
	Surge	300	25.6	47.6	86.9	0.7	1.5	3.1	5.2	92.1	7.9
	Surge	150	28.7	41.9	87.3	0.1	0.9	2.9	3.9	91.1	8.9
	Average		28.0	45.0	87.8	0.3	0.9	2.4	3.6	91.4	8.6
COO 83008-1	Furrow	300	26.0	56.6	93.2	0.2	0.4	0.8	1.4	94.6	5.4
	Furrow	150	26.0	57.6	92.6	0.2	0.6	2.2	2.9	95.5	4.5
	Surge	300	19.4	67.8	93.3	0.1	0.4	2.7	3.2	96.5	3.5
	Surge	150	30.2	53.0	93.9	0.1	0.4	1.4	1.9	95.8	4.2
	Average		25.3	59.0	93.2	0.1	0.5	1.9	2.5	95.7	4.3
NDTX 8-731-1R	Furrow	300	25.7	54.1	93.0	0.0	0.0	0.0	0.0	93.0	7.0
	Furrow	150	32.3	49.9	94.0	0.0	0.0	0.0	0.0	94.0	6.0
	Surge	300	26.3	55.3	91.9	0.0	0.0	0.0	0.0	91.9	8.1
	Surge	150	27.8	51.7	92.8	0.0	0.0	0.0	0.0	92.8	7.2
	Average		28.0	52.6	92.9	0.0	0.0	0.0	0.0	92.9	7.1
All varieties	Furrow	300	25.8	46.7	86.7	0.4	0.7	2.8	3.9	90.6	9.4
	Furrow	150	28.5	47.1	88.8	0.1	0.8	1.9	2.9	91.7	8.3
	Surge	300	24.9	49.4	86.9	0.3	0.8	2.9	4.0	90.9	9.1
	Surge	150	29.2	43.8	88.7	0.3	0.6	1.9	2.7	91.4	8.6
LSD (0.05) Trt			ns	ns	ns	ns	ns	ns	ns	ns	ns
LSD (0.05) Variety			3.5	4.8	2.1	0.3	0.4	1.2	1.1	1.5	1.5

Table 4. Influence of reduced N application and surge irrigation on tuber specific gravity and stem-end fry color of six potato varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

Variety	Irrigation type	N rate	Stem-end fry color	Specific gravity	Variety	Treatment	N rate	Stem-end fry color	Specific gravity
		lb N/ac	% reflectance				lb N/ac	% reflectance	
R. Burbank	Furrow	300	34	1.089	R. Russet	Furrow	300	42.4	1.099
	Furrow	150	28.6	1.090		Furrow	150	42.6	1.102
	Surge	300	29.7	1.084		Surge	300	43.2	1.096
	Surge	150	28.0	1.090		Surge	150	43.4	1.101
	Average		30.1	1.088		Average		42.9	1.100
Shepody	Furrow	300	42.7	1.093	AO 82611-7	Furrow	300	39.9	1.093
	Furrow	150	45.1	1.092		Furrow	150	41.7	1.095
	Surge	300	43.7	1.087		Surge	300	43.2	1.092
	Surge	150	46.8	1.087		Surge	150	43.7	1.097
	Average		44.6	1.090		Average		42.0	1.094
F. Russet	Furrow	300	29.8	1.084	COO 83008-1	Furrow	300	44.7	1.091
	Furrow	150	32.4	1.091		Furrow	150	46.9	1.095
	Surge	300	30.0	1.081		Surge	300	47.5	1.092
	Surge	150	33.1	1.092		Surge	150	49.3	1.096
	Average		31.3	1.087		Average		47.3	1.094
All varieties	Furrow	300	38.6	1.092					
	Furrow	150	39.7	1.094					
	Surge	300	39.7	1.089					
	Surge	150	40.7	1.094					
LSD (0.05) Trt			ns	ns					
LSD (0.05) Variety			2.1	0.003					

Table 5. Influence of reduced N application and surge irrigation on the seasonal available nitrogen accounting in potatoes and in the soil profile. Malheur Experiment Station, Ontario, OR , 1995.

Irrigation type	N rate	N supply				Fall nitrogen accounting			Balance*
		Pre-plant soil available N (0-6')	Fertilizer N	N in irrigation water	Estimated N mineralization	Fall soil available N (0-6')	Plant N recovery	Accounted N	
	lb N/ac	——— lb/ac ———							
Furrow	300	186.5	300	18.6	206.2	165.3	228.2	393.5	-317.8
Furrow	150	182.2	150	18.6	215.9	122.1	162.2	284.3	-282.3
Surge	300	180.5	300	18.6	253.4	173.4	202.2	375.6	-377
Surge	150	188.8	150	18.6	233.9	133.7	177.2	310.9	-280.4
LSD (0.05) N		ns				39.3	ns	81.9	ns
LSD (0.05) Irr		ns				ns	ns	ns	ns
LSD (0.05) N X Irr		ns				ns	ns	ns	ns

* based on the difference between all N supplies and fall N accounting.

Table 6. Influence of reduced N application and surge irrigation on the seasonal available nitrogen accounting in potatoes and in the top two feet. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

Irrigation type	N rate	N supply				Fall nitrogen accounting			Balance*
		Pre-plant soil available N (0-2')	Fertilizer N	N in irrigation water	Estimated N mineralization	Fall soil available N (0-2')	Plant N recovery	Accounted N	
	lb N/ac	——— lb/ac ———							
Furrow	300	63.2	300	18.6	206.2	80.5	228.2	308.8	-279.3
Furrow	150	63	150	18.6	215.9	54.7	162.2	216.9	-230.6
Surge	300	64.8	300	18.6	253.4	78.2	202.2	280.3	-356.5
Surge	150	65.3	150	18.6	233.9	54.8	177.2	232.1	-235.7
LSD (0.05) N		ns				17.3	ns	69.5	-72.5
LSD (0.05) Irr		ns				ns	ns	ns	ns
LSD (0.05) N X Irr		ns				ns	ns	ns	ns

* based on the difference between all N supplies and fall N accounting.

Figure 1. Nitrogen fertilizer was shanked into the bed between the furrow and seed piece. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

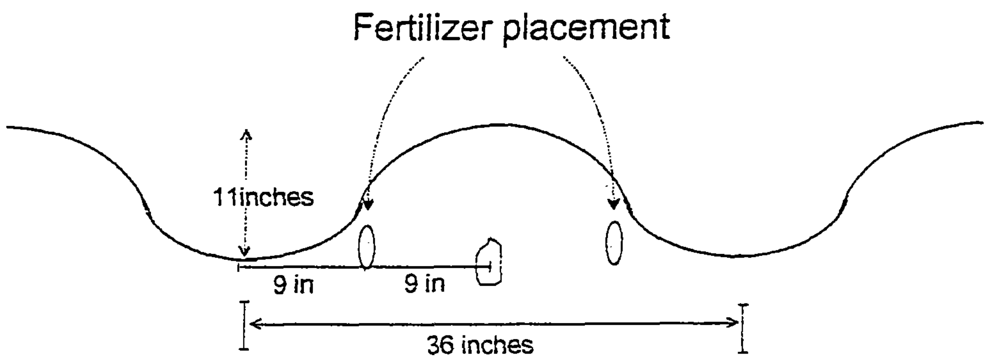


Figure 2. Soil water potential at 8-inch depth over time for conventional furrow irrigated and surge irrigated potatoes. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

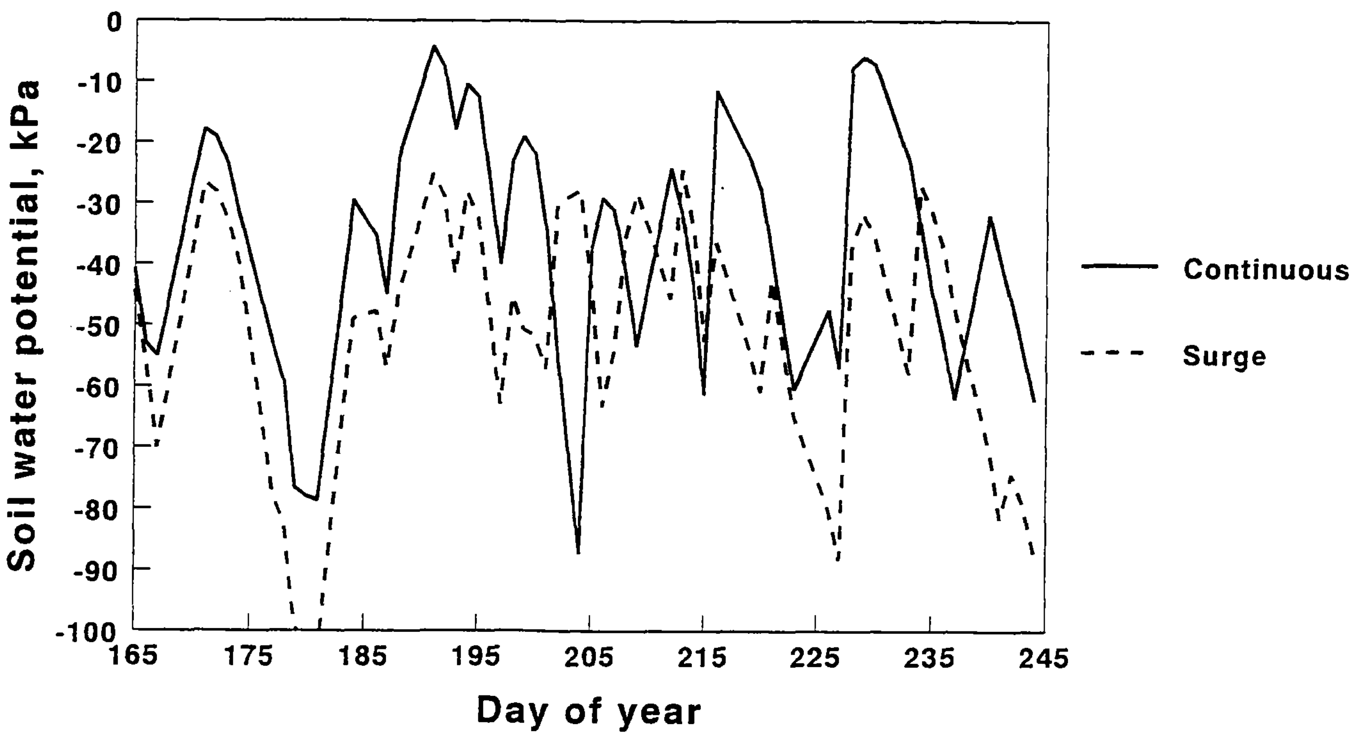


Figure 3. Petiole nitrate over time with reduced N fertilizer inputs and conventional furrow vs surge irrigated potatoes. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

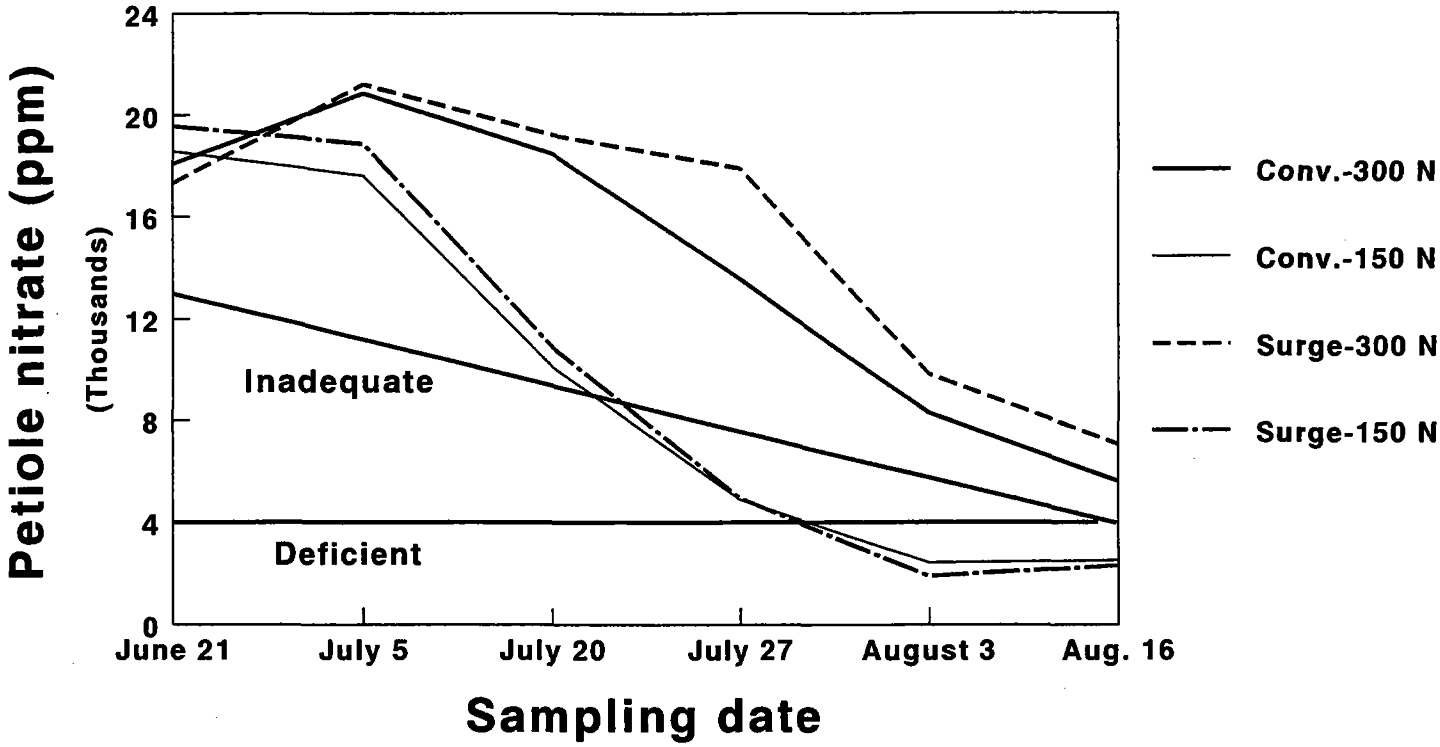
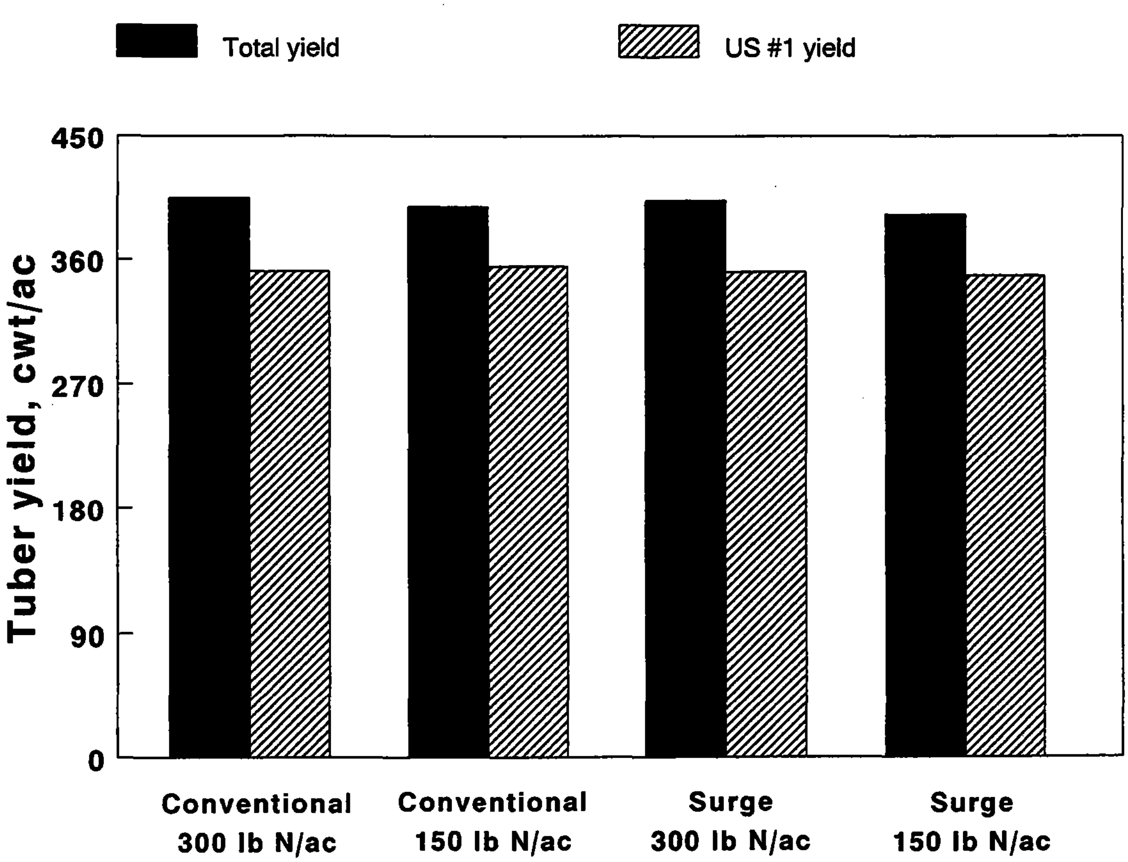


Figure 4. Tuber yield with reduced N applications and conventional furrow vs surge irrigation. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.



NITROGEN REQUIREMENTS FOR NEW POTATO VARIETIES UNDER FURROW IRRIGATION

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Summary

A trial was designed to test potato nitrogen requirements for potato varieties under furrow irrigation in a N deficient field. The highest potato yield (518 cwt/ac over all varieties tested) was obtained in 1995 by the use of only 84 lb N/ac soon after planting. Additional N produced no additional economic returns. Varieties did not differ significantly in their response to N fertilizer. The new potato variety A082611-7 had higher total US Number One and marketable tuber yield than Russet Burbank and Shepody in this trial.

Introduction

The development of new potato varieties has made it possible to achieve good tuber yield and quality with furrow irrigation. These new varieties might differ from each other in their nitrogen requirements. Previous studies under sprinkler irrigation showed that the optimum N rate was less than the rate recommended by either the Oregon or Idaho fertilizer guides (Feibert et al., 1995). This trial compared Russet Burbank, Shepody, Frontier Russet, Ranger Russet, and three experimental lines AO82611-7 and COO83008-1 (both for processing), and NDTX 8-731-1R (a fresh market, red variety) as to their nitrogen requirements under furrow irrigation.

Procedures

The 1995 trial was conducted on an Owyhee silt loam previously planted to wheat at the Malheur Experiment Station. The field was bedded into 36-inch hills in the fall of 1994. A soil sample taken from the top foot on May 1, 1995 showed a pH of 7.8, 1.7 percent organic matter, 19 meq per 100 g of soil cation exchange capacity, 8 ppm nitrate-N, 4 ppm ammonium-N, 13 ppm phosphorus, 439 ppm potassium, 2350 ppm calcium, 383 ppm magnesium, 370 ppm sodium, 1.0 ppm zinc, 12.2 ppm iron, 8.8 ppm manganese, 1.0 ppm copper, 19 ppm sulfate-S and 0.7 ppm boron.

Two-ounce seed pieces were planted April 27 at 9-inch spacing. On May 19, Thimet 20G insecticide at 3 lbs ai/ac was shanked-in at the same time that urea for the nitrogen treatments was applied. The urea was applied before emergence to both sides of the hill (Figure 1). The shanks were adjusted to place the urea in bands located at the same depth as the seed piece and offset 9 inches from the hill center. The hills were remade with a Lilliston cultivator. Prowl at 1 lb ai/ac and Dual at 2 lbs ai/ac were broadcast on the entire soil surface on May 23 and incorporated with the Lilliston. A late blight and insect control program consisting of weekly aerial applications of fungicide and insecticide mixes was initiated on July 14 and continued through August 26.

The experimental design had four N treatments as main plots and the seven potato varieties as split-plots within the main plots (Table 3). The main plots were 9 rows wide and 50 feet long. The four nitrogen treatments were replicated six times.

Nitrogen fertilizer rates were 0, 84, 144, and 204 lb N/ac (Table 1). Pre-emergence urea was applied on May 19. The second nitrogen application consisted of urea applied to the furrow bottom immediately before an irrigation to simulate water-run nitrogen.

Table 1. Nitrogen rates applied to seven potato varieties. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Treatment	Spring nitrate plus ammonium N 0-1 feet	Pre-emergence N (May 19)	Post-emergence "water-run" N (July 14)	Total nitrogen supply*
	————	————	lbs N/ac ————	
1	36	0	0	36
2	36	60	24	120
3	36	100	44	180
4	36	140	64	240

* Does not include mineralized nitrogen during the season.

Twenty four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) were installed in the top foot of soil and six GMS were placed in the second foot of soil. The daily sensor readings were used to schedule irrigations. The GMS in the top foot of soil were offset 6 inches from the hill top and centered 8 inches below the hill surface. The second foot GMS were placed in the hill center and centered 20 inches below the hill surface. Half of the first foot sensors were located on the wheel traffic side of the potato hill and the other half were located on the non-wheel traffic side of the hill. Sensors were read five times per week from June 10 to September 4 at 8 AM. Irrigations were started when the average soil water potential in the first foot of soil dried to -50 kPa.

At each irrigation, every other furrow was irrigated, with the irrigated furrows alternating from irrigation to irrigation. Seventeen irrigations were applied from June 12 to

September 1. Irrigation durations were 24 hours from June 12 through July 17 and 12 hours from July 17 through September 1.

Petiole samples were collected every two weeks from June 21 to August 16, and analyzed for nitrate.

Russet Burbank, Shepody, and Frontier Russet plants in each plot were sampled for petiole nitrate. Plant available-N contributed from organic matter mineralization was determined by the buried bag method (Westermann and Crothers, 1980).

Tubers from 40 feet in each plot were harvested on September 26 and evaluated for yield and grade. A subsample was stored and analyzed for tuber specific gravity and stem-end fry color in early November.

Results and Discussion

The soil remained generally wetter than -60 kPa until late in the season (Figure 2). We have shown that soil much drier than -60 kPa at the 8-inch depth can be associated with an increase in US Number Two tubers and other quality defects.

The maximum total potato yield, over all varieties, was 518 cwt/ac obtained at 84 lb N/ac (Table 3). This yield was achieved with substantially less N fertilizer than the university fertilizer guides would have recommended for this field (Table 2). The N in this trial was shanked in after planting, which would improve the use efficiency compared to pre-plant broadcast applications. When broadcast N applications are used, substantial amounts of N can be lost to leaching, lost to volatilization, or be located in tops of the potato hill that are inaccessible to the roots. The average total potato yield for Malheur County in 1995 was 405 cwt/ac, using substantially more N fertilizer than used in this trial (225 lb N/ac).

Total tuber yield, total US Number Ones, large US Number Ones and marketable tuber yield increased with 84 lb N/ac, over all varieties (Table 3). The proportion of large US Number One tubers increased with 84 lb N/ac (Table 4).

Varieties AO82611-7 and COO83008-1 had among the highest marketable yield and AO82611-7 had the highest total US Number One yield. Ranger Russet had the highest tuber specific gravity (Table 5). Shepody, AO82611-7, and COO83008-1 had among the lightest tuber stem-end fry color.

Organic matter mineralization in the top foot of soil released 10 lbs N/ac between May 1 and May 18 and 46 lb N/ac between May 18 and July 5, based on analysis of the soil in the buried bags (Figure 3). The nitrogen in the buried bags represents residual soil available nitrogen plus nitrogen released from organic matter mineralization without the effects of crop uptake, leaching, and other losses.

The positive response of potato yields to N fertilization in 1995 compared to 1994 was probably due to the lower pre-plant soil nitrate and ammonium N in 1995 (75 lb N/ac on May 1) compared to 1994 (108 lb N/ac on March 24). Nitrogen mineralization released about the same amount of N by June 30 both years (90 lb N/ac from March 24 to June 30 in 1994 and 98 lb N/ac from May 1 to July 5 in 1995). By July 5 the buried bags in the top two feet of soil contained amounts of nitrate and ammonium corresponding to 173 lb N/ac in 1995 compared to 198 lb N/ac on June 30 in 1994.

Only the 204 lb N/ac treatment for Russet Burbank and Shepody and the 144 lb N/ac and 204 lb N/ac treatments for Frontier Russet resulted in petiole nitrate in the sufficiency range (Jones and Painter, 1974); levels that proved to be unnecessary for maximum yields (Figures 4-6).

Conclusions

Sidedressed N fertilization beyond 84 lb N/ac did not increase potato yields in 1995, over all varieties. The 84 lb N/ac resulting in the maximum total yield of 518 cwt/ac is substantially less than the university fertilizer recommendations for this field.

Averaged over all N rates, the experimental processing varieties AO82611-7 and COO83008-1, performed as well as, or better than Shepody and Ranger Russet in US Number One and marketable yield. Russet Burbank and Frontier Russet had among the darkest stem-end fry color and lowest tuber specific gravity.

Table 2. University N fertilizer recommendations compared to actual sidedressed N fertilizer needed to maximize furrow irrigated potato yield. Malheur Experiment Station, Ontario, Oregon, 1995.

Year	Soil nitrate & ammonium, 0-24 inches at planting	University recommendation		Lowest N rate tested achieving top yield
		Oregon	Idaho	
	-------- lb/ac --------			
1994	108	80	110	0
1995	75	236*	220**	84

* 176+ 60 (20 lb N/ac per ton of wheat straw residue)

** 175+45 (15 lb N/ac per ton of wheat straw residue)

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Table 3. Yield response of seven potato cultivars to four nitrogen fertilizer treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Nitrogen fertilizer rate	Potato yield by market grade										
		US Number One				US Number Two				Marketable	Undersize	Total yield
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total			
	lb N/ac	cwt/ac										
R. Burbank	0	126.0	174.3	122.1	422.3	2.8	8.9	20.5	32.1	454.4	94.2	548.6
	84	119.1	175.2	138.0	432.3	5.8	12.3	30.4	48.5	480.9	86.7	567.6
	144	106.4	170.2	152.2	428.8	6.3	15.0	30.8	52.1	480.9	80.6	561.5
	204	92.2	149.2	150.1	391.5	3.1	13.8	29.6	46.5	438.0	84.0	522.0
	Average	110.9	167.2	140.6	418.7	4.5	12.5	27.8	44.8	463.5	86.4	549.9
Shepody	0	39.0	98.7	278.0	415.6	0.3	1.8	5.4	7.5	423.2	17.3	440.4
	84	32.8	84.7	332.2	449.8	1.7	2.8	16.3	20.9	470.7	22.1	492.8
	144	33.1	91.5	312.8	437.4	1.8	2.9	28.6	33.3	470.7	19.2	489.9
	204	26.3	78.7	348.4	453.4	1.3	4.3	37.5	43.1	496.4	16.1	512.5
	Average	32.8	88.4	317.9	439.0	1.3	3.0	21.9	26.2	465.3	18.7	483.9
F. Russet	0	90.0	176.7	168.5	435.2	1.2	3.3	16.8	21.3	456.5	56.6	513.0
	84	76.9	137.5	223.3	437.7	2.0	2.1	18.7	22.7	460.5	63.1	523.6
	144	72.8	137.5	191.0	401.3	2.0	5.5	24.1	31.6	432.8	52.5	485.3
	204	71.2	115.2	199.2	385.6	2.7	7.2	23.3	33.1	418.7	59.5	478.2
	Average	77.7	141.7	195.5	414.9	2.0	4.5	20.7	27.2	442.1	57.9	500.0
R. Russet	0	49.2	142.7	181.6	373.5	3.0	6.8	19.7	29.6	403.1	30.2	433.2
	84	41.0	123.6	284.8	449.3	2.7	5.5	24.1	32.3	481.7	26.4	508.1
	144	42.4	110.3	271.5	424.3	1.2	7.6	25.0	33.8	458.1	27.2	485.3
	204	40.1	83.7	269.0	392.7	3.1	10.0	34.5	47.6	440.3	32.0	472.3
	Average	43.1	115.1	251.7	409.9	2.5	7.5	25.8	35.8	445.8	29.0	474.7
AO 82611-7	0	81.4	191.2	166.1	438.8	1.0	3.6	12.7	17.3	456.1	49.0	505.1
	84	61.5	158.5	240.1	460.2	1.6	6.1	20.3	28.0	488.2	38.5	526.7
	144	63.2	147.8	266.2	477.1	1.4	6.4	23.7	31.5	508.6	43.6	552.2
	204	59.7	145.2	299.0	504.0	2.3	5.8	19.3	27.5	531.4	43.3	574.8
	Average	66.5	160.7	242.9	470.0	1.6	5.5	19.0	26.1	496.1	43.6	539.7
COO 83008-1	0	40.2	128.8	220.0	389.0	1.1	6.7	24.1	31.9	421.0	19.2	440.2
	84	30.4	94.0	324.7	449.2	1.5	8.4	39.9	49.7	498.9	13.9	512.7
	144	39.6	135.3	270.2	445.0	1.5	8.9	21.8	32.2	477.2	20.6	497.8
	204	27.3	111.5	311.7	450.5	1.1	4.7	33.2	39.0	489.5	21.2	510.7
	Average	34.4	117.4	281.6	433.4	1.3	7.2	29.7	38.2	471.6	18.7	490.4
NDTX 8-731-1R	0	59.1	144.8	198.0	401.9	0.0	0.0	0.0	0.0	401.9	42.4	444.3
	84	68.4	146.2	240.2	454.8	0.0	0.0	0.0	0.0	454.8	45.4	500.2
	144	68.9	145.6	205.2	419.6	0.0	0.0	0.0	0.0	419.6	40.4	460.1
	204	59.2	142.0	197.6	398.8	0.0	0.0	0.0	0.0	398.8	42.3	441.1
	Average	63.9	144.6	210.2	418.8	0.0	0.0	0.0	0.0	418.8	42.6	461.4
All varieties	0	69.3	151.0	190.6	410.9	1.3	4.4	14.2	20.0	430.9	44.1	475.0
	84	61.5	131.4	254.8	447.6	2.2	5.3	21.4	28.9	476.5	42.3	518.8
	144	60.9	134.0	238.4	433.4	2.0	6.6	22.0	30.6	464.0	40.6	504.6
	204	53.7	117.9	253.6	425.2	1.9	6.5	25.3	33.8	459.0	42.6	501.7
LSD (0.05) Trt		6.5	9.3	23.7	21.5	ns	ns	6.6	8.5	21.5	ns	20.8
LSD (0.05) Variety		8.9	15.2	29.4	28.3	1.2	3.0	8.0	9.8	29.2	6.1	29.2
LSD (0.05) Trt X Var		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 4. Tuber market grade response of seven potato cultivars to four nitrogen fertilizer treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Nitrogen fertilizer rate	Potato market grade distribution									
		US Number One				US Number Two				Marketable	Undersize
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total		
	lb N/ac	%									
R. Burbank	0	22.8	31.5	22.8	77.1	0.5	1.6	3.8	5.9	83.0	17.0
	84	21.0	30.8	24.3	76.1	1.0	2.2	5.4	8.6	84.7	15.3
	144	19.3	30.4	26.5	76.2	1.2	2.6	5.4	9.2	85.4	14.6
	204	17.5	28.3	29.5	75.3	0.6	2.6	5.6	8.8	84.0	16.0
	Average	20.2	30.2	25.7	76.2	0.8	2.3	5.1	8.1	84.3	15.7
Shepody	0	9.0	22.8	62.6	94.4	0.1	0.4	1.2	1.6	96.0	4.0
	84	6.9	17.3	67.3	91.4	0.3	0.6	3.2	4.0	95.4	4.6
	144	6.8	18.8	63.7	89.3	0.4	0.6	5.8	6.7	96.0	4.0
	204	5.1	15.4	68.3	88.9	0.2	0.8	6.9	8.0	96.9	3.1
	Average	6.9	18.6	65.5	91.0	0.3	0.6	4.3	5.1	96.1	3.9
F. Russet	0	17.3	34.3	33.0	84.6	0.2	0.6	3.4	4.2	88.9	11.1
	84	14.9	26.3	42.3	83.5	0.4	0.4	3.5	4.3	87.8	12.2
	144	15.0	28.4	39.1	82.5	0.4	1.2	5.0	6.6	89.1	10.9
	204	15.0	23.9	41.6	80.5	0.6	1.5	4.9	6.9	87.5	12.5
	Average	15.6	28.3	39.0	82.8	0.4	0.9	4.2	5.5	88.3	11.7
R. Russet	0	11.4	33.3	41.6	86.3	0.7	1.5	4.4	6.7	93.0	7.0
	84	8.0	24.4	56.0	88.4	0.5	1.1	4.8	6.4	94.8	5.2
	144	8.9	22.7	55.8	87.3	0.2	1.5	5.2	7.0	94.3	5.7
	204	8.6	17.8	56.9	83.4	0.6	2.1	7.0	9.7	93.1	6.9
	Average	9.2	24.5	52.6	86.3	0.5	1.6	5.4	7.5	93.8	6.2
AO 82611-7	0	16.3	37.9	32.6	86.8	0.2	0.7	2.5	3.4	90.2	9.8
	84	11.7	30.1	45.4	87.2	0.3	1.2	4.0	5.4	92.6	7.4
	144	11.4	26.9	48.2	86.5	0.2	1.1	4.3	5.6	92.1	7.9
	204	10.6	25.7	51.3	87.5	0.4	1.0	3.3	4.7	92.3	7.7
	Average	12.5	30.1	44.4	87.0	0.3	1.0	3.5	4.8	91.8	8.2
COO 83008-1	0	9.2	28.9	50.1	88.2	0.2	1.6	5.5	7.3	95.5	4.5
	84	6.1	18.5	62.7	87.4	0.3	1.6	8.0	9.9	97.3	2.7
	144	8.0	27.2	54.2	89.3	0.3	1.8	4.4	6.5	95.8	4.2
	204	5.4	22.1	60.6	88.1	0.2	0.9	6.6	7.7	95.8	4.2
	Average	7.2	24.2	56.9	88.3	0.3	1.5	6.1	7.9	96.1	3.9
NDTX 8-731-1R	0	13.2	33.3	43.9	90.4	0.0	0.0	0.0	0.0	90.4	9.6
	84	13.8	29.3	47.8	90.9	0.0	0.0	0.0	0.0	90.9	9.1
	144	15.0	31.9	44.3	91.1	0.0	0.0	0.0	0.0	91.1	8.9
	204	13.4	32.2	44.8	90.4	0.0	0.0	0.0	0.0	90.4	9.6
	Average	13.9	31.7	45.2	90.7	0.0	0.0	0.0	0.0	90.7	9.3
All varieties	0	14.2	31.7	40.9	86.8	0.3	0.9	3.0	0.2	91.0	9.0
	84	11.8	25.2	49.4	86.4	0.4	1.0	4.1	5.5	91.9	8.1
	144	12.1	26.6	47.4	86.0	0.4	1.3	4.3	6.0	92.0	8.0
	204	10.8	23.6	50.4	84.9	0.4	1.3	4.9	6.6	91.4	8.6
LSD (0.05) Trt		1.7	1.9	3.8	ns	ns	ns	1.3	1.6	ns	ns
LSD (0.05) Variety		1.7	2.9	4.6	2.2	0.2	0.6	5.6	1.9	1.2	1.2
LSD (0.05) Trt X Var.		ns	5.8	ns	ns	ns	ns	ns	ns	ns	ns

Table 5. Tuber stem-end fry color and specific gravity response of six potato cultivars to four nitrogen fertilizer treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Nitrogen fertilizer rate	Stem-end fry color	Specific gravity	Variety	Nitrogen fertilizer rate	Stem-end fry color	Specific gravity
	lb N/ac	% reflectance			lb N/ac	% reflectance	
R. Burbank	0	32.5	1.094	R. Russet	0	44.7	1.159
	84	33.8	1.092		84	45.2	1.102
	144	33.2	1.088		144	45.5	1.100
	204	33.4	1.087		204	44.4	1.098
	Average	33.2	1.090		Average	44.9	1.115
Shepody	0	46.5	1.094	AO 82611-7	0	45.6	1.095
	84	47.6	1.093		84	46.5	1.094
	144	46.4	1.087		144	46.3	1.093
	204	44.9	1.089		204	45.9	1.094
	Average	46.3	1.091		Average	46.1	1.094
F. Russet	0	35.6	1.097	COO 83008-1	0	48.3	1.097
	84	34.0	1.088		84	47.2	1.095
	144	32.9	1.088		144	50.3	1.096
	204	30.1	1.083		204	49.1	1.092
	Average	33.1	1.089		Average	48.7	1.095
All varieties	0	42.2	1.106				
	84	42.4	1.094				
	144	42.4	1.092				
	204	41.3	1.090				
LSD (0.05) Trt		ns	ns				
LSD (0.05) Variety		19.7	0.016				
LSD (0.05) Trt X Var		ns	ns				

Figure 1. Nitrogen fertilizer was shanked into the bed between the furrow and seed piece. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

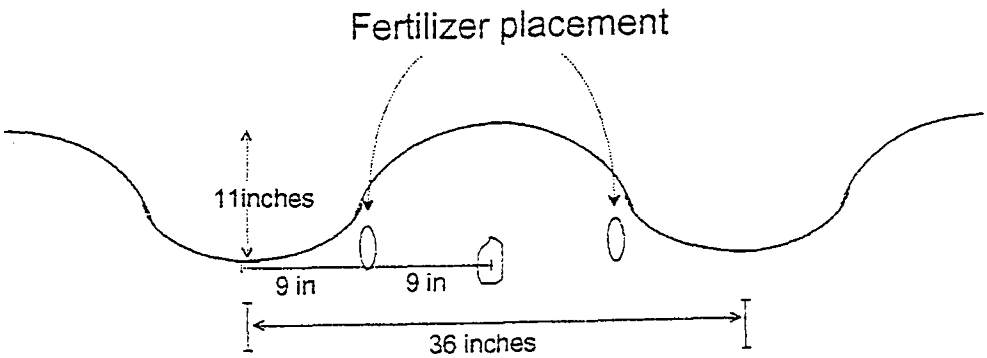


Figure 2. Soil water potential over time for furrow-irrigated potatoes. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

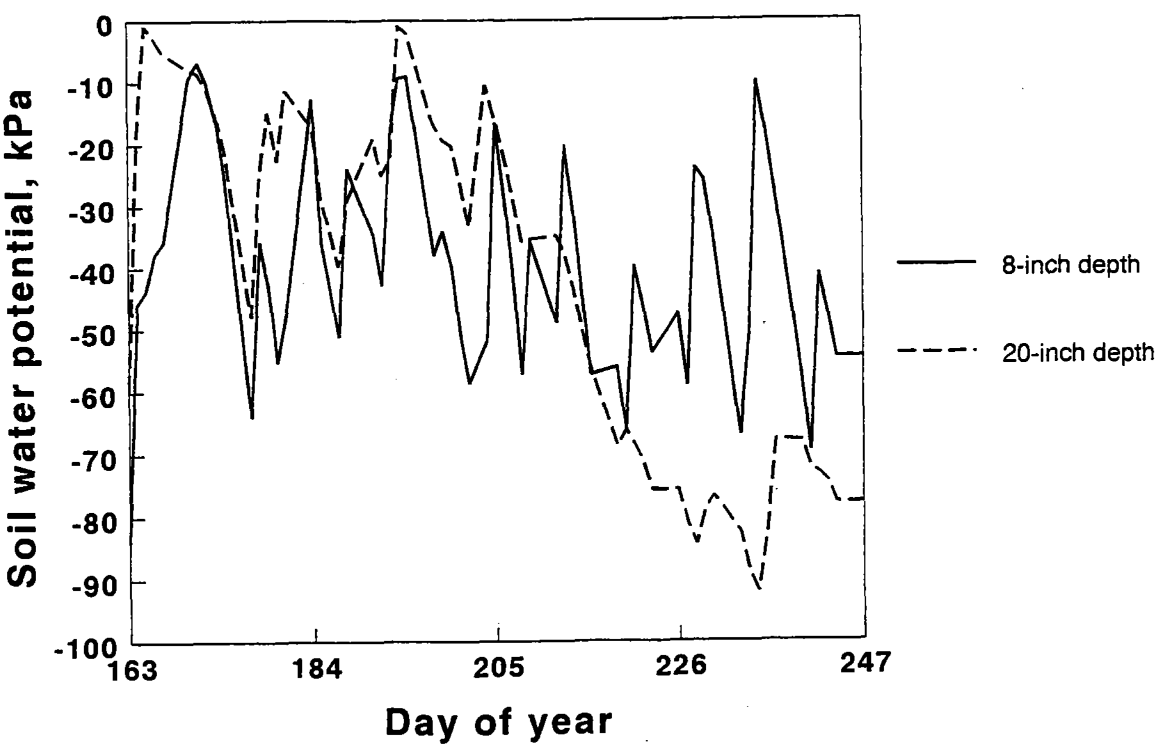


Figure 3. Available soil N in the first and second foot of soil released through organic matter mineralization as estimated by the buried-bag method. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

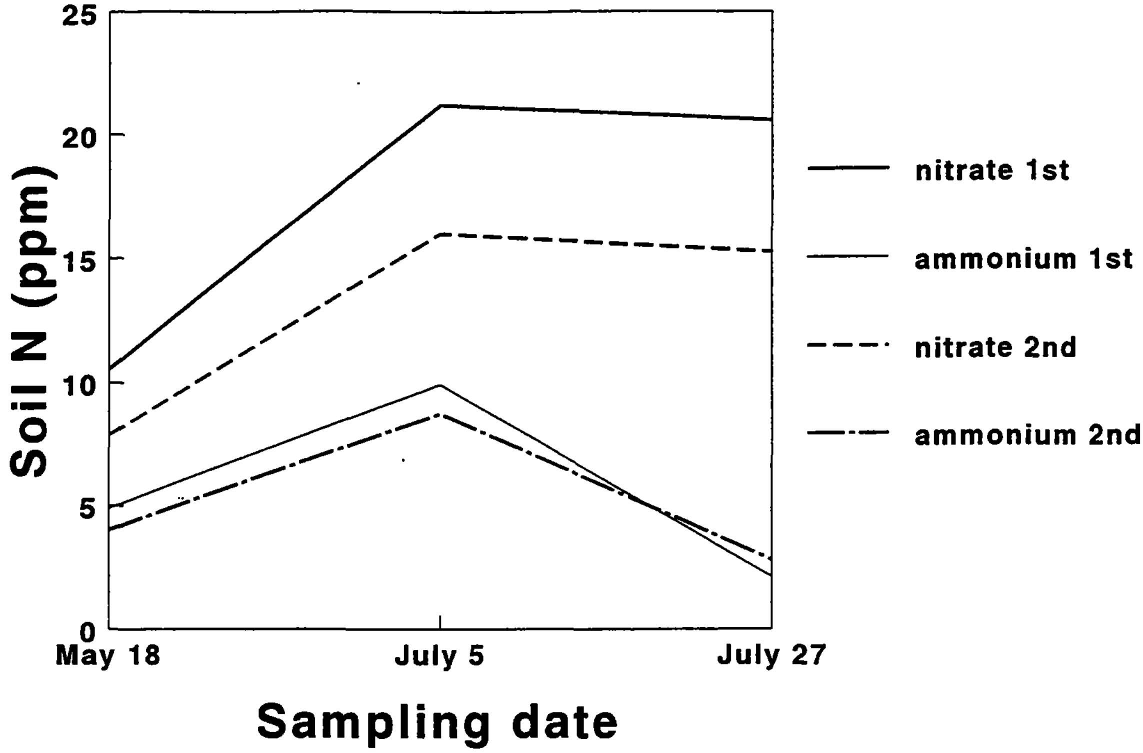


Figure 4. Russet Burbank petiole nitrate over time for furrow-irrigated potatoes receiving different N treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

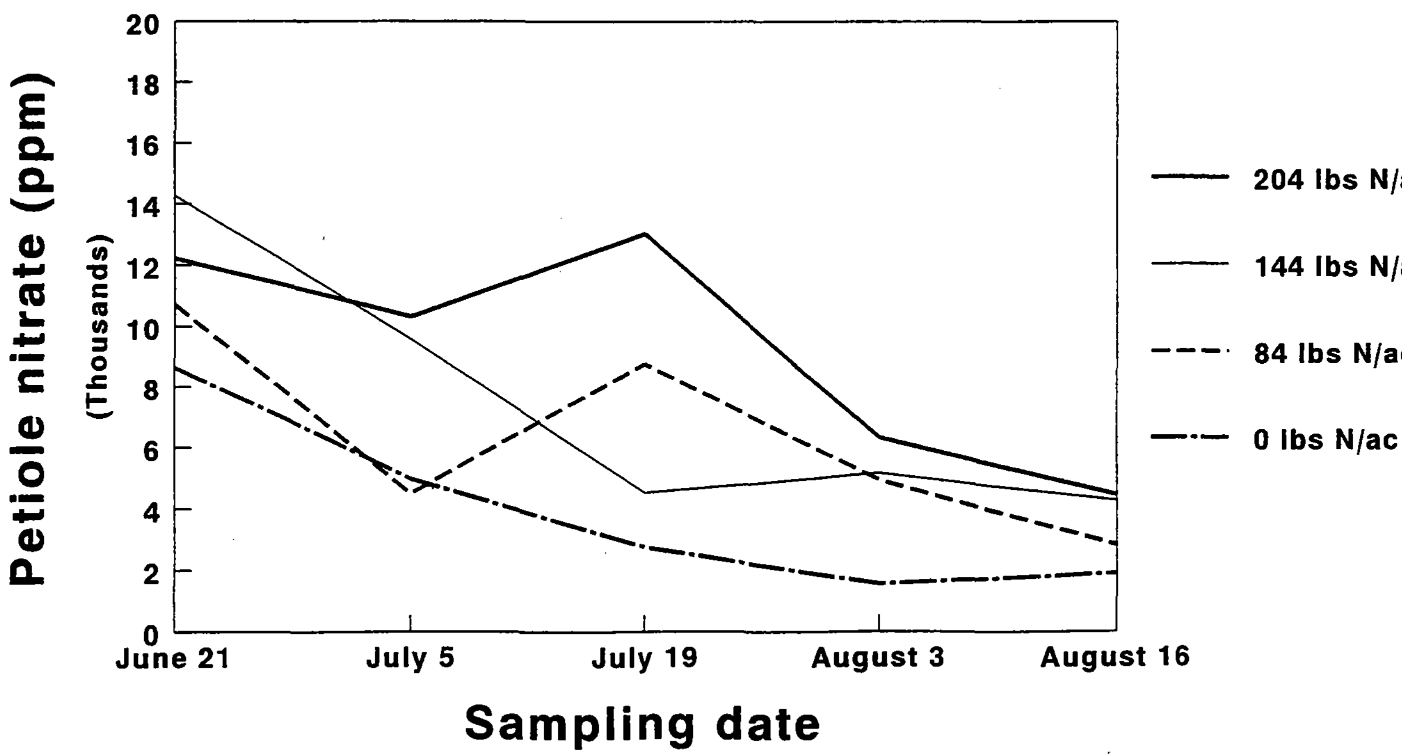


Figure 5. Shepody petiole nitrate over time for furrow-irrigated potatoes receiving different N treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

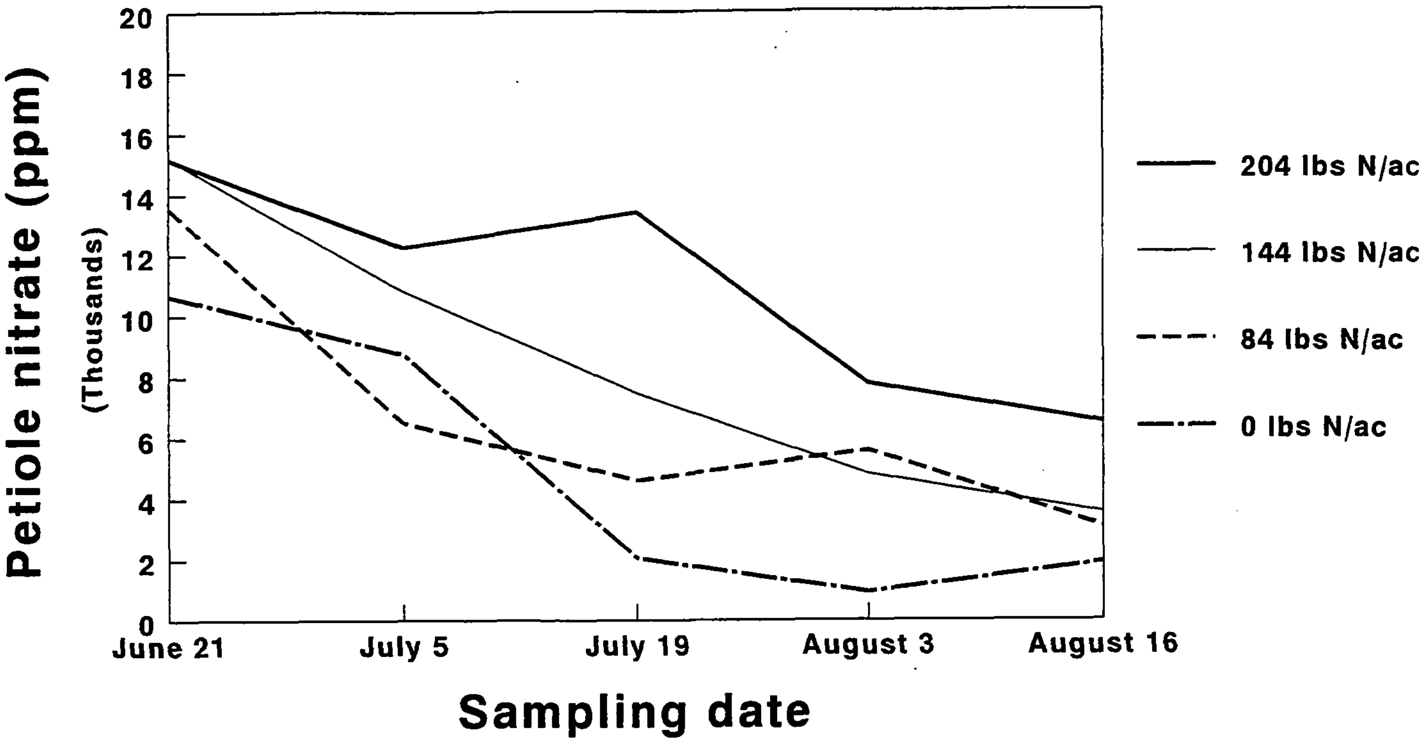
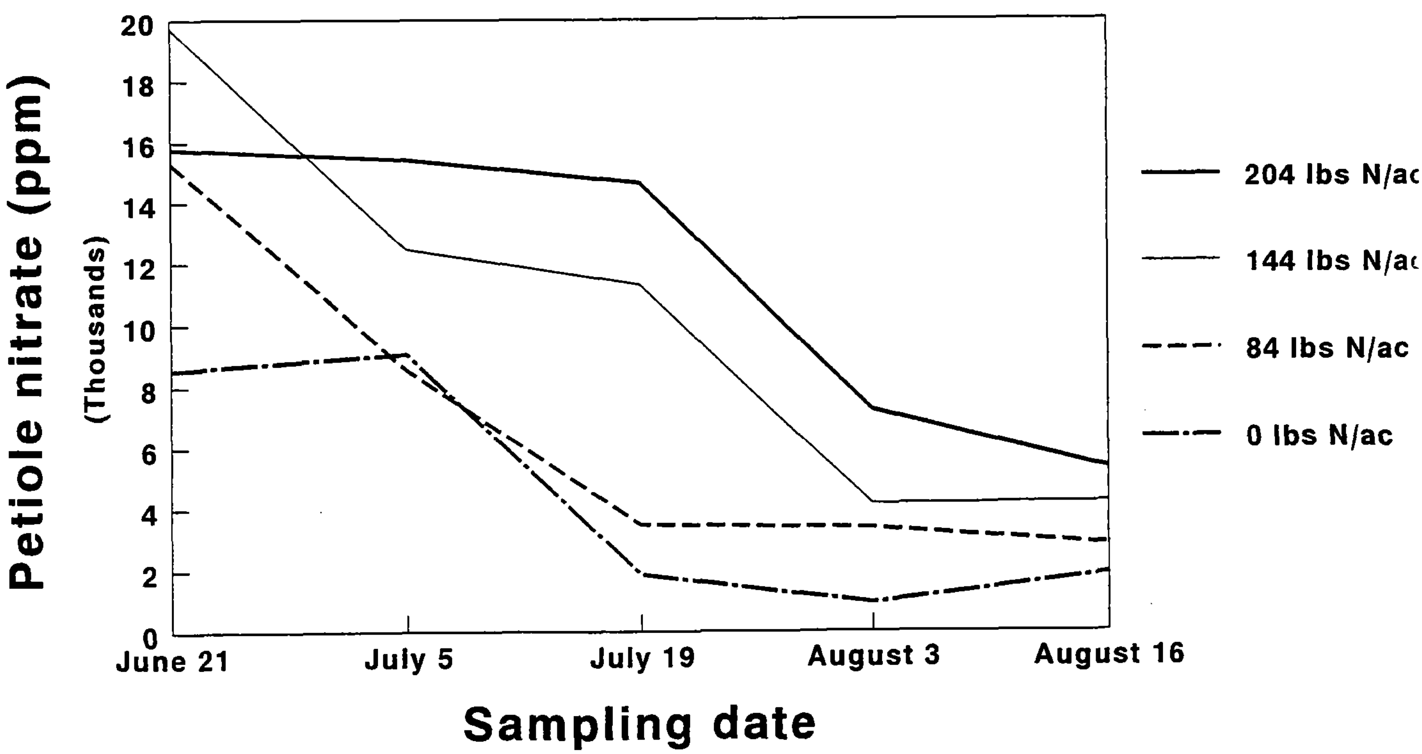


Figure 6. Frontier Russet petiole nitrate over time for furrow-irrigated potatoes receiving different N treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.



AN EVALUATION OF POTATO QUALITY DURING STORAGE

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Introduction

Tuber stem-end fry color and specific gravity are important quality criteria for frozen french fries. Processors require a light, uniform fry color. Processors also have requirements for specific gravity. Low tuber specific gravity results in poor processing quality. Potatoes are stored by processors from harvest to harvest, so tuber quality loss during storage can be a problem.

Two experimental varieties from the Oregon Variety Development Program, AO82611-7 and COO83008-1, have shown superior agronomic characteristics in statewide trials and are being considered for release for processing in the near future. The quality of these new varieties after storage is not well known. This trial compared Russet Burbank, Shepody, Frontier Russet, Ranger Russet, AO82611-7 and COO83008-1 for changes in tuber stem-end fry color and specific gravity during storage following production under furrow irrigation.

Procedures

The six potato varieties were grown with furrow irrigation and fertilized at four rates (0, 84, 144, and 204 lb N/ac) during the 1995 season. Potatoes were harvested on September 26. Tuber stem-end fry color and specific gravity were determined for a 20 tuber sample from every variety, N rate and replicate on November 10, 1995. An additional 70 lb of tubers from each variety from each N rate treatment were placed in a controlled atmosphere storage at 45 °F and 90 percent relative humidity. The remaining tubers were transported to a commercial potato storage in Ontario, Oregon, and treated with sprout inhibitor (Sproutnip 7A at 1 lb ai/600 cwt of tubers) on December 20, 1995. These potatoes were returned to the Malheur Experiment Station storage on December 22. Four 20-tuber samples of each variety were used to determine stem-end fry color and specific gravity. Each 20 tuber sample for each variety consisted of five tubers from each N rate treatment. Tuber stem-end fry color and specific gravity were evaluated January 5, February 6, and March 12, 1996. Tuber stem-end fry color was determined one half inch from the tuber stem end on fried slices using a Photovolt Reflectance Meter Model 577 (Photovolt Co., Indianapolis, IN) and methodology as described by Shock et al., 1994. Tuber specific gravity calculations were based on tuber weight in air and in water.

Results and Discussion

The experimental cultivar COO83008-1 had the lightest frying tubers on November 10, 1996 (Table 1, Figure 1). The experimental cultivars AO82611-7 and COO83008-1 had significantly lighter stem-end fry colors than the commercial cultivars on all subsequent evaluation dates. Ranger Russet had the highest specific gravity on November 10, 1995 and on March 12, 1996 (Table 1, Figure 2). AO82611-7 and COO83008-1 had among the next highest specific gravities on November 10, 1996. COO83008-1 and Frontier Russet had among the next highest specific gravity on March 12, 1996.

Conclusions

The superior tuber stem-end fry color and high specific gravity of the experimental varieties AO82611-7 and COO 83008-1, relative to the commercial varieties, were maintained during the 4 month storage.

Literature cited

Shock, C. C., T. D. Stieber, J. C. Zalewski, E. P. Eldredge, and M. D. Lewis. 1994. Potato tuber stem-end fry color determination. Am Potato J. 71:77-88.

Table 1. Tuber quality over time for six potato cultivars in controlled atmosphere storage. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1996.

	Stem-end fry color				Specific gravity			
	November 10, 1995	January 5, 1996	February 6, 1996	March 12, 1996	November 10, 1995	January 5, 1996	February 6, 1996	March 12, 1996
Variety	— % reflectance —							
Russet Burbank	33.2	22.6	21.6	21.9	1.090	1.090	1.090	1.090
Shepody	46.3	28.8	29.9	31.2	1.090	1.090	1.090	1.090
Frontier Russet	33.1	22.5	23.9	26.4	1.090	1.090	1.090	1.090
Ranger Russet	44.9	26.2	24.0	27.5	1.120	1.100	1.100	1.100
AO82611-7	46.1	36.8	37.5	39.0	1.090	1.090	1.080	1.090
COO 83008-1	48.7	33.2	34.9	39.2	1.100	1.090	1.090	1.090
LSD (0.05)	1.5	2.2	2.6	2.4	0.020	0.010	0.010	0.010

Figure 1. Tuber stem-end fry color over time for six potato clones during storage using a Photovolt Reflectance Meter. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1996.

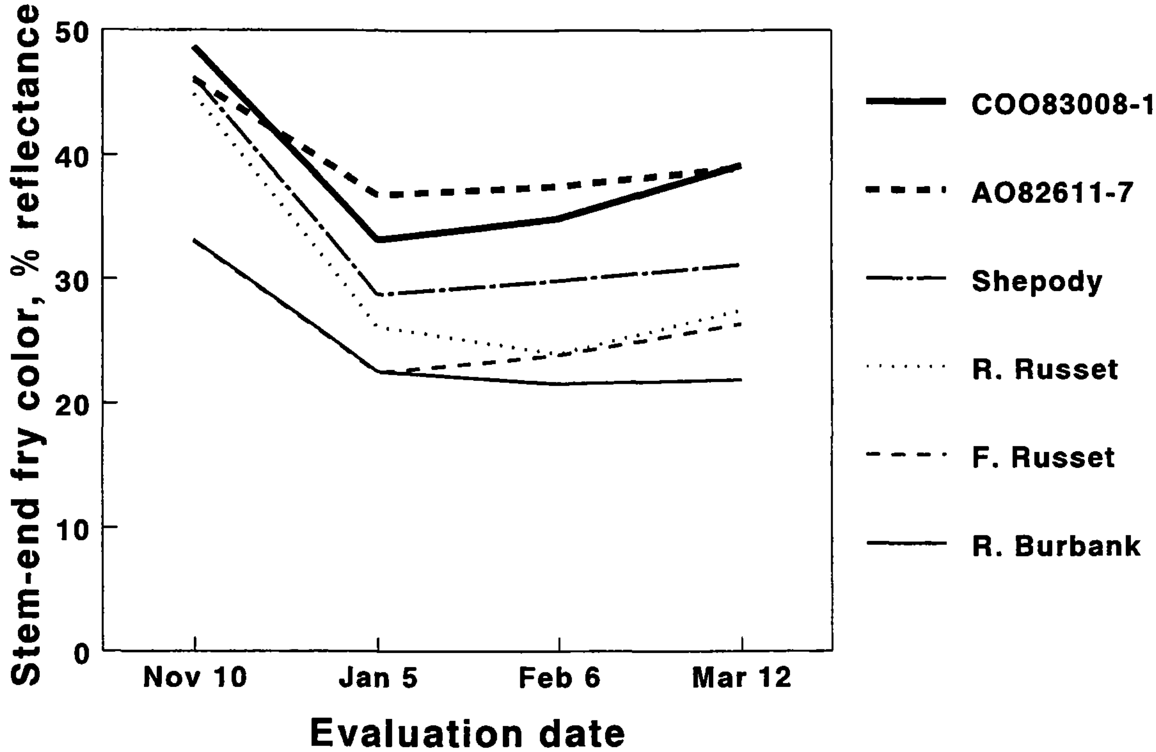
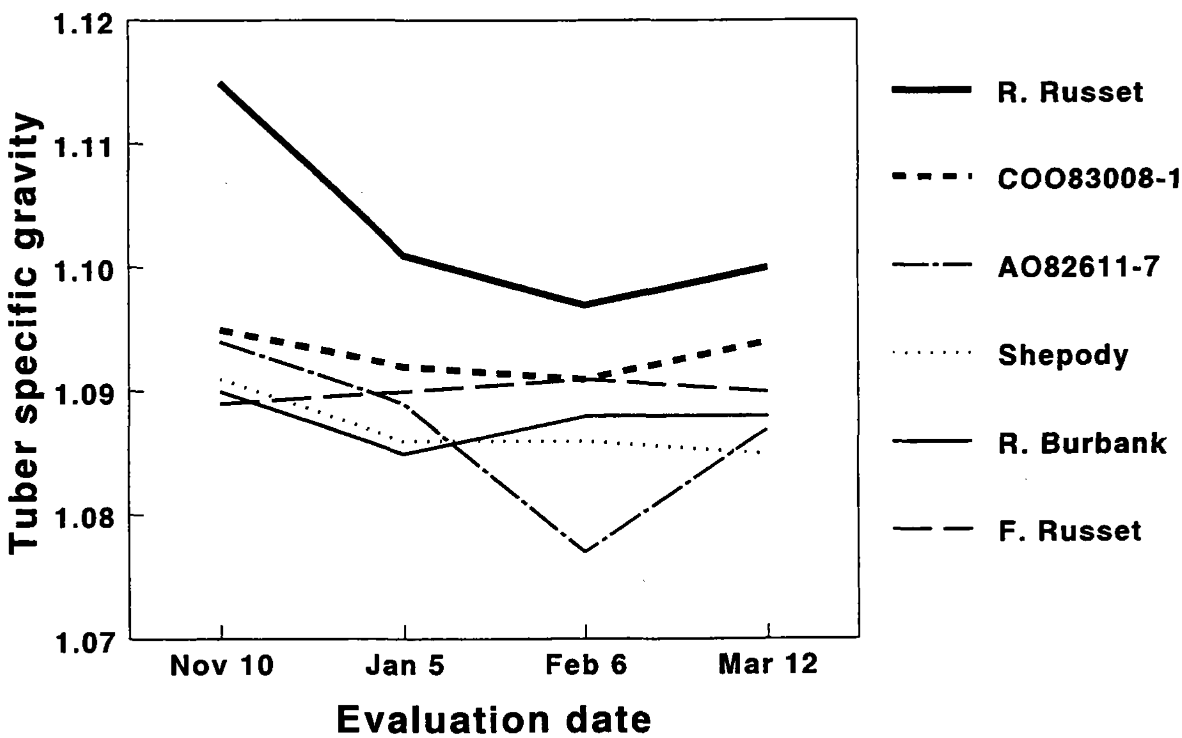


Figure 2. Tuber specific gravity over time for potato varieties in storage. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1996.



YIELD AND QUALITY OF FOUR POTATO CULTIVARS IN RESPONSE TO PAM (Polyacrylamide) TREATMENT OF IRRIGATION WATER

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Summary

Russet Burbank, Shepody, Frontier Russet, and Ranger Russet potatoes were tested for their response to furrow irrigation with PAM-treated irrigation water. Treatment of irrigation water with PAM did not result in any difference in potato yield or grade in 1995. The use of PAM was found to be associated with lighter frying tubers, over all varieties.

Introduction

Polyacrylamide (PAM) is a water soluble polymer and is a high potency flocculent. PAM has been shown to significantly reduce soil erosion (90-95 % reduction) associated with surface irrigation when applied to irrigation water. The PAM application rate for effective erosion control is approximately 1 lb/acre/irrigation for the first few irrigations (Shock et al., 1995). The need for PAM in subsequent irrigations is not well established.

PAM has been shown to maintain soil water infiltration rates during the season and to reduce the compaction of the soil caused by surface irrigation (Terry and Nelson, 1986; Wallace et al., 1986). Furrow irrigated potato production with PAM treated water could result in an increase in tuber yield and quality and more "mellow" soil at harvest reducing clods and soil attached to tubers.

Procedures

The 1995 trial was conducted on an Owyhee silt loam previously planted to wheat at the Malheur Experiment Station. The field was bedded into 36-inch hills in the fall of 1994. A soil sample taken from the top foot on May 1, 1995 showed a pH of 7.8, 1.7 percent organic matter, 19 CEC, 8 ppm nitrate-N, 4 ppm ammonium-N, 13 ppm phosphorus, 439 ppm potassium, 2350 ppm calcium, 383 ppm magnesium, 370 ppm sodium, 1.0 ppm zinc, 12.2 ppm iron, 8.8 ppm manganese, 1.0 ppm copper, 19 ppm sulfate-S and 0.7 ppm boron.

Two-ounce seed pieces were planted April 27 at 9-inch spacing. On May 19, Thimet 20G insecticide at 3 lbs ai/ac was shanked-in with urea at 100 lb N/ac. The urea was applied after planting and before emergence to both sides of the hill. The shanks were adjusted to place the urea in bands located at the same depth as the seed piece and offset 9 inches from the hill center. The hills were remade with a Lilliston cultivator. The herbicides Prowl at 1 lb ai/ac and Dual at 2 lbs ai/ac were broadcast on the entire soil surface on May 23 and incorporated with the Lilliston. Forty four pounds of N/ac were applied as water-run urea on July 14. A late blight and insect control program consisting of weekly aerial applications of fungicide and insecticide mixes was initiated on July 14 and run through August 26.

The plots were furrow irrigated and received either PAM-treated or untreated water at each irrigation. PAM was applied as an aqueous solution at 1 lb/ac during the first two irrigations and at 0.2 lb/ac during subsequent irrigations (Table 1). The premixed PAM solution was applied directly into the irrigation water by way of a K-Box in the transmission line in order to enhance mixing with the irrigation water. PAM application rate was adjusted so that 80 percent of the PAM was applied during the advance time and the remainder of the PAM was applied during the rest of the irrigation set. Four potato varieties (Russet Burbank, Shepody, Frontier Russet, and Ranger Russet) were split-plots within the main plots. The treatments were replicated six times.

Four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) were installed in the top foot of soil and one GMS was placed in the second foot of soil in each plot. The GMS in the top foot of soil were offset 6 inches from the hill top and centered 8 inches below the hill surface and the second foot GMS were placed in the hill center and centered 20 inches below the hill surface. Half of the first foot sensors were located on the wheel traffic side of the potato hill and the other half were located on the non-wheel traffic side of the hill. Sensors were read five times per week from June 10 to September 4 at 8 AM. Irrigations were scheduled to avoid the average soil water potential in the first foot of soil drying beyond -50 kPa. PAM-treated and untreated plots were irrigated separately as needed.

At each irrigation, every other furrow was irrigated, with the irrigated furrows alternating from irrigation to irrigation. Seventeen irrigations were required by the untreated plots and 18 irrigations were required by the PAM-treated plots from June 12 to September 1. Irrigation durations were 24 hours from June 12 through July 17 and 12 hours from July 17 through September 1.

Petiole samples were collected every two weeks from June 21 to August 16, and analyzed for nitrate. Russet Burbank, Shepody, and Frontier Russet plants in each plot were sampled. Tubers from 40 feet in each plot were harvested on September 26 and evaluated for yield and grade. A subsample was stored and analyzed for tuber specific gravity and stem-end fry color in early November.

Two soil bulk density samples at 2-inch depth and offset 6 inches horizontally from the non-wheel and wheel furrow bottoms were taken on September 19 from each replicate of each treatment. Four penetrometer readings were also taken in the same locations in each replicate. PAM-treated and untreated furrow shapes in two dimensions were measured using a drop rod measuring device on September 20. Each shape is an average of four measurements taken in close proximity in the same furrow.

Results and Discussion

The average soil water potential in the potato hills at 8-inch depth for the PAM-treated and untreated plots followed a similar pattern during the season (Figure 1).

Treatment of irrigation water with PAM did not result in any significant difference in potato yield or grade in 1995 (Tables 1 and 2). PAM-treated irrigation water was associated with lighter frying tubers over all varieties (Table 3).

There was no significant difference in soil bulk density between the PAM-treated and untreated plots. The PAM-treated non-wheel furrows had lower penetrometer readings than the untreated non-wheel furrows (2.8 and 3.7 kg/cm^2 for PAM and non-PAM, respectively, significant at the P = 0.02 level). At the end of the season, the untreated wheel furrows at the bottom of the field were shallower than the PAM-treated wheel furrows (Figure 2). The shallower furrows in the untreated plots suggest soil movement and deposition from the top of the field and soil redistribution from the sides to the bottom of the potato hills. Since PAM was effective in maintaining a deep furrow, the depth of water in the PAM-treated furrows during irrigations was probably less than in the untreated furrows resulting in less effective wetting of the hill. Further research to determine the appropriate furrow shape to be used with PAM-treated water could improve the wetting of the hills.

The patterns of petiole nitrate over time were similar between the PAM-treated and untreated plots for each of the three varieties (Figure 3).

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Table 1. Yield response of four potato cultivars to PAM-treated irrigation water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Treatment	Potato yield by market grade										
		US Number One				US Number Two				Marketable	Undersize	Total yield
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	Total			
		cwt/ac										
R. Burbank	No PAM	106.4	170.2	152.2	428.8	6.3	16.8	30.8	53.8	482.6	80.6	563.2
	PAM	112.2	148.6	119.1	379.9	3.8	11.3	14.6	29.6	409.5	82.6	492.1
	Average	109.3	159.4	135.7	404.3	5.1	14.0	22.7	41.7	446.1	81.6	527.7
Shepody	No PAM	33.1	91.5	312.8	437.4	1.8	2.9	29.7	34.5	471.9	19.2	491.1
	PAM	22.3	73.4	314.4	410.1	0.0	1.7	20.0	21.7	431.9	16.7	448.5
	Average	27.7	82.5	313.6	423.8	0.9	2.3	24.9	28.1	451.9	17.9	469.8
F. Russet	No PAM	72.8	137.5	191.0	401.3	2.0	5.5	24.1	31.6	432.8	52.5	485.3
	PAM	73.8	132.5	221.6	427.8	1.0	1.8	15.5	18.3	446.1	52.4	498.5
	Average	73.3	135.0	206.3	414.6	1.5	3.6	19.8	24.9	439.5	52.4	491.9
R. Russet	No PAM	42.4	110.3	271.5	424.2	1.2	7.6	25.0	33.8	458.1	27.2	485.3
	PAM	45.0	128.5	242.3	415.8	3.3	9.9	22.2	35.4	451.2	46.4	497.6
	Average	43.7	119.4	256.9	420.0	2.2	8.8	23.6	34.6	454.6	36.8	491.4
All varieties	No PAM	63.6	127.4	231.9	422.9	2.8	8.2	27.4	38.4	461.3	44.9	506.2
	PAM	63.3	120.8	224.4	408.4	2.0	6.2	18.1	26.2	434.7	49.5	484.2
LSD (0.05) Trt		ns	ns	ns	ns	ns	ns	7.6	12.5	ns	ns	ns
LSD (0.05) Variety		11.2	14.3	33.7	ns	2.3	4.9	ns	12.3	ns	38.6	38.4
LSD (0.05) Trt X var		ns	20.2	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 2. Market grade distribution response of four potato cultivars to PAM-treated irrigation water. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

Variety	Treatment	Potato market grade distribution									
		US Number One				US Number Two				Marketable	Undersize
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total		
		%									
R. Burbank	No PAM	19.2	30.3	26.4	75.9	1.2	3.0	5.4	9.5	85.5	14.5
	PAM	22.8	30.3	24.2	77.2	0.8	2.3	2.9	5.9	83.2	16.8
	Average	21.0	30.3	25.3	76.6	1.0	2.6	4.2	7.7	84.3	15.7
Shepody	No PAM	6.8	18.8	63.6	89.1	0.4	0.6	6.0	6.9	96.0	4.0
	PAM	5.0	16.7	69.6	91.3	0.0	0.4	4.6	4.9	96.2	3.8
	Average	5.9	17.8	66.6	90.2	0.2	0.5	5.3	5.9	96.1	3.9
F. Russet	No PAM	15.0	28.4	39.1	82.5	0.4	1.2	5.0	6.6	89.1	10.9
	PAM	14.8	26.7	44.3	85.8	0.2	0.3	3.1	3.6	89.4	10.6
	Average	14.9	27.5	41.7	84.2	0.3	0.7	4.0	5.1	89.3	10.7
R. Russet	No PAM	8.9	22.7	55.8	87.3	0.2	1.5	5.2	7.0	94.3	5.7
	PAM	9.4	26.2	48.5	84.1	0.7	2.0	4.6	7.3	91.4	8.6
	Average	9.1	24.4	52.1	85.7	0.5	1.8	4.9	7.2	92.9	7.1
All varieties	No PAM	12.5	25.0	46.2	83.7	0.5	1.6	5.4	7.5	91.2	8.8
	PAM	13.0	25.0	46.7	84.6	0.4	1.3	3.8	5.4	90.0	10.0
LSD (0.05) Trt		ns	ns	ns	ns	ns	ns	1.4	1.9	ns	ns
LSD (0.05) Variety		2.2	2.9	4.5	2.8	0.5	0.9	ns	ns	2.5	2.5
LSD (0.05) Trt X Var		ns	ns	6.3	ns	ns	ns	ns	ns	ns	ns

Table 3. Tuber quality response of four potato cultivars to PAM-treated irrigation water. Malheur Experiment Station, Oregon State University, Ontario, OR, 1995.

Variety	Treatment	Stem-end fry reflectance color	Specific gravity
		%	
R. Burbank	No PAM	33.2	1.09
	PAM	35.4	1.09
	Average	34.3	1.09
Shepody	No PAM	46.4	1.09
	PAM	48.9	1.09
	Average	47.7	1.09
F. Russet	No PAM	32.9	1.09
	PAM	34.9	1.09
	Average	33.9	1.09
R. Russet	No PAM	45.5	1.1
	PAM	45.7	1.1
	Average	45.6	1.1
All varieties	No PAM	39.5	1.09
	PAM	41.2	1.09
LSD (0.05) Trt		1.1	ns
LSD (0.05) Variety		1.9	0
LSD (0.05) Trt X Var		ns	ns

Figure 1. Soil water potential over time at 8-inch depth in potato hills furrow irrigated with PAM-treated and untreated water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

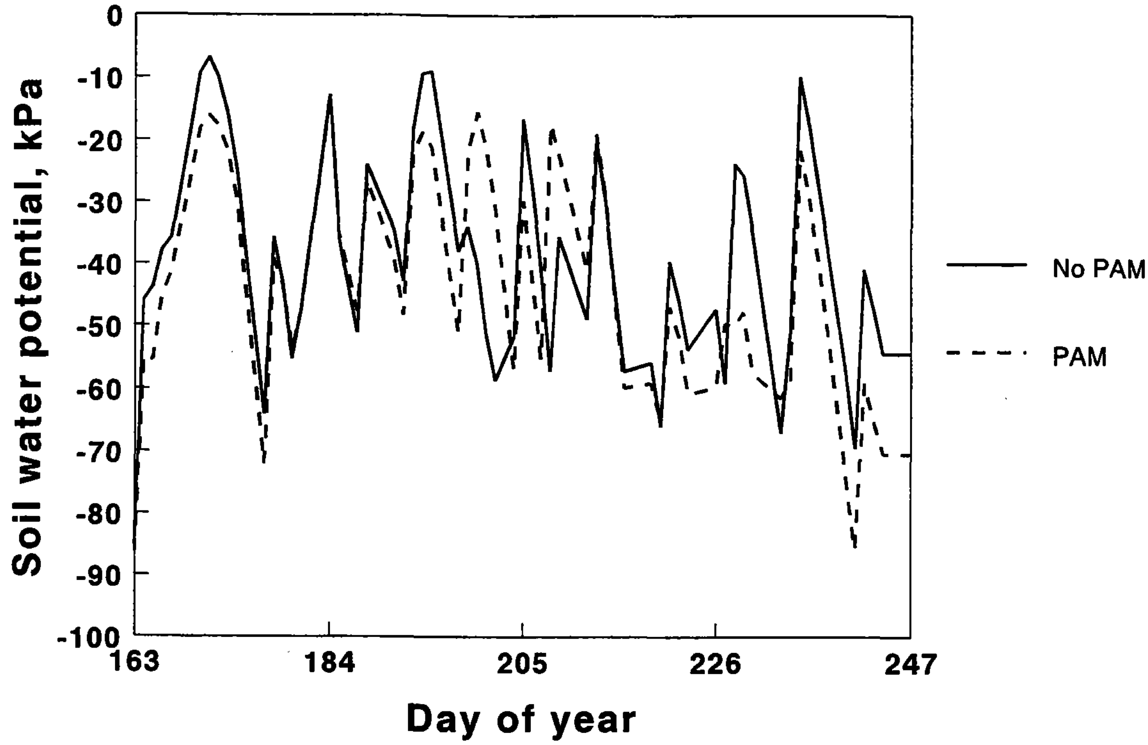


Figure 2. Furrow shapes at the field bottom (400' from top, wheel furrows). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

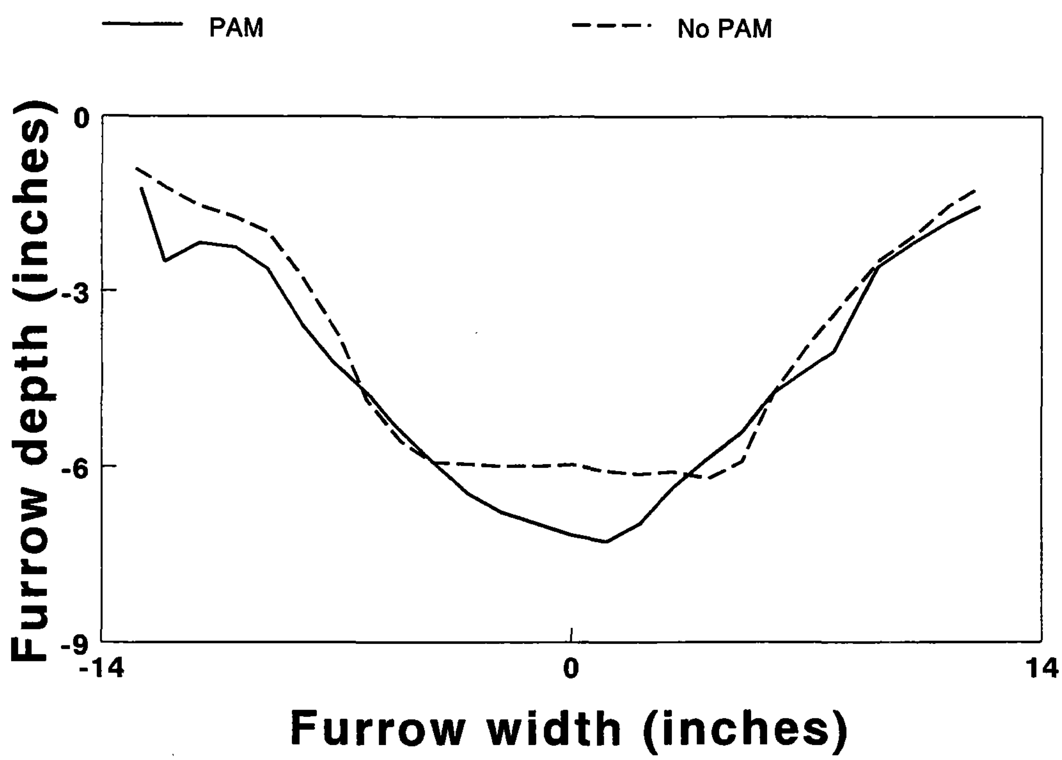
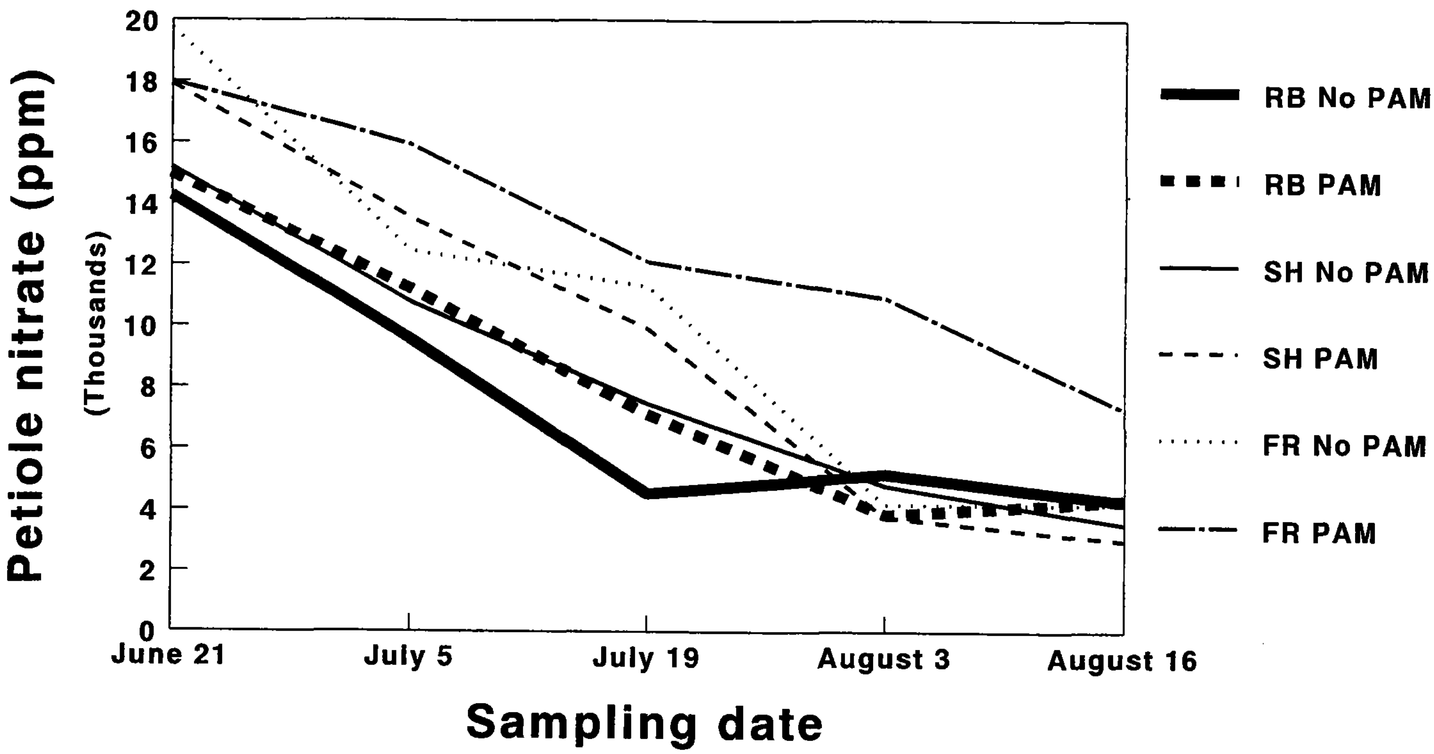


Figure 3. Petiole nitrate over time for Russet Burbank, Shepody and Frontier Russet plants. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.



POTATO HERBICIDE TRIAL

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Purpose

To evaluate herbicides for crop tolerance and weed control when applied at different rates as postplant preemergence and postemergence applications to Shepody and Russet Burbank potato varieties.

Procedure

Herbicides applied as postplant preemergence treatments included Frontier, Dual, Prowl, and Eptam. Frontier was applied alone at rates of 1.17 and 2.34 lb ai/ac. Dual was applied alone at 2.0 lb ai/ac and in tank-mix combination with Prowl and Eptam at 2.0 lb ai/ac of Dual and 1.5 and 2.0 lb ai/ac of Prowl and Eptam, respectively. Frontier was also tank-mixed with Prowl and Eptam using 1.17 lb ai/ac of Frontier and 1.5 and 2.0 lb ai/ac of Prowl and Eptam. These treatments were applied on May 2, and the potatoes were planted on April 25. Potato seed pieces were sprouted and weed seeds germinated, but there was no emergence. After application, three-quarters inch of water was applied by sprinkle irrigation to activate the herbicides.

The postemergence applied herbicides included Matrix (Dupont E9636) applied alone at rates of 0.0156 and 0.0238 lb ai/ac and in tank-mix combination with Eptam, Prowl, and Lexone. Eptam, Prowl, and Lexone rates were 3.0, 0.75, and 0.375 lb ai/ac, respectively. Two surfactants, non-ionic X-77 and MorAct crop-oil-concentrate were compared as herbicide activators. Assure II was tank-mixed with Lexone to evaluate for compatibility and grass control. The postemergence herbicides were applied on May 2. Russet Burbank potatoes were about 90 percent emerged with 4 inches of height on some plants. Shepody plants were about 35 percent emerged with the remainder of the plants pushing up underneath the thin soil crust. Herbicides had to be applied, because the emerged weeds were getting too large. Weed species included redroot pigweed, hairy nightshade, lambsquarters, kochia, and barnyardgrass. Most of the broadleaf weeds had 4-true leaves and were 1-inch in height. The barnyardgrass was with one to three leaves. When postemergence herbicides were applied, the air temperature was 72°F, soil temperature at 4-inches 61°F, and the wind calm with clear skies. The soil surface was dry. On May 3, about 24 hours after the herbicides were applied, the trial area was sprinkle irrigated with one-half inch of water to activate the soil active herbicides.

The herbicide treatments were applied as double overlap broadcast applications using a single bicycle wheel plot sprayer. Spray nozzles were 8002 Teejet fan nozzles spaced 10-inches apart on a 9-foot boom. Spray pressure was 35 psi, and water was applied at a volume of 31.8 gal/ac.

The previous crop in 1994 had been Stephens winter wheat. After the wheat was harvested, the stubble straw was mulched with a steel flail beater, disked, and irrigated. In October the field was chiseled to a depth of 18-inches and bedded. Soil texture was a silt loam with 1.3 percent organic matter and a pH of 1.3. Bronate at 1 qt/ac had been applied to control weeds in the wheat. One-hundred lb/ac of phosphate and 60 lb/ac of nitrogen were broadcast before chiseling.

In the spring before planting, the bedded land was spike-tooth harrowed, and the centers of the beds were chiseled to a depth of 16-inches with a single shank. Individual plots were two rows wide and forty feet long. An unplanted buffer area one row wide (36 inches) was along both sides of the two treated rows and was used to prevent herbicide mixing between adjacent plots. Each treatment was replicated three times and randomly arranged in blocks using a complete randomized block experimental design. The two-row plots consisted of one row Russet Burbank and the second row Shepody. Individual seed pieces were cut to weigh about two ounces. Seed pieces were spaced about 9 inches apart in the row and planted about 4 inches below the surface of leveled soil. Rows were spaced 36 inches apart. After planting, the potato rows were rehilled using hilling shovels mounted in-front-of and behind rolling teeth of a Lilliston cultivator. The planted potatoes received no further tillage except for two rows where the weeds were controlled by cultivation only without the use of herbicides. This area served as the untreated cultivation check plot. It was cultivated with a Lilliston when the potato foliage was about twelve inches tall and weeds had 2 to 4 inches of growth.

The treatments were evaluated on June 8 for early weed control and crop injury and again on August 30 when the tops had started to desiccate to identify treatments controlling weeds till time of harvest.

Potato tubers were harvested and graded on September 5, 6, and 7. Tubers were graded as number 1, 2, and culls. Number 1 tubers were graded into size categories 4 to 8 oz, 8 to 12 oz, and over 12 oz. Culls were tubers less than 4 oz. Number 2 were larger than 4 oz and too misshapen to be number 1.

Results

Both Shepody and Russet Burbank potato varieties were tolerant to all herbicide treatments. The following postplant preemergence applied herbicide treatments controlled better than 95 percent of all weed species: Frontier at both 1.17 and 2.34 lb ai/ac rates and tank-mix combinations of Frontier or Dual with Prowl and Eptam. Dual at 2.0 lb ai/ac did not control all weed species. Postemergence applied herbicides giving 95 percent control of all weed species included Matrix + Eptam + NIS at both Matrix rates of 0.0156 and 0.0238 lb ai/ac, Matrix + Prowl + NIS at 0.0238 lb ai/ac of Matrix and 0.75 lb ai/ac Prowl, Matrix + Lexone + NIS at 0.0238 and 0.375 lb ai/ac, and

Matrix + COC at 0.0238 lb ai/ac. Several herbicide treatments gave complete control of pigweed and barnyardgrass. Hairy nightshade and lambsquarters were most difficult for Matrix to control in this trial. Most herbicide treatments that controlled weeds early persisted to control weeds until harvest. Matrix was more active with a crop-oil-concentrate than a non-ionic surfactant. Eptam gave better control of hairy nightshade at the lower rate of Matrix than did Prowl. Good weed control was obtained in this trial with the tank-mix combination of Lexone and Assure II at rates of 0.5 and 0.075 lb ai/ac. This treatment controlled 100 percent pigweed, lambsquarters, kochia, barnyardgrass, and over 85 percent control of hairy nightshade. About 65 percent of the weeds were controlled by cultivation.

Herbicide treatments, with the possible exception of Lexone + Assure II, did not injure the potatoes causing a reduction in tuber size or yield, but tuber yield was reduced by weed competition in those treatments where weed control was not complete. These differences were great enough to be significant at the 5 percent level. Hairy nightshade left uncontrolled was the most competitive weed species in this trial causing the greatest reduction in tuber yield. Total tuber yield was higher for Russet Burbank, but Shepody produced larger tubers, more number 1 and more marketable tubers (Table 3).

The better treatments in this trial included Frontier 2.34 lb, Frontier or Dual in tank-mix combination with Prowl and Eptam applied preemergence, and the postemergence tank-mix applications containing Matrix with Eptam or Prowl and a surfactant.

Table 1. Early crop injury ratings and percent weed control in Shepody and Russet Burbank potatoes treated with herbicides applied as postplant preemergence and post emergence applications. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Crop injury						Percent weed control														
			Russet Burbank			Shepody			H. nightshade			Pigweed			Lambsquarters			Kochia			Barnyardgrass		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		—— % ——			—— % ——			—— % ——														
Frontier	1.17	pre	0	0	0	0	0	0	98	95	95	100	98	99	100	98	95	95	95	98	100	100	100
Frontier	2.34	pre	0	0	0	0	0	0	100	98	99	100	98	99	100	99	99	98	95	98	100	100	100
Dual	2. 0	pre	0	0	0	0	0	0	93	95	85	98	98	90	100	100	95	98	98	98	100	100	100
Frontier + Prowl + Eptam	1.17 + 1.5 + 2. 0	pre	0	0	0	0	0	0	99	99	99	100	100	100	100	100	100	100	100	100	100	100	100
Dual + Prowl + Eptam	2. 0 + 1.5 + 2. 0	pre	0	0	0	0	0	0	100	99	100	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + NIS	0. 156	post	0	0	0	0	0	0	50	50	60	100	100	100	90	90	90	85	80	85	93	95	95
Matrix + Eptam + NIS	0. 0156 + 3. 0	post	0	0	0	0	0	0	98	99	98	100	100	100	98	100	100	98	98	100	100	100	100
Matrix + Prowl + NIS	0. 0156 + 0.75	post	0	0	0	0	0	0	93	90	93	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl	0. 0156 + 0.75	post	0	0	0	0	0	0	98	93	93	100	100	100	98	100	100	100	98	98	100	100	100
Matrix + Lexone + NIS	0. 0156 + 0.375	post	0	0	0	0	0	0	65	75	50	100	100	90	98	98	90	95	95	98	100	100	100
Matrix + NIS	0. 0238	post	0	0	0	0	0	0	65	85	80	95	100	100	95	95	85	85	90	90	95	100	100
Matrix + Eptam + NIS	0. 0238 + 3. 0	post	0	0	0	0	0	0	95	98	99	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl + NIS	0. 0238 + 0.75	post	0	0	0	0	0	0	99	99	99	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl	0. 0238 + 0.75	post	0	0	0	0	0	0	85	85	65	100	100	100	90	90	90	100	100	100	100	100	100
Matrix + Lexone + NIS	0. 0238 + 0.375	post	0	0	0	0	0	0	100	99	99	98	100	100	100	100	100	100	100	100	100	100	100
Matrix + COC	0. 0238	post	0	0	0	0	0	0	93	98	98	100	100	100	100	100	100	100	100	100	100	100	100
Lexone + Assure II	0.5 + 0.075	post	0	0	0	0	0	0	80	85	80	100	100	100	100	100	100	100	100	100	100	100	100
Cultivated check	–	–	0	0	0	0	0	0	60	55	45	65	70	65	55	60	60	45	50	50	40	35	40
Untreated check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NIS = non-ionic surfactant (X-77) added at rate of 0.25% v/v.

COC = crop oil concentrate (MorAct) added at rate of 1% v/v.

Evaluated June 8.

Ratings: 0 = no herbicide effect. 100 = all plants killed by herbicides.

Table 2. Weed control ratings taken on August 30 for control of late germinating weeds in Shepody and Russet Burbank potatoes treated with herbicides applied as postplant preemergence and postemergence applications. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Percent weed control														
			H. nightshade			Pigweed			Lambsquarters			Kochia			Barnyardgrass		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		%														
Frontier	1.17	pre	95	95	98	100	100	100	100	100	100	100	100	100	100	100	100
Frontier	2.34	pre	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Dual	2. 0	pre	95	92	80	95	95	90	90	95	90	90	95	90	90	95	90
Frontier + Prowl + Eptam	1.17 + 1.5 + 2. 0	pre	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Dual + Prowl + Eptam	2. 0 + 1.5 + 2. 0	pre	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + NIS	0. 156	post	50	50	35	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Eptam + NIS	0. 0156 + 3. 0	post	95	93	95	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl + NIS	0. 0156 + 0.75	post	98	95	90	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl	0. 0156 + 0.75	post	75	70	85	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Lexone + NIS	0. 0156 + 0.375	post	80	65	35	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + NIS	0. 0238	post	35	45	50	100	95	95	95	95	95	100	95	95	100	95	95
Matrix + Eptam + NIS	0. 0238 + 3. 0	post	98	90	98	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl + NIS	0. 0238 + 0.75	post	98	100	98	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Prowl	0. 0238 + 0.75	post	85	80	75	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + Lexone + NIS	0. 0238 + 0.375	post	50	80	98	100	100	100	100	100	100	100	100	100	100	100	100
Matrix + COC	0. 0238	post	85	80	90	100	100	100	100	100	100	100	100	100	100	100	100
Lexone + Assure II	0.5 + 0.075	post	85	90	90	100	100	100	100	100	100	100	100	100	100	100	100
Cultivated check	–	–	65	60	60	70	65	70	70	70	70	70	70	70	50	60	50
Untreated check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NIS = non-ionic surfactant (X-77) added at rate of 0.25% v/v.

COC = crop oil concentrate (MorAct) added at rate of 1% v/v.

Evaluated August 30.

Ratings: 0 = no herbicide effect. 100 = all plants killed by herbicides.

Table 3. Potato tuber grade, size, and yield of Russet Burbank and Shepody varieties treated with herbicides applied postplant preemergence or postemergence. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Tuber size, grade, and yield															
			Number 2		< 4 oz		4 - 8 oz		8 - 12 oz		> 12 oz		Total yield		Percent no. 1		Percent > 12 oz	
Herbicides	Rate	Applied	Shep	R. Bur	Shep	R. Bur	Shep	R. Bur	Shep	R. Bur	Shep	R. Bur	Shep	R. Bur	Shep	R. Bur	Shep	R. Bur
	lb ai/ac		cwt/ac															
Frontier	1. 17	pre	20	37	34	188	45	162	140	156	236	62	476	604	88. 5	62. 8	49 .6	10. 2
Frontier	2. 34	pre	30	62	31	191	42	161	108	156	281	64	492	634	87. 4	60. 2	57. 1	10. 2
Frontier + Prowl + Eptam	1.17 + 1.5 + 2. 0	pre	36	49	40	194	60	133	128	143	250	65	515	585	85. 0	58. 5	48. 6	11. 2
Dual + Prowl + Eptam	2 + 1.5 + 2. 0	pre	36	47	27	191	48	143	114	147	280	59	504	586	87. 4	59. 5	55. 6	10. 0
Matrix + NIS	0. 0156	post	18	36	36	105	43	75	62	70	53	14	210	300	74. 6	53. 2	25. 1	4. 7
Matrix + Eptam + NIS	0. 0156 + 3. 0	post	20	70	37	177	58	150	137	154	246	53	497	603	88. 6	59. 0	49. 5	8. 7
Matrix + Prowl + NIS	0. 0156 + 0.75	post	44	61	43	154	68	120	110	137	239	52	504	523	82. 7	58. 9	47. 4	10. 0
Matrix + Prowl	0. 0156 + 0.75	post	21	79	27	141	56	100	116	109	224	61	444	490	89. 2	55. 0	50. 5	12. 4
Matrix + Lexone + NIS	0. 0156 + 0.375	post	25	40	31	131	50	119	101	121	168	22	394	433	85. 8	60. 6	47. 6	5. 1
Matrix + NIS	0. 0238	post	20	74	38	128	42	115	114	91	132	32	346	439	83. 2	54.0	38. 1	7. 2
Matrix + Eptam + NIS	0. 0238 + 3. 0	post	26	59	34	198	68	174	144	134	263	26	534	591	88. 8	56. 6	49. 2	4. 5
Matrix + Prowl + NIS	0. 0238 + 0.75	post	31	89	39	174	51	122	120	188	254	30	495	603	85. 9	56. 4	51. 3	5. 0
Matrix + Lexone + NIS	0. 0238 + 0.375	post	30	57	40	225	61	213	144	143	194	39	468	678	85. 1	58. 4	41. 5	5. 8
Matrix + COC	0. 0238	post	23	58	38	188	56	165	134	137	204	47	455	595	86. 6	58. 6	44. 8	7. 9
Lexone + Assure II	0.50 + 0.075	post	46	77	33	147	42	144	100	127	196	45	416	540	81. 2	58. 5	47. 2	8. 3
Untreated check	--	--	6	26	27	108	26	65	26	51	17	12	102	263	67. 6	59. 1	16. 7	4. 5
Mean			28	57	33	164	47	133	107	129	196	42	410	525	83. 2	57. 8	44. 7	7. 7
LSD (0.05%)			6	12	6	19	7	16	12	15	12	8	22	36	0. 3	2. 9	0. 3	1. 4
CV (%)			12. 6	12. 5	11. 2	6. 9	9. 3	7. 1	6. 4	7. 1	3. 4	10. 9	3. 1	4. 1	1. 8	3. 1	3. 3	10. 8

Area harvest = 1 row x 40 ft/variety for each replication.

THE EFFECT OF SIMULATED HAIL ON YIELD AND QUALITY OF PUMPKINS AND TWO SQUASH VARIETIES

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Introduction

Hail is a potential threat during every crop season. Pumpkin and squash growers and the crop insurance industry are interested in having an accurate method for estimating crop loss due to hail. This trial evaluated one pumpkin and two squash varieties for their response to simulated hail damage that resulted in 75 percent defoliation, before or after fruit set.

Procedures

The field received 30 lb N/ac, 143 lbs P_2O_5/ac, and 6 lbs Zn/ac the previous fall and the field was plowed and disked.

Howden pumpkins, Table Ace acorn squash, and Waltham butternut squash were planted on May 18, 1994 with two seeds at 18-inch spacing in rows 12 feet apart using a Model 900 Mulch Planter (Mechanical Transplanter Co, Holland, Michigan). Replanting was done in spots with low stand on May 28.

The experiment was designed with three replicates each containing nine plots. Each plot was 30 feet long and one row wide. The rows were 12 feet apart to allow access for hail treatments. Each plot contained either pumpkins, butternut squash, or acorn squash and received either no hail, early hail, or late hail. The varieties and treatments within each replicate were completely randomized.

The hail treatments consisted of a non-hailed check treatment, simulated hail before fruit set, and simulated hail after fruit set (Table 1). The early date before fruit set was June 28 and the dates after fruit set were July 21 or August 4. Butternut squash were not hailed on July 21 since there was not yet any fruit set. Each plot in each hail treatment received hail only once. The hail treatments consisted of cubed ice being blown through a flexible plastic tube until approximately seventy-five percent of the leaf cover was removed.

Before the hail was applied, observations on plant development were made and recorded including plant width, height, and fruit size. Vines were turned back into each 30 ft by 12 ft plot on July 21, August 4, August 11, and August 22.

The crops were irrigated as needed in a single furrow down one side of the each row. Weeds were controlled by preplant application and incorporation of Prefar at 5 lbs ai/ac, by two cultivations, and by three quick hand weedings of only the planted row.

The pumpkins were harvested October 15-23 and the squash were harvested from September 25 through October 9. All of the sound fruit were harvested regardless of defects or imperfect maturity. Each fruit was weighed and graded individually. Fruit was graded into five groups: perfect, minor defects, major defects, cull and immature. Fruit with minor defects were considered to be scratches and hail damage that might be overlooked by a consumer. Fruit with minor defects and perfect fruit were considered marketable.

Results and Discussion

No hail or major cause of leaf damage occurred during the 1994 season. Growing conditions were favorable for high yields of good quality fruit.

Variety differences in yield and grade

Howden pumpkins were more productive than Table Ace acorn squash or Waltham butternut squash averaging 65,453 lb/ac total yield (Table 2); however the pumpkins also had more fruit with minor and major defects than either squash variety. The pumpkins averaged 18.94 lbs each, Table Ace acorn squash weighed 1.84 lbs each, while Waltham butternut squash averaged 2.98 lbs.

Hail Treatments

Simulated hail treatments produced significant reductions in perfect fruit (Figure 1), marketable yield (Figure 2), total yield (Figure 3), and percent marketable yield (Figure 4). Hail treatments were associated with significant increases in major defects in pumpkins, especially the late hailed pumpkins (Table 2).

Figure 1. Response of perfect fruit of Howden pumpkin, Table Ace acorn squash, and Waltham butternut squash to simulated hail treatments. The simulated hail removed 75 percent of the vegetation. Ontario, Oregon, 1994.

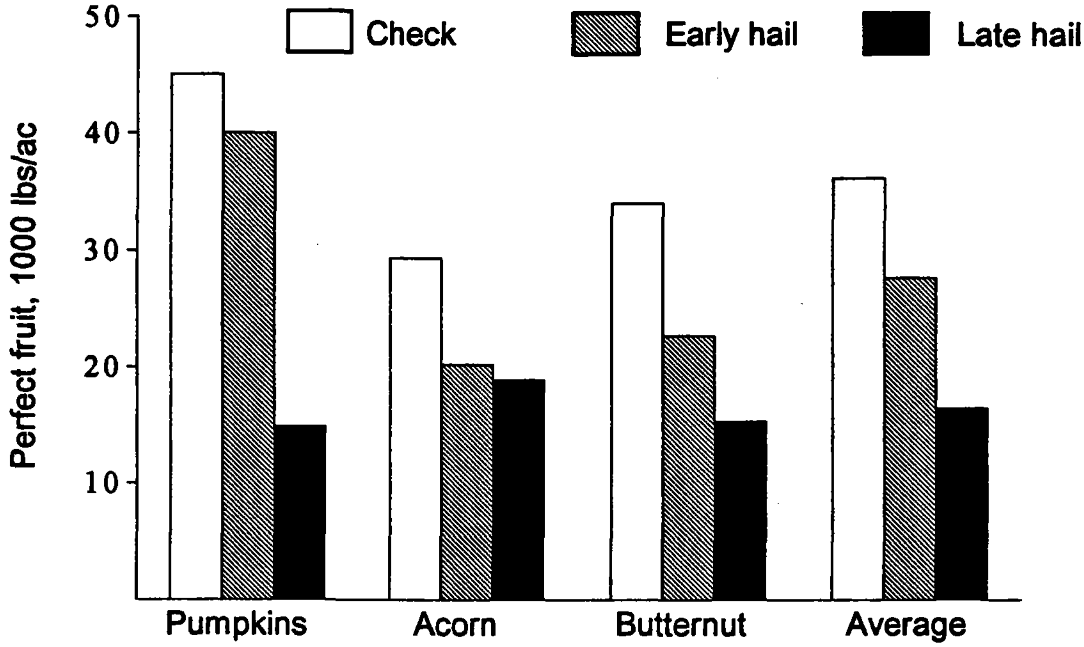

Figure 2. Response of marketable yield of Howden pumpkin, Table Ace acorn squash, and Waltham butternut squash to simulated hail treatments. The simulated hail removed 75 percent of the vegetation. Ontario, Oregon, 1994.

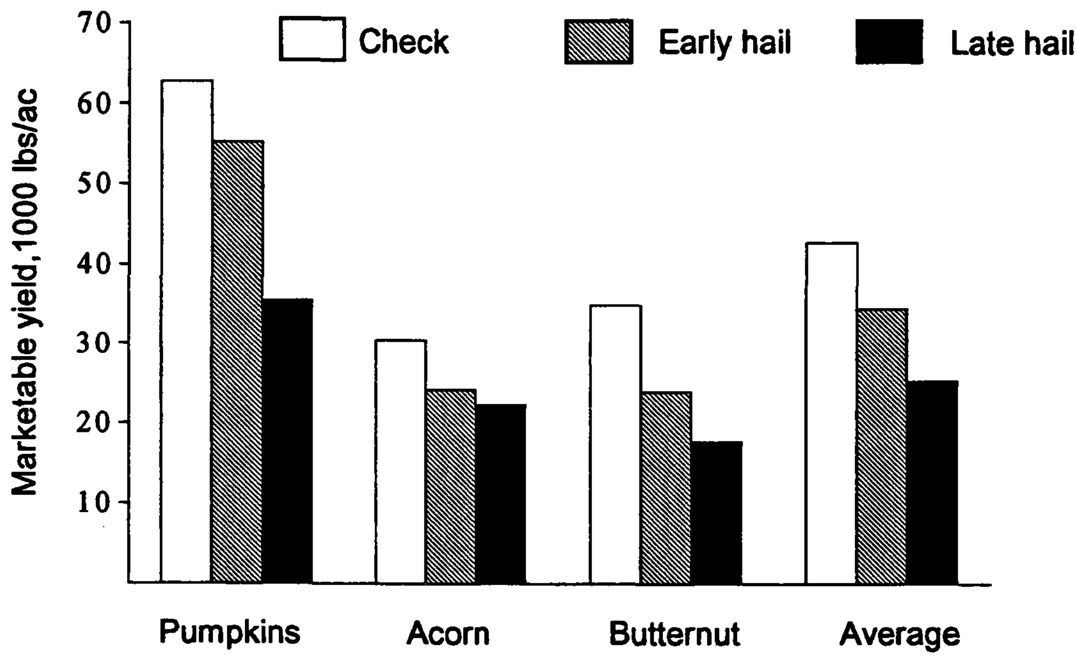

Figure 3. Response of total yield of Howden pumpkin, Table Ace acorn squash, and Waltham butternut squash to simulated hail treatments. The simulated hail removed 75 percent of the vegetation. Ontario, Oregon, 1994.

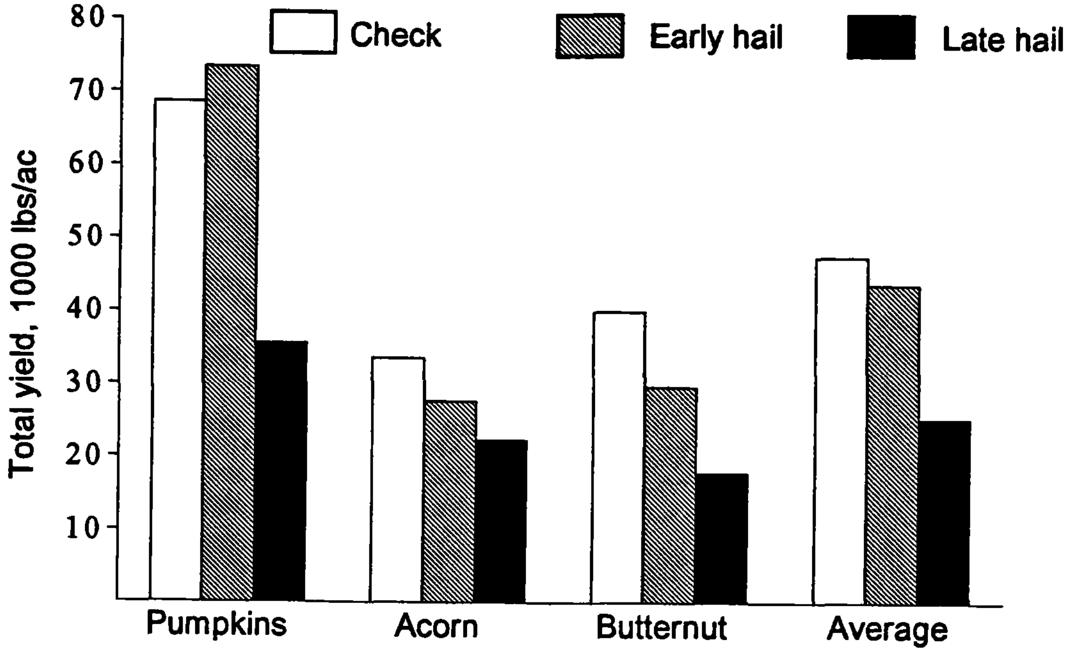

Figure 4. Percent marketable yield of Howden pumpkin, Table Ace acorn squash, and Waltham butternut squash to simulated hail treatments. The simulated hail removed 75 percent of the vegetation. Ontario, Oregon, 1994.

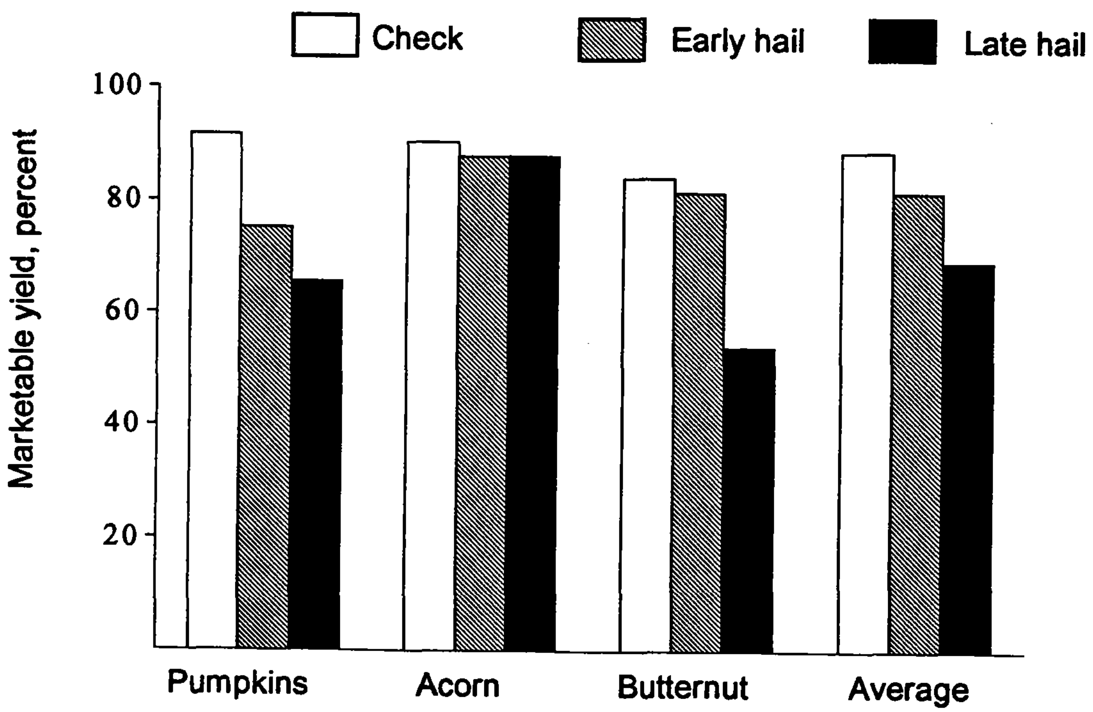

Table 1. Timing of simulated hail on pumpkins and squash planted May 18, 1994 at Ontario, Oregon.

Treatment number	Variety	Hail treatment	Defoliation	Plant growth stage at hail				
				Fully expanded	Plant height	Plant width	Average fruit length	Range of fruit length
			%	leaves	inches	inches	inches	inches
1	Howden	Check	0	--	--	--	--	--
2	pumpkin	June 28	75	7	14	24	na	na
3		July 21	75	--	28	132	4	2-8
4	Table Ace	Check	0	--	--	--	--	--
5	acorn	June 28	75	6	12	19	na	na
6	squash	July 21	75	--	25	72	2	0-4
7	Waltham	Check	0	--	--	--	--	--
8	butternut	June 28	75	6	6	14	na	na
9	squash	August 4	75	--	18	192	4	0-8

Table 2. Yield and grade, marketable fruit by weight, and average marketable fruit weight of pumpkins and squash subjected to simulated hail damage, Ontario, Oregon, 1994.

Variety	Hail timing	Yield by grade: Perfect fruit	Minor defects	Major defects	Culls	Immature	Total yield	Marketable yield §	Percent marketable	Average marketable fruit weight
		lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	%	lbs
Howden pumpkin	None	44,970	17,802	450	769	4,573	68,564	62,772	91.55	18.53
	Early	39,940	15,257	3,250	3,431	11,568	73,445	55,197	75.15	19.83
	Late	14,890	20,755	8,461	4,546	5,729	54,381	35,645	65.55	18.46
	Average	33,267	17,938	4,054	2,915	7,290	65,463	51,205	77.42	18.94
Table Ace acorn squash	None	29,269	1,093	211	150	2,870	33,593	30,362	90.38	1.91
	Early	20,174	4,065	199	444	2,718	27,600	24,238	87.82	1.78
	Late	18,923	3,406	250	459	2,346	25,383	22,329	87.97	1.82
	Average	22,789	2,855	220	351	2,645	28,859	25,643	88.72	1.84
Waltham butternut squash	None	33,967	980	961	1,640	2,375	39,922	34,947	84.08	2.98
	Early	22,716	1,149	931	898	3,940	29,634	23,865	81.45	2.97
	Late	15,301	2,473	1,420	1,751	7,006	27,950	17,774	53.97	2.98
	Average	23,995	1,534	1,104	1,430	4,440	32,502	25,529	73.17	2.98
Averages	None	36,069	6,625	541	853	3,273	47,360	42,694	88.67	7.81
	Early	27,610	6,824	1,460	1,591	6,075	43,560	34,433	81.46	8.19
	Late	16,371	8,878	3,377	2,252	5,027	35,905	25,249	69.16	7.75
LSD (0.05)$_{Variety}$		6,287	4,509	986	1,860	ns	6,321	6,482	7.64	1.48
LSD (0.05)$_{Hail}$		6,287	ns	986	ns	ns	6,321	6,482	7.64	ns
LSD (0.05)$_{Variety\ X\ Hail}$		10,889	ns	1,707	ns	ns	ns	ns	ns	ns

§ Perfect fruit plus fruit with minor defects

SOYBEAN RESEARCH AT ONTARIO IN 1995

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Introduction

Soybean is a potentially valuable new crop for Oregon. Soybeans could provide a high quality protein for animal nutrition and oil for human consumption, both of which are in short supply in the Pacific Northwest. In addition, edible or vegetable soybeans could be exported to the Orient and provide a raw material for specialized food products. Soybeans would also be a valuable rotation crop because of the soil improving qualities of its residues and N_2-fixing capability.

Because of the high value irrigated crops in the Snake River valley, soybeans may be economically feasible only at high yields. Hoffman and Fitch (1972) demonstrated that soybeans lines of the 0 and 00 maturity groups adapted to Minnesota could yield 50 to 65 bushels/acre at Ontario. The most productive lines averaged 60-65 bushels/acre for several years. Furthermore, yields were increased by approximately 20 percent for certain cultivars by decreasing row widths to 22 inches.

Soybean varieties developed for the midwestern and southern states are not necessarily well adapted to Oregon due to lower night temperatures, lower relative humidity, and other climatic differences. Previous research at Ontario has shown that compared to the commercial cultivars bred for the midwest, plants for Oregon need to have high tolerance to seed shatter and lodging, reduced plant height, increased seed set, and higher harvest index (ratio of seed to the whole plant). In addition, there is a need to identify cultivars that will grow and yield well under high seeding rates and narrow row spacing. We believe that yields could also be increased by increasing the seeding rate from 200,000 seeds/ac to 300,000 seeds/ac if semi-dwarf lines were found adapted to local conditions.

In 1992, 241 single plants were selected from five F_5 lines that were originally bred and selected for adaptation to eastern Oregon. Seed from these selections was planted and evaluated in 1993. A total of 18 selections were found promising and selected for further testing in larger plots in 1994 and 1995. This report summarizes work done in 1995 as part of the continuing breeding and selection program to adapt soybeans to eastern Oregon.

Procedures

The 1995 trials were conducted on a Greenleaf silt loam previously planted to sugar beets. Dual at 1 lb ai/ac was broadcast and incorporated with a bed harrow on May 9. Seed was planted on May 15 at 300,000 seeds/acre in rows 22 inches apart.

Rhizobium japonicum soil implant inoculant was applied in the seed furrow at planting. The crop was furrow irrigated as necessary.

Thirteen of the single plant selections from 1992, 11 single plant selections made in 1993, and 8 older cultivars were planted in replicated plots four rows wide by 25 feet long in 1995. The experimental design was a complete randomized block with five replicates. Fifteen single plant selections made in 1994 were planted in single rows 25 feet long.

Plant height and reproductive stage were measured weekly for each cultivar. Prior to harvest the cultivars were evaluated for lodging and seed shatter. The middle two rows in each 4 row plot and single rows from the single plant selection plots, were harvested on October 13 using a Wintersteiger Nurserymaster small plot combine. The beans were cleaned, weighed and oven dried for moisture content determination. Dry bean yields were corrected to 13 percent moisture. Single plant selections were cut at ground level, threshed in the small plot combine and labeled individually.

Results and Discussion

Emergence started on May 22 and was poor due to inadequate soil moisture.

Yields ranged from 7 to 55 bu/ac (Table 1). Three hail events on June 16, June 19, and July 29 decreased the performance of all crops at the Malheur Experiment Station during the 1995 season. The older cultivars, in general, lodged heavily and took too long to mature or did not reach adequate harvest maturity for efficient combining. Seven of the 1992 single plant selections reached physiological maturity in 115 days or less, had no lodging, and had seed sizes large enough for the manufacturing of tofu (< 2,270 seeds/lb). Three of the 1994 selections matured in 115 days or less, had no lodging, and had seeds large enough for the manufacturing of tofu (Table 2).

Literature Cited

Hoffman, E.N. and L.A. Fitch. 1972. Soybean trials in the Annual Report of the Malheur Branch Experiment Station, Ontario, Oregon. pp 84-89.

Table 1. Performance characteristics of soybean cultivars. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Cultivar	Days to maturity[1]	Days to harvest maturity[2]	Lodging	Shatter	Height	Yield	Seed count
	days from emergence		0-10[3]	%	cm	bu/ac	seeds/lb
M92-223	115	129	0	0	65	55.3	2,017
M92-350	106	129	8	0	105	55.2	2,219
M92-330	98	123	2	0	95	51.1	2,037
M92-237	106	123	0	0	95	50.6	2,142
M92-220	123	n	0	0	80	49.6	2,213
M92-217	115	129	0	0	75	49.3	2,033
M92-225	106	115	0	0	80	49.1	2,353
M92-314	106	123	0	0	55	48.9	2,113
M92-085	106	123	0	0	95	48.7	2,188
M92-213	123	129	0	0	80	43.4	1,995
M92-239	106	129	0	0	55	42.2	1,946
Agassiz	123	n	5	0	100	36.3	2,166
OR-8	129	n	7	0	100	34	2,059
M93-19	129	n	1	0	95	33.3	2,030
Gnome 85	123	129	6	0	100	32.6	2,167
M93-46	135	n	4	0	90	32.3	1,975
M92-249	123	129	0	0	70	31.9	2,046
Lambert	129	n	6	0	85	31.7	2,126
M92-201	123	129	0	0	60	31.1	2,238
M93-20	129	n	0	0	75	28.4	1,996
OR-6	106	123	2	0	100	28.2	2,205
M93-26	129	n	1	0	85	27	1,891
Sibley	125	n	8	0	90	24	1,845
HC89-2018	131	n	9	0	90	22.1	2,225
M93-28	132	n	1	0	85	18.9	1,827
M93-21	129	n	2	0	85	18.5	2,250
M93-18	131	n	1	0	90	18	2,030
M93-84	132	n	6	0	100	15.1	2,188
M93-25	131	n	2	0	100	14.5	2,081
Evans	123	129	8	0	110	13.2	2,152
M93-42	132	n	3	0	85	8.3	1,875
M93-27	132	n	0	0	75	7.1	1,959
LSD (0.05)						14.1	155

[1]Pods yellowing, 50% of leaves yellow. [2]95% of pods brown, stems dry enough to be combined. [3] 0= none, 10= 100 percent lodging. n= never reached harvest maturity.

Table 2. Performance characteristics of single-plant soybean selections made in 1994. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Cultivar	Days to maturity[1]	Days to harvest maturity[2]	Lodging	Shatter	Height	Yield[4]	Seed count
	days from emergence		0-10[3]	%	cm	bu/ac	seeds/lb
M94-C	115	129	0	0	90	62.2	1,993
M94-B5	115	129	1	0	110	60.4	2,016
M94-E	123	129	0	0	85	53	2,525
M94-B3	115	129	4	0	100	52.6	1,945
M94-A6	123	n	0	0	85	51.2	1,906
M94-B2	115	129	0	0	85	47	1,865
M94-D	123	129	0	0	80	43	1,842
M94-B1	115	129	0	0	85	41.4	2,010
M94-B4	115	129	6	0	100	41.1	1,982
M94-A3	123	129	3	0	90	38.4	2,223
M94-A4	123	129	4	0	95	38.3	2,170
M94-A2	123	129	0	0	95	37.8	2,389
M94-A1	123	129	0	0	80	36.2	2,123
M94-A7	123	129	0	0	90	34.3	2,135
M94-A5	123	129	4	0	95	31.6	2,212

[1] Pods yellowing, 50% of leaves yellow. [2] 95% of pods brown, stems dry enough to be combined. [3]0= none, 10= 100 percent lodging. [4]Yields are not necessarily realistic due to lack of border, on single row plots. n= never reached harvest maturity.

SUGAR BEET VARIETY TESTING RESULTS, 1995

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Ontario, Oregon, 1995

Purpose

Commercial varieties and experimental lines of sugar beets were evaluated to identify lines with high sugar yields and root quality. A joint seed advisory committee evaluates the accumulated performance data for the varieties, and restricts growers in Idaho and Malheur County of Oregon to planting only those varieties ranking above minimum industry requirements.

Procedures

Nineteen commercial and 43 semi-commercial varieties of sugar beets were evaluated in a trial conducted by Oregon State University at the Malheur Experiment Station. Seed for evaluation was received from American Crystal, Betaseed, Hilleshog Mono-Hy Inc., Holly, Seedex, and Spreckels beet seed companies. The sugar beets were planted in Owyhee silt loam soil where winter wheat was grown the previous year. Soil pH was 7.3 at the site on the Experiment Station. The soil organic matter was 1.2 percent. The field was plowed in the fall of 1994. One hundred lb/ac of phosphate and 60 lb/ac of N were applied as a broadcast treatment before plowing. An additional 150 lb/ac of nitrogen was added by sidedressing ammonium sulfate after thinning. Two lb ai/ac of Nortron was broadcast for weed control and incorporated using a spike-tooth bed harrow before planting.

The commercial and semi-commercial varieties were planted in separate trials. Each entry was replicated eight times using a randomized complete block experimental design. Each plot was four rows wide and 23 feet long with 3-foot alleys separating plots. Approximately 12 viable seeds per foot of row were planted in each plot row. The seed was planted on April 10 and 11 with a cone-seeder mounted on a John Deere model 71 flexi-planter equipped with disc openers. After planting, the sugar beets were corrugated and furrow-irrigated to furnish moisture for uniform seed germination and seedling emergence.

The sugar beets were hand-thinned during the first week of May. Spacing between plants was approximately 7 inches. In mid-July, and again on August 10, 80 lb/ac powdered sulfur was spread by aerial application and by hand over the foliage to protect the sugar beet leaves from powdery mildew infection.

The sugar beets were harvested during the third week of October. The foliage was removed by a flail beater and the crowns clipped with rotating scalping knives. The roots from the two center rows of each four-row plot were dug with a single-row wheel-type lifter harvester, and all roots in each 23 feet of row were weighed to calculate root yields. A sample of eight beets was taken from each of the harvested rows and analyzed for percent sucrose, pulp nitrate nitrogen, and conductivity. The percent extraction was calculated using a formula which required percent sucrose and conductivity readings as factors.

Results

Variety performance has been grouped by seed company (Table 1 and 2). Each variety was ranked (designing order) within each company's variety by yield of recoverable sugar per acre. The data was analyzed statistically for LSD value at the 5 percent level of significance, and coefficient of variation for each variable is reported.

Yields of recoverable sugar from commercial varieties ranged from a high of 14,300 pounds of sugar/ac to a low of 11,250 pounds of sugar/ac, with a variety mean of 12,550 pounds of sugar/ac.

Yield of recoverable sugar from semi- commercial lines ranged from 14,270 pounds of sugar/ac to a low of 11,120 pounds of sugar/ac, with an entry mean of 12,560 pounds of sugar/ac.

Table 1. Root yields, sugar yields and root quality data from sugar beet lines entered as commercial varieties at the Malheur Experiment Station, Oregon State University, Ontario, Oregon 1995.

Entry		Sugar beet yield and quality							
Company	Variety	Root yield	Sugar content	Gross sugar	Conductivity	Root-NO3-N	Extraction	Estimated recoverable sugar	
		tons/ac	%	lbs/ac	mmho	ppm	%	lb/ac	lb/ton
American Crystal	ACH 203	44.9 2	17.12	15370	.802	207	84.32	12960	288.8
	ACH 211	42.7 0	17.56	14990	.751	169	85.09	12750	298.9
	ACH 203 Goucho	43.87	17.22	15110	.820	187	84.11	12710	289.7
	ACH 322	40.29	17.82	14360	.766	170	84.94	12200	302.8
Betaseed	Beta 8422	43.81	17.47	15300	.842	188	83.86	12830	293. 0
	Beta 8422 Goucho	44.37	17.35	15390	.887	219	83.23	12810	288.8
	Beta 8450	42.7 0	17.34	14810	.797	218	84.44	12500	292.8
	Beta 8545	43.19	16.48	14220	.891	173	83.01	11810	273.7
	Beta 4689	38.3 0	17.3 0	13260	.759	156	84.93	11260	293.8
Hilleshog Mono-Hy	Canyon	49.07	17.25	16920	.790	197	84.51	14300	291.6
	WS 62	46.9 0	16.9 0	15850	.769	162	84.72	13430	286.5
	WS 88	47.28	16.88	15950	.827	200	83.95	13390	283.4
	WS 91	45.48	17.16	15610	.785	200	84.56	13200	290.2
	HM 9155	44.06	17.31	15250	.808	190	84.29	12850	291.8
	WS PM9	44.8 0	16.82	15060	.743	159	85.05	12810	286.1
	HM R2	42.32	16.45	13930	.852	187	83.52	11640	274.9
	WS 21	39.67	16.92	13420	.835	208	83.85	11250	283.7
Holly	HH 67	42.2 0	16.77	14150	.815	205	84.09	11900	282.1
Seedex	Monohikari	39.6 0	17.41	13810	.635	165	86.57	11950	301.4
LSD (0.05)		1.6 0	0.42	586	.047	49	0.67	512	8.6
CV (%)		3.8 0	2.4 0	3.9	5.9	26.4	0.8	4.1	3. 0
Mean		43.4 0	17.13	14880	.798	188	84.37	12550	289.2

Table 2. Root yields, sugar yields and root quality data from sugar beet lines entered as semicommercial lines at the Malheur Experiment Station, Oregon State University, Ontario, 1995.

Entry		Sugar beet yield and quality							
Company	Variety	Root yield	Sugar content	Gross sugar	Conduct-ivity	Root-NO3-N	Extraction	Estimated recoverable sugar	
		tons/ac	%	lbs/ac	mmho	ppm	%	lb/ac	lb/ton
American Crystal	ACH 203	44.31	17.14	15350	.776	170	84.68	12860	290.3
	ACH 212	42.69	17.21	14860	.763	175	84.85	12470	292.1
	9450217	37.69	17.27	13160	.721	135	85.43	11120	295.1
Betaseed	2BG6303	48.02	17.16	16660	.820	189	84.09	13860	288.6
	3BG6110	46.84	17.16	16250	.829	190	83.98	13500	288.2
	3BG6111	47.15	16.85	16060	.866	210	83.42	13250	281.0
	4CG6486	46.84	16.58	15710	.873	184	83.27	12940	276.2
	2BG6282	47.83	16.26	15730	.931	220	82.43	12820	268.1
	Beta 4006	42.88	17.03	14760	.637	141	86.47	12620	294.4
	2BG6314	43.25	17.29	15110	.806	239	84.31	12600	291.5
	Beta 8450	43.25	16.89	14780	.814	227	84.12	12290	284.3
	3BG6350	44.18	16.60	14830	.853	191	83.55	12260	277.5
	3BG6348	44.61	16.21	14620	.924	212	82.51	11930	267.5
	Beta 4581	43.25	16.29	14250	.885	263	83.05	11700	270.6
Hilleshog	HM-2919	48.76	17.19	16940	.739	189	85.17	14270	292.8
	HM-2925	47.83	17.43	16860	.718	152	85.50	14260	298.1
	HM-2922	45.67	17.70	16350	.639	123	86.57	13990	306.4
	HM-2923	46.04	17.56	16340	.669	142	86.16	13920	302.6
	HM-2921	47.15	17.25	16440	.708	136	85.59	13910	295.3
	HM-2924	47.34	17.30	16560	.757	151	84.95	13910	294.0
	WS-91	46.90	17.05	16170	.746	182	85.04	13610	290.0
	HM-2916	46.59	17.14	16150	.774	184	84.7	13530	290.3
	HM-2975	46.78	16.52	15620	.747	189	84.94	13120	280.5
	WS-PM9	45.60	16.61	15320	.754	176	84.86	12860	281.9
	HM-2971	45.42	16.70	15330	.797	203	84.32	12790	281.6
	HM-2972	44.43	16.45	14780	.842	205	83.66	12230	275.3
	HM-2974	41.95	16.90	14340	.761	196	84.83	12030	286.7
	HM-55	42.94	16.54	14360	.823	174	83.93	11920	277.6
	HM-2920	41.83	16.70	14130	.869	197	83.36	11650	278.4
Holly	HH101R	46.47	15.86	14910	.901	203	82.74	12200	262.6
	Rival	43.13	16.64	14500	.782	201	84.49	12120	281.1
	HH97R	44.18	16.18	14450	.880	220	83.10	11880	268.9
	Rhizosen	43.62	16.15	14240	.788	243	84.30	11870	272.3
	Rhizoguard	43.62	16.05	14160	.849	184	83.48	11690	268.0
	93HX18	42.26	16.30	13930	.767	206	84.60	11650	275.9
	95HX22	40.47	16.81	13750	.787	209	84.46	11490	283.9
Seedex	SX1506	44.49	17.03	15320	.801	186	84.33	12780	287.2
	SX1507	43.50	16.39	14420	.846	160	83.60	11920	274.1
	SX1505	41.33	17.03	14230	.814	208	84.15	11840	286.6
	SX1508	43.32	16.25	14230	.891	225	82.96	11680	269.6
Spreckels	SS 92338	44.00	16.20	14420	.883	218	83.06	11840	269.2
	SS 93424	43.63	15.86	13990	.936	206	82.27	11380	261.0
	SS 781R	43.25	15.92	13920	.927	218	82.41	11340	262.5
LSD (0.05)		1.50	0.29	525	.051	35	0.69	459	6.3
CV (%)		3.40	1.78	3.5	6.3	18.5	0.83	3.7	2.2
Mean		44.50	16.74	15080	.807	192	84.18	12560	281.9

INSECTICIDE APPLICATIONS TO SUGAR BEETS FOR CROWN BORER CONTROL

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Introduction

The sugar beet crown borer, *Heilstia undulatilla* (Clemens), is a periodic moth pest to seedling sugar beets grown in southwest Idaho and Malheur County, Oregon. In certain instances within Utah and Colorado, crown borer populations have been high enough to kill 30 to 50 percent of the sugar beet crop. Severe outbreaks of the borer have also occurred in the Central Valley California.

The crown borer attacks the crown area of different species of plants. On sugar beets they feed on the crowns of the young plants, on the leaf petioles near the ground, or even on leaves that touch the soil surface. The larvae move back and forth inside characteristic silken tubes which are often two to six inches long and radiate out from the beet roots just under the surface of the soil. The caterpillars feed primarily upon the crown area, and the feeding may be superficial or may cause a girdling of the roots. Partial girdling of the roots causes a weakened condition so that the plant often breaks off at the ground level.

Moths can lay up to 300 eggs singly on the petioles of the plants. The insect has two generations per year. At an average temperature of 76°F a complete life-cycle is completed in 34 to 39 days.

Dr. Ed Bechinski, University of Idaho, has established the economical threshold level for crown borer, when ten or more moths are found in a pheromone trap each day for seven consecutive days before the middle of May. The threshold level is the point where treatment is necessary to avoid economic loss to the sugar beet crop.

In this study, Temik and Counter granular formulated insecticides were applied as infurrow treatments during planting at the rate of 2.0 pounds active ingredient per acre. An additional treatment included Sevin XLR insecticide applied at weekly intervals over the Temik treated plots, at the rate of 0.5 lb ai/ac. Data obtained include plant populations during emergence and seedling growth, insect counts from traps, and harvest information including root yield, percent sucrose, percent extractable sugar, and estimated yields of recoverable sugar per acre.

Procedure

Soil in the trial area is a silt loam texture with 1.3 percent organic matter and a pH of 7.3. Wheat was the previous crop. Following wheat harvest the stubble was shredded with a steel flail beater, and the field was disked and irrigated. Fall tillage included chiseling the soil to a depth of 18 inches, moldboard plowing, and fall bedding. One hundred lb/ac of phosphate (P_2O_5) and 60 lb/ac of nitrogen (N) were broadcast applied before plowing.

In the spring the beds were harrowed using a spike-toothed bed-harrow. The beds were harrowed twice, and sugar beet seed of variety WS-PM9 and the insecticides (Temik and Counter) were planted and applied at the same time on April 26. Temik and Counter rates were 2 lb ai/ac. In-row applicators were calibrated to deliver 9 ounces of Temik and 6.7 ounces of Counter per 1000 feet of row. Beck planter with shoe openers were used. Ezee-flow granular applicators were mounted on the planter and the granular insecticides distributed in the planted row. The insecticide tube was located behind the disc-opener and in front of the press-wheel. Soil separated the sugar beet seeds from the insecticides, but a shallow layer of soil covered the insecticides. Sugar beet planting depth was 0.75 inches. Coated seed was used, and the planter was set to place seeds at 4 inches apart. Row spacing was 22 inches. Each plot was 8 rows wide by 50 feet long, treatments were replicated six times using a randomized complete block experimental design.

After planting, the rows were corrugated and furrow irrigated to assure enough soil moisture for uniform seed germination and seedling growth. Counts of emerged plants were taken on May 3, 5, 8, 12, 16, 24, and June 5. Average number of plants from 50 feet of 4 different rows in each plot of all replications were taken. The results are recorded in Table 1. Traps were set up by Steve Yungen, Amalgamated Sugar Company, to monitor moth populations of crown borer and fly populations of root maggot. Moth and fly catches were monitored routinely from May 24 to June 23. The numbers are reported in Table 2.

Postemergence applications of Sevin XLR were applied over Temik in one treatment at the rate of 0.5 lb ai/ac. Sevin XLR was applied on May 3, May 15, May 25, and June 5. Applications were made in 8-inch bands over the rows using a single bicycle wheel plot sprayer equipped with four Teejet fan nozzles on a spray boom. A single nozzle was centered over each row. Spray pressure was 42 psi, and water volume was 19.5 gal/ac. Weeds were controlled with postemergence applications of Betamix Progress, Upbeet, and Poast herbicides. Rates were 0.25, 0.0156, and 0.1 lb ai/ac. Herbicides were not tank-mixed with Sevin XLR but were applied using the same sprayer and procedures as used when applying Sevin.

Sugar beet plants were observed for crown borer damage during regular plant stand counts. No crown damage resulting in plant losses was observed. On June 6 the sugar beets were hand-thinned to an 8-inch spacing. On June 8 the trial area was sidedressed with 750 lb/ac of ammonium sulfate (150 lb/ac N). Irrigation furrows were made between each row of sugar beets, and all furrows were irrigated at regular intervals. A total of 80 lb/ac of powdered sulfur was applied as equal amounts by hand spreading on July 11 and aerial application on August 10 for control of powdery mildew.

Sugar beets were harvested on October 12. Roots from 4 rows, 50 feet long, were taken from each plot and weighed to determine root yield. Eight samples with each sample containing 8 sugar beet roots were taken from each plot. Sugar beet samples were analyzed at the Nyssa Amalgamated Sugar Factory tare laboratory for percent sucrose, conductivity readings, and root NO_3-N content. Percent extractable sugar and estimated recoverable sugar per acre and per ton of sugar beets were calculated. Individual treatments in all replications were harvested (Table 3).

Results

Crown borer populations were not high enough to cause sugar beet stand losses. No visible injury occurred, and moth populations recorded in traps were not high enough as outlined by Dr. Ed Bechinski, University of Idaho, to result in economic losses (Table 2). Moth densities must occur before mid-May in western Idaho to cause economic losses. Significant reduction in growing plants did occur in Counter plots because of Counter insecticide damage to germinating and emerging sugar beets but not from the crown borer insect. Plant counts in the Temik plots were equal to those in the untreated check. Plant counts in the Counter plots ranged from 5 to 11 percent less over the period of time from May 3 to June 5 when counts were taken (Table 1).

Although Counter insecticide reduced the number of emerged plants, the plant populations after thinning were comparable for all treatments, and insecticides had no detrimental effect on root or sugar yield per acre. Percent sucrose was significantly higher in the one Temik treatment but was not great enough to result in a significant increase in recoverable sugar per acre. For the grower, however, the higher percent sucrose reading would result in an increase in the per ton value of the sugar beets (Table 3).

Sevin XLR applied alone, not tank-mixed with Betamix Progress, showed no visible damage to the seedling sugar beets nor did it improve yield potential because of the lack of detrimental populations of both crown borer or root maggot to meet threshold levels.

Table 1. Effect of Temik, Temik + Sevin, and Counter insecticides on sugar beet stands when Temik and Counter were applied as infurrow treatments during planting and Sevin applied to emerged seedlings. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

		Number of plants per 50 feet of row by date beginning at emergence													
Insecticide	Rate	May 3		May 5		May 8		May 12		May 16		May 24		June 5	
	lb ai/ac	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Temik	2.0	119	100.1	129	99.2	142	100.7	147	101.3	149	102.0	151	100.0	151	100.0
Temik + Sevin	2.0 + 0.5	122	103.4	131	100.7	139	98.6	144	99.3	147	100.7	150	99.3	150	99.3
Counter	2.0	105	88.9	117	90.0	126	89.4	133	91.7	138	94.5	144	95.4	144	95.4
Untreated check	–	118	100.0	130	100.0	141	100.0	145	100.0	146	100.0	151	100.0	151	100.0
Mean		116	–	127	–	137	–	142	–	145	–	149	–	149	–
LSD (0.05)		4	–	2	–	4	–	5	–	4	–	1	–	1	–
CV (%)		2.3	–	1.4	–	2.4	–	2.6	–	2.3	–	0.5	–	0.5	–

Table 2. Crown borer moth and root maggot fly counts from pherome traps set on each side of trial area. Steve Yungen, fieldman for Amalgamated Sugar Company, Nyssa, Oregon, 1995.

		Number of insects trapped on given dates									
Trap location	Insect	May 24	May 30	June 2	June 6	June 9	June 13	June 16	June 21	June 23	Total
North	Crown borer	1	8	5	10	3	14	1	2	0	44
South	Crown borer	0	2	2	11	1	11	5	0	1	33
OSU (94)	Crown borer	(2)	(2)	(37)	(4)	(7)	(5)	(3)	(2)	(8)	(74)
North	Root maggot	5	14	9	7	0	1	0	0	0	39
South	Root maggot	4	11	6	3	0	0	0	0	0	26
OSU (94)	Root maggot	(0)	(3)	(9)	(11)	(12)	(12)	(13)	(13)	(14)	(87)

Numbers in parenthesis are counts recorded from 1994 trapping in fields adjacent to where trials are located in 1995.

Table 3. Root yield, sugar yield, and root quality data from sugar beets treated with Temik, Counter, and Sevin insecticides for crown borer control. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

		Sugar beet yield and quality						
Insecticides	Rate	Root yield	Sucrose	Conductivity	Root NO_3N	Extraction	Recoverable sugar	
	lb ai/ac	tons/ac	%	µ mho	ppm	%	lb/ac	lb/ton
Temik	2.0	45.39	15.71	832	356	83.62	11,920	262.6
Temik + Sevin	2.0 + 0.5	45.92	15.59	851	391	83.35	11,930	259.8
Counter	2.0	45.59	15.39	842	416	83.43	11,710	256.8
Untreated check	–	45.45	15.46	840	385	83.46	11,730	258.1
Mean		45.59	15.54	841	387	83.47	11,820	259.4
LSD (0.05)		(ns)	.32	(ns)	50	(ns)	(ns)	2.7
CV (%)		2.3	2.5	6.0	15.6	0.84	4.1	2.6

SUGAR BEET TOLERANCE TO TANK-MIX COMBINATION OF SEVIN INSECTICIDE FORMULATIONS AND BETAMIX PROGRESS, UPBEET, AND STINGER HERBICIDES APPLIED POSTEMERGENCE TO SEEDLING SUGAR BEETS

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Purpose

To study the tolerance of seedling sugar beets when Sevin XLR and Sevin 4F formulations of insecticides are tank-mixed with Betamix Progress, Upbeet, or Stinger herbicides and applied to seedling sugar beets in the cotyledon leaf, two true leaf, and four leaf stage of growth. Sevin insecticide is applied to sugar beets for the control of adult sugar beet root maggot and crown borer.

Procedures

Sugar beet variety WS-PM9 was planted on April 10, 1995. Pelleted seed was planted at 4-inch spacing using a Beck planter equipped with shoe openers. Soils in the trial area were silt loam texture with 1.3 percent organic matter and a pH of 7.2. Stephens winter wheat had been grown during 1994. Bronate at 1 quart per acre had been applied to control weeds in the wheat. Following wheat harvest, the stubble was shredded with a steel tooth flail beater and the field was disked, corrugated, and surface irrigated. In October the field was deep chiseled, mold-board plowed, and bedded. Twenty gallons of C-17 soil fumigant was injected in the rows while bedding. One hundred lb/ac of phosphate (P_2O_5) and 60 lb/ac of nitrogen were broadcast before plowing. The seed bed in the spring was prepared by harrowing the beds twice using a spike tooth bed-harrow. Preemergence herbicides were not used. Temik was banded in a 5-inch strip over the planted row at a rate of 2.0 lb ai/ac and incorporated with a small drag chain. All treatments were replicated three times using a randomized block experimental design.

The first application of herbicide/insecticide treatments was made on May 3. Both weeds and sugar beets had small cotyledon leaves. Sugar beet cotyledon leaves were 0.5 inch long. Weed species included lambsquarters, kochia, redroot pigweed, barnyardgrass, and green foxtail. Skies were partly cloudy; air temperature was 65°F, and soil temperature at 4-inch depth was 52°F. Wind speed was 2 to 3 mph from the west. Both the sugar beets and weeds were healthy and growing rapidly.

The second application of the treatments was made on May 15. Sugar beets had two true leaves, and new emerging weeds had cotyledon leaves. Skies were partly cloudy; air temperature was 72°F, the soil temperature at 4-inches was 62°F, and the wind was calm. The seedling sugar beets were normal without foliar injury from the previous herbicide/insecticide applications.

The third herbicide/insecticide applications were made on May 25. Sugar beets had four true leaves, and there were very few weeds in treated plots. Air temperature was 84°F and extremely warm for applying Betamix Progress herbicides. Skies were clear with the sun bright and the wind calm. Soil temperature at the 4-inch depth was 71°F.

All herbicide/insecticide treatments were applied using a single bicycle wheel plot sprayer. Individual plots were 4-rows wide and 25 feet long. Four Teejet fan nozzles were mounted on the spray boom, and a nozzle was located over the center of each row of the plot. The nozzle size was 6502. Spray pressure was 42 psi, and water as the carrier was applied at the rate of 19.5 gallons per acre. Formulations of Sevin evaluated were 4F flowable and XLR emulsifiable concentrate; each was applied at 1.5 lb ai/ac. Herbicides tank-mixed with Sevin insecticide included Betamix, Betamix Progress, Stinger, and Upbeet (were 0.25, 0.25, 0.05, and 0.0156, lb ai/ac respectively).

The sugar beets were thinned to 8-inch spacing on June 5 and 6. On June 15 the sugar beets were sidedressed with 150 lb/ac of nitrogen and another 2 lb ai/ac of Temik. Nitrogen was injected on each side of every row. Sugar beets were watered by furrow irrigation. Furrows were made between each row, and water was applied to all furrows. A total of 80 lb/ac of sulfur dust was broadcast for the control of powdery mildew. Forty lb/ac were hand broadcast on July 12, and another forty lb/ac were applied by aerial application on August 8.

The sugar beets were harvested on October 12 to obtain root yields, percent sucrose, conductivity readings, and concentrations of NO_3N in the roots. Percent extractable sugar and estimated recoverable sugar per acre were calculated. Sugar beet leaves and crowns were removed with a topping unit equipped with a flail beater and rotating disc knives. Roots from the two center rows were harvested with a single row International Harvester. A total of 46 feet of row was harvested from each plot. Two samples, each consisting of eight sugar beet roots, were taken from each plot and sent to the Amalgamated Sugar Company tare laboratory in Nyssa, Oregon, for sugar and root quality analysis. The data is summarized in Tables 1 through 4.

Results

The XLR formulation of Sevin insecticide activated Betamix herbicide and caused more foliar injury to the seedling sugar beets than the 4F formulation or the herbicides by themselves. The greatest degree of injury occurred when XLR formulation of Sevin included Betamix with Stinger or Upbeet. In early studies when sugar beet tolerance was being evaluated with low-repeat applications of Betamix and Betamix tank mixed with surfactants, sugar beet selectivity was lost, and severe injury with stand reduction often occurred. The solvents and emulsifiers used to formulate the XLR material may be acting as surfactants stimulating herbicide activity. Slightly but non-significant improvement in weed control was also noted when XLR Sevin was tank-mixed with Betamix herbicides. Also more injury from the XLR occurred with the late application when air temperatures exceeded 84°F. Betamix is more active at higher temperatures in bright sunlight. Injury symptoms from XLR plus Betamix combinations included leaf chlorosis, necrosis of leaf margin, and reduced foliar growth. The reduced foliage growth persisted and was distinguishable from the non-XLR treated sugar beets even after thinning.

The only significant measurable reduction in yield of sugar beet roots and estimated yield of recoverable sugar was with the XLR treatment used in combination with Progress and Stinger at rates of 0.25 and 0.05 lb ai/ac. Sugar beet root yields were less in other XLR treatments, but the reduction was not great enough to be significant or to reduce the yield of recoverable sugar. The effect of lower root yields on the amount of recoverable sugar can be overcome by slightly higher percent sucrose and lower conductivity readings (Table 4).

It appears that the XLR formulation of Sevin can be used in tank combinations with Betamix and other herbicides if the application restrictions on the label for Betamix applications under specific environmental conditions are followed.

Table 1. Crop injury and percent weed control ratings of seedling sugar beets after first application of Sevin insecticide formulations tank-mixed with Betamix, Progress, Upbeet, or Stinger herbicides. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent Weed control											
		Crop injury			Kochia			Pigweed			Lambsquarters			Annual grasses		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	%			%											
Betamix	0.25	5	0	5	98	99	98	100	100	100	100	100	100	75	70	75
Betamix + Sevin XLR	0.25 + 1.5	5	10	5	99	99	100	100	100	100	100	100	100	75	80	75
Betamix + Sevin 4F	0.25 + 1.5	0	5	0	98	98	98	100	100	100	100	100	100	70	75	70
Progress	0.25	0	5	0	98	98	98	100	100	100	100	100	100	75	70	70
Progress + Sevin XLR	0.25 + 1.5	10	5	10	100	99	99	100	100	100	100	100	100	75	75	75
Progress + Sevin 4F	0.25 + 1.5	0	5	0	99	99	99	100	100	100	100	100	100	75	75	70
Progress + Stinger + Sevin XLR	0.25 + 0.05 + 1.5	10	10	5	100	100	100	100	100	100	100	100	100	75	70	70
Progress + Stinger + Sevin 4F	0.25 + 0.05 + 1.5	5	0	0	100	100	100	100	100	100	100	100	100	70	75	70
Progress + Upbeet + Sevin XLR	0.25 + 0.0156 + 1.5	10	15	10	100	100	100	100	100	100	100	100	100	75	75	70
Progress + Upbeet + Sevin 4F	0.25 + 0.0156 + 1.5	5	0	0	100	100	100	100	100	100	100	100	100	70	70	75
Untreated check	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

First evaluation: May 7, cotyledon leaf sugar beets.

Table 2. Crop injury and percent weed control ratings of seedling sugar beets after second application of Sevin insecticide formulations tank-mixed with Betamix, Progress, Upbeet, or Stinger herbicides. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent weed control											
		Crop injury			Kochia			Pigweed			Lambsquarters			Annual grasses		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	%			%											
Betamix	0.25	0	0	5	99	99	100	100	100	100	100	100	100	65	60	60
Betamix + Sevin XLR	0.25 + 1.5	5	5	10	100	109	100	100	100	100	100	100	100	60	65	70
Betamix + Sevin 4F	0.25 + 1.5	5	0	0	99	99	99	100	100	100	100	100	100	60	65	55
Progress	0.25	5	5	0	100	100	100	100	100	100	100	100	100	65	55	50
Progress + Sevin XLR	0.25 + 1.5	10	10	10	100	100	100	100	100	100	100	100	100	60	65	60
Progress + Sevin 4F	0.25 + 1.5	0	5	0	100	100	100	100	100	100	100	100	100	55	60	60
Progress + Stinger + Sevin XLR	0.25 + 0.05 + 1.5	10	12	10	100	100	100	100	100	100	100	100	100	65	60	60
Progress + Stinger + Sevin 4F	0.25 + 0.05 + 1.5	5	0	5	100	100	100	100	100	100	100	100	100	60	55	55
Progress + Upbeet + Sevin XLR	0.25 + 0.0156 + 1.5	10	15	15	100	100	100	100	100	100	100	100	100	65	60	60
Progress + Upbeet + Sevin 4F	0.25 + 0.0156 + 1.5	5	5	0	100	100	100	100	100	100	100	100	100	50	50	55
Untreated check	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Second evaluation: May 23, two true leaf sugar beets.

Table 3. Crop injury and percent weed control ratings of seedling sugar beets after third application of Sevin insecticide formulations tank-mixed with Betamix, Progress, Upbeet, or Stinger herbicides. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent Weed control															
		Crop injury			Kochia			Pigweed			Lambsquarters			Annual grasses						
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
	lb ai/ac		%							%										
Betamix	0.25	5	0	5	100	100	100	100	100	100	100	100	100	45	50	50				
Betamix + Sevin XLR	0.25 + 1.5	15	20	15	100	100	100	100	100	100	100	100	100	50	45	50				
Betamix + Sevin 4F	0.25 + 1.5	5	0	5	100	100	100	100	100	100	100	100	100	55	60	55				
Progress	0.25	5	5	5	100	100	100	100	100	100	100	100	100	50	45	45				
Progress + Sevin XLR	0.25 + 1.5	20	20	15	100	100	100	100	100	100	100	100	100	65	60	65				
Progress + Sevin 4F	0.25 + 1.5	5	0	5	100	100	100	100	100	100	100	100	100	55	45	40				
Progress + Stinger + Sevin XLR	0.25 + 0.05 + 1.5	20	15	25	100	100	100	100	100	100	100	100	100	60	55	55				
Progress + Stinger + Sevin 4F	0.25 + 0.05 + 1.5	5	5	5	100	100	100	100	100	100	100	100	100	45	50	45				
Progress + Upbeet + Sevin XLR	0.25 + 0.0156 + 1.5	25	20	20	100	100	100	100	100	100	100	100	100	50	55	65				
Progress + Upbeet + Sevin 4F	0.25 + 0.0156 + 1.5	5	0	5	100	100	100	100	100	100	100	100	100	45	50	45				
Untreated check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

Evaluated June 4, 4-leaf sugar beets.

Grass species include green foxtail and barnyardgrass.

Ratings: 0 - 50 indicates degree of plant injury from stunting, leaf chlorosis, and minor leaf necrosis.

50 - 100 indicates stand reduction from 5 to 100 percent. In this trial a reduction in stand loss did not occur.

Table 4. Root yields, sugar yields, and root quality data of sugar beets treated with two formulations of Sevin insecticide in tank-mix combinations of Betamix Progress, Upbeet, and Stinger herbicides. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

		Sugar beet yield and quality							
Herbicides	Rates	Root yield	Sucrose	Conductivity	Nitrate-N	Extraction	Gross sugar	Recoverable sugar	
	lb ai/ac	t/a	%	µmho	ppm	%	lb/ac	lb/ac	lb/t
Betamix	0.25	44.5	16.02	883	422	83.02	14,250	11,830	266.0
Betamix + Sevin XLR	0.25 + 1.5	43.6	15.99	892	416	82.90	13,940	11,550	265.2
Betamix + Sevin 4F	0.25 + 1.5	44.7	15.54	925	485	82.35	13,920	11,470	256.0
Progress	0.25	44.7	15.61	925	477	82.36	13,950	11,490	257.3
Progress + Sevin XLR	0.25 + 1.5	43.7	16.06	861	372	83.32	14,040	11,700	267.6
Progress + Sevin 4F	0.25 + 1.5	45.0	15.86	886	413	82.94	14,280	11,840	263.1
Progress + Singer + Sevin XLR	0.25 + 0.05 + 1.5	42.0	15.58	963	503	81.84	13,090	10,710	255.0
Progress + Stinger + Sevin 4F	0.25 + 0.05 + 1.5	43.7	15.62	893	405	82.80	13,660	11,310	258.7
Progress + Upbeet + Sevin XLR	0.25 + 0.0156 + 1.5	44.7	15.75	903	455	82.69	14,070	11,630	260.4
Progress + Upbeet + Sevin 4F	0.25 + 0.0156 + 1.5	44.5	15.64	916	452	82.49	13,920	11,480	258.0
Untreated check	–	45.40	15.82	914	447	82.56	14,360	11,850	261.3
Mean		44.2	15.77	905	440	82.66	13,950	11,530	260.8
LSD (0.05)		1.9	ns	88	ns	ns	754	732	ns
CV (%)		2.5	2.3	5.7	16.5	0.9	3.2	3.7	3.1

"ON FARM" VALIDATION OF NITROGEN FERTILIZATION RECOMMENDATIONS FOR SUGAR BEETS

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Introduction

Sugar beet nitrogen fertilizer guidelines are based on either fall or spring nitrate-N levels to 3-foot depth in the soil and total plant needs estimated at 8 pounds N per ton of beets. These assumptions provide estimates for N fertilization which have been useful for many years. To make beet production and processing as efficient as possible, it is important to use only the N fertilizer needed to grow the crop. In the cases where soil organic matter mineralization is large compared with residual soil nitrate or fertilization, the current guidelines could over-estimate crop fertilizer needs.

When sugar beets receive N in excess of their needs, total beet yield and leaf growth are high, but both beet sugar content and total sugar yields can be depressed. Extra nitrate and ammonium in the beet pulp reduce sugar factory efficiency.

Objectives

The objectives of this study were to examine the amount and importance of N mineralized from soil organic matter in commercial sugar beet fields and to make observations of sugar beet plant N uptake in N fertilizer trials conducted by beet fieldmen in commercial fields to improve our understanding of beet responses to N fertilizer.

Procedures

Sugar beet fieldmen have conducting N fertilizer rate trials in growers fields during the last few years. These trials have the basic structure of large plots with several N rates and one to three replicates. In general the recommended N fertilizer rate is based on the soil nitrate present in the soil profile to a depth of 3 feet in each field and a yield goal for that field. Other large field plots are treated with twice the recommended N rate, half the recommended N rate, and no fertilizer as the check. In a few fields with high residual nitrate, the fieldman and grower opted to leave all plots unfertilized. Twelve growers' fields were studied through harvest in 1994 and an additional eight fields in 1995 between Brogan, Oregon, and Burley, Idaho (Table 1). Several other fields were set up each year, but their experimental value was lost in cultivation or harvesting errors.

The growers take care of all of the cultural practices and the fertilizers are applied in cooperation with fertilizer industry representatives. Sugar beet fieldmen kept track of crop progress and coordinated the harvest, collecting yield and quality data based on the entire field plots. Beets were evaluated for total yield, tare, sucrose content, conductivity, and beet pulp nitrate by the Amalgamated Sugar Co.

Additional work was done by the Malheur Experiment Station. The percent sugar extraction and recoverable sugar were calculated based on empirical formulas. Soil samples were collected in the spring for estimates of N mineralization via three methods: anaerobic incubation, aerobic incubation, and the buried-bag method. Twelve to fourteen representative beets with their leaves and crowns were harvested from each plot just prior to harvest and taken to the Malheur Experiment Station. Leaves and crowns were dried, weighed, ground, and analyzed for total N content. The beets were weighed fresh after the leaves and crown were removed, ground, and a subsample of the beet pulp was weighed wet and oven-dried to determine dry matter content, then analyzed for total N content. Beet N uptake per acre in the leaves, crowns, and beets was calculated based on the clean beet yield of each plot, the beet dry weight to fresh weight ratio, the proportion of dry crown and leaf tissue to dry beet in the tissue samples, and the tissue sample N contents.

Total available soil N supply was calculated based on the sum of spring available nitrate and ammonium, any applied fertilizer N, and N mineralization (estimated by anaerobic incubation or seasonal N balance). Nitrogen use efficiency was calculated for each plot by dividing the total plant N uptake by the total available N supply for each plot and multiplying by 100.

Results and Discussion

Spring soil nitrate N ranged from 61 to 284 lb N/acre, depending on the field (Table 2). Optimistic yield goals ranging from 25 to 40 tons of beets per acre implied N fertilizer needs of 0 to 216 lb N/acre. The lowest applied N rates were 0 lb N/acre at thirteen of the twenty sites.

The 1994 season was favorable for high yields (Table 3), and all cooperating growers kept weeds and diseases under control. The 1995 season was far less favorable, with lower temperatures and cloud cover during the growing season. Repeated rainfall events in 1995 made efficient N use difficult and reduced residual nitrate and ammonium in the fields at harvest. Repeated hail in the Treasure Valley was damaging at certain locations.

The highest-yielding N fertilizer rates ranged from 0 to 205 lb N/acre depending on the field studied. Sugar beet response to N fertilizer varied substantially. Reasonable yields were obtained in certain fields with low rates of N fertilizer (Tables 2 and 3). Beet pulp nitrate at 0 applied N suggested that there was extra N supplies in five fields without any fertilizer nitrogen (Table 3). Beet petiole nitrate was consistent with high yields at low N fertilizer inputs in these fields (data not shown).

The optimal N rate was determined independently for each field based on the highest yield of recoverable sugar. Beet plants at the optimal-applied N levels contained 126 to 426 lb N/acre at harvest depending on the field (Table 4). Anaerobic incubation estimates of N mineralization ranged from 88 to 251 lb N/acre depending on the field (Table 5). Mineralized N appears to be a large N source averaging 163 lb N/ac over the 20 fields (Table 4). Fields with high spring residual nitrate are not necessarily going to have high rates of N mineralization; fields with low spring residual nitrate are not necessarily going to have to low rates of N mineralization , r^2=0.029.

In 1994, the anaerobic incubation estimates of N mineralized ranged in the same order of magnitude as field method of N balance method. The N balance method was based on measuring residual soil nitrate and ammonium at harvest and plant N content at harvest, then subtracting all known available N sources. The N balance was not comparable in 1995, as would be expected after a season with untimely rainfall events.

At the most productive N level tested at each site, sugar beets were able to recover between 40.4 and 88.8 percent of the estimated total N supply (based on the sum of soil nitrate and ammonium to the 3-foot depth, fertilizer N, and N mineralization in Table 4). Efficiencies less than 75 percent appear to be related to very high N supply at 0 N applied, irrigations and rainfall in excess of evapotranspiration, or sugar beet cyst nematode.

Acknowledgments

These trials depended of the work of many growers and fertilizer fieldmen, without which the effort would have been impossible.

Table 1. Characteristics of 20 sugar beet fields used for soil N mineralization studies in 1994 and 1995. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Field	Location	Soil texture	pH	Organic matter	Soil depth	Variety	Planting date	Irrigation system	Comments	Previous crop
1994				%						
1	Burley	sandy loam	8.4	1.25	> 6'	MH 9455	April 11	side roll	cyst nematode	beets
2	Minidoka	silt loam	8.0	1.5	2.5'	PM-9	March 19	side roll	rock at 2-3'	wheat
3	Minidoka	silt loam	8.0	2.35	2.5'	WS91	March 20	side roll	rock at 2-3'	wheat
4	Jerome	loam	7.55	1.05	2.5'	WS91	April 25	side roll	rock at 2-3'	potatoes
5	Nyssa	silt loam	7.65	1.4	>6'	PM-9	last week March	furrow		onions
6	Ontario-Vale	fine sandy loam	7.5	1.6	>6'	PM-9	March 7	furrow		onions
7	Ontario-Vale	silt loam	7.75	2.2	>6'	PM-9	March 12	furrow		onions
8	Ontario-Nyssa	fine sandy loam	7.4	1.75	>6'	PM-9	2nd week March	furrow		onions
9	Nyssa	silt loam	7.9	2.1	>6'	PM-9	March 26	furrow	B deficient	potatoes
10	Vale	silt loam	7.6	2.05	>6'	PM-9	March 18	furrow		onions
11	Brogan	silt loam	7.6	1.6	>6'	RSW-81	March 14	furrow		onions
12	Ontario	silt loam	7.6	1.5	>6'	PM-9	April 5	furrow		beans
1995										
1	Buhl	silt loam	8.1	1.2	>6'	PM-9	May 10	furrow		beans
2	Burley	silt loam	8.1	1.49	2.5'	Beta 8422	April 10	side roll		wheat
3	Rupert	sandy loam	7.8	1.28	>6'	WS62	April 20	furrow		beans
4	Minidoka	silt loam	8.2	1.65	2.5'	PM-9	April 4	side roll		potatoes
5	Nyssa	silt loam	7.6	1.45	>6'	PM-9	March 30	furrow	rhizoctonia	onions
6	Vale	silt loam	7.8	3.29	>6'	PM-9		furrow		potatoes
7	Ontario	silt loam	7.7	1.43	>6'	PM-9	March 29	sideroll		potatoes
8	Nyssa	silt loam	7.4	1.47	>6'	PM-9	March 27	furrow	rhizoctonia, flooding	beans

Table 2. Optimistic yield goals, soil nitrate, recommended N fertilizer rates, grower's preferred N fertilizer rates, and best fertilizer N rates for 1994 and 1995. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Field	Location	Optimistic yield goal	Soil nitrate 0-3'	Total N needed for optimistic yield goal	Recommended N fertilizer for optimistic yield goal	Growers' preferred N rate	Lowest N rate used in 1994 trial	Highest yielding N rate for 1994 trial
1994		t/ac	lb N/ac					
1	Burley	28	164	224	60	80	0	40
2	Minidoka	35	171	280	109	110	0	110
3	Minidoka	35	85	280	195	205	80	205
4	Jerome	35	155	280	125	50	0	25
5	Nyssa	40	207	320	113	-	0	0
6	Ontario-Vale	40	284	320	36	75	0	0
7	Ontario-Vale	40	238	320	82	0	0	0
8	Ontario-Nyssa	40	148	320	172	-	60	60
9	Nyssa	40	165	320	154	-	60*	80
10	Vale	40	356	320	-36	150	0	0
11	Brogan	35	165	280	115	100	0	0
12	Ontario	40	104	320	216	-	0	0
1995								
1	Buhl	25	199	200	1	100	0	0
2	Burley	25	61	200	139	160	80	160
3	Rupert	35	95	280	185	120	19	171
4	Minidoka	25	105	200	95	163	0	85
5	Nyssa	30	115	240	125	100	35	35
6	Vale	40	122	320	198	150	0	150
7	Ontario	34	108	272	164	170	80	80
8	Nyssa	32	138	256	118	100	0	40

*Boron deficient part of field.

Table 3. Beet yield and quality at the best N rate for each of 20 growers' fields. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994 and 1995.

Summary of characteristics					Highest yielding plant performance					
Field	Location	Optimistic yield goal	Soil nitrate 0-3'	Most productive N rate for 1994 trial	Clean beet yield	Sucrose	Conductivity	Extraction	Recoverable sugar	Pulp nitrate
1994		t/ac	lb N/ac	lb N/ac	t/ac	%		%	lb/ac	ppm
1	Burley	28	164	40	24.0	16.9	0.73	86.4	6,998	187
2	Minidoka	35	171	110	35.5	18.1	0.73	86.5	10,799	148
3	Minidoka	35	85	205	39.2	17.4	0.9	84.2	11,479	na
4	Jerome	35	155	25	32.7	16.8	1.00	82.8	9,064	411
5	Nyssa	40	207	0	31.3	15.0	0.84	84.7	7,950	552
6	Ontario-Vale	40	284	0	40.9	15.8	0.87	84.4	10,925	483
7	Ontario-Vale	40	238	0	34.8	13.7	1.09	81.0	7,708	701
8	Ontario-Nyssa	40	148	60	39.0	16.7	0.68	87.1	11,342	294
9	Nyssa	40	165	80	33.4	16.2	0.72	86.4	9,372	283
10	Vale	40	356	0	38.3	14.8	0.98	82.7	9,406	581
11	Brogan	35	165	0	29.4	14.9	0.95	83.1	7,280	629
12	Ontario	40	104	0	45.6	16.2	0.75	86.1	12,732	175
1995										
1	Buhl	25	199	0	21.3	16.9	0.60	88.1	6,352	145
2	Burley	25	61	100	22.9	19.2	0.88	84.6	7,452	178
3	Rupert	35	95	171	31.9	16.6	0.77	85.8	9,110	313
4	Minidoka	25	105	85	21.4	16.6	0.62	87.8	6,787	152
5	Nyssa	30	115	35	25.2	16.3	0.72	86.4	7,078	243
6	Vale	40	122	150	31.4	14.9	1.06	81.6	7,630	691
7	Ontario	34	108	80	28.0	17.6	0.64	87.7	8,649	161
8	Nyssa	32	138	40	31.8	16.9	0.71	86.7	9,283	194

Table 4. Comparison of soil nitrogen supply, beet plant nitrogen content, and N use efficiency at harvest for beets grown at the highest-yielding N level in 20 fields. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994 and 1995.

		Beet plant performance		N supply					Plant N content					
Field	Location	Beet yield	Recoverable sugar	Most productive N rate for 1994 trial	Spring soil nitrate -N 0-3'	Spring soil ammonium -N 0-3'	Estimate of N-mineralization (anaerobic)	Total available N supply	Leaves	Crown	Beets	Total	Total plant N content at harvest per ton of beets	N use efficiency[2]
1994		t/ac	lb/ac		lb N/ac	lb N/ac	lb N/ac		lb N/ac				lb N/ton	%
1	Burley	24.0	6,998	40	164	23	112	339	70	20	94	184	7.65	54.2
2	Minidoka	35.5	10,799	110	171	17	172	469	63	18	148	229	6.65	48.9
3	Minidoka	39.2	11,479	205	85	14	167	470	98	23	187	308	7.82	65.4
4	Jerome	32.7	9,064	25	155	16	135	331	103	15	145	263	8.07	79.5
5	Nyssa	31.3	7,950	0	207	64	88	359	127	18	150	295	9.42	82.3
6	Ontario-Vale	40.9	10,925	0	284	30	149	459	122	19	225	366	8.93	79.9
7	Ontario-Vale	34.8	7,708	0	238	32	251	520	162	17	197	376	10.87	72.4
8	Ontario-Nyssa	39.0	11,342	60	148	48	115	371	111	23	180	314	8.06	84.6
9	Nyssa	33.4	9,372	80	165	31	97	373	87	27	129	243	7.26	65.1
10	Vale	38.3	9,406	0	356	39	236	631	165	35	226	426	11.06	67.5
11	Brogan	29.4	7,280	0	165	48	224[1]	437[1]	100	37	164	301	10.08	68.9[1]
12	Ontario	45.6	12,732	0	104	49	292[1]	445[1]	123	46	226	395	8.65	88.8[1]
1995														
1	Buhl	21.3	6,352	0	199	–	95	294	88	8	78	174	8.20	59.2
2	Burley	22.9	7,452	100	61	17	158	336	79	5	65	149	6.50	44.4
3	Rupert	31.9	9,110	171	95	–	195	461	92	9	116	217	6.79	47.1
4	Minidoka	21.4	6,787	85	105	–	130	320	52	6	77	135	5.80	42.2
5	Nyssa	25.2	7,078	35	115	34	121	305	52	4	70	126	5.00	41.3
6	Vale	31.4	7,630	150	122	27	210	509	130	13	112	255	8.10	50.1
7	Ontario	28.0	8,649	80	108	24	189	401	55	9	98	162	5.80	40.4
8	Nyssa	31.8	9,283	40	138	30	136	344	72	8	136	216	6.80	62.8

[1]N mineralization estimate by season-long N balance.

[2]Total plant N content as a percent of the total available N supply.

Table 5. Estimates of N mineralization made in 20 growers' sugar beet fields by four different methods. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994 and 1995.

				N-mineralization estimate			
Grower	Location	Soil texture	Organic matter	Anaerobic incubation	Aerobic incubation	Available nitrogen balance	Buried bags
1994			%	----------------	lb N/ac	----------------	
1	Burley	sandy loam	1.25	112	170	-	-
2	Minidoka	silt loam	1.5	172	155	-	-
3	Minidoka	silt loam	2.35	167	137	-	-
4	Jerome	loam	1.05	135	132	283	110
5	Nyssa	silt loam	1.4	88	120	238	-
6	Ontario-Vale	fine sandy loam	1.6	149	182	238	-
7	Ontario-Vale	silt loam	2.2	251	298	304	-
8	Ontario-Nyssa	fine sandy loam	1.75	115	134	125	-
9	Nyssa	silt loam	2.1	97	110	61	-
10	Vale	silt loam	2.05	236	291	251	-
11	Brogan	silt loam	1.6	149	-	224	-
12	Ontario	silt loam	1.5	159	123	293	255
1995							
1	Buhl	silt loam	1.2	95		-	
2	Burley	silt loam	1.49	158		-11	
3	Rupert	sandy loam	1.28	195		12	
4	Minidoka	silt loam	1.65	130		3	
5	Nyssa	silt loam	1.45	121		16	
6	Vale	silt loam	3.29	210		-	
7	Ontario	silt loam	1.43	189		48	
8	Nyssa	silt loam	1.47	136		38	

EFFECTS OF SMALL AMOUNTS OF PENDIMETHALIN HERBICIDE ON SUGAR BEET PLANT DEVELOPMENT

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Introduction

We have observed phytotoxic damage to sugar beets following onions in Malheur County since 1991. In the spring and summer of 1994 the loss of sugar beet stands in commercial fields was particularly pronounced. Surviving plants in affected fields were stunted and roots became deformed.

The most recent change in cultural practices for onion production in Malheur County has been the use of pendimethalin for weed control, particularly effective for the control of dodder and many other weeds in onions. Four fields with deformed beets were sampled in August, 1994 for pendimethalin residues, following crops of onions that had pendimethalin application in 1993. Soil residual pendimethalin ranged from 0.03 to 0.08 ppm in the top foot of soil in August, 1994.

Trials were conducted to determine whether small amounts of residual pendimethalin herbicide could cause damage to sugar beets that follow onions or potatoes in the crop rotation and to identify damage symptoms (if any).

Procedures

Two trials, using the same procedures and the same soil, were conducted with different rates of pendimethalin. The first trial (Trial 1) using lower pendimethalin rates was conducted from November 4, 1994 to February 2, 1995 and the second trial (Trial 2) using higher pendimethalin rates was conducted from February 23, 1995 to May 24, 1995.

Approximately 1.5 tons of Owyhee silt loam 0 to 8-inch depth with no history of pendimethalin application was thoroughly mixed to fill forty 3-gallon pots. For each experiment eight pots were assigned to each of five treatments (Tables 1 and 3). The proper amount of soil to be treated for a given treatment was spread out in a thin layer and sprayed with a dilute rate of pendimethalin to achieve the desired treatments. The pendimethalin treatments were applied to the soil with a sprayer and then the soil was mixed in a concrete mixer and put in the eight pots in a greenhouse. The pendimethalin was applied either to all the soil in each pot or to only half the soil. Replicated soil samples were collected from each treatment and frozen for pendimethalin analysis.

Eighteen sugar beet seeds (cv. Hilleshog MonoHy HM WSPM9) were planted in each pot at one-inch depth on November 4, 1994 for Trial 1 and on February 23, 1995 for Trial 2. The plants were grown in a greenhouse and watered as necessary. The greenhouse lights and heaters were set to maintain 12 hr. day length at 70 °F and 12-hr nights at 40 °F. Grow lights were installed to ensure adequate daytime light intensity. The pots were randomly placed within the lighted area and were moved twice a week to avoid bias from unequal light distribution. The seedlings were thinned to 9 plants/pot, three weeks after planting. One month after planting, six plants/pot were carefully removed and checked for root deformities and root length was measured approximately. The soil was carefully replaced in each pot around the remaining three plants. The pots were fertilized with urea at 50 lb N/ac approximately 2 months after planting. Three months after planting the plants were removed, washed, weighed and the roots measured and checked for deformities. Soil at 6-inch depth in the center of each pot was sampled and frozen.

Results and Discussion

Sugar beet seedlings grown in pot tests were maintained at ideal temperature and nearly ideal soil moisture conditions without insect or disease pressure. These conditions were less stressful than the conditions that sugar beets would normally encounter in the field.

Seedlings emerged normally in all treatments in Trial 1. No root deformities were noted in any treatment on December 6 (Table 1). The pendimethalin treatments did not result in any significant difference in any of the measured parameters in the first trial. Root deformities consisting of forked roots were only found on 3 plants in the check treatment.

Pendimethalin content of the soil at planting was designed to be higher in Trial 2 than in the Trial 1 (Tables 2 and 4). Pendimethalin treatments in the second trial resulted in reduced plant height and reduced root length (Table 3). The treatments with only half the soil receiving pendimethalin resulted in reduced total plant fresh weight in late May. The plants in the untreated soil had the single, long tap root characteristic of sugar beets. There were high proportions of plants with short and deformed roots (roots with 2 or 3 forks) in the pendimethalin-treated soil compared with the check treatment.

The reported 90-day half-life for pendimethalin in the soil was substantiated by the pot tests. The average pendimethalin concentration on November 4, 1994 was 0.089 ppm and 90 days later on February 2, 1995 the concentration was about half at 0.041 ppm (Table 2). Trial 2 pendimethalin concentrations were 1 ppm at planting on February 23, 1995 and 0.46 ppm on May 24, 1995, 90 days later (Table 4).

Considering a half-life of 90 days, the range of concentrations of pendimethalin in March, 1994 in the fields that had sugar beet damage could be estimated. The soil in these fields had 0.03 and 0.08 ppm pendimethalin in the top foot of soil in August of

1994, so it is very likely that the soil had 0.8 to 0.24 ppm pendimethalin at March planting dates. The pot tests found that a pendimethalin concentration in the soil at planting of 0.25 ppm resulted in considerable damage to sugar beet seedlings, especially their roots (Table 5).

Where pendimethalin was present at 0.25 ppm or above at planting, differences in or effects on plant height, root length, and deformed beet roots were evident (Table 5). The plants were very sensitive to damage in spite of little additional plant stress from other environmental factors. Beet seedling tolerance to pendimethalin could be less in the field where seedlings are subject to other sources of stress.

Conclusions

Pendimethalin at 0.25 ppm and higher in the soil at planting reduced sugar beet plant height and root length development in pot tests. These low rates were within the range of pendimethalin concentrations estimated to be present in the soil at planting in fields showing sugar beet damage in the summer of 1994. These fields had pendimethalin applied for weed control in onion crops in 1993. The results of this trial suggest that pendimethalin residues in growers fields may be associated with damage observed to sugar beets. Caution should be exercised when planting sugar beets following crops of onions and potatoes where pendimethalin has been applied.

Table 1. Effect of pendimethalin herbicide on performance of potted sugar beets in Trial 1. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1996.

Rate	Treatment	Tap root length (12-6-94)	Beets with deformed roots	Plant height (2-2-95)	Beets with deformed roots	Plant fresh weight (tops and roots, 2-2-95)
lb ai/ac	(depth) of treated soil in pot	inches	%	inches	%	ounces
none	Check	3	0	6	13	7
1/8	0-12 inches	3	0	7	0	7
1/16	3-9 inches	3	0	6	0	6
1/4	0-12 inches	3	0	7	0	7
1/8	3-9 inches	3	0	7	0	7
LSD (0.05)		ns	ns	ns	ns	ns

Table 2. Pendimethalin content in potting soil in Trial 1. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Rate	Treatment	Replicates	Measured concentration	
			November 4, 1994	February 2, 1995
lb ai/ac	depth of treated soil		ppm	
none	0 - 12 inches		0. 000	0. 000
0.25	3-9 inches	1	0.085	0.039
0.25	3-9 inches	2	0.095	0.038
0.25	3-9 inches	3	0.086	0.046

Table 3. Effect of pendimethalin on performance of potted sugar beets in Trial 2. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Rate	Treatment	Plant height (3-15-95)	Root length (3-28-95)	Root length	Beets with deformed roots	Plant fresh weight (tops and roots)
				—— 5-24-95 ——		
lb ai/ac	Depth of treated soil in pot	inches			%	ounces
none	Check	3.5	3.2	6.2	8.3	5.9
0.75	0-12 inches	2.3	2.3	3.0	45.8	5.4
0.75	3-9 inches	2.8	2.6	3.7	45.8	4.6
1.50	0-12 inches	2.0	2.0	2.7	54.2	5.9
1.50	3-9 inches	3.0	2.6	2.7	83.3	4.2
LSD (0.05)		0.4	0.5	1.1	38.8	0.8

Table 4. Pendimethalin content in potting soil in Trial 2. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Rate	Treatment	Replicate	Measured concentration	
			February 23, 1995	May 24, 1995
lb ai/ac	Depth of treated soil in pot		——— ppm ———	
none	0 - 12 inches		0.00	0.00
1.5	3-9 inches	1	0.84	0.34
1.5	3-9 inches	2	0.89	0.44
1.5	3-9 inches	3	1.26	0.61

Table 5. Synthesis of the data from Trials 1 and 2 examining the effects of small amounts of pendimethalin on sugar beet development. Only significant differences from the check in Tables 1 and 3 are reported. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Distribution in soil	Residual pendimethalin at planting		Percent reduction			
			Plant height	Final root length	Beets with deformed roots	Plant fresh weight
	lb ai/ac	ppm	——— % ———			
Uniform 0-12 inches	0.125	0.04	ns	ns	ns	ns
	0.25	0.08	ns	ns	ns	ns
	0.75	0.25	34	55	38	ns
	1.50	0.50	43	56	46	ns
Non-uniform 3-9 inches	0.063	0.04	ns	ns	ns	ns
	0.125	0.08	ns	ns	ns	ns
	0.75	0.50	20	40	38	22
	1.50	1.00	14	56	75	29

SUGAR BEET TOLERANCE TO SOIL CARRY-OVER RESIDUES OF PROWL HERBICIDE

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Ontario, Oregon, 1995

Introduction

Depending on the crop, pendimethalin (Prowl) is a selective herbicide applied preplant, preemergence, or early postemergence for the control of annual broadleaf and grassy weeds. Prowl has low solubility in water (0.5 ppm) and can persist in the soil up to eighteen months when applied at the upper limit use rates. Pendimethalin inhibits plant growth and development by stopping cell division (mitosis) in roots and shoots. The herbicide is used extensively for weed control in onions, potatoes, corn, beans, and mint crops. Sugar beets, in some cases, follow these crops in rotation. The objective of this study was to measure the effects of pendimethalin on root yield, root quality, and root morphology and development when the herbicide was applied at four rates in the fall and compared for sugar beet injury when diluted in the soil by mold-board plowing and surface tillage (6 inches) by a Triple-k field cultivator. Variations of individual treatments were evaluated by determining plant populations, root yield, beet shape and quality, and yield of recoverable sugar per acre.

Procedures

Soil at the experimental site was a silt loam texture with 1.3 percent organic matter, 18.5 cation exchange capacity, and a pH reading of 7.1. The field was summer fallowed previous to applying herbicide treatments in October 1994. Individual plots were 30 feet by 18 feet and each treatment was replicated 4 times. Ten foot wide untreated buffer strips were adjacent (sides, top, and bottom) to each treated plot. Herbicide rates in the mold-board plowed treatments were Prowl applied at 0.25, 0.50, 1.0, and 2.0 lb ai per acre. Prowl rates in the non-plowed, cultivated treatments were 0.1, 0.25, 0.50, and 1.0 lb ai per acre. Following application of the herbicide, the trial area was disked twice before plowing or cultivating. Plowing depth was 12 inches. Tillage teeth on the cultivator were set to operate to a depth of 8 inches. After plowing and cultivating the trial site was worked with a Ground-hog and the field bedded on 22 inch row spacings and left until spring.

Spray equipment included a single wheel bicycle plot sprayer with an 8.5 foot boom. Spraying pattern was double-overlap with 8002 teejet fan nozzles spaced 10 inches apart on the boom. Spray pressure was 42 psi, and the spray volume of water was 29 gallons per acre.

On April 8 the seed-bed of the bedded land was prepared by harrowing the bed tops with a spike-tooth harrow, and sugar beet seed, variety WS-PM9, was planted to stand at a 5-inch drop between seeds using a Beck planter. Soil active herbicides were not applied in 1995, and the trial site was not hand-thinned. On May 4 a tank-mix combination of Betamix-Progress and Poast herbicides were applied to sugar beets in the cotyledon to 2 true leaf seedling stage. Betamix-Progress and Poast herbicide rates were 0.25 and 0.10 lb ai per acre, respectively. The few weeds emerging after the postemergence herbicide applications were removed by hand-weeding. The trial was irrigated in furrows. Total amount of fertilizer applied was 210 lb of nitrogen and 100 lb of phosphate. Sixty pounds of nitrogen and 100 pounds of phosphate were applied in the fall before plowing and cultivating, and 150 pounds of nitrogen were sidedressed on June 13.

Plant populations were determined by counting the number of plants in 120 feet of row on May 10 when the sugar beets had 6 true leaves. Plants emerged in all treated plots but showed injury and began dying between cotyledon and 4 true leaf stage of growth.

Harvesting began on October 12. Sugar beet roots from 4 rows, 28 feet long, were harvested from each plot. Eight samples were collected and sent to the Amalgamated tare laboratory at Nyssa, Oregon, for analysis to determine percent sucrose, conductivity, and pulp nitrate-N. Each sample contained eight sugar beet roots. All roots in the 28 foot length were weighed to determine root yield per acre. Percent extraction and estimated recoverable sugar per acre were calculated. Roots were observed at harvest time for any abnormal root or crown growth. Roots from the check treatments were compared to roots growing in treated plots.

Results and Discussion

Sugar beets germinated and emerged uniformly in all treated plots regardless of Prowl herbicide rates in both non-plowed and plowed areas. Prowl injury became evident in the non-plowed treatments at rates of 0.25, 0.50, and 1.0 lb ai per acre rates when the sugar beet seedlings were in the full cotyledon to 2 true leaf growth stage. Many sugar beet plants in the non-plowed plots with Prowl applied at rates of 0.25, 0.5, and 1.0 lb ai per acre had died. Plants in plowed plots at all rates appeared healthy without stand losses. The higher the rate the more severe were the first injury symptoms. Injured sugar beet seedlings became stunted in growth; the cotyledon leaves were darker green, and the hypocotyl dark red. Later symptoms demonstrated by the plants were that the leaves became necrotic, the roots desiccated, and plants with severe symptoms eventually died leaving carcasses of seedling plants. Plant counts (Table 1) show that plant populations were significantly reduced at all rates of Prowl not-plowed and at the 2.0 lb rate of Prowl mold-board plowed. Prowl at the 0.25, 0.50, and 1.0 lb ai per ac rates did not affect plant populations when these herbicide rates were diluted in the top 12 inches of the soil by mold-board plowing. When the soil was not plowed, Prowl rates of 0.25 lb ai per acre reduced plant populations by 12 percent. Rates of 0.50 and 1.0 lb ai per ac rates were eventually lethal to all sugar beet plants.

Prowl herbicide did not lower percent sucrose or reduce root quality by increasing conductivity or nitrate-N readings when sugar beet populations were not reduced. When sugar beet populations were reduced from Prowl injury (0.25 lb non-plowed), root pulp quality was lowered as a result of higher conductivity and nitrate-N readings (Table 2). The lower root quality resulted in 1.76 percent reduction in extractable sugar when sugar beet populations were 12 percent less than in the untreated checks and sugar beets were spaced farther apart. Root yields (t/ac) were not affected when Prowl was plowed under at rates of 0.25, 0.50, and 1.0 lb ai per ac and non-plowed Prowl at 0.1 lbs ai per ac. All other treatments resulted in significant reduction in root yield . Estimated recoverable sugar yields were less in non-plowed Prowl treatments at rates of 0.25, 0.50, and 1.0 lb ai per ac rates. Roots and crown development, shape and growth where not different than those in the untreated checks except in the non-plowed treatments. Crowns of sugar beets in the non-plowed plots treated with Prowl at 0.25 lb grew above the ground. Prowl did not appear to cause stubby or sprangled root growth.

Conclusions

Sugar beets are sensitive to low concentrations of pendimethalin which can cause injury to seedling sugar beets if residues of the herbicide remain in the soil where sugar beet seed germinates and roots of seedling sugar beet plants forage. In this trial, sugar beet injury occurred from Prowl in the non-plowed treatments between 0.1 to 0.25 lb ai/ac. Soil containing Prowl concentrations of more than 0.1 ppm could result in a significant reduction in sugar yield because of sugar beet stand losses.

Table 1. Number of growing sugar beet plants from plots treated with Prowl herbicide turned-under with mold-board plow and non-plowed but tilled into upper 6 inches of soil with triple-k and roller seed-bed tiller. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Number of plants per 120 feet of row (4-30 foot rows)							
Plowed or non-plowed	Prowl rate	Rep 1	Rep 2	Rep 3	Rep 4	Average	% Check
	lb ai/ac	%					
Plowed	0.25	267	261	255	252	259	100.3
Plowed	0.5	261	257	253	256	257	99.6
Plowed	1.0	249	254	259	255	254	98.4
Plowed	2.0	243	248	253	249	248	96.1
Non-plowed	0.1	240	249	251	247	247	95.7
Non-plowed	0.25	215	225	237	231	227	87.9
Non-plowed	0.5	5	0	5	0	3	0.01
Non-plowed	1.0	0	0	0	0	0	0
Untreated check	0	262	250	256	264	258	100
LSD (0.05)						8	
CV (%)						2.8	

Table 2. Root yields, sugar yield, and root quality data of sugar beets planted following applications of Prowl when Prowl was applied the previous fall or plowed under and non-plowed treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Herbicides	Rate	Plowed or non-plowed	Root yield	Sugar	Conductivity	Root nitrate-N	Extraction	Estimated recoverable sugar
	lb ai/ac		t/ac	%	µmho	ppm	%	lb /ac
Prowl	0.25	plowed	49.04	15.72	842	343	83.51	12,880
Prowl	0.5	plowed	49.36	15.65	882	382	82.94	12810
Prowl	1	plowed	49.04	15.94	834	330	83.65	13060
Prowl	2	plowed	47.91	15.74	832	331	83.62	12620
Prowl	0.1	non-plowed	49.15	15.51	868	388	83.09	12650
Prowl	0.25	non-plowed	35.64	15.58	1,010	421	81.19	8997
Prowl	0.5	non-plowed	0	0	0	0	0	0
Prowl	1	non-plowed	0	0	0	0	0	0
Untreated check	0	plowed	50.8	15.55	880	381	82.95	13,105
LSD (0.05)			2.75	0.32	71	69	0.96	737
CV (%)			7.1	3.2	12.5	29	1.8	7.3

COMBINING PREPLANT INCORPORATED NORTRON SC AND POSTEMERGENCE APPLICATIONS OF BETAMIX PROGRESS TO OBTAIN OPTIMUM WEED CONTROL IN SUGAR BEETS

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Purpose

To compare rates and timing of postemergence applications of Betamix Progress to sugar beets with cotyledon leaves, 2-true leaves, and 4-true leaves after receiving 2 lbs ai/ac of Nortron SC herbicide applied as a preplant incorporated application.

Procedures

The soil texture of the experimental site was a silt loam with 1.2 percent organic matter and a pH of 7.3. Stephens variety of wheat was the previous crop. After harvest the straw stubble was shredded with a flail beater and the field disked and irrigated. One hundred lb/ac of P_2O_5 and sixty lb/ac of nitrogen were broadcast before plowing. In October the field was mold-board plowed and bedded.

Nortron SC was applied on April 6, 1995, in an 11-inch band at the rate of 2.0 lb ai/ac and incorporated in the top 2 inches of soil using a spike-tooth bed-harrow. Sugar beet variety MonoHy WS-PM9 was planted on April 11. The trial area was irrigated to germinate seed and furnish moisture for seedling growth.

On May 3, Betamix Progress at the rate 0.25 lbs ai/ac was applied to sugar beets with cotyledon leaves. The cotyledon leaves were about 0.5 inches long. Weed species that emerged with the sugar beets included hairy nightshade, lambsquarters, redroot pigweed, and kochia. Weeds were cotyledon-leaf size. At time of herbicide application air temperature was 65°F, soil temperature 52°F at a soil depth of 4 inches. Wind was out of the west at 2 to 3 mph. Skies were partly cloudy. The emerged sugar beets appeared normal without any effects from Nortron SC that had been applied before planting.

The second Betamix Progress treatments were applied to sugar beets with 2 true leaves on May 15. The cotyledon leaves were fully expanded, and the 2 true leaves varied in size between individual plants from 0.75 to 1.0 inches long. Very few broadleaf weeds were in these plots because they were previously treated with Betamix Progress on May 3. Weed species was mostly kochia which had emerged after the previous application was applied. When spraying, air temperature was 72°F, soil temperature, 4-inch depth was 62°F. The wind was calm; skies were partly cloudy.

The third application to sugar beets with 4 true leaves was applied on May 25. The third and fourth leaves were about 1.5 inches long. The individual sugar beet plants ranged from 2.5 to 3.0 inches diameter across the rosettes. The plots previously treated with two applications of Betamix Progress were free of weeds. Broadleaf weeds in plots which received only one application of Betamix Progress on May 3 ranged in size from cotyledon-leaf to plants about 0.75 tall and with 2 to 3 true leaves. Weed species in these plots were redroot pigweed, lambsquarters, hairy nightshade, and kochia. Barnyardgrass was beginning to emerge and had 1 to 2 leaves. The sugar beets in plots which were applied with Betamix Progress at 0.4 lb ai/ac were smaller in size, chlorotic, and had some necrotic areas on the margins of the true leaves. Sugar beets in plots treated with 0.25 and 0.33 lb ai/ac appeared normal. Air temperature on May 25 while spraying was 78°F. Soil temperature at 4 inches was 66°F. The wind was calm and the skies overcast.

All herbicides were applied using a single bicycle wheel plot sprayer. The spray boom had 4 teejet fan nozzles size 6502, spaced 22 inches apart. A single nozzle was centered over each row. Individual plots were 4 rows wide and 25 feet long. Spray pressure was 42 psi, and water as the herbicide carrier was applied at a volume of 19.5 gal/ac. The treatments were arranged using a randomized complete block experimental design. The treatments were evaluated by visual ratings for crop injury and percent weed control on June 1. After evaluation the trial area was hand-thinned and weeded, and the sugar beet crop was taken through to harvest.

The sugar beets were harvested on October 13. The sugar beet tops and crowns were removed with a flail beater and rotating disc knives. All the sugar beet roots from the two center rows of each 4 row plots were harvested and weighed to determine root yield. One sample containing eight average size roots was taken from each row (2 samples/plot) to analyze the pulp from roots for percent sucrose, conductivity, and nitrate readings. Percent extractable sugar and estimated recoverable sugar per acre and recoverable sugar per ton of roots was calculated. The sugar beet root analysis was done at the Amalgamated Sugar Beet Company's tare laboratory at the Nyssa, Oregon, factory.

Results

Nortron SC at 2.0 lb ai/ac followed by two postemergence applications of Betamix Progress at rates of 0.25 and 0.33 lb ai/ac applied to cotyledon and 2 leaf sugar beets controlled 100 percent of the weeds including redroot pigweed, lambsquarters, hairy nightshade, and kochia with a low rating (6 percent) for foliar injury (Table 1). Three applications of Betamix Progress without a preplant application of Nortron SC gave 100 percent control of redroot pigweed, lambsquarters, and hairy nightshade, and 99 percent control of kochia. Nortron SC applied preplant at 2.0 lb ai/ac followed by 0.25 lb ai/ac of Betamix Progress at the cotyledon stage and another 0.4 lb ai/ac at the 4-leaf stage controlled all weed species, but the 0.4 lb ai/ac caused foliar damage to the 4-leaf sugar beets. Optimum rates of Betamix Progress were 0.25 lb ai/ac and 0.33

lb ai/ac. Betamix Progress at 0.4 lb ai/ac caused foliar burn to the young sugar beet leaves and was not needed for acceptable weed control.

Root yields and recoverable sugar yields were significantly less in the untreated check treatment compared to yields from the treated plots because of early weed competition (Table 2). Differences in yield were not significant between individual plots treated with herbicides. Sugar beet stands were not reduced by the herbicide treatments, and the foliar injury was not great enough to affect yields. Significant differences did exist between treatments for percent sucrose, but the differences in percent sucrose were not great enough to reflect differences in yield of recoverable sugar per acre. It is not uncommon to measure differences in percent sucrose readings that are significant when only three replications are involved because of variations between replications and the individual sugar beet roots sampled. Significant differences did not exist between herbicide treatments for percent extractable sugar or recoverable sugar per acre.

Table 1. Crop injury ratings and percent weed control in seedling sugar beets treated with Nortron SC preplant and postemergence applications of Betamix Progress at different rates to sugar beets at cotyledon, two, and four leaf stage of growth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

								Percent weed control											
					Crop injury			Pigweed			Lambsquarter			H. Nightshade			Kochia		
Herbicides	Rate				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac and time applied				%			%											
	ppi	cotyledon	2-leaf	4-leaf															
Betamix Progress	–	0. 25	0. 33	–	5	5	5	100	100	100	100	100	100	100	100	100	92	90	92
Betamix Progress	–	0. 33	0. 40	–	25	20	20	100	100	100	100	100	100	100	100	100	95	95	93
Betamix Progress	–	0. 25	0. 25	0. 25	5	10	10	100	100	100	100	100	100	100	100	100	98	100	98
Betamix Progress	–	0. 25	–	0. 40	15	20	15	98	95	95	98	98	98	95	95	95	90	92	88
Nortron SC + Betamix Progress	2. 0	0. 25	0. 33	–	5	10	5	100	100	100	100	100	100	100	100	100	100	100	100
Nortron SC + Betamix Progress	2. 0	0. 25	–	0. 40	20	15	20	100	100	100	100	100	100	100	100	100	100	100	100
Untreated check	–	–	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated June 1.
Ratings: 1 - 50 = degree of plant stunting and severity of leaf chlorosis and necrosis. 51 - 100 = severe foliar injury with stand losses due to herbicide
Weed or sugar beet plant losses can range from 2 to 100 percent.

Table 2. Root yield, percent sucrose, root quality reading, and sugar yields from sugar beets treated with preplant applied Nortron SC and postemergence applications of Betamix Progress applied at different rates and timing of applications. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Sugar beet yield and quality						
Herbicides	Rate				Root yield	Sucrose	Conductivity	Nitrate-N	Extraction	Recoverable sugar	
	lb ai/ac and time applied				tons/ac	%	µmho	ppm	%	lb/ac	lb/ton root
	ppi	cotyledon	2-leaf	4-leaf							
Betamix Progress	–	0. 25	0. 33	–	43.37	15.59	885	417	82.90	11210	258.5
Betamix Progress	–	0. 33	0. 40	–	44.60	15.47	933	518	82.22	11340	254.3
Betamix Progress	–	0. 25	0. 25	0. 25	43.40	15.89	892	415	82.88	11440	263.6
Betamix Progress	–	0. 25	–	0. 40	43.23	15.84	917	453	82.54	11300	261.4
Nortron SC + Betamix Progress	2. 0	0. 25	0. 33	–	43.40	15.52	923	517	82.38	11100	255.8
Nortron SC + Betamix Progress	2. 0	0. 25	–	0. 40	44.17	15.23	877	569	81.58	11090	251.1
Untreated check	–	–	–	–	37.61	15.36	835	495	82.26	9504	252.7
Mean					42.83	15.56	894	483	82.40	10997	256.8
LSD (0.05)					2.94	.37	68	78	.97	569	ns
CV (%)					2.5	1.3	4.2	9.1	.9	2.8	4.6

AN EVALUATION OF FOLIAR ACTIVE GRASS HERBICIDES TANK-MIXED WITH BROADLEAF HERBICIDES FOR WEED CONTROL IN SEEDLING SUGAR BEETS

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Purpose

New grass herbicides with foliar activity and different surfactants were evaluated for control of annual grasses in seedling sugar beets. The herbicides were applied as single and repeat applications beginning when sugar beets had cotyledon leaves. Grass herbicides were evaluated for compatibility when tank-mixed with broadleaf foliar active herbicides including Betamix Progress and Pyramin DF.

Procedures

Sugar beet variety MonoHy WS-PM9 and seed of barnyardgrass and green foxtail were planted on June 14. Sugar beet seed was planted with a Beck planter equipped with shoe openers. Grass seed was planted in the sugar beet row using an Ezee flow granular insecticide applicator. Grass seed was dropped through a tube, falling in a 1-inch wide band over the top of the planted sugar beet seed. The trial area was watered by furrow irrigation the same day of planting to furnish soil moisture for seed germination and emergence.

Stephens winter wheat had been grown during 1994. Bronate herbicide had been applied at the rate of 1 quart per acre to control weeds in the wheat. Following wheat harvest, the straw stubble was shredded with a flail beater and the field was disked and irrigated. In October, the field was mold-board plowed and bedded. One hundred lb/ac of phosphate and 60 lb/ac of nitrogen per acre were applied broadcast before plowing.

The herbicide treatments were applied to fully expanded cotyledon leaf sugar beets on June 23. Grass population was 15 plants/ sq ft and individual grass plants had 1 to 3 leaves. Broadleaf weeds varied in size from cotyledon leaf to 4 true leaves and about 1 inch tall. Broadleaf weed species included redroot pigweed, hairy nightshade, common lambsquarters, and kochia. Air temperature when spraying was 76°F. The wind was calm and the skies clear.

On June 29, herbicide treatments were applied to true-leaf sugar beets on plots previously treated June 23. Sugar beets had two fully developed true leaves with the third and fourth leaves about the size of a dime. Broadleaf species of weeds were 3 to 4 inches tall, and the larger grass plants had 1 to 2 tillers. On June 29, air temperature was 72°F, the skies were clear, and the wind was calm.

All herbicide treatments were applied using a single bicycle wheel plot sprayer. Four teejet 6502 fan nozzles were mounted 22 inches apart on the spray boom. A spray nozzle was centered over each row of the 4-row plots. Spray pressure was 42 psi, and water as the herbicide carrier applied at a volume of 19.5 gallons per acre. Each treatment was replicated three times using a randomized complete block experimental design.

Results

Poast and Ultima 160 at a rate of 0.1 lb ai per acre and Prism at 0.06 lb ai per acre gave 100 percent control of barnyardgrass and green foxtail when applied to cotyledon-leaf sugar beets when the grass had 1 to 3 leaves. These same herbicides also controlled 100 percent of the grasses when applied at higher rates of 0.3 lb ai per acre and 0.09 lb ai per acre to sugar beets with 2 true leaves and the grass plants were tillering. Differences between surfactants, Atplus 411 or Dash, in activating the grass herbicides were not noted. Both were effective with the herbicides.

The broadleaf herbicides Betamix, Betamix Progress, and Pyramin DF controlled about 75 percent of the grasses when the sugar beets had cotyledon leaves and 30 percent when applied to 2-leaf sugar beets when the grass plants were tillering. The tank-mix combinations which included Pyramin DF and Ultima 160 did not control grass as well as Ultima 160 with Betamix Progress. There appeared to be some antagonism between Ultima 160 and Pyramin DF. Progress applied at 0.73 lb ai per acre to 2-leaf sugar beets caused more injury to sugar beets than lower rates (0.25 lb ai per acre) applied as repeat applications to cotyledon-leaf sugar beets.

The best treatments for both grass and broadleaf weed control and sugar beet tolerance included foliar active grass herbicides tank-mixed with Betamix Progress and applied as repeat applications at low rates to cotyledon-leaf sugar beets. Injury ratings were zero, and weed control ratings were 100 percent. These herbicide combinations applied 2 or 3 times as new weeds emerge gave complete weed control.

Table 1. Sugar beet tolerance and percent weed control from foliar active herbicides applied to seedling sugar beets to control annual grasses and broadleaf weeds. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

						Percent weed control														
			Crop injury			Pigweed			H. nightshade			Lambsquarters			Barnyardgrass			Green foxtail		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		%			%														
Poast + Atplus 411	0.1 + 1.25%	cotyledon + 21f	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Ultima 160 + Dash	0.1 + 1.25%	cotyledon + 21f	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Progress	0.25	cotyledon + 21f	0	0	0	100	100	100	100	100	100	100	100	100	80	70	70	85	75	75
Prism + Atplus 411	0.06 + 1.25%	cotyledon + 21f	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Progress + Ultima 160	0.25 + 0.1	cotyledon + 21f	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Pyramin DF	0.25 + 0.33	cotyledon + 21f	0	0	0	100	100	100	98	100	100	100	100	100	70	80	70	75	80	70
Betamix + Pyramin DF + Ultima 160	0.25 + 0.33 + 0.1	cotyledon + 21f	0	0	0	100	95	98	100	95	95	100	98	98	98	98	98	100	100	99
Betamix + Ultima 160	0.25 + 0.1	cotyledon + 21f	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Progress + Pyramin DF	0.25 + 0.33	cotyledon + 21f	0	0	0	98	100	100	95	100	100	98	100	100	70	70	70	70	70	70
Ultima 160 + MorAct	0.1 + 1.25%	cotyledon + 21f	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Poast + Atplus 411	0.3 + 1.25%	2 leaf	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Ultima 160 + Dash	0.3 + 1.25%	2 leaf	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Progress	0.73	2 leaf	10	20	25	90	95	95	80	85	85	80	90	95	60	65	60	60	65	60
Prism + Atplus 411	0.09 + 1.25%	2 leaf	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Progress + Ultima 160	0.73 + 0.1	2 leaf	20	25	25	90	75	95	90	75	95	90	80	95	100	100	100	100	100	100
Betamix + Pyramin DF	0.73 + 1.0	2 leaf	10	25	20	85	90	95	70	85	90	90	95	95	30	30	30	30	30	30
Betamix + Pyramin DF + Ultima 160	0.73 + 1.0 + 0.1	2 leaf	5	10	10	95	98	98	90	95	98	95	90	60	80	80	60	80	85	65
Betamix + Ultima 160	0.73 + 0.3	2 leaf	5	25	25	98	85	80	95	80	80	95	80	80	98	95	98	99	95	98
Progress + Pyramin DF	0.73 + 1.0	2 leaf	5	15	15	90	95	90	85	90	90	85	90	90	40	40	30	40	40	30
Ultima 160 + MorAct	0.3 + 1.25%	2 leaf	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Untreated	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated July 10. Ratings: 0 = no herbicide effect. 100 = all plants killed.

Plot size = 4 rows x 15 feet, 3 replications

Dates of application: –cotyledon leaf sugar beets, June 23 first application; repeat application June 29.

–single application to 2-leaf sugar beets June 29.

Air temperature was 76°F at spraying time with a high of 88°F forecast. Skies were clear with no wind.

THE CONTROL OF ANNUAL GRASSES IN SEEDLING SUGAR BEETS WITH POSTEMERGENCE HERBICIDES

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Purpose

To evaluate Poast, Prism, and Assure II herbicides with X-77 or MorAct surfactants for seedling sugar beets tolerance and control of green foxtail (Setaria viridis) and barnyardgrass (Echinochlva crus-galli) species of annual grasses.

Procedures

Sugar beet variety MonoHy WS-PM9 and seed of barnyardgrass and green foxtail was planted on June 14. Sugar beet seed was planted in the sugar beet row using an Ezee flow granular insecticide applicator. Grass seed was dropped through a tube, falling in a 1-inch wide band over the top of the planted sugar beet seed. The trial area was watered by furrow irrigation the same day of planting to furnish soil moisture for seed germination, seedling emergence, and growth.

Stephens winter wheat had been the previous crop grown during 1994. Bronate herbicide had been applied at the rate of 1 quart per acre to control weeds in the wheat. No other herbicides were applied to the trial area before the herbicides in this trial were applied to the sugar beets. Following wheat harvest the straw stubble was shredded with a flail beater and the field disked and irrigated. In October the field was mold-board plowed and bedded. Fertilizer applied was 100 lbs/ac of phosphate and 200 lbs/ac of nitrogen. The phosphate and 60 lbs/ac of nitrogen were broadcast applied before plowing. The remainder of the nitrogen was sidedressed when the sugar beets had six to eight leaves. Temik at 2.0 lb ai/ac was sidedressed with the nitrogen.

The herbicide treatments were applied on July 10 to sugar beets with six leaves. Air temperature was 78°F, and wind was calm.

Herbicide treatments were applied using a single bicycle wheel plot sprayer. Four Teejet fan nozzles size 6502 were mounted 22 inches apart on the spray boom so a single nozzle was centered over each row of the 4 row plots. Spray pressure was 42 psi, and water as the herbicide carrier was applied at a volume of 19.5 gal/ac. Each treatment was replicated three times and placed at random in blocks using a complete block experimental design. Barnyardgrass and green foxtail plants had four to five leaves with one to three tillers and dense populations of both species (15 plants/sq ft) when the herbicides were applied. All plants were growing vigorously. The treatments were evaluated on July 24 for crop injury and percent grass control.

Results

Crop injury and percent grass control was evaluated 14 days after herbicide application. Treatments resulting in complete weed control were Assure II at 0.15 lb ai/ac with both surfactants, Prism at the 0.094 lb ai/ac with crop-oil-concentrate, and Prism at 0.125 lb ai/ac with both surfactants. Poast at 0.28 lb ai/ac with both surfactants also controlled 100 percent of both grass species.

Crop-oil-concentrate (MorAct) was generally better than X-77 as a surfactant for all herbicides. This effect was measurable with the lower rates of Assure II and Prism. It was not measurable with the higher rates of herbicides. Sugar beets were tolerant to all herbicides and rates evaluated. Grass control persisted until August 15 at which time the trial was terminated. Reoccurrence of grass populations after herbicide application was probably prevented by competition because of a fall stand of rapidly growing sugar beet plants.

Table 1. Crop injury ratings and percent weed control from herbicides applied postemergence to sugar beets for control of barnyardgrass and green foxtail. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent weed control					
		Crop injury			Barnyardgrass			Green foxtail		
Herbicides	Rate	1	2	3	1	2	3	1	2	3
	lb ai/ac		%				%			
Assure II + X-77	0.075 + 0.25%	0	0	0	95	95	95	90	92	90
Assure II + MorAct	0.075 + 1%	0	0	0	98	99	100	95	98	98
Assure II + X-77	0.15 + 0.25%	0	0	0	100	100	100	100	100	100
Assure II + MorAct	0.15 + 1%	0	0	0	100	100	100	100	100	100
Prism + X-77	0.094 + 0.25%	0	0	0	95	98	98	95	98	98
Prism + MorAct	0.094 + 1%	0	0	0	100	100	100	100	100	100
Prism + X-77	0.125 + 0.25%	0	0	0	100	100	100	100	100	100
Prism + MorAct	0.125 + 1%	0	0	0	100	100	100	100	100	100
Poast + X-77	0.28 + 0.25%	0	0	0	100	100	100	100	100	100
Poast + MorAct	0.28 + 1%	0	0	0	100	100	100	100	100	100
Untreated check	–	0	0	0	0	0	0	0	0	0

Evaluated July 24.

Ratings: 0 = no herbicide effect. 100 = all plants killed.

LATE SEASON WEED CONTROL IN SUGAR BEETS WITH POSTEMERGENCE APPLICATIONS OF FRONTIER HERBICIDE

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Purpose

Weeds emerging with sugar beet seedlings and until sugar beets have six to eight leaves are controlled very effectively with repeated applications of Betamix, Betamix Progress, Stinger, and Upbeet herbicides. These herbicides are very active on seedling species of redroot pigweed, lambsquarters, hairy nightshade, kochia, buckwheat, annual sowthistle, and other species of broadleaf weeds. Most species of annual grasses can be controlled with Poast or Prism tank-mixed with the broadleaf herbicides. Weeds emerging under the leaves of sugar beets are not controlled by these herbicide treatments because of the canopy effect of the sugar beet leaves. Weeds emerging under sugar beet leaves must be controlled by herbicides with preemergence activity. The purpose of this trial was to evaluate Frontier for sugar beet tolerance and late season weed control when applied to sugar beets with two and four true leaves. Frontier was evaluated when applied at two rates with Poast herbicide and in tank-mix combinations with Betamix Progress and Poast.

Procedures

Frontier herbicide at rates of 0.5, 1.17, and 2.34 lb ai/ac and Poast at 0.3 lb ai/ac were applied with and without Betamix Progress at 0.25 lb ai/ac in tank-mixes to seedling sugar beets with two or four true leaves. Mono-Hy WS-PM9 sugar beet seeds were planted in silt loam with a Beck shoe type drill on June 6. Soil pH was 7.3 and the soil had 1.3 percent organic matter.

The previous crop had been Stephens winter wheat. Weeds had been controlled in the wheat with 1 qt/ac Bronate. Following wheat harvest, 100 lbs/ac of phosphate and 60/lbs/ac of nitrogen were broadcast and plowed down. An additional 100 lbs/ac of nitrogen were sidedressed when sugar beets had six leaves. Eighty lbs/ac of powdered sulfur was applied as a split application on July 5 and August 16 to control powdery mildew.

Herbicide application to 2-leaf sugar beets was made on June 29. Broadleaf weed species present included redroot pigweed, hairy nightshade, and lambsquarters. These weeds had two to six true leaves. Grass species were barnyardgrass and green foxtail. Grassy weeds ranged in size from 1-leaf to 1-tiller. Applications to 4-leaf sugar beets were applied on July 5. On June 29, the skies were sunny, the wind calm, air temperature 74°F with a high of 75°F. Soils were moist from an application of water by furrow irrigation on June 26. On July 5 the skies were clear, air temperature 78°F, and wind calm. Soil temperatures on these two dates at the 4-inch depth were 72°F and 74°F, respectively.

Each herbicide treatment was applied using a single bicycle wheel plot sprayer. Individual plots were 4 rows wide and 25 feet long. The spray boom had four Teejet 6502 fan nozzles spaced 22 inches apart so a single nozzle was centered over each row of sugar beets. Spray pressure was 42 psi, and water as the herbicide carrier was applied at a volume of 19.5 gallons per acre. Each treatment in the trial was replicated three times using a randomized complete block experimental design.

Evaluations for crop injury and weed control from postemergence activity were evaluated on July 12. Weeds escaping the postemergence herbicide treatments were removed by hand-weeding on July 13. Final weed control evaluations were taken on September 20. These evaluations determined the effectiveness of Frontier herbicide for control of weeds emerging after lay-bye cultivation.

Sugar beets were harvested on October 12 to obtain root yield and root quality data including percent sucrose, conductivity readings, and root nitrate-N content. The percent extraction and estimated yield of recoverable sugar were calculated. All roots from the two center rows of each four-row plot (a total of 50 feet of row) were weighed to determine beet yield per acre. Root quality was obtained from two samples, each containing eight sugar beet roots taken from each plot. Beet quality measurements were determined at the Amalgamated Sugar Company tare laboratory in Nyssa, Oregon.

Results and Discussion

Sugar beets with two and four leaves were tolerant to Frontier at all rates (0.5, 1.17, and 2.34 lb ai/ac) when applied in tank-mix combination with Poast herbicide at 0.3 lb ai/ac (Tables 1 and 2). Frontier tank-mixed with Betamix Progress resulted in injury to the leaves of sugar beets in both the 2 and 4-leaf stages. The first injury noted was leaf chlorosis followed by severe burning of all leaves. In some cases the leaf tissue was burned back to the leaf midribs and petioles. In all cases new leaf tissue grew from the crown of all seedling sugar beets, and plant stands were not reduced. Solvents or emulsifiers used to formulate the Frontier increased the herbicidal activity of Betamix. Frontier by itself did not have herbicidal postemergence activity shown on the weed species or sugar beets at the rates evaluated.

Poast herbicide was compatible with Frontier, and excellent control of both barnyardgrass and green foxtail was obtained. Good to excellent late season weed control was obtained with Frontier. Weed control improved as the rate of Frontier was increased from 0.5 to 1.17 to 2.34 lb ai/ac. Frontier at 2.34 lb ai/ac resulted in complete control of redroot pigweed, lambsquarters, hairy nightshade, barnyardgrass, and green foxtail. Tank-mixing Frontier with Betamix Progress for early application would probably be unacceptable to growers because of foliar damage even though the plants recovered and stand-reduction did not occur.

None of the treatments resulted in reduction of root yield, percent sucrose, or recoverable sugar per acre, nor did it reduce root quality by increasing conductivity readings or the amount of NO_3-N in the root tissue (Table 3).

Based on the results of this trial, Frontier could have a place in sugar beet production when applied alone or in combination with Poast herbicide to seedling sugar beets for control of emerged grass and preemergence control of summer annual broadleaf and grassy weeds.

Table 1. Early ratings for crop injury and per cent weed control from Frontier herbicide applied in tank-mix combination with Betamix Progress and Poast herbicides to sugar beets with 2 or 4 true leaves. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

						Percent weed control														
			Crop injury			Pigweed			H. nightshade			Lambsquarters			Barnyardgrass			Green foxtail		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		%			%														
Frontier + Poast	0.5 + 0.3	2 leaves	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Frontier + Poast	1.17 + 0.3	2 leaves	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Frontier + Poast	2.34 + 0.3	2 leaves	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Frontier + Progress + Poast	0.5 + 0.25 + 0.3	2 leaves	5	5	5	90	90	90	90	90	90	95	95	95	100	100	100	100	100	100
Frontier + Progress + Poast	1.17 + 0.25 + 0.3	2 leaves	25	15	10	95	98	98	95	98	98	98	100	95	100	100	100	100	100	100
Frontier + Poast	1.17	4 leaves	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Frontier + Poast	2.34	4 leaves	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100	100
Frontier + Progress + Poast	0.5 + 0.25 + 0.3	4 leaves	20	20	25	65	65	65	60	60	60	65	60	60	100	100	100	100	100	100
Frontier + Progress + Poast	1.17 + 0.25 + 0.3	4 leaves	25	35	25	70	65	65	60	60	60	70	70	70	100	100	100	100	100	100
Untreated check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated July 12, 1995.

Ratings: 0 = no herbicide effect. 50 = 1 percent stand loss and severe stunting and leaf necrosis. 100 = all plants killed.

Table 2. Late season ratings for crop injury and percent weed control from soil active preemergence activity of Frontier herbicide applied in tank-mix combinations with Betamix Progress and Poast herbicides to seedling sugar beets with 2 or 4 true leaves. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

						Percent weed control														
			Crop injury			Pigweed			H. nightshade			Lambsquarters			Barnyardgrass			Green foxtail		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		%			%														
Frontier + Poast	0.5 + 0.3	2 leaves	0	0	0	90	85	85	80	75	80	85	90	90	85	80	90	90	85	85
Frontier + Poast	1.17 + 0.3	2 leaves	0	0	0	98	100	98	95	90	95	95	90	95	98	98	98	98	98	98
Frontier + Poast	2.34 + 0.3	2 leaves	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Frontier + Progress + Poast	0.5 + 0.25 + 0.3	2 leaves	0	0	0	85	85	85	75	80	80	85	80	80	90	80	85	85	80	80
Frontier + Progress + Poast	1.17 + 0.25 + 0.3	2 leaves	0	0	0	98	95	98	95	90	95	95	95	90	98	98	98	98	98	98
Frontier + Poast	1.17 + 0.3	4 leaves	0	0	0	95	98	98	95	95	95	90	95	90	98	98	98	98	100	98
Frontier + Poast	2.34 + 0.3	4 leaves	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Frontier + Progress + Poast	0.5 + 0.25 + 0.3	4 leaves	0	0	0	80	85	85	80	85	75	80	85	80	85	80	85	85	90	85
Frontier + Progress + Poast	1.17 + 0.25 + 0.3	4 leaves	0	0	0	98	95	95	90	85	90	90	95	85	99	95	99	99	98	98
Untreated check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated September 20. Harvested on October 13, 1995.

Herbicides activated by mechanical incorporation with sinner weeders, in row cultivating tools.

Table 3. Root yield, percent sucrose, sugar yield, and root quality data from sugar beets treated at the 2 and 4 true leaf stage with Frontier herbicide applied in tank-mixed combinations with Betamix Progress and Poast herbicides. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

			Sugar beet yield and quality							
Herbicides	Rate	Applied	Root yield	Sucrose	Conductivity	Root NO_3N	Extraction	Gross sugar	Recoverable sugar	
	lb ai/ac		tons/ac	%	µmho	ppm	%	lb/ac	lb/ac	lb/ton
Frontier + Poast	0.5 + 0.3	2 leaves	43.4	15.59	885	417	82.9	13,250	11,210	258.5
Frontier + Poast	1.17 + 0.3	2 leaves	44.6	15.47	933	518	82.2	13,790	11,340	254.4
Frontier + Poast	2.34 + 0.3	2 leaves	43.4	15.89	892	415	82.88	13,790	11,440	263.4
Frontier + Progress + Poast	0.5 + 0.25 + 0.3	2 leaves	43.2	15.84	917	453	82.54	13,690	11,300	261.5
Frontier + Progress + Poast	1.17 + 0.25 + 0.3	2 leaves	43.4	15.52	923	517	82.38	13,470	11,100	255.7
Frontier + Poast	1.17 + 0.3	4 leaves	44.2	15.43	957	529	81.58	13,640	11,170	252.7
Frontier + Poast	2.34 + 0.3	4 leaves	44.2	15.45	936	468	82.28	13,657	11,102	251.2
Frontier + Progress + Poast	0.5 + 0.25 + 0.3	4 leaves	43.2	15.85	901	488	82.68	13,694	11,372	263.2
Frontier + Progress + Poast	1.17 + 0.25 + 0.3	4 leaves	43.6	15.65	921	477	82.45	13,646	11,268	258.4
Untreated check	–	–	43.6	15.77	896	456	82.83	13,751	11,540	264.7
Mean			43.7	15.65	918	478	82.48	13,670	11,270	258.1
LSD (0.05)			ns	ns	ns	ns	ns	ns	ns	ns
CV (%)			2.5	1.32	4	9	0.66	2.6	2.8	1.8

SWEET CORN VARIETY EVALUATION FOR THE TREASURE VALLEY

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Objectives

Sweet corn and supersweet corn varieties were evaluated for agronomic and processing performance.

Procedures

Two trials were conducted on a Owyhee silt loam following sugar beets. One hundred pounds per acre of phosphate and 10 lbs per acre of zinc were plowed down in the fall of 1994. The was field was then groundhogged twice and worked into 30-inch beds. Alachlor (Partner) at 3 lbs ai/ac was broadcast and incorporated with a bed harrow on April 10, 1995. Eighteen supersweet corn (SH_2) and 17 sweet corn (SU_1) varieties were planted in separate trials. Each trial had a randomized complete block design with five replicates. The seed had standard fungicide seed treatments applied by the suppliers. The supersweet varieties were planted on April 26 and the sweet varieties on May 12. Seed was planted at 2-inch depth using an Amalco cone seeder on a John Deere 77 Flexi Planter.

A soil sample taken on May 5 showed 84 lbs per acre of available N in the upper two feet of soil. Urea at 150 lb N/ac was sidedressed on June 8. The field was furrow irrigated as needed on alternate furrows starting on May 31.

All plots in the supersweet trial were evaluated for vigor on May 12. Vigor was a subjective evaluation based on stand, uniformity, overall growth, color, and health. All plots were thinned to 24,000 plants/ac (1 plant every 8.71 inches) on June 10 following the emergence counts on May 12, May 23, and May 30, (only May 30 for the sweet corn). Starting on July 5, the silk stage of 20 plants in one of the middle two rows of each plot in the first replicate was evaluated. Varieties were considered to be at the mid-silk stage when 40 to 60 percent of the plants were silking. About 16 days after the mid-silk stage, ear samples from the border rows were taken and analyzed for moisture content to determine the stage of maturity. The target ear moisture for harvest was 78 percent for the supersweet varieties and 71 percent for the sweet varieties.

At harvest all ears in the central 15 feet of the middle two rows in each plot were picked and weighed. A 10 ear subsample was weighed, shucked, weighed, and evaluated for length, maximum diameter, diameter 6 inches from the base, and kernel row number. Ear taper was calculated by the difference between the maximum diameter and the diameter at 6 inches from the base. Ear taper is a descriptive measure of ear shape;

the higher the ear taper, the less cylindrical the shape of the ear. Another subsample was taken to the American Fine Foods processing lab and evaluated for moisture and processing recovery. The processing recovery was calculated as the percentage of the weight of the unhusked ears that was recovered as cut corn. Processing recovery data for each variety was based on a composite sample and was not replicated.

Results and Discussion

Emergence for the supersweet corn started on May 9. Varieties HMX 2384S, Zenith, XPH 3091, XPH 3121, Krispy King, GSS 6273, Endeavor, and C&S 710 had among the highest stand on May 12 (Table 1). Supersweet Jubilee and Sweet Ear had among the lowest subjective estimates of vigor and GSS 6273, Challenger, and HMX2384S had high subjective estimates of vigor on May 12. Final stand counts on May 30 ranged from 50 to 91 percent. GSS 6273 and HMX 2384S had among the highest stand on May 30. Yield of Supersweet Jubilee (50 percent emergence) could have been compromised by low stand, despite the high seeding rate. Varieties GSS 6273 and Marvel lodged heavily. Yields of unhusked ears ranged from 8 to 13 t/ac (Table 2). Krispy King, Marvel, Shaker, and HM 701 had among the highest yield. Marvel, Shaker, Challenger, and HM701 had ears with among the least taper (most cylindrical ears). Recovery of cut corn ranged from 33.1 to 54.0 percent among varieties.

Emergence for the sweet corn varieties started on May 22 and ranged from 30 to 90 percent (Table 3). Soil conditions were less favorable for emergence of the sweet corn than for the supersweet varieties. Yield of variety DMC 20-35 (27 percent stand May 30) could have been compromised by low stand, despite the high seeding rate. Yields of unhusked ears ranged from 8 to 11 t/ac. GS 1861, GS 9056, Splendor, Tracer, and DMC 20-38 had among the highest yields. Elite and GS9056 had ears with among the least taper (most cylindrical ears). Recovery of cut corn ranged from 32.9 to 54.8 percent.

Table 1. Supersweet corn stand counts. Corn was planted on April 26, 1995 and emergence started on May 9. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Seed source[1]	Stand count		
		May 12	May 23	May 30
		%		
Krispy King	1	69.2	90.5	87.0
Supersw. Jubilee	1	6.7	53.7	50.3
GSS 6273	1	68.0	94.2	91.5
Sweet Ear	2	18.7	72.8	68.0
Victor	2	52.3	82.7	78.3
Marvel	3	42.2	73.0	69.0
Contender	3	31.7	67.7	65.3
C & S 710	3	68.2	85.7	84.2
Shaker	4	37.2	73.2	71.2
Challenger	4	60.7	91.2	83.3
Endeavor	4	68.2	87.8	84.8
Sheba	4	57.8	85.0	83.3
XPH 3091	4	75.7	90.7	89.5
XPH 3121	4	70.0	89.7	83.8
HM 701	5	47.2	80.7	77.2
HMX 4399S	5	29.7	87.0	82.2
Zenith	5	69.7	85.7	82.7
HMX 2384S	5	70.5	91.3	90.8
Average		52.4	82.4	79.0
LSD (0.05)		13.3	7.5	5

[1]Sources: 1= Rogers/Sandoz, 2= Ferry-Morse, 3= Crookham, 4= Asgrow, 5= Harris-Moran

Table 2. Plant development, yield, and ear characteristics of supersweet corn varieties in 1995. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Seed source[1]	Days to mid-silk[2]	Days to harvest[2]	Degree days to harvest[3]	Vigor[4]	Yield[5]	Harvest date	Ear weight	Ear length	Max. ear diameter	Taper[6]	Rows	Moisture	Recovery[7]
					1-5	t/ac		lb	----- inches -----			#	------ % ------	
Krispy King	1	64	91	1315	4.8	13.5	August 8	0.36	8.0	19.0	0.25	19.0	76.9	48.8
Super Sw. Jubilee	1	70	93	1331	1.2	10.0	August 10	0.31	8.6	18.1	0.25	18.1	76.7	50.6
GSS 6273	1	70	93	1331	5.0	9.5	August 10	0.31	8.7	20.1	0.31	20.1	75.8	33.1
Sweet Ear	2	66	91	1315	2.4	12.5	August 8	0.40	9.0	18.1	0.24	18.1	76.0	54.0
Victor	2	66	91	1315	3.9	12.1	August 8	0.36	8.6	19.6	0.22	19.6	75.8	47.0
Marvel	3	66	90	1309	3.5	13.1	August 7	0.35	8.8	18.8	0.19	18.8	75.6	35.8
Contender	3	61	90	1309	3.0	11.2	August 7	0.34	8.5	16.7	0.20	16.7	75.8	51.1
C & S 710	3	62	91	1315	4.3	11.1	August 8	0.32	8.5	18.8	0.29	18.8	76.1	46.7
Shaker	4	66	90	1309	3.3	13.0	August 7	0.30	8.9	16.9	0.19	16.9	76.1	43.2
Challenger	4	66	90	1309	5.0	11.7	August 7	0.31	8.5	18.0	0.16	18.0	76.8	46.9
Endeavor	4	64	91	1315	4.1	11.4	August 8	0.30	8.3	18.4	0.27	18.4	75.8	47.4
Sheba	4	59	84	1220	3.9	11.0	July 31	0.25	8.1	14.6	0.38	14.6	76.0	45.1
XPH 3091	4	70	93	1331	4.2	10.5	August 10	0.31	8.7	19.2	0.33	19.2	75.2	45.4
XPH 3121	4	70	92	1322	4.1	8.7	August 9	0.25	8.3	18.4	0.29	18.4	76.1	43.0
HM 701	5	65	90	1309	3.8	13.0	August 7	0.33	8.7	18.0	0.17	18.0	77.7	36.2
HMX 4399S	5	74	93	1331	4.0	10.9	August 10	0.33	9.2	19.8	0.40	19.8	76.5	36.9
Zenith	5	70	92	1322	4.7	10.0	August 9	0.26	7.8	18.1	0.37	18.1	75.5	40.9
HMX 2384S	5	70	93	1331	5.0	9.3	August 10	0.29	8.5	16.7	0.36	16.7	75.5	46.2
Average		67	91	1313	3.9	11.3		0.32	8.5	1.9	0.27	18.1	76.1	45.5
LSD (0.05)					0.6	1.3		0.02	0.01	0.1	0.05	0.7		

[1]Seed sources: 1= Rogers/Sandoz, 2= Ferry-Morse, 3= Crookham, 4= Asgrow, 5= Harris-Moran

[2]from emergence. [3]degree days (50 - 86 °F) from emergence. [4]1= low, 5= high. [5]yield of unhusked ears.

[6] max. diameter minus diameter 6" from the base. [7] % of unhusked ear weight recovered as cut corn.

Table 3. Plant development, yield, and ear characteristics of sweet corn varieties in 1995. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Seed source[1]	Days to mid-silk[2]	Days to harvest[2]	Degree days to harvest[3]	Stand May 30	Yield[4]	Harvest date	Ear weight	Ear length	Max. ear diameter	Taper[5]	Rows	Moisture	Recovery[6]
					%	t/ac		lb	----- inches -----			#	----- % -----	
GS 9056	1	63	92	1,351	78.3	11.2	August 21	0.35	9.2	1.9	0.15	19.3	68.9	51.7
GS 1861	1	52	80	1251	85.7	11.0	August 9	0.33	8.6	2.0	0.31	18.7	69.6	47.4
Elite	1	62	89	1319	86.3	9.5	August 18	0.33	8.4	1.9	0.17	19.5	72.5	43.8
FMX 333	2	52	80	1251	78.5	10.2	August 9	0.31	8.6	2.0	0.32	17.9	70.0	50.4
Excalibur	2	62	88	1314	91.0	10.2	August 17	0.31	8.5	2.0	0.32	20.5	71.2	45.1
StylePak	2	61	89	1319	89.8	9.9	August 18	0.33	8.7	1.9	0.23	20.7	72.0	44.9
FMX 293	2	61	87	1314	87.2	9.5	August 16	0.33	8.9	2.0	0.26	19.8	70.8	51.7
Splendor	3	61	87	1314	87.5	11.3	August 16	0.33	8.8	2.0	0.28	21.8	70.7	49.9
Bolero	3	56	85	1303	86.8	10.9	August 15	0.31	7.9	2.0	0.43	17.4	69.6	54.8
Bingo	3	54	80	1251	82.5	9.1	August 9	0.29	7.6	2.0	0.55	18.7	69.2	51.1
Tracer	4	62	88	1314	89.8	11.0	August 17	0.39	9.3	2.1	0.21	17.5	75.8	48.6
More	4	62	92	1351	89.3	10.0	August 21	0.30	8.1	2.0	0.39	19.4	66.6	44.2
DMC 20-38	5	61	88	1314	76.2	11.9	August 17	0.36	8.7	2.0	0.27	19.3	72.3	32.9
DMC 20-04	5	56	85	1303	84.0	9.8	August 15	0.26	8.2	1.9	0.44	16.6	65.8	46.9
DMC 20-10	5	54	85	1303	90.5	9.8	August 15	0.27	8.2	1.9	0.44	16.5	66.9	49.6
HMX 4397	5	61	88	1314	79.8	9.3	August 17	0.35	8.5	2.1	0.33	21.3	72.8	51.3
DMC 20-35	5	63	92	1351	27.0	8.1	August 21	0.30	8.5	2.0	0.42	16.3	69.7	40.7
Average		59	87	1,308	81.8	10.1		0.32	8.5	2.0	0.33	18.9	70.3	47.4
LSD (0.05)					4.7	0.8		0.02	0.2	0.1	0.06	0.8		

[1]Sources: 1= Rogers/Sandoz, 2= Ferry-Morse, 3= Crookham, 4= Asgrow, 5= Harris-Moran

[2]from emergence. [3]Degree days (50 - 86 °F) from emergence [4]yield of unhusked ears.

[5] max. diameter minus diameter 6" from the base. [6] % of unhusked ear weight recovered as cut corn.

WEED CONTROL IN SWEET CORN

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Purpose

Several herbicides were applied at various rates alone and in tank-mix combinations as preplant incorporated and postemergence applications to evaluate Jubilee of sweet corn herbicide tolerance and control of common problem weed species in corn production.

Procedures

Herbicides evaluated in the trial included Dual II, Frontier, Axiom, and Axiom tank-mixed with Atrazine or Bladex applied as preplant incorporated applications. Herbicides applied postemergence to both corn and weeds included Peak, Tough, and Basagran. Tough was evaluated as wettable powder and emulsifiable formulations. Postemergence tank-mix combinations included Peak/Atrazine and Tough/Basagran. Crop oil concentrate (MorAct) was added to Peak, Tough/Basagran, and Basagran herbicides.

The trial site for this study had been planted to Stephens winter wheat in October 1993. Following wheat harvest in August of 1994, the straw was shredded with a flail chopper and the field double disked and furrow irrigated. In October, before mold-board plowing, 100 lb/ac of phosphate and 60 lb/ac of nitrogen were applied broadcast. After plowing, the soil was tilled, bedded, and left to overwinter. Soil texture was silt loam with 1.3 percent organic and a pH of 7.2.

On May 9, 1995, the beds were harrowed using a spike-tooth bed harrow. The preplant herbicides were applied and incorporated in the top 2 inches of soil using the spike- toothed bed harrow. Jubilee variety of sweet corn was planted with a John Deere flexi planter. The trial area was furrow irrigated after planting to furnish moisture for seed germination and seedling emergence. Air temperature was 68°F; soil temperature at 4-inch depth was 58°F; wind was calm, and skies overcast when herbicides were applied.

The postemergence herbicide treatments were applied on May 29. Corn plants were 4 inches tall and had 4 to 6 leaves. Emerged weed species included lambsquarters, redroot pigweed, hairy nightshade, kochia, and barnyardgrass. Broadleaf weeds ranged from plants with cotyledon leaves to plants one-inch tall and one-inch rosettes. Barnyardgrass plants had 1 to 3 leaves. When postemergence herbicides were applied, the wind was calm, air temperature 72°F, soil temperature 62°F at 4-inch depth; skies were clear, and the soil moist on the surface.

The herbicides in both the preplant incorporated and the postemergence treatments were applied with a single bicycle wheel experimental plot sprayer. Individual plots were 4-rows wide and 25 feet long. Distance between rows was 22-inches. Each treatment was replicated 3 times using a randomized strip-type experimental plot design. The spray boom covered 4 rows with a spray nozzle centered over each plot row. Teejet fan nozzles size 6502 were used. Spray pressure was 42 psi, and water was applied at a volume of 20 gallons per acre.

Results

Jubilee sweet corn was tolerant to all the preplant incorporated herbicides and to the postemergence applied Basagran and wettable powder formulation of Tough. Jubilee corn was not as tolerant to the 0.94 lb ai/ac emulsifiable concentrate formulation of Tough which caused some temporary yellowing of the corn leaves. Corn was less tolerant to Peak which caused severe leaf chlorosis and some stunting of growth to the corn plants. The symptoms occurred within 3 days after herbicide application and persisted for 10 to 14 days before the corn resumed normal growth. The herbicidal activity of Peak increased when the rate of crop oil concentrate increased from 1 to 2 pints. The best treatments for broadleaf weed control included Frontier, Axiom, and the tank-mixes of Axiom with Atrazine or Bladex. Axiom alone did not completely control hairy nightshade. Tough, Tough plus Basagran , and Basagran plus a crop oil concentrate controlled most broadleaf weeds. The preplant incorporated herbicides controlled barnyardgrass, but barnyardgrass was not controlled by the herbicides applied postemergence.

Table 1. Early evaluations (June 5) for crop injury and percent weed control from herbicides applied preplant incorporated and postemergence to Jubilee sweet corn. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

						Percent weed control																	
			Crop injury			Lambsquarters			Pigweed			H. nightshade			Kochia			Barnyardgrass		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		—— % ——			—— % ——														
Dual II + Peak + COC	2 + 0.018 + 1 pt	ppi + post	20	30	20	80	98	95	80	99	95	95	99	92	90	85	85	98	95	95
Dual II	2	ppi	0	0	0	99	96	98	99	95	98	99	93	95	95	90	95	100	98	98
Frontier	1.5	ppi	0	0	0	100	99	100	100	100	100	100	99	100	100	98	100	100	100	100
Axiom	0.68	ppi	0	0	0	98	98	98	95	95	98	95	90	80	95	95	98	100	100	100
Axiom	0.72	ppi	0	0	0	100	100	100	100	100	100	93	95	90	99	98	98	100	100	100
Axiom	0.77	ppi	5	0	0	100	100	100	100	98	98	100	95	90	100	100	100	100	100	100
Axiom + Atrazine	0.72 + 1.4	ppi	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Axiom + Bladex	0.72 + 2.25	ppi	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Peak + Atrazine + COC	0.018 + 0.05 + 1 pt	post	20	30	30	100	100	100	100	100	100	80	85	80	100	100	100	45	60	50
Peak + COC	0.018 + 1 pt	post	25	25	25	85	90	85	100	100	100	80	80	75	80	85	85	0	0	0
Peak + COC	0.018 + 2 pt	post	35	35	35	98	98	98	98	98	100	85	90	90	95	98	95	0	0	0
Tough (ec)	0.47	post	0	0	0	100	100	100	100	100	100	98	98	95	100	100	100	0	0	0
Tough (ec)	0.94	post	15	15	15	100	100	100	100	100	99	100	100	99	100	100	100	0	0	0
Tough (wp)	0.47	post	0	0	0	95	98	98	95	98	98	95	98	98	95	98	95	0	0	0
Tough (wp)	0.94	post	0	0	0	100	100	100	100	100	100	100	100	100	99	100	98	0	0	0
Tough + Basagran + COC	0.47 + 0.5 + 1 pt	post	15	15	10	100	100	100	100	100	100	100	100	100	100	100	100	0	0	0
Basagran + COC	1.0 + 1 pt	post	0	0	0	100	100	100	100	100	100	100	100	100	100	98	100	0	0	0
Untreated Check	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated June 5, 1995. Corn about 10-12 inches tall in checks.

Ratings: 0 = no herbicide effect. 100 = all plants killed.

COC = MorAct

Postemergence treatments applied on May 29.

Table 2. Second evaluations (June 22) for crop injury and percent weed control from herbicides applied to Jubilee sweet corn as preplant incorporated and postemergence applications. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

						Percent weed control														
			Crop injury			Lambsquarters			Pigweed			H. nightshade			Kochia			Barnyardgrass		
Herbicides	Rate	Applied	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac		%			%														
Dual II + Peak + COC	2 + 0.018 + 1 pt	ppi + post	5	10	10	85	85	85	90	95	95	70	85	85	80	85	85	90	95	95
Dual II	2. 0	ppi	0	0	0	95	95	95	98	98	98	83	85	90	90	95	90	98	95	95
Frontier	1.5	ppi	0	0	0	98	98	98	99	99	99	99	99	99	95	95	95	98	98	98
Axiom	0.68	ppi	0	0	0	93	95	93	95	98	98	83	85	70	90	90	88	95	95	92
Axiom	0.72	ppi	0	0	0	98	93	98	99	99	99	80	85	80	95	90	95	100	98	98
Axiom	0.77	ppi	0	0	0	99	99	99	98	95	98	95	90	80	93	95	95	95	98	98
Axiom + Atrazine	0.72 + 1.4	ppi	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Axiom + Bladex	0.72 + 2.25	ppi	0	0	0	100	100	100	100	100	99	100	100	99	100	100	100	100	100	100
Peak + Atrazine + COC	0.018 + 0.05 + 1 pt	post	15	5	5	100	100	100	100	100	100	90	85	90	95	98	95	25	35	35
Peak + COC	0.018 + 1 pt	post	15	10	15	100	100	98	100	100	98	80	85	80	90	95	90	0	0	0
Peak + COC	0.018 + 2 pt	post	15	15	15	100	100	100	100	100	100	90	95	80	95	95	95	0	0	0
Tough (ec)	0.47	post	0	0	0	99	98	100	100	98	99	100	100	95	99	95	99	35	40	30
Tough (ec)	0.94	post	5	5	0	100	100	100	100	100	100	98	98	100	100	100	100	50	60	60
Tough (wp)	0.47	post	0	0	0	95	95	95	95	95	95	98	98	90	90	95	90	50	40	45
Tough (wp)	0.94	post	0	0	0	100	100	100	100	100	100	99	100	100	100	98	100	55	45	55
Tough + Basagran + COC	0.47 + 0.5 + 1 pt	post	0	5	10	100	100	100	100	95	100	100	100	99	100	100	100	30	25	30
Basagran + COC	1.0 + 1 pt	post	0	0	0	100	100	100	100	98	98	100	99	99	100	98	98	0	0	0
Untreated Check	–	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated June 22, 1995. Corn 24 inches tall in checks.

Ratings: 0 = no herbicide effect. 100 = all plants killed.

COC = MorAct

Postemergence treatments applied on May 29.

PAM AND/OR LOW RATES OF STRAW FURROW MULCHING TO REDUCE SOIL EROSION AND INCREASE WATER INFILTRATION IN A FURROW IRRIGATED FIELD, 1995 TRIAL

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Summary

Polyacrylamide (PAM) and straw mulch were tested to measure reduction of soil erosion and increases in water infiltration in furrow irrigated onions. PAM was applied at a rate of 1 lb/ac and straw was applied at 150 lbs/ac. During a single irrigation, following cultivation, the untreated furrows lost 0.93 tons/ac of soil. The straw mulched furrows lost 0.62 tons/ac. The furrows irrigated with water treated with PAM lost 0.36 tons/ac of soil. Furrows with PAM plus straw mulch plots lost 0.08 tons/ac. Straw mulching 150 lb/ac decreased the amount of sediment loss by 33 percent (P = 0.17). PAM decreased the amount of sediment loss by 61 percent. The combination of PAM and straw mulch decreased the amount of sediment loss by 91 percent over nonmulched furrows without PAM.

During the irrigation, straw mulching increased water infiltration from 42 to 45 percent of applied water. PAM alone had little effect on the percent infiltration in this trial. PAM combined with straw mulch increased infiltration from 42 to 56 percent of applied water.

Introduction

Polyacrylamide (PAM), is a long chain polymer. It is used as a flocculating agent in several industrial processes, including the reduction of soil erosion during the irrigation of row crops. Polyacrylamide binds the soil together making it more difficult for water to break off soil particles; it also acts as an agent to settle already suspended soil particles. It gathers and carries sediment to the bottom of the furrow, instead of off the field.

PAM was marketed to treat the tilled soil layer, but due to the large quantities required, the product was considered uneconomical. Recent laboratory studies using new products and application techniques have shown PAM can be used in small quantities to increase soil infiltration rates and reduce erosion (Shock, et. al., 1994; Trout, et. al. 1993).

Mechanically applied straw mulch has been used to reduce erosion and increase water infiltration in Malheur County for 11 years. Manual straw mulching is very laborious and time consuming, but the mulching machines on the market work effectively. Straw mulch is applied mechanically to the bottom of the furrow, where it impedes the progress of the water. By slowing the water, erosion is reduced and the larger wetted area in the furrow bottom improves infiltration.

The purpose of this experiment is to compare low rate of straw mulch to PAM in erosion prevention and infiltration. The products individually were also compared to the combined application of application of straw mulch plus PAM.

The distance between the source of the PAM and the PAM's effectiveness in preventing erosion was also examined.

Procedures

The experiment was conducted in twenty tractor passes of Vernon Nakada's onion field on Morgan Ave., Ontario, Oregon. Each plot consisted of three furrows, 42 inches apart and 466 feet long. The Owyhee silt loam had a 2.12 percent slope (1.22 degrees) (Figure 1). Cashe yellow onions were planted on April 9, 1995. Five plots were left untreated, five were strawed by hand at an approximate rate of 150 lb/ac, five had liquid PAM applied at a rate of 1 lb/ac in the irrigation water, and five received both PAM and straw (Table 1). The PAM was applied during the first hours of the 24-hour irrigation set. The field was furrow-irrigated by siphon tubes. Inflow, outflow, and soil loss data were collected during the fourth irrigation following cultivation.

Inflow readings were taken at approximately thirty minute intervals, by measuring the amount of time it took for the siphon pipe to fill a 2.56 L bucket. Outflow readings were taken at approximately one hour intervals, with the use of Powlus V Flumes.

The liquid PAM was added to the irrigation water as it entered the head ditch and mixed by water turbulence in the ditch. The PAM plots were irrigated during the first irrigation set and the non-PAM plots were irrigated the next day.

Onset of water inflow and water outflow, and measurements of water inflow rate, water outflow rate and sediment yield were recorded during the irrigation. For each water outflow rate reading, a 1-liter sample of runoff water was placed in an Imhoff cone and allowed to settle for fifteen minutes before being read for sediment content.

The minimum distance between the source of the PAM and a measured furrow was 29 ft, the maximum distance was 123 ft, 7 in.

Total inflow, outflow, infiltration, and sediment loss were integrated from field measurements using a Lotus Improv program "InfilCal 5.0" (Shock and Shock 1993).

Results

Water treated with PAM had a significantly decreased sediment loss (Table 2, Figures 2-5). The relatively small benefits obtained with straw mulch in reducing erosion were not surprising given the very low application rate, 150 lb/ac. Straw application rates are commonly 600 to 800 lb/ac. Straw increased infiltration by 24 mm from 69 to 93 mm. Pam increased infiltration by 19 mm from 69 to 88 mm. The interaction of PAM and straw did not significantly reduce soil loss, a fact that may have been caused by experimental error due to a larger amount of variation among the furrows as is apparent in Tables 3 and 4, but came close to causing a significant increase in the infiltration.

The distance from the PAM source did not make a consistent difference in erosion in this experiment (Table 3 & 4).

Conclusions

PAM was better than straw mulch at reducing sediment loss in this experiment; however, straw was better than PAM at increasing infiltration.

Literature Cited

Shock, C.C., J. Zattiero, K. Kantola, and L.D. Saunders. 1994. Comparative cost and effectiveness of polyacrylamide and straw nulch on sediment loss from furrow irrigated potatoes. Malheur Experiment Station, Oregon State University, Ontario, OR

Trout, T.J., R.E. Sojka, and R.D. Lentz. 1993. Polyacrylamide effect on furrow erosion and infiltration. USDA Research Service. ASAE International Summer Meeting, Spokane, Washington.

Table 1. Erosion control plan for Vernon Nakada's 7 acre, Owyhee silt loam, Onion field, with a slope of 2.1 percent on Morgan Avenue, Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Tractor Pass	Treatment	Replicate
1*	Border	
2	1. Check	1
3	3. PAM	1
4	2. Straw	1
5	4. PAM + Straw	1
6	2. Straw	2
7	3. PAM	2
8	1. Check	2
9	4. PAM + Straw	2
10	2. Straw	3
11	4. PAM + Straw	3
12	1. Check	3
13	3. PAM	3
14	1. Check	4
15	3. PAM	4
16	2. Straw	4
17	4. PAM + Straw	4
18	2. Straw	5
19	4. PAM + Straw	5
20	1. Check	5
21	3. PAM	5
22	Border	
etc	Border	

Management

* Odd tractor passes receive 1 lb/ac PAM every irrigation
* Even tractor passes receive PAM starting with tractor pass #22
* Tractor passes 4, 5, 6, 9, 10, 11, 16, 17, 18, 19 will receive approximately 150 lb/ac straw mulch.

Morgan Avenue

Table 2. Average sediment loss, water inflow, outflow, and infiltration for furrow irrigated onions, during one irrigation. Erosion control options were furrow mulching with wheat straw at approximately 150 lb/ac, PAM at 1 lb/ac, both or neither. Owyhee silt loam with a 2.1 percent slope on the farm of Vernon Nakada, June 28 through 30, 1995, Ontario, Oregon. Malheur Experiment Station, Oregon State University.

	Sediment loss	Inflow	Outflow	Infiltration
	t/ac	ac-in/ac	ac-in/ac	ac-in/ac
Averages				
Check	0.93	6.3	3.7	2.6
Straw	0.62	7.1	3.9	3.2
PAM	0.36	6.6	3.8	2.8
PAM + straw	0.08	7.3	3.2	4.1
Overall averages				
With straw	0.35	7.2	3.5	3.7
Without straw	0.65	6.4	3.7	2.7
With PAM	0.22	7. 0	3.5	3.5
Without PAM	0.77	6.7	3.8	2.9
LSD (0.05) Straw	ns[&]	ns	ns	0.5
LSD (0.05) PAM	0.41	ns	ns	0.5
LSD (0.05) PAM x straw	ns	ns	ns	ns[#]

& significant at P = 0.17

significant at P = 0.15

Table 3. Sediment loss during a single irrigation of an Owyhee silt loam onion field with a 2.1 percent slope compared to distance from the source of PAM to the furrows treated with a 1 lb/ac of PAM. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Plot	Distance from PAM source	Sediment loss (lb/ac)
6	44 ft	0.89
12	68 ft 9 in	94.2
2	86 ft	2,784.29
14	89 ft 4 in	731.16
20	149 ft 7 in	7.95

Table 4. Sediment loss in a single irrigation of an Owyhee silt loam onion field with a 2.1 percent slope compared to distance from the source of PAM in furrows treated with both 1 lb/ac PAM and approximately 150 lb/ac straw mulch. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Plot	Distance from PAM source	Sediment loss (lb/ac)
8	29 ft	15.98
10	45 ft 10 in	148.3
4	64 ft 10 in	38.13
16	109 ft 9 in	612.5
18	129 ft	2.38

Figure 1. Vernon Nakada's onion field on Morgan Avenue. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

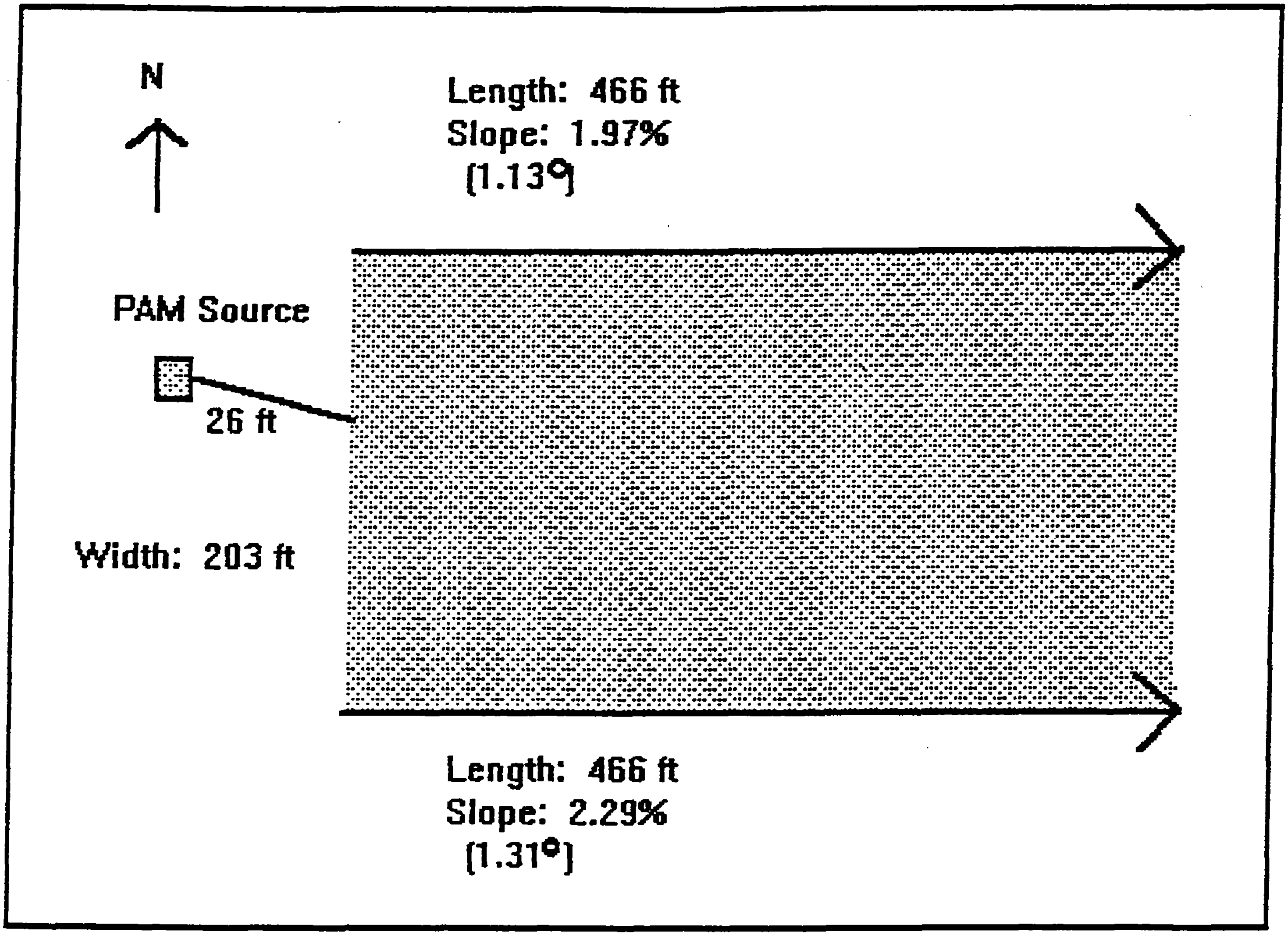


Figure 2. Average sediment loss in furrow irrigated onions during a single irrigation on Owyhee silt loam with 2.1 percent slope. Straw mulch was applied at an approximate rate of 150 lb/ac, PAM was applied at a rate of 1 lb/ac (LSD (0.05) PAM = 820 lb/ac). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

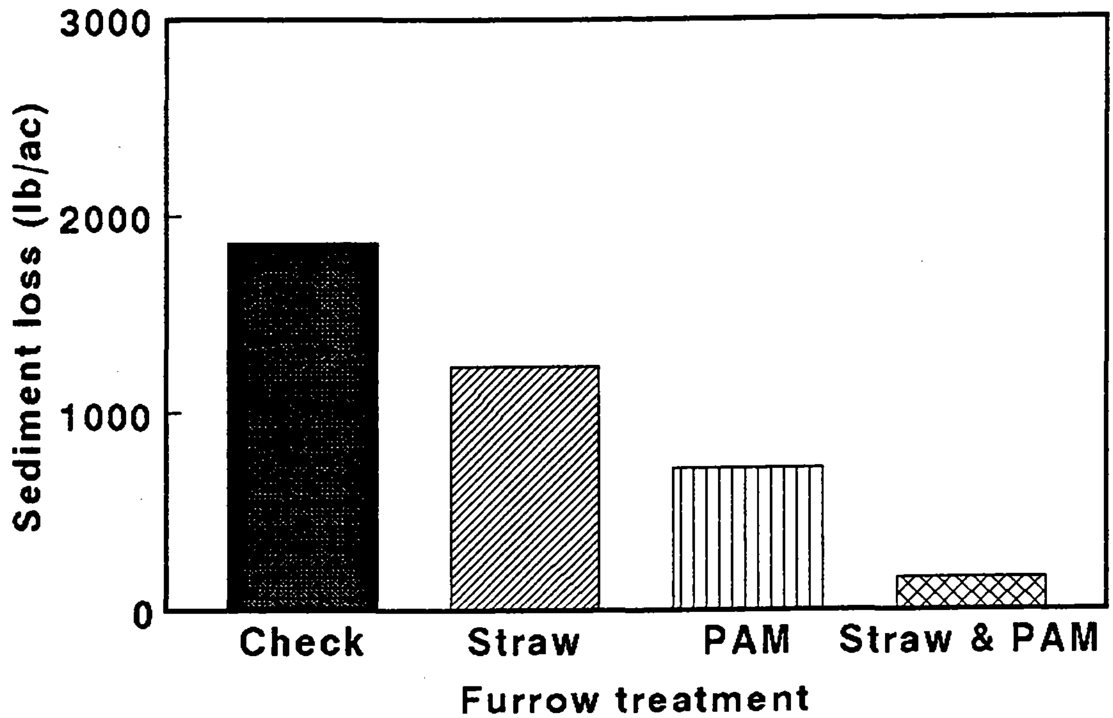


Figure 3. Average infiltration in furrow irrigated onions during a single irrigation on Owyhee silt loam with a 2.1 percent slope. Straw mulch was applied at an approximate rate of 150 lb/ac, PAM was applied at a rate of 1 lb/ac (LSD (0.05) PAM = 0.5 ac-in/ac, LSD (0.05) straw = 0.5 ac-in/ac). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

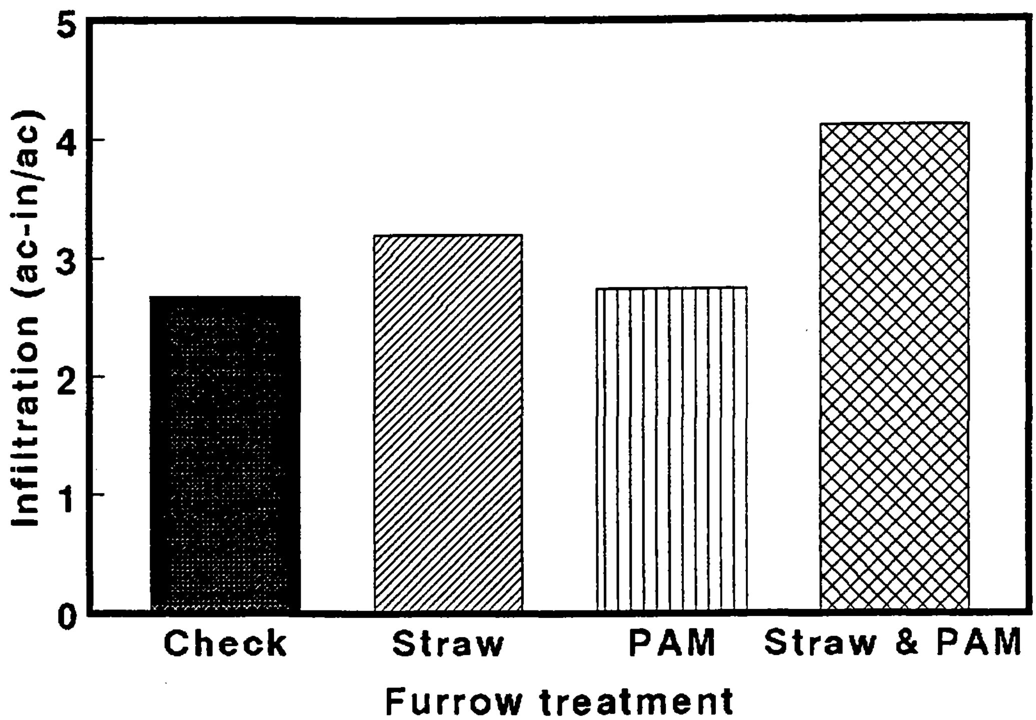


Figure 4. Effect of straw, PAM, or both on infiltration and runoff during a single furrow irrigation on Owyhee silt loam with a 2.1 percent slope. Straw mulch was applied at a rate of approximately 150 lb/ac, PAM was applied at a rate of 1 lb/ac. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

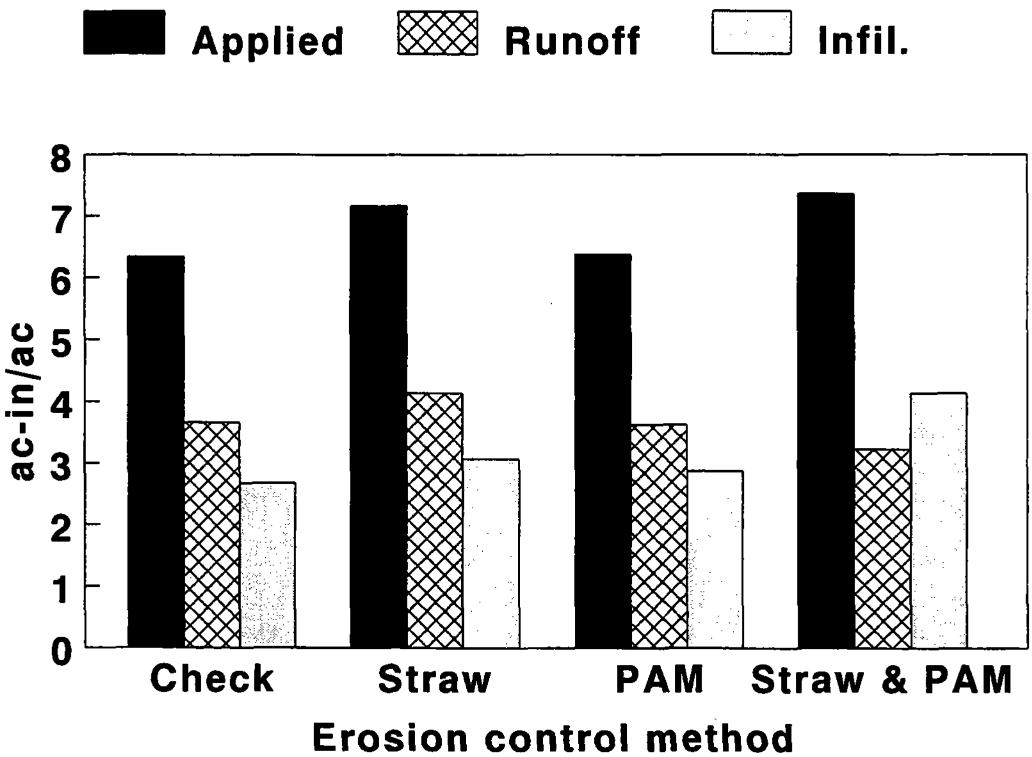
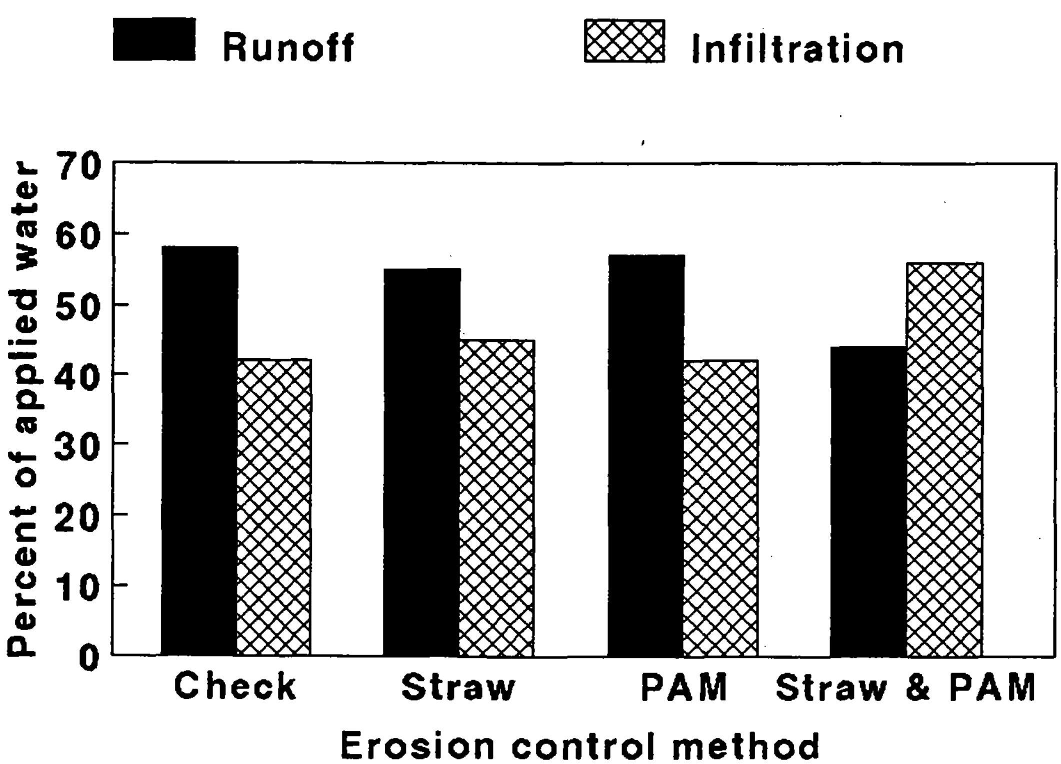


Figure 5. Effect of straw, PAM, or both on infiltration and runoff during a single irrigation on Owyhee silt loam with a 2.1 percent slope. Straw mulch was applied at a rate of approximately 150 lb/ac, PAM was applied at a rate of 1 lb/ac. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.



SEASON-LONG COMPARATIVE EFFECTIVENESS OF POLYACRYLAMIDE AND FURROW MULCHING TO REDUCE SEDIMENT LOSS AND IMPROVE WATER INFILTRATION IN FURROW IRRIGATED ONIONS

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Summary

Polyacrylamide (PAM) and straw mulch were tested to measure their ability to reduce soil erosion and increase water infiltration in furrow irrigated onions. The experiment was conducted in a Nyssa silt loam with a 3 percent slope. The length of the furrows was 245 ft. The PAM was applied at a rate of 1 lb/ac during the early part of the first irrigation in each furrow, and 0.5 lb/ac in subsequent irrigations. The straw mulch was applied to the bottom of the irrigation furrows as a single application at 563 lb/ac. During twelve furrow irrigations, the untreated furrows lost an average seasonal total of 60.1 t/ac soil, while the straw plots lost 5.3 t/ac soil and the PAM plots lost 6.2 t/ac soil. Straw mulching decreased the amount of sediment loss by 91 percent. PAM decreased the amount of sediment loss by 90 percent.

Straw mulching increased water infiltration from 23.6 to 69.8 percent of the applied water. PAM increased water infiltration from 23.6 to 53.1 percent of the applied water in this experiment.

Furrow mulching increased onion yield and grade signifigantly above the check treatment. PAM was associated with an improvement in grade.

Furrow mulching increased onion yield and grade significantly above the check treatment. PAM was associated with an improvement in grade.

Introduction

Polyacrylamide (PAM), is a long chain polymer. It is used as a flocculating agent in several industrial processes, including the reduction of soil erosion during the irrigation of row crops. Polyacrylamide binds the soil together making it more difficult for water to break off soil particles. It also acts as an agent to settle already suspended soil particles. It gathers and carries sediment to the bottom of the furrow, instead of off the field.

PAM was marketed rather unsuccessfully to treat the tilled soil layer, but due to the large amounts necessary the product was considered uneconomical. Recent laboratory studies using new products and application techniques have shown PAM can be used in small quantities to increase soil infiltration rates and reduce erosion (Shock, et. al. 1994; Trout, et. al. 1993).

Straw mulch has been used to reduce erosion and increase water infiltration in Malheur County for several years. Manual straw mulching is very laborious and time consuming, but there are machines on the market that work very effectively. Straw mulch is applied mechanically to the bottom of the furrow, where it impedes the progress of the water. By slowing the water, erosion is reduced and the larger wetted area in the furrow bottom improves infiltration.

Three different phosphorus rates were applied on this field as well, 0 lb/ac, 100 lb/ac, and 400 lb/ac. Both phosphorus rates and the furrow mulching have been repeated on every crop in the rotation in the same plots at this site for six years. PAM treatments were added in 1994 and continued in 1995.

The purpose of this experiment was to evaluate the value of straw mulch and PAM in erosion prevention and infiltration improvement.

Procedures

The experiment was conducted in a Nyssa silt loam with a 3 percent slope (Figure 1). Previous crops with the identical straw and phosphate treatments were as follows: potatoes in 1990, onions in 1991, sugar beets in 1992, wheat in 1993, and potatoes in 1994. Harvested potato beds were left idle over the winter of 1994. Spring field work consisted of deep ripping in two directions, disking and one groundhog operation before phosphate rates were applied. Twenty-two inch beds were made, then harrowed in preparation for planting. No pre-emergent herbicide was used except one application of Roundup at 1.5 pt/ac.. The field consisted of 30 plots, each plot was 245 ft long and 44 inches wide. There were twelve plots without straw or PAM, twelve plots treated with straw, as well as four PAM plots. The onion variety Vision was planted on April 17. The field was cultivated on June 1. On June 13 straw mulch was mechanically applied to the furrow bottoms in twelve of the plots, at a rate of 563 lb/ac. There were no other cultivations after the straw mulch was applied. During every furrow irrigation, PAM was applied to each furrow of the four plots. The rate of 1 lb/ac was applied during the first irrigation and 0.5 lb/ac during subsequent irrigations. The correct amount of PAM was applied to each furrow each irrigation by measuring out a PAM stock into a bucket with a valve at the head of each furrow. The PAM solution was metered into the water at a rate that would put approximately 80 percent of the solution into the furrow during the initial water advance during the irrigation. Furrows were irrigated at the rate of 2 gal/min. Inflow and outflow measurements were taken hourly for every irrigation measured. Imhoff cones were used to measure the sediment loss at the same time outflow measurements were taken.

Granular matrix sensors (Watermark Soil Moisture Sensors, Irrometer Co., Riverside, CA) were used to measure the soil water potential. Six sensors were placed in a PAM plot, six in a check plot, and six in a straw plot (Figure 1). Two of the six sensors were placed at 61.25 feet, two were placed 122.5, and two were placed 183.75 feet from the top of the field in each of the plots that were measured. The sensors were buried at a depth of 8 inches, and approximately 8 inches from the center of the hill (directly lined up in the onion row). Sensors were read daily at 8 AM starting July 18 using a 30 KTCD meter (Irrometer Co., Riverside, CA).

The onions were irrigated for emergence by sprinklers without PAM, at a rate of approximately 0.1 ac-in/ac per hour, four times over a period of six weeks, starting on April 22 (Table 1). A total of 3.2 ac-in/ac of water was applied in this manner. All subsequent irrigations were 24 hour furrow irrigations (Table 1). The field was furrow-irrigated twelve times starting on June 22. On all but two of the furrow irrigations, inflow, outflow and sediment loss data were collected. The data from those two irrigations, the second and the fourth, was estimated by averaging the data from the irrigation immediately preceding and following the one that was skipped.

Roundup at 1.5 pints per acre was broadcast, sprayed pre-emergence on May 2. Poast at 16 oz/ac and 10 oz/ac of Buctril were applied on May 20. On June 12, 20 oz/ac of Poast, 12 oz/ac of Buctril, and 12 oz/ac of Goal were applied. On July 10, 16 oz/ac of Poast, 12 oz/ac of Buctril, and 12 oz/ac of Goal were applied. To minimize residual effects for the following growing season, lay-by herbicides were not used . Sprayed Poast at 20 oz./ac on July 31 in strawed plots only. One hand weeding was necessary.

The onions were lifted and harvested at the end of September. Onions were stored until mid December then graded out from storage.

Results

Onion results and phosphate fertilizer effects on onion yield are not reported here (February 12, 1996). Onions in the plots without phosphate had root phosphate levels below 2000 ppm (Figure 3), but phosphate did not effect onion yields. Onion yields and grade were drastically increased by the use of furrow mulching from 370 cwt/ac for the untreated check to 703 cwt/ac for the furrow mulched plots (Table 2). PAM did improve onion grade, since jumbo onions increased from 161 cwt/ac in the check to 247 cwt/ac in the PAM treated plots.

The soil remained wetter when the water was treated with PAM or the furrows were mulched with straw (Figure 2). Both the check and the PAM plots occasionally became too dry.

Irrigation water treated with PAM significantly increased infiltration and reduced sediment loss . Seasonal total sediment loss averaged 60.1 t/ac from the check plots compared with 6.2 t/ac lost from the PAM plots and 5.3 t/ac lost from the furrow mulched plots (Figure 4). Season total water infiltration increased from 13.2 ac-in/ac in the check plots to 28.9 ac-in/ac in the PAM plots and 40.2 ac-in/ac in the furrow mulched plots (Figure 5). PAM and straw mulching did not differ significantly in preventing sediment loss, but straw was significantly better than PAM at increasing infiltration (LSD (0.05)=6.30 ac-in/ac). Runoff was reduced by both PAM and furrow mulching, but there was significantly less runoff with a single furrow mulching at 563 lb of straw/ac than with twelve successive applications of PAM (LSD (0.05)=6.28 ac-in/ac).

The relative amounts of applied water, infiltration, and runoff are described in Figures 6 and 7.

Sediment losses from the untreated check treatment ranged from four to more than six tons per acre per irrigation, and were undiminished all season (Figure 8). Onion vegetation never grew to the extent to contribute to a reduction in erosion potential. As the soil became more stable with time, the progressive erosion narrowed the bottom of the irrigation furrow. Sediment losses from the PAM treated plots started very low, increased slightly mid-season, then declined. Later in the season various spots in the furrow irrigated with PAM treated water began to fill. Furrows treated with straw mulch had very low amounts of sediment loss early in the irrigation season and proportionally more past mid-season. The poorer late season erosion control compared with the early season may have been caused by decomposition of the straw, burial of straw, and the failure of the onions to provide cover to help reduce late season erosion. The water infiltration in the straw mulched furrows was also greater earlier in the season (Figure 9).

Conclusions

PAM and straw both cause a considerable reduction in sediment loss. While both also increase infiltration and reduce runoff, a single application of straw mulch increased infiltration and reduced runoff more than twelve repeated PAM applications in this trial. PAM was associated with an improvement in onion grade in this trial. Furrow mulching was associated with a large increase in total yield, a large improvement in onion grade, and an increase in cullage.

Literature Cited

"Comparative cost and effectiveness of polyacrylamide and straw mulch on sediment loss from furrow irrigated potatoes." Malheur Experiment Station, Oregon State University, Ontario, OR, Special Report 947, pp 128 - 137.

Thomas J. Trout, R. E. Sojka, R.D. Lentz. 1993. "Polyacrylamide effect on furrow erosion and infiltration," USDA Research Service

Table 1. Irrigation schedule for the B3 onion field. The field is a Nyssa silt loam with a 3 percent slope, 12 plots were treated with 563 lb/ac of straw mulch, 4 were irrigated with PAM treated water, and the remaining twelve were check plots. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Furrow irrigation #	Date	Duration	Method
	April 22	8 hrs	Sprinkler
	May 26	12 hrs	Sprinkler
	June 3	4 hrs	Sprinkler
	June 5	8 hrs	Sprinkler
1	June 22	24 hrs	Furrow
2	June 29	24 hrs	Furrow
3	July 5	24 hrs	Furrow
4	July 12	24 hrs	Furrow
5	July 18	24 hrs	Furrow
6	July 24	24 hrs	Furrow
7	July 28	24 hrs	Furrow
8	August 2	24 hrs	Furrow
9	August 15	24 hrs	Furrow
10	August 8	24 hrs	Furrow
11	August 21	24 hrs	Furrow

Table 2. Response of onion yield and grade after storage to the repeated use of PAM or furrow mulching to reduce erosion in a field with three percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

	Rot	#2	Small	Medium	Jumbo	Colossal	Total	Total Jumbo
					3-4 "	> 4"		> 3"
	-------------------- cwt/ac --------------------							
Check	8	0	45	155	162	0	370	162
Straw	73	17	14	69	492	38	703	530
PAM	13	3	37	94	247	0	394	247
LSD (0.05)	40	4	10	28	55	11	59	56

Figure 1. The location of the watermark soil moisture sensors in B3, the field is a Nyssa silt loam planted to onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

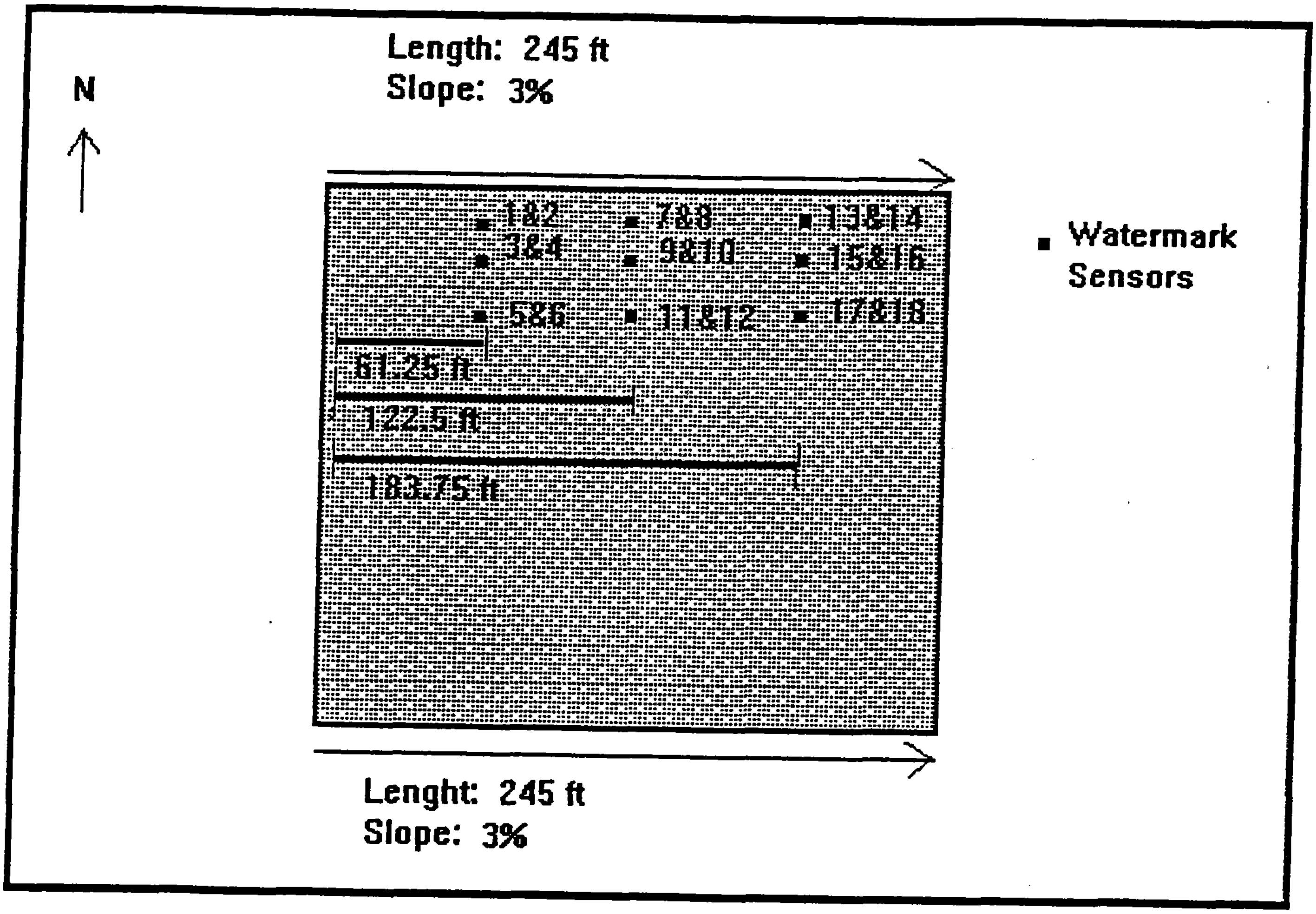


Figure 2. Soil water potential at 8-inch depth in onion hills. Furrow irrigated onions were treated with soil applied furrow mulching at a rate of 563 lb/ac, PAM treated irrigation water, or an untreated check. The field was a Nyssa silt loam with a 3 percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

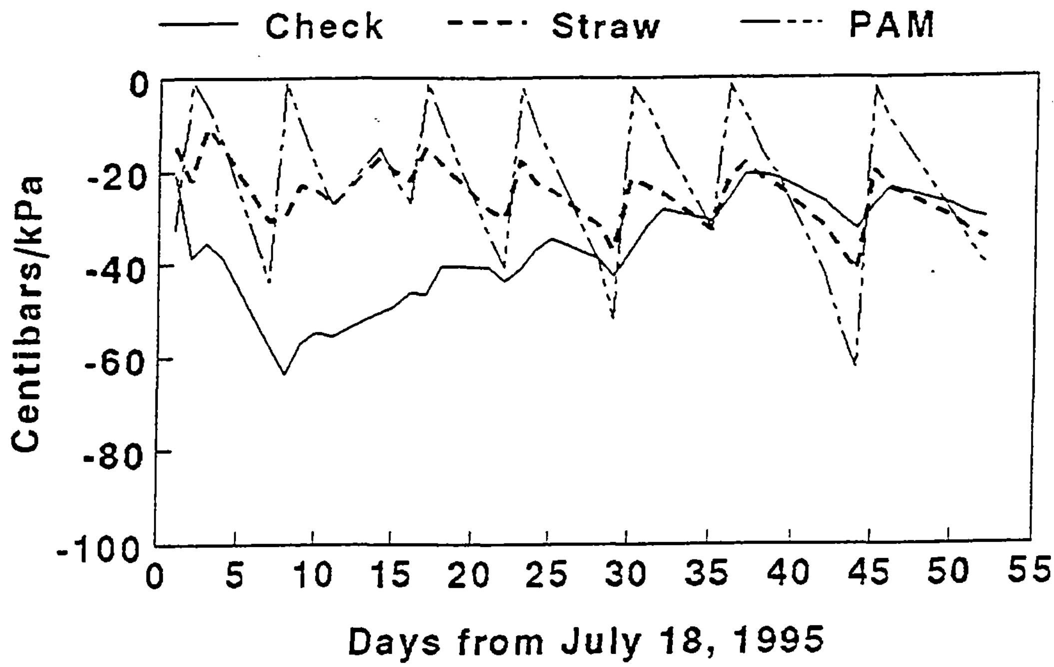


Figure 3. Onion root phosphate as a function of phosphate, furrow mulching at a rate of 563 lb/ac, and time. The field was a Nyssa silt loam with a 3 percent slope planted to onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

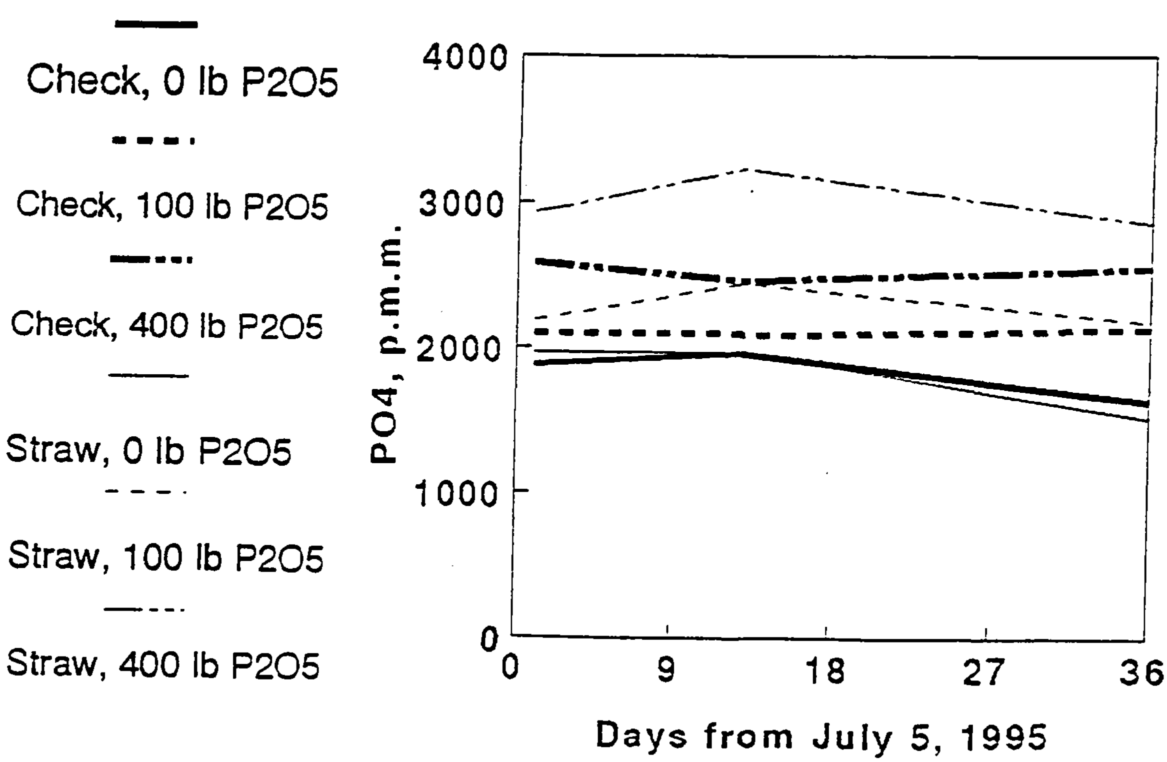


Figure 4. Season total average sediment loss in furrow irrigated onions over twelve irrigation of a Nyssa silt loam with a 3 percent slope in field B3, LSD (0.05) = 6.3 t/ac. The straw mulch was applied at a rate of 563 lb/ac, the PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

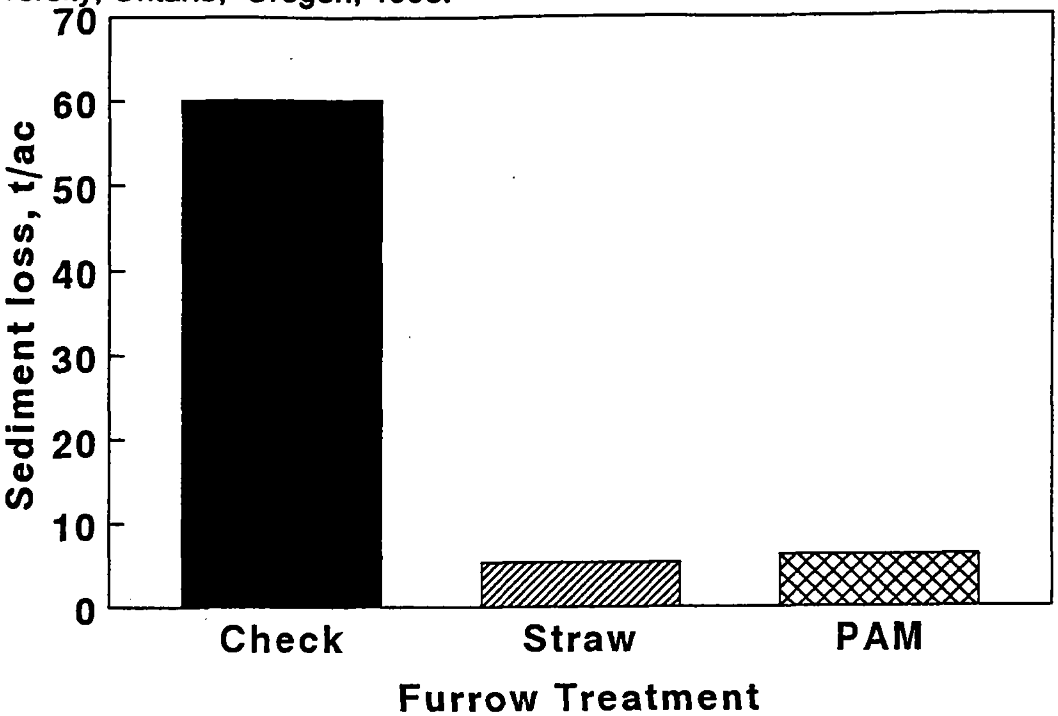


Figure 5. Seasonal total average infiltration of furrow irrigated onions over twelve irrigations of a Nyssa silt loam, with a 3 percent slope in B3, on 245 foot long runs, LSD (0.05) = 6 ac in/ac. Straw mulch was applied at a rate of 563 lb/ac, PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

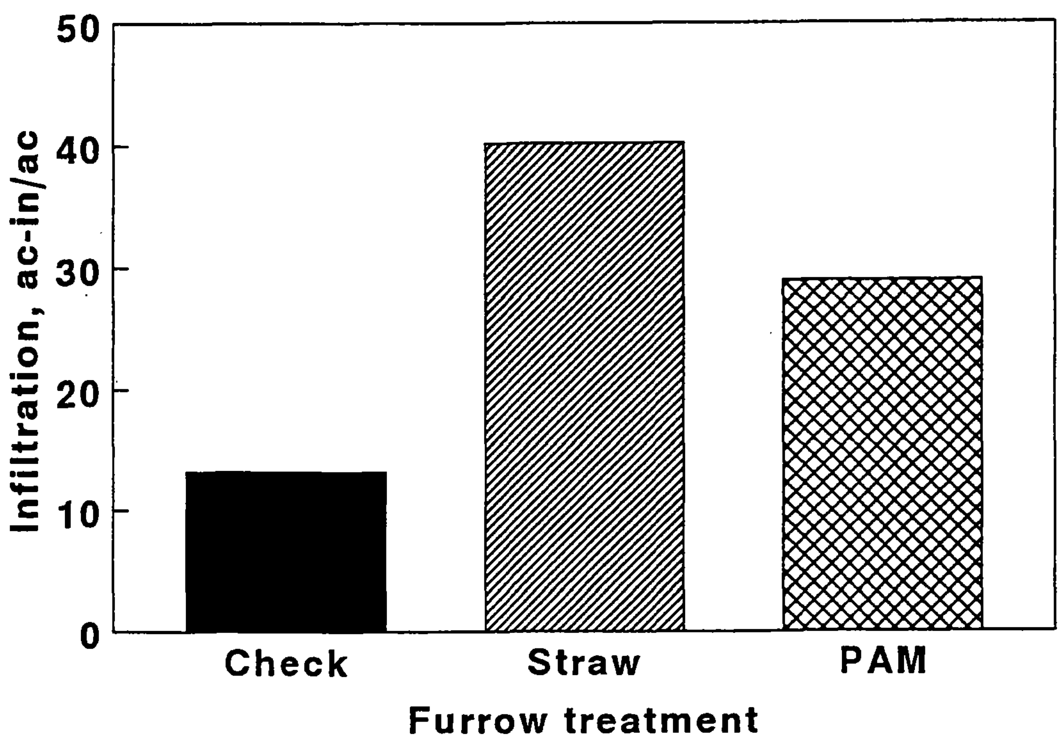


Figure 6. Season average effect of straw mulch, applied at a rate of 563 lb/ac, or PAM, applied during each irrigation, on infiltration and runoff on furrow irrigated onions during 12 irrigations of a Nyssa silt loam with a 3 percent slope, on 245 foot long runs, LSD (0.05) = 6 ac in/ac. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

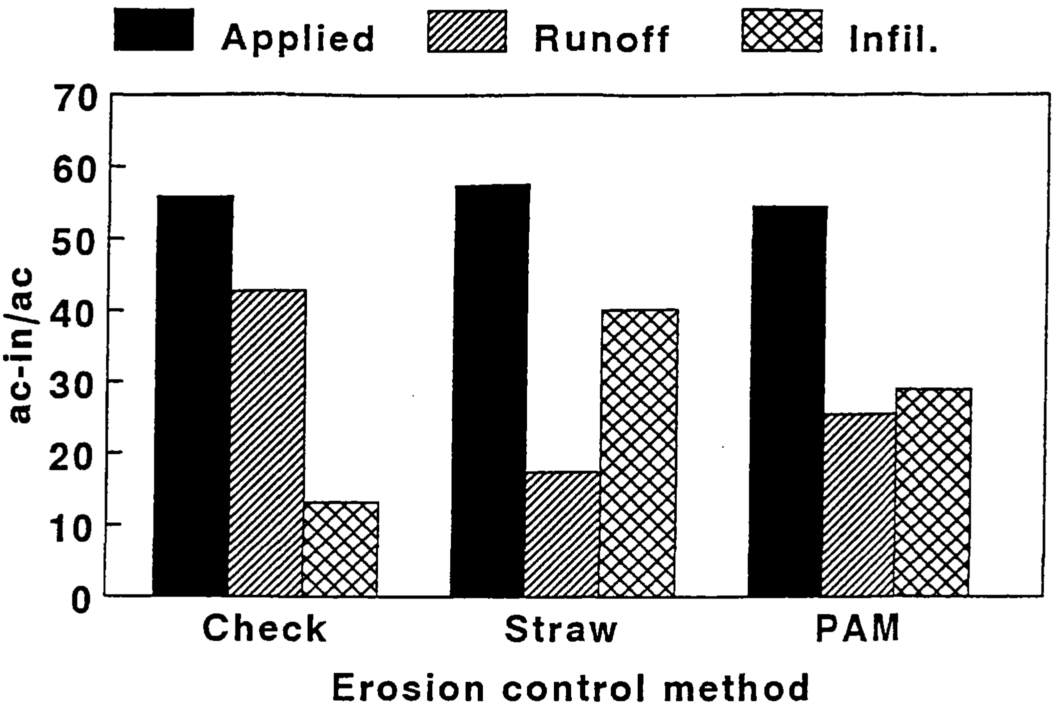


Figure 7. Season average effect of straw mulch or PAM on the percent infiltration and runoff in furrow irrigated onions during twelve irrigations of a Nyssa silt loam with a 3 percent slope. Straw was applied at a rate of 563 lb/ac, PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

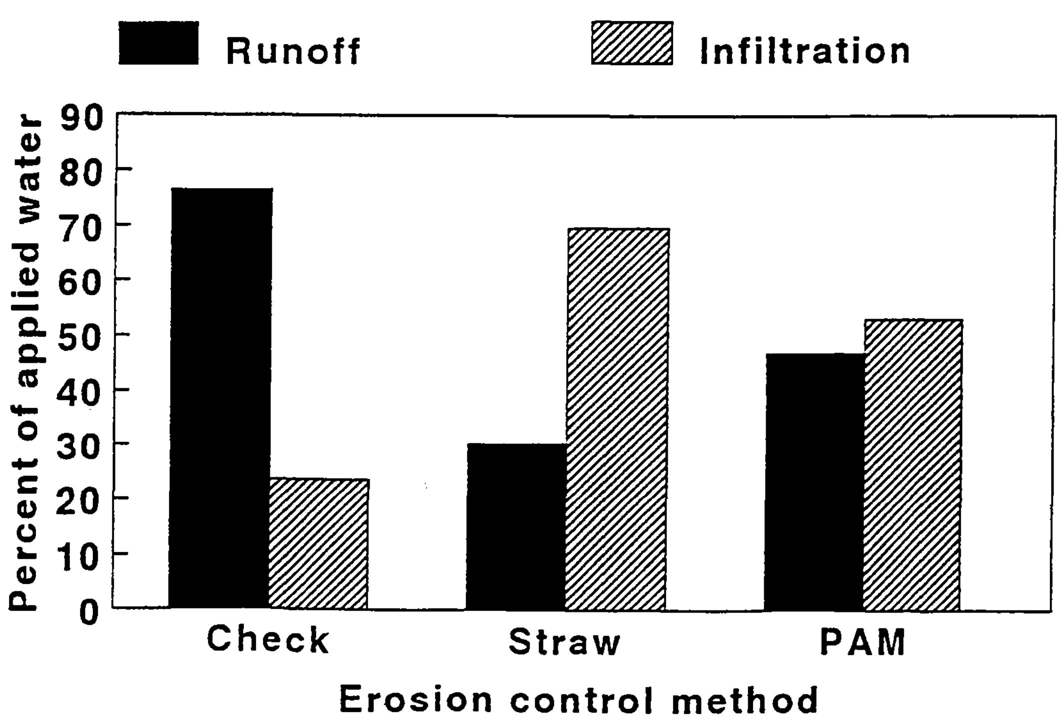


Figure 8. Average sediment loss during sequential furrow irrigations over a Nyssa silt loam with 3 percent slope. The field was planted to onions, 12 furrows were treated with 563 lb/ac straw mulch, 4 with PAM during each, and the remainder were left untreated. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

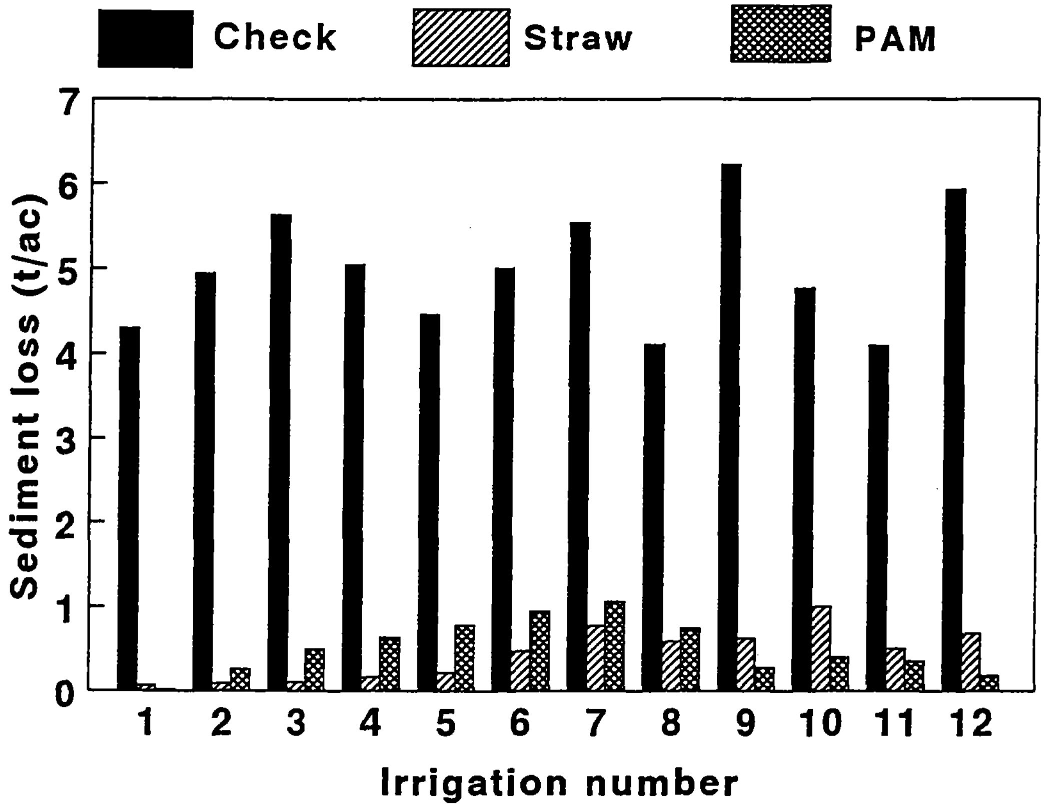
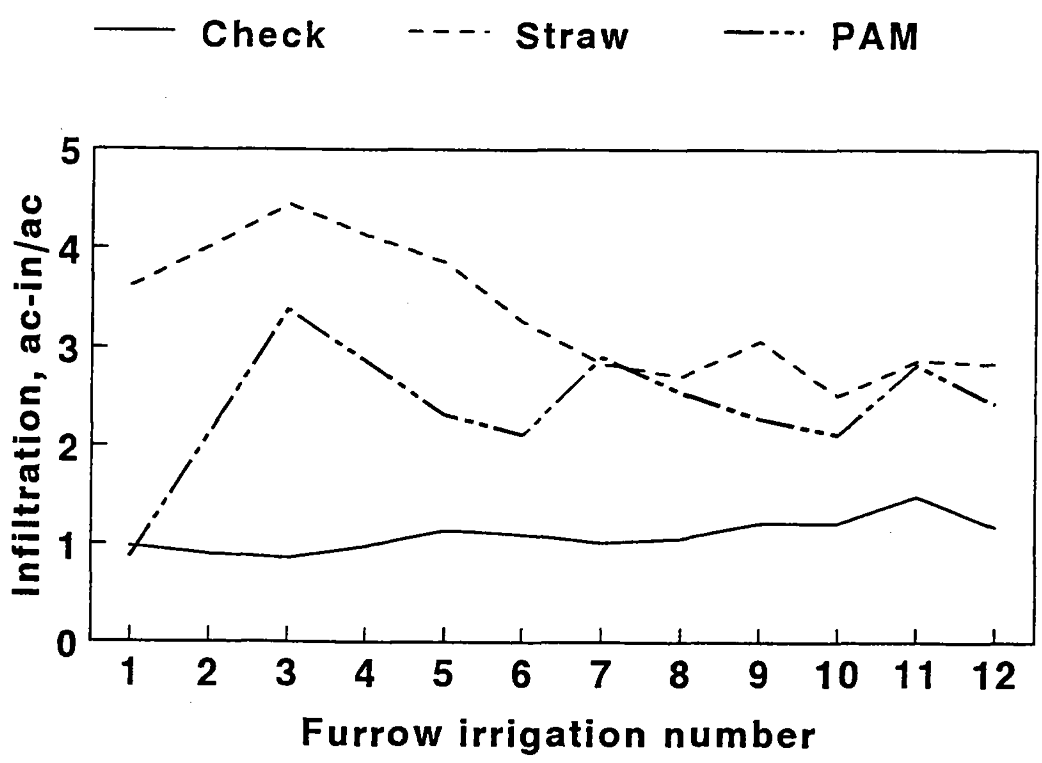


Figure 9. Average infiltration in onions grown in a Nyssa silt loam with a 3 percent slope. Straw was applied at a rate of 563 lb/ac, PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.



EFFECTS OF POLYACRYLAMIDE APPLICATION METHOD ON SOIL EROSION AND WATER INFILTRATION

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Abstract

In late June 1995, a study was conducted on a Teramura Farms' furrow-irrigated onion field to compare the effectiveness of two different application methods of polyacrylamide (PAM) to irrigation water in reducing soil loss and increasing infiltration. Water applied to individual furrows was treated with dissolved PAM, granular PAM, or left untreated.

The study showed that both PAM application methods reduced sediment loss and increased water infiltration. Granular PAM was highly effective at reducing sediment loss.

Introduction

Irrigation induced soil erosion is a serious problem on furrow irrigated agricultural land in the western United States. Growers lose money long term from soil erosion because the topsoil has been washed off, making the land less productive and crops less profitable.

Polyacrylamide (PAM) applied to the irrigation water in small quantities has been shown to decrease the amount of sediment loss, as well as increase water infiltration into the soil in furrow-irrigated fields (Trout et. al. 1993, Shock et. al. 1994). Polyacrylamide is a slightly water-soluble, high molecular weight, long chain polymer, that flocculates suspended soil particles.

Polyacrylamide was first marketed 30 years ago as a product named Krillium. Krillium was deemed uneconomical because of the large quantities needed to adequately treat the soil.

In 1994, five Malheur County growers experimented with liquid PAM and in 1995 dozens of growers used the more easily transported and more conveniently handled granular form, without knowing how well it would perform to reduce soil loss and enhance water infiltration. This experiment was conducted to compare granular PAM with liquid PAM with regards to sediment loss and water infiltration. Furthermore granular PAM had been criticized for water application because it dissolves slowly. We wanted to determine if granular PAM could be as effective at reducing erosion in furrows when applied starting at the beginning of the head ditch (where it has not yet thoroughly dissolved) as when applied to the furrows further down the head ditch.

Procedures

This experiment was conducted on 18 measured furrows of a 7 acre Teramura Farm onion field following a mid-season cultivation. The water used to irrigate each of three sets of the six measured furrows either received dissolved (liquid) PAM, granular PAM, or no treatment, the check (Figure 1).

The plot layout compared if PAM was as effective further down the head ditch of the field as at the beginning (Figure 1). The plot layout skipped 90 furrows in the center of the field. Furrows were approximately 40 inches apart and 600 feet long. The soil was Owyhee silt loam (Coarse-silty, mixed, mesic Xerollic Camborthid) Sweet Spanish onions, cultivar Vega, were planted on March 24, 1995. The 7.5 acre field had a slope of 1.4 percent (0.8 degrees) (Figure 1). Both liquid and granular PAM were to be applied at 1 lb/ac during the first 4 hours of a 24 hour irrigation set. Due to water flow changes in the head ditch, the actual rate of the liquid PAM application was 0.9 lb/ac and the actual rate of granular PAM was 1.8 lb/ac. All furrows were irrigated using siphon tubes. The average irrigation duration was 22 hours and 52 minutes and the average irrigation rate was 2.89 gallons per minute in each furrow. The PAM used was finely ground, had molecular weight of 15-18,000,000 daltons and was 30 percent anionic (Soil Saver, Aqua II, Rupert, Idaho).

Water inflow rates were determined by timing how long the water coming out of the siphon tube took to fill a 0.975 liter can. Inflow rates were taken at hourly intervals. Outflow was determined with use of a Powlus V flume which was inserted into the outlet end of the furrow and read by a gauge on the flume's side. The outflow readings were taken at hourly intervals. Sediment loss measurements were taken in conjunction with the outflow readings by means of Imhoff cones in which runoff irrigation water was placed and read by means of a gauge on the side. Imhoff cone readings after 15 minutes of settling had been previously related to sediment loss by the equation $y=1.015x$ where y is the grams of soil lost in each liter of water washing of the field at any given moment of time and x is the Imhoff cone reading. Inflow, outflow, and sediment loss data were entered and converted in a number of different computer programs to calculate the data for this report.

Results and Discussion

The results for sediment loss were clear and pronounced. Check furrows lost 322 lb/ac of sediment off of the field in a single irrigation. Furrows irrigated with granular PAM lost 7 lb/ac of sediment off of the field, while those irrigated with the liquid solution of PAM lost 104 lb/ac in the runoff water (Figure 2). During the irrigation the two PAM treatments showed a difference in soil erosion, but recall that the granular PAM was applied at twice the rate of the liquid PAM. The difference in PAM rates was not intentional, but caused by changes in volume of water flowing in the head ditch during the experiment caused by other changes in irrigation management on the farm.

Infiltration tended to increase by both PAM application methods, but did not reach statistical significance. Out of the total water applied treated with granular PAM, 73.3 percent of the water infiltrated into the soil and 26.5 percent was lost as runoff. Out of the total water treated with liquid PAM, 70.8 percent of the water infiltrated and 29.1 percent was lost as runoff. In the check furrows 62.5 percent of the total water applied infiltrated and 37.5 percent of the water was lost as runoff (Figure 3). Granular PAM was as effective in stopping loss of sediment in the first furrows as in the last (Figure 4)

Polyacrylamide costs about $4.50 a pound, so use during an entire season following cultivations increases costs moderately. Irrigation using PAM requires added maintenance as the siphon tubes tend to clog with coagulated soil. The rate of PAM has to be monitored carefully and the measurements must be accurate. The added costs and maintenance required when PAM is used could be offset financially in the short term by increased onion yield and quality if the crop suffers less water stress when irrigated with PAM. The use of PAM appears to stabilize furrow shape, providing growers with a potential immediate benefit in reduced cultivation costs. Polyacrylamide may be profitable to growers who use it, as they may not have to irrigate as often or for as long due to increased infiltration. With improved water infiltration, onions may suffer less water stress and be more productive, but this experiment was not designed to measure onion responses to irrigation management options.

Conclusion

Polyacrylamide is an effective soil erosion control chemical. The convenient granular form worked effectively in an on farm trial. This study shows that the granular PAM can be highly effective at controlling soil erosion. The water treated with liquid PAM or granular PAM had infiltration rates that were slightly higher than untreated water, but the differences in infiltration were not statistically significant.

Literature Cited

Trout, T.J., R.E. Sojka, and R.D. Lentz. 1993. Polyacrylamide effect on furrow erosion and infiltration, American Society of Agricultural Engineers, Spokane, Washington.

Shock, C.C., J. Zattiero, K. Kantola, and L.D. Saunders. 1994. Comparative cost and effectiveness of polyacrylamide and straw mulch on sediment loss from furrow irrigated potatoes, Oregon state University Agricultural Experiment Station Special Report 947:128-137.

Figure 1. Plot layout for testing granular and liquid PAM at a Teramura Farms onion field. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

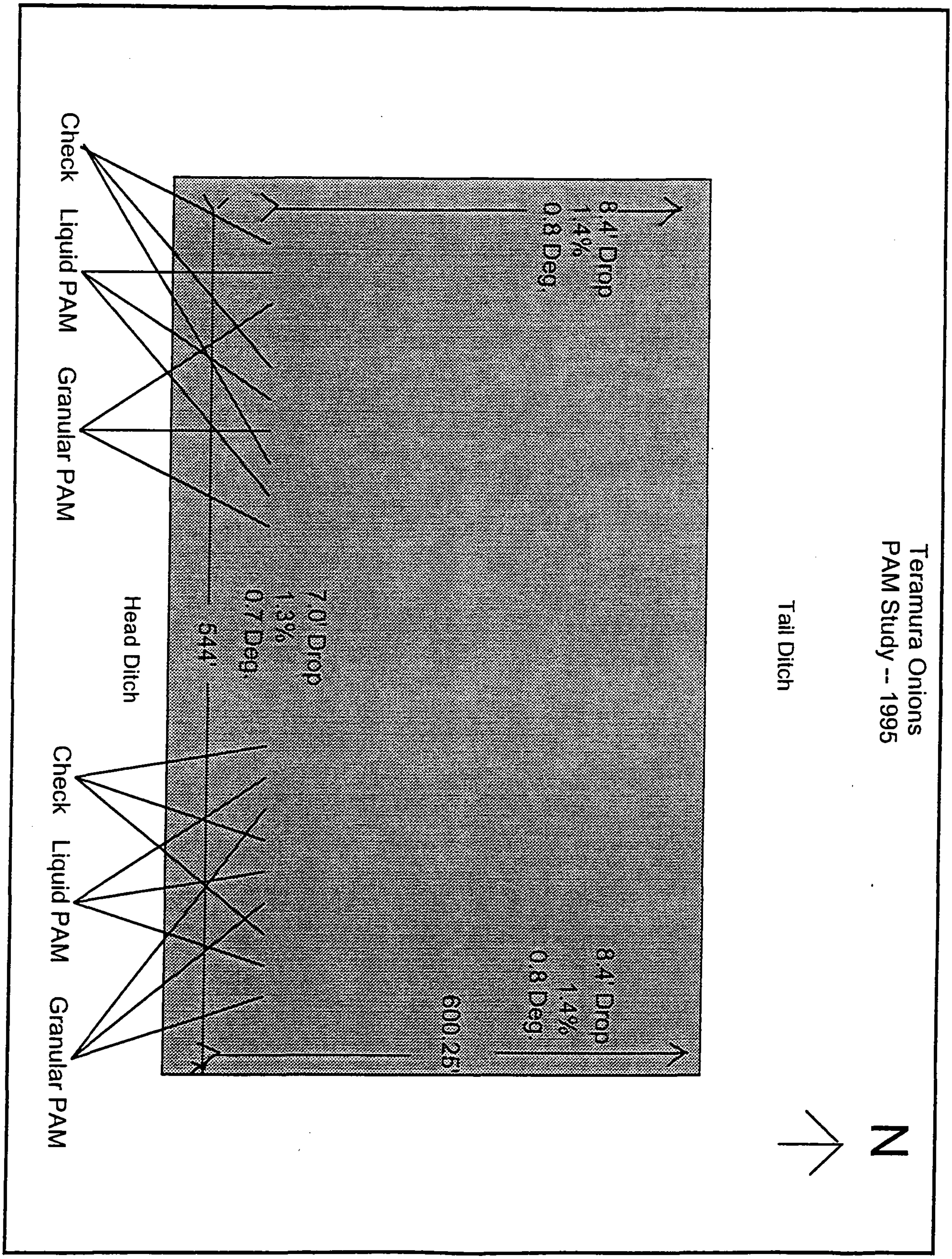


Figure 2. Effects of liquid PAM at 0.9 lb/ac and granular PAM at 1.8 lb/ac on sediment loss from furrow irrigated onions (LSD (0.05) = 233 lb/ac). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

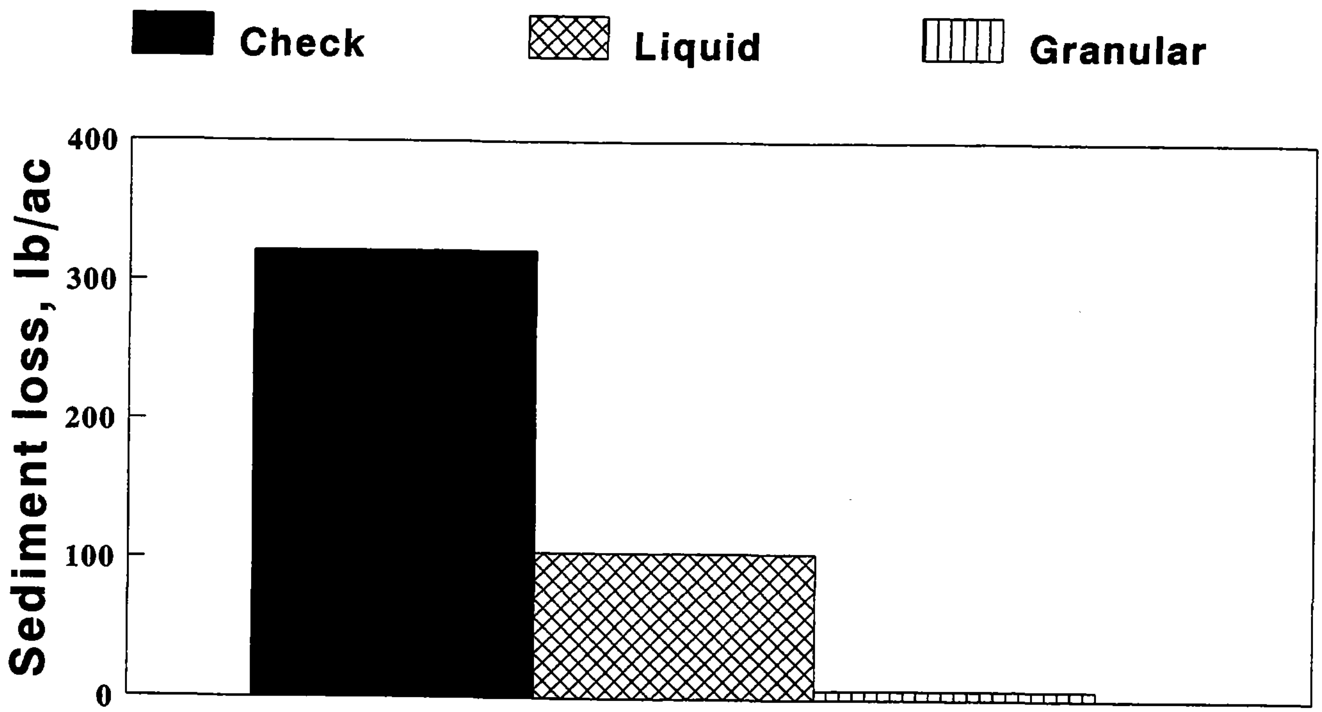


Figure 3. Effect of liquid PAM at 0.9 lb/ac and granular PAM on the water infiltration and runoff as a percent of water applied. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

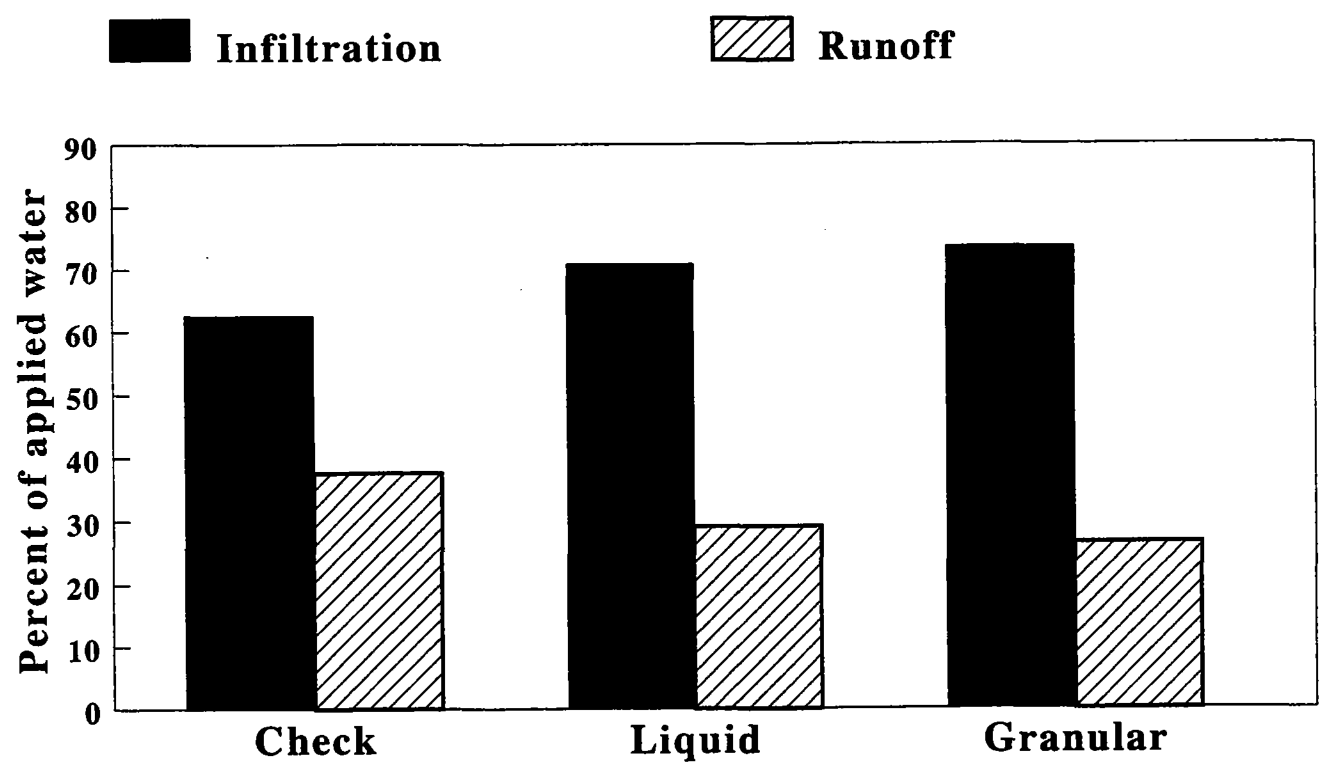
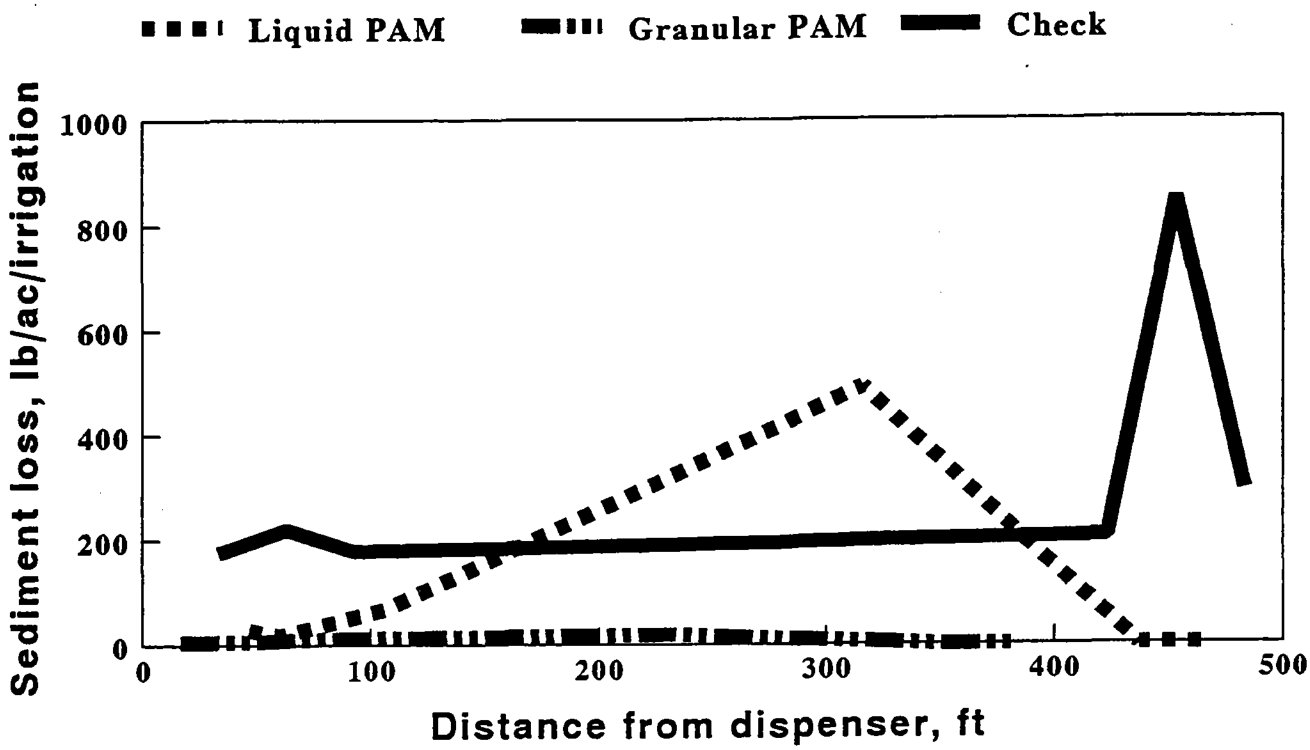


Figure 4. Effect of liquid PAM at 0.9 lb/ac and granular PAM at 1.8 lb/ac on the sediment loss as a function of distance from PAM dispenser. Malheur Experiment Station, Oregon State University, 1995.



NITROGEN MINERALIZATION FROM POTATO SLUDGE

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Introduction

Disposing of potato sludge from Malheur County's only potato processing plant has been an ongoing problem. While potato waste products are an excellent feed; the nutritional value of sludge is low, making it a poor feed. Land application by shanking directly into the soil has been tried, but the cost made it economically unfeasible. Land applying sludge to the soil surface can be done economically with manure application equipment over a wider time frame than was available for shanking methods. The feasibility of this application method along with a limited approval from the Oregon Department of Environmental Quality has made this application method worth pursuing. Two questions that have arisen and need answers are: 1) How much sludge can be applied without endangering ground water? 2) what is the nitrogen release curve, and how does it match up with crop nitrogen use requirements.

Materials and Methods

An analysis of the potato sludge indicated a total Kjeldahl nitrogen content of 10,100 ppm. Based upon the nitrogen release of other organic materials, it was postulated that about 30 percent of the total nitrogen would convert to available nitrogen during the initial growing season. A typical commercial fertilizer application for crops grown in Malheur County would range from 150 - 200 pounds of nitrogen per acre. In order to achieve this amount of nitrogen from sludge it was estimated that 25 tons of sludge would need to be applied.

25 tons sludge = 550 lb total N

[*.3 (estimated release %) = 151 lb of available N]

On June 10th two application rates of sludge (25 and 50 tons/ac) were used in the trial. One hundred pounds of soil from a commercial potato field was collected and thoroughly blended in a portable cement mixer. Sixteen check samples were taken, then potato sludge was added at a rate to equal 25 tons/ac and sixteen 25-ton samples were then taken. Additional sludge was added to bring the remaining blend to 50 tons of sludge per acre and sixteen 50-ton samples were taken.

Each sample was poured into a small plastic bag that held about two pounds of soil. One end of the bag was heat sealed prior to filling the bags. After filling the bags were tied with nylon fishing line. The sixteen filled bags of each treatment were divided into groups of four to make four replications. Four bags of each treatment were buried eight inches deep in a potato hill at four sites in the field. This allowed for four replications of each treatment to be dug up and analyzed for June, July, August, and September.

The buried plastic bags create a closed micro climate that approximates that of a field without allowing leaching or anaerobic denitrification to occur.

Results

The nitrogen mineralization going on in the soil itself was compared with the nitrogen mineralization when 25 and 50 tons/ac of potato sludge was added (Figure 1). Over the three month period the soil released 118 lbs N/ac. This number is consistent with mineralization studies conducted by the Malheur Experiment Station on local fields.

A comparison was made of the nitrogen released from the potato sludge after subtracting the soil contribution (Figure 2). The 50 t/ac sludge rate tended to release slightly over twice the amount as the 25 t/ac rate. The total nitrogen release of 254 lb N/ac from the 50 t/ac rate would be excessive for most crops grown in Malheur County and would have the potential to move into groundwater. The 25 t/ac rate released 110 lb N/ac which would be adequate for most crops, although some crops might need an additional 50 lb N/ac to supplement that released from the sludge. The amount of nitrogen released each month appears adequate for maximum crop growth.

Figure 1. Comparisons of mineralization in the soil compared with the two rates of potato sludge and soil. Nyssa, OR, 1995.

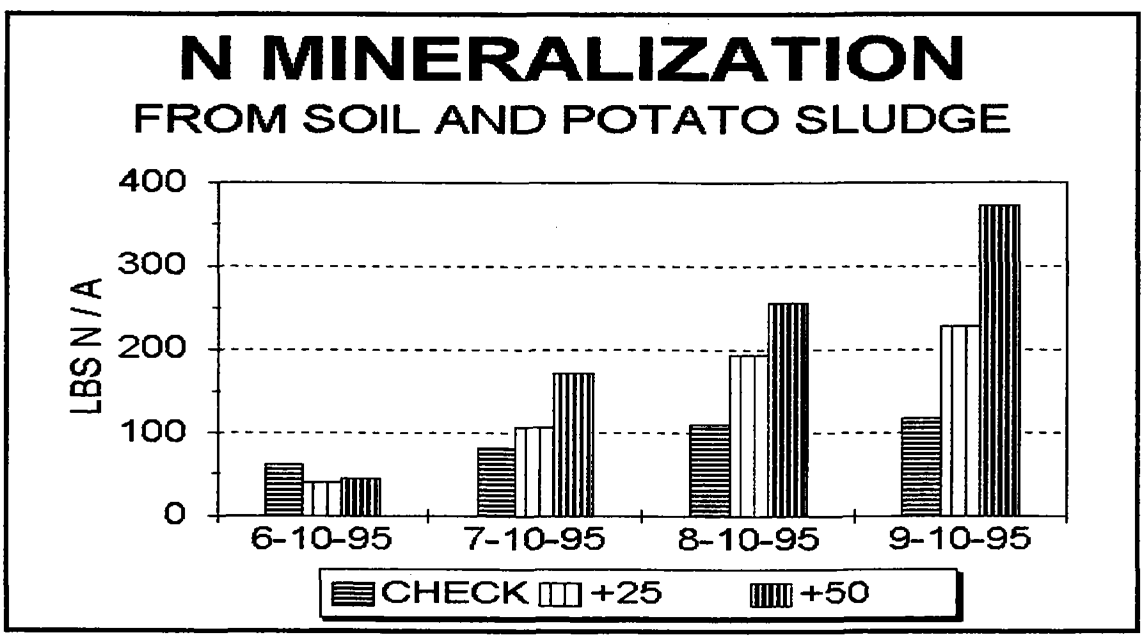
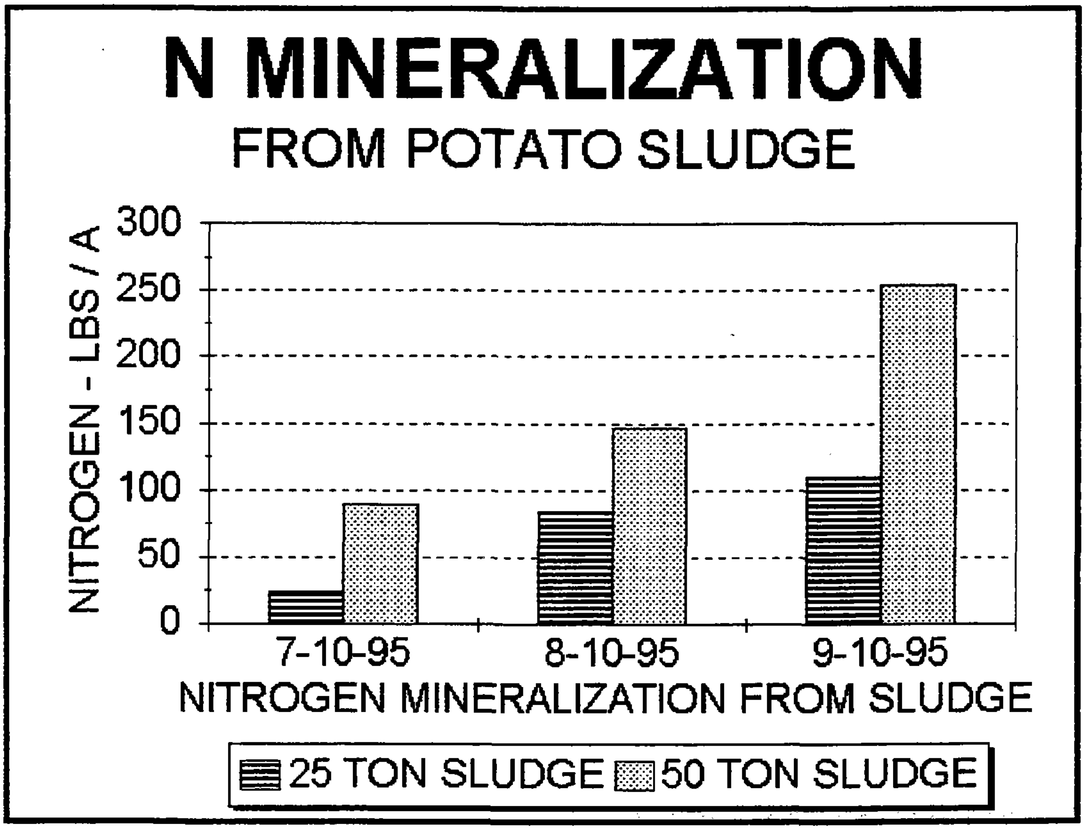


Figure 2. Comparisons of nitrogen released from the potato sludge after subtracting the soil contribution. Nyssa, OR, 1995.



1995 SMALL-GRAIN VARIETY TRIALS

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Purpose

The purpose of these trials is to evaluate the performance of newly released and commercially available small-grain cultivars under local cultural practices and environmental conditions. Data obtained from these trials provide OSU Extension personnel, industry representatives, and local producers with area-specific information for cultivar selection. Additionally, the data provide public and private plant breeders with site-specific performance information for advanced lines and newly released varieties.

Eight cereal grain evaluation trials were conducted at the Malheur Experiment Station during the 1994-95 crop year. The OSU statewide winter cereal, winter barley, spring cereal, and spring barley trials were conducted as part of a statewide small-grain variety testing program. The HybriTech hybrid soft white winter wheat trials evaluated the performance of the company's proprietary hybrid soft white winter wheat lines. For the fourth year fall-planted fall-emergence and fall-planted winter-emergence wheat trials were conducted at the Malheur Experiment Station. The purpose of these trials is to develop a database to help local growers decide when to stop planting winter types and start planting spring types.

Procedure

All winter and spring trials, except the HybriTech hybrid soft white winter wheat trial, were planted in a randomized complete-block design with three replications. Each plot was planted on two 60-inch beds with seven rows spaced 7 inches apart on each bed. The dimensions of each plot were 10 feet wide by 15 feet long. The two HybriTech Trials were planted in a randomized complete-block design with four replications, and each individual plot measured 5 feet wide by 15 feet long. All trials were furrow irrigated. At maturity, harvest samples were collected from a 50-inch swath through the center of each plot, 62.5 square feet. All "harvester-run" samples from the OSU Statewide Trials were transported to the OSU campus at Corvallis where they were recleaned with a Pelz seed cleaner and then processed. The "harvester-run" samples from HybriTech and fall and winter emergence wheat trials were rough-cleaned with an aspirator cleaner and processed at the Malheur Experiment Station.

Winter Trials

The 1995 winter cereal trials followed the 1994 harvest of sweet corn. The field was disked two ways, chisel-plowed two ways, and floated twice. No preplant fertilizer was applied. The OSU statewide winter cereal, OSU statewide winter barley, fall-planted fall-emergence wheat, and two HybriTech hybrid soft white winter wheat trials were planted on October 18, 1994. Each HybriTech hybrid soft white winter wheat trial (Block 1 and Block 2) included 47 soft white hybrid and 3 common soft white winter wheat entries. All entries were drilled approximately 1 inch deep into moderately moist soil. The seeding rate for the OSU statewide winter cereal trial and the OSU statewide winter barley trial was 30 seeds per square foot. The seeding rate for the fall-planted fall-emergence wheat and the two HybriTech hybrid soft white winter wheat trials was 120 pounds per acre. To insure rapid uniform emergence, a 12-hour post-plant, pre-emergence sprinkler irrigation was applied over all 5 plantings.

The fall-planted winter-emergence wheat trial was planted at 120 pounds per acre on December 5, 1994. Except for drilling the seed through approximately 1 inch of snow and not applying the post-plant pre-emergence irrigation, the planting procedure was the same as for the previously described fall-planted trials.

On March 29, 1995, all six nurseries were top-dressed with approximately 140 lb/ac N as urea.

To control broadleaf weeds, a tank-mix containing 0.75 lb ai/ac bromoxynil and 0.75 lb ai/ac MCPA (Bronate 4EC), and 0.125 lb ai/ac dicamba (Banvel) in 20 gallons of water per acre was applied by ground-rig over the entire field on April 15, 1995.

The five wheat trials were furrow irrigated on May 17, June 2, and June 14. The winter barley trial was furrow irrigated on May 17 and June 3.

The OSU Statewide trials were harvested on August 3, 1995. The fall-planted fall-emergence and the fall-planted winter-emergence wheat trials were harvested on August 4. The HybriTech trials were harvested on August 9.

Spring Trials

The 1995 spring cereal trials were grown in a field cropped to soybeans. In the fall of 1994 the field was chisel-plowed two ways, disked two ways, floated twice, bedded-up on 60-inch centers, and laid by until spring. On March 24, 1995, the beds were spiketooth harrowed, floated, and re-furrowed. All entries in the two trials, the OSU statewide spring cereal and the OSU statewide spring barley, were drilled, approximately 1 inch deep into moist soil. The seeding rate for both plantings was 30 seeds per square foot.

On March 29 both trials were top-dressed with approximately 43 lb/ac N as urea.

On April 15 a tank-mix containing 0.75 lb ai/ac bromoxynil and 0.75 lb ai/ac MCPA (Bronate 4EC), and 0.125 lb ai/ac dicamba (Banvel) in 20 gallons of water per acre was applied by ground-rig over the entire field.

Irrigations were applied to the wheat/triticale trial on May 25, June 3, June 16, and July 5. The barley trial was irrigated on May 25, June 3, and June 16.

Both trials were harvested August 8, 1995.

Results and Discussion

1994-95 Winter Cereal Grain Trials

Good seedling emergence was noted in the OSU statewide winter cereal, OSU statewide winter barley, fall-planted fall-emergence wheat, and two HybriTech hybrid soft white winter wheat trials by the end of October 1994. Emergence in the Fall-planted winter-emergence wheat trial occurred during the last week of February 1995.

The OSU statewide winter cereal trial included 13 soft white winter wheats, 3 hard red winter wheats, 1 winter club wheat, and 3 winter triticales (Table 1). Yields for the soft white cultivars ranged from 159 bu/ac for OR 939645 to 127.7 bu/ac for Stephens. Test weights for the soft whites ranged from 63.4 lb/bu for Mac 1 to 60.1 lb/bu for WA 7663. Protein for the soft white cultivars ranged from 9.3 percent for WA 7663 to 11.1 percent for Mac 1. The average heading date (50 percent headed) for the trial was May 24. Heading dates for soft white wheat cultivars ranged from May 22 for Gene and Stephens to May 27 for Basin. At maturity, plant heights within the soft whites ranged from 30 inches for Basin to 41 inches for Mac 1. No significant lodging was observed within any entry in this trial.

The OSU statewide winter barley trial included 10 six-row feed barley entries (Table 2). Yields ranged from 8,670 lb/ac for AB-812 to 5,786 lb/ac for OR 7. Test weights ranged from 50.6 lb/bu for OR 7 to 48.0 lb/bu for the variety called Hundred. Protein ranged from 10.5 percent for Kold and Showin to 9.5 percent for AB-812 and OR 6. The average heading date (50 percent headed) for the nursery was May 20. Heading dates ranged from May 17 for AB-812 and OR 6 to May 22 for Kold, Hesk, and Hundred. At maturity, plant height ranged from 29 inches for Showin to 39 inches for OR 7. With the exception of Hesk, some degree of lodging was observed within all entries. Severe lodging was observed within the Hundred, Steptoe, and Showin plots.

Both the fall-planted fall-emergence wheat trial and the fall-planted winter-emergence wheat trial included the same eight soft white and two hard red wheat cultivars (Tables 3 and 4).

Yields in the fall-emergence trial ranged from 166.6 bu/ac for Stephens to 131.9 bu/ac for Meridian (Table 3). Test weights for the soft white types ranged from 62.3 lb/bu for

Alpowa to 58.5 lb/bu for MacVicar. The average heading date (50 percent headed) for the fall-emergence trial was May 21. Heading dates ranged from May 17 for Alpowa to May 26 for MacVicar and Meridian. The difference in the mean heading dates for winter versus spring cultivars was significant. At maturity, plant heights ranged from 34 to 39 inches. At harvest no significant lodging was observed.

In the winter-emergence trial, yields ranged from 154.9 bu/ac for Yolo to 121.3 bu/ac for Meridian (Table 4). Test weights for the soft white types ranged from 63.09 lb/bu for Centennial to 57.6 lb/bu for MacVicar. The average heading date (50 percent headed) for the winter-emergence trial was May 25. Heading dates ranged from May 20 for Alpowa and Yolo to June 2 for Meridian. At maturity, plant heights ranged from 34 to 36 inches. At harvest no significant lodging was observed.

Yields for Block 1 of the HybriTech hybrid soft white winter wheat ranged from 170.2 bu/ac for 24.1x172 to 140.6 bu/ac for Gene (Table 5). Yield differences between 24.1x172 and Stephens were not significant. The 61.6 lb/bu test weight for 45x68 was significantly greater than the test weights for Gene, Madsen, and Stephens. Yields for Block 2 ranged from 172.7 bu/ac for 871x113 to 147.3 for Gene (Table 6). The yield for 871x113 was significantly greater than the yield for Stephens. The 62.8 lb/bu test weight for 81x70R was significantly greater than the test weights for Gene, Madsen, and Stephens. Within the two trial blocks (1 and 2), the average heading date (50 percent headed) was May 25. All entries in both blocks headed between May 23 and May 28. At maturity, plant heights for the hybrid types ranged from 36 to 42 inches. In both blocks the mature height for Stephens was 37 inches. No lodging was observed within any entry in either block.

1995 Spring Cereal Grain Trials

Yields for the soft white types in the OSU statewide spring cereal trial ranged from 129.3 bu/ac for Wawawai to 91.2 bu/ac for Dirkwin (Table 7). Yields for the hard red types ranged from 111.3 bu/ac for Yolo to 90.7 bu/ac for WPB 926R. The yield for the triticale Juan was significantly greater than the yield for the triticale Victoria. Test weights for the soft white wheats ranged from 64.4 lb/bu for Wawawai to 58.6 lb/bu for Dirkwin. Test weights for the hard red cultivars ranged from 64.3 lb/bu for WPB 936R to 63.3 lb/bu for Anza. The test weight for Juan was significantly better than the test weight for Victoria. Protein for the soft white types ranged from 9.5 percent for ID 448 to 10.8 percent for Penawawa. Heading dates (50 percent headed) for the soft white wheats ranged from May 31 for Centennial to June 5 for ID 448. Heading dates for the hard red types ranged from May 30 for WPB 926R to June 3 for Anza and Yolo. At maturity, plant heights for the soft white cultivars ranged from 33 inches for Dirkwin, ID 471, and Treasure to 38 inches for Wawawai. No lodging was observed among any of the entries in this trial.

The OSU statewide spring barley trial included eight feed, four malting, three feed/malting, and one hulless cultivar (Table 8). Yields ranged from 6,389 lb/ac for Germain's 2319 to 4,572 lb/ac for Russell. Test weights ranged from 63.4 lb/bu for

WPB-BZ489-74 to 51.2 lb/bu for Columbia. Protein ranged from 13.4 percent for WPB-BZ489-74 to 9.8 percent for Colter. The average heading date (50 percent headed) for the trial was June 1. Heading dates ranged from May 27 for BSR 41 to June 4 for Columbia and Maranna. At maturity, plant heights ranged from 24 inches for Germain's 2319 to 34 inches for Russell. BSR 41, Crest, and 78Ab10274 lodged severely. Moderate lodging was noted within the Baroness, WPB-BZ489-74, Crystal, and Harrington plots.

Table 1. Statewide winter cereal trial planted October 18, 1994, and harvested August 3, 1995, at Ontario, Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Protein	Plant height	Heading date
		bu/ac	lb/bu	%	inches	
OR 939645	SW	159.0	60.4	9.9	31	May 26
WA 7663	SW	158.0	60.1	9.3	36	May 26
Meridian	HR	153.7	60.8	9.1	35	May 26
IDO 426	HR	151.6	62.4	10.0	36	May 25
Malcolm	SW	150.3	62.2	9.6	38	May 23
MacVicar	SW	150.2	62.1	10.1	37	May 23
Mac 1	SW	148.6	63.4	11.1	41	May 24
WA 7686	SW	146.9	61.4	9.7	37	May 25
W301	SW	146.0	61.4	9.6	37	May 24
Gene	SW	142.5	61.4	10.6	33	May 22
Basin	SW	141.4	61.3	9.5	30	May 27
Daws	SW	139.6	62.8	9.8	36	May 24
Hoff	HR	136.5	63.9	10.3	36	May 22
Madsen	SW	136.5	61.3	9.6	33	May 26
Hill 81	SW	134.9	61.5	9.5	37	May 26
Celia	Triticale	132.8	57.6	10.2	37	May 24
Rhode	Club	131.0	61.3	9.3	34	May 26
Stephens	SW	127.7	60.9	9.4	35	May 22
Parma	Triticale	127.2	56.6	8.7	42	May 24
Whitman	Triticale	117.7	56.1	9.6	44	May 19
Mean		141.6	60.9	9.7	36	May 24
LSD(0.05)		19.6	0.9	1.0	2	1
CV (%)		8.0	0.9	6.0	3	1

[1]Yield reported on basis of 60 lb/bu at 10 percent moisture.

Table 2. OSU statewide winter barley trial planted October 18, 1994, and harvested August 3, 1995, at Ontario, Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Yield[1]	Test weight	Protein	Plant height	Heading date	Lodging
	lb/ac	lb/bu	%	inches		%
AB-812	8670	48.9	9.5	35	May 17	>30 <40
OR 6	8535	49.1	9.5	33	May 17	>30 <40
SDM208	8255	50.3	10.1	34	May 19	None
Hesk	8001	48.8	9.9	34	May 22	>10 <20
Hundred	7669	48.0	10.2	36	May 22	>50 <60
Steptoe	7454	50.1	9.8	35	May 18	>50 <60
OR 81019	7432	50.0	10.3	33	May 18	>40 <50
Kold	6637	50.5	10.5	35	May 22	>10 <20
Showin	6456	48.6	10.5	29	May 20	100
OR 7	5786	50.6	9.8	39	May 21	>1 <10
Mean	7489	49.5	10.0	34	May 20	
LSD(0.05)	1246	0.7	0.6	3	1	
CV (%)	10	0.8	3.4	6	3	

[1]Yield reported on basis of 10 percent moisture.

Table 3. Malheur fall emergence wheat trial planted October 18, 1994; emerged late October 1994; harvested August 4, 1995. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Plant height	Heading date	Lodging
		bu/ac	lb/bu	inches		%
Stephens	SWW	166.6	60.6	38	May 23	None
Penawawa	SWS	159.2	61.0	38	May 18	<6
Alpowa	SWS	152.9	62.3	36	May 17	<6
Malcolm	SWW	151.2	59.0	39	May 25	None
Centennial	SWS	148.5	62.1	35	May 18	<6
IDO 448	SWS	148.1	61.9	37	May 21	None
MacVicar	SWW	147.6	58.5	37	May 26	None
Yolo	HRS	144.6	60.9	34	May 19	None
Treasure	SWS	134.6	61.4	38	May 20	>6 <21
Meridian	HRW	131.9	60.5	36	May 26	None
Mean		148.5	60.8	37	May 21	
LSD(0.05)		14.9	0.9	2	1.3	
CV (%)		5.9	1.0	3	0.5	

[1]Yield reported on basis of 60 lb/bu at 12 percent moisture

Table 4. Malheur winter emergence wheat trial planted December 5, 1994; emerged late February 1995; harvested August 4, 1995. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Plant height	Heading date	Lodging
		bu/ac	lb/bu	inches		%
Yolo	HRS	154.9	61.5	34	May 20	None
Stephens	SWW	151.2	58.5	35	May 29	None
Penawawa	SWS	148.0	61.8	35	May 21	<6
Treasure	SWS	146.4	61.7	36	May 25	<6
Centennial	SWS	139.6	63.0	36	May 21	<6
IDO 448	SWS	138.1	61.7	36	May 24	None
Alpowa	SWS	132.8	62.9	35	May 20	<6
MacVicar	SWW	131.7	57.6	36	May 30	None
Malcolm	SWW	130.2	59.0	35	May 28	None
Meridian	HRW	121.3	60.6	35	Jun 2	<6
Mean		139.4	60.8	35	May 25	
LSD(0.05)		17.8	1.3	2	2	
CV (%)		7.4	1.2	3	1	

[1]Yield reported on basis of 60 lb/bu at 12 percent moisture

Table 5. HybriTech hybrid soft white winter wheat trial (Block 1) planted October 18, 1994, and harvested August 9, 1995, at Ontario, Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Plant height	Heading date
		bu/ac	lb/bu	inches	
24.1x172	Hybrid	170.2	59.8	37	May 25
2x69	Hybrid	169.9	60.8	37	May 25
6x3	Hybrid	167.4	60.6	37	May 26
24.1x18.1	Hybrid	166.3	59.8	38	May 24
38x113	Hybrid	164.9	60.2	39	May 26
2x113.1	Hybrid	164.3	60.2	39	May 26
45x69	Hybrid	164.0	60.4	37	May 24
27x920	Hybrid	163.2	61.1	38	May 26
45x68	Hybrid	162.9	61.6	38	May 25
Stephens	Common	161.5	60.8	37	May 23
45x18.1	Hybrid	161.0	60.9	41	May 25
2x844.2	Hybrid	160.7	60.9	38	May 26
2x903	Hybrid	160.4	60.2	40	May 26
2x18	Hybrid	159.9	59.9	40	May 25
6x11	Hybrid	159.9	60.2	38	May 26
27x18.1	Hybrid	159.9	60.9	39	May 26
45x81	Hybrid	158.7	60.5	36	May 27
18x908	Hybrid	157.6	60.3	38	May 24
18x69	Hybrid	157.3	60.1	39	May 23
2x920	Hybrid	157.1	61.0	37	May 26
18x187	Hybrid	156.2	60.9	39	May 24
45x807.1	Hybrid	156.2	61.0	38	May 26
24.1x44.1	Hybrid	155.7	60.2	36	May 26
27x908	Hybrid	155.7	60.9	38	May 26
18x68	Hybrid	155.4	60.7	36	May 24
27x18	Hybrid	155.1	60.3	40	May 24
18x843	Hybrid	154.8	60.7	39	May 24
18x10.1	Hybrid	154.0	61.4	39	May 24
18x838	Hybrid	154.0	60.6	39	May 24
45x75	Hybrid	153.1	60.1	38	May 23
2x842	Hybrid	152.9	60.1	38	May 27
24x804	Hybrid	152.9	59.6	37	May 26
38x4	Hybrid	152.9	60.5	39	May 26
18x858	Hybrid	152.3	60.5	38	May 25
18x867.1	Hybrid	152.3	60.1	34	May 24
45x3	Hybrid	152.0	60.6	40	May 26
18x82.1	Hybrid	151.5	60.5	38	May 23
18x11	Hybrid	150.9	60.6	39	May 24
38x179	Hybrid	150.1	61.2	36	May 25
18x178	Hybrid	149.8	59.8	38	May 24
18x865.1	Hybrid	149.0	60.9	39	May 23
2x62	Hybrid	148.4	60.3	41	May 25
45x179	Hybrid	148.4	61.4	37	May 26
6x18.1	Hybrid	147.5	59.8	39	May 25
18x95	Hybrid	147.3	61.0	39	May 23
18x62.1	Hybrid	142.8	60.0	39	May 24
2x906	Hybrid	142.2	60.3	35	May 26
Madsen	Common	142.0	59.9	37	May 28
45x10.1	Hybrid	141.7	61.0	39	May 26
Gene	Common	140.6	60.2	36	May 23
Mean		155.3	60.5	38	May 25
LSD(0.05)		14.1	1.2	3	1
CV (%)		6.5	1.4	6	1

[1] Yield reported on basis of 60 lb/bu with no correction for moisture.

Table 6. HybriTech hybrid soft white winter wheat trial (Block 2) planted October 18, 1994, and harvested August 9, 1995, at Ontario, Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Plant height	Heading date
		bu/ac	lb/bu	inches	
871x113	Hybrid	172.7	60.5	39	May 26
93x113.1	Hybrid	170.5	60.0	39	May 25
45x875.1	Hybrid	169.4	61.6	39	May 25
827.2x62	Hybrid	168.5	60.7	40	May 24
827.2x69	Hybrid	167.7	60.6	37	May 25
827.2x187	Hybrid	167.3	60.9	40	May 26
754x844.1	Hybrid	166.0	61.1	37	May 26
827.2x158	Hybrid	166.0	61.6	38	May 26
62x94	Hybrid	165.7	61.4	38	May 24
62x158	Hybrid	165.7	61.3	39	May 24
871x844.1	Hybrid	164.6	61.0	37	May 26
93x75	Hybrid	164.3	59.8	38	May 24
754x844.2	Hybrid	164.3	61.4	39	May 26
842x95	Hybrid	164.3	60.9	39	May 24
827.2x68	Hybrid	163.8	61.4	37	May 25
62x187	Hybrid	162.9	61.1	41	May 24
62x844.1	Hybrid	162.6	61.1	38	May 24
62.1x69	Hybrid	162.4	60.6	37	May 23
93x18	Hybrid	162.1	60.6	40	May 24
62x875.1	Hybrid	161.2	60.7	39	May 24
827.2x804	Hybrid	161.0	60.2	38	May 27
93x89.1	Hybrid	159.6	61.0	38	May 25
871x68	Hybrid	159.6	61.3	36	May 26
903x113	Hybrid	159.0	60.4	38	May 26
45x884.1	Hybrid	158.2	61.4	37	May 25
93x920	Hybrid	157.3	60.6	37	May 25
62x68	Hybrid	157.1	60.7	39	May 24
842x158	Hybrid	157.1	61.3	37	May 26
827.2x875.1	Hybrid	156.2	61.0	37	May 26
871x833	Hybrid	156.2	60.3	38	May 26
903x920	Hybrid	155.9	61.0	38	May 25
62.1x807	Hybrid	155.7	61.8	41	May 24
754x804	Hybrid	154.8	60.4	38	May 27
62.1x843	Hybrid	154.3	61.3	40	May 25
62.1x867.1	Hybrid	154.3	60.6	39	May 24
842x68	Hybrid	154.0	61.1	38	May 26
903x96.1	Hybrid	153.9	59.8	38	May 28
842x877	Hybrid	153.7	59.8	42	May 25
81x837	Hybrid	153.4	61.1	36	May 24
871x518	Hybrid	153.4	61.2	38	May 26
903x844.1	Hybrid	153.4	60.9	37	May 26
Madsen	Common	152.9	60.0	37	May 27
62x89.1	Hybrid	152.6	61.0	39	May 24
871x62.1	Hybrid	152.3	59.9	40	May 25
93x95	Hybrid	150.3	60.9	39	May 24
871x75	Hybrid	150.3	60.5	37	May 24
Stephens	Common	149.8	60.6	37	May 24
81x885R	Hybrid	149.5	61.0	39	May 25
81x70R	Hybrid	148.7	62.8	38	May 24
Gene	Common	147.3	60.1	34	May 23
Mean		158.9	60.8	38	May 25
LSD(0.05)		11.1	0.7	2	1
CV (%)		5.0	1.0	4	1

[1]Yield reported on basis of 60 lb/bu with no correction for moisture.

Table 7. OSU statewide spring cereal trial planted March 24, 1995, and harvested August 8, 1995, at Ontario, Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Protein	Plant height	Heading date
		bu/ac	lb/bu	%	inches	
Wawawai	SW	129.3	64.4	10.0	38	Jun 2
Penawawa	SW	115.6	63.2	10.8	34	Jun 3
Alpowa	SW	113.3	64.1	10.5	34	Jun 2
ID 471	SW	111.3	63.8	9.9	33	Jun 1
Yolo	HR	111.3	63.6	10.3	32	Jun 3
Treasure	SW	111.2	62.2	9.8	33	Jun 4
ID 377S	HW	109.5	64.1	11.3	37	Jun 3
ID 448	SW	108.3	60.9	9.5	34	Jun 5
WPB Vanna	SW	108.3	62.9	10.1	34	Jun 3
Centennial	SW	107.9	64.0	10.2	33	May 31
Klasic	HW	107.9	63.6	12.6	25	May 31
Calorwa	Club	105.2	61.4	10.0	30	Jun 2
WPB 936R	HR	102.2	64.3	12.4	33	May 31
Juan	Triticale	101.3	54.7	10.4	41	Jun 3
Yecora Rojo	HR	101.1	63.5	13.3	24	May 31
Anza	HR	99.4	63.3	10.5	32	Jun 3
Owens	SW	98.1	63.2	10.5	35	Jun 1
Dirkwin	SW	91.2	58.6	10.2	33	Jun 4
WPB 926R	HR	90.7	64.1	13.4	33	May 30
Victoria	Triticale	86.0	52.9	10.3	36	Jun 3
Mean		105.5	62.1	10.8	33	Jun 2
LSD(0.05)		11.8	1.0	0.6	2	2
CV (%)		6.8	1.0	3.6	3	1

[1]Yield reported on basis of 60 lb/bu at 10 percent moisture.

Table 8. OSU statewide spring barley trial planted March 24, 1995, and harvested August 8, 1995, at Ontario, Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Market class	Yield[1]	Test weight	Protein	Plant height	Heading date	Lodging
		lb/ac	lb/bu	%	inches		%
Germain's 2319	6RF	6389	52.2	11.8	24	May 28	None
Colter	6RF	6250	52.3	9.8	33	May 31	None
BSR 41	2RF/M	6047	52.9	11.6	29	May 27	>80
Columbia	6RF	5943	51.2	11.2	29	Jun 4	None
Steptoe	6RF	5752	52.0	10.3	32	Jun 1	None
Baronesse	2RF	5608	55.0	11.3	29	Jun 2	>20 <30
Maranna	6RF	5425	52.2	11.6	25	Jun 4	None
WPB-BZ489-74	6R hulless	5380	63.4	13.4	28	Jun 3	>20 <30
Payette	6RF	5298	53.4	11.4	29	Jun 4	None
Crest	2RM	5290	51.5	10.9	29	Jun 2	>70 <80
BSR 45	2RF/M	5207	53.9	12.1	32	May 28	<10
78Ab10274	2RF/M	5187	54.1	11.1	31	Jun 2	>80
Crystal	2RM	5165	54.3	11.4	32	Jun 3	>30 <40
Harrington	2RM	5130	54.1	11.1	31	Jun 3	>30 <40
WPB-Sissy	6RF	4674	54.2	11.8	28	Jun 2	None
Russell	6RM	4572	55.5	11.0	34	May 29	None
Mean		5457	53.9	11.4	30	Jun 1	
LSD(0.05)		1246	1.0	0.6	2	2	
CV (%)		12	1.1	3.4	4	1	

[1]Yield reported on basis of 10 percent moisture.

BROADLEAF WEED CONTROL IN SPRING WHEAT

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Ontario, Oregon, 1995

Purpose

In two separate trials, 13 different herbicides and formulations were evaluated for weed control and tolerance to spring wheat when applied at different rates in tank-mix combinations.

Materials and Methods

Treasure variety of spring wheat and kochia (Kochia scoparia) weed seed were planted on April 3, 1995, in a field where potatoes had been grown during 1994. Herbicides applied to control weeds in potatoes included Prowl, Eptam, Matrix and Poast. Herbicide rates for potatoes were 1.5, 3.0, 0.028 and 0.3 lb ai/ac, respectively. The potatoes had been irrigated by sprinkler irrigation. The field was not plowed after potatoes but left over-winter to freeze leftover tubers and tilled with a triple-K field cultivator and ground-hog field cultivator in the spring before planting the wheat. Seeding rate of wheat was 130 lb/ac planted with a double-disc drill with 6-inch row spacing. The field was harrowed and corrugated after planting in preparation for furrow irrigation. One hundred lbs/ac nitrogen was applied broadcast and tilled in the soil as the seedbed was prepared. Soil texture was a silt loam with a pH of 7.3 and 1.1 percent organic matter.

Herbicide treatments were applied on May 18. The wheat had two to three tillers and was 6 to 8 inches tall. Weed populations were dense, and species included kochia, lambsquarters, redroot pigweed, tumble mustard, hairy nightshade, and annual sow thistle. Weed species varied from 1 to 6 inches tall. The tallest species was kochia. Tumble mustard and sowthistle had 2 to 3-inch rosettes. At application, the wind was blowing 2 to 3 mph from the northwest. Air temperature was 78°F, and soil temperature at 4-inches deep was 72° F. Relative humidity was 38 percent with clear skies.

Herbicides were applied with a single bicycle-wheel plot sprayer. The spray boom was 8.5 feet long. Teejet fan nozzles size 8002 were spaced 10-inches apart on the spray boom, and herbicides were applied broadcast as double-overlap applications. Spray pressure was 42 psi, and water as the herbicide carrier was applied at a volume of 33.4 gal/ac. Individual plots were 9 feet wide and 40 feet long, and each treatment was replicated three times in blocks using a randomized complete block experimental design.

The plots were harvested on August 22 and 23 to determine grain yields. Harvest area was 4 feet wide x 35 feet long. Grain yields are reported as bushels per acre of clean wheat.

Results

All herbicide treatments, with the exception of Peak, controlled all weed species (Tables 1 and 3). Peak controlled about 90 percent of kochia, lambsquarters, and redroot pigweed and about 82 percent control of hairy nightshade and 63 percent control of annual sow thistle. The highest wheat yields occurred when weeds were fully controlled with herbicides. Weed competition in the untreated checks reduced wheat yields significantly (Tables 2 and 4). Kochia was very vigorous and grew 3 to 4 feet above the height of the wheat in the untreated checks. Tough, a herbicide, in tank-mix combination with Sencor caused severe necrosis to the leaves of the wheat. The wheat plants recovered from the foliar injury, but wheat yields were significantly less compared to yields from other treatments.

Table 1. Crop injury ratings and percent weed control from herbicide treatments applied to Treasure spring wheat. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent weed control																	
		Crop injury			Kochia			Lambsquarters			Pigweed			Tumble mustard			H. nightshade			Sowthistle		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	%			%																	
Peak + X-77	0.018 + 0.25%	0	0	0	93	90	90	85	90	85	95	95	95	90	95	90	85	80	80	65	60	60
Bronate Gel	0.5	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate	0.5	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate	0.8	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Harmony Extra + X-77	0.016 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate Gel + Harmony Extra + X-77	0.5 + 0.016 + 0.25%	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate + Harmony Extra + X-77	0.5 + 0.016 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MCPA Ester + Harmony Extra + X-77	0.25 + 0.016 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Weedar 64 + Harmony Extra + X-77	0.25 +0.016 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel SGF + Harmony Extra + X-77	0.25 + 0.016 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate + Express + X-77	0.5 + 0.004 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate	1. 0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Weedar 64	1. 0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Harmony Extra + X-77	0.0234 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Harmony Extra + Weedar 64 + X-77	0.0234 + 0.5 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bronate + Harmony Extra + X-77	0.25 + 0.0234 + 0.25 %	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Untreated Check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Evaluated on May 30 and June 6. Ratings on the two dates were the same.

Ratings: 0 = No herbicide effect. 100 = all plants killed.

Table 2. Grain yields of Treasure spring wheat treated with herbicides applied postemergence for control. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

		Yield			
Herbicides	Rate	R_1	R_2	R_3	Mean
	lb ai/ac	bu/ac			
Peak + X-77	0.018 + 0.25%	96	99	101	98.7
Bronate Gel	0.5	102	105	100	102.3
Bronate	0.5	106	102	104	104.0
Bronate	0.8	104	101	107	104.0
Harmony Extra + X-77	0.016 + 0.25%	101	103	105	103.0
Bronate Gel + Harmony Extra + X-77	0.5 + 0.016 + 0.25%	105	100	103	102.7
Bronate + Harmony Extra + X-77	0.5 + 0.016 + 0.25%	103	106	105	104.7
MCPA ester + Harmony Extra + X-77	0.25 + 0.016 + 0.25%	101	104	98	101.0
Weedar 64 + Harmony Extra + X-77	0.25 + 0.016 + 0.25%	99	103	96	99.3
Banvel SGF + Harmony Extra + X-77	0.25 + 0.016 + 0.25%	98	100	97	98.3
Bronate + Express + X-77	0.5 + 0.004 + 0.25%	104	101	99	101.3
Bronate	1.0	102	104	106	104.0
Weedar	1.0	101	98	104	101.0
Harmony Extra + X-77	0.0 2	103	105	99	102.3
Harmony Extra + X-77 Harmony Extra + Weedar 64 + X-77	0.0234 + 0.5 + 0.25%	99	103	101	101.0
Bronate + Harmony Extra + X-77	0.25 + 0.0234 + 0.25%	104	106	103	104.3
Untreated Check	--	81	88	93	87.3
LSD (0.05)					5.0
CV (%)					3.0
Mean					101.3

Harvested August 22, 1995.

Table 3. Crop injury and percent weed control from herbicide treatments applied to Treasure spring wheat. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

					Percent weed control														
		Crop injury			Kochia			Lambsquarters			Pigweed			Tumble mustard			H. nightshade		
Herbicides	Rate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	lb ai/ac	%			%														
Banvel + Buctril	0.094 + 0.25	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Buctril + MCPA amine	0.094 + 0.125 + 0.25	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Buctril + MCPA amine	0.094 + 0.025 + 0.25	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Buctril + Harmony Extra	0.094 + 0.125 + 0.0078	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Buctril + Harmony Extra	0.094 + 0.25 + 0.0078	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Buctril + Harmony Extra	0.125 + 0.0078	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Buctril + MCPA amine	0.094 + 0.125 + 0.25 + 0.0078	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Tough (ec)	0.9	40	30	40	85	90	85	90	90	85	90	95	95	75	80	75	95	90	95
Tough (ec)	0.5	20	25	15	75	80	80	80	85	80	90	80	80	65	70	70	85	80	80
Banvel + Tough (ec)	0.094 + 0.47	30	30	40	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Weedar 64	0.094 + 0.38	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Weedar 64 + Tough (ec)	0.094 + 0.38 + 0.235	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Tough (ec) + Sencor	0.47 + 0.125	45	50	45	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Weedar 64 + Harmony Extra	0.094 + 0.25 + 0.0078	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Weedar 64 + Harmony Extra	0.094 + 0.25 + 0.0156	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Weedar 64 + Tough (ec)	0.094 + 0.25 + 0.47	10	10	15	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Banvel + Weedar 64 + Buctril	0.094 + 0.25 +0.25	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
San 845H + Weedar 64	0.094 + 0.38	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
San 845H + Savage	0.094 + 0.38	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Untreated Check	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Banvel formulated 45L was used in all Banvel treatments.

X-77 was added to all herbicide treatments at the rate of 0.25 % v/v.

Evaluated on May 30 and June 6. On June 6 the wheat plants were recovering from the Tough and Tough combination treatments.

Ratings: 0 = No herbicide effect. 100 = all plants killed.

Table 4. Grain yields in bushels per acre from herbicide treatments applied to Treasure spring wheat. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

		Yield			
Herbicides	Rate	R_1	R_2	R_3	Mean
	lb ai/ac	bu/ac			
Banvel + Buctril	0.094 + 0.25	98	102	99	99.7
Banvel + Buctril + MCPA amine	0.094 + 0.125 + 0.25	101	98	96	98.3
Banvel + Buctril + MCPA amine	0.094 + 0.25 + 0.25	98	100	102	100.0
Banvel + Buctril + Harmony Extra	0.094 + 0.125 + 0.0078	104	102	99	101.7
Banvel + Buctril + Harmony Extra	0.094 + 0.25 + 0.0078	103	101	104	102.7
Buctril + Harmony Extra	0.125 + 0.0078	106	103	101	103.3
Banvel + Buctril + MCPA amine + Harmony Extra	0.094 + 0.125 + 0.0078	103	99	102	101.3
Tough (ec)	0.9	101	105	99	101.7
Tough (ec)	0.5	99	103	98	100.0
Banvel + Tough (ec)	0.094 + 0.47	102	99	101	100.7
Banvel + Weedar 64	0.094 + 0.38	103	98	99	100.0
Banvel + Weedar 64 + Tough	0.094 + 0.38 + 0.235	102	104	98	101.3
Tough (ec) + Sencor	0.47 + 0.125	96	94	97	95.6
Banvel + Weedar 64 + Harmony Extra	0.094 + 0.25 + 0.0078	102	104	98	101.3
Banvel + Weedar 64 + Harmony Extra	0.094 + 0.25 + 0.0156	103	99	101	101.0
Banvel + Weedar 64 + Tough	0.94 + 0.25 + 0.47	104	102	103	103.0
Banvel + Weedar 64 + Buctril	0.094 + 0.25 + 0.25	101	104	99	101.3
San 845 H + Weedar 64	0.094 + 0.38	103	99	101	101.0
San 845 H + Savage	0.094 + 0.38	104	101	98	101.0
Untreated check	–	83	85	80	82.7
LSD (0.05)					3.6
CV (%)					2.2
Mean					99.8

Harvested August 23, 1995.