PRELIMINARY RESULTS OF THE INFLUENCE OF SIMULATED HAIL TIMING ON YIELD AND QUALITY OF THREE POTATO CULTIVARS

Erik Feibert, Clint Shock and Monty Saunders
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Introduction

Hail is a potential threat during every cropping season. Potato growers and the insurance industry are interested in having an accurate method for estimating potato crop loss due to hail. The new varieties Shepody and Frontier Russet are assuming increasing economic importance, but very little is known about their relative response to hail damage compared with Russet Burbank. This trial evaluates the three varieties for their response to simulated hail damage.

Procedures

An alfalfa seed field was plowed and disked in the fall of 1991. On April 1, 1992 Roundup at 0.46 gal ai/ac and Bronate at 1.80 qt ai/ac were sprayed for weed control. A soil sample taken on April 10 showed a pH of 7.4, 1.5 percent organic matter, cation exchange capacity of 26 meq/100g, 36 ppm nitrate-N, 5 ppm ammonium-N, 29 ppm phosphorus, 598 ppm potassium, 3059 ppm calcium, 376 ppm magnesium, 222 ppm sodium, 1.6 ppm zinc, 22.5 ppm iron, 10.1 ppm manganese, 0.6 ppm copper, 27 ppm sulfate-S and 0.6 ppm boron. The field was bedded into 36 inch hills on April 15. Dual at 2.5 lbs ai/ac and Prowl at 1.25 lbs ai/ac were applied on April 16 for weed control. Two ounce seed pieces of the three varieties were planted 9 inches apart in the hills on April 23.

The experimental design was a split plot with the four hail treatments as the main plots and the three varieties as split plots within the main plots. Each plot was 50 feet long by 7 rows wide. The three varieties were planted in the center three rows of the plot with two rows of Russet burbank as border on each side. The hail timing treatments were completely randomized within each of the six replicates. The varieties were randomized within each plot.

Potatoes started to emerge May 15. The field was irrigated with a solid set sprinkler system with nozzles spaced 40 by 50 feet, starting on May 22. Soil water potential was monitored by 15 Granular matrix sensors (GMS) (Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) placed 8 inches below the hill top and offset 6 inches from the hill center and 15 GMS placed 18 inches below the hill top and offset 6 inches from the hill center. GMS were read at 8 am five days a week. The field was irrigated when soil water potential in the first foot of soil reached -60 kPa. Accumulated evapotranspiration from the last irrigation was replaced in each irrigation. Evapotranspiration was determined by the Agrimet weather station at the experiment station.

Dithane F-45 at two pounds ai/ac and Uniflow Sulfur at 3 lbs S/ac (plus Uniroyal ZKP) were foliar applied on July 3 and 11 for preventive control of leaf fungi. Petiole samples were collected every two weeks during tuber bulking from Russet Burbank plants in the check plots and analyzed for nitrate content. The field was fertilized with 20 lbs N/ac as water-run URAN on June 22 and with 40 lbs N/ac as broadcast urea on July 20.

The four hail treatments consisted of three simulated hail dates (7-9, 7-29, 8-19) and a non-hailed check treatment. Each plot in each hail treatment received only one hail treatment. The hail consisted of cubed ice being blown through a flexible plastic tube onto the three middle potato rows of the plot. Approximately 3 lbs of cubed ice per foot of row were used for each hail treatment. Prior to each hail treatment one plant of each variety in nine unhailed plots throughout the field were sampled and analyzed for stem height, number of stems, number of nodes on main stem, length of largest tuber, number of tubers and total tuber weight. Immediately after each hail treatment, five plants of each variety in each hailed plot and in each check plot had the total number of viable leaves on the main stem counted. The three varieties in each plot were rated for leaf area compared to the check on September 14.

Forty five feet of each of the three middle rows in each plot were harvested on October 8. The tubers were graded and a subsample analyzed for specific gravity and fry color.

Results and Discussion

Potato vegetative characteristics prior to each hail treatment and percent leaf loss to hail are shown in Table 1. The interpretation of the vegetative characteristics in terms of growth stage according to the National Crop Insurance Services guidelines (anonymous, 1990) (Table 2) is shown in Table 3. In addition to leaf loss the plants suffered substantial stem bruising and some stem breakage. Russet Burbank was the tallest variety, had the most nodes on the main stem and the longest tubers on all hail dates. Frontier Russet had the highest hill yield on the first two hail dates and Russet Burbank had the highest hill yield on August 19. Percent leaf loss due to hail was similar for the three varieties.

Soil water potential was inadvertently allowed to go below -60 kPa a few times during the season (Figure 1). US Number One tuber yields and stem-end fry color could have been better if soil water potential had remained above -60 kPa all season. Petiole nitrate levels were 6250 ppm on July 13, 9500 ppm on August 3 and 8000 ppm on August 14. The rise in petiole nitrate level between the first and second sampling was probably due to application of urea at 40 lbs N/ac on July 20. Petiole nitrate levels were below established guidelines on all sample dates (Jones and Painter, 1974).

The hail treatments resulted in significant losses in both yield and grade (Tables 4 and 5 respectively). The July 29 hail date resulted in the largest reduction in yield of US Number One tubers in relation to the check for all three varieties. For greater than 10 ounce number one tubers, the July 29 hail date resulted in the largest reduction in yield and the July 9 hail date resulted in the smallest reduction for all varieties. The July 29 hail date also resulted in the largest reduction in percent number one tubers and in percent number one's greater than ten ounces.

Hail treatment did not significantly affect stem-end fry color (Table 5). Shepody had the lightest frying tubers on all hail dates. The August 19 hail date was among the lowest in specific gravity in relation to the check (Table 5). Frontier Russet had the highest specific gravity on all hail dates.

The estimated tuber yield at each plant growth stage is shown in Table 1 and Figure 2. The plants in this trial were found to recover from the hail damage by producing new leaves and resuming growth, especially after the first two hail dates. Potato fields that have suffered hail damage are susceptible to diseases that can rapidly kill the plants. If potato plants had died at the time of hail treatments both yield and tuber size would have been severely reduced. However, actual yield reductions in hail damaged plots were much less than the plant growth data would suggest, mainly due to rapid recovery of plants after hail damage.

Conclusive results of agricultural management trials should be based on multi-year data. Consequently the data from this one year trial should not be considered definitive.

Literature cited

Anonymous, 1990. Potato loss instructions. National Crop Insurance Services. Overland Park, Kansas, NCIS 6453 Potato/90. p. 12

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 1. Potato vegetative characteristics at the time of each simulated hail treatment and at the final harvest and leaf loss caused by simulated hail treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Variety	Hail date/ DAI§	Plant height	# of stems/ plant	# of nodes on main stem	Length of largest tuber	# of tubers/plant	Hill weight	Av. tuber weight	Leafloss	Est. yield
		inches			inches		— oz. —		%	cwt/ac
R. Burbank	July 9/34§	36.9	1.78	17.3	2.8	8.69	6.08	1.01	77.8	70.1
	July 29/54§	41.5	2.56	22.7	4.9	6.64	14.97	2.58	79.8	172.5
	August 19/75§	42.9	1.89	23.8	6.4	6.32	30.90	5.50	91.0	356.1
	October 8/125§					6.33	39.0	6.16		449.4
Shepody	July 9/31§	29.3	2.22	15.6	3.0	5.62	5.29	0.56	70.8	61.0
	July 29/51§	36.7	2.44	18.8	4.6	6.10	14.42	2.20	81.7	166.2
	August 19/72§	33.0	1.89	15.8	6.0	5.45	26.31	4.43	94.7	303.2
	October 8/122§					5.45	43.6	8		502.3
F. Russet	July 9/31§	23.3	2.56	12.2	2.6	11.94	6.18	1.01	62.8	71.2
	July 29/51§	30.4	3.11	18.7	4.3	7.56	15.63	2.42	78	180.1
	August 19/72§	26.0	2.11	14.2	4.9	6.02	32.56	5.41	94.5	375.3
	October 8/122§					6.01	36.6	6.09		421.7

§ DAI, days after the onset of tuber initiation.

Table 2. White potato stage of growth chart from the National Crop Insurance Services potato loss instructions pg.4 1990.

White potato stage of growth chart				
Stage	Canopy	Height (in)	Tuber	Hill wt (oz)
Emergence	none	1/2	seed	
V-1	Vegetative growth only, determine by actual measure	2-5	seed	
V-2	Vegetative growth with 6-8 discernible nodes on the main	5-8	seed	
R-1	10-12 discernible nodes, small buds at the very top of the	10-16	¼"-½"	0.6
R-2	Primary inflorescence shows above leaves, many buds, little	16-20	½"-1"	2.7
R-3	Secondary shoots starting to elongate, growth of plant is	20-24	1"-1½"	8.0
R-4	Blossoms on primary inflorescence open, secondary stem	24-28	1½"-2"	15.3
R-5	Most flowers on the primary inflorescence open and	28-32	2"-3"	21.6
R-6	Majority of the first blooms have fallen. Secondary blossoms	32-36	3"-3½"	27.9
R-7	All primary and most secondary flowers have fallen, some	36-40	3½"-4"	34.2
R-8	Considerable lateral vine growth, two or more third-order	40-42	tubers to 8 oz	40.5
R-9	All blooms will have fallen, leaves starting to change color	42-44	80% of tubers	45.0
R-10	Lower leaves will be yellowish, no blossoms present	48-48	tubers to 10 oz or	48.4
R-11	All leaves have become yellow, leaves starting to fall	"	most tubers	49.5
R-12	All leaves drying, many leaves have fallen	"	fully mature	51.0

Table 3. Growth stage of three potato varieties at three simulated hail application dates according to Table 2. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Variety	Hail date/DAI*	Height	Canopy Description	Tuber Size	Hill Weight	Average[1]
R. Burbank	July 9/34*	R-6	R-6	R-5	R-3	R-5
	July 29/54*	R-7	R-7	R-7	R-4	R-6
	August 19/75*	R-8	R-8	R-8	R-6	R-7.5
Shepody	July 9/31*	R-5	R-6	R-5	R-3	R-5
	July 29/51*	R-6	R-7	R-7	R-4	R-6
	August 19/72*	R-6	R-8	R-8	R-6	R-7
Frontier R.	July 9/31*	R-3	R-6	R-5	R-3	R-4
	July 29/51*	R-5	R-7	R-7	R-4	R-6
	August 19/72*	R-5	R-8	R-8	R-6	R-7

* DAI, days after the onset of tuber initiation

[1] Average of canopy description, tuber size and hill weight

Table 4. Yield response of three potato cultivars to simulated hail timing. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

		Potato yield by market grade										
		#1				#2			Total Marketable	Undersize	Rot	Total Yield
Variety	Treatment	4-6 oz	6-10 oz	> 10 oz	total	6-10 oz	> 10 oz	total				
		cwt/ac										
R. Burbank	No hail	61.8	114.5	81.4	257.7	49.2	68.2	117.4	375.1	57.0	17.4	449.4
	Hail on 7-9	58.1	101.7	58.9	218.8	86.0	93.5	179.5	398.4	59.6	5.9	463.9
	Hail on 7-29	71.9	92.9	36.4	201.2	79.2	66.5	145.6	346.8	79.8	6.1	432.7
	Hail on 8-19	69.1	114.0	52.3	235.4	53.4	50.5	103.9	339.2	57.3	8.2	404.7
Shepody	No hail	54.7	127.4	184.4	366.5	29.9	54.1	83.9	450.4	49.9	9.7	510.0
	Hail on 7-9	52.9	118.4	222.1	393.3	18.9	32.2	51.2	444.5	45.7	12.1	502.3
	Hail on 7-29	58.6	111.9	129.6	300.1	44.2	51.3	95.5	395.6	67.7	9.6	472.9
	Hail on 8-19	67.7	130.4	171.3	369.4	18.1	22.2	40.3	409.7	62.9	9.4	482.0
F. Russet	No hail	69.6	136.4	134.5	340.6	8.3	9.4	17.7	358.3	59.9	4.6	421.7
	Hail on 7-9	78.6	143.1	98.0	319.7	10.2	6.6	16.8	336.5	68.2	5.4	410.2
	Hail on 7-29	81.2	142.0	64.4	287.6	7.4	7.6	15.0	302.6	81.6	1.5	385.7
	Hail on 8-19	78.0	134.0	77.5	289.5	6.0	4.7	10.8	300.3	66.3	3.0	369.5
Average	No hail	61.4	369.3	146.0	330.5	25.5	36.6	62.1	392.6	54.2	11.4	457.8
	Hail on 7-9	63.8	124.1	113.8	301.7	42.0	51.4	93.4	395.1	59.2	7	461.4
	Hail on 7-29	70.6	115.6	76.8	263.0	43.6	41.8	85.4	348.3	76.4	5.7	430.4
	Hail on 8-19	71.6	126.1	100.4	298.1	25.8	25.8	51.7	349.7	62.2	6.9	417.7
LSD(0.05) Treatment		ns	ns	31.9	37.5	11.7	9.42	28.7	39.7	15.0	ns	42.1
LSD(0.05) Variety		7.9	11.1	17.3	25.5	7.9	6.9	13.0	24.4	7.2	2.5	29.1
LSD(0.05) Treatment X Var.		ns	ns	ns	ns	15.8	13.8	25.9	ns	ns	5.1	ns

Table 5. Tuber market grade and tuber quality response of three potato cultivars to simulated hail timing. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

		Potato market grade distribution									Stem-end fry color	Specific gravity
		#1				#2			undersize	rot		
Variety	Treatment	4-6 oz	6-10 oz	> 10 oz	total	6-10 oz	> 10 oz	total				
		%									% reflect.	
R. Burbank	No hail	13.9	25.4	18.0	57.3	10.8	15.2	26.0	12.6	4.0	38.4	1.084
	Hail on 7-9	12.5	21.9	12.8	47.3	18.3	20.3	38.6	12.8	1.3	38.0	1.085
	Hail on 7-29	16.7	21.8	8.7	47.1	18.2	15.2	33.5	18.0	1.5	33.0	1.081
	Hail on 8-19	17.1	28.0	12.8	57.9	13.5	12.4	25.9	14.1	2.0	35.2	1.080
Shepody	No hail	10.7	25.0	36.4	72.1	5.8	10.5	16.3	9.8	1.9	47.7	1.083
	Hail on 7-9	10.7	23.8	43.8	78.2	3.8	6.4	10.3	9.2	2.4	47.3	1.083
	Hail on 7-29	12.4	23.7	27.1	63.3	9.4	10.9	20.3	14.4	2.0	45.9	1.080
	Hail on 8-19	14.0	27.4	34.9	76.2	3.9	4.6	8.6	13.3	2.0	47.6	1.080
F. Russet	No hail	16.5	32.1	32.4	80.9	2.0	2.2	4.2	14.1	1.1	35.6	1.088
	Hail on 7-9	21.1	36.9	16.7	74.7	1.9	1.9	3.9	21.1	0.4	36.3	1.084
	Hail on 7-29	19.2	35.3	23.3	77.9	2.5	1.6	4.08	16.8	1.3	36.6	1.087
	Hail on 8-19	20.8	36.5	20.8	78.0	1.7	1.3	3.1	18.1	0.8	36.8	1.082
Average	No hail	13.7	27.1	31.4	72.1	5.5	7.9	13.5	12.0	2.5	40.4	1.085
	Hail on 7-9	14.1	27.4	24.2	65.8	8.9	10.8	19.7	13.1	1.5	40.8	1.085
	Hail on 7-29	16.7	27.5	17.5	61.7	9.8	9.3	19.2	17.8	1.3	38.4	1.082
	Hail on 8-19	17.3	30.6	22.8	70.7	6.4	6.1	12.5	15.2	1.6	39.9	1.081
LSD(0.05) Treatment		2.7	2.4	6.0	5.3	2.4	2.0	3.0	3.3	ns	ns	0.004
LSD(0.05) Variety		1.3	2.0	3.0	2.1	1.6	1.7	2.1	1.2	0.5	1.8	0.002
LSD(0.05) Treatment X Var.		ns	ns	ns	4.3	3.2	3.3	4.3	ns	1.1	ns	ns

Figure 1. Soil water potential over time in hail timing trial. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

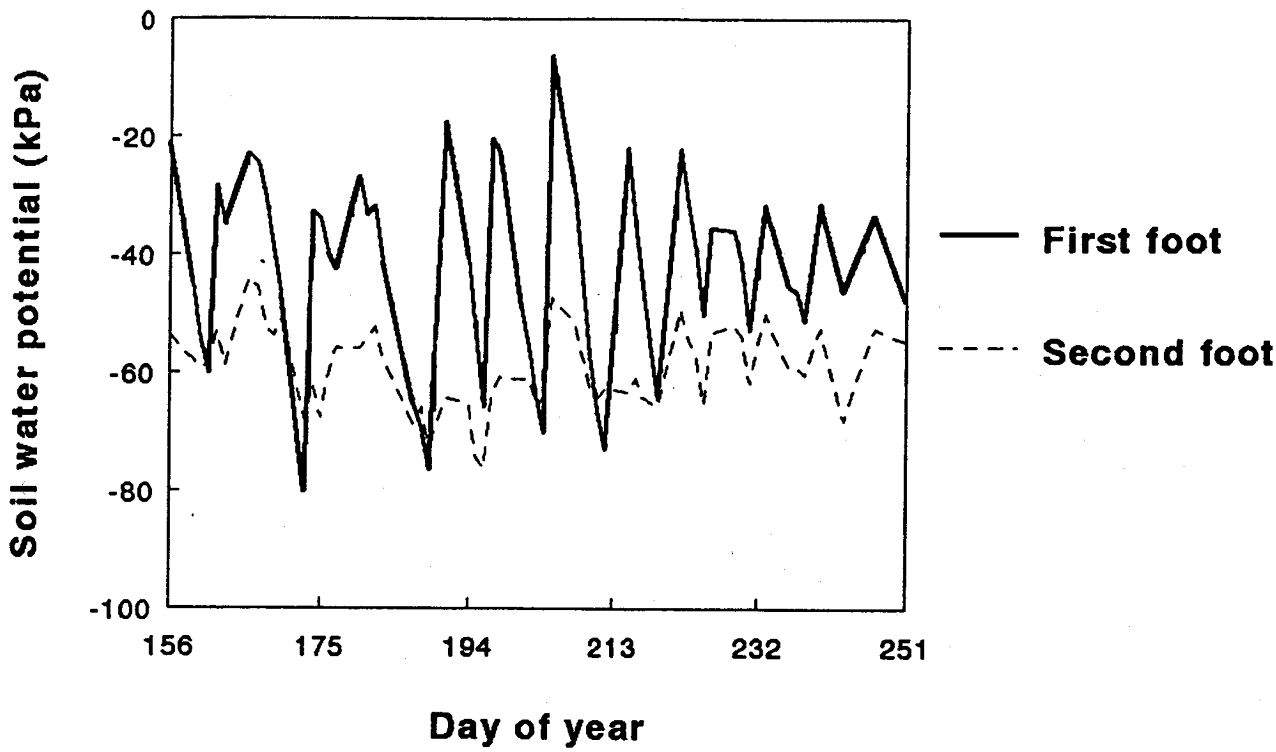
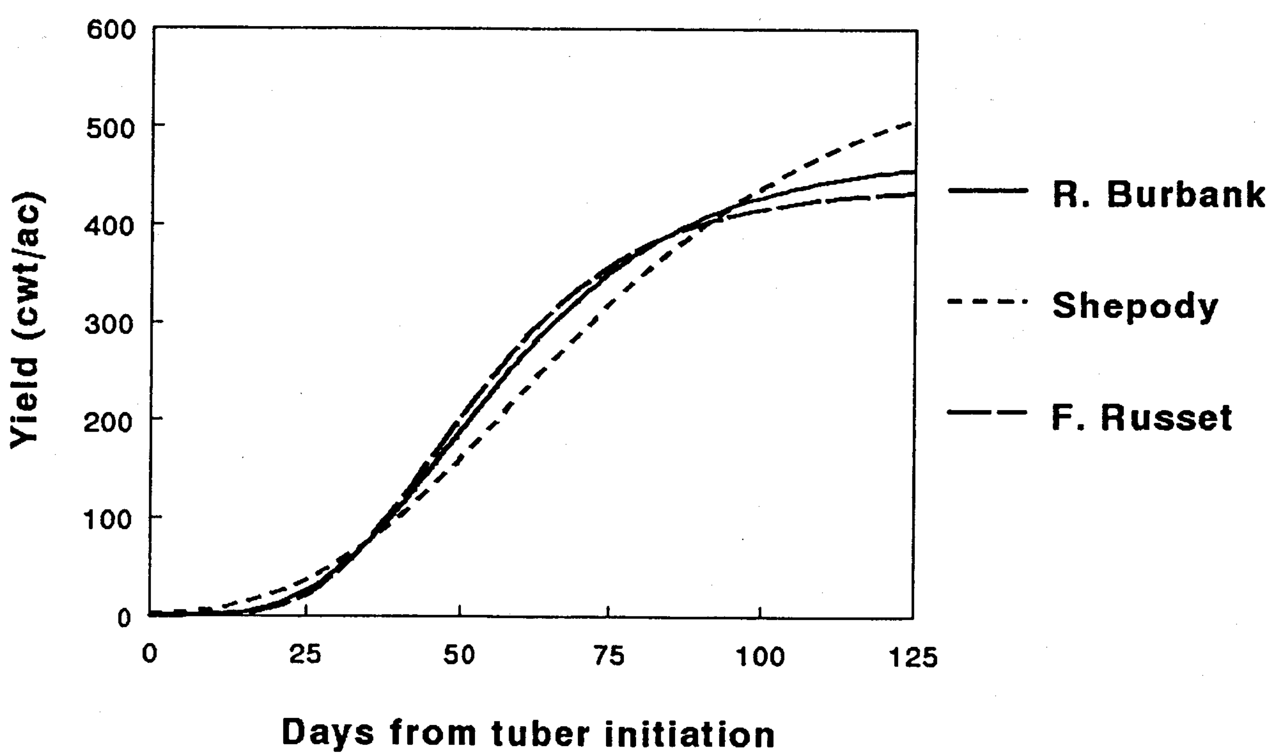


Figure 2. Tuber development over time for three potato cultivars without hail. Days are the number of days from the onset of tuber initiation, June 8, 1992 from this trial. Malheur Experiment Station, Oregon State University, Ontario, Oregon.



SOYBEAN RESEARCH AT ONTARIO IN 1992

Clint Shock, Erik Feibert, and Monty Saunders
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Introduction

Soybeans are 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 soybean production 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 irrigated cropping patterns in the Snake River valley, soybeans may be economically feasible only at high yields. Hoffman and Fitch (1972) demonstrated that soybean cultivars adapted to Minnesota could yield 50 to 65 bushels/acre per year 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 10 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 differences in day length. 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).

This report summarizes work done in 1992 as part of the continuing breeding program to adapt soybeans to Eastern Oregon.

Procedures

The trial was conducted on a silt loam soil previously planted to unfertilized spring wheat. A soil sample for the first foot taken on July 12 showed a pH of 7.5, cation exchange capacity of 20 meq/100 g, 1.4 percent organic matter, 50 ppm nitrate-N, 27 ppm phosphorus, 393 ppm potassium, 1,860 ppm calcium, 440 ppm magnesium, 190 ppm sodium, 2.8 ppm zinc, 19.5 ppm iron, 7.2 ppm manganese, 1.1 ppm copper, 45 ppm sulfate-S, and 0.5 ppm boron. Seed of the different cultivars was planted on May 23 at 200,000 seeds/acre in rows 22 inches apart. Rhizobium japonicum soil implant inoculant was applied in the seed furrow at planting.

Twenty-three new selections (Table 1) from R. Cooper, USDA in Wooster, Ohio were planted in plots four rows wide by 25 feet long. In addition, single plants were selected from five F_5 lines (Table 3) originally bred for eastern Oregon adaptation. The five lines were planted in plots four rows wide by 400 feet long. Other cultivars found to yield well in eastern Oregon or possessing valuable traits (Table 2) were planted in plots four rows wide by 25 feet long for seed maintenance.

The field was furrow irrigated immediately after planting and as necessary until harvest. On July 15, at the full bloom stage, a representative sample of fully expanded leaves was collected and analyzed for nutrient levels. The results showed inadequate levels of nitrogen and copper. Urea at 15 lbs N/acre was water run, and tribasic copper sulfate was applied as a foliar spray at 0.6 lb/acre on July 23. Comite at 2 lbs ai/acre and Orthene at 1 lb ai/acre were sprayed on July 28 for control of spider mites and lygus bugs. Phosphorus at 0.2 lb/acre as phosphoric acid, iron at 0.07 lb/acre as iron sulfate, and zinc at 0.02 lb/acre as zinc sulfate were applied in a foliar spray on August 6.

Plant height and reproductive stage were measured every week for each cultivar. Prior to harvest the cultivars were evaluated for lodging and shatter. The middle two rows in each plot of the new selections, and the plots for seed maintenance were harvested on October 1 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 labeled individually and measured for plant height. Seeds were subsequently harvested from the plants by hand.

Results and Discussion

Yields for the new selections ranged from 39 to 65 bushels per acre (Table 1). Four of the lines yielding above 60 bushels per acre had no lodging or shatter. Seed counts ranged from 1,890 to 2,834 seeds /lb. Yields for the other cultivars ranged from 31 to 64 bushels/acre (Table 2). Seed size ranged from 1,890 to 2,520 seeds/lb.

Breed and selection has resulted in several determinate F_5 soybean lines with reduced stature, no shatter, and little lodging. These lines have shown little potential for enhanced yield at high plant population because their stature is still too tall, leading to lodging at high plant populations. Single plant selections were made from these lines in 1992, selecting for reduced plant stature, and subjective judgement for pod and seed yield (Table 3). The single plant selections will be evaluated for yield at high population density in 1993.

Table 1. Performance characteristics of soybean new selections introduced from USDA, Wooster, Ohio as ranked by yield. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Cultivar	Lodging	Shatter	Height	Yield	Seed count
	0-10†	%	cm	bu/ac	seeds/lb
H91168	10	0	105	48	2268
H91298	5	0	95	50	2520
H911450	0	0	90	50	1890
H91771	0	70	75	51	2268
H91176	0	0	67	51	2268
H911068	50	50	98	52	2520
H91167	30	0	105	52	2268
H911512	10	0	105	53	2834
H911386	0	0	90	54	2520
H91898	0	10	78	54	2520
H91682	0	90	90	55	2268
H911465	30	0	90	56	1890
H911403	0	0	90	56	2520
H91465	0	80	100	56	2520
H91831	10	0	95	57	2268
H91542	0	0	96	59	2268
H91827	0	0	90	59	2520
H91299	0	0	100	60	2520
H91466	0	0	100	61	2520
H91934	40	0	100	61	2268
H91400	0	0	100	64	2061
H91303	0	0	100	65	2268

† 0= none, 10= 100 % lodging

Table 2. Performance characteristics of soybean cultivars produced in seed maintenance plots. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Cultivar	Days to maturity*	Lodging	Shatter	Height	Yield	Seed count
		0-10+	%	cm	bu/ac	Seeds/lb
Evans	105	0	10	75	63.71	2061
HC87-59	122	0	0	95	60.21	2520
Sibley	122	5	0	85	54.01	1890
Gnome 85	112	1	0	80	49.07	2061
HC89-2018	122	1	0	85	47.72	2268
Hoyt	122	1	0	95	46.45	2268
OR-8	112	0	0	70	31.38	1890
OR-6	99	0	0	60	31.02	2520

* from emergence

\+ 0 = none, 10 = 100%

Table 3. Summary of characteristics of 241 single plant selections made in 1992 from soybean F_5 lines originally bred and selected for eastern Oregon adaptation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Mother line	# of selections	Height range	Seed size range
		cm	seeds/lb
H16-12	106	24-110	1890-3240
H16-3	50	14-83	2062-3240
H16-7	54	20-88	1890-3780
H4-6	12	37-78	1890-2835
H82-14	19	57-86	2268-3240

PERFORMANCE OF LARGE SEEDED SOYBEAN CULTIVARS HARVESTED AS GREEN SOYBEANS (EDAMAME)

Clint Shock, Erik Feibert, Marcos Kogan, and Monty Saunders
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Introduction

Interest in the production and export of green soybeans (edamame) has grown in the Pacific Northwest in the last few years. Soybeans for edamame are harvested at the large green bean stage, and the pods can then be sold fresh or frozen and exported to the Orient. The pods are boiled for a few minutes and then shelled by hand at the table and consumed as a snack. Green soybeans would also provide a low fat, high protein alternative snack food for the domestic market. As the crop is harvested at the green bean stage, a shorter growing season is required than for conventional dry beans. Seven large seeded soybean cultivars were evaluated for their use as edamame.

Procedures

The trial was conducted on a silt loam soil previously planted to unfertilized spring wheat. A soil sample for the first foot taken on July 12 showed a pH of 7.5, cation exchange capacity of 20 meq/100 g, 1.4 percent organic matter, 50 ppm nitrate-N, 27 ppm phosphorus, 393 ppm potassium, 1,860 ppm calcium, 440 ppm magnesium, 190 ppm sodium, 2.8 ppm zinc, 19.5 ppm iron, 7.2 ppm manganese, 1.1 ppm copper, 45 ppm sulfate-S, and 0.5 ppm boron. Seed of seven cultivars was planted on May 23, at 118,800 seeds/acre on 22 inch beds. The experimental design was a randomized complete block with five replicates. Plots were four rows wide and 25 feet long. Rhizobium japonicum soil implant inoculant was applied in the seed furrow at planting.

The field was furrow irrigated immediately after planting. On July 15, at the full bloom stage, a representative sample of fully expanded leaves was collected and analyzed for nutrient levels. The results showed inadequate levels of nitrogen and copper. Urea at 15 lbs N/acre was water run, and tribasic copper sulfate at 0.6 lb/acre was foliar applied on July 23. Comite at 2 lbs ai/acre and Orthene at 1 lb ai/acre were sprayed on July 28 for control of spider mites and lygus bugs. Phosphorus at 0.2 lb/acre as phosphoric acid, iron at 0.07 lb/acre as iron sulfate, and zinc at 0.02 lb/acre as zinc sulfate were applied in a foliar spray on August 6.

Plant height and reproductive stage were measured every week for each cultivar. Three feet of the middle two rows in each plot were harvested when the bean moisture content for a variety reached 70 percent. Plants were cut at ground level and measured for total weight and pod weight. A subsample of pods was weighed, shelled, and the beans were weighed and oven dried for moisture content determination. The remaining 20 feet of the middle two rows in each plot was harvested at the dry bean stage on October 1 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.

Results and Discussion

Green soybeans for export to Japan must have a seed count of 1,512 seeds/lb or less, and pods must have white pubescence. Beans must have a characteristic taste that is sweeter and less beany than conventional soybeans. In addition the plants should be about 18-24 inches (45-60 cm) tall to facilitate mechanical harvesting.

Only cultivars Disoy and PI-417451 had large enough beans to meet the export criterion, with Disoy having white pod pubescence (Table 1). Cultivars Grande and PI-536546 were taste-tested at the green bean stage and found to be lacking in sweetness and too beany tasting to be of export quality as green soybeans (John Konovski, pers. comm.). The other cultivars were not at the green bean stage at the time of the taste test. All cultivars were too tall for efficient mechanical harvest. Shatter was too high for PI536546, Vinton81, Disoy, and PI417451 for seed production. PI536546 and Vinton 81 lodged too heavily for efficient mechanical seed harvest.

Further soybean introductions are needed to identify cultivars that could merit export quality. Research will continue with introductions and evaluations in 1993.

Table 1. Characteristics of seven large seeded soybean cultivars harvested at the green bean stage (edamame). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Cultivar	Height	Days to green bean harvest*	Plant top FW yield	Pod yield	Bean/pod ratio	Pod pubescence color	Green bean moisture	Lodging	Shatter	Dry bean yield	Dry seed count
	cm		— lb/ac —		g/g		%	0-10+	%	bu/ac	seeds/lb
Grande	80	87	35058	12247	0.52	brown	71	0	0	52	1620
PI194647	120	88	38884	7498	0.32	light brown	74	1	0	47	1890
PI417459	110	101	41930	11624	0.43	white	70	2	0	33	1620
PI536546	77	83	30532	13797	0.50	light brown	72	0	80	37	1890
Vinton 81	80	103	40231	10051	0.41	light brown	70	5	50	27	1890
Disoy	75	93	42417	17198	0.36	white	74	0	90	27	1260
PI417451	80	102	35015	13656	0.45	brown	70	0	70	28	1512
LSD(0.05) Cultivar			4637	2257	0.03		1.7			8.3	

* from emergence

\+ 0 = no lodging, 10 = 100% lodging

SUGAR BEET VARIETY TESTING RESULTS

Charles E. Stanger and Joey Ishida
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

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 accumulative performance data for the varieties, and restricts growers in Idaho and Malheur County of Oregon to planting only those varieties ranking above minimum requirements.

Procedures

Sixteen commercial and 20 experimental lines of sugar beets were evaluated in trials conducted at the Malheur Experiment Station. Seed for evaluation was received from American Crystal, Betaseed, and Hilleshog Mono-Hy Inc. The sugar beets were planted in Owyhee silt loam soil where wheat was planted the previous two years. Soil pH was 7.3 and the soil organic matter was 1.2 percent. The field was plowed in the fall of 1991. One hundred pounds of phosphate and 60 lb of N were applied as a broadcast treatment before plowing. An additional 150 lb of nitrogen was added by sidedressing ammonium sulfate after thinning. Two lb ai/ac of Nortron was broadcast and incorporated using a spike-tooth harrow before planting for weed control.

The commercial varieties and experimental lines were planted in separate trials. Each entry was replicated eight times and arranged in a complete randomized block experimental design. Each plot was four rows wide and 23 feet long with four-foot alley ways separating each plot. Approximately 12 viable seeds per foot of row were planted. The seed was planted on April 2 and 3 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 surface-irrigated to assure moisture for uniform seed germination and seedling emergence.

The sugar beets were hand-thinned during the second week of May. Spacing between plants was approximately 8 inches. In mid-July, 60 lbs/ac powdered sulfur was spread by aerial application over the foliage to protect the sugar beet leaves from powdery mildew infection. The sugar beets were severely infected with curly-top virus by leafhopper populations prior to thinning. Curly-top virus symptoms were evident at time of thinning. The trial was continued to compare varieties for resistance to curly-top. Curly-top ratings were taken on June 17 and August 5 by Dr. John Gallian and Dennis Searle.

The sugar beets were harvested on October 17, 18, 21, and 22. 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 22 feet of row were weighed to calculate root yields. A sample of eight beets were taken from each of the harvested rows and analyzed for percent sucrose, and conductivity. The percent extraction was calculated using percent sucrose and conductivity values.

Results

Varieties (Table 1 and 2) have been grouped by seed companies. Each variety is ranked within each company's group by yield of recoverable sugar per acre. The data was analyzed statistically for LSD value at 0.05 percent level of significance, coefficient of variation, and means for all evaluated parameters.

Yields of recoverable sugar from experimental varieties ranged from a high of 6.180 tons of sugar/ac to a low of 1.664 tons/ac, with a variety mean of 4.523 tons/ac. Yields of curly-top susceptible varieties were greatly reduced by infection.

Yield of recoverable sugar from commercial lines ranged from 6.162 tons of sugar/ac to a low of 2.241 tons of sugar/ac, with an entry mean of 4.452 tons of sugar/ac. Curly-top ratings are included in both tables for commercial and experimental lines. Ratings of curly-top ranged from 2.6 to 5.1 for commercial varieties on June 17. On August 5 ratings for the same varieties changed for a low of 2.8 to a high of 6.6. On June 17th ratings of experimental lines ranged from 2.9 to 5.1. On August 5 ratings for the same varieties went from a low of 3.1 to a high of 6.9. Ratings are averages for each variety over 8 replications.

Table 1. Results of sugar beet commercial variety entered in testing trials at the Malheur Experiment Station, Ontario, Oregon, 1992.

Company	Entry	Roots	Sucrose	Root Nitrogen	Conductivity	Extraction	Recoverable sugar	Curly-top ratings[1]	
		tons/ac	%	ppm		%	tons/ac	6/17	8/5
American Crystal	ACH-200	35.08	16.86	128	590	87.04	5.137	4.5	4.0
	ACH-203	31.50	17.35	108	545	87.71	4.792	4.9	4.5
	ACH-199	28.70	17.06	128	566	87.39	4.269	3.8	4.6
	ACH-139	25.16	16.88	97	555	87.49	3.712	4.6	5.0
	ACH-177	14.60	17.41	79	522	88.01	2.241	5.1	6.6
Betaseed	8251	33.49	17.18	134	616	86.77	4.980	4.4	4.4
	8450	30.18	17.33	133	630	86.62	4.518	4.9	4.9
	8422	25.80	17.87	89	566	87.54	4.032	4.9	5.0
	9380	25.80	17.39	95	575	87.34	3.911	4.8	4.9
	8428	22.53	17.45	96	578	87.32	3.432	4.8	5.5
Hilleshog Mono-Hy	WS-91	41.08	17.22	124	589	87.13	6.162	2.6	2.8
	WS-62	39.29	16.97	104	539	87.72	5.843	3.2	3.0
	WS-PM9	38.45	17.08	102	532	87.82	5.763	3.6	3.0
	WS-88	37.97	16.99	139	620	86.68	5.590	3.4	3.4
	R2	26.81	16.95	87	569	87.33	3.963	4.8	5.4
	WS-41	19.43	17.03	96	568	87.37	2.885	4.8	6.1
Mean		29.74	17.19	109	572	87.33	4.452	4.3	4.6
LSD .5		3.16	.34	29	43	0.59	0.434	0.46	0.57
CV (S/Mean)		10.7	1.99	27.0	7.5	0.69	9.8	10.9	12.8
CV (SE/Mean)		3.7	0.70	9.5	2.6	.24	3.5	3.9	4.5

[1] Curly-top ratings taken by John Gallian, University of Idaho and Dennis Searle, Amalgamated Sugar Co. Average of 8 replications.

Table 2. Results of sugar beet experimental varieties entered in testing trials at the Malheur Experiment Station, Ontario, Oregon, 1992.

Company	Entry	Roots	Sucrose	Root Nitrogen	Conductivity	Extraction	Recoverable sugar	Curly-top ratings[1]	
		tons/ac	%	ppm		%	tons/ac	6/17	8/5
American Crystal	9050 109	37.06	17.19	140	620	86.72	5.522	2.9	3.6
	9050 106	35.88	17.36	132	624	86.71	5.405	3.0	4.1
	9050 103	33.83	17.41	120	582	87.25	5.136	3.2	4.2
	ACH-203	26.84	17.67	96	528	88.00	4.171	5.0	4.9
Betaseed	OBG 6953	40.00	17.41	116	641	86.49	6.016	3.5	3.1
	0BG 6954	36.86	17.32	114	664	86.18	5.491	3.9	3.6
	1BX 8423	31.80	18.00	129	625	86.81	4.964	3.2	4.6
	OBG 6025	28.09	18.00	119	615	86.94	4.396	4.6	5.1
	OBG 6063	25.53	17.75	112	602	87.05	3.933	4.9	5.4
	8450	23.88	17.90	103	578	87.40	3.732	5.1	5.6
	9BG 6085	18.18	17.58	118	606	86.97	2.781	5.0	5.9
	OBG 6489	14.74	17.10	141	665	86.12	2.182	4.9	6.6
	9BG 6380	13.52	17.30	99	580	87.25	2.048	4.9	6.4
	9BG 5349	10.35	18.24	102	539	87.96	1.664	5.1	6.9
Hilleshog Mono-Hy	PM9	40.30	17.50	104	550	87.68	6.180	3.8	3.6
	HM WS-8174	38.92	17.78	105	585	87.28	6.034	3.8	4.0
	HM 2914	35.41	17.91	101	538	87.91	5.563	4.4	4.4
	HM WS-870	35.18	17.36	112	559	87.54	5.330	3.5	4.2
	HM 2912	33.56	17.37	116	605	86.95	5.062	4.8	4.8
	HM WS-26	31.26	17.75	119	571	87.46	4.854	4.0	4.6
Mean		29.56	17.59	115	594	87.13	4.523	4.2	4.8
LSD .5		3.39	.33	24	46	0.61	0.516	0.51	0.63
CV (S/Mean)		11.5	1.89	21	7	0.71	11.54	12.3	13.3
CV (SE/Mean)		4.1	0.67	7.5	2.7	.25	4.1	4.4	4.7

Curly-top ratings taken by John Gallian, University of Idaho and Dennis Searle, Amalgamated Sugar Co. Average of 8 replications.

HERBICIDE TRIALS TO EVALUATE SOIL AND FOLIAR ACTIVE TREATMENTS FOR WEED CONTROL AND SUGAR BEET TOLERANCE

Charles E. Stanger and Joey Ishida
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Purpose

Several trials were conducted to obtain data on weed control and tolerance of sugar beets to herbicides applied as preplant incorporated and postemergence applications. Preplant treatments included formulations of Nortron, Roneet, and Antor. These herbicides were spring applied and mechanically incorporated at time of planting. The postemergence treatments included Betamix, Stinger, Nortron, Poast, Select, Assure, Dupont 66037, NorAm NA307, and NA308. NA307 and NA308 are compounds containing different ratio's of Betamix and Nortron. Postemergence treatments were applied as tank-mix combinations at various rates. Application of postemergence treatments were begun when the sugar beets had cotyledon leaves. Sequential or repeat applications followed as new weeds emerged, usually at 7-10 day intervals for a total of three applications. Other trials were conducted to evaluate tolerance of sugar beets to postemergence herbicides under both frost and a high temperature environment. The object of the study was to continue to evaluate herbicides to identify rates and proper timing of applications to control all broadleaf and grassy weeds selectively so hand-labor is not required in the production of sugar beets for weed removal or plant spacing.

I. Preplant Incorporated Herbicide Study

Procedure

Roneet, Antor, and the emulsifiable concentrate (EC) and flowable formulations of Nortron were evaluated as single and tank-mix herbicide combinations for sugar beet tolerance and weed control when applied before planting and mechanically incorporated.

Herbicides applied as preplant incorporated treatments are included in Table 1. Herbicide treatments were applied March 26 in an 11-inch band on rows spaced 22 inches apart, and incorporated to a 2-inch depth using a four-row, 9-inch-wide-band power driven rotary incorporator. MonoHy PM9 variety sugar beets were seeded on March 27 and the trial furrow irrigated on March 31. Soils are silt loam texture, with a pH of 7.3 and 1.3 percent organic matter. The previous 1991 crop was Owens variety spring wheat. The herbicides were applied using 6506 teejet fan nozzles, a spray pressure of 42 psi, and water volume of 32 gallons/ac. Individual plots were four-rows wide and 25 feet long. The herbicides were sprayed with a single bicycle wheel plot sprayer and a four nozzle boom, centering a spray nozzle over each row of the four-row plots. When spraying, air temperature was 69° F, soil surface dry, skies overcast and wind calm.

Results

Sugar beet tolerance was good with all treatments except with the tank-mix combination of Nortron SC and Roneet (Table 1). Nortron plus Roneet at tank-mix rates of 1 plus 2 lbs ai/ac reduced sugar beet stand by 10 percent. Roneet and Antor applied singly or as a tank-mix did not control kochia or lambsquarters, but effectively controlled redroot pigweed, barnyardgrass, and green foxtail. Roneet applied at 4 lbs ai/ac also controlled hairy nightshade. Hairy nightshade was not controlled by Roneet when tank-mixed with Antor because of the reduced rate of Roneet in the tank mix. Antor did not control hairy nightshade. Excellent weed control was obtained with Nortron plus Roneet but sugar beet tolerance is questionable. Both the EC and flowable formulations of Nortron gave full control of hairy nightshade, lambsquarters, pigweed, annual sowthistle, kochia, and green foxtail. Nortron is less active on barnyardgrass. The two formulations of Nortron were comparable in herbicide activity, and compatible as tank-mixes with other herbicides.

II. Frost Tolerance of Seedling Sugar Beets Treated with Postemergence Herbicides

Procedure

MonoHy PM9 variety of raw sugar beet seed was planted, and the field furrow irrigated on March 11. The first postemergence application of herbicide treatments was applied on April 2. The sugar beets had cotyledon leaves and the weeds had cotyledon or two true leaves. Herbicides in all postemergence trials were applied using a single bicycle wheel plot sprayer equipped with a four nozzle boom with a single nozzle centered over each row of the four-row plots. All treatments were applied at broadcast rates with any overlap between nozzles falling between rows. Rows were spaced 22 inches apart and plots were 25 feet long. Teejet nozzles were 8002's, spray pressure was 42 psi, and volume of water applied was 19.8 gallons/acre. Air temperature was 80° F while spraying. All plants were healthy, skies were clear, and wind calm. Air temperatures on the mornings of April 6 and 7 fell to 29° F and 25° F respectively. Freezing temperatures occurred 4 and 5 days following the applications of the postemergence treatments.

Results

Betamix and Betamix tank-mix combinations with Stinger, DPX 66037, or Poast, applied postemergence to cotyledon leaf sugar beets, did not precondition sugar beets making them more susceptible to frost damage when temperatures fell to 25°F five days after herbicides were applied. Plant counts show that about 5 percent of the sugar beet plants were killed by frost, but stand losses were equal between untreated and treated plots. In other trials cotyledon leaf sugar beets treated with Betamix were susceptible to freezing temperatures if they occurred within 24 hours following the herbicides application. In this trial seedling sugar beets were tolerant to all herbicide treatments applied as repeat applications. Betamix at 0.33 lbs ai/ac gave better control of hairy nightshade than Betamix at 0.25 lbs ai/ac. Stinger at 0.1 lb ai/ac in combination with Betamix at 0.25 lbs ai/ac gave complete control of hairy nightshade. Dupont 66037 was most active on kochia, but had no herbicide activity on hairy nightshade. Excellent weed control was obtained with Betamix plus Nortron tank-mixes at 0.15 and 0.25 lbs ai/ac. All herbicides were compatible as tank-mix combinations. Both Select and Poast gave complete control of barnyardgrass and green foxtail when tank-mixed with broadleaf herbicides. Percent weed control and crop injury ratings are included in Table 2.

III. Nortron-Betamix Combination and Rate Study

Procedures

Nortron added with Betamix as a tank-mix has been shown to improve control of kochia and hairy nightshade. Seedling sugar beets are more sensitive to Nortron/Betamix combinations and injury can occur. Various rates of Betamix and Nortron in tank-mix combination were compared to identify optimum rates for crop safety, and for control of kochia and hairy nightshade. Betamix at 0.15 and 0.25 lbs was evaluated with Nortron at 0.10, 0.15, and 0.25 lbs ai/ac. Applications were begun on April 16 when sugar beets had small cotyledon leaves. Second and third applications were applied on May 1 and May 13. Other herbicide treatments evaluated included Betamix tank-mixes with Poast, Select, and Dupont 66037.

Results

Sugar beets were tolerant to all rates and tank-mix combinations of Betamix and Nortron (Table 3). Good weed control was obtained with Betamix applied at 0.15 or 0.25 lbs ai/ac, in a tank-mix combination of Nortron at 0.25 lbs ai/ac. Dupont 66037 applied at 0.0156 lbs ai/ac, with 0.25 lbs ai/ac of Betamix, gave excellent control of kochia. All hairy nightshade was controlled with Stinger and Betamix combinations. Select and Poast herbicides were compatible with all broadleaf herbicides, and tank-mix combination treatments, including either Poast or Select, gave excellent control of all broadleaf weeds, barnyardgrass, and green foxtail.

IV. Tolerance of Seedling Sugar Beets to Betamix Applied During High Temperatures

Procedures

Sugar beets are generally more sensitive to Betamix applied when air temperatures exceed 85°F and the Betamix label cautions against the application of Betamix during morning or early afternoon hours under high light intensity and temperatures. The objective of this study was to evaluate the tolerance of cotyledon leaf sugar beets to low rates of Betamix, and Betamix combinations applied as repeat applications during high daytime temperatures. Sugar beets were planted on May 1. The first application of Betamix treatments was applied on May 13. Sugar beets and weeds had small cotyledon leaves. Air temperature on May 13, May 23, and June 1 when herbicides were applied was 91 °F, 94 °F, and 97 °F respectively. On May 23 the sugar beets had two to four true leaves and four to six leaves on June 1.

Results

Cotyledon leaf sugar beets were more sensitive to Betamix as day-time temperatures exceeded 90 °F. A few cotyledon leaves were burned, but sugar beet stands and plant growth were not reduced, and new leaves emerging after the cotyledon applications were normal in size, color, and growth. Betamix applied at 0.25 lbs ai/ac, and Betamix in combination with other herbicides, did not injure sugar beets with true leaves when applications were applied on May 23 and June 1 at temperatures of 94 ° and 97 ° F. In this trial it was observed that sugar beets treated with Counter insecticide at planting time for maggot and crown borer control may be more sensitive to Stinger and DPX 66037 herbicides. Counter treated sugar beets became chlorotic after Stinger and DPX 66037 were applied. This effect was noted when herbicides were applied on May 23 and June 1 to sugar beets with three to four true leaves. This effect was not noted when Stinger and DPX 66037 were applied in other trials at lower air temperatures. Weed control was about equal to the weed control obtained with these same herbicide rates and combinations applied earlier at cooler temperatures in other trials. Results of this trial shows that seedling sugar beets can be safely treated with Betamix and Betamix tank-mix combinations when air temperatures are in the 90 °F range.

V. The Tolerance of Seedling Sugar Beets, to Prowl and Prowl/Betamix Tank-Mixes Applied Postemergence

Procedures

Prowl herbicide is very effective for control of dodder in alfalfa seed crop and onions. Sugar beet seeds germinating in Prowl treated soils are sensitive to Prowl at low concentrations. The objective of this study was to evaluate the tolerance of sugar beets to Prowl applied postemergence to sugar beets with cotyledon leaves. Prowl was applied at rates of 1.0, 1.5, 2.0, and 3.0 lbs ai/ac, in combination with Betamix and Betamix tank-mixed with Stinger, DPX 66037, or Poast herbicides. The early application was applied on April 24. The sugar beets had fully expanded cotyledon leaves with true leaves beginning to develop on about 20 percent of the sugar beet plants. The true leaves were about ⅛ inch long. Air temperature was 61 °F on April 24 when the early treatments were applied. Prowl was only applied during the initial application and not with repeat applications. Repeat applications of Betamix and Betamix combinations were applied on May 1 and May 13. Prowl injury to sugar beet seedlings was noted when the second application of Betamix was applied on May 1. The amount of visible injury increased as the rate of Prowl increased from 1.0 to 3.0 lbs ai/ac, and it appeared that sugar beet stands would be reduced by Prowl applied at the 2 and 3 lb ai/ac rate. On May 13 when the last application of Betamix and combination treatments were applied, it was apparent that sugar beet seedlings previously injured with Prowl applied postemergence are more sensitive to Betamix applied in repeat applications.

Results

Significant losses in sugar beet stand occurred as a result of Prowl applied postemergence at 2 or 3 lbs ai/ac to cotyledon leaf sugar beets. Sugar beets treated with 1.0 and 1.5 lbs ai/ac were severely stunted but stands were not reduced. Prowl increased the activity of Betamix and Betamix combinations, resulting in good control of kochia and hairy nightshade when Betamix rate was reduced to 0.25 lbs ai/ac. Good control of pigweed, lambsquarters, and sowthistle was obtained with combinations of 1.0 and 1.5 lbs ai/ac Prowl, and 0.25 lbs ai/ac of Betamix. Betamix, Prowl, and Poast in combination gave good control of green foxtail and barnyardgrass. Stinger was very active on hairy nightshade when tank-mixed with Betamix and Prowl.

VI. DPX 66037 and Betamix Tank-Mix Combinations

Procedures

Dupont DPX 66037 was applied at 0.0156 lbs ai/ac with surfactant in tank-mix combinations of Betamix, Stinger, Poast, and Assure herbicides (Table 6). Assure herbicide was evaluated for grass control and tank-mix compatibility with broadleaf herbicides. MorAct (COC) was added when Assure was tank-mixed with Betamix, Stinger, or DPX 66037. The first application of herbicides was applied on April 16 to cotyledon leaf sugar beets and weeds. Two additional applications were applied on April 24 and May 5. On April 16 the air temperature was 67°F and soil temperature at the 4-inch depth was 58°F. Skies were partly cloudy and the wind was calm. On April 24 the sugar beets had fully expanded cotyledon leaves with true leaves starting to form on 25 percent of the sugar beet plants. Air and soil temperatures were 61°F and 54°F respectively. On May 5 the sugar beets had two to four true leaves. Air and soil temperatures were 87°F and 79°F.

Results

The early application of the three-way tank-mix including DPX 66037, Betamix, and Stinger, caused leaf chlorosis and some early stunting to plant size compared to sugar beets in untreated plots. Leaf chlorosis and stunting of plants did not appear with DPX 66037 alone or in two-way tank mixes including either Betamix or Stinger. DPX 66037 was most active on redroot pigweed and kochia. DPX 66037 did not control hairy nightshade, lambsquarters, green foxtail, or barnyardgrass. DPX 66037, Betamix, and Stinger in a three-way tank-mix controlled hairy nightshade, redroot pigweed, lambsquarters, and kochia. Poast in combination with DPX 66037 gave better control of green foxtail and barnyardgrass than did Assure in combination with DPX 66037. Antagonism from DPX 66037 and Assure occurred when these materials were tank-mixed, resulting in reduced control of kochia and redroot pigweed. DPX 66037 added to Betamix improves the control of kochia, but Betamix is needed with DPX 66037 to control redroot pigweed and lambsquarters. Stinger added to DPX 66037 as a two-way mix gave excellent control of hairy nightshade, which was not controlled by a Betamix and DPX 66037 tank-mix combination. Excellent control of all broadleaf weed species was obtained with a tank-mix of DPX 66037 plus Betamix and Stinger.

VII. Nortron and Betamix Premix Co-Formulated Ratio's

Procedures

Co-formulation 21 EC NA307 and co-formulation 21 EC NA308 were each applied as repeat treatments on sugar beets beginning at the cotyledon leaf stage. The first application was made on April 22. Repeat applications of each treatment were applied on May 1 and May 13. Air and soil temperatures (at 4 inch depth) on April 22 was 59°F and 54°F respectively. Skies were overcast and wind calm. On May 1 the sugar beets had fully expanded cotyledon leaves with 25 percent of the plants having two true leaves, with leaf blades about ½ inch long. Air temperature was 61°F, and soil temperature 54°F with clear skies. When the May 1 (2nd application) was made the sugar beets were severely injured from the first application of 307 and 308 applied at 0.45 lbs ai/ac. Seedling sugar beets were not injured with 307 or 308 at the 0.28 lb ai/ac rate. On May 13 when the third application was applied, the sugar beets in all plots except the 307 and 308 treated plots had two or four true leaves. Sugar beets in the 307 and 308 plots were severely stunted. Air and soil temperatures were 87°F and 79°F respectively. Skies were partly cloudy and wind was calm. Other herbicide treatments in the study were Betamix 1.3 EC applied at 0.19 and 0.30 lbs ai/ac, and Betamix 1.3 EC plus Nortron 50-SC (tank-mix) applied at rates of 0.19 plus 0.10, and 0.30 plus 0.15 lbs ai/ac. The herbicide treatments were compared for crop tolerance and weed control.

Results

Co-formulations of 307 and 308 at 0.45 lbs ai/ac caused severe injury resulting in plant stunting and foliage damage, which persisted after June 9th when the final evaluations were taken. Plant stands, however were not reduced. Injury to sugar beets did not occur with NA307 or NA308 at the 0.28 lbs ai/ac rate, or with Betamix EC at 0.19 or 0.30 lbs ai/ac. Slight stunting of seedling plants did occur with Betamix EC plus Nortron 50-SC at the 0.3 plus 0.15 lb ai/ac rate. Good control of hairy nightshade, lambsquarters, redroot pigweed, and kochia was obtained with Betamix at 0.3 lbs ai/ac, the co-formulation of NA307 and 308, and with Betamix EC plus Nortron tank mixes. About 80 percent of the barnyardgrass and green foxtail was controlled with these treatments. When Poast was added to Betamix EC plus Nortron all grass was controlled (Table 7).

Table 1. Percent weed control and crop injury ratings from preplant incorporated applications of herbicides to sugar beets. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

	Rate	Crop Injury				H. Nightshade				Pigweed				Lambsquarters				Kochia				A. Sowthistle				A. Grasses			
Herbicides	lbs ai/ac	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Roneet	3.0	0	0	0	0	98	98	96	97	100	100	96	98	80	85	80	82	60	60	60	60	20	20	20	20	98	99	99	98
Roneet	4.0	0	0	0	0	100	100	96	99	96	100	98	98	85	100	90	92	70	85	80	80	35	40	40	37	100	100	98	99
Antor	3.0	0	0	0	0	65	60	60	62	90	80	90	87	85	80	70	78	35	30	25	30	20	20	20	20	99	98	100	99
Antor	4.0	0	0	0	0	75	60	60	65	95	95	95	95	75	70	70	72	35	30	30	32	20	20	20	20	100	100	100	100
Roneet + Antor	1.5+1.5	0	0	0	0	80	85	95	87	100	100	100	100	80	80	85	82	60	60	70	63	40	60	65	55	100	100	100	100
Roneet + Antor	1.0+1.0	0	0	0	0	85	90	95	90	100	100	100	100	85	80	85	83	50	35	30	38	10	10	10	10	100	100	100	100
Nortron SC + Roneet	1.0+2.0	55	65	60	60	100	100	100	100	100	100	100	100	100	99	100	99	100	100	100	100	100	100	100	100	100	100	100	100
Nortron SC	2.0	0	0	0	0	98	100	100	99	100	100	100	100	100	100	99	99	100	100	100	100	100	100	100	100	85	95	90	90
Nortron EC	2.0	0	0	0	0	100	98	100	99	100	100	100	100	100	100	98	99	100	100	100	100	100	100	100	100	95	95	90	93
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 June 9, 1992

Ratings: 0 = no effect, 5-50 = percent crop plant stunting, 51-100 = 5 to 50 percent crop plant stand loss, 100 = all plants killed.

Table 2. Percent stand losses from frost and weed control ratings in seedling sugar beets treated with postemergence herbicides four days before temperatures dropped to 25°F. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Herbicides	Rates	Stand Loss %				Crop Injury			
	lbs ai/ac	1	2	3	Avg	1	2	3	Avg
Betamix	0.25	5	3	4	4	0	0	0	0
Betamix	0.33	4	3	2	3	0	0	0	0
Betamix	0.50	5	3	2	3	0	0	0	0
66037 + X-77	0.0156+0.25%	6	2	3	4	0	0	0	0
Betamix + 66037	0.25+0.0156	4	3	1	3	0	0	0	0
66037 + Stinger	0.0156+0.095	3	4	2	3	5	0	0	2
Betamix + 66037 + Stinger	0.25+0.0156+0.095	5	6	3	5	0	0	0	0
Betamix + Poast	0.25+0.1	6	2	3	4	0	0	0	0
Betamix + 66037 + Poast	0.25+0.0156+0.1	5	4	2	4	0	0	0	0
Betamix + Select	0.25+0.05	3	6	2	4	0	0	0	0
Betamix + Stinger + Select	0.25+0.095+0.05	5	2	4	4	0	0	0	0
Betamix + Nortron SC	0.15+0.25	6	3	2	4	5	0	0	2
Betamix + Nortron SC	0.15+0.5	4	5	5	5	5	15	15	11
Betamix + Nortron + Poast	0.15+0.25+0.1	5	6	5	6	0	0	0	0
Check	---	5	6	4	5	0	0	0	0

Herbicides	H. Nightshade				Pigweed				Lambsquarters			
	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Betamix	98	95	95	96	100	100	100	100	100	100	100	100
Betamix	98	100	100	99	100	100	100	100	100	100	100	100
Betamix	100	100	100	100	100	100	100	100	100	100	100	100
66037 + X-77	50	50	50	50	90	80	80	83	30	30	30	30
Betamix + 66037	99	90	90	93	100	100	100	100	100	100	100	100
66037 + Stinger	100	100	100	100	100	100	100	100	70	70	70	70
Betamix + 66037 + Stinger	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Poast	100	100	95	98	100	100	100	100	100	100	100	100
Betamix + 66037 + Poast	92	90	92	91	100	100	100	100	100	100	100	100
Betamix + Select	100	90	98	96	100	100	100	100	100	100	100	100
Betamix + Stinger + Select	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Nortron SC	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Nortron SC	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Nortron + Poast	100	100	100	100	100	100	100	100	100	100	90	96
Check	0	0	0	0	0	0	0	0	0	0	0	0

Herbicides	Kochia				A. Grasses			
	1	2	3	Avg	1	2	3	Avg
Betamix	100	90	85	92	95	98	95	96
Betamix	100	100	100	100	90	95	98	94
Betamix	100	100	100	100	98	90	90	92
66037 + X-77	100	100	100	100	75	90	85	83
Betamix + 66037	100	100	100	100	100	100	100	100
66037 + Stinger	95	100	100	98	25	35	30	30
Betamix + 66037 + Stinger	100	100	100	100	95	98	98	97
Betamix + Poast	90	90	90	90	100	100	100	100
Betamix + 66037 + Poast	100	100	100	100	100	100	100	100
Betamix + Select	90	90	90	90	100	100	100	100
Betamix + Stinger + Select	90	100	100	96	100	100	100	100
Betamix + Nortron SC	100	100	100	100	100	85	85	90
Betamix + Nortron SC	95	100	100	98	100	98	95	98
Betamix + Nortron + Poast	100	100	100	100	100	100	100	100
Check	0	0	0	0	0	0	0	0

Evaluated June 12th for weed control and crop injury. Stand losses were determined two days after date of frost.

Ratings: 0 = no herbicide effect, 5-50 = degree crop plant stunting, 51-100 = 5 to 50 percent crop plant reduction, 100 = all plants killed.

Table 3. Percent weed control and crop injury ratings from varying rates of Betamix and Nortron herbicide combinations applied as postemergence sequential applications. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Herbicides	Rate	Crop Injury				H. Nightshade				Pigweed				Lambsquarters				Kochia				A. Grasses			
	lbs ai/ac	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Betamix	0.25	0	0	0	0	95	95	98	96	100	100	100	100	100	100	100	100	100	100	100	100	95	90	90	92
Betamix	0.33	0	0	0	0	99	99	99	99	100	100	100	100	100	100	100	100	100	100	100	100	90	95	90	92
Betamix + Nortron ec	0.15+0.10	0	0	0	0	93	90	90	91	100	100	100	100	99	100	100	99	100	100	100	100	80	80	80	80
Betamix + Nortron ec	0.15+0.15	0	0	0	0	90	98	99	96	100	100	100	100	99	99	100	99	100	100	100	100	90	85	85	87
Betamix + Nortron ec	0.15+0.25	0	0	0	0	99	99	100	99	100	100	100	100	100	100	100	100	100	100	100	100	90	90	90	90
Betamix + Nortron ec	0.25+0.10	0	0	0	0	98	99	99	98	100	100	100	100	100	100	100	100	100	100	100	100	90	92	92	91
Betamix + Nortron ec	0.25+0.15	0	0	0	0	99	100	100	99	100	100	100	100	100	100	100	100	100	100	100	100	95	95	95	95
Betamix + Nortron ec	0.25+0.25	0	0	0	0	99	100	99	99	100	100	100	100	100	100	100	100	100	100	100	100	98	95	95	97
Betamix + Stinger	0.25+0.05	0	0	0	0	99	99	100	99	100	100	100	100	100	100	100	100	95	100	100	100	90	90	85	88
Betamix + Stinger	0.25+0.10	0	0	0	0	100	100	100	100	100	100	100	100	100	100	98	99	100	100	100	100	85	95	90	90
Betamix + Poast	0.25+0.10	0	0	0	0	99	95	95	96	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Select	0.25+0.045	0	0	0	0	98	95	95	96	100	100	100	100	100	100	100	100	95	98	98	97	100	100	100	100
Betamix + Select	0.25+0.090	0	0	0	0	88	95	98	94	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Nortron ec + Poast	0.15+0.15+0.1	0	0	0	0	99	99	96	98	99	100	100	99	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + 66037	0.25+0.0156	0	0	0	0	99	99	100	99	100	100	100	100	100	100	100	100	100	100	100	100	85	90	90	88
Betamix + 66037 + Poast	0.25+0.0156+0.1	0	0	0	0	96	93	99	96	100	100	100	100	99	100	100	100	100	100	100	100	100	100	100	100
Betamix + 66037 + Select	0.25+0.0156+0.045	0	0	0	0	90	98	98	94	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
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 June 9.

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

Betamix at 0.25 and 0.33 lbs ai/ac controlled 100 percent annual sowthistle.

Table 4. Tolerance of seedling sugar beets treated with Betamix and Betamix combinations applied postemergence during high-day-time temperatures. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

	Rate	Crop Injury				H. Nightshade				Pigweed				Lambsquarters				Kochia				A. Grasses			
Herbicides	lbs ai/ac	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Betamix	0.25	5	0	5	3	85	85	80	83	100	100	100	100	100	100	100	100	85	90	90	87	90	85	70	82
Betamix + Poast	0.25+0.1	10	0	0	3	85	80	80	82	100	100	100	100	100	100	100	100	85	90	90	87	100	100	100	100
Betamix + Select	0.25+0.045	5	0	0	2	75	80	85	80	100	100	100	100	100	100	100	100	90	90	90	90	100	100	100	100
Betamix + Nortron	0.1+0.1	5	0	0	2	60	50	50	53	100	98	98	99	100	100	100	100	100	80	80	87	70	70	70	70
Betamix + Nortron	0.15+0.1	0	0	0	0	70	65	65	66	92	95	93	93	100	100	100	100	95	90	90	92	75	70	70	72
Betamix + Nortron	0.2+0.1	0	5	5	3	80	85	90	85	100	99	100	99	100	100	100	100	100	100	100	100	95	90	80	88
Betamix + Nortron	0.1+0.2	0	0	0	0	85	85	85	85	100	99	99	99	100	100	100	100	100	95	95	97	80	90	90	86
Betamix + Nortron	0.15+0.2	0	0	0	0	95	95	95	95	100	98	100	99	100	100	100	100	100	98	95	98	98	90	90	92
Betamix + Nortron	0.2+0.2	0	0	0	0	100	98	98	99	100	100	100	100	100	100	100	100	100	100	100	100	95	90	95	93
Betamix + Stinger + Poast	0.25+0.094+0.1	5	10	15	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + Stinger + Select	0.25+0.094+0.045	10	10	10	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + 66037 + Stinger	0.25+0.0156+0.094	5	15	10	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	80	93
Betamix + 66037 + Stinger	0.33+0.0156+0.094	10	15	10	12	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	80	95	90
Betamix + 66037 + Poast	0.25+0.0156+0.1	15	10	10	12	90	95	90	92	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
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 June 9

Ratings: 0 = no herbicide effect, 5-50 = 5 to 50 percent crop plant stunting, 51-100 = 5 to 50 percent crop plant loss, 100 = all plants killed.

Table 5. Crop tolerance to Prowl and Betamix/Prowl combinations applied to seedling sugar beets as postemergence applications. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Herbicides	Rate	Crop Injury				H. Nightshade				Pigweed				Lambsquarters				Kochia				A. Grasses			
	lbs ai/ac	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Betamix + Prowl	0.25+1.0	35	35	30	33	75	60	50	65	100	100	100	100	100	100	100	100	80	80	80	80	70	70	70	70
Betamix + Prowl	0.25+1.5	30	30	30	30	30	30	30	30	100	100	100	100	100	100	100	100	80	90	80	82	70	40	40	50
Betamix + Prowl	0.25+2.0	70	60	50	60	45	45	45	45	100	100	100	100	100	100	100	100	80	80	80	80	50	50	60	52
Betamix + Prowl	0.25+3.0	75	80	80	78	60	60	60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	90	90	92
Betamix + 66037 + Prowl	0.25+0.0156+1.0	25	25	20	23	70	70	70	70	100	100	100	100	100	100	100	100	100	100	100	100	100	85	80	88
Betamix + 66037 + Prowl	0.25+0.0156+1.5	65	50	60	58	75	60	45	64	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Betamix + 66037 + Prowl	0.25+0.0156+2.0	70	60	70	68	70	70	75	72	100	100	100	100	100	100	100	100	100	100	100	100	90	100	100	97
Betamix + Stinger + Prowl	0.25+0.1+1.0	30	20	25	25	99	99	99	99	100	100	100	100	100	100	100	100	80	80	80	80	95	75	75	85
Betamix + Stinger + Prowl	0.25+0.1+1.5	40	50	50	47	99	100	100	99	100	100	100	100	100	100	100	100	80	80	80	80	70	70	70	70
Betamix + Stinger + Prowl	0.25+0.1+2.0	75	60	60	65	98	98	100	99	100	100	100	100	100	100	100	100	100	95	100	98	98	98	90	95
Betamix + Poast + Prowl	0.25+0.1+1.0	20	25	30	25	75	75	70	73	100	100	100	100	100	100	100	100	95	100	80	92	100	100	100	100
Betamix + Poast + Prowl	0.25+0.1+1.5	25	35	25	28	25	70	70	55	100	100	100	100	100	100	100	100	100	90	90	92	100	100	100	100
Betamix + Poast + Prowl	0.25+0.1+2.0	60	40	30	43	70	70	70	70	100	100	100	100	100	100	100	100	90	90	90	90	100	100	100	100
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 June 9.

Ratings: 0 = no herbicide effect, 5-50 = 5 to 50 percent crop plant stunting, 51-100 = 5 to 50 percent crop plant stand loss, 100 = all plants killed.

Table 6. Percent crop injury and weed control ratings for DPX 66037 herbicide applied to seedling sugar beets as postemergence applications. Malheur Experiment Station Oregon State University, Ontario, Oregon, 1992.

Herbicides	Rate	Crop Injury				H. Nightshade				Pigweed				Lambsquarters				Kochia				A. Grasses			
	lbs ai/ac	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
66037 + Surfactant	0.0156	0	0	0	0	45	45	60	50	90	95	70	85	35	50	65	50	93	95	95	94	45	40	40	42
66037 + Betamix	0.0156+0.33	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	85	80	85	83
66037 + Stinger	0.0156+0.094	0	0	0	0	99	99	99	99	98	98	98	98	75	75	80	77	98	99	99	98	45	40	45	43
66037 + Betamix + Stinger	0.0156+0.33+0.094	10	10	10	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	90	93	90	91
66037 + Poast + COC	0.0156+0.20+1 qt	0	0	0	0	60	45	55	53	85	90	90	88	40	40	60	47	99	98	98	98	100	100	100	100
66037 + Assure + COC	0.0156+0.0875+1% v/v	0	0	0	0	40	45	40	42	90	80	90	87	20	25	60	35	85	85	85	85	99	90	99	96
Betamix + Poast	0.25+0.1	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
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 June 9.
Ratings: 0 = no herbicide effect, 5-50 = 5 to 50 percent crop plant stunting, 51-100 = 5 to 50 percent crop plant loss, 100 = all plants killed.

Table 7. Seedling sugar beet tolerance to Betamix/Nortron formulated materials applied as postemergence applications to seedling sugar beets. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Herbicides	Rate	Crop Injury				H. Nightshade				Lambsquarters				Pigweed				Kochia				A. Grasses			
	lbs ai/ac	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Betamix CP 211	0.19	0	0	0	0	88	85	88	87	95	90	95	93	85	90	90	88	80	80	75	78	60	50	55	55
Betamix CP 211	.030	0	0	0	0	95	93	90	93	100	100	100	100	99	97	99	98	93	90	95	93	80	70	75	75
NA 307	0.28	0	0	0	0	99	100	98	99	100	100	100	100	100	98	100	99	98	96	98	97	85	80	80	82
NA 307	0.45	20	25	20	22	100	100	98	99	100	98	100	99	100	100	100	100	99	99	98	98	90	95	90	92
NA 308	0.28	0	0	0	0	99	100	98	99	100	100	100	100	100	100	100	100	99	100	98	99	90	85	85	86
NA 308	0.45	25	30	25	27	100	100	98	99	100	100	100	100	100	99	100	99	100	100	98	99	90	85	85	86
Betamix + Nortron 50SC	0.19+0.1	5	5	0	3	95	95	93	94	100	100	100	100	100	98	100	99	100	100	96	99	85	85	85	85
Betamix + Nortron 50SC	0.30+0.15	5	10	5	7	100	98	100	99	100	100	100	100	100	100	99	99	98	98	98	98	80	85	85	83
Betamix + Nortron 50SC + Poast	0.15+0.25+0.1	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	98	99	100	100	100	100
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 June 9.
Ratings: 0 = no effect, 5-50 = percent crop stunting, 51-100 = 5 to 50 percent crop plant loss, 100 = all plants killed.

IMPROVED IRRIGATION EFFICIENCY AND EROSION PROTECTION BY MECHANICAL FURROW MULCHING SUGAR BEETS

C.C. Shock, J. Hobson, J. Banner, L.D. Saunders and B. Townley
Malheur Experiment Station
Oregon State University,
Hobson Manufacturing Inc.
Ontario, Oregon, 1992

Summary

Sugar beet yield, quality, and recoverable sugar were measured for the HM-PM9 sugar beets grown on a Nyssa silt loam soil at 3 percent slope, with and without mechanically applied wheat straw mulch in irrigation furrows. Water inflow, outflow, and sediment loss were measured over time on each of 24 plots for all thirteen irrigations. Infiltration was calculated, and irrigation durations were managed so that total water infiltration would be the same in strawed and non-strawed sugar beets. Runoff water and sediment from each plot were independently analyzed for nitrate, ammonium, total N, phosphate, and total P during one irrigation. Irrigation efficiency increased with furrow mulching. Mechanically applied straw mulch increased the beet yield by 2.5 t/ac and recoverable sugar by 866 lb/ac. Furrow mulching decreased the loss of sediment from 78.8 to 6.7 tons per acre, decreased estimated total P loss from 133 to 12 lb/ac, and decreased total estimated N loss from 334 to 75 lb/ac. Most N losses were in the form of organic N, and most P losses were in the form of insoluble P in the sediment.

Introduction

This study sought to measure the potential of mechanically applied wheat straw mulch to reduce nutrient, pesticide, and sediment losses from furrow irrigated sugar beets, and increase water use efficiency. Water shortages over the last six years have increased awareness of the importance of conserving water through increased irrigation efficiency. Nitrogen and phosphorus losses were of particular interest, both because of their economic importance as farm inputs, and their roles as environmental contaminants.

Measured losses of phosphorus included phosphate-P dissolved in runoff water, phosphate-P present in the sediment, and total P in the sediment. Measured nitrogen losses included ammonium and nitrate, both in runoff and in the sediment, and total reduced N in the sediment.

Methods

Sugar beet (Beta vulgaris variety HM-PM9) seed was planted in rows 22 inches apart, with one seed every 1.9 inches in the row, on April 1, 1992. The Nyssa silt loam with 3 percent slope had received 0, 100, and 400 lb P_2O_5/ac in the form of triple superphosphate before planting. Treatments consisted of two wheat straw mulch rates, 0 and 800 lb/ac, each with three rates of applied phosphate in a complete factorial design with four replicates. Straw mulch was applied to the full length of irrigation furrows (furrow-mulching) using a Hobson Mechanical Straw Mulch Applicator. The site was located at the Malheur Experiment Station, OSU, Ontario, Oregon, and followed exactly on top of identical phosphate and mechanical straw mulch treatments for potatoes in 1990, and onions in 1991. Soil was sampled to 4 feet in 1-foot increments in the fall of 1991 before planting and in the fall of 1992 after harvest, and analyzed for nitrate-N, ammonium-N, and phosphate -P. Sugar beets were sidedressed with 100 lb N/ac as urea on May 19.

Half of the straw was applied to the furrow bottoms prior to the first irrigation on May 4, and half of the straw was applied after cultivations and lay bye prior to the third irrigation on May 23. Sugar beets were thinned to one plant for every 6 to 7 inches of row. Irrigation furrows were 235 feet long and all furrows of all plots received 13 irrigations during the season, with water inflow in each furrow set at 120 gal/h. Crop evapotranspiration (ET_c) was calculated by an Agrimet weather station at the experimental site. All irrigation furrows were front wheel tracks of a John Deere 2040 tractor. Irrigation duration in furrows with and without mulch depended on the anticipated time necessary to meet ET_c. Estimated irrigation duration was based on the accumulated ET_c in the crop to date (less infiltration and rainfall), and the rate of water infiltration of the previous irrigation for each treatment.

Weeds were controlled using 1.875 lb ai/ac Nortron preplant on March 30, a post-emergence mixture of 25 oz/ac Poast and 2.5 oz/ac Stinger on April 20, and a lay bye treatment of one pint Treflan per acre on May 21. Mildew was controlled by aerial spraying of 8 oz/ac Bayleton July 24, and sulfur on July 27.

Water and Sediment Measurement

Onset of inflow and outflow, and hourly measurements of inflow, outflow, and sediment yield were recorded for every irrigation. For each water outflow rate reading, a one liter sample of the runoff was placed in an Imhoff cone and allowed to settle for 15 minutes. Sediment content in the water, (y in g per liter) was found to be related to the Imhoff cone reading after 15 minutes (x) by the empirical equation

$$y = 1.015x \quad r^2 = 0.98 \quad P < 0.0001.$$

Composite water samples were collected in 20-liter buckets to obtain sediment samples for nutrient analysis during one irrigation. Sediment was analyzed for nitrate-N, ammonium-N, total N, phosphate-P, and total P. Total inflow, outflow, infiltration, and sediment loss were integrated from hourly measurements using the LOTUS 1-2-3 software program, InfilCal 4.0 (Shock and Shock).

During one irrigation, hourly inflow water samples and hourly outflow water samples were collected from every plot. The collection time of the water was recorded, and composite water samples were made in proportion to the sample represented in the water inflow or outflow calculated by using InfilCal 4.0. Composite water samples were analyzed for nitrate-N, ammonium-N, and phosphate-P. Net nutrient losses of N and P were calculated by comparing the nutrient content in inflow water with the nutrient content in the outflow, plus sediment. Average nutrient concentrations from the single sampled irrigation were used to estimate the nutrient concentrations in the other twelve irrigations where no water or sediment samples were collected for analysis.

Ten beets were sampled October 21 from each plot, and they were evaluated for leaf, crown, and beet fresh weight, dry weights, N content, and P content. Beets were topped October 22 and dug October 23. For the middle 50 feet of each of the two middle rows, beet stand was counted, beets were dug and weighed, and a subsample of seven beets was analyzed for sugar content, conductivity, and nitrate-N. The percent extraction and total recoverable sugar was calculated based on the industry's empirical formulas.

Results and Discussion

During the first irrigation, greater lateral movement of water was evident in mulched furrows. Splitting the application of straw mulch allowed cultivation for weed control. Pronounced differences in sediment yield continued throughout the season. Mechanical furrow mulching decreased runoff, increased infiltration, increased irrigation efficiency, and decreased sediment yield (Table 1). Water infiltration in plots with and without furrow mulch was managed to match the crop's evapotranspiration water requirement.

Furrow mulching increased sugar beet yield and recoverable sugar (Table 2). Lower economic responses would be expected on a less erodible site, but greater economic responses would occur if the producer had limited irrigation water supplies.

Phosphate-P additions in the irrigation water amounted to 1.94 lb P/ac in the check plots compared with 1.25 lb P/ac in the furrow mulched plots because 36 percent less water was applied. Net phosphate-P losses were 3.6 lb P/ac from the non-strawed plots and 0.03 lb P/ac from the strawed plots. Net phosphorus losses in the runoff were estimated to be 131.5 lb P/ac from non-mulched plots, and 10.6 lb P/ac from the furrow mulched plots averaged over all levels of applied phosphate (Table 3). Straw mulch reduced the losses of dissolved and soluble phosphate-P and insoluble-P lost in the sediment. The large difference in P losses was composed mostly of insoluble P in the sediment.

Because nitrate and ammonium content of the irrigation water, 4.6 and 2.0 ppm N respectively, the irrigation water was estimated to add 142.3 lb N/ac in the check plots and 91.2 lb N/ac in the furrow mulched plots, (Table 4). Less N was contributed by irrigation in the furrow mulched plots because less water was used. Furrow mulching reduced organic nitrogen losses in the sediment by 89.8 percent. Losses of nitrate-N and ammonium-N, were reduced by furrow mulching. Total nitrogen loss was reduced from 333.5 lb N/ac to 74.6 lb N/ac.

Sediment, phosphorus, and nitrogen losses were particularly large for sugar beets grown on this site. Sediment and nutrient losses may be very high without furrow-mulching because the sugar beet plant presents little in the way of roots or leaves to interfere with erosive processes, especially early in the season.

Phosphate applications increased beet yield (93 percent confidence level) and recoverable sugar (81 percent confidence level) only at the 100 lb rate. Phosphate applications increased phosphate-P losses dissolved in the water and phosphate-P present on the sediment, particularly at the high rate of applied phosphate without furrow mulching (Table 5).

Conclusions

Irrigation efficiency was greatly increased by furrow mulching. Beet tonnage and recoverable sugar increased with straw mulch. Mechanically applied straw mulch at 800 lb/ac decreased sediment yield by 91.5 percent. Large losses of sediment, nitrogen, and phosphorus occurred with the production of sugar beets under furrow irrigation without mulch on a three percent slope. Most of the phosphorus lost was in the form of insoluble phosphorus in the sediment. Most of the nitrogen lost was in the form of soil organic material in the sediment. High levels of applied phosphate aggravated losses of phosphate in the water and on the sediment.

Table 1. Furrow irrigations, water infiltration, potential consumptive water use, and soil loss with and without wheat straw furrow mulching. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Furrow mulch	# of irrigations	Total irrigation duration	Water applied	Water infiltration	Irrigation efficiency	ET_c from May 6 to October 14	ET_c Deficit as of October 14[1]	Sediment loss
lb/ac		hrs	ac-in	ac-in	%	in	in	t/ac
None	13	425	95.97	32.38	33.7	40.83	6.39	78.8
800	13	266	61.51	32.37	52.5	40.83	6.40	6.7
LSD (0.05)	--	--	1.73	ns	2.2	--	--	6.6

[1] Taking into account 2.06 inches of rainfall.

Table 2. Performance of sugar beets on bench ground with and without furrow mulching. Beets were irrigated so that mulched and non-mulched beets had similar and adequate water for growth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Furrow mulch	Beet yield	Sugar	Conductivity	Extraction	Recoverable sugar
lb/ac	t/ac	%		%	lb/ac
none	41.7	16.2	.783	85.6	11,593
800	44.1	16.4	.738	86.2	12,458
LSD (0.05)	1.9	ns	ns	ns	682

Table 3. Average phosphorus accumulations and losses in furrow irrigated sugar beets with and without furrow mulching. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Furrow mulch	Runoff water phosphate-P	Sediment phosphate-P	Irrigation water phosphate-P	Net loss phos-P	Sediment insoluble -P	Total P lost	Net P lost
lb/ac	-----------------------			lb P/ac	-----------------------		
none	1.9	3.6	1.9	3.6	127.9	133.4	131.5
800	1.1	0.2	1.3	0.03	10.5	11.9	10.6
LSD (0.05)	0.4	0.5	-	-	-	14.1	-

Table 4. Surface nitrate accumulations and losses in furrow irrigated sugar beets with and without furrow mulching. Malheur Experiment Station, Oregon State University, Ontario, Oregon 1992.

Furrow mulch	Runoff water		Sediment			Total N lost	Irrigation water		Net N lost
	nitrate	ammonium	nitrate	ammonium	other reduced N		nitrate	ammonium	
lb/ac	-----------------------				lb N/ac	-----------------------			
0	81.3	26.3	1.3	0.5	224.1	333.5	99.1	43.2	191.2
800	37.8	13.6	0.2	0.1	22.9	74.6	63.5	27.7	none†
LSD (0.05)	6.7	3.6	0.1	0.2	38.8	48.5	-	-	-

† 16.6 lb N/ac net accumulation

Table 5. Influence of applied phosphate and furrow mulching on sugar beet productivity and phosphate losses in runoff water and in sediment lost. Malheur Experiment Station, Oregon State University, Ontario, Oregon 1992.

Treatment		Sugar beet yield		Phosphate losses	
Furrow mulch	Phosphate fertilization	Beets	Recoverable sugar	In the runoff	In the sediment
lb/ac	lb/ac	t/ac	lb/ac	lb/ac	lb/ac
None	0	40.2	10932	1.8	3.0
	100	42.8	11955	1.5	3.4
	400	42.0	11891	3.2	5.6
	Average	41.7	11593	2.2	4.0
800	0	43.2	12315	0.9	0.3
	100	46.1	12816	1.2	0.2
	400	43.2	12244	1.4	0.3
	Average	44.1	12458	1.2	0.3
Mean	0	41.7	11623	1.4	1.6
	100	44.4	12385	1.3	1.8
	400	42.6	12068	2.3	2.9
LSD (0.05) straw		1.9	682	0.4	0.5
LSD (0.05) phos		(7%)	(19%)	0.5	0.6
LSD (0.05) straw x phos		ns	ns	0.7	0.8

SUGAR BEET PERFORMANCE AND NITROGEN RECOVERY FOLLOWING ONIONS

Clinton E. Shock, John G. Miller,
Lamont D. Saunders, and Tim D. Stieber
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Objectives

Describe the performance of HM-PM9 sugar beets supplied with only residual nitrate and ammonium following onions and from other natural occurring nitrogen sources. Improve the nitrogen fertilizer efficiency on sugar beets by understanding nitrogen sources. Develop guidelines to help growers utilize the ability of sugar beets to extract topsoil and subsoil nitrogen sources, thereby substituting for costly fertilizer nitrogen, reducing nitrate leaching loss through the soil profile, and improving groundwater quality. Describe a nitrogen balance sheet approach that will allow beet growers to avoid high nitrate in their beets and factory discounts.

Introduction

Sugar beets are a deep rooted crop with well-recognized ability to scavenge the soil profile for residual available soil nitrogen. When sugar beets are grown in rotation with shallow rooted crops such as onions and potatoes, or after nitrogen fixing crops such as alfalfa, sugar beet N fertilizer requirements may be lower than otherwise expected.

The application of unnecessary nitrogen fertilizer to sugar beets is disadvantageous to the beet grower and to the beet processing factory. Sugar beets with extra nitrogen supplies accumulate nitrate and ammonium compounds that interfere with the extraction and purification of sugar. Growers have price incentives for low nitrate beets and penalties for high nitrate beets.

Three trials over a two year period tested the idea that sugar beets might not need much if any nitrogen fertilizer following heavily fertilized onions. A nitrogen budget approach was investigated to evaluate expected nitrogen supplies to sugar beet plants.

Procedures

Three sugar beet trials followed sweet spanish onion nitrogen fertility trials where the onions had been fertilized with 0, 50, 100, 200, or 400 lb N/ac as broadcast, sidedressed, or split-sidedressed urea-based nitrogen fertilizers. Onions had been preceded by unfertilized winter wheat in an attempt to even out field fertility differences before planting onions. Sugar beets (cv HM-PM9) were planted on an Owyhee silt loam that grades into a Greenleaf silt loam April 3, 1991, on a Nyssa silt loam bench ground April 7, 1992, and on Owyhee silt loam bottom ground April 2, 1992.

Following onions, the soil was sampled during November of 1990 and 1991 in every plot in 1 foot increments to 6 feet deep. Each soil sample for the top foot of soil consisted of a composite of 20 subsamples while the sample for each subsequent foot of soil consisted of a composite of four soil cores made with a Giddings hydraulic soil probe. Every composite soil sample from each plot was analyzed for nitrate-N and ammonium-N. Nitrate and ammonium analytical data was converted to lb available-N/acre using the soil volume and bulk density.

Beets both years received Counter 15 G at 12 lbs per acre before emergence for insect control. In 1992, beets were sprayed with 3 pints of MSR for black bean aphid control. Beets were sprayed separately with Bayleton and sulfur for mildew control both years. Weed control utilized standard commercial herbicides. Beets both years were dug in late October. Two beet samples, consisting of seven typical beets from each plot, were analyzed for sucrose, pulp nitrate, and conductivity.

The day before beet harvest, 10 beets from each plot were dug by hand, washed, and separated into leaves, crown, and beets. The leaves and crowns were weighed fresh, dried, weighed, ground, and analyzed for Kjeldahl N. The beets were weighed, shredded, subsampled, the subsample weighed, dried, weighed again, ground, and analyzed for Kjeldahl N.

Following the sugar beet harvest, the soil in the middle of each plot was sampled and analyzed in exactly the same way that it had been following onions the previous fall.

Results and Discussion

Weather conditions were ideal for early rapid beet development in April and May both years. Beet stand averaged 36,500 plants per acre in 1991 and 40,700 plants per acre in 1992. In 1992, numerous individual plants showed symptoms of curly top virus.

Following onions, the average total residual nitrate and ammonium in the soil profile to 6 feet ranged from 169 to 472 lb N/ac, depending on the rate of urea-based nitrogen fertilizer applied to the onions (Table 1). Beet yields, beet pulp nitrate, and pulp conductivity increased with increasing residual available nitrogen (Table 2). Beet sucrose and estimated percent extraction decreased with increasing residual available nitrogen. Recoverable sugar was greatest (14,264 lb/ac) for unfertilized beets following onions receiving 200 lbs N/acre.

Beet plants grown following onions accumulated large amounts of nitrogen in their leaves, crowns, and beets despite no fertilization during the sugar beet production year (Table 3). Sugar beets following onions with 200 lbs N/ac accumulated a total of 320 lbs N/ac: 88, 36, and 192 lbs N/ac respectively in their leaves, crowns, and beets at harvest time. This nitrogen uptake of 320 lbs N/ac for a harvest yield averaging 45.7 tons/ac corresponded to 7.07 lbs of plant N uptake per ton of harvested beets. Plant nitrogen recovery averaged consistently much greater than analyses of available N in the top three feet of the soil profile (Table 4). By construction of an average nitrogen budget for unfertilized sugar beets following onions that received 200 lbs

N/ac, we expect to need 320 lbs N/ac in the beet crop in order to realize yields of 40 tons/ac. The 320 lbs N/ac nitrogen requirement is based on the notion that beet plants need to contain about 8 lbs N per ton of beets eventually harvested. The nitrogen available from the soil and water, including the top three feet of the soil profile, averaged 252 lbs N/ac based on the following: 80 lb N/ac as nitrate; 53 lb N/ac as ammonium; 65 lb N/ac available to the plants from organic matter mineralization, using a mineralization coefficient of 50 due to the long season and average 1.3 percent soil organic matter; 40 lb N in the irrigation water; and 15 lbs N/ac released from the over 30 lbs N/ac incorporated into the soil in the form of onion tops. The nitrogen budget (Table 5) suggests that 67 lbs of fertilizer nitrogen was needed for sugar beet production following onions fertilized with 200 lbs of urea fertilizer. Indeed these beets recovered an average of 320 lbs N/ac and produced 45.7 tons per acre with 14,264 lbs of recoverable sugar. The nitrogen budget underestimated the amount of N available and no fertilizer N was required.

Through the use of a nitrogen budget approach, growers may be able to make efficient use of soil and water nitrogen sources, thereby reducing N fertilizer costs and optimizing beet yields and quality. Beets with the highest yields of recoverable sugar also averaged only 190 ppm pulp nitrate content. Errors in underestimating nitrogen supplies can be guarded against by routine petiole nitrate sampling.

Table 1. Average available N in the form of nitrate and ammonium in the fall preceding sugar beets following onions fertilized with 0 to 400 lbs N/acre. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

	N rate on preceding onions, lb N/ac					
Soil depth increment	0	50	100	200	400	LSD(0.05)
feet	lb N/ac					
0-1	44.0	71.6	69.6	67.6	105.6	-
1-2	23.1	30.8	31.7	32.9	63.2	-
2-3	21.0	37.3	28.8	32.1	69.2	-
3-4	27.7	41.5	40.1	42.9	94.9	-
4-5	26.0	39.1	40.1	40.5	73.7	-
5-6	27.5	46.9	37.4	42.9	65.9	-
0-6	169.3	267.2	247.7	259.0	472.5	51.7

Table 2. Yield and quality of unfertilized HM-PM9 sugar beets following sweet spanish onions fertilized with 0, 50, 100, 200, and 400 lb N/ac. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Sugar beet performance, units	N rate on preceding onions, lb N/ac					
	0	50	100	200	400	LSD(0.05)
Beet yield, t/ac	39.0	40.9	42.6	45.7	46.8	2.7
Sucrose, %	17.6	16.9	16.8	16.9	15.4	0.3
Pulp nitrate, ppm	85	176	196	190	509	66
Conductivity, μ mhos	646	718	716	709	864	37
Extraction, %	87.6	86.5	86.5	86.6	84.3	0.5
Recoverable sugar, lb/ac	12777	12743	13232	14264	13188	811

Table 3. Nitrogen content and uptake by unfertilized HM-PM9 sugar beets following sweet spanish onions fertilized with 0, 50, 100, 200, or 400 lb N/ac. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Sugar beet performance, units	N rate on preceding onions, lb N/ac					
	0	50	100	200	400	LSD(0.05)
Nitrogen content	---------- % ----------					
Leaves	2.10	2.00	2.18	2.19	2.70	0.18
Crown	1.42	1.67	1.66	1.77	2.18	0.30
Beet	0.74	0.84	0.81	0.87	1.12	0.12
Dry matter	---------- lb/ac ----------					
Leaves	2891	3596	3517	3960	5446	1466
Crown	1885	1520	1756	2157	1979	300
Beet	20729	20793	21583	23247	22544	548
Total	25505	25909	26856	29364	29969	1883
Nitrogen recovery	---------- lb/ac ----------					
Leaves	64	72	78	88	145	25
Crown	26	24	28	36	42	6
Beet	155	173	174	196	239	14
Total	245	269	280	320	426	36
Plant N	---- lb N per ton of beets ----					
	6.30	6.59	6.57	7.07	9.32	0.71

Table 4. Comparison of nitrate and ammonium in the top three feet of soil and sugar beet nitrogen recovery. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Available N, 0-3 feet and plant uptake		N rate on preceding onions, lb N/ac					
		0	50	100	200	400	LSD(0.05)
		lb N/ac					
Soil	Nitrate	42.	78.	77.	80.	189.	33
	Ammonium	46.	62.	53.	53.	49.	(7%)
	Total	88.	140.	130.	133.	238.	(9%)
Plant N recovery		245	269	280	320	426	36

Table 5. Average nitrogen budget for unfertilized HM-PM9 sugar beets grown in three fields following onions that had received 200 lb N/ac as urea. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Nitrogen budget	- - - lb N/ac - - -
A. Estimated crop N requirement 40 tons/ac x 8 lb N/ton	320
B. Estimated soil and water nitrogen supply	
1. Nitrate in soil 0-3'	80
2. Ammonium in soil 0-3'	53
3. Expected N mineralization	65
4. N in irrigation water	40
5. Manure or organic fertilization	0
6. Crop residue breakdown	15
Total N supply (sum B1 through B5)	253
C. N chemical fertilizer requirement; estimated requirement (a) minus the total soil and water nitrogen supply (B)	67
D. Actual plant N content at harvest 45.7 tons/ac x 7.07 lb plant N/ton	320

RESPONSE OF SEVERAL SUGAR BEET CULTIVARS TO N FERTILIZATION: YIELD, QUALITY, AND NITROGEN RECOVERY

Charles E. Stanger and Joey Ishida
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Purpose

The level of nitrogen available affects sugar beet (Beta vulgaries) quality, sucrose production, and amount of low quality crown tissue produced. The response of several sugar beet cultivars to N fertilization was studied in 1990, 1991, and 1992 to determine: 1) what level of available N was needed by each cultivar to maximize sucrose production; 2) if each cultivar would respond similarly to N fertilization; 3) if crown tissue production varies with cultivar; and 4) percent of available soil nitrogen recovered by sugar beet cultivars. The 1992 study is the final year of a three-year study to complete the evaluation of the above listed parameters.

Methods and Materials

The study was continued during 1992 on a Owyhee silt loam soil at the Malheur Experiment Station. Sugar beet cultivars were WS-PM9, WS-91, WS-41, American Crystal 203, and Betaseeds 8450 and 8428. Curly-top virus carrying leafhoppers infected the area and three of the six sugar beet cultivars were severely damaged by curly top disease. The data tables include root yield and quality results for all six cultivars, but only results from WS-PM9, WS-91, and American Crystal 203 will be discussed for nitrogen recovery and utilization because these cultivars were resistant to curly-top virus.

Each year a budget N fertilizer rate, needed to maximize sucrose production, was estimated based on soil test data from soil samples collected in March before planting. Nitrogen requirement for a 40-ton crop was estimated to be 320 lbs. The residual soil N plus 100 pounds of added N was considered to be the optimum amount, or the budget rate to produce a 40-ton root crop. Soil samples were taken at 1 foot increments to a depth of 6 feet. A total of 12 soil samples were taken at random locations within the trial area to determine nitrogen need. Nine individual holes were dug per sample, using a drill bit and power driven drill. Additional soil samples were taken at 1 and 2 foot depths, and analyzed for mineralizable nitrogen. Post-harvest soil samples at 1 foot increments were taken to 6 foot depths from individual treatment plots to determine amount of available nitrogen left in the soil following the growing season.

A split-plot design was used with N rates as main plots and sugar beet cultivars as subplots, with six replications. Plot size was 7.5 x 25 feet. Adequate levels of soil P and K were present for sugar beet production with sodium bicarbonate extractable P levels > 35 ppm, and ammonium acetate extractable K levels > 500 ppm in the first 1 foot of soil. The sugar beets were seeded on 22 April, and thinned to average plant population of 35,704 per acre. All plots were furrow irrigated to maintain adequate soil moisture. The sugar beets were irrigated in furrows on each side of every row. The plots receiving added N were sidedressed with ammonium sulfate on June 6. Three N rates (0, 100, and 200 lbs N/ac) of ammonium sulfate were applied 6 inches to the side of the planted rows and 4 inches deep. Sampling of petioles from each plot was begun on June 17 and continued at two week intervals until October 12. Petioles were sampled from the same row of each four row plot all season. The rows harvested for yield and quality data were not sampled or walked into during petiole sampling. Two 25 foot rows were machine harvested from each plot on October 15-16. Two samples of eight sugar beets per sample were taken from each plot and analyzed at "The Amalgamated Sugar Company" tare lab at Nyssa, Oregon for percent sucrose, conductivity, and root nitrates. Percent extraction and estimated recoverable sugar/acre were calculated. Five sugar beet plants (tops, crown, and roots) were hand-harvested from WS-PM9, WS-91, and AC-203. Total plant N, and N used for sugar beet growth was calculated for each sugar beet cultivar at each rate of added nitrogen.

The total amount of nitrogen recovered by the sugar beet cultivars was subtracted from the total amount of nitrogen available to determine sugar beet efficiency in extracting available nitrogen in the soil profile. Data was collected to determine cultivar response to added nitrogen for root yield, percent sucrose, root nitrogen, conductivity, percent extraction, sugar yield, and N content of roots, crowns, and tops. Standard statistical procedures were used to analyze the data at the 95 percent confidence level. All L.S.D. values are expressed at the 5 percent probability level.

Results and Discussion

Recoverable sugar production was maximum for each cultivar at the budget rate of 100 lb N (Table 1). Additional N reduced recoverable sugar production by lowering root yield, percent sucrose, and percent extraction. Additional nitrogen also reduced root quality by increasing both conductivity and concentration of root nitrates (Table 1). Curly-top injury drastically reduced root yields of cultivars WS-41, Beta 8450, and Beta 8428. Root yields of AC-203 also appeared somewhat reduced by curly-top injury when compared to 1991 root yields for these cultivars when curly-top virus infection was not a factor. Curly-top did not lower root quality by affecting percent sucrose, conductivity, or root nitrate concentrations.

As N rate increased, the percentage of each whole beet consisting of crown tissue and top foliage increased linearly for each cultivar (Table 3). Cultivars differed, but not significantly among each other in crown and leaf tissue percentage. In general, the relative order of crown tissue production for each cultivar increased linearly and significantly with each increment of added nitrogen. Crown tissue from sugar beets treated with 200 lbs added N amounted to 12 percent of the total fresh weight of the sugar beet roots. This was about 5 percent more production of low quality crown tissue on these beet roots than on roots produced without the addition of excessive nitrogen. Significant interactions between nitrogen x cultivars did not occur. Analysis indicated that the effect N has on reducing sucrose content and percent extraction does not overcome the advantage received from increasing root yield with additional N applications.

Significant differences occurred ppm NO_3-N in petioles for all cultivars at different rates of nitrogen added by sidedressed applications (Table 2). Petiole nitrogen readings were significantly lower for the three cultivars (WS-41, Betaseed 8450, and Betaseed 8428) injured by curly-top virus. Results of this study indicate that optimum sugar yields can be produced when petiole NO_3-N readings are much lower than petiole NO_3-N readings recommended to growers by petiole fertilizer guides. Sugar beets are excellent foragers for soil nutrients, and nitrogen for root growth takes precedence over top growth when nitrogen supply is not abundant. Good root yields with excellent root quality were obtained in this study without nitrogen being added. The sources of nitrogen coming from residual nitrogen in the soil and nitrogen made available by soil mineralization were adequate. Sugar beets extract nitrogen at low concentrations from the soil and efficiently utilize it in the production of a high yielding, high quality sugar crop.

Table 1. Gross sucrose yield, whole root yield, sucrose content, conductivity, root nitrates percent extraction, and curly-top injury ratings for six sugar beet cultivars as affected by rate of N applied. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

N added	WS-PM9	WS-91	WS-41	Beta 8450	Beta 8428	AC-203
lbs/ac	- - - - - - - - - - Gross Sugar Yield (lbs/acre) - - - - - - - - - -					
0	13,158	14,582	7,432	8,222	7,642	10,394
100	14,564	14,988	7,028	10,184	7,812	12,774
200	13,590	13,094	6,078	8,896	7,314	10,274
LSD .05	N mean = 744					
	Whole root yield (tons/ac) and curly-top injury rating (1-10) 10 = most severe					
0	41.4 (3.1)	44.9 (2.9)	23.8 (6.6)	25.1 (6.2)	23.8 (6.0)	32.3 (5.6)
100	45.8 (2.9)	46.6 (2.8)	22.5 (6.3)	31.8 (5.8)	24.5 (5.8)	40.0 (5.2)
200	43.8 (3.0)	42.2 (2.8)	19.9 (6.1)	29.0 (5.6)	23.3 (5.5)	32.8 (4.9)
LSD .05	N mean = 2.6					
	- - - - - - - - - - Sucrose (%) - - - - - - - - - -					
0	18.02	18.46	17.74	18.63	18.27	18.21
100	18.01	18.42	17.74	18.30	18.20	18.20
200	17.82	17.90	17.39	17.73	17.99	17.76
LSD .05	N mean = 0.23					
	- - - - - - - - - - Extraction (%) - - - - - - - - - -					
0	88.26	88.02	88.23	88.20	87.84	88.47
100	88.35	87.46	88.13	87.40	87.81	87.81
200	87.57	86.79	87.4	86.76	87.22	87.69
LSD .05	N mean = 0.38					
	- - - - - - - - - - Conductivity (Mohms) - - - - - - - - - -					
0	512	536	510	525	548	498
100	503	580	518	583	550	550
200	563	625	570	625	593	530
LSD .05	N mean = 42					
	- - - - - - - - - - Root nitrates (ppm) - - - - - - - - - -					
0	63	61	64	59	66	61
100	65	81	71	68	69	69
200	91	106	99	140	110	94
LSD .05	N mean = 16					

Table 2. Petiole NO_3-N readings for six sugar beet varieties and three rates of sidedressed nitrogen. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Variety	Sidedressed N	17 June	1 July	15 July	29 July	12 Aug	26 Aug	11 Sept	23 Sept	12 Oct
WS-PM9	0	2492	472	72	75	88	115	61	67	52
	100	9317	4233	900	154	209	164	87	78	41
	200	9667	7033	3673	1628	730	647	333	276	185
	Mean	7158	3913	1548	619	343	308	161	140	93
	LSD .05	1746	1740	1450	735	417	468	197	115	160
	CV (%)	7.7	14.1	29.7	37.7	38.6	48	38	26	54
WS-91	0	2717	773	133	128	175	199	93	101	50
	100	7467	3133	737	167	158	217	192	171	68
	200	7450	4708	3342	1445	675	715	487	520	244
	Mean	5878	2872	1404	580	336	377	257	264	121
	LSD .05	1225	1747	1452	504	126	197	158	209	103
	CV (%)	6.6	19.3	32.8	2705	11.9	16.5	19.4	25.2	27.1
WS-41	0	1553	302	45	82	69	93	68	53	34
	100	3950	2567	620	170	113	227	139	93	59
	200	3283	4417	2238	1133	395	493	224	103	51
	Mean	2929	2428	968	462	192	271	144	83	48
	LSD .05	1399	2247	1644	687	73	272	163	59	29
	CV (%)	15.1	29.4	53.9	47.2	11.9	31.9	35.9	22.5	19.4
Betaseed 8450	0	1917	397	38	57	76	206	92	76	36
	100	4517	2268	355	185	177	368	129	129	78
	200	6050	6150	3138	1397	472	552	264	129	114
	Mean	4161	2938	1177	546	242	375	161	112	75
	LSD .05	1202	1728	1366	574	236	351	199	104	90
	CV (%)	9.1	18.6	35.4	33.4	31.0	29.7	39.1	29.8	37.6
Betaseed 8428	0	2192	650	73	75	76	65	44	58	31
	100	4550	3233	977	372	149	104	97	73	33
	200	5133	4383	2335	1422	767	455	230	104	76
	Mean	3958	2756	1128	622	330	208	124	78	47
	LSD .05	1592	1784	1414	623	345	158	128	57	24
	CV (%)	12.7	20.5	39.7	31.7	33.2	24.1	32.9	23	16.6
A. Crystal 203	0	3300	372	52	76	86	91	45	54	38
	100	4667	2370	363	114	78	83	49	92	49
	200	6733	4142	2374	1168	843	469	304	191	111
	Mean	4900	2294	929	452	335	214	133	112	66
	LSD .05	2432	1802	1510	643	502	398	357	148	105
	CV (%)	15.7	24.9	51.5	45.0	47.5	58.9	85.5	41.6	50.7
Mean		4831	2867	1192	547	296	292	163	132	75
LSD .05		1565	1545	1313	586	294	315	201	116	88
CV (%)		11.5	19.2	39.1	38.1	35.2	38	44	31	42

Sidedressed on June 6, 1992.

Table 3. Pounds of nitrogen per acre in tops, crowns, and roots from three sugar beet varieties sidedressed with three nitrogen rates. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Sidedressed Nitrogen	Plant Tissue	WS-PM9	WS-91	AC 203	WS-PM9	WS-91	AC 203
		- - - - lbs Nitrogen/ac - - - -			Percent of whole plant		
		lbs	lbs	lbs	%	%	%
0	Tops	53.33	39.84	52.01	19.3	16.8	20.0
	Crown	35.26	44.10	39.36	5.4	5.7	5.7
	Roots	139.40	133.60	100.20	75.3	77.4	74.3
	Total	228.00	217.50	190.40	---	---	---
100	Tops	75.58	72.96	49.38	20.8	21.4	25.4
	Crown	57.91	45.61	61.22	6.21	7.2	6.1
	Roots	161.40	156.00	124.50	73.0	71.5	68.5
	Total	294.80	274.60	229.10	---	---	---
200	Tops	108.50	94.14	79.49	22.1	27.4	29.5
	Crown	73.54	51.40	52.90	6.8	8.7	7.6
	Roots	184.20	160.30	138.90	71.2	63.9	62.9
	Total	366.30	305.80	270.30	---	---	---
Means	Tops - 69.47	LSD .05	Tops - 27.34	CV (%)	Tops - 13.48		
	Crown - 51.25		Crown - 13.85		Crown - 9.25		
	Roots - 144.3		Roots - 33.1		Roots - 7.8		
	Total - 264.2		Total - 57.7		Total - 7.4		

Table 4. Nitrogen uptake per unit of sugar beet root yield at harvest for three varieties and three rates of sidedressed nitrogen. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Sidedressed	Root Yield			Lbs N/A Utilized by sugar beet plants			Pounds Nitrogen per ton root yield		
Nitrogen	WS-PM9	WS-91	AC 203	WS-PM9	WS-91	AC 203	WS-PM9	WS-91	AC 203
lbs/ac									
0	41.4	44.9	32.3	229	218	193	5.53	4.86	5.98
100	45.8	46.6	40.0	296	275	237	6.46	5.90	5.93
200	43.8	42.2	32.8	368	308	272	8.40	7.30	8.29
LSD .05		2.6			144			1.67	

Table 5. The efficiency of three varieties of sugar beets in utilization of residual soil nitrogen, mineralizable nitrogen and nitrogen added by sidedressing. Malheur Experiment Station. Oregon State University, Ontario, Oregon, 1992.

Variety	Sidedressed[1] Nitrogen	Soil N at[2] Planting	Mineralized[3] Nitrogen	Soil N after[4] Harvest	Plant Nitrogen Roots	Plant Nitrogen Crown	Plant Nitrogen Tops	Accountable N	Unaccountable N	
	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	%
WS-PM9	0	280	112	155	139	36	54	229	237	97
	100	266	101	176	162	58	76	296	291	102
	200	271	116	192	185	74	109	368	395	93
WS-91	0	268	109	158	134	44	40	218	219	100
	100	281	117	183	156	46	73	275	315	87
	200	274	112	199	161	52	95	308	387	80
AC 203	0	275	112	172	101	40	52	193	215	90
	100	246	104	185	125	62	50	237	265	89
	200	269	114	205	139	53	80	272	378	72

1 Pounds N sidedressed as NH_4SO_4.

2 NO_3 and NH_4 nitrogen in soil to a depth of six feet. (Sampled at one foot increments).

3 Nitrogen in top-two-foot of soil made available by soil mineralization.

4 NO_3 and NH_4 nitrogen left in soil to a depth of six feet after sugar beets were harvested.

WATER USE EFFICIENCY FOR SUGAR BEET PRODUCTION

J. Mike Barnum, C.C. Shock, and L.D. Saunders
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Introduction

In response to sugar beet grower and refiner concern over projected severe irrigation water shortages stemming from the continuing drought that has plagued the Pacific Northwest over the past few years, and a lack of area-specific information concerning the affect of irrigation water shortages on beet production, two field trials to evaluate the performance of sugar beets under several different irrigation strategies were conducted at the Malheur Experiment Station during the 1992 crop year. The objectives of these trials were: 1) to determine what effect might result if irrigation was discontinued on July 1 or August 1; 2) to compare production under full season furrow irrigation with full season sprinkler irrigation; 3) to compare irrigation strategies on a bench soil (deep water table) and a bottom soil (shallow water table); and 4) to compare sugar yields from beets grown under different irrigation strategies on a yield per acre and a yield per acre foot of applied irrigation water basis.

Procedure

Two field trials to evaluate the effects of six different irrigation strategies on sugar beets were laid out in a three acre field of Greenleaf silt loam, and a three-quarter acre field of Nyssa silt loam. The sugar beet variety HM PM-9 was planted on a seed spacing of 149,800 seeds per acre (6.3 seeds/ft) on 22-inch centers. Following emergence, the stands in both fields were hand thinned to a 7-inch spacing resulting in a population of approximately 40,400 plants per acre.

Three replications of the six irrigation treatments described below were laid out in each field. The six irrigation strategies evaluated in each field were:

- T-1 Furrow irrigate, on 44-inch centers, according to visual indication of crop need for the entire production season (late April through late September).
- T-2 Furrow irrigate, on 44-inch centers, according to visual indication of crop need from beginning of season (late April) until July 1.
- T-3 Furrow irrigate, on 44-inch centers, according to visual indication of crop need from beginning of season (late April) until July 1, plus one additional irrigation to refill the soil profile. (This refill irrigation was applied on July 19.)

T-4 Furrow irrigate, on 44-inch centers, according to visual indication of crop need from beginning of season (late April) until August 1.

T-5 Furrow irrigate, on 44-inch centers, whenever the mean crop water stress index (CWSI) of the three replicated plots in the field was determined with a Scheduler™ Plant Stress Monitor to be ≥ 2.0.

T-6 Sprinkler irrigate according to visual indication of crop need for the entire production season.

The first irrigation was applied to the Greenleaf silt loam field on April 27. Approximately 4.6 acre inches of water were applied to all furrow irrigated treatment plots at the inflow rate of approximately 132 gallons per hour per furrow for 24 hours. Approximately 3 inches of water were applied to the sprinkler plots at the rate of approximately one-fourth inch per hour for 12 hours. These flow rates were maintained for all subsequent irrigations applied to each treatment.

The first irrigation was applied to the Nyssa silt loam field on May 2. Approximately 3.5 acre inches of water were applied to all furrow irrigated treatment plots at the inflow rate of approximately 33 gallons per hour per furrow for 24 hours. Approximately 4.0 inches of water were applied to the sprinkler plots at the rate of approximately one-half inch per hour for 8 hours. These flow rates were maintained for all subsequent irrigations applied to each treatment.

The final irrigation for treatments T-1, T-5, and T-6 was applied in both fields on September 29.

All treatment plots in both fields were sidedressed with 217 pounds of prilled urea (100 lbs N) per acre on May 19. An additional 80 pounds of N were water run on all treatments in both fields prior to the July 1 cut off date for treatment T-2.

Representative portions of the center two rows in all plots in both fields were harvested on October 20 and 21. Two, 8 to 10 beet, samples were collected from each treatment plot and sent to the Amalgamated Sugar Company laboratory at Nyssa, Oregon, where they were analyzed for percent sucrose, parts per million nitrate nitrogen, and conductivity.

Results and Discussion

Well-watered HM PM-9 sugar beets produced similar yields, quality, and recoverable sugar when grown on Greenleaf silt loam bottom soil (Table 1) and Nyssa silt loam bench soil (Table 2) in 1992. Since the sugar beets performed comparably in terms of yield, quality, and response to stress, the data were combined for further analysis and interpretation (Table 3).

Analysis of the combined data from both fields showed that over the entire irrigation season (late April through late September), significantly more irrigation water was applied to the full season furrow irrigated beets (T-1 and T-5) than was applied to the full season sprinkler irrigated beets(T-6) (Figure 1).

There was no significant difference in yield where HM PM-9 sugar beets were irrigated full season (T-1, T-5, and T-6). However, with progressively greater water stress, yields were progressively reduced (Figure 2).

Sugar content was significantly greater in those beets managed under the irrigation strategies for T-1, T-4, T-5, and T-6 than for those beets managed under the strategies for T-2 and T-3 (Figure 3). However, there was no significant difference between treatments in percent extractable sugar (Figure 4).

Recoverable sugar closely paralleled beet yield. When calculated in tons per acre, the sugar yield for those beets managed under minimal stress was significantly greater than the sugar yield for those beets managed under early cut off strategies (Figure 5).

Analysis of the relationship between beet yield and irrigation water quantity showed that beet yield, in tons per acre foot of water applied, for those beets managed under the T-2 (July 1 cut off) strategy was significantly greater than the beet yield per acre foot of water applied for all other treatments (Figure 6). In terms of extractable sugar, there was no significant difference in sugar yield in tons per acre between T-2 and T-6. Sugar yield in tons per acre foot of water applied was significantly greater for those plots managed under irrigation treatments T-2 and T-6 than for those plots managed under treatments T-1 and T-5 (Figure 6).

Conclusions

1. In those treatments where sugar beet water requirements were adequately met, similar yields resulted on both Greenleaf silt loam "bottom" soil and Nyssa silt loam "bench" soil.

2. Both sugar beet yield and recoverable sugar were significantly reduced when irrigation was cut off early (on or before August 1).

3. Comparable sugar beet yields and quality along with a significant savings in water were realized when beets were irrigated with sprinklers as compared to furrows.

4. For sugar beets maintained under minimal water stress, recoverable sugar yield per acre foot of irrigation water applied was significantly higher for sprinkler irrigated beets (2.1 t/ac.ft) than for furrow irrigated beets (1.4 t/ac.ft).

Table 1. The effects of six irrigation treatments on the yield and quality of HM PM-9 sugar beets grown on Greenleaf silt loam (bottom soil). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Irrigation treatment	Total water applied (ac.ft)	Beet yield (t/ac)	Beet yield per ac. ft. H_2O (t/ac.ft)	Percent sugar in beets (%)	NO_3 content (ppm)	Cond.[1] (mho)	Extractable sugar (%)	Sugar yield (t/ac)	Sugar yield per ac. ft. H_2O (t/ac.ft)
Furrow, full season	5.2	43.2	8.3	17.4	156.0	0.5	88.8	6.7	1.3
Furrow, cut off Jul 1	2.0	28.2	13.8	16.1	215.3	0.6	87.8	4.0	2.0
Furrow, cut off Jul 1 + 1	2.9	37.9	13.0	16.1	272.2	0.6	87.7	5.4	1.8
Furrow, cut off Aug 1	3.3	35.5	10.8	17.5	158.1	0.6	88.4	5.5	1.7
Furrow, CWSI ≥2.0	5.6	42.6	7.6	17.3	129.2	0.5	88.9	6.5	1.2
Sprinkler, full season	3.0	43.8	14.6	17.3	138.3	0.6	88.4	6.7	2.2
Mean	3.7	38.5	11.4	17.0	178.2	0.6	88.3	5.8	1.7
$LSD_{(\alpha=0.05)}$		4.6	1.4	.5	56.9	.05	.7	.7	.2

[1] Conductivity

Table 2. The effects of six irrigation treatments on the yield and quality of HM PM-9 sugar beets grown on Nyssa silt loam (bench soil). Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Irrigation treatment	Total water applied (ac.ft)	Beet yield (t/ac)	Beet yield per ac. ft. H_2O (t/ac.ft)	Percent sugar in beets (%)	NO_3 content (ppm)	Cond.[1] (mho)	Extractable sugar (%)	Sugar yield (t/ac)	Sugar yield per ac. ft. H_2O (t/ac.ft)
Furrow, full season	3.7	43.7	11.7	15.7	418.7	0.8	85.3	5.8	1.6
Furrow, cut off Jul 1	1.3	28.3	22.2	16.9	366.3	0.8	84.8	4.0	3.2
Furrow, cut off Jul 1 + 1	2.0	23.4	12.0	17.0	389.5	0.8	85.5	3.4	1.8
Furrow, cut off Aug 1	2.3	34.5	15.3	17.2	269.5	0.7	87.3	5.3	2.3
Furrow, CWSI ≥2.0	4.0	44.2	11.0	16.4	254.3	0.7	86.4	6.3	1.6
Sprinkler, full season	3.7	44.5	12.0	16.4	364.5	0.8	85.8	6.3	1.7
Mean	2.8	36.4	14.0	16.6	343.8	0.8	85.9	5.2	2.0
$LSD_{(\alpha=0.05)}$		7.4	3.1	1.6	324.3	.2	3.1	1.3	.5

[1] Conductivity

Table 3. The effects of six irrigation treatments on the yield and quality of HM PM-9 sugar beets averaged over a bench and a bottom soil. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Irrigation treatment	Total water applied (ac.ft)	Beet yield (t/ac)	Beet yield per ac. ft. H_2O (t/ac.ft)	Percent sugar in beets (%)	NO_3 content (ppm)	Cond.[1] (mho)	Extractable sugar (%)	Sugar yield (t/ac)	Sugar yield per ac. ft. H_2O (t/ac.ft)
Furrow, full season	4.7	43.3	9.4	16.8	243.6	0.6	87.6	6.4	1.4
Furrow, cut off Jul 1	1.8	28.2	16.6	16.4	265.6	0.7	86.8	4.0	2.4
Furrow, cut off Jul 1 + 1	2.6	33.1	12.7	16.4	311.3	0.7	87.0	4.7	1.8
Furrow, cut off Aug 1	2.9	35.2	12.3	17.4	195.2	0.6	88.0	5.4	1.9
Furrow, CWSI ≥2.0	5.1	43.2	8.7	17.0	170.9	0.6	88.1	6.4	1.3
Sprinkler, full season	3.2	44.0	13.7	17.0	213.7	0.6	87.5	6.6	2.1
Mean	3.4	37.8	12.2	16.8	233.4	0.6	87.5	5.6	1.8
$LSD_{(\alpha=0.05)}$	.5	4.6	2.5	.7	130.5	.1	1.5	.7	.4

[1] Conductivity

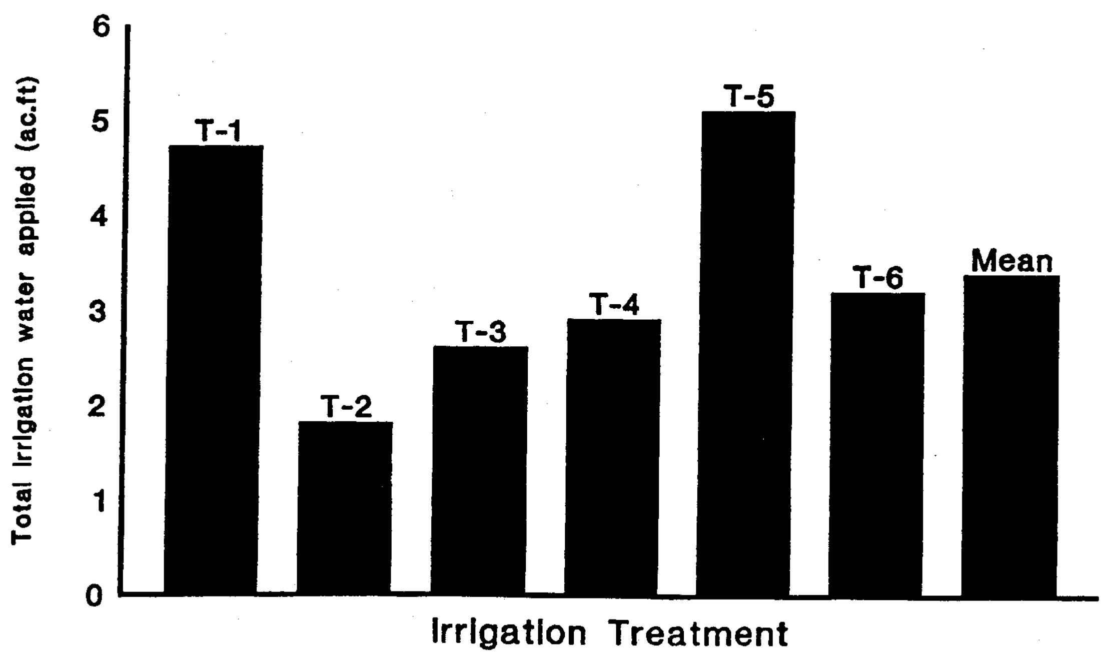


Figure 1. Mean total irrigation water applied to each irrigation treatment and to all six treatments in two fields of HM PM-9 sugar beets during the 1992 production season. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

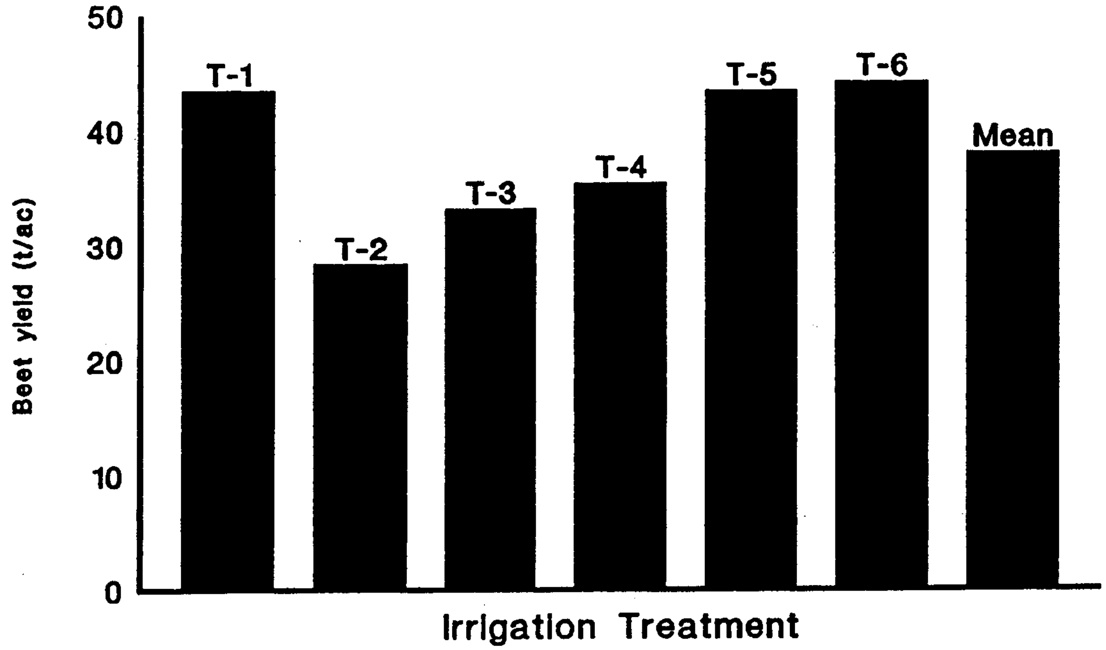


Figure 2. Mean yield of HM PM-9 sugar beets for each irrigation treatment and for all six treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

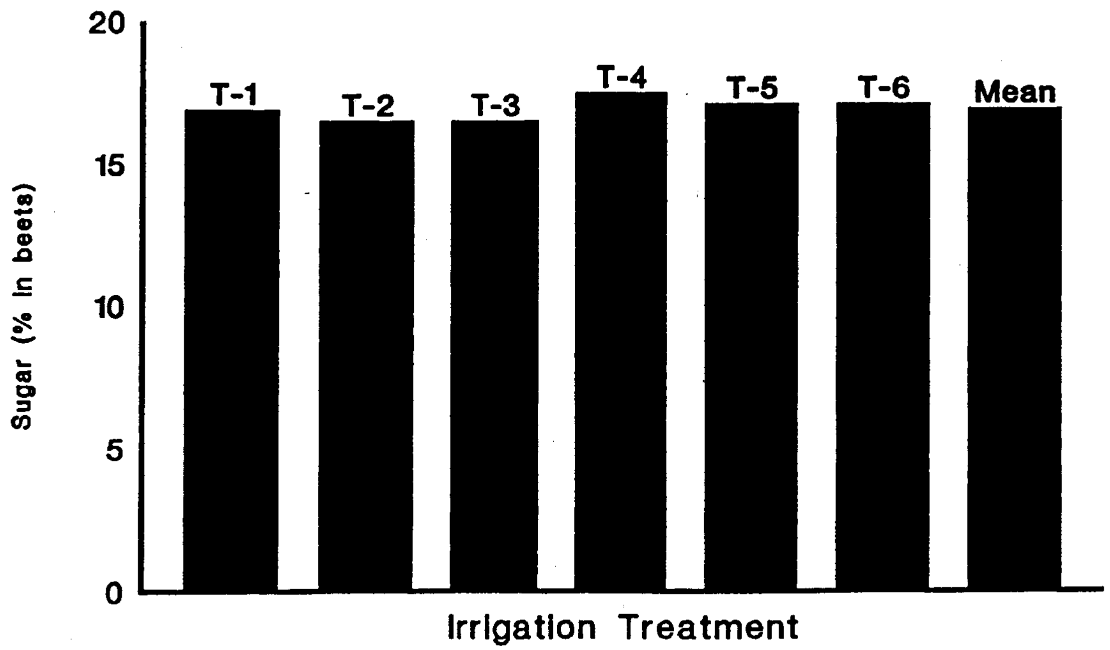


Figure 3. Mean percent sugar in HM PM-9 sugar beets for each irrigation treatment and for all six treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

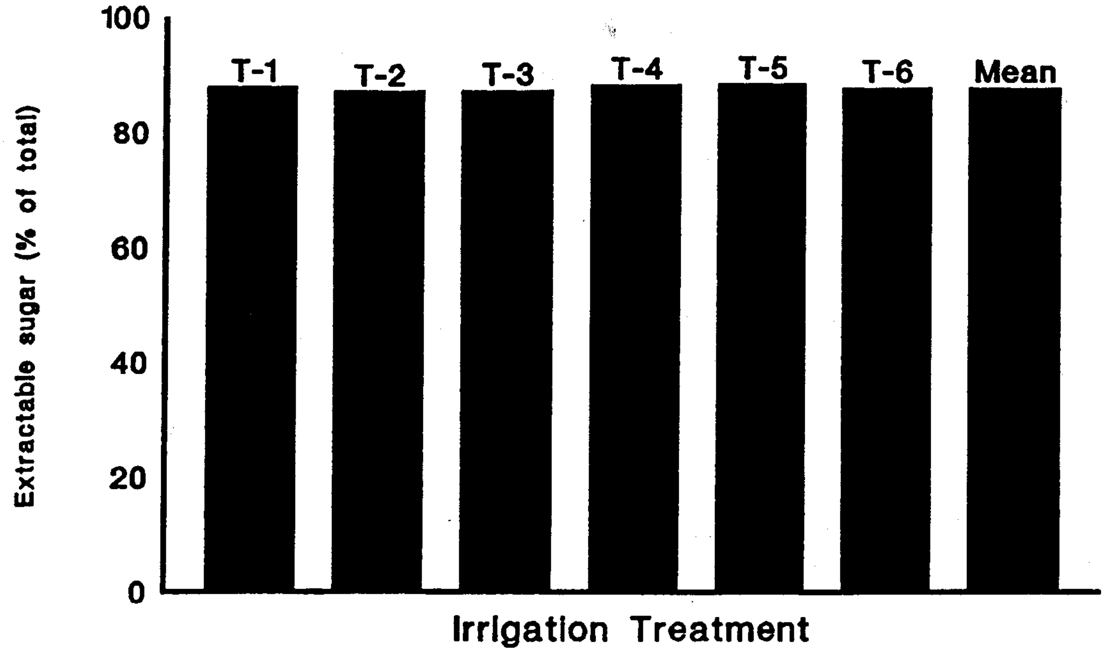


Figure 4. Mean percent extractable sugar in HM PM-9 sugar beets for each irrigation treatment and for all six treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

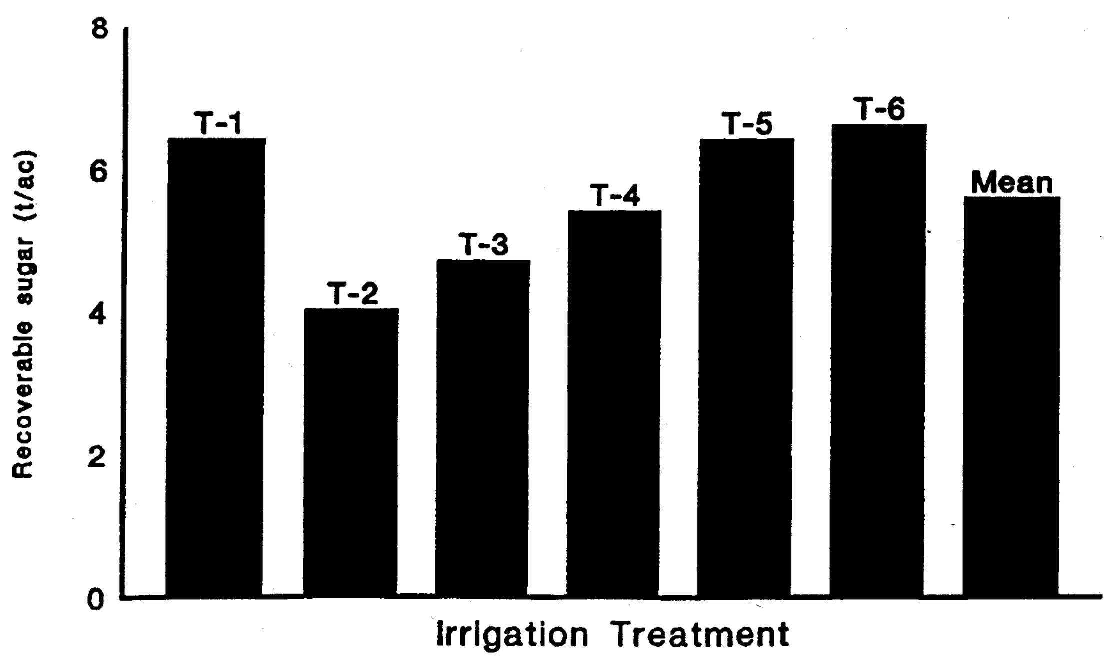


Figure 5. Mean per acre sugar yield from HM PM-9 sugar beets for each irrigation treatment and for all six treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

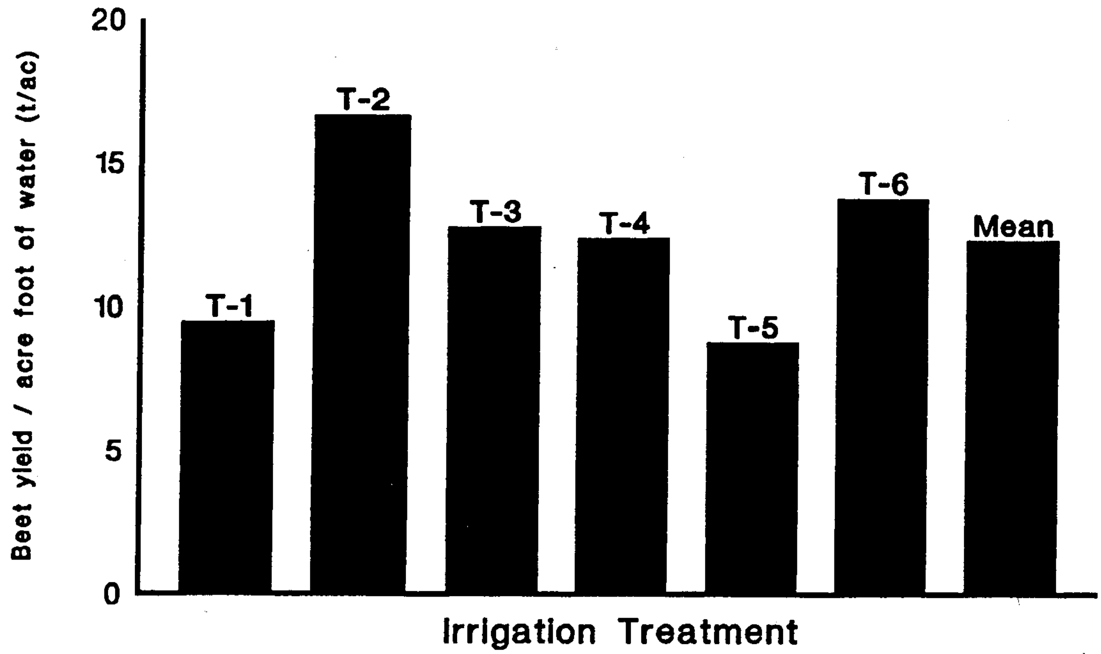


Figure 6. Mean yield of HM PM-9 sugar beets per acre foot of irrigation water applied for each irrigation treatment and for all six treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

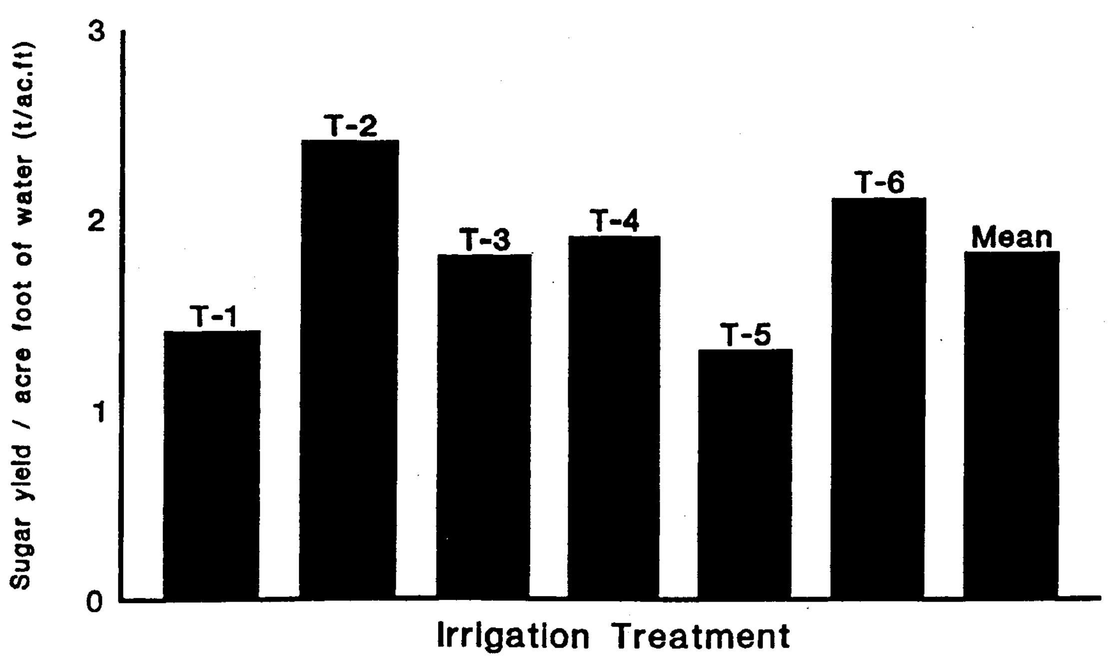


Figure 7. Mean sugar yield for HM PM-9 sugar beets per acre foot of irrigation water applied for each irrigation treatment and for all six treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

TREATMENT OF SOIL WITH BRIGHT SUN SOIL BOOSTER[1] AND POLYACRYLAMIDE[1] AS SOIL CONDITIONERS FOR IMPROVED SEEDLING EMERGENCE

Clint Shock, Erik Feibert, Monty Saunders,
Sally Wimpy and Hillary Cox
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Introduction

Surface crusting of soil after planting can result in poor emergence and reduced stands. The use of polysaccharides and polyelectrolytes for soil conditioning has been found to improve seedling emergence. This trial evaluated the use of a molasses and nutrient based soil conditioner (Bright Sun Soil Booster[1], Cargill Inc., Minneapolis, MN) and a polyacrylamide soil conditioner (P.A.M.[1], Complete Green Co., El Segundo, CA) applied in the planting row for improvement of seedling emergence.

Procedures

The trial was conducted in two fields, a Nyssa silt loam and an Owyhee silt loam, using identical procedures. Both fields had been planted to spring wheat during 1992. Wheat stubble was disked and plowed. The soil was bedded into 22 inch rows. Planting depth was 1.0 inch. Soil conditioner treatments were the main plots and each was replicated five times in each field (Table 1). Four crop species were planted as split plots in each of the main plots. The crops used were broccoli cultivar "Packman" , onion cultivar "Great Scott", sugar beet cultivar "HM PM 9" and tomato cultivar "Nema 512". One hundred seeds of each of the four crops were planted in 25 foot by four row plots on September 2 and 3 using an Almaco cone seeder on a John Deere 'flexi-planter. The soil conditioner applicator was mounted on the planter.

The soil conditioner treatments were diluted in water and applied in the planting row on the soil above the seed just after seed drop. The total liquid application rate was 80 gal/acre. Rhodamine B red dye was mixed with all treatments at the rate of 750 g/ac in order to locate, measure, and photograph the soil conditioner distribution pattern. Both fields were irrigated the day after planting with two lines of solid set sprinklers on each side of the field. Each field was irrigated for six hours at a rate of one inch of water per hour to intentionally crust the soil. Emergence counts were taken on September 11, 14, 17, 21, and 24. Ten soil strength readings (pocket penetrometer CL-700, Soiltest Inc., Chicago, IL) were taken in the planting row in the unplanted but treated area of each plot on September 15 for the Nyssa silt loam and September 21 for the Owyhee silt loam.

[1]The use of certain products does not constitute an endorsement by Oregon State University.

Results and Discussion

The average maximum and minimum soil temperature at four inch depth between September 4 and September 14 was 76.4 and 65.1°F respectively. The application of the soil conditioners to the soil resulted in a V shape distribution of the water, dye, and soil conditioner in the top of the soil averaging 0.65 inches wide at the top and 0.87 inches deep for the Nyssa silt loam and a U shape distribution in the Owyhee silt loam averaging 0.53 inches wide by 0.77 inches deep.

Emergence was higher on the Owyhee silt loam than on the Nyssa silt loam (data not shown). Soil type did not alter the treatment effect on emergence. Soil treatment with either the Bright Sun or P.A.M. resulted in a significant improvement of sugar beet seedling emergence (Table 1). The other crops did not show a response to the soil conditioners. Broccoli emerged very quickly before the soil dried. Tomatoes and onions emerged slowly and irregularly due to cool soil temperatures and soil drying. The average strength of the soil crust was reduced by both soil conditioners (Table 1).

Table 1. Emergence of sugar beet seedlings and average soil strength readings in response to low rates of soil conditioners applied in the planting row. Malheur Experiment Station, Oregon State University, Ontario, OR, 1992.

	Emergence by days after planting				Soil strength
Treatment	8	11	14	Maximum	Penetrometer reading
	-------- % ----------				g/cm^2
Water	28.2	46.6	43.3	47.5	1.89
Bright Sun 0.96 gal/ac	32.2	51.2	51.0	55.2	1.89
Bright Sun 1.91 gal/ac	33.2	53.7	54.6	56.4	1.78
Bright Sun 3.82 gal/ac	26.2	41.5	43.8	45.7	1.44
P.A.M. 0.36 g/ac	23.3	37.5	42.9	45.6	1.93
P.A.M. 3.62 g/ac	38.0	55.4	55.9	57.6	1.53
P.A.M. 36.2 g/ac	35.4	53.9	51.3	54.8	1.36
LSD(0.05)	9.1	10.5	9.6	9.7	0.36

INFLUENCE OF FOLIAR APPLIED NUTRIENTS ON CURLY TOP INFECTED SUGAR BEETS

Erik Feibert and Clint Shock
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Objective

This trial sought to determine whether foliar feeding with nitrogen and/or other nutrients can help salvage sugar beets severely infected with the curly top virus. The hypothesis was that since curly top infected beets have a compromised root system, nutrient deficiencies may occur. These nutrient deficiencies could be attenuated by foliar-applied nutrients.

Procedures

A sugar beet field that was severely infested with the curly top virus, located northwest of the experiment station was chosen for the experimental use of foliar sprays. On April 15, the grower had planted PM-9 sugar beet seed in 21-inch rows. The in-row spacing was thinned to 7 inches. Temik at 2 lbs ai/ac was applied at planting.

Poast at 0.23 pint ai/ac was applied on June 1, and Eptam at 3.5 pint ai/ac plus Treflan at 0.5 pint ai/ac were applied on June 4 for weed control. On June 30 0.03 qt ai/ac of Furadan and 151 lb N, 75 lb P_2O_5, and 2.5 g/ac Zinc also were applied.

A uniformly infected part of the field was chosen in early June, and divided into twenty-five 4-row plots each 50 feet long. The treatments consisted of foliar-applied nitrogen, and micronutrients (Table 1) replicated five times in a randomized complete block design. The foliar sprays were applied with a bicycle sprayer with four 8004 Tee-Jet nozzles at a pressure of 40 PSI. The applications were always done after 8:OO pm to reduce the risk of foliar burning by URAN. Each nitrogen application consisted of foliar URAN (Urea ammonium nitrate, 2.7 lbs N/gal.) at 15 lbs N/ac, in 30 gallons of water per acre. The application rates for the other nutrients are listed in Table 2. All micronutrient applications were the same.

A sample of petioles from uninfected plants in the check plots was collected on July 19 and analyzed for macro and micro nutrients. Soil samples were taken on July 14 and August 11. In addition, on August 11 a sample of petioles was collected from each plot and analyzed for nitrate-N. Bayleton at 4 oz ai/ac was applied on August 10 for control of powdery mildew.

On October 20, all beets in 30 feet of the middle two rows in each plot were dug, topped, counted, and weighed. Two subsamples from each plot were taken for sugar analysis. Beet yields were corrected for tare dirt. Recoverable sugar was calculated by first estimating the efficiency of the sugar recovery at the factory based on beet conductivity and sugar content.

Results

The foliar treatments did not result in significant differences in yield, sugar content, conductivity, recoverable sugar, and petiole nitrate (Table 3). The soil had 205 lbs nitrate-N/ac in the top three feet in mid-July, and 342 lbs of nitrate and ammonium-N/ac in the top two feet on August 11. Petiole nitrate levels in mid-July in the untreated plots were within the adequate zone. Petiole nitrate levels for the different treatments on August 11 were not significantly different and within the adequate zone. Plant stand was low due to plant death from curly top. The average plant stand was 21,240 plants/acre.

The results of the first petiole analysis showed 6,750 ppm nitrate, 2,600 ppm ammonium, 0.32 ppm phosphorus, 5.46 ppm potassium, 0.16 ppm sulfur, 0.95 ppm calcium, 0.59 ppm magnesium, 2.60 ppm sodium, 21 ppm zinc, 42 ppm manganese, 8 ppm copper, 167 ppm iron, and 22 ppm boron. Only sulfur and boron were in the deficient range.

The soil sample taken on July 14 showed a pH of 7.8, 1.4 percent organic matter, 26 ppm nitrate-N in the first foot, 15 ppm nitrate-N in the second foot, and 16 ppm nitrate-N in the third foot, 24 ppm phosphorus, 482 ppm potassium, 3,034 ppm calcium, 526 ppm magnesium, 220 ppm sodium, 1.9 ppm zinc, 3 ppm iron, 6.5 ppm manganese, 0.5 ppm copper, 32 ppm sulfur (sulfate sulfur), and 0.6 ppm boron. The August 11 soil sample showed a pH of 7.9, cation exchange capacity of 9 meq/100 g, 1.1 percent organic matter, 37 ppm nitrate-N and 8 ppm ammonium-N in the first foot, and 43 ppm nitrate-N and 7 ppm ammonium-N in the second foot, 23 ppm phosphorus, 399 ppm potassium, 1,600 ppm calcium, 306 ppm magnesium, 342 ppm sodium, 2 ppm zinc, 3 ppm iron, 11.1 ppm manganese, 1.2 ppm copper, 42 ppm sulfur (sulfate sulfur) and 0.7 ppm boron.

Discussion

The results of this trial suggest that foliar applications of plant nutrients to curly top infected sugar beets were ineffective. The curly top virus possibly reduced top growth to the same or greater degree as root growth, and thus the plant maintains adequate levels of nutrients due to a lack of top growth and photosynthesis, and not due to a reduced uptake. The excessive amounts of available soil nitrogen in this field could have been detrimental to the crop, and could have been an additional factor leading to plant death, thereby contributing to the low stand. The results of this trial might not be applicable to all situations with curly top infected beets, but no foliar feeding was of benefit to this field.

Table 1. The five treatments and foliar spray application dates. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Treatment	Date of application			
	July 16	July 21	July 28	August 3
Check				
0 N + micronutrients			micronutr.	
15 lb N + micronutr.	nitrogen		micronutr.	
30 lb N + micronutr.	nitrogen	nitrogen	micronutr.	
45 lb N + micronutr.	nitrogen	nitrogen	micronutr.	nitrogen

Table 2. Quantities of nutrients applied at each micronutrient spray. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Nutrients applied	Quantity	
	lb/acre	kg/hectare
Boron	0.17	0.193
Phosphorus (P_2O_5)	0.83	0.929
Manganese	0.14	0.155
Zinc	0.32	0.360
Sulfur	0.15	0.165
Copper	0.07	0.79

Table 3. Influence of foliar applied macro and micronutrients on yield, sugar content, conductivity, recoverable sugar and petiole nitrate of curly top infected sugar beets. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

Treatment	Beet yield	Sugar	Conductivity	Recoverable sugar	Petiole nitrate on August 11
	tons/acre	%	micromhos	lb/acre	ppm
Check	15.4	16.19	837	4285	5640
0 N + micronutrients	12.1	16.62	793	3476	4880
15 lb N + micronutr.	15.7	16.43	803	4433	4460
30 lb N + micronutr.	13.6	16.35	798	3812	4820
45 lb N + micronutr.	16.1	16.23	810	4462	4760
LSD(0.05) Treatment	ns	ns	ns	ns	ns

SURVEY FOR PESTICIDE RESIDUES IN MALHEUR COUNTY SURFACE WATER

Ben Simko and Lynn Jensen
Malheur County Extension Office
Oregon State University
Ontario, Oregon, 1992

Introduction

Northeast Malheur County has been declared a Groundwater Management Area by the Oregon Department of Environmental Quality (DEQ). Additionally the region is designated a Hydrologic Unit Area by the USDA. These designations are to address water quality concerns with nitrates, pesticides and soil erosion in the project area. In August of 1988, the DEQ initiated a program to monitor and evaluate groundwater quality. Frequent pesticide screens of aquifer samples are part of this ongoing monitoring program. The only significant detection of a pesticide in the groundwater has been a di-acid metabolite of the herbicide dacthal. Dacthal di-acid levels found, range from 0.2 to 300 ppb. The official EPA health advisory level for dacthal is 4000 ppb.

The purpose of this study was to conduct a preliminary survey of surface water quality drainage from the irrigated areas of NE Malheur County. A broad pesticide residue screen for 100 compounds was conducted on water samples from the Malheur and Owyhee rivers. In addition water samples were analyzed from a major irrigation drainage canal flowing into the Snake River in the Oregon Slope district.

Methods

From May through September of 1992 water samples were collected monthly at each of three sites. Samples were drawn from within 1/2 mile of the confluence of the Malheur and Snake Rivers and within 3 miles of the confluence of the Owyhee and the Snake Rivers. The third sample site was within 100 feet of the Snake River entry point of a major irrigation drain canal. This location was 10 miles north of Ontario in the Oregon Slope district. Sample dates were May 5, June 4, July 7, August 3, and September 8. The sampling period covered the time of peak agricultural pesticide use.

One quart water samples were collected and immediately placed in an insulated cooler. The jars were then surrounded with blue ice. Samples were shipped by commercial bus the same evening to Columbia Lab in Corbett, Oregon. The lab took possession of the samples the next morning. The lab screened each water sample for 100 compounds including insecticides, herbicides and fungicides. Analyses included synthetic pyrethroid insecticides. Four pyrethroids were targeted for special screening including permethrin (Ambush), bifenthrin (Capture), cypermethrin (Cymbush, Ammo), and fenvalerate (Pydrin), because of concerns regarding their contamination of aquatic habitats and potential negative impact on aquatic organisms. Synthetic pyrethroids, in water solution, are particularly toxic to fish and aquatic invertebrates.

Results and Discussion

In 1987 OSU conducted a survey of pesticide use in Malheur County. The results of this survey indicated a total of 78 pesticide active ingredients were used totaling 1.01 million lbs. a.i. applied that year (Rinehold and Witt, 1989). These pesticides are used on approximately 179,000 acres of irrigated cropland resulting in an average of 5.6 lbs. a.i. of pesticide applied per acre. In 1992 a survey conducted by the authors estimated a total of 3,323 lbs. a.i. of cypermethrin applied to 10,100 acres of onions and 550 lbs. a.i. of bifenthrin applied to 5,500 acres of alfalfa seed.

The Malheur and Owyhee Rivers are the principal drainage for the northeast area of Malheur County. Both rivers run through irrigated cropland and are part of the drainage system for the region's irrigation projects. The Oregon Slope drainage canal, emptying into the Snake River, included both run off from irrigated fields and groundwater seeping off the farmed benches in that area.

No detectable residues of any pesticide were found in any of the samples including the four synthetic pyrethroids (Tables 1-4). No residues for synthetic pyrethroids were found at the three sites for all dates (Table 4). Recent section 18 requests to the EPA for use of synthetic pyrethroids have prompted concerns over the drift effects of these materials on the aquatic environments surrounding the agricultural production area. The preliminary evidence suggests that agricultural pesticide use in the intensively cropped areas of Malheur County does not contaminate the two major tributary rivers to the Snake nor contribute to water quality degradation in the aquatic habitats. Chemical and biological degradation processes appear to break down agricultural pesticides that enter the Malheur County environment.

Reference

Rinehold, J. and J. Witt, 1989. Malheur county pesticide use estimates for 1987, Oregon State University Extension Service Special Report 843.

Table 1. Pesticide residue analysis of water samples from Oregon Slope drainage canal, Malheur County, Oregon, 1992.

Basic Pesticide Profile

Compound	5/6	6/5	7/7	8/4	9/9
	Sample Dates				
Aldrin	ND	ND	ND	ND	ND
Aspon	ND	ND	ND	ND	ND
Balan (Benfluralin)	ND	ND	ND	ND	ND
BHC, alpha	ND	ND	ND	ND	ND
BHC, beta	ND	ND	ND	ND	ND
BHC, delta	ND	ND	ND	ND	ND
Bromophos	ND	ND	ND	ND	ND
Bromophos ethyl	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND
Chlorthion	ND	ND	ND	ND	ND
CIPC	ND	ND	ND	ND	ND
Dacthal	ND	ND	ND	ND	ND
DDE	ND	ND	ND	ND	ND
DDT	ND	ND	ND	ND	ND
DEF	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Dichlobenil	ND	ND	ND	ND	ND
Dichlorofenthion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	9/4	9/9
	Sample Dates				
Dieldrin	ND	ND	ND	ND	ND
Dyfonate	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Ethion	ND	ND	ND	ND	ND
Fenitrothion	ND	ND	ND	ND	ND
Fusarex (TCN)	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor Epox	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND
Isobenzan (Telodrin)	ND	ND	ND	ND	ND
Isodrin	ND	ND	ND	ND	ND
Isopropalin	ND	ND	ND	ND	ND
Lindane	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND
Methyl Parathion	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND
Ovex	ND	ND	ND	ND	ND

Compounds	5/6	6/5	7/7	8/4	9/9
	Sample Dates				
Oxadiazon	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND
PCB's	ND	ND	ND	ND	ND
PCNB	ND	ND	ND	ND	ND
Pentachloroaniline	ND	ND	ND	ND	ND
Pentachlorobenzene	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND
Procymidone	ND	ND	ND	ND	ND
Prothiophos	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Strobane	ND	ND	ND	ND	ND
TDE	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND
Tetrasul	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND
Trialate	ND	ND	ND	ND	ND
Trichloronate	ND	ND	ND	ND	ND
Vinclozolin	ND	ND	ND	ND	ND

Extended Pesticide Profile

Compound	5/6	6/5	7/7	8/4	9/9
Atrazine	ND	ND	ND	ND	ND
Bromophos	ND	ND	ND	ND	ND
Cardophenothion	ND	ND	ND	ND	ND
Chlorpyriphos	ND	ND	ND	ND	ND
Chlorpyriphos	ND	ND	ND	ND	ND
DEF	ND	ND	ND	ND	ND
Demeton-s	ND	ND	ND	ND	ND
Demeton-S-Sulfone	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Diphenamid	ND	ND	ND	ND	ND
Disulfoton Sulfone	ND	ND	ND	ND	ND
Ethion	ND	ND	ND	ND	ND
Ethoprop	ND	ND	ND	ND	ND
Famphur	ND	ND	ND	ND	ND
Fenamiphos	ND	ND	ND	ND	ND
Fenitrothion (Sumithion)	ND	ND	ND	ND	ND
Fensulfothion	ND	ND	ND	ND	ND
Fenthion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	8/4	9/9
Fenthion oxygen analog	ND	ND	ND	ND	ND
Fenthion oxygen analog sulfoxide	ND	ND	ND	ND	ND
Fenthion sulfone	ND	ND	ND	ND	ND
Fonofos (Dyfonate)	ND	ND	ND	ND	ND
Gardona	ND	ND	ND	ND	ND
Isofenphos	ND	ND	ND	ND	ND
Isopropalin	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Malathion oxygen analog	ND	ND	ND	ND	ND
Methidathion	ND	ND	ND	ND	ND
Metribuzin	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND
Oxadiazon	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	8/4	9/9
Parathion oxygen analog	ND	ND	ND	ND	ND
Parathion methyl	ND	ND	ND	ND	ND
Phenthoate	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND
Phosphamidon	ND	ND	ND	ND	ND
Primicarb	ND	ND	ND	ND	ND
Pirimiphos ethyl	ND	ND	ND	ND	ND
Pirimiphos methyl	ND	ND	ND	ND	ND
Procymidone	ND	ND	ND	ND	ND
Profenfos	ND	ND	ND	ND	ND
Prometryne	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Simazine	ND	ND	ND	ND	ND
Sulfallate	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND
Triadimeform	ND	ND	ND	ND	ND
Vinclozolin	ND	ND	ND	ND	ND

ND = None Detected; Basic Pesticide Profile Detection Limits = 0.01 ppb; Extended Pesticide Profile Detection Limits - 1 ppb

Table 2. Pesticide residue analysis of water samples from Malheur River, Malheur County, Oregon, 1992.

Basic Pesticide Profile

Compound	Sample Dates 5/6	6/5	7/7	8/4	9/9
Aldrin	ND	ND	ND	ND	ND
Aspon	ND	ND	ND	ND	ND
Balan(Benfluralin)	ND	ND	ND	ND	ND
BHC, alpha	ND	ND	ND	ND	ND
BHC, beta	ND	ND	ND	ND	ND
BHC, delta	ND	ND	ND	ND	ND
Bromophos	ND	ND	ND	ND	ND
Bromophos ethyl	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND
Chlorthion	ND	ND	ND	ND	ND
CIPC	ND	ND	ND	ND	ND
Dacthal	ND	ND	ND	ND	ND
DDE	ND	ND	ND	ND	ND
DDT	ND	ND	ND	ND	ND
DEF	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Dichlobenil	ND	ND	ND	ND	ND
Dichlorofenthion	ND	ND	ND	ND	ND

Compound	Sample Dates 5/6	6/5	7/7	9/4	9/9
Dieldrin	ND	ND	ND	ND	ND
Dyfonate	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Ethion	ND	ND	ND	ND	ND
Fenitrothion	ND	ND	ND	ND	ND
Fusarex (TCN)	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor Epox	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND
Isobenzan(Telodrin)	ND	ND	ND	ND	ND
Isodrin	ND	ND	ND	ND	ND
Isopropalin	ND	ND	ND	ND	ND
Lindane	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND
Methyl Parathion	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND
Ovex	ND	ND	ND	ND	ND

Compounds	Sample Dates 5/6	6/5	7/7	8/4	9/9
Oxadiazon	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND
PCB's	ND	ND	ND	ND	ND
PCNB	ND	ND	ND	ND	ND
Pentachloroaniline	ND	ND	ND	ND	ND
Pentachlorobenzene	ND	ND	ND	ND	ND
Pethane	ND	ND	ND	ND	ND
Procymidone	ND	ND	ND	ND	ND
Prothiophos	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Strobane	ND	ND	ND	ND	ND
TDE	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND
Tetrasul	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND
Trialate	ND	ND	ND	ND	ND
Trichloronate	ND	ND	ND	ND	ND
Vinclozolin	ND	ND	ND	ND	ND

Extended Pesticide Profile

Compound	5/6	6/5	7/7	8/4	9/9
Atrazine	ND	ND	ND	ND	ND
Bromophos	ND	ND	ND	ND	ND
Cardophenothion	ND	ND	ND	ND	ND
Chlorpyriphos	ND	ND	ND	ND	ND
Chlorpyriphos	ND	ND	ND	ND	ND
DEF	ND	ND	ND	ND	ND
Demeton-s	ND	ND	ND	ND	ND
Demeton-S-Sulfone	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Diphenamid	ND	ND	ND	ND	ND
Disulfoton Sulfone	ND	ND	ND	ND	ND
Ethion	ND	ND	ND	ND	ND
Ethoprop	ND	ND	ND	ND	ND
Famphur	ND	ND	ND	ND	ND
Fenamiphos	ND	ND	ND	ND	ND
Fenitrothion (Sumithion)	ND	ND	ND	ND	ND
Fensulfothion	ND	ND	ND	ND	ND
Fenthion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	8/4	9/9
Fenthion oxygen analog	ND	ND	ND	ND	ND
Fenthion oxygen analog sulfoxide	ND	ND	ND	ND	ND
Fenthion sulfone	ND	ND	ND	ND	ND
Fonofos (Dyfonate)	ND	ND	ND	ND	ND
Gardona	ND	ND	ND	ND	ND
Isofenphos	ND	ND	ND	ND	ND
Isopropalin	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Malathion oxygen analog	ND	ND	ND	ND	ND
Methidathion	ND	ND	ND	ND	ND
Metribuzin	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND
Oxadiazon	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	8/4	9/9
Parathion oxygen analog	ND	ND	ND	ND	ND
Parathion methyl	ND	ND	ND	ND	ND
Phenthoate	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND
Phosphamidon	ND	ND	ND	ND	ND
Primicarb	ND	ND	ND	ND	ND
Pirimiphos ethyl	ND	ND	ND	ND	ND
Pirimiphos methyl	ND	ND	ND	ND	ND
Procymidone	ND	ND	ND	ND	ND
Profenfos	ND	ND	ND	ND	ND
Prometryne	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Simazine	ND	ND	ND	ND	ND
Sulfallate	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND
Triadimeform	ND	ND	ND	ND	ND
Vinclozolin	ND	ND	ND	ND	ND

ND = None Detected; Basic Pesticide Profile Detection Limits = 0.01 ppb; Extended Pesticide Profile Detection Limits - 1 ppb

Table 3. Pesticide residue analysis of water samples from Owyhee River, Malheur County, Oregon, 1992.

Basic Pesticide Profile

	Sample Dates				
Compound	5/6	6/5	7/7	8/4	9/9
Aldrin	ND	ND	ND	ND	ND
Aspon	ND	ND	ND	ND	ND
Balan (Benfluralin)	ND	ND	ND	ND	ND
BHC, alpha	ND	ND	ND	ND	ND
BHC, beta	ND	ND	ND	ND	ND
BHC, delta	ND	ND	ND	ND	ND
Bromophos	ND	ND	ND	ND	ND
Bromophos ethyl	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND
Chlorthion	ND	ND	ND	ND	ND
CIPC	ND	ND	ND	ND	ND
Dacthal	ND	ND	ND	ND	ND
DDE	ND	ND	ND	ND	ND
DDT	ND	ND	ND	ND	ND
DEF	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Dichlobenil	ND	ND	ND	ND	ND
Dichlorofenthion	ND	ND	ND	ND	ND

	Sample Dates				
Compound	5/6	6/5	7/7	9/4	9/9
Dieldrin	ND	ND	ND	ND	ND
Dyfonate	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Ethion	ND	ND	ND	ND	ND
Fenitrothion	ND	ND	ND	ND	ND
Fusarex (TCN)	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor Epox	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND
Isobenzan (Telodrin)	ND	ND	ND	ND	ND
Isodrin	ND	ND	ND	ND	ND
Isopropalin	ND	ND	ND	ND	ND
Lindane	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND
Methyl Parathion	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND
Ovex	ND	ND	ND	ND	ND

	Sample Dates				
Compounds	5/6	6/5	7/7	8/4	9/9
Oxadiazon	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND
PCB's	ND	ND	ND	ND	ND
PCNB	ND	ND	ND	ND	ND
Pentachloroaniline	ND	ND	ND	ND	ND
Pentachlorobenzene	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND
Procymidone	ND	ND	ND	ND	ND
Prothiophos	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Strobane	ND	ND	ND	ND	ND
TDE	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND
Tetrasul	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND
Trialate	ND	ND	ND	ND	ND
Trichloronate	ND	ND	ND	ND	ND
Vinclozolin	ND	ND	ND	ND	ND

Extended Pesticide Profile

Compound	5/6	6/5	7/7	8/4	9/9
Atrazine	ND	ND	ND	ND	ND
Bromophos	ND	ND	ND	ND	ND
Cardophenothion	ND	ND	ND	ND	ND
Chlorpyriphos	ND	ND	ND	ND	ND
Chlorpyriphos	ND	ND	ND	ND	ND
DEF	ND	ND	ND	ND	ND
Demeton-s	ND	ND	ND	ND	ND
Demeton-S-Sulfone	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Diphenamid	ND	ND	ND	ND	ND
Disulfoton Sulfone	ND	ND	ND	ND	ND
Ethion	ND	ND	ND	ND	ND
Ethoprop	ND	ND	ND	ND	ND
Famphur	ND	ND	ND	ND	ND
Fenamiphos	ND	ND	ND	ND	ND
Fenitrothion (Sumithion)	ND	ND	ND	ND	ND
Fensulfothion	ND	ND	ND	ND	ND
Fenthion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	8/4	9/9
Fenthion oxygen analog	ND	ND	ND	ND	ND
Fenthion oxygen analog sulfoxide	ND	ND	ND	ND	ND
Fenthion sulfone	ND	ND	ND	ND	ND
Fonofos (Dyfonate)	ND	ND	ND	ND	ND
Gardona	ND	ND	ND	ND	ND
Isofenphos	ND	ND	ND	ND	ND
Isopropalin	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Malathion oxygen analog	ND	ND	ND	ND	ND
Methidathion	ND	ND	ND	ND	ND
Metribuzin	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND
Oxadiazon	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND

Compound	5/6	6/5	7/7	8/4	9/9
Parathion oxygen analog	ND	ND	ND	ND	ND
Parathion methyl	ND	ND	ND	ND	ND
Phenthoate	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND
Phosphamidon	ND	ND	ND	ND	ND
Primicarb	ND	ND	ND	ND	ND
Pirimiphos ethyl	ND	ND	ND	ND	ND
Pirimiphos methyl	ND	ND	ND	ND	ND
Procymidone	ND	ND	ND	ND	ND
Profenfos	ND	ND	ND	ND	ND
Prometryne	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Simazine	ND	ND	ND	ND	ND
Sulfallate	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND
Triadimeform	ND	ND	ND	ND	ND
Vinclozolin	ND	ND	ND	ND	ND

ND = None Detected; Basic Pesticide Profile Detection Limits = 0.01 ppb; Extended Pesticide Profile Detection Limits - 1 ppb

Table 4. Pesticide residue analysis for synthetic pyrethroid insecticides from surface water located in Malheur County, Oregon, 1992.

	Dates Sampled				
	5/6	6/5	7/7	8/4	9/9
	Oregon Slope Drainage Canal				
Fenvalerate	ND	ND	ND	ND	ND
Bifenthrin	ND	ND	ND	ND	ND
Cypermethrin	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND
	Malheur River				
Fenvalerate	ND	ND	ND	ND	ND
Bifenthrin	ND	ND	ND	ND	ND
Cypermethrin	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND
	Owyhee River				
Fenvalerate	ND	ND	ND	ND	ND
Bifenthrin	ND	ND	ND	ND	ND
Cypermethrin	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND

ND = None Detected; Minimum Detection Limits (MDL) for fenvalarate, bifenthrin, and cypermethrin = 0.5 ppb, MDL for permethrin = 1.0 ppb

NUTRIENT CONTENT IN NORTHEASTERN MALHEUR COUNTY IRRIGATION WATER

Clint Shock, Tim Stieber, and John Miller
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Objectives

The objectives of this study were to establish season-long estimates for the nitrogen and phosphate concentrations contained in irrigation canals, and to estimate fertilizer reductions possible if nutrients in irrigation water are accounted for in crop fertilization practices.

Introduction

Agricultural areas with intensive crop production utilize large inputs of fertilizer and pesticides. Deep percolation and runoff from these lands can carry fertilizer and pesticides from the soil to the groundwater, and into streams and lakes.

There is a widespread concern about the loss of phosphate and pesticide residues into surface waters of the Pacific Northwest. Phosphate loss to the Snake River drainage has been identified as a major pollutant causing algal blooms in the river and associated reservoirs. Furrow irrigated cropland in eastern Oregon and southwestern Idaho produce considerable water return flow to irrigation ditches and eventually part of the recycled runoff escapes into the Snake River. A reduction in sediment, phosphorus, and Dacthal breakdown products is perceived to be desirable.

Knowledge of the nitrogen content of surface water could contribute directly to a reduction of nitrogen fertilizer use in areas receiving considerable nitrogen in the irrigation water. Minor economic savings and a reduction of environmental contamination are possible. Nitrogen in irrigation water is not usually counted by growers toward their crop nitrogen needs. A "nitrogen budget" approach for nitrogen management would count all soil and water nitrogen sources against crop nitrogen needs, then estimate nitrogen chemical fertilizer application by difference. Knowledge of the nitrogen content in irrigation water is a component of a comprehensive nitrogen budget.

Hobson et al. (1990) found that runoff water from furrow irrigated crops results in substantial nutrient loading of surface water. Furrow irrigation in Malheur County relies on return flow water so that the water may be used successively by three or more farms. The use of return flow increases the irrigation efficiency of the surface irrigation system, but also increases the risk of accumulation of soluble fertilizer salts.

Phosphorus has become a major pollutant in the Snake River Basin (Zimmer and Glover, 1980; Carter et al., 1976). Zimmer and Glover state that algal blooms limit recreational use by reducing water clarity and esthetic qualities. Under bloom conditions algae have a negative impact on the reservoir fishery because of periodic oxygen depletion associated with algal respiration and decomposition. Nuisance algal blooms are stimulated by an average July-August phosphorus concentration of 0.082 mg/l in Lake Lowell surface water. Surface water phosphorus concentrations must be reduced to less than 0.025 mg/l to significantly improve water clarity.

Procedures

Irrigation water was sampled and analyzed the season long. Water was sampled along the canal distribution system as soon as the irrigation season began, and continued through the season from mid-April to September (Table 1).

Table 1. Timing of 1991 nutrient monitoring.

Sampling	Sample Date	Analysis
1	April 11	Detailed[1]
2	April 18	Nitrogen[2]
3	April 25	Nitrogen
4	May 2	Nitrogen
5	May 9	Detailed
6	May 16	Nitrogen
7	May 23	Nitrogen
8	May 30	Nitrogen
9	June 6	Detailed
10	June 13	Nitrogen
11	June 20	Nitrogen
12	June 27	Nitrogen
13	July 4	Detailed
14	July 11	Nitrogen
15	July 18	Nitrogen
16	July 25	Nitrogen
17	Aug. 1	Detailed
18	Aug. 8	Nitrogen
19	Aug. 15	Nitrogen
20	Aug. 22	Nitrogen
21	Aug. 29	Detailed
22	Sept. 5	Nitrogen

[1] Detailed analysis consisted of nitrate-N, ammonium-N, total N, electrical conductivity (total dissolved solids), pH, and phosphate-P.

[2] Nitrogen analysis consisted of nitrate-N, ammonium-N, and total N.

Canals from two main water sources, the Owyhee River and Snake River were monitored where water enters the canals and further along these canals below where return flow enters (surface runoff). A total of thirteen sites were monitored (Table 2).

Table 2. Sampling sites for weekly irrigation canal nutrient monitoring, 1991, Malheur County, Oregon.

<u>Nyssa Ditch</u>

1. Start (sampled at the Morgan Avenue syphon)
2. Before Snake River water inflow (Buffalo Ranch)
3. After Snake River water inflow (Buffalo Ranch)
4. Near the Malheur Experiment Station at Clark Blvd.
5. Near end Vista Avenue

<u>Old Owyhee Ditch</u> (catches runoff from above)

1. Start (sampled at the Morgan Avenue syphon)
2. Before Snake River water inflow off Highway 201
3. After Snake River water inflow
4. At Gem Avenue
5. At endpoint off Clark Blvd.
6. Stewart-Carter ditch, Alameda spur below the old Owyhee ditch at Alameda Drive

<u>Other Locations</u>

1. Snake River pumping outlet at the Buffalo Ranch
2. Warmsprings ditch endpoint at Clark Blvd. (catches return flow from Nyssa ditch endpoint)
3. MES irrigation well #1

Water at the beginning of both the Old Owyhee ditch and the Nyssa ditch enter irrigation canals without appreciable contamination from return flow. A location similar to the start of the Old Owyhee ditch and the Nyssa ditch is the start of the Morgan Avenue syphon. It was much more accessible and weekly samples were taken there.

Locations were selected for nutrient sampling so that regional nutrient loading from irrigation water could be estimated. An estimate of the proportion of nitrogen needs covered by nitrogen in the irrigation water could be estimated by crop and geographic area.

Water was sampled by placing a sampler in the middle of the water flow and drawing the sampler through the water to obtain a representative sample. The samples were taken immediately the same day that the water was sampled to Western Laboratories in Parma, Idaho, for analysis.

On April 25 seven duplicate samples were collected along the Nyssa ditch, Owyhee ditch and Stewart-Carter ditch. These samples were analyzed for Dacthal di-acid residues by the Department of Agricultural Chemistry at Oregon State University.

Results and Discussion

Nitrate-N, ammonium-N, phosphate-P, and soluble salts in the irrigation water showed significant increases with distance down the canal system (Table 3). Phosphate-P was above 0.04 ppm throughout the length of the irrigation canal system and in the Snake River. With progressive distance to the north, irrigation water picks up return flows, and presumably the increase in nutrients is caused by contributions to the canals from return flow.

Averaging over all locations, nutrients in the irrigation water varied with sampling date (Figure 1). Nitrate-N had peak concentrations April 25, May 30, June 20, and July 4 through July 18. Ammonium-N had peaks April 25, and July 11 through July 25. Phosphate-P was analyzed only every fourth week, so trends are not as easily established.

Averaging over the irrigation season, irrigation water contributed 2.7 to 15.3 lb N/ac of nitrate-N and ammonium-N to row crops depending on location, assuming that 2.5 acre feet of water infiltrated and was used by the crop (Table 4). Unfortunately the total reduced nitrogen in the irrigation water from suspended organic material and microbes was not estimated because the analytical results were too close to the laboratory detection limit to allow proper estimates. Actual nutrient contributions in the irrigation water would also vary with the crop, since crop evapotranspiration varied from about two acre-feet/acre for onions or dry beans to nearly four acre-feet/acre for alfalfa.

Dacthal di-acid residues in the irrigation water were measured only one time during the season without replication. Dacthal di-acid concentrations appeared to increase with length down the distribution system (Table 5). The abnormally high concentration of Dacthal di-acid in the Stewart-Carter ditch on April 25, 1991 has not been explained.

Conclusions

As the water proceeded along the irrigation ditches, nitrate-N, ammonium-N, phosphate-P, and soluble salts increased, probably because of return flow. Nutrient concentrations in the irrigation water varied during the irrigation season. Nutrient contributions of nitrate-N, ammonium-N, and phosphate-P from irrigation water to row crops is only a minor addition to crop nutrient requirements; however, well-water at the Malheur Experiment Station could contribute 47 lb N per acre per year. The contribution of organic-N in irrigation water was not successfully measured in this study.

Literature Cited

1. Carter, D.L., M.J. Brown, and J.A. Bondurant. 1976. Sediment-phosphorus relations in surface runoff from irrigated lands. Proc. Third Federal Inter-Agency Sedimentation Conf., p. 3-41 to 3-52.

2. Hobson, J., C.C. Shock, T. Stieber, J. Banner, L. Jensen, and M. Saunders. 1990. Mechanical straw mulching to reduce phosphorous pollution in irrigation run-off water. Report to USDA, SBIR, CSRS, Agreement No 90-33610-5127.

3. Zimmer, D.W. and J.E. Glover. 1980. Algae blooms and phosphorous loading in Lake Lowell. Water and Power Resource Service, Boise, Idaho.

Table 3. Average properties of the irrigation water from several Malheur County sources, 1991.

		Nitrate-N	Ammonium-N	Phosphate-P	pH	Soluble Salts
		----- ppm	-----			mMhos
Nyssa Ditch						
	1. Start	0.26	0.14	0.063	8.35	0.29
	2. Before Snake River inflow	0.45	0.24	0.060	8.33	0.35
	3. After Snake River inflow	0.60	0.25	0.066	8.33	0.37
	4. Malheur Experiment Station	1.06	0.41	0.127	8.10	0.43
	5. Vista Ave.	0.97	0.69	0.147	8.12	0.41
Old Owyhee Ditch						
	1. Start	0.26	0.14	0.063	8.35	0.29
	2. Before Snake River inflow	0.56	0.28	0.090	8.33	0.31
	3. After Snake River inflow	0.53	0.36	0.087	8.28	0.33
	4. Gem Ave.	0.53	0.48	0.115	8.05	0.37
	5. Clark Blvd. endpoint	0.78	0.55	0.145	8.15	0.50
	6. Stewart-Carter Ditch	1.88	0.39	0.145	8.25	0.39
Other Water Sources						
	1. Snake River	0.59	0.32	0.073	8.35	0.35
	2. Warmsprings Ditch, Clark Blvd.	1.28	0.60	0.145	8.18	0.52
	3. MES irrigation well #1	7.02	0.15	0.103	7.83	0.95
LSD (0.05) site		0.20	0.19	0.065	‡	0.12

‡ different at 94% confidence.

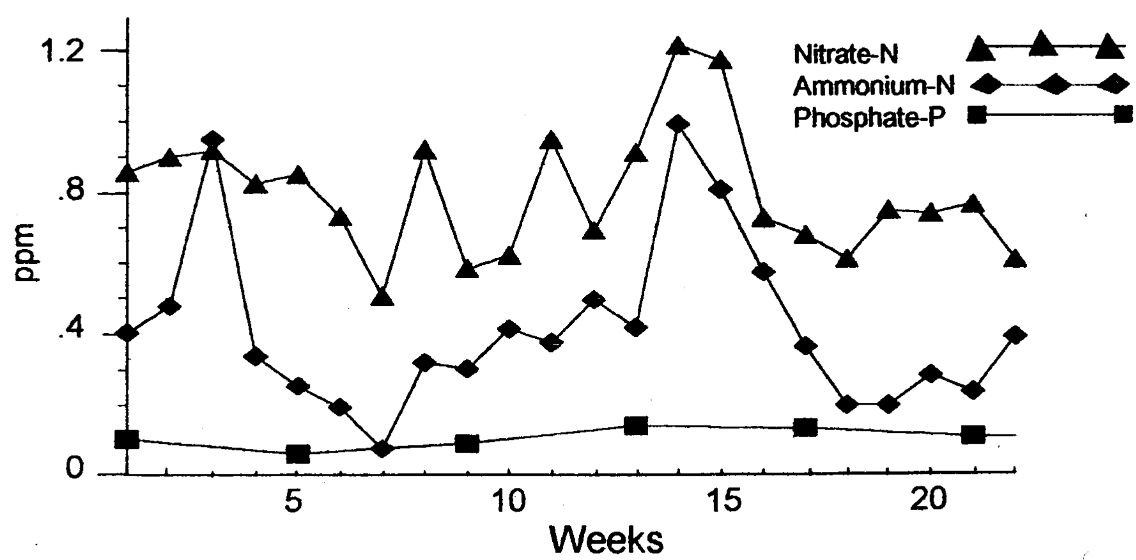
Table 4. Nutrient contribution by irrigation to Malheur County crops in 1991 assuming the infiltration and use of 2.5 acre feet of water.

		Nitrate-N	Ammonium-N	Phosphate-P
		----------	lb/acre	----------
Nyssa Ditch				
	1. Start	1.76	0.95	0.42
	2. Before Snake River inflow	3.04	1.62	0.40
	3. After Snake River inflow	4.05	1.69	0.45
	4. Malheur Experiment Station	7.16	2.77	0.86
	5. Vista Ave.	6.55	4.66	0.99
Old Owyhee Ditch				
	1. Start	1.76	0.95	0.43
	2. Before Snake River inflow	3.78	1.89	0.61
	3. After Snake River inflow	3.58	2.43	0.59
	4. Gem Ave.	3.58	3.24	0.78
	5. Clark Blvd. endpoint	5.27	3.71	0.98
	6. Stewart-Carter Ditch	12.67	2.63	0.98
Other Water Sources				
	1. Snake River	3.98	2.16	0.49
	2. Warmsprings Ditch, Clark Blvd.	8.64	4.05	0.98
	3. MES irrigation well #1	47.39	1.01	0.70
LSD (0.05) site		1.35	1.28	0.44

Table 5. Dacthal di-acid residue in the irrigation canal system, northeastern Malheur County, Oregon, April 25, 1991. Results were from one non-replicated sample.

		ppb
Nyssa Ditch		
	2. Before Snake River water inflow	0
	4. Malheur Experiment Station	1.6
	5. Vista Ave.	3.5
Old Owyhee Ditch (catches	runoff from above)	
	2. Before Snake River water inflow	0
	3. At Gem Ave.	1.5
	5. Clark Blvd. endpoint	3.1
	6. Stewart-Carter Ditch	91

Figure 1. Weekly trends of nitrate-N, ammonium-N, and phosphate-P in Malheur County irrigation water averaged over twelve sampling sites, 1991.



LSD (0.05) nitrate-N over time = 0.28 ppm
LSD (0.05) ammonium-N over time = 0.25 ppm
LSD (0.05) phosphate-P over time = 0.046 ppm

WEED CONTROL IN SWEET CORN

Charles E. Stanger and Joey Ishida
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Purpose

Herbicides were applied as preplant incorporated and postemergence applications to Jubilee variety sweet corn to evaluate herbicide effectiveness for crop tolerance and control of annual broadleaf and grassy weeds.

Procedures

Preplant herbicides were applied on May 15 to Owyhee silt loam soils and incorporated with the upper 3 inches of soil using a power driven roto-tiller. The tiller was operated over the preplant plots twice to assure thorough incorporation. The soils had 1.2 percent organic matter with a pH of 7.3. Jubilee variety sweet corn was planted on May 16 and furrow irrigated on the same day. Corn was planted in rows spaced 30 inches apart using a John Deere Model 70 flexi-planter. The preplant herbicides included Dual, Atrazine, Battalion, and Lasso.

The postemergence herbicide treatments were applied on June 1. The corn plants were about 6 inches tall. Weeds included barnyardgrass, green foxtail, pigweed, lambsquarters, hairy nightshade, and kochia. Grasses had 1-5 leaves. Broadleaf weeds were 2 inches tall. Air temperature was 91°F and soil temperature at the 4-inch depth was 82°F. The crop was irrigated again following the application of postemergence treatments. Herbicides applied postemergence included Accent, Atrazine, Buctril, Banvel, and Permit, applied as tank-mixed combinations applied at various rates.

Individual plots were eight rows wide and 40 feet long. Each treatment was replicated three times. The experimental design was a randomized complete block. All herbicide treatments were applied using a single wheel bicycle plot sprayer. Preplant treatments were applied as broadcast double-overlap applications. Postemergence treatments were applied as banded applications using a four nozzle boom with a spray nozzle centered over the planted row. Spray nozzles were fan teejet size 8002. Spray pressure was 42 psi and water volume applied in broadcast treatments was 32 gallons/acre. For postemergence treatments water volume was 21 gallons/acre.

Visual ratings for crop injury and percent weed control were recorded on June 9. The corn was taken through harvest. Twenty-five ears were pulled from each plot treated with Accent herbicide to evaluate for deformed ears.

Results

Symptoms from herbicide injury occurred with all treatments except for the preplant application of Dual plus Atrazine at two plus two lbs ai/ac. The most severe symptoms occurred with Permit, Battalion, and with Buctril used in tank-mix combinations. In all cases the corn soon outgrew the symptoms without affecting corn growth, development, maturity date, or ear yields. Accent did not cause corn ears to become deformed. All ears were well developed and straight. The treatment giving the best control of both broadleaf and grassy weeds was the tank-mix combination of Dual and Atrazine, and the high rate of Battalion with Lasso. Accent in tank-mix combinations with either Atrazine, Buctril, or Banvel applied postemergence resulted in excellent broadleaf weed control, but gave only partial control of barnyardgrass and green foxtail (Table 1). Permit applied alone was quite ineffective for both broadleaf and grass control. It was most active on redroot pigweed giving about 87 percent control of this weed species. It was least active on hairy nightshade and grasses. Battalion controlled all redroot pigweed and lambsquarters, but had very little herbicidal activity on hairy nightshade, barnyardgrass, or green foxtail.

Table 1. Percent crop injury and weed control for preplant and postemergence herbicide treatments to Jubilee variety of sweet corn. Malheur Experiment Station, Oregon State University, Ontario, Oregon 1992.

							Percent Weed Control																			
	Rate		Crop Injury				Pigweed				Lambsquarters				H. Nightshade				Barnyardgrass				Green Foxtail			
Herbicides	lbs ai/ac	Applied	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
Accent + Atrazine	0.03125+1.0	Post	0	20	10	10	100	100	100	100	100	100	100	100	100	100	100	100	80	85	85	83	85	90	85	87
Accent + Buctril	0.03125+0.375	Post	20	25	20	22	100	100	100	100	100	100	100	100	100	100	100	100	75	75	75	75	80	80	80	80
Accent + Buctril + Atrazine	0.03125+0.25+.075	Post	20	20	20	20	100	100	100	100	100	100	100	100	100	100	100	100	90	80	85	85	95	85	90	90
Accent + Banvel	0.03125+0.25	Post	0	10	20	10	100	100	100	100	100	100	100	100	100	100	100	100	95	80	80	85	98	85	85	89
Accent + Banvel + Atrazine	0.03125+0.25+0.55	Post	0	15	20	11	100	100	100	100	100	100	100	100	100	100	100	100	65	70	65	67	68	80	80	76
Permit + X-77	0.016	Post	10	20	10	13	85	85	85	85	80	50	40	57	45	60	75	60	20	25	20	22	20	30	20	23
Permit + X-77	0.032	Post	20	20	10	17	90	90	80	87	50	50	50	50	45	20	20	28	50	20	20	30	60	25	20	35
Permit + Accent + X-77	0.016+0.03125	Post	20	40	15	25	90	90	85	88	50	65	75	63	80	60	80	73	85	65	85	78	85	65	85	78
Dual + Atrazine	2.0+2.0	PPI	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	98	99	99	100	99	100	99
Dual	4.0	PPI	0	10	10	7	100	98	100	99	100	95	100	98	98	95	95	96	100	100	98	99	100	100	99	99
Battalion	0.065	PPI	0	0	20	7	90	90	95	92	45	70	45	53	45	40	30	38	40	30	30	33	40	30	35	35
Battalion	0.075	PPI	25	20	20	22	100	100	100	100	100	100	100	100	20	25	20	22	20	20	30	23	20	20	45	28
Battalion + Lasso	0.065+4.0	PPI	10	10	15	12	100	100	100	100	100	100	100	100	85	85	90	87	100	99	99	99	100	99	100	99
Battalion + Lasso	0.075+4.0	PPI	10	20	25	18	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	96	99	98
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 June 9 - 8 days following application of postemergence treatments.

Ratings: 0 = no herbicide effect, 1-50 = reduction in plant growth because of herbicide injury, 100 = all plants killed.

SWEET WORMWOOD (ARTEMISIA ANNUA) RESEARCH AT ONTARIO IN 1991

Erik Feibert, Clint Shock and Monty Saunders
Malheur Experiment Station
Oregon State University
Ontario, Oregon

Introduction

Sweet wormwood (Artemisia annua), a highly aromatic annual herb of the Compositae family, has potential value as a source of artemisinin. Artemisinin is a secondary plant compound (sesquiterpene lactone) that has been found to have strong anti-malarial properties with little or no side effects (Klayman, 1985). New anti-malarial drugs are important due to the increasing resistance of the malaria-causing protozoans to current drugs (WHO, 1981). Artemisinin can be synthesized; however, the synthetic compound is unlikely to be economically competitive with the naturally produced compound (Scmid and Hofheinz 1983; Xu et al. 1986). Eighty-nine percent of the total artemisinin in the plant is found in the leaves (Charles et al., 1989).

This research has shown that Artemisia annua is adapted to local conditions. Past research at Ontario has investigated the effects of different herbicides on leaf artemisinin content. The effect of soil moisture stress on leaf artemisinin content was also investigated along with post-harvest handling methods and their effects on leaf artemisinin content.

The biochemical pathways to the synthesis of gibberellic acid and sesquiterpenes are competitive, and inhibition of gibberellic acid synthesis by growth regulators can increase the production of artemisinin (Kudakasseril et al., 1986). Soil moisture stress and nitrogen availability to the plant can also affect secondary compound levels (Simon et al., 1990).

This report includes results of the effects of soil moisture stress, nitrogen fertilizer level, plant growth regulators (PGR's), and harvest timing on leaf yield and leaf artemisinin content.

General Procedures

The 1991 trials were conducted on a Nyssa silt loam previously planted to winter wheat. A soil test taken on March 20 showed a pH of 8.2, cation exchange capacity of 24 meq/100 g, 1.8 percent organic matter, 4.6 ppm ammonium, 15 ppm nitrate, 22 ppm phosphorus, 400 ppm potassium, 695 ppm magnesium, 248 ppm sodium, 1.5 ppm zinc, 1.9 ppm iron, 1.5 ppm manganese, 0.3 ppm copper, 41 ppm sulfate, and 0.7 ppm boron. Sonalan at 1.25 lb ai/acre was applied on March 28. Artemisia seed collected from two individual plants in 1990 was blended then directed seeded on March 29 at 3 ounces/acre with a John Deere Flexi-planter using easyflows to drop the seed on the soil surface with 44 inches between rows. Poast at 0.25 lb ai/acre was applied on May 1 to kill volunteer wheat. A combination of rainfall and furrow irrigation kept the soil surface moist until emergence on May 10. The seedlings were thinned on June 17 to 20 inches apart on the bed. Prowl at 1.5 lb ai/acre was applied on June 20 for weed control. The trials were sidedressed with zinc sulfate at 0.25 lb zinc/acre on June 27. Poast at 0.25 lb ai/acre was again sprayed on June 25 for weed control.

The experimental design for each trial was a randomized complete block. The nitrogen fertilizer, PGR, and harvest timing trials were furrow irrigated as necessary. The soil water stress trial was harvested on August 14, and the nitrogen fertilizer and PGR trials were harvested on August 15. Fifteen plants from the middle row in each plot were cut at soil level for harvest sample. The plants were weighed and stored in a barn to air dry immediately after harvest. The leaves were removed from the plants by hand and weighed. A subsample was sent to Purdue University in West Lafayette, IN for analysis of artemisinin content by high pressure liquid chromatography (HPLC).

Soil Water Stress Trial

The experimental design consisted of four soil water stress treatments (Table 1) replicated five times. The plots were three beds wide by 90 feet long. Ten plants in each plot were chosen and measured for height on July 10, July 29, and August 13. Soil water potential was monitored by two granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) placed 6 inches below the soil surface in the plant row, and two GMS placed 18 inches below the soil surface in the plant row. The GMS had been previously calibrated to soil water potential at this site. The GMS were read five days a week at 8:00 am. Plots were furrow irrigated when the average soil water potential in the plots of a treatment reached that treatment's criterion. The soil water stress treatments for the soil moisture stress trial were started on July 9.

Nitrogen Fertilization Trial

A soil sample taken March 20 showed 166 lbs of nitrate-N in the top 2 feet of soil. The experimental design consisted of three nitrogen fertilizer rates (0, 45, and 135 lb N/ac) applied June 27 and replicated six times (Table 2). The plots were four beds wide by 50 feet long. Ten plants in each plot were chosen and measured for height on July 10, July 29, and August 13.

Plant Growth Regulator Trial

The experimental design consisted of four plant growth regulators at two rates, and one check treatment replicated four times in a split plot design (Table 3). The plots were four beds wide by 50 feet long. The high rate of each chemical was sprayed on the two north rows and the low rate sprayed on the two south rows of each plot. The plant growth regulators tested were Cyclocel (Cyanamid, Wayne, NJ), Spotless (Valent USA Corporation, Walnut Creek, CA), and Paclobutrazol (Uniroyal Chemical, Middlebury, CT), all of which are gibberellic acid synthesis inhibitors and Gibgro (Agtrol Chemical Products, Houston, TX), which is a gibberellic acid. Urea at 45 lbs N/acre was sidedressed on June 27. The plant growth regulators were sprayed on July 8 using a backpack sprayer with four 8002 nozzles. Ten plants in the middle of each plot were chosen and measured for height on July 10, July 29, and August 13.

Harvest Timing Trial
The experimental design consisted of four harvest dates replicated five times (Table 4). Ten plants from each replicate were harvested on July 3, July 24, August 13, and September 4. The plants were measured, cut at ground level, weighed, and air dried in a barn.

Results and Discussion

Effect of Soil Water Stress
The attempt to maintain soil water potential wetter than -50 kPa was not completely successful because water uptake by this soil type was very poor (Figure 1). Water was kept running almost continuously in the furrows in the attempt to maintain soil water potential above -50 kPa throughout the trial period. Soil water potential drier than -50 kPa resulted in a significant increase in the whole plant dry weight to fresh weight ratio (Table 1). Soil moisture stress did not have any significant effect on any of the other measurements. However, the highest total fresh plant yield and the dry leaf yield were highest with the wettest treatment.

Effect of Nitrogen Fertilization
Nitrogen fertilization at 45 lbs N/acre resulted in a significant increase in plant height (Table 2). Nitrogen fertilization did not have any significant effect on any of the other measurements. However, there is a trend for increases in total fresh plant yield and dry leaf yield with nitrogen fertilization.

Effect of Plant Growth Regulators
The application of several plant growth regulators significantly reduced the growth in height and increased total fresh plant yield, but not as expected (Table 3). The low rate of Gibgro and the high rate of Spotless resulted in significant reductions in plant growth. Paclobutrazol at the low and high rate resulted in significant increases in total plant fresh yield.

Effect of Harvest Timing
Fresh plant yield, dry plant yield, dry leaf yield, percent artemisinin, and artemisinin yield all increased with time (Table 4, Figures 1,2,3,4). The highest artemisinin content and artemisinin yield were obtained at the last harvest date on September 4 (117 days after emergence). The plants had flower buds that were close to opening on the last harvest date. Interpretation of these results appears to be complicated because the 1990 harvest timing trial results showed highest artemisinin content with a July 26 harvest (111 days after planting)(Charles et al., 1991). Plant age as well as reproductive stage may influence artemisinin content.

Estimate of Error of Artemisinin analysis
The standard deviation of the artemisinin analytical procedure was 0.031.

Conclusions

Plant growth, leaf yield, leaf artemisinin content, and yields appear to be unaffected by soil moisture stress and nitrogen fertilization. This suggests that sweet wormwood could be grown with low water and nitrogen fertilizer inputs. Likewise, the results of these trials suggest that the plant growth regulators at the rates used here resulted in little increase in artemisinin yield.

The results of the harvest timing trial suggest that artemisinin content and yield varies with growth stage, plant age, or other climatic factors.

Acknowledgements

Artemisinin analyses were conducted by Denys Charles and Dr. Jim Simon in the Department of Horticulture, Purdue University.

Literature cited

Charles, D.J., J.E. Simon, K.V. Wood, and P. Heinstein. 1989. An improved, rapid and sensitive method for artemisinin analysis in crude plant extracts of Artemisia annua L. J. Nat. Prod. 53(1): 157-160.

Charles, D.J., J.E. Simon, and C.C. Shock, and E.B.G. Feibert. 1993. Effect of post-harvest handling and water stress on artemisinin content. In: Advances in New Crops II. (in press). Timber Press, Portland, OR.

Klayman, D.L. 1985. Qinghaosu (artemisinin): an antimalarial drug from China. Science 228: 1049-1055.

Kudakasseril, G.J., L. Lam and E.J. Staba, 1987. Effect of sterol inhibitors on the incorporation of ^{14}C-Isopentenyl pyrophosphate into Artemisinin by a cell-free system from Artemsia annua tissue cultures and plants. Planta Medica pp. 280-284.

Schmid, G. and W. Hofheinz. 1983. Total synthesis of Qinghaosu. J. Am. Chem. Soc. 105: 624-625.

Simon, J.E., D. Charles, E. Cebert, L. Grant, J. Janick, and A. Whipkey, 1990. Artemisia annua L. : A promising aromatic and medicinal, p. 522-526. In: Janick, J. and J.E. Simon (eds.) Advances in New Crops. Timber press, Portland, OR.

World Health Organization. 1981. Report of the fourth meeting of the scientific working group on the chemotherapy of malaria. Beijing, People's Republic of China, October 6-10, 1981.

Xu, X., J. Zhu, D. Huang, and W. Zhou. 1986. Total synthesis of arteannuin and deoxyarteannuin. Tetrahedron 42: 819-828.

Table 1. Effect of soil moisture stress on vegetative characteristics and leaf artemisinin content of Artemisia annua. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

Treatment irrigation criterion	Total growth	Total fresh plant yield	Leaf to top dry weight ratio	Dry to fresh weight ratio	Dry leaf yield	Leaf artemisinin content	Artemisinin yield
	cm	lbs/ac			lbs/ac	%	lbs/ac
-50 kPa	136	19666	0.28	0.31	1700	0.111	1.89
-100 kPa	141	16514	0.29	0.33	1533	0.120	1.88
-150 kPa	133	16749	0.29	0.33	1636	0.108	1.80
-50, then -150 kPa last two weeks	139	17326	0.28	0.33	1602	0.109	1.74
LSD(0.05) Trt.	ns	ns	ns	0.01	ns	ns	ns

Table 2. Effect of nitrogen fertilization on vegetative characteristics and leaf artemisinin content of Artemisia annua. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

N fertilizer treatment	Total growth	Total fresh plant yield	Leaf to Top dry weight ratio	Dry to fresh weight ratio	Dry leaf yield	Leaf artemisinin content	Artemisinin yield
lbs N/ac	cm	lbs/ac			lbs/ac	%	lbs/ac
0	139.5	19795	0.29	0.29	1680	0.12	2.07
45	149.2	21365	0.30	0.29	1853	0.11	2.05
134	154.5	24168	0.29	0.30	2067	0.13	2.58
LSD(0.05) Trt.	9.7	ns	ns	ns	ns	ns	ns

Table 3. Effect of plant growth regulators on vegetative characteristics and leaf artemisinin content of Artemisia annua. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

Treatment	Product rate	Active ingredient rate	Total growth	Total fresh plant yield	Leaf to top dry weight ratio	Dry to fresh weight ratio	Dry leaf yield	Leaf artemisinin content	Artemisinin
	oz/ac	oz/ac	cm	lbs/ac			lbs/ac	%	lbs/ac
Check	none	none	160	22286	0.28	0.34	2027	0.082	1.66
Gibgro	0.21	0.008	147	25438	0.28	0.31	2171	0.083	1.80
	2.1	0.08	148	26458	0.36	0.36	3658	0.079	2.71
Cyclocel	0.034	0.004	157	23657	0.28	0.30	1978	0.071	1.40
	0.34	0.04	149	24538	0.28	0.30	2059	0.080	1.65
Spotless	4	1	153	26333	0.29	0.30	2238	0.073	1.62
	40	10	146	25294	0.29	0.29	2156	0.084	1.80
Paclobutrazol	0.0008	$3.2X10^{-6}$	152	27236	0.29	0.30	2327	0.079	1.83
	0.008	$3.2X10^{-5}$	160	27976	0.28	0.30	2275	0.076	1.73
LSD(0.05) Trt.			13	4208	ns	ns	ns	ns	ns

Table 4. Vegetative characteristics and artemisinin yield for Artemisia annua stages of growth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

Harvest date	Days to harvest*	Total plant fresh weight	Total top dry weight	Leaf dry weight	Leaf artemisinin content	Artemisinin yield
		- - - - - - - - - - lbs/acre	- - - - - - - - -		%	lbs/acre
July 3	54	3046	637	304	0.132	0.41
July 24	75	13439	3504	1209	0.171	2.03
August 13	95	23856	6921	2106	0.170	3.56
September 4	117	38548	13077	3297	0.192	6.28
LSD(0.05) Trt.		4410	1405	417	0.028	0.53

* from emergence

Figure 1. Variation in soil water potential of four irrigation treatments for the production of sweet wormwood. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

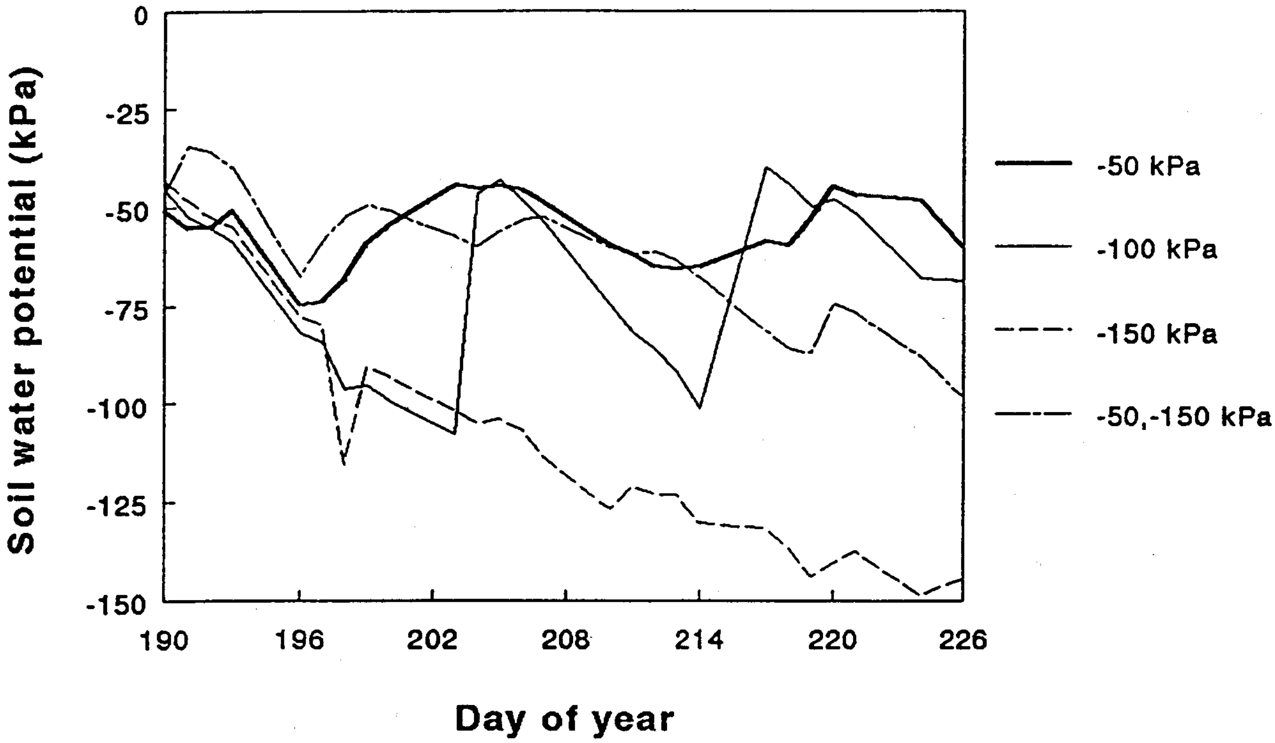


Figure 2. Sweet wormwood plant top fresh weight development over time. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

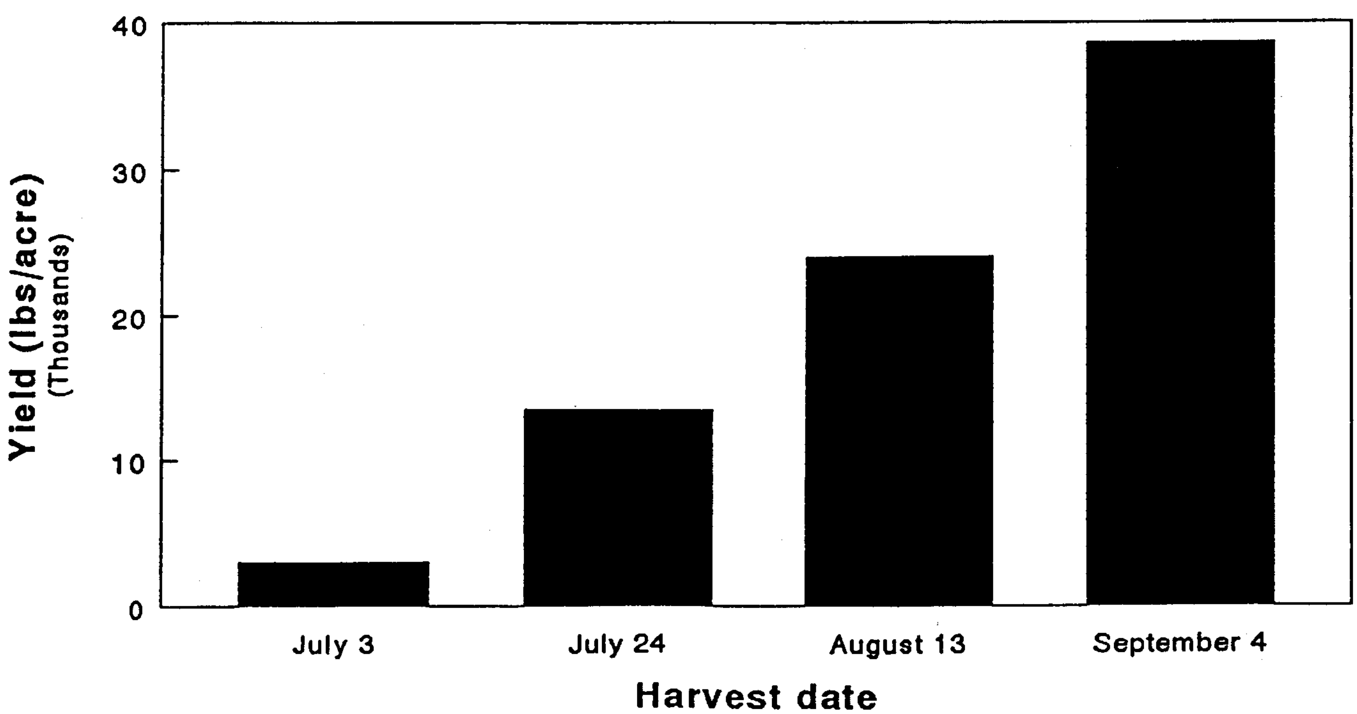


Figure 3. Sweet wormwood total plant top dry weight and leaf dry weight development over time. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991.

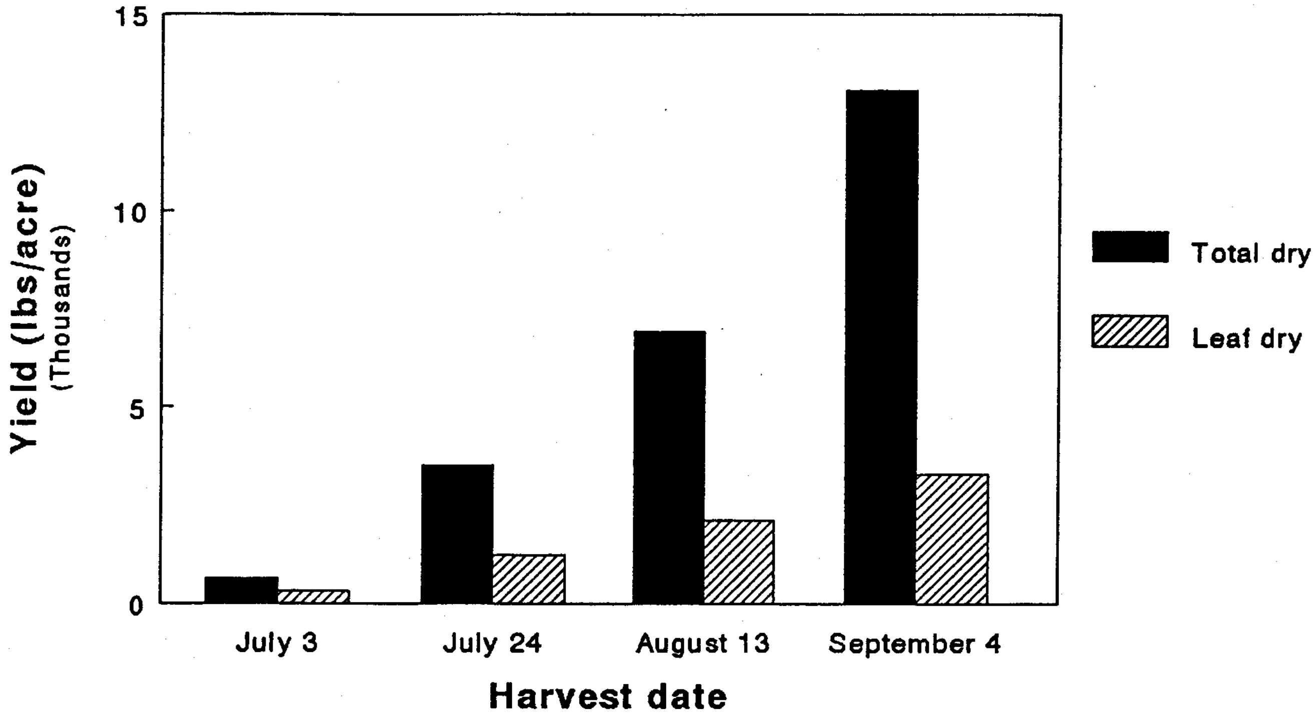


Figure 4. Artemisinin content of sweet wormwood leaves collected at four successive harvest dates during the 1991 season. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

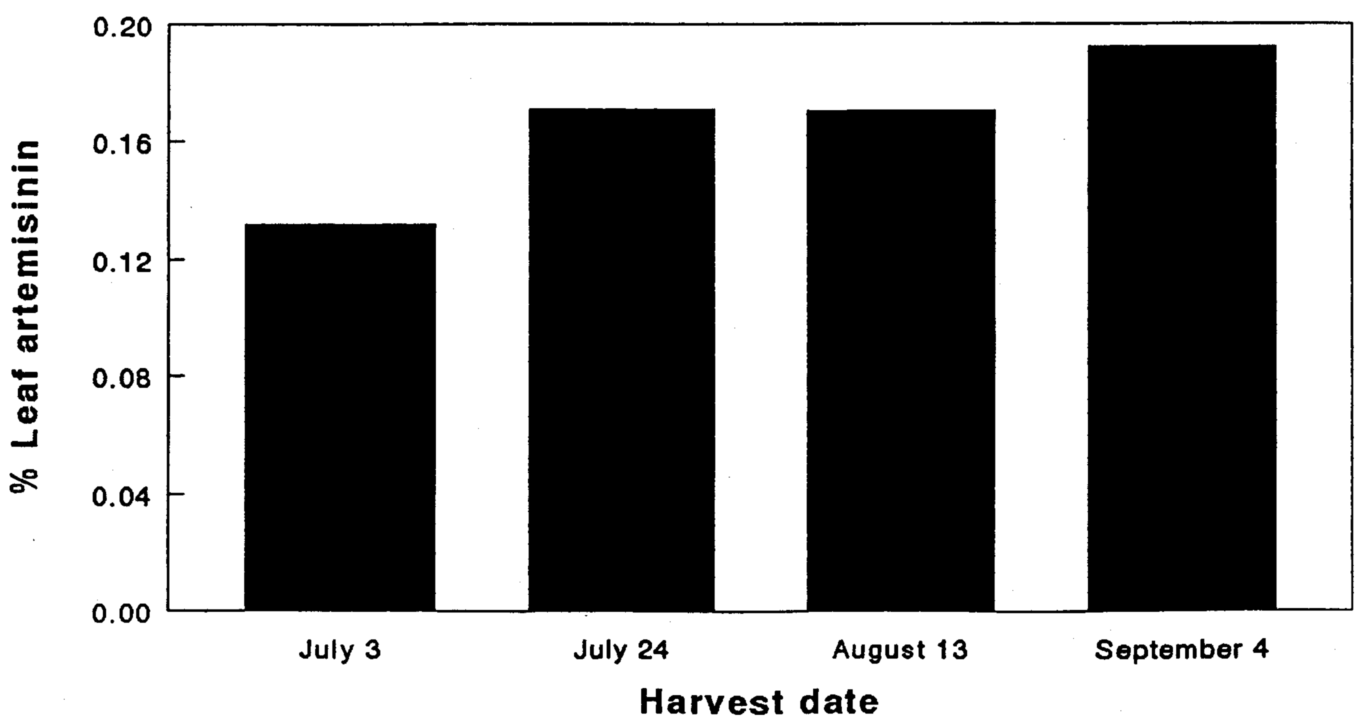
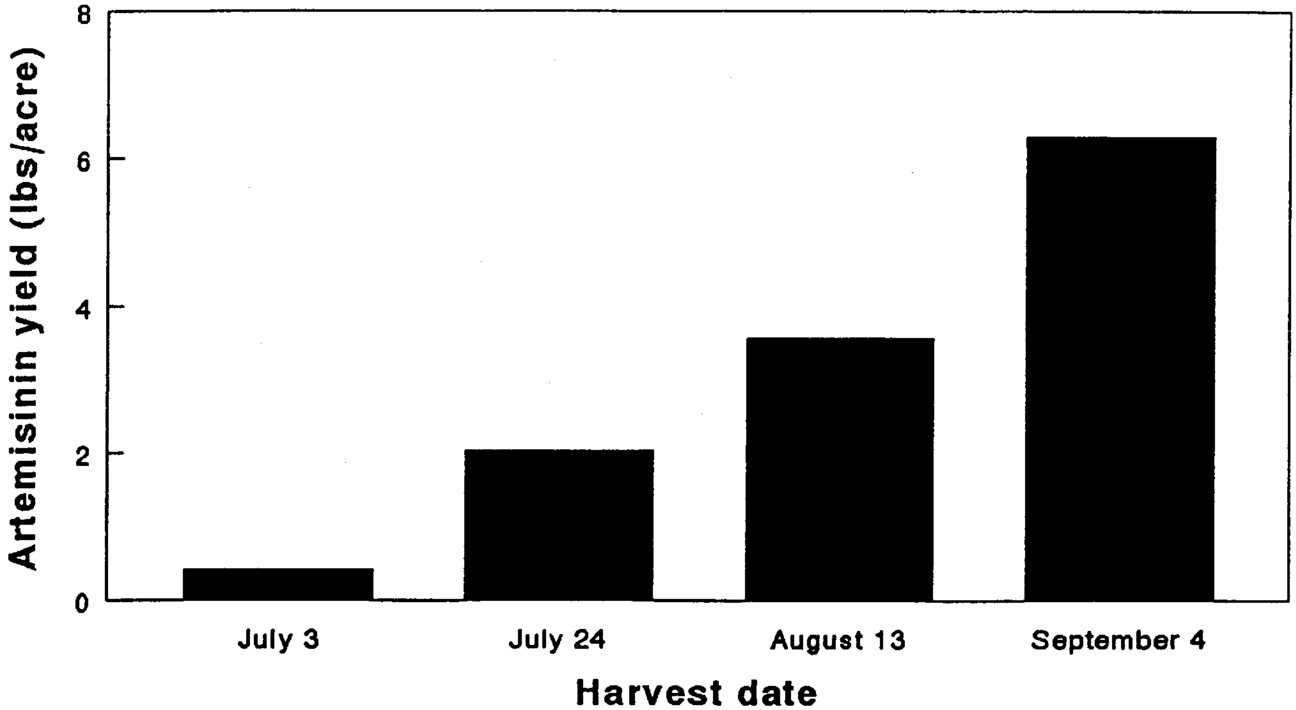


Figure 5. Total artemisinin yield from sweet wormwood leaves collected at four successive harvest dates during the 1991 season. Malheur Experiment Station, Oregon State University, Ontario, Oregon.



BROADLEAF WEED CONTROL IN WINTER WHEAT

Charles E. Stanger and Joey Ishida
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Purpose

Buctril, Bronate, 2,4-D, and Banvel herbicides were applied singly and in tank-mix combinations with Harmony-Extra to evaluate these herbicides at various rates for broadleaf weed control. The tolerance of Stephens variety winter wheat to the various herbicide combinations and application rates was also evaluated.

Procedure

Stephens variety of winter wheat was planted on October 23, in silt loam soil with a pH of 7.3 and 1.1 percent organic matter. Sugar beets were the previous crop. Following sugar beet harvest, the field was moldboard plowed and the seedbed prepared for planting wheat with a groundhog. Sixty lbs of phosphate and 100 lbs of nitrogen per acre were broadcast applied before plowing. After planting, the field was rill irrigated.

The herbicides were applied on April 3. Wheat plants had 4-5 tillers. Weed species included tansy and tumbling mustard, prostrate knotweed, kochia, lambsquarters, pigweed, and hairy nightshade. The sizes of weeds at time of spraying are as follows for each weed species: tansy and tumbling mustards, 6-8 inch rosettes; kochia, 3-4 inches tall; lambsquarters and pigweed, 2-3 inches tall; and hairy nightshade 1-2 inches tall. Herbicides were applied as double overlap broadcast applications using a single bicycle wheel plot sprayer, and 9-foot long boom, with 8002 fan teejet nozzles. Spray pressure was 42 psi and a water volume of 28 gallons per acre was applied. When spraying, air temperature was 80°F, soil temperature at 4-inches depth was 64°F, soil surface was moist following an irrigation, skies were clear, and wind was calm. Individual plot size was 9 x 35 feet and each treatment was replicated three times. Experimental plot design was a randomized complete block. The treatments were evaluated for crop injury on April 10 and June 8, 1992. The trial was harvested on August 5 using a plot harvester. The harvested area was a 4-foot swath taken from the center of each 35 foot long plot. The harvest wheat was cleaned and weighed, and wheat yields were calculated as bushels/acre.

Results

Visual ratings did not indicate crop injury from herbicide treatments (Table 7), although significant differences in grain yields were measured. Although grain yield differences were measured between treatments, the yield differences are likely due to soil variations within the trial area rather than herbicide injury. Weed control was good with all treatments at better than 90 percent (Table 1). The gel formulation of Buctril (EX 30973A) was as active as the emulsifiable concentrate (EC) formulation, and crop safety and weed control was comparable. Consistently good herbicide treatments for weed control included Bronate (1 lb), Bronate plus Harmony-Extra, Banvel with MCPA and Urea nitrogen, and Banvel plus 2,4-D amine, Buctril, or Harmony-Extra. Weed density in untreated check plots was great enough to result in the lowest grain yield, although differences between yields in the untreated check were not significantly different from some plots receiving herbicide treatments.

Table 1. Percent weed control and crop injury ratings for herbicides applied to Stephens wheat for broadleaf weed control. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

					Percent Weed Control																				
	Rate	Crop Injury			Tansy			Tumbling			Kochia			Lambsquarters			Pigweed			Knotweed			H. Nightshade		
Herbicides	lbs ai/ac	5	14	28	5	14	28	5	14	28	5	14	28	5	14	28	5	14	28	5	14	28	5	14	28
2,4-D + Harmony-Extra	0.25+0.016	0	0	0	60	95	100	60	90	95	75	95	100	80	100	100	70	90	100	45	75	90	70	95	100
EX 30973A	0.25	0	0	0	70	98	100	70	95	100	70	93	98	80	100	100	65	80	92	40	75	90	70	95	100
Buctril EC	0.25	0	0	0	70	95	100	70	95	100	70	90	98	80	100	100	65	80	90	40	75	90	70	95	100
Banvel + 2,4-D amine	0.125+0.375	0	0	0	60	94	99	60	90	96	60	85	96	70	90	98	60	90	96	60	85	100	60	80	96
Bronate	0.75	0	0	0	75	95	99	75	98	100	75	90	93	80	100	100	70	93	100	60	75	93	80	90	98
Bronate	1.0	0	0	0	75	98	100	75	98	100	75	98	100	80	100	100	70	98	100	60	80	95	80	98	100
Bronate + Harmony-Extra	0.375+0.016	0	0	0	75	100	100	75	100	100	75	100	100	80	100	100	80	100	100	65	85	95	80	98	100
Bronate + Harmony-Extra	0.5+0.016	0	0	0	80	100	100	75	100	100	75	100	98	80	100	100	80	100	100	65	88	92	80	98	98
2,4-D amine	0.75	0	0	0	60	85	95	960	80	92	60	80	92	60	83	98	60	85	96	65	75	90	60	75	95
2,4-D amine	1.0	0	0	0	60	90	95	60	90	95	60	85	92	60	85	98	60	88	98	65	80	92	60	80	95
Banvel + MCPA	0.125+0.375	0	0	0	70	93	98	65	93	98	65	90	98	60	92	99	70	92	98	60	83	100	60	80	98
Banvel + Urea + Surfactant	0.125+30+0.25%	0	0	0	80	98	98	80	99	96	80	95	96	80	95	99	85	95	98	75	90	100	75	90	96
Bronate + Stinger	0.75+0.125	0	0	0	75	95	100	75	98	100	75	88	94	80	100	100	80	100	100	65	75	90	80	93	96
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 5, 14 and 28 days after herbicides applied. Average of 3 replications

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

Table 2. Wheat yields from herbicides applied to Stephens variety of winter wheat for control of broadleaf weeds. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

	Plot Weights (lbs)					
	Rate				Mean	Total Yield
Herbicides	lbs ai/ac	R1	R2	R3	Plot wts	bu/ac
2,4-D + Harmony-Extra	0.25+0.016	32.34	33.42	31.22	32.33	167.8
EXP 30973A	0.25	32.28	31.57	31.71	31.85	165.3
Buctril EC	0.25	30.89	31.50	32.71	31.70	164.5
Banvel + 2,4-D amine	0.125+0.375	32.51	30.64	31.83	31.66	164.3
Bronate	0.75	29.59	30.73	30.81	30.38	157.7
Bronate	1.0	31.24	31.22	30.68	31.05	161.2
Bronate + Harmony-Extra	0.375+0.016	30.41	31.61	30.31	30.78	159.8
Bronate + Harmony-Extra	0.5+0.016	29.69	30.43	29.12	29.75	154.4
2,4-D amine	0.75	30.80	30.58	30.84	30.74	159.5
2,4-D amine	1.0	29.08	30.95	30.02	30.02	155.8
Banvel + MCPA	0.125+0.375	31.22	30.10	31.09	30.80	159.8
Banvel + Urea + Surfactant	0.125+30+.25%	31.75	29.61	29.08	30.15	156.5
Bronate + Stinger	0.75+0.125	30.43	29.27	30.14	29.95	155.4
Untreated Check	—	31.14	29.91	26.98	29.34	152.3
LSD.05					1.68	8.7
CV (%)					3.25	3.25
Mean					30.68	159.2

SPRING WHEAT PERFORMANCE AND NITROGEN RECOVERY FOLLOWING ONIONS

Clinton C. Shock, John G. Miller,
Lamont D. Saunders and Tim D. Stieber
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Objectives

Describe the ability of spring wheat to recover residual nitrate and ammonium following onions. Improve the efficiency of N fertilization of small grains. Develop guidelines to help growers utilize the ability of small grains to extract topsoil and subsoil nitrogen sources, thereby substituting for costly fertilizer nitrogen, reducing nitrate leaching loss through the soil profile, and improving groundwater quality.

Introduction

Shallow rooted crops such as onions and potatoes are relatively inefficient in taking up fertilizer nitrogen, permitting the possibility of nitrate accumulation in the soil. With water percolation, nitrate can move to the subsoil. Subsoil nitrate can accumulate and be subject to leaching losses to the groundwater. In Malheur County shallow rooted crops such as onions and potatoes are planted in rotation with deeper rooted crops such as wheat, barley, and sugar beets. These rotation crops are generally also fertilized with adequate nitrogen to produce optimal yields. Yet these crops may have the capability to efficiently recover residual nitrate including subsoil nitrates. Fertilization recommendations for deep rooted crops could be rewritten to optimize the use of residual nitrate and ammonium in the soil profiles, thereby reducing nitrate leaching to groundwater. Small grains could become an integral part of the solution to nitrate groundwater problems in Malheur County, through crop rotations to efficiently recover residual N fertilizer following shallow rooted crops.

Three trials, one in 1991 and two in 1992, tested the ability of spring wheat to utilize variable amounts of residual N in the form of nitrate and ammonium following nitrogen fertilizer trials on onions.

Procedures

During the 1990 and 1991 seasons, sweet spanish onions were fertilized with urea-based nitrogen fertilizers at the rates of 0, 50, 100, 200, and 400 lb N/ac. All onion trials had been preceded by unfertilized winter wheat to help even out N fertility differences in the field before testing N fertilizer treatments on onions. Nitrogen was applied to onions in the spring or summer as one application (broadcast or side dressed) or split-sidedressed. Trials in 1990 were conducted on an Owyhee silt loam that graded into a Greenleaf silt loam. The 1991 trials used an Owyhee silt loam bottom land and a Nyssa silt loam bench site.

Following onions, the soil was sampled during October and November in every plot in 1 foot increments to 6 feet deep. The soil sample for the top foot of soil consisted of a composite of 20 subsamples while the sample for each subsequent foot of soil consisted of a composite of four soil cores made with a Giddings hydraulic soil probe. Every composite soil sample from each plot was analyzed for nitrate-N and ammonium-N. Nitrate and ammonium analytical data were converted to lb N/acre using the soil volume and bulk density.

In 1991 Bliss spring wheat was planted at 120 lb/ac on March 28 and received 1 quart of Bronate and 1 pint of 2-4 D/ac on June 10 to control broadleaf weeds. In 1992 Treasure spring wheat was planted at 120 lb/ac on the Nyssa silt loam March 12, and on the Owyhee silt loam March 20. The spring wheat on the Owyhee silt loam was sprayed with 1 quart of Bronate/ac on April 23 to control broadleaf weeds. The crop received no other chemical inputs. Plant nutrient needs were met only by soil residual nutrients following onions.

Before harvest, a 1 square meter subsample of grain and stubble was cut out to estimate the ratio of grain to stubble, and the stubble was ground, subsampled, ground again, and analyzed for Kjeldahl N content. A 30 to 40 foot length of grain from the center of each plot was harvested with a Wintersteiger Nurserymaster plot combine to determine grain yield. A subsample of the grain was ground and analyzed for Kjeldahl N content. Following the grain harvest, the soil in the middle of each plot was sampled and analyzed in exactly the same way that it had been following onions the previous fall.

Calculations

The nitrogen content in the grain and stubble, the yield of grain, and the ratio of grain to stubble were used to calculate the amount of nitrogen contained in the crop at harvest.

Results and Discussion

Following onions, the average available N in the soil profile to 6 feet deep ranged from 209.5 lb N/ac in the untreated check plots to 458.6 lb N/ac in the onion plots that had received 400 lb N/acre (Table 1). The appearance of spring wheat grown ranged from medium yellow on the check plots with the lowest available-N to lush dark green. Averaged over three trials, spring wheat yields were the highest following onions receiving 100 and 200 lb N/ac (Table 2). Wheat yield and quality were reduced in the plots with the highest residual available N where 400 lb N/ac had been applied to onions (Table 2).

Spring wheat yield and plant N responses to residual N peaked at 100 to 200 lb N/ac applied to the preceding onion crop. By careful examination of the average spring wheat nitrogen budget following onions (200 lb N/ac applied to the onions), it is possible to predict that no spring wheat response to additional N fertilizer would be expected (Table 3). The soil profile to 3 feet deep contained 152 lb N/ac as ammonium and nitrate. A total of 39 lb N/ac of plant N uptake from organic matter mineralization was expected based on a mineralization factor of 30 and an average 1.3 percent organic matter. Nitrogen contributions in the irrigation water were estimated to average 20 lb N/ac. A credit of 15 lb N/ac was given assuming the decomposition of the dry onion tops, which contained slightly over 30 lbs N/ac at harvest. Total N supply to the developing spring wheat was estimated as 226 lb N/ac without chemical fertilization, against an estimated crop requirement of 216 lb N/ac (Table 3).

Both spring wheat plant N content and wheat yield responded to the residual N following onions, up to 90 lb N/ac considering the top 2 feet of soil (Figures 1 and 2), and up to 120 lb N/ac considering the top 3 feet of soil (Figures 3 and 4). Total levels of residual nitrate and ammonium greater than 280 lb N/ac in the soil profile to 6 feet depth were associated with reduced wheat yield in these trials.

The notion of using nitrogen credits from sources other than residual nitrate and ammonium is validated by net nitrogen changes. Net positive nitrogen changes of approximately 100 lb N/ac were verified for all three site-years whether based on 0-2, 0-3, or 0-6 foot increments of the soil profile, and over the entire range of residual soil nitrogen levels (Table 4). Considerable nitrogen fertilizer savings can be obtained through a holistic N budgeting approach.

Table 1. Available N in the fall in the form of nitrate and ammonium following onions fertilized with 0 to 400 lb N/acre. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Soil depth increment	N rate on preceding onions, lb N/ac					
	0	50	100	200	400	LSD(0.05)
feet	lb N/ac					
0-1	47.8	49.1	62.2	76.9	132.7	19.6
1-2	28.6	31.5	29.7	38.6	54.0	11.2
2-3	25.0	39.1	29.9	36.7	64.7	11.1
3-4	39.7	50.9	42.1	45.5	85.1	ns
4-5	35.4	35.2	44.1	42.4	69.4	ns
5-6	32.9	37.7	39.8	39.5	52.7	ns
Total 0-6	209.5	243.6	247.8	279.7	458.6	49.6

Table 2. Performance of Bliss and Treasure Spring wheat following sweet spanish onions fertilized with 0 to 400 lb N/acre, Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Wheat performance (units)	N rate on preceding onions, lb N/ac					
	0	50	100	200	400	LSD(0.05)
Yield (bu/ac)	87.1	94.6	100.1	100.9	87.9	7.5
Bushel weight (lb/bu)	61.11	61.42	61.40	61.24	60.04	0.59
Grain N (%)	1.86	2.02	1.99	2.09	2.19	0.11
Stubble N (%)	0.68	0.81	0.82	0.97	1.06	0.17
Grain N (lb/ac)	83.9	97.7	104.2	108.6	99.3	10.0
Stubble N (lb/ac)	40.5	62.8	55.4	62.6	75.4	15.7
Plant top N (lb/ac)	124.4	161.6	155.0	170.1	174.7	18.9

Table 3. Average nitrogen budget for unfertilized spring wheat grown in three fields following onions that had received 200 lb N/ac as urea. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

Nitrogen budget	lb N/ac
A. Estimated crop N requirement 120 bu/ac X 1.8 lb N/bu	216
B. Estimated soil and water nitrogen supply	
1. Nitrate & ammonium in soil 0-3'	152
2. Expected N mineralization	39
3. N in irrigation water	20
4. Manure or organic fertilization	0
5. Crop residue breakdown	15
Total N supply (sum B1 through B5)	226
C. N chemical fertilizer requirement; estimated requirement (A) minus soil and water nitrogen supply B1 through B5[1]	-10
D. Plant N content at harvest	170

[1]Negative values indicate excess levels of N

Table 4. Nitrogen recovery by spring wheat and nitrogen accounting based on fall pre-plant soil analyses, following onions fertilized at five rates. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

		N rate on preceding onions, lb N/ac					
Soil depth	N component or accounting	0	50	100	200	400	LSD (0.05)
		lb N/ac					
0-2'	Fall preplant soil	76.4	87.0	93.9	118.7	186.7	25.1
	Plant top	124.4	157.8	155.0	170.1	174.7	18.9
	Post harvest soil	57.2	65.3	63.1	61.9	111.8	ns
	Accounted N	181.6	223.1	218.2	232.0	286.5	34.1
	Net change	+105.1	+136.1	+124.2	+113.3	+99.8	ns
0-3'	Fall preplant soil	101.4	128.1	124.6	152.8	251.4	31.1
	Plant top	124.4	157.8	155.0	170.1	174.7	18.9
	Post harvest soil	78.6	94.5	86.0	84.7	143.9	ns
	Accounted N	202.9	252.2	241.0	254.8	318.6	37.1
	Net change	+101.5	+124.2	+116.4	+102.0	+67.2	ns
0-6'	Fall preplant soil	209.5	225.8	248.7	277.5	458.6	49.6
	Plant top	124.4	157.8	155.0	170.1	174.7	18.9
	Post harvest soil	203.8	239.9	197.6	209.6	314.2	ns
	Accounted N	328.2	397.7	352.6	379.7	488.9	66.9
	Net change	+118.7	+142.0	+103.9	+102.2	+30.2	ns

+ indicates more N accounted for at harvest than was available in the soil to that depth than was indicated by the previous fall soil sample.

Figure 1. Total N content in spring wheat grain and stubble was a function of the residual soil nitrate and ammonium following onions at 0 to 2 feet depth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

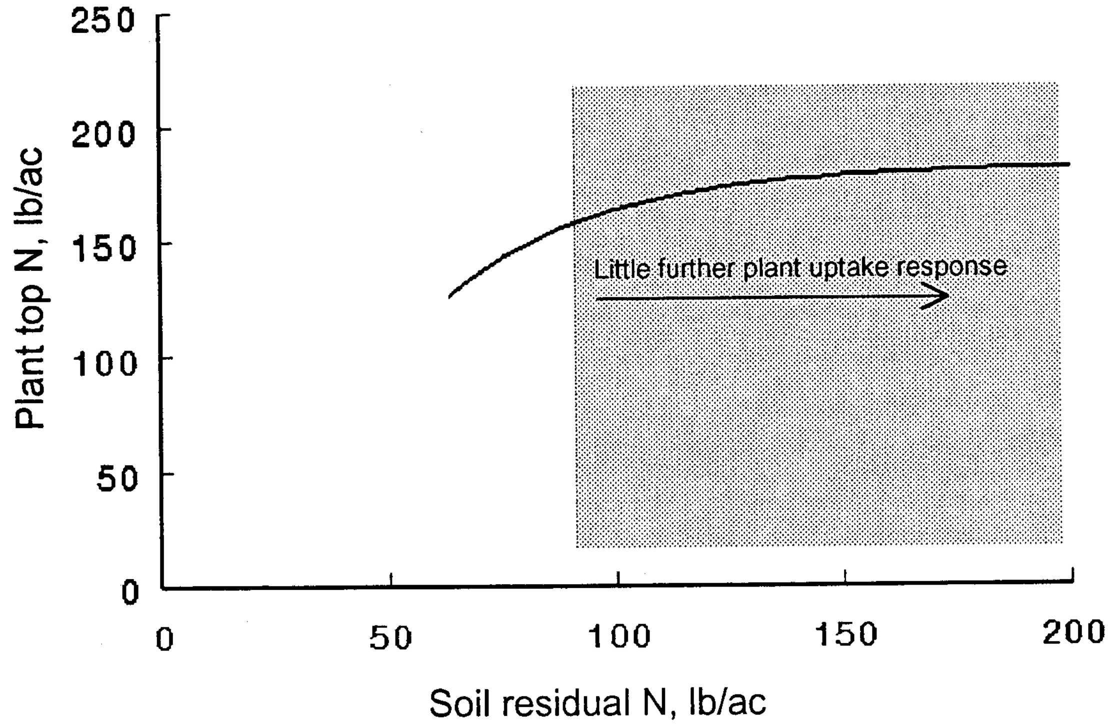


Figure 2. Spring wheat yield as a function of the residual soil nitrate and ammonium following onions at 0 to 2 feet depth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

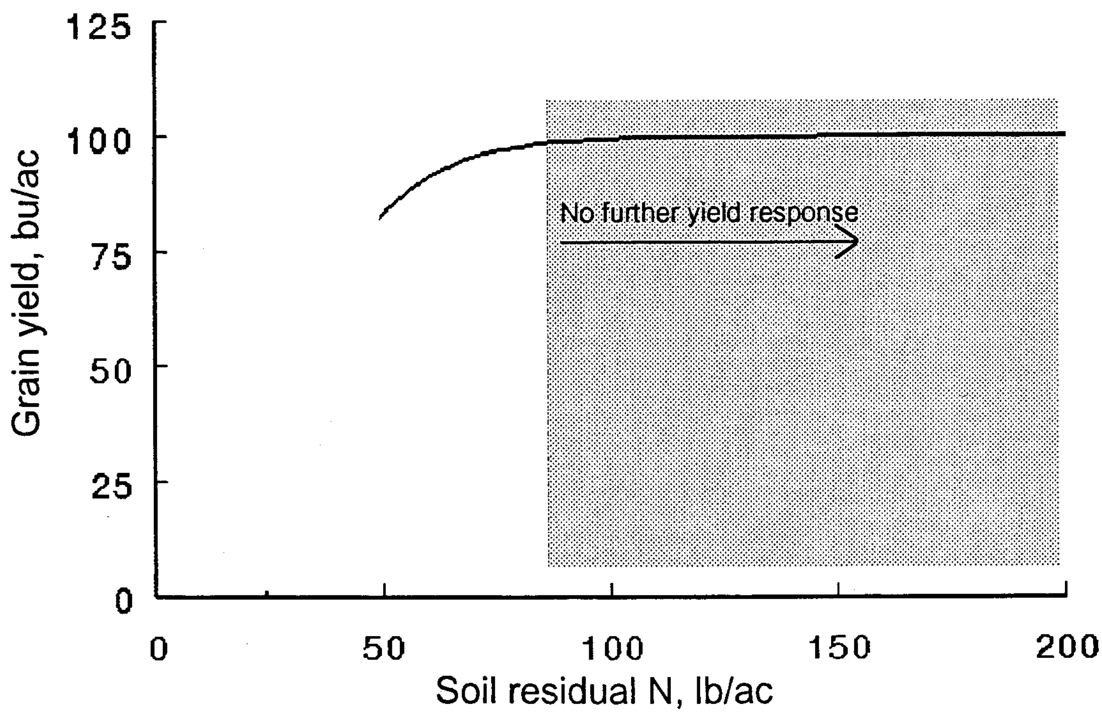


Figure 3. Total N content in spring wheat grain and stubble was a function of the residual soil nitrate and ammonium following onions at 0 to 3 feet depth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.

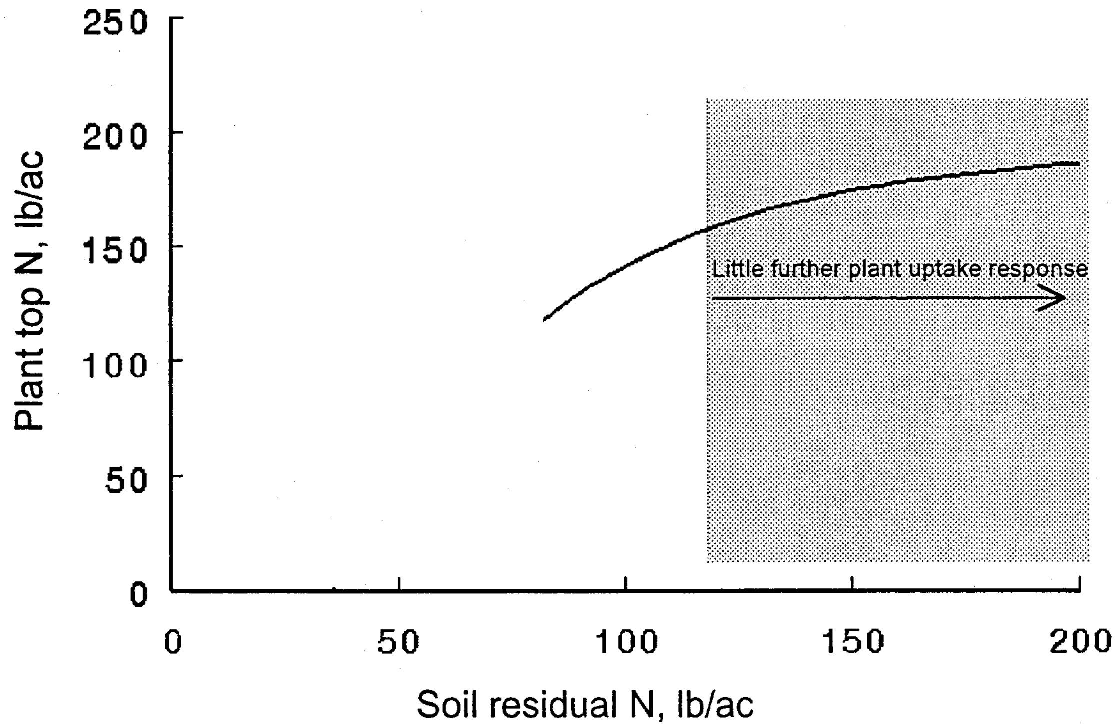
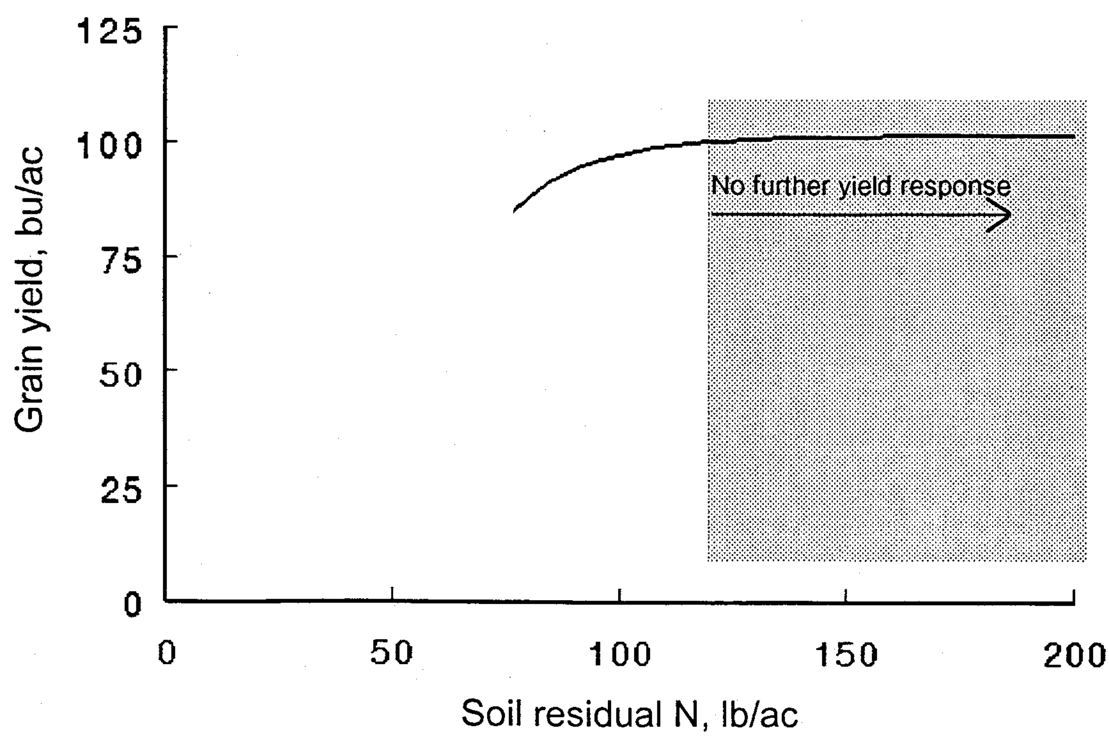


Figure 4. Spring wheat yield as a function of the residual soil nitrate and ammonium following onions at 0 to 3 feet depth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1991 and 1992.



NITROGEN FERTILIZER DEMONSTRATION PLOTS IN WINTER WHEAT FOLLOWING ONIONS

Ben Simko, Lynn Jensen and Heidi Supkis
Malheur County Extension Office
Oregon State University
Ontario, Oregon, 1992

Introduction

Northeast Malheur County has been declared a Groundwater Management Area by the Oregon Department of Environmental Quality (DEQ). This designation is to address concerns about nitrates leaching into shallow aquifers and contaminating rural wells. The use of nitrogen containing fertilizers over the last several decades is suggested as a contributing factor toward the nitrate loading of the shallow groundwater system. Nitrate is particularly evident in the rural wells, SW of Ontario, around the Cairo district of the DEQ management area, and near Nyssa.

Winter wheat in rotation following onions may provide an opportunity to recover residual soil nitrates and reduce the amount of nitrates leached beyond the effective root zone of area crops. This nitrogen recover opportunity with wheat can only be accomplished through timely soil testing, judicious nitrogen budgets, and adoption of careful irrigation water management techniques.

The purpose of this study was to compare winter wheat yield and quality under two nitrogen fertilizer practices; one with a fall nitrogen application and one without any additional nitrogen applied. The plots were established on a commercial field in the Cairo district. A secondary goal was to demonstrate to the grower the ability of a wheat crop to recover residual soil nitrogen.

Methods

Stephens winter wheat was planted in late October 1991 following onion harvest. Most of the field received a preplant broadcast application of 100 lbs N/ac as ammonium sulfate in mid-October. A large plot the length of the field was left unfertilized and received no fertilizer treatments. The wheat crop nitrogen in the untreated plot would only be provided by residual nitrogen left over from the previous onion crop, mineralized nitrogen, and N content in the irrigation water.

Soil samples were taken from the different treatment areas of the field. The plots were divided into 5 sub-areas and in each sub-area approximately 10 soil subsamples were taken from 0-12 inch depth and 12-24 inch depth. The subsamples were mixed in a bucket and a sample taken from the first foot and the second food in each of the five areas of the plot. The samples were collected October 11 before fertilization, April 1 before the first irrigation, April 19 after the first irrigation, and August 22 after harvest. Soil samples were analyzed for nitrate and ammonium.

At harvest the grower and the custom combiner assisted in collecting yield data. A 0.20 ac area was harvested from each plot, loaded on trucks and weighed. Samples from each treatment area were drawn and both test weight and percent protein were determined.

Results and Discussion

Before planting in October the soil contained more than 300 lbs. of available N in the top 2 feet of soil (Table 1). After first irrigation the plot that received 100 units/ac nitrogen in the fall tested at almost 400 units N/ac while the untreated area tested at 320.4 lbs N/ac, 72.5 lbs. lower than the portion of the field that received a fall ammonium sulfate application. At the post harvest August 22 sample date the soil nitrogen levels in the top two feet were 135.8 lbs N/ac for the untreated area and 179.2 lbs/ac for the area that received fall fertilization.

Yield and quality parameters were virtually identical in both treatment areas (Table 2). This experiment was not replicated so it does not lend itself to statistical validation. The results demonstrate that wheat will not respond to additional nitrogen inputs where residual available N levels following onions exceed 300 units in the top two feet. Additionally the practice of soil sampling and testing should be encouraged particularly in winter wheat rotations following onions. Based on local surveys only 2.4 percent of the wheat acreage is soil tested on local farms (Jensen and Simko 1991). More recent data from a commercial soil testing lab indicates soil tests for wheat fields in Malheur County represent only 7.8 percent of the labs testing census while the wheat acreage was 38,000 in 1992. This was greater than the onion, potatoes and sugar beet acreage combined (Table 3).

Many growers could realize net savings of about $40/ac of wheat production input costs by adopting more judicious fertilizer management techniques. Soil sampling, soil testing, nitrogen fertilizer budgeting and irrigation management have potential to become Best Management Practices (BMP's) for the wheat row crop rotations in NE Malheur County. These BMP's should pass the criterion of being cost effective, protecting current yield and quality expectations while providing environmental and social benefits to the Malheur County Groundwater Management Area.

Table 1. Nitrogen soil test results from winter wheat following onions, Cairo District, Ontario, Oregon, 1992.

Sample dates	No additional fertilizer application			100 lbs/ac fall nitrogen fertilizer application ammonium sulfate		
	1st foot	2nd foot	Total	1st foot	2nd foot	Total
	lbs N/ac					
October 11	166.9	133.9	300.8	169.1	145.2	314.3
April 1	222.2	159.7	381.9	241.9	138.1	380.0
April 19	175.6	144.6	320.4	188.8	204.1	392.9
August 22	72.8	63.0	135.8	94.5	84.7	179.2

Table 2. Stephens winter wheat yield and bushel weight with and without N fertilization following onions, Cairo District, Ontario, Oregon, 1992.

Treatment	Yield	Test weight	Protein
	bu/ac	lbs/bu	%
No N fertilizer	138.3	57.1	11.3
100 lbs N/ac fall applied	138.3	57.5	11.6

Table 3. Distribution by crop of commercial lab soil tests for Malheur County farms, October 1991 - October 1992[1].

Crop	Soil tests run	1992 acreage
	%	acres
Sugar beets	30.0	5,700
Onions	22.2	10,100
Potatoes	20.0	8,300
Wheat	7.8	38,000
All others	20.0	–

[1] Ten fertilizer companies requested a total 1,041 tests from fields in Malheur County and adjacent areas in SW ID. Data provided by Western Labs, Parma, ID.

Reference

Jensen L. and B. Simko, 1991. Malheur County crop survey of nitrogen and water use practices, Oregon State University, Agricultural Experiment Station, Special Report 882, p 187-198.

1992 WESTERN REGIONAL SMALL GRAIN NURSERIES

J. Mike Barnum and Mathias F. Kolding
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

Western Regional Small Grain Nurseries are maintained as a part of a cooperative effort among land grant college agricultural research facilities and the USDA Agricultural Research Service (ARS) in the Pacific Northwest. Seed distribution, and data analysis for these trials are coordinated by ARS personnel. The data for each commodity presented in this report, along with the data from other cooperating facilities, appears in annual reports published by ARS.

Purpose

The purpose of these nursery trials is to evaluate the performance and adaptability of newly developed small grain cultivars and lines. Data obtained from these trials allow cooperating plant breeders to access their materials over a wide range of cultural practices and environmental conditions. Additionally, these trials allow agronomists and growers within the various areas to identify superior new cultivars for local use.

Procedure

All trials described here were planted in a randomized complete block design with four replications. Plots were 10 feet wide by 15 feet long. Plots were planted on two 60-inch beds with seven rows on each bed. All nurseries were furrow irrigated. In order to facilitate evaluation and harvest, each plot was shortened to a length of 12.5 feet. Harvest samples were collected from a 52-inch swath through the center of each plot. Harvest area for each plot was 54.125 sq. ft. (0.0012425 acres).

Western Regional White Winter Wheat Nursery

Following a 1991 harvest of sweet corn, the field where the winter wheat nursery was planted was disked two ways, chisel plowed two ways, and floated twice. A dry fertilizer blend (11-52-0) containing 22 pounds per acre of N and 104 pounds per acre of P_2O_5 was broadcast over the field and disked in. Since soil tests showed that 360 pounds per acre of available residual nitrogen as NO_3 and NH_4 was present in the top two feet of the profile, no additional N was applied to this crop. The nursery was planted at 128 pounds of seed per acre on October 1, 1991. A pre-emergence sprinkler irrigation was applied on October 3.

Following the initiation of spring growth and the emergence of weed seedlings, 2.66 pints of Curtail (0.126 lb ai/ac clopyralid plus 0.665 lb ai/ac 2,4D amine) was applied by ground rig in 30 gallons of water per acre on March 13, 1992. Furrow irrigation was started on April 6. Additional furrow irrigations were applied on May 9 and May 29. The nursery was harvested on August 5, 1992.

Western Regional Spring Wheat and Barley Nurseries

Prior to planting the field (which was in soybeans and garbanzo beans [chick peas] in 1991) was chisel plowed two ways, disked two ways, and floated twice. No preplant fertilizer was applied as soil samples taken from the top 2 feet of the soil profile indicated that residual levels of N, P, K, and S were adequate. On March 16, 1992, the wheat and barley nurseries were planted at 130 and 100 pounds of seed per acre, respectively. A pre-emergence irrigation was applied by sprinkler on March 20. Three additional furrow irrigations were applied to both nurseries on March 30, May 19, and June 7.

On April 18, 1992, both nurseries were sprayed by ground rig with a tank mix of 2,4D amine at .66 lbs ai/ac and dicamba (Banvel) at .125 lbs ai/ac in 30 gallons of water per acre for broadleaf weed control. On April 19, Diclofop (Hoelon 3EC) was applied at 1 lb ai/ac in 30 gallons of water per acre to control a severe infestation of seedling barnyard grass (*Echinochloa crus-galli*).

The wheat nursery was harvested on August 8. The barley nursery was harvested on August 11.

Results and Discussion

Western Regional White Winter Wheat Nursery

Forty-six soft white winter wheat and two soft white spring wheat cultivars were in the 1992 nursery (Table 1). Yields ranged from a high of 145.1 bu/ac for OR 860303 to a low of 79.1 bu/ac for Kharkoff. The yields of three commercially available cultivars, Malcolm (OSU 1987), Rod (WA 7662, WSU 1992), and MacVicar (OR 75336, OSU 1992) were significantly greater than the yield for Stephens. Bushel weights ranged from 60.6 pounds for Owens (a soft white spring wheat) to 54.6 pounds for WA 7621. The test weights for Malcolm and MacVicar were significantly greater than the test weight for Stephens. The test weight for Stephens was significantly greater than the test weight for Rod. Test weights for the two spring cultivars, Owens and Treasure, were both significantly greater than the test weights for either Stephens or Rod.

The average heading date (50 percent headed) for the 46 winter wheat cultivars was May 18. Heading dates for winter cultivars ranged from May 15 to May 22. The two spring cultivars, Owens and Treasure, headed out on May 1 and May 12, respectively.

At maturity, plant heights ranged from 49 inches for Kharkoff to 39 inches for OR 86302. With the exceptions of OR 860303, OR 860302, and OR 851048, all entries exhibited some degree of lodging.

The two spring cultivars, Owens and Treasure, were included in the nursery in an attempt to better evaluate the winter hardiness of the winter cultivars. However, both spring checks performed far better than was expected. Although Owens and Treasure were 100 percent lodged well before harvest, they yielded near the average for the nursery, and their bushel weights were above average. The heading date for Owens was two weeks earlier than the earliest winter cultivar, and 11 days earlier than Treasure. Compared to the winter cultivars, the spring cultivars grew more aggressively after emergence in the fall of 1991 and in the early spring of 1992. This unexpected performance probably resulted because of the unusually mild winter, however, similar performance of spring cultivars under winter seeding has been reported in Parma, ID and Corvallis, OR.

Western Regional Spring Wheat Nursery

Forty-two entries were in the spring wheat nursery (Table 2). Yields ranged from a high of 129.7 bu/ac for Treasure to a low of 82.4 bu/ac for Federation. Yield differences between Treasure, Owens, Bliss, and Penawawa were not significant. Bushel weights ranged from 63.6 pounds for OR 487255 to 59.5 pounds for Bliss. Heading dates (50 percent headed) ranged from June 6 for Klasic to June 15 for Bliss.

The average heading date for all cultivars was May 26. Heading dates ranged from May 23 to June 1.

Plant heights ranged from 48 inches for UT 002571 to 25 inches for Klasic. No significant lodging was observed in any plot in this nursery.

Western Regional Spring Barley Nursery

The spring barley nursery contained 30 entries (Table 3). Yields ranged from a high of 7,104 lbs/ac for WA 7190-86 to a low of 4,701 lbs/ac for BA 1614. The yields for Steptoe, Klages, Morex, Excel, and Micah were all significantly lower than the yield of WA 7190-86, OR 2, OR 1, or Columbia. Test weights ranged from 53.7 lbs/bu for ND 11231-1 to 44.6 lbs/bu for UT 3109. Plump kernels over a $^{6}/_{64}$ sieve averaged 96 percent.

The average heading date for the nursery was May 24. Heading dates ranged from May 21 to May 31.

Plant height ranged from 42 inches for Steptoe to 25 inches for BZ 588-335. Lodging varied greatly from plot to plot ranging from none to 100 percent. Mean lodging for all entries was 18 percent with a range of 0 to 75 percent.

Grain uniformity was quite consistent. Plumps over a $^{6}/_{64}$ sieve ranged from a high of 98 percent for BA 2888-5133 to a low of 91 percent for Klages.

Table 1. Western Regional White Winter Wheat Nursery 1992. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Type	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent lodging (%)	Percent of Stephens (%)	Historic average yield[3] (bu/ac)
Kharkoff	comm	79.1	59.8	9.4	135	49	100.0	66	83 (9)
Elgin	club	89.0	58.8	10.0	138	44	100.0	74	89 (9)
Moro	club	97.8	54.6	8.9	140	44	100.0	82	102 (9)
Nugaines	comm	119.0	58.0	9.6	140	43	37.5	100	115 (9)
Stephens	comm	119.5	57.9	9.3	135	46	58.8	100	136 (9)
Tres	club	98.9	56.9	9.5	135	43	85.0	83	101 (4)
MacVicar	comm	127.8	58.9	9.5	135	44	35.0	107	141 (2)
Kmor	comm	112.4	55.2	9.4	140	42	80.0	94	128 (2)
OR 855	club	114.7	58.4	9.5	140	43	85.0	96	107 (1)
WA 7621	club	109.1	54.6	9.0	138	42	55.0	91	103 (1)
OR 83115	comm	135.8	58.2	9.5	138	42	31.3	114	125 (1)
WA 7662	comm	129.7	57.0	9.5	140	40	57.5	109	129 (1)
WA 7663	comm	127.7	56.4	9.4	138	42	65.0	107	132 (1)
OR 833725	comm	111.4	56.1	9.1	140	45	80.0	93	93 (1)
OR 833765	comm	109.5	58.3	9.3	140	43	62.5	92	96 (1)
OR 840815	comm	125.2	58.3	9.1	138	44	7.5	105	109 (1)
ID 081277	comm	129.1	57.1	9.1	138	44	43.8	108	125 (1)
WA 7686	comm	126.0	57.4	9.4	142	42	20.0	105	131 (1)
WA 7687	comm	125.0	55.8	9.4	140	42	62.5	105	118 (1)
WA 7622	club	103.1	57.0	9.1	138	44	55.0	86	119 (1)
WA 7690	comm	115.1	58.1	9.0	140	45	23.8	96	131 (1)
WA 7691	comm	126.2	58.1	9.4	138	42	52.5	106	121 (1)
OR 850933	comm	137.6	57.9	9.6	138	42	10.0	115	96 (1)
OR 850594	comm	124.1	58.5	9.8	138	43	20.0	104	108 (1)
OR 851048	comm	121.3	56.5	9.3	135	45	0.0	102	111 (1)
OR 860303	comm	145.1	57.1	9.5	140	43	0.0	121	71 (1)
OR 087636	club	116.5	57.8	10.0	138	44	77.5	97	127 (1)
ID 085153	comm	107.3	57.4	9.7	135	47	38.8	90	124 (1)
WA 7729	club	107.2	55.3	9.8	135	44	40.0	90	new
WA 7730	comm	105.5	57.9	10.2	135	44	52.5	88	new
WA 7717	comm	98.7	55.8	8.7	140	46	22.5	83	new
WA 7695	club	98.3	56.2	9.7	135	42	72.5	82	new
WA 7697	club	115.8	58.7	10.1	138	44	51.3	97	new
X WH 1004	comm	126.8	58.9	9.7	138	45	12.5	106	new
X WH 1002	club	114.3	58.7	9.0	138	45	60.0	96	new
X WH 1005	comm	119.9	59.2	9.3	138	46	17.5	100	new
PB 185WW1	comm	105.2	58.4	9.9	138	47	62.5	88	new
OR 851139	comm	96.1	58.7	9.4	140	44	77.5	80	new
OR 857847	comm	131.3	56.3	9.5	135	42	32.5	110	new
OR 860302	comm	144.9	57.9	9.0	138	39	0.0	121	new
OR 856537	club	91.1	59.2	10.7	138	45	92.5	76	new
OR 855350	club	98.3	54.9	8.8	135	46	95.0	82	new
OR 0333	comm	117.4	58.0	10.3	138	45	45.0	98	new
Dusty	comm	110.7	58.6	9.4	140	45	55.0	93	135 (5)
Malcolm	comm	136.9	59.3	9.4	135	43	30.0	115	141 (4)
Lewjain	comm	104.3	56.7	9.5	140	42	65.0	87	137 (3)
Owens	comm	111.7	60.6	10.0	121	43	100.0	93	new
Treasure	comm	116.6	59.6	10.6	132	44	85.0	98	new
Mean		115.3	57.6	9.5	137	43	52.3		
LSD (0.05)		13.8	2.1	1.1		2	26.3		
C.V. (%)		9	3	8		3	36		

1 Yields are based on 60 lbs/bu at 14% moisture.
2 Number of calendar days from January 1 (137 = May 17).
3 Average of all previous years the entry has been represented in a regional trial at MES, (#) = years to calculate average.

Table 2. Western Regional Spring Wheat Nursery 1992. Malheur Experiment Station, Ontario, Oregon.

Variety	Type	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent of Owens (%)	Historic average yield[3] (bu/ac)
Mckay	HR	116.4	60.9	10.6	149	38	97	93 (12)
Federation	SW	82.4	59.6	12.0	152	44	68	78 (12)
Owens	SW	120.4	61.5	11.1	145	38	100	100 (12)
Penawawa	SW	116.3	61.4	11.3	147	33	97	101 (12)
Wakanz	SW	108.0	60.2	12.2	149	36	90	91 (8)
WA 007176	SW	110.9	59.8	11.2	152	39	92	91 (6)
ID 000420	HR	114.2	61.4	11.8	147	32	95	65 (2)
Klasic	HW	110.7	62.6	12.2	145	25	92	65 (3)
Serra	HR	115.2	61.8	11.2	145	34	96	76 (3)
OR 478462	HR	105.1	61.3	11.6	145	36	87	79 (2)
OR 487279	HW	109.0	61.8	11.7	143	34	91	71 (2)
OR 487453	HW	115.7	61.5	12.1	147	34	96	77 (2)
UC 000784	HR	107.7	62.0	11.6	145	27	89	77 (2)
UC 000786	HR	109.7	62.4	10.6	147	27	91	71 (2)
UC 000785	HR	120.1	61.5	10.6	149	28	100	73 (2)
ID 000392	SW	122.5	61.3	12.4	147	37	102	80 (2)
ID 000408	SW	102.6	59.5	11.1	145	35	85	87 (2)
UT 001708	HR	92.2	60.8	12.2	147	43	77	72 (1)
UT 001711	HR	103.4	61.7	11.3	149	43	86	68 (1)
UT 001723	HR	83.2	61.1	11.8	149	43	69	65 (1)
OR 487249	HW	110.5	62.2	11.4	145	34	92	79 (1)
OR 487255	HW	108.3	63.6	10.6	145	36	90	77 (1)
OR 488403	HW	112.4	61.1	11.4	145	31	93	81 (1)
OR 487469	HR	106.4	61.9	11.4	143	32	88	73 (1)
OR 488189	HR	99.5	61.1	11.9	143	33	83	63 (1)
ID 00377S	HW	106.2	63.5	11.9	145	36	88	80 (1)
ID 000410	SW	114.4	62.0	12.0	145	36	95	85 (1)
OR 489025	HR	113.2	62.0	11.9	143	36	94	new
OR 386306	HW	122.1	62.1	11.3	145	32	101	new
WA 007677	SW	127.6	62.8	11.6	147	38	106	new
WA 007702	HR	118.2	62.2	12.3	145	35	98	new
ID 000439	HR	104.4	60.5	10.8	147	32	87	new
ID 000440	SW	112.4	61.0	12.1	143	38	93	new
ID 000441	SW	115.9	60.9	12.0	145	37	96	new
ID 000429	SW	106.6	62.7	11.1	143	38	89	new
UT 001597	HR	100.1	61.0	11.9	145	36	83	new
UT 002571	HR	87.2	61.4	10.9	147	48	72	new
UT 850646	HR	105.2	60.0	11.4	147	33	87	new
SUNDER 02	HR	109.6	62.3	12.3	145	34	91	new
ML 000042	SW	100.5	61.6	11.2	149	38	83	new
Treasure	SW	129.7	60.0	12.1	147	35	108	99 (3)
Bliss	SW	117.3	59.5	12.2	149	37	97	99 (5)
Mean		109.4	61.4	11.6	146	35		
LSD (0.05)		16.9	0.7	2.1		4		
C.V. (%)		12	1	13		7		

1 Yields are based on 60 lbs/bu at 14% moisture.
2 Number of calendar days from January 1 (146 = May 26).
3 Average of all previous years the entry has been represented in a regional trial at MES, (#) = years to calculate average.

Table 3. Western Regional Spring Barley Nursery 1992. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Type	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent lodging (%)	Percent over 6/64 sieve (%)	Percent of Steptoe (%)	Historic average yield[3] (bu/ac)
Trebi	6-F	120.1	48.1	12.6	145	39	50	96	109	92 (12)
Steptoe	6-F	109.9	49.3	13.8	141	42	60	92	100	93 (12)
Klages	2-M	113.0	52.7	15.4	143	39	40	91	103	100 (12)
Morex	6-M	100.0	49.4	15.3	141	41	6	97	91	99 (11)
Excel	6-M	107.4	50.0	12.3	143	38	34	96	98	94 (3)
ID 842974	2-M	132.8	52.0	13.9	145	36	30	97	121	108 (2)
OR 006	6-M	125.6	47.9	13.0	143	36	0	96	114	102 (2)
OR 1209	6-F	112.6	49.1	15.3	147	35	0	97	103	92 (2)
OR 2	6-F	136.8	50.1	14.6	145	33	0	95	125	111 (2)
WA 11163-86	6-M	111.6	50.9	16.0	143	36	11	96	102	84 (1)
BA 2B86-5113	2-M	130.0	52.7	13.0	147	38	35	96	118	92 (1)
BA 2B88-5133	2-M	118.5	52.2	15.1	143	37	23	98	108	88 (1)
ID 86Ab2317	2-M	120.7	51.8	13.3	141	38	40	97	110	74 (1)
UT 502355	6-F	130.3	48.5	14.6	145	38	4	98	119	91 (1)
PB 401	6-F	116.9	49.5	14.0	143	38	6	95	106	94 (1)
WA 7190-86	2-M	148.0	52.0	13.2	147	31	13	96	135	new
WA 9593-87	6-F	128.1	47.8	14.8	145	39	0	97	117	new
WA 10489-86	6-M	98.3	47.3	14.0	141	38	25	97	89	new
BZ 588-335	6-F	127.5	48.8	14.4	145	25	0	97	116	new
BA 1614	6-M	97.9	49.7	14.3	141	38	13	97	89	new
UT 1181	6-F	112.5	45.2	14.6	143	33	0	96	102	new
UT 11640	6-F	131.0	47.1	14.5	143	37	13	94	119	new
UT 3109	6-F	119.8	44.6	13.9	143	35	0	97	109	new
UT 150582	6-F	125.4	47.4	15.0	145	34	0	97	114	new
PB 88R801	2-F	113.9	50.1	15.0	147	36	75	97	104	new
ND 11853	2-M	115.7	52.1	14.0	145	38	25	97	105	new
ND 11231-6	2-M	119.8	53.7	15.0	145	40	28	96	109	new
Columbia	6-F	124.9	46.6	15.3	149	34	23	97	114	100 (1)
OR 1	2-M	136.1	50.8	14.5	151	30	0	96	124	100 (3)
Micah	6-F	110.3	48.6	16.0	143	36	3	95	100	82 (2)
Mean		119.8	49.5	14.4	144	36	18	96		
LSD (0.05)		19.4	1.4	2.1		4	34	3		
C.V. (%)		12	2	11		7	132	2		

1 Yields are based on 48 lbs/bu at 12% moisture.
2 Number of calendar days from January 1 (144 = May 24).
3 Average of all previous years the entry has been represented in a regional trial at MES, (#) = years to calculate average.

1992 OSU STATEWIDE AND MALHEUR SMALL GRAIN TRIALS

J. Mike Barnum and Mathias F. Kolding
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 1992

In addition to the various Western Regional Cereal Grain Nurseries, several other cereal grain evaluation trials were conducted at the Malheur Experiment Station during the 1991-92 crop year. These trials were comprised of commonly grown cultivars, and newly released and experimental cultivars that have exhibited characteristics that might prove beneficial to small grain producers in the state of Oregon.

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 provides OSU Extension personnel, industry representatives, and local producers with statistical information that can be utilized in recommending or choosing a cultivar for a specific area or situation.

Procedure

All trials were planted in a randomized complete block design. Entries in the Malheur White Winter Wheat Trial were replicated three times. Entries in the Malheur Winter Barley Trial, the OSU Statewide Spring Barley Trial, and the Malheur Spring Oat Trial were replicated four times. Plots were 10 feet wide by 15 feet long. Plots were planted on two 60-inch beds with seven rows on each bed. All nurseries were furrow irrigated. In order to facilitate evaluation and harvest, plots were shortened to a length of 12.5 feet. Harvest samples were collected from a 52-inch swath through the center of each plot. The harvest area for each plot was 54.125 sq. ft. (0.0012425 acres).

Malheur White Winter Wheat and Winter Barley Trials

Following a 1991 harvest of sweet corn, the field where the winter wheat and winter barley trials were planted was disked two ways, chisel plowed two ways, and floated twice. A dry fertilizer blend (11-52-0) containing 22 pounds per acre of N and 104 pounds per acre of P_2O_5 was broadcast over the field and disked in. Since soil tests showed that 360 pounds per acre of available residual nitrogen as NO_3 and NH_4 was present in the top two feet of the profile, no additional N was applied to this crop. The nursery was planted at 128 pounds of seed per acre on October 1, 1991. A pre-emergence sprinkler irrigation was applied on October 3.

Following the initiation of spring growth and the emergence of weed seedlings, 0.126 lb ai/ac clopyralid plus 0.665 lb ai/ac 2,4D amine (Curtail) was applied by ground rig in 30 gallons of water per acre on March 13, 1992. The first furrow irrigation was applied to both trials on April 6. One Additional furrow irrigations was applied to the barley trial on May 9. Two additional furrow irrigations were applied to the wheat trial on May 9 and May 29.

The winter wheat trial was harvested on August 5, 1992. The winter barley trial was harvested on August 7.

OSU Statewide Spring Barley and Malheur Spring Oat Trials

Prior to planting, the field (which was in soybeans and garbanzo beans [chick peas] in 1991) was chisel plowed two ways, disked two ways, and floated twice. No preplant fertilizer was applied, as soil samples taken from the top 2 feet of the soil profile indicated that residual levels of N, P, K, and S were adequate. On March 16, 1992, the barley and oat trails were planted at 100 and 75 pounds of seed per acre, respectively. A pre-emergence sprinkler irrigation was applied on March 20. Three additional furrow irrigations were applied to each trial on March 30, May 19, and June 7.

On April 18, 1992, both trials were sprayed by ground rig with a tank mix containing 2,4D amine at 0.66 lbs ai/ac, and dicamba (Banvel) at 0.125 lbs ai/ac in 30 gallons of water per acre for broadleaf weed control. On April 19 the barley trial was sprayed by ground rig with diclofop (Hoelon 3EC) at 1.0 lb ai/ac in 30 gallons of water per acre to control a severe infestation of seedling barnyardgrass (*Echinochloa crus-galli*). Since diclofop could not be applied to the oat trial, the barnyardgrass was treated with diuron (Karmex DF) at 1.2 lbs ai/ac in 30 gallons of water per acre. Additionally, because of an infestation of Canada thistle (*Cirsium arvense*) in the oat trial, clopyralid (Stinger) at 0.125 lbs ai/ac was tank-mixed with the diuron.

The barley trial was harvested on August 11, and the oat trial on August 12.

Results and Discussion

Malheur White Winter Wheat Trial

Seven soft white winter wheats and one soft white spring wheat were in the 1992 nursery (Table 1). Yields ranged from a high of 145.2 bu/ac for MacVicar (OSU 1992) to a low of 103.41 bu/ac for Eltan (WSU 1990). The yields for MacVicar and Malcolm (OSU 1987) were not significantly greater than the yield for Stephens. The yield for Stephens was significantly greater than the yields for Kmor (WSU 1990), Dusty (WSU 1985), Lewjain (WSU 1982), Eltan, and Owens (UE, 1981). Bushel weights ranged from 60.9 pounds for Owens (a soft white spring wheat) to 57.2 pounds Eltan. The test weights for Malcolm and MacVicar were significantly greater than the test weight for Stephens. The test weight for Owens was significantly better than that of any other entry.

The average heading date (50 percent headed) for the seven winter wheat cultivars was May 18. Heading dates for winter cultivars ranged from May 15 to May 20. The spring cultivar, Owens, headed on May 1.

At maturity there was no significant difference in plant height between entries. There was no significant difference in lodging between Stephens, MacVicar, and Malcolm.

The spring cultivar Owens, which was included in the trial in an attempt to better evaluate the winter hardiness of the winter cultivars, performed far better than anticipated. No winter injury was evident. It's 108.8 bushel per acre yield was above its historic spring trial yield at this station. The heading date for Owens was two weeks earlier than the heading date for Stephens. Compared to the winter cultivars, Owens grew more aggressively after emergence in the fall of 1991 and in the early spring of 1992. This unexpected performance probably resulted because of the unusually mild winter, however, similar performance of the spring cultivare Owens under winter seeding has been reported in Parma, ID, and Corvallis, OR trials.

Malheur Winter Barley Trial

Four entries were represented in the winter barley trial (Table 2). Yields ranged from a high of 146.7 bu/ac for OR 81019 to a low of 111.1 bu/ac for Boyer. Performance among the four entries was similar except that the yield for Boyer was less than that of the other cultivars/lines. There was no significant difference in bushel weight, heading date, plant height, lodging, or percent plumps between the entries.

OSU Spring Barley Trial

The OSU spring barley trial contained thirty entries (Table 3). Yields ranged from a high of 135.1 bu/ac for Gustoe to a low of 79 bu/ac for Shonkin. The average yield for the trial was 112.5 bu/ac. Test weights ranged from 59.0 lbs/bu for Shonkin to 47.2 lbs/bu for Columbia. Plump kernels over a $^{6}/_{64}$ sieve ranged from a high of 98 percent for Crystal and Columbia to a low of 74 percent for Shonkin.

The average heading date for the nursery was May 25. Heading dates ranged from May 21 to May 28.

Plant height ranged from 40 inches for Morex to 26 inches for OR 2. With the exceptions of Shonkin, MT 851023, Morex, Excel, Klagus, and MT 140523, lodging was of little significance. Lodging ranged from 0 to 78 percent.

Although no green florets or kernels were evident at harvest, the high moisture readings indicate that the trial might have been combined prematurely.

Malheur Spring Oat Trial

Twenty-one entries were included in the spring oat trial (Table 4). Yields ranged from a high of 168.8 bu/ac for 83Ab3250 to a low of 119.3 bu/ac for Trucker. Of those cultivars that are commercially available, the yields for Ogle, Border, Valley, Monida, Minimax, and Calibre were significantly greater than the yields for Cayuse and Park. Bushel weights ranged from a high of 39.5 lbs/bu for Trucker to a low of 32.4 lbs/bu for 86Ab664. The test weights were ≥36 lbs/bu for Trucker, Cayuse, Riel, Valley, and Otana.

The average heading date for the trial was June 5. Heading dates ranged from June 1 to June 9.

Plant heights ranged from 48 inches to 32 inches. No severe lodging was observed. The range of lodging was from 0 to 38 percent.

The high moisture readings in this trial also indicate that the harvest may have been premature.

Table 1. Malheur White Winter Wheat Trial 1992. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Type	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent lodging (%)	Percent of Stephens (%)	Historic average yield[3] (bu/ac)
Stephens	comm	133.0	57.9	10.1	135	44	10	100	136 (34)
MacVicar	comm	145.2	58.4	10.1	135	43	10	109	132 (14)
Malcolm	comm	139.5	58.8	10.5	138	42	3	105	129 (20)
Kmor	comm	118.7	56.9	11.2	138	43	40	89	125 (5)
Dusty	comm	112.4	58.4	10.1	138	42	47	85	127 (19)
Lewjain	comm	113.8	57.6	10.1	140	42	73	86	129 (13)
Eltan	comm	103.4	57.2	10.2	140	44	77	78	124 (2)
Owens (sprg)	comm	108.8	60.9	10.7	121	44	97	82	(**)
Mean		121.9	58.3	10.4	136	43	45		
LSD (0.05)		13.8	0.8	1.8		2	26		
C.V. (%)		7	1	7		3	34		

1 Yields are based on 60 lbs/bu @14% moisture.
2 Number of calendar days from January 1 (136 = May 16).
3 Average of all previous years the entry has been represented in any trial at this station, (#) = years to calculate average.
** Owens, a soft white spring wheat, has no history under winter planted conditions. Its mean yield for 15 spring planted trials at this station is 104 bu/ac. Its mean yield for two 1991-92 winter trials was 112 bu/ac.

Table 2. Malheur Winter Barley Trial 1992. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Type	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent lodging (%)	Percent over 6/64 sieve (%)	Percent of Steptoe (%)	Historic average yield[3] (bu/ac)
Hesk	6-F	131.6	45.9	8.9	125	40	100	68	100	140 (13)
AB Eight-Twelve	6-F	133.4	45.6	8.8	125	39	100	63	101	144 (7)
Boyer	6-F	111.1	45.2	8.9	125	42	100	68	84	129 (12)
OR 81019	6-F	146.7	46.8	9.3	121	39	100	77	111	(**)
Mean		130.7	45.9	9.0	124	40	100	69		
LSD (0.05)		23.1	2.1	0.5		3		14		
C.V. (%)		9	2	3		4		11		

1 Yields are based on 48 lbs/bu @12% moisture.
2 Number of calendar days from January 1 (124 = May 4).
3 Average of all previous years the entry has been represented in a trial at this station, (#) = years to calculate average.
** OR 81019 is a new experimental cultivar developed by Mathias F. Kolding at the Hermiston Experiment Station.

Table 3. OSU Spring Barley Trial 1992. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Type	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent lodging (%)	Percent over 6/64 sieve (%)	Percent of Steptoe (%)	Historic average yield[3] (bu/ac)
Bearpaw	2-M	114.9	52.4	12.9	72	35	26	97	99	
Crystal	2-M	123.3	53.0	16.1	72	34	18	98	106	
Gustoe	6-F	135.1	47.7	14.0	70	27	8	98	116	142 (1)
Russell	6-M	94.5	48.8	14.9	68	33	0	96	81	
Shonkin	2-M	79.0	59.0	16.4	66	38	78	74	68	
Steptoe	6-F	116.0	48.5	16.0	68	34	5	98	100	117 (25)
OR M8408	2-M	103.5	52.9	16.2	70	32	18	94	89	
OR 2	6-F	118.1	49.9	16.2	72	26	0	96	102	120 (4)
OR 3	6-F	127.5	50.0	15.9	72	27	0	90	110	
Columbia	6-F	112.3	47.2	13.4	74	27	0	97	97	127 (12)
Klages	2-M	112.8	52.3	15.7	70	37	40	95	97	106 (16)
Harrington	2-M	107.7	52.8	16.4	70	34	0	97	93	
Excel	6-M	110.1	49.6	16.8	68	36	43	96	95	
Morex	6-M	108.0	50.5	16.2	66	40	58	96	93	105 (16)
MT 140523	2-M	121.2	53.0	15.6	70	34	38	94	104	
Colter	6-F	118.6	48.0	16.0	70	35	0	92	102	
WA 8771-78	2-M	105.6	52.6	14.7	70	35	23	98	91	
BA 1202	2-M	106.8	52.4	17.0	72	35	18	97	92	
BA 2601	6-M	104.2	50.1	16.5	70	32	0	95	90	
Medalion	6-F	115.5	49.3	16.1	72	29	5	89	100	
OR 1	2-M	124.6	51.9	16.6	70	27	0	96	107	108 (5)
WP 584118	6-F	120.3	47.4	16.1	70	28	0	95	104	
MT 851012	2-M	116.6	52.3	16.4	72	37	68	97	101	
Micah	6-F	104.1	48.5	16.1	74	33	0	97	90	109 (10)
Mean		112.5	50.8	15.8	70	33	18	94		
LSD (0.05)		19.2	1.1	2.1		4	31	4		
C.V. (%)		12	2	10		9	119	3		

[1] Yields are based on 48 lbs/bu @12% moisture.
[2] Number of calendar days from planting, March 16 (70 = May 25).
[3] Average of all previous years the entry has been represented in a trial at this station, (#) = years to calculate average.

Table 4. Malheur Spring Oat Trial 1992. Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Variety	Yield[1] (bu/ac)	Bushel weight (lbs/bu)	Moisture at harvest (%)	Heading date[2] (days)	Plant height (inches)	Percent lodging (%)	Percent of Park (%)
Park	127.5	33.0	15.9	81	47	38	100
Cayuse	129.0	38.9	16.1	77	46	20	101
Otana	138.2	36.7	16.0	79	48	0	108
Appoloosa	134.9	34.9	17.0	81	44	0	106
Border	160.2	34.2	17.2	81	45	23	126
Monida	144.0	32.7	16.9	77	48	25	113
Ogle	162.8	34.1	16.7	81	45	0	128
Calibre	142.4	34.8	16.9	83	46	5	112
Riel	140.9	37.6	17.0	79	42	5	111
Valley	147.4	37.4	17.2	79	40	0	116
82Ab248	149.7	34.7	17.0	81	39	0	117
82Ab1178	151.9	34.1	17.1	81	43	3	119
Robert	132.0	34.7	16.8	83	46	38	104
Trucker	119.3	39.5	17.1	77	45	6	94
Minimax	143.5	33.5	16.2	83	35	0	113
83Ab3119	152.3	34.1	16.9	85	38	8	119
83Ab3250	168.8	35.8	16.9	85	40	5	132
86Ab664	146.9	32.4	17.2	83	32	0	115
86Ab1867	151.8	36.3	17.1	77	42	0	119
Newdak	136.4	35.7	17.1	77	42	10	107
87Ab5125	163.9	35.8	17.0	83	39	0	129
Mean	144.9	35.3	16.8	81	42	9	
LSD (0.05)	22.5	2.7	1.5		7	31	
C.V. (%)	11	6	6		12	252	

[1] Yields are based on 32 lbs/bu @14.5% moisture.
[2] Number of calendar days from planting, March 16 (81 = June 5).

1992 IRRIGATED WINTER CEREAL EVALUATION TRIALS

Mathias F. Kolding and Mike Barnum
Malheur Experiment Station
Oregon State University
Ontario, Oregon

Introduction

Yield trials are conducted in order to allow breeders and agronomists the opportunity to evaluate the performance of plant materials under different conditions. Often growers volunteer the use of portions of their land to grow cereal trials. Sometimes the plot area is in the middle of a very high-producing field, or there may be some special feature such as high pH, disease presence, exposure to freezing, and/or special tillage practices.

Results gathered from cereal grain yield trials allow breeders, agronomists, and growers to make informed decisions. Breeders utilize the agronomic information gathered from yield trial data to make decisions concerning the performance of new lines. Agronomists and growers use the results of these trials to evaluate variety performance and make choices concerning the adaptability of varieties to specific production sites. Breeders can compare the performance of named varieties and other new lines against their own, exchange evaluations, use material in new crosses, and give better informed advice about a new variety's adaptation to local areas.

The purpose of the cereal grain evaluation trials discussed in this report was to provide information about advanced selections in the variety development project. A series of diverse check varieties with an "expected" response to a given environment were used to estimate the relative adaptation of an advanced selection.

Procedures

Eastern Oregon Soft White Winter Wheat Trials

Eighteen soft white wheats were evaluated at five sites in northeastern Oregon in 1992. Eleven were named varieties, and seven were experimental selections that were being considered for release. Site #1 was at the Hermiston Agricultural Research and Extension Center at Hermiston, Oregon. Sites #2, #3, #4, and #5 were in cooperating Oregon grower's fields near Boardman, Irrigon, Baker City, and Union, respectively. The Boardman, Baker City, and Union trials were planted in late September. The Irrigon and Hermiston trials were planted in mid-October. All trials were drilled in four rows at 1.2 bushels per acre. At all locations each entry was replicated six times in plots measuring 4 feet wide by 11 feet long. The Hermiston trial was grown under a hand-line sprinkler system. The trials at Boardman and Irrigon were grown under center-pivot sprinkler systems, and the trials at Baker City and Union were grown under lateral wheel-roll sprinkler systems.

Eastern Oregon Winter Barley Trials

Twelve winter barleys were evaluated at the same locations as the Eastern Oregon Soft White Winter Wheat Trials described previously. Three were named varieties, and nine were experimental selections that were being considered for release. With the exception of the trial at the Hermiston Agricultural Research and Extension Center, these trials were planted immediately adjacent to the winter wheat trials. Subsequently, they were managed under the same cultural and irrigation regimes. The barley trial at the Hermiston Agricultural Research and Extension Center was grown in a separate field. The Boardman, Baker City, and Union trials were planted in late September. The Irrigon and Hermiston trials were planted in mid- October. All trials were drilled in four rows at 1.2 bushels per acre. At all locations each entry was replicated six times in plots measuring 4 feet wide by 11 feet long. The Hermiston trial was grown under a hand-line sprinkler system, the trials at Boardman and Irrigon were grown under center-pivot sprinkler systems, and the trials at Baker City and Union were grown under lateral wheel-roll sprinkler systems.

A Six Year Comparison Of Selected Winter Barleys

To allow for the evaluation and promotion of Gwen, a newly released (1992) winter barley variety developed at the Hermiston Agricultural Research and Extension Center, yield data for the years 1987 through 1992 for Gwen and seven other named winter barley varieties that are adapted to eastern Oregon conditions were compiled and analyzed.

Results and Discussion

Eastern Oregon Soft White Winter Wheat Trials

Grain yields at the Hermiston site (Table 1) ranged from 76 to 111 bushels per acre, and averaged 96 bushels per acre. They are lower than expected for an irrigated trial. The plot site received 105 pounds of nitrogen per acre and was watered at about 95 percent of pan evaporation. The very low test weights attest to stress from Fusarium and/or other root infections, low nitrogen rates, and lack of adequate water. In this trial Stephens, MacVicar, and W 301 were the top three. The test weights in Tables 1 through 6 represent blown samples instead of screened samples common to the sales of wheat.

Plant heights at this site were a little shorter than in previous years. Hill 81, Madsen, and Eltan are usually taller than Stephens.

Grain yields under center pivot irrigation at the Boardman site (Table 2) were much lower than expected. Previous trials conducted under this grower's management system have regularly averaged over 125 bushels per acre. The manager, however, commented about how rapidly the circle ripened. Dusty was the top yielder and has performed very well for a number of years in the Boardman area trials. The long term checks (1 through 6) had nearly equal yields. Kmor and Eltan were the lowest yielders. Test weights averaged 53.1 pounds per bushel.

The Irrigon site averaged 103.1 bushels per acre (Table 3). The Irrigon site was nearly lost due to sand blasting and wind damage during a late fall wind storm. Some of the field was reseeded. Malcolm, Dusty, and MacVicar had the best grain yields. Test weights averaged 55.1 pounds per bushel, which was 2 and 3.4 pounds per bushel better than the Irrigon and Hermiston sites, respectively.

The Baker City site (Table 4) was summer-fallowed in 1991; the soil was very dry when seeded. Although late fall rain soaked the soil, the plants did not emerge until mid-January. Grain yield averaged 99.7 bushels per acre. MacVicar and Kmor were the better yielding named varieties. The advanced line FW81422-S4008, selected near Flora for smut resistance and survivability beneath snow, was the highest yielder at 120 bushels per acre.

Test weights were superior to those measured near Hermiston, Boardman, and Irrigon. Grain appearance was excellent.

Several samples (Table 5) were sent for soft white winter wheat milling and baking evaluations, as were several samples from a disease stress site near Hermiston. Wheat proteins at both sites were too high, especially for the club wheats OR855 and Hyak. Flour yield was fair at the Baker City site but low at the Hermiston site. Milling scores for Baker City were in the acceptable range. Hill 81 and OR855 at Baker City and W 301 at Hermiston were the only samples with a cookie diameter over 9 centimeters.

The trial at the Union site (Table 6) had the highest average grain yields at 106.3 bushels per acre. Malcolm, W301, and Dusty were the highest yielders. The Union site has a rather high pH (Table 7), but, with the exception of Hyak, all of the entries appeared normal and vigorous. Test weights at Union were lower than at Baker: 56.9 versus 58.7 pounds per bushel.

In summary, of the five locations used in 1992, the overall mean of five locations times 18 entries (90 yield estimates) is 98.2 bushels per acre (Table 8). The average grain yields are given in Table 8 as well as the percent of Stephens and yield rank. Malcolm, MacVicar, W 301, Dusty, and FW81422-S4008 ranked higher than Stephens, an indication of their stability over locations.

When grain yields are summarized across locations and years, averages start to blend closer and closer to what happens if large acreages are grown (Table 9). MacVicar, for instance, at 100.6 percent of Stephens, could mean an extra 60,000 bushels of grain for each 100,000 acres grown. The increase is a very rough estimate of genetic gain. Entry 17, FW81422-S4008, yields are an example of early promise, but its fate hinges on future trials.

Eastern Oregon Winter Barley Trials

Hesk and Kamiak were the standard checks for this trial. Hesk is a mid-season, mid-tall, mid-hardy, six-row winter type, and was the third most popular barley grown in

Oregon in 1992. Kamiak is an early maturing, tall, hardy, six-row, plump seeded type for shallow soils or dryland areas. Gwen, a 1992 release, is a very hardy, six-row, plump seeded, feed type offered as a replacement for Kamiak. Foundation seed was produced during the 1992 crop year and is available for 1993. The barleys with the "FB" prefix are advanced lines. Those with the "PI" prefix are currently being evaluated in the Western Regional Winter Barley Nursery program. Of the "PI" lines, entry number PI 555582 is the most promising for irrigation. In 1992 it had the highest average in Eastern Oregon Winter Barley trials (Tables 10 through 16). Breeders seed was produced in 1992 pursuant to recent agreements accorded the release of new cereal cultivars.

Tables 10 through 16 summarize barley observations including grain yield, test-weight, date headed, plant height, and percent plump (percent of 200 grams remaining on a standard 1 by 6/64 inch slotted screen).

A Six Year Comparison Of Nine Named Winter Barleys

Six years of grain yield and test-weight comparisons for nine named 6-row winter feed barleys are reported (Tables 17 and 18). The newly released entry, Gwen, had the highest yields and test-weight average. A great portion of that ranking is due to its ability to survive winter freezes. Consequently, the grain yield average nearly reflects the relative ability of this cultivar to withstand freezing on bare soil near Hermiston.

The barley plot areas at the Hermiston station are given less than 120 pounds of nitrogen during the growing season. In 1992 no nitrogen was added to the plot area. Kamiak and Gwen are the earliest maturing and usually have very good test weights and a high percent of uniform plump kernels. Kamiak and Gwen are candidates for dry land production where earliness is an important consideration. Eight Twelve and Showin are shorter stiffer straw varieties that have high yield potentials under intense irrigation. The remainder are stable mid-tall varieties for general production. Additionally, Schuyler may have a high level of resistance to the new barley stripe-rust that is being reported throughout much of the barley production area in the south central United States.

Table 1. Eastern Oregon White Winter Wheat, 1992, summary of grain yield, test-weight, plant height, and date headed of winter wheats tested at Hermiston Agricultural Research and Extension Center, Hermiston, Oregon.

Entry	Variety Name/ Origin	Grain yield	% of check[1]	Test weight	Plant height	Date headed
		bu/ac	%	lbs/bu	in	Julian[2]
CI 17596	Stephens	109	100	52	34	132
PI 497672	Malcolm	98	90	52	34	132
CI 17954	Hill 81	104	95	52	32	135
PI 511673	Madsen	98	90	52	28	135
PI 552427	MacVicar	110	101	52	28	135
PI 559718	W 301	111	102	52	32	135
CI 17909	Lewjain	97	89	52	38	132
PI 566995	Kmor	98	90	51	34	137
OR855	"Rhode", PAHA//72-330/DAWS	100	92	52	34	131
PI 511674	Hyak	89	82	50	35	129
OR880510	OR7946/2*Hill	99	91	52	36	129
FW83185 D5044	LUKE*2/PI 178210,M81-516/4/SPN	88	81	52	36	132
FW84111 F6004	Spn*2/FW75336F701/CO723595	81	74	51	33	136
FW83117 D5071	Spn*2/FW75536F701	96	88	50	32	133
PI 536994	Eltan	76	70	51	32	138
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..	92	84	53	34	134
FW81422-S4008	TT/2*P-101/2/LUKE	94	86	53	32	134
PI 486429	Dusty	88	81	51	33	131
Date planted: October 10, 1991	Mean	96		51.7	33.2	133.3
Date harvested: July 27, 1992	Standard dev.	9.44		.84	2.5	2.54
	Range	35		3	10	9

[1] Stephens
[2] Calendar days from January 1.

Table 2. Eastern Oregon White Winter Wheat, 1992, summary of grain yield, test-weight, plant height, and date headed of winter wheats evaluated under a center-pivot irrigation system near Boardman, Oregon.

Entry	Variety Name/ Origin	Grain yield bu/ac	% of check[1] %	Test weight lbs/bu	Plant height in	Date headed Jullian[2]
CI 17596	Stephens	93	100	57	34	135
PI 497672	Malcolm	96	103	55	38	134
CI 17954	Hill 81	98	105	55	48	136
PI 511673	Madsen	94	101	53	39	136
PI 552427	MacVicar	97	104	55	37	137
PI 559718	W 301	94	101	54	37	136
CI 17909	Lewjain	72	77	52	39	134
PI 566995	Kmor	62	67	50	41	142
OR855	"Rhode", PAHA//72-330/DAWS	99	106	53	46	134
PI 511674	Hyak	78	84	51	41	134
OR880510	OR7946/2*Hill	108	116	52	38	132
FW83185 D5044	LUKE*2/PI 178210,M81-516/4/SPN	71	76	54	38	138
FW84111 F6004	Spn*2/FW75336F701/CO723595	96	103	51	40	137
FW83117 D5071	Spn*2/FW75536F701	96	103	53	37	134
PI 536994	Eltan	63	68	48	43	137
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..	79	85	54	40	133
FW81422-S4008	TT/2*P-101/2/LUKE	98	105	55	41	134
PI 486429	Dusty	110	118	54	42	133
Date planted: Sept. 23, 1991	Mean	89.1		53.1	39.9	135.3
Date harvested: July 9, 1992	Standard dev.	14.5		2.17	3.37	2.35
	Range	48		9	14	10

[1] Stephens

[2] Calendar days from January 1.

Table 3. Eastern Oregon White Winter Wheat, 1992, summary of grain yield, test-weight, plant height, and date headed of winter wheats tested under a center pivot system near Irrigon, Oregon.

Entry	Variety Name/ Origin	Grain yield bu/ac	% of check[1] %	Test weight lbs/bu	Plant height in	Date headed Jullian[2]
CI 17596	Stephens	110	100	55	36	136
PI 497672	Malcolm	122	111	56	36	136
CI 17954	Hill 81	111	101	57	42	138
PI 511673	Madsen	98	89	55	36	139
PI 552427	MacVicar	117	106	55	37	136
PI 559718	W 301	106	96	54	36	136
CI 17909	Lewjain	96	87	56	39	136
PI 566995	Kmor	94	85	54	36	141
OR855	"Rhode", PAHA//72-330/DAWS	103	94	56	38	136
PI 511674	Hyak	84	76	53	37	136
OR880510	OR7946/2*Hill	96	87	55	37	137
FW83185 D5044	LUKE*2/PI 178210,M81-516/4/SPN	94	85	57	37	139
FW84111 F6004	Spn*2/FW75336F701/CO723595	95	86	53	35	139
FW83117 D5071	Spn*2/FW75536F701	102	93	54	33	137
PI 536994	Eltan	94	85	55	34	139
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..	105	95	56	36	136
FW81422-S4008	TT/2*P-101/2/LUKE	111	101	56	36	138
PI 486429	Dusty	117	106	55	36	138
Date planted: October 14, 1991	Mean	103.1		55.1	39.9	137.4
Date harvested: July 10, 1992	Standard dev.	10.10		1.18	3.37	1.54
	Range	38		4	14	5

[1] Stephens

[2] Calendar days from January 1.

Table 4. Eastern Oregon White Winter Wheat, 1992, summary of grain yield, test-weight, plant height, and date headed of winter wheats evaluated in a wheel-roll irrigated field near Baker City, Oregon.

Entry	Variety Name/ Origin	Grain yield bu/ac	% of check[1] %	Test weight lbs/bu	Plant height in	Date headed Julian[2]
CI 17596	Stephens	103	100	60	36	152
PI 497672	Malcolm	101	98	61	32	153
CI 17954	Hill 81	87	84	60	34	156
PI 511673	Madsen	89	86	56	36	155
PI 552427	MacVicar	114	111	60	37	152
PI 559718	W 301	104	101	59	31	151
CI 17909	Lewjain	98	95	58	41	153
PI 566995	Kmor	117	114	56	36	157
OR855	"Rhode", PAHA//72-330/DAWS	100	97	59	37	154
PI 511674	Hyak	88	85	57	36	152
OR880510	OR7946/2*Hill	74	72	58	39	152
FW83185 D5044	LUKE*2/PI 178210,M81-516/4/SPN	89	86	60	38	154
FW84111 F6004	Spn*2/FW75336F701/CO723595	108	105	58	35	153
FW83117 D5071	Spn*2/FW75536F701	107	104	58	40	152
PI 536994	Eltan	104	101	59	33	156
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..	96	93	59	35	154
FW81422-S4008	TT/2*P-101/2/LUKE	120	117	59	40	155
PI 486429	Dusty	95	92	59	32	152
Date planted: Sept. 19, 1991	Mean	99.7		58.7	32.9	153.5
Date harvested: August 7, 1992	Standard dev.	11.67		1.37	4.52	1.72
	Range	46		5	15	6

[1] Stephens
[2] Calendar days from January 1.

Table 5. Quality of five winter wheats grown at a stressed site near Hermiston and at an irrigated site near Baker City, Oregon.

Variety	Test weight lbs/bu	% Protein	Flour yield*	Milling score**	Cookie diameter***
	- - - - - - - - - - - Hermiston site - - - - - - - - - - -				
Stephens	53.2	13.9	60.8	70.5	8.64
MacVicar	53.6	13.7	62.5	72.7	8.90
W 301	54.3	14.0	63.3	74.3	9.09
OR855	54.5	13.7	62.6	71.5	8.96
FW81422-S4008	53.8	13.3	58.9	68.7	8.54
	- - - - - - - - - - - - - Baker site - - - - - - - - - - - - -				
Stephens	61.1	13.4	63.9	78.9	8.35
Hill 81	60.7	12.6	68.4	83.4	9.20
Hyak	60.2	14.0	66.0	82.2	8.65
OR855	61.4	13.0	67.2	83.8	9.06
FW81422-S4008	59.6	12.2	62.2	78.0	8.35

* Flour yield: Percent recoverable as straight-grade flour. A score above 80 is desirable.
** Milling score: Calculation involving flour yield, ash, milling time, percent long patent flour, and first tempering moisture.
*** Cookie diameter: Average diameter in centimeters of a cookie from a know standard set of ingredients.

Table 6. Eastern Oregon White Winter Wheat, 1992, summary of grain yield, test-weight, plant height, and date headed of winter wheats evaluated in a wheel-roll irrigated field near Union, Oregon.

Entry	Variety Name/ Origin	Grain yield	% of check[1]	Test weight	Plant height	Date headed
		bu/ac	%	lbs/bu	in	Julian[2]
CI 17596	Stephens	105	100	57	34	150
PI 497672	Malcolm	125	119	58	34	151
CI 17954	Hill 81	110	105	57	35	154
PI 511673	Madsen	116	110	57	38	153
PI 552427	MacVicar	109	104	58	36	151
PI 559718	W 301	122	116	58	34	149
CI 17909	Lewjain	110	105	59	37	151
PI 566995	Kmor	106	101	58	38	156
OR855	"Rhode", PAHA//72-330/DAWS	92	88	58	37	152
PI 511674	Hyak	75	71	54	35	150
OR880510	OR7946/2*Hill	102	97	57	37	150
FW83185 D5044	LUKE*2/PI 178210,M81-516/4/SPN	99	94	57	36	152
FW84111 F6004	Spn*2/FW75336F701/CO723595	106	101	54	36	151
FW83117 D5071	Spn*2/FW75536F701	101	96	56	36	150
PI 536994	Eltan	100	95	55	37	154
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..	103	98	56	34	151
FW81422-S4008	TT/2*P-101/2/LUKE	110	105	57	36	154
PI 486429	Dusty	122	116	59	36	152
Date planted: Sept. 18, 1991	Mean	106.3		56.9	35.9	151.7
Date harvested: Aug. 6, 1992	Standard dev.	11.69		1.47	1.39	1.84
	Range	50		5	4	7

[1] Stephens

[2] Calendar days from January 1.

Table 7. Soil test results at the site at Union, Oregon, July 1992.

Sample depth	pH	Soluble salts	Organic matter	P	K	Ca	Mg	N03	NH4	S	Total bases
in		mmhos	%	ppm	ppm	meq	meq	#/a	#/a	ppm	
0-6	8.2	0.54	2.7	31	113	37.9	13.5	38	11	11.4	51.7
6-18	8.5	0.64	1.4	13	50	31.5	10.9	33	13	18.8	42.5

Table 8. Eastern Oregon White Winter Wheat, 1992, combined average grain yield, test-weight, plant height, and date headed of irrigated winter wheats for the five sites (Hermiston, Boardman, Irrigon, Baker City, and Union).

Entry	Variety Name/ Origin	Grain yield bu/ac	% of check[1] %	Rank	Test weight lbs/bu	Plant height in	Date headed Julian[2]
CI 17596	Stephens	104.0	100	6	56.2	34.4	141.0
PI 497672	Malcolm	108.4	104	2	56.4	35.2	141.2
CI 17954	Hill 81	102.0	98	7	56.2	39.4	143.8
PI 511673	Madsen	99.0	95	9	54.6	36.0	143.6
PI 552427	MacVicar	109.4	105	1	56.0	33.2	142.2
PI 559718	W 301	107.4	103	3	55.4	34.2	141.4
CI 17909	Lewjain	94.6	91	15	55.4	38.8	141.2
PI 566995	Kmor	95.4	92	13	53.8	36.0	146.6
OR855	"Rhode", PAHA//72-330/DAWS	98.8	95	10	55.6	38.0	141.4
PI 511674	Hyak	82.8	80	18	53.0	37.6	140.2
OR880510	OR7946/2*Hill	95.8	92	12	54.8	35.8	140.0
FW83185 D5044	LUKE*2/PI 178210,M81-516/4/SPN	88.2	85	16	56.0	35.2	143.0
FW84111 F6004	Spn*2/FW75336F701/CO723595	97.2	93	11	53.4	37.6	143.2
FW83117 D5071	Spn*2/FW75536F701	100.4	96	8	54.2	36.4	141.2
PI 536994	Eltan	87.4	84	17	53.6	37.6	144.8
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..	95.0	91	14	55.6	36.6	141.6
FW81422-S4008	TT/2*P-101/2/LUKE	106.6	102	4	56.0	36.0	143.0
PI 486429	Dusty	106.4	102	5	55.6	37.0	141.2
Date planted: October 10, 1991	Mean	98.2			55.1	36.39	142.3
Date harvested: July 27, 1992	Standard dev.	12.83			2919	4.411	8.845
	Range	63.0			13.0	22.0	28.0

[1] Stephens
[2] Calendar days from January 1.

Table 9. Eastern Oregon White Winter Wheat six-year grain yield summary of white winter whats in yield trials grown near Hermiston, Boardman, Irrigon, Union, Baker City, and Ontario, Oregon.

Entry	Variety Name/ Origin	- - - - - - - - - Bushels/ac - - - - - - - - -							Percent Stephens*	Test years
		1987	1988	1989	1990	1991	1992	Avg.		
CI 17596	Stephens	126	131	81	89	100	104	100.3	100.0	29
PI 497672	Malcolm	131	137	76	91	88	108	100.7	100.4	29
CI 17954	Hill 81	121	130	80	86	100	102	98.3	98.0	29
PI 511673	Madsen					87	99	93.0	91.2	10
PI 552427	MacVicar	132	135	83	92	86	109	100.9	100.6	29
PI 559718	W 301	131	140	76	93	80	107	99.0	98.7	29
CI 17909	Lewjain	129	139	72	90	88	95	96.5	96.2	29
PI 566995	Kmor						95	95.0	91.3	5
OR855	"Rhode", PAHA//72-330/DAWS				86	88	99	90.2	93.8	18
PI 511674	Hyak						83	83.0	79.8	5
OR880510	OR7946/2*Hill						96	96.0	92.3	5
FW83185 D5044	LUKE*2/PI 178210,M81-				75	91	88	83.0	86.3	18
FW84111 F6004	Spn*2/FW75336F701/CO723595					89	97	93.0	91.1	10
FW83117 D5071	Spn*2/FW75536F701					79	100	89.5	87.7	10
PI 536994	Eltan						87	87.0	83.6	5
FW83116 B801	SPN/M81-603,LUKE/DAWS/2/..						95	95.0	91.3	5
FW81422-S4008	TT/2*P-101/2/LUKE						107	107.0	102.9	5
PI 486429	Dusty	128	137	76	91	90	106	99.4	99.1	29
	Number of tests per year	3	3	5	8	5	5			

*Percent Stephens: Stephens percent of yield for same years grown 100.3, 96.2, 102.0, and 104 bushels per acre used for 29, 18, 10, and 5 years, respectively.

Table 10. Eastern Oregon Winter Barley, 1992, grain yield, test-weight, date headed, plant height, and percent plump of 12 winter barleys evaluated at the Hermiston Agricultural Research and Extension Center, Hermiston, Oregon.

Entry	Variety Name/Origin	Grain yield	% of Hesk	Test weight	Date headed	Plant height	% Plump
		lbs/ac	%	lbs	Jan. 1	in	over 6/64
CI 15816	Hesk	4534	100	43	114	44	28
CI 15197	Kamiak	4010	88	43	106	43	62
PI 554155	Gwen	4549	100	45	106	49	71
FB84279 GP#3	-235/2/Boyer/DR68-1608	3489	77	42	114	40	89
PI 555582	(FB81019), E-822/FB79204	4309	95	42	106	35	62
PI 555583	(FB84221-91A) FB77818/3/M66-85...	4569	101	44	124	40	36
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	4344	96	40	124	30	89
FB84279 GP#1	-235/2/Boyer/DR68-1608	4916	108	44	117	34	50
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	4894	108	43	125	39	80
PI 555584	(FB84435-A) FB79019/FB77818/2/..	5154	113	44	111	36	52
PI 555585	(FB84435-B) FB79019/FB77818/2/..	4790	106	44	111	39	60
FB80667	Ltr/Hpr	5180	114	43	116	35	70
Date seeded: August 31, 1991				Standard error 316.9			
Date harvested: July 6, 1992				CV (SE/Mean) 6.947			

Table 11. Eastern Oregon Winter Barley, 1992, grain yield, test-weight, date headed, plant height, and percent plump of 12 winter barleys evaluated at the Hermiston Agricultural Research and Extension Center, Hermiston, Oregon.

Entry	Variety Name/Origin	Grain yield	% of Hesk	Test weight	Date headed	Plant height	% Plump
		lbs/ac	%	lbs	Jan. 1	in	over 6/64
CI 15816	Hesk	4783	100	45	118	45	52
CI 15197	Kamiak	3798	79	46	117	44	56
PI 554155	Gwen	4617	96	50	113	49	74
FB84279 GP#3	-235/2/Boyer/DR68-1608	4041	84	46	112	42	88
PI 555582	(FB81019), E-822/FB79204	4679	98	50	117	36	54
PI 555583	(FB84221-91A) FB77818/3/M66-85...	4150	87	42	127	41	80
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	5520	115	45	125	30	82
FB84279 GP#1	-235/2/Boyer/DR68-1608	4612	96	46	122	35	76
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	4028	84	44	126	39	63
PI 555584	(FB84435-A) FB79019/FB77818/2/..	4228	88	46	116	36	54
PI 555585	(FB84435-B) FB79019/FB77818/2/..	4472	93	46	116	39	44
FB80667	Ltr/Hpr	4874	102	45	125	37	74
Date seeded: October 11, 1991				Standard error 238.3			
Date harvested: July 7, 1992				CV (SE/Mean) 5.316			

Table 12. Eastern Oregon Winter Barley, 1992, grain yield, test-weight, date headed, plant height, and percent plump of 12 winter barleys evaluated under a center pivot system, near Boardman, Oregon.

Entry	Variety Name/Origin	Grain yield	% of Hesk	Test weight	Date headed	Plant height	% Plump
		lbs/ac	%	lbs	Jan. 1	in	over 6/64
CI 15816	Hesk	4878	100	48	108	36	78
CI 15197	Kamiak	4424	88	50	107	32	76
PI 554155	Gwen	5391	111	50	105	30	79
FB84279 GP#3	-235/2/Boyer/DR68-1608	3700	76	51	109	37	92
PI 555582	(FB81019), E-822/FB79204	5289	109	48	114	36	79
PI 555583	(FB84221-91A) FB77818/3/M66-85...	4440	92	46	121	38	52
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	5811	120	45	124	35	83
FB84279 GP#1	-235/2/Boyer/DR68-1608	5408	112	50	111	36	88
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	5397	111	47	121	38	76
PI 555584	(FB84435-A) FB79019/FB77818/2/..	5132	106	47	113	34	48
PI 555585	(FB84435-B) FB79019/FB77818/2/..	5361	111	46	112	33	62
FB80667	Ltr/Hpr	5167	107	49	121	38	92
Date seeded: September 23, 1991				Standard error 332.4			
Date harvested: July 9, 1992				CV (SE/Mean) 6.607			

Table 13. Eastern Oregon Winter Barley, 1992, grain yield, test-weight, date headed, plant height, and percent plump of 12 winter barleys evaluated under a center pivot system, near Irrigon, Oregon.

Entry	Variety Name/Origin	Grain yield	% of Hesk	Test weight	Date headed	Plant height	% Plump
		lbs/ac	%	lbs	Jan. 1	in	over 6/64
CI 15816	Hesk	4907	100	47	135	36	94
CI 15197	Kamiak	5332	109	47	133	39	96
PI 554155	Gwen	5761	117	48	130	37	96
FB84279 GP#3	-235/2/Boyer/DR68-1608	4864	99	45	134	37	98
PI 555582	(FB81019), E-822/FB79204	6161	125	45	130	36	88
PI 555583	(FB84221-91A) FB77818/3/M66-85...	4465	91	49	135	35	87
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	3045	62	43	142	35	91
FB84279 GP#1	-235/2/Boyer/DR68-1608	4580	93	48	136	35	94
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	5027	102	48	136	35	94
PI 555584	(FB84435-A) FB79019/FB77818/2/..	5397	110	47	130	36	86
PI 555585	(FB84435-B) FB79019/FB77818/2/..	6176	126	47	130	36	89
FB80667	Ltr/Hpr	3107	63	43	142	39	94
Date seeded: October 14, 1991				Standard error 371.0			
Date harvested: July 10, 1992				CV (SE/Mean) 7.569			

Table 14. Eastern Oregon Winter Barley, 1992, grain yield, test-weight, date headed, plant height, and percent plump of 12 winter barleys evaluated under a wheel roll irrigation system, near Baker City, Oregon.

Entry	Variety Name/Origin	Grain yield	% of Hesk	Test weight	Date headed	Plant height	% Plump
		lbs/ac	%	lbs	Jan. 1	in	over 6/64
CI 15816	Hesk	6828	100	48	mid-season	32	98
CI 15197	Kamiak	4603	67	45	early	35	94
PI 554155	Gwen	5803	85	48	early	33	98
FB84279 GP#3	-235/2/Boyer/DR68-1608	5072	74	45	mid-season	36	98
PI 555582	(FB81019), E-822/FB79204	6294	92	46	early	33	97
PI 555583	(FB84221-91A) FB77818/3/M66-85...	7181	105	48	late	30	96
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	5658	83	43	late	30	80
FB84279 GP#1	-235/2/Boyer/DR68-1608	6420	94	47	mid-season	31	94
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	5326	78	47	late	28	98
PI 555584	(FB84435-A) FB79019/FB77818/2/..	5627	82	48	mid-season	32	98
PI 555585	(FB84435-B) FB79019/FB77818/2/..	6027	88	47	mid-season	35	92
FB80667	Ltr/Hpr	5996	88	46	late	36	98

Date seeded: September 19, 1991
Date harvested: August 7, 1992
*Date headed characterized by relative maturity dates of winter barley.

Standard error 559.7
CV (SE/Mean) 9.458

Table 15. Eastern Oregon Winter Barley, 1992, grain yield, test-weight, date headed, plant height, and percent plump of 12 winter barleys evaluated under a wheel roll irrigation system, near Union, Oregon.

Entry	Variety Name/Origin	Grain yield	% of Hesk	Test weight	Date headed	Plant height	% Plump
		lbs/ac		lbs	Jan. 1	in	over 6/64
CI 15816	Hesk	5471	100	48	mid-season	42	99
CI 15197	Kamiak	3998	73	48	early	43	100
PI 554155	Gwen	4890	89	49	early	38	100
FB84279 GP#3	-235/2/Boyer/DR68-1608	3954	72	44	mid-season	42	99
PI 555582	(FB81019), E-822/FB79204	5415	99	51	early	38	100
PI 555583	(FB84221-91A) FB77818/3/M66-85...	5855	107	50	late	30	99
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	6096	111	45	late	36	88
FB84279 GP#1	-235/2/Boyer/DR68-1608	4819	88	48	mid-season	40	100
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	5649	103	50	late	40	100
PI 555584	(FB84435-A) FB79019/FB77818/2/..	4438	81	48	mid-season	36	100
PI 555585	(FB84435-B) FB79019/FB77818/2/..	4784	87	49	mid-season	36	100
FB80667	Ltr/Hpr	5480	100	47	late	42	97

Date seeded: September 18, 1991

Standard error 347.9

Table 16. Eastern Oregon Winter Barley, 1992, combined average grain yield, test-weight, date headed, plant height, and percent plump of 12 irrigated winter barleys evaluated at six sites (Hermiston, Boardman, Irrigon, Baker City, and Union, Oregon).

Entry	Variety Name/Origin	Grain lbs/ac	% of %	Test lbs	Date Jan. 1	Plant in	% over 6 /64
CI 15816	Hesk	5201	100	46.5	118.7	39.2	74.8
CI 15197	Kamiak	4333	83	46.5	115.7	39.3	80.7
PI 554155	Gwen	5169	99	48.3	113.5	39.3	86.3
FB84279 GP#3	-235/2/Boyer/DR68-1608	4187	80	45.5	118.5	39.0	94.2
PI 555582	(FB81019), E-822/FB79204	5358	103	47.0	116.7	35.7	80.0
PI 555583	(FB84221-91A) FB77818/3/M66-83...	5110	98	46.5	126.7	35.7	75.0
FB84221-208	FB77818/3/M66-85/Cly/2/OR7107	5079	98	43.5	128.7	32.7	85.5
FB84279 GP#1	-235/2/Boyer/DR68-1608	5126	98	47.2	121.5	35.2	83.7
FB84378-614	Mnr/B69735/2/Mlr/3/198 dwf	5054	97	46.5	127.0	36.5	85.2
PI 555584	(FB84435-A) FB79019/FB77818/2/..	4996	96	46.7	117.5	35.0	73.0
PI 555585	(FB84435-B) FB79019/FB77818/2/..	5268	101	46.5	117.2	36.3	74.5
FB80667	Ltr/Hpr	4968	95	45.5	126.0	37.8	87.5
	Overall Mean	4987		46.35	120.7	36.8	81.7

Table 17. A six-year grain yield summary of nine winter barleys tested at the Hermiston Agricultural Research and Extension Center, Hermiston, Oregon.

Name	----------- Yield -----------							
	1987	1988	1989	1990	1991	1992	Avg.	% Kamiak
Kamiak	47	62	48	65	33	35	48.3	100
Schuyler	55	58	47	72	43	34	51.5	107
Boyer	50	58	49	70	39	41	51.1	106
Hesk	41	60	39	74	34	39	47.8	99
Scio	42	76	42	72	29	35	49.3	102
Eight Twelve	57	69	38	69	33	33	49.8	103
Showin	51	77	42	61	23	46	50.0	104
Hundred	41	69	45	62	31	40	48.0	99
Gwen	45	67	66	72	40	47	56.2	116
Standard Error at 5% = 2.611								

Table 18. A six-year test-weight summary of nine winter barleys tested at the Hermiston Agricultural Research and Extension Center, Hermiston, Oregon.

Name	-------- Test weight --------							
	1987	1988	1989	1990	1991	1992	Avg.	% Kamiak
Kamiak	47	51	49	47	46	48	48.0	100
Schuyler	43	50	48	47	47	45	46.7	97
Boyer	47	50	46	47	48	44	47.0	98
Hesk	46	49	48	44	45	42	45.7	95
Scio	46	49	50	45	48	43	46.8	98
Eight Twelve	47	48	49	45	49	48	47.7	99
Showin	47	48	47	45	46	40	45.5	95
Hundred	46	48	48	46	47	45	46.7	97
Gwen	48	50	50	47	49	48	48.7	101
Standard Error at 5% = .5796			Overall Mean = 46.96					

1992 WEATHER REPORT

J. Mike Barnum and Clinton C. Shock
Malheur Experiment Station
Oregon State University
Ontario, Oregon

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 a pyranometer, to monitor solar 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, and 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 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, which is connected by satellite to the Northwest Cooperative Agricultural Weather Network (AgriMet) computer in Boise, Idaho, began transmitting data from Malheur Experiment Station. The station monitors air temperature, relative humidity, dew point temperature, precipitation, wind run, wind speed, wind direction, solar radiation, soil temperature at 8- and 20-inch depths, and soil-water content at 8- and 20-inches. Data pertaining to the previously mentioned parameters are automatically transmitted to the computer at programmed 15- or 60-minute intervals. The database may be accessed via computer modem. Daily Malheur County crop water use estimates based on weather station data are also available by modem.

Precipitation during the first half of 1992 (January through June) was 18 and 20 percent below the 10- and 50-year averages, respectively. Precipitation during the second half (July through December) was slightly greater than the 10-year average, and slightly less than the average for the past 50 years (Table 1 and Figure 1). Total precipitation for the year was 12 percent below the 50-year mean (Table 2).

Although the fall 1991 (October through December) and winter 1992 (January through March) seasonal moisture total of 5.34 inches was 15 percent below the 50-year average, it was an improvement over the amounts received during the two previous fall-winter (1989-90 and 1990-91) periods (Table 3). Precipitation during the fall of 1992 (October through December) was 114 percent greater than the 50-year mean for the period.

Annual mean air and soil temperatures (Table 4, Figure 2, and Figure 3) for 1992 were slightly higher than the 10- and 50-year means. The mean air temperature for the first half of the year (January through June) was above the 10- and 50-year means for that period (Figure 2). The mean 4-inch soil temperature for the same period was likewise slightly higher than both long term means. These above-average temperatures enhanced early season plant growth and effectively moved the start of the irrigation season and winter cereal harvest ahead by approximately two weeks.

Although mean air temperature during the irrigation season (April through October) was slightly higher than normal (Table 4), wind run for the period was 19 percent below the 10-year mean. Subsequently, mean evaporation for the period was below normal (Table 5).

Although the last spring frost (≥32°F) occurred one week ahead of the 20-year mean date of May 1, the first fall frost occurred on September 15, a full three weeks earlier than normal. Table 6 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°F for the past 20 years. Table 7 shows the number of days between the last spring occurrence and the first fall occurrence of those threshold temperatures.

Total cumulative growing degree days (≥50°F and ≤86°F) at the end of June were nearly equal to 126 percent of the seven-year mean. Growing degree days for March, April, May, and June were the highest recorded for those months since the biophenometer was installed at this station in 1985 (Table 8 and Figure 4). This earlier than normal accumulation of heat units along with early drying of vegetation in the range was directly responsible for the unseasonably early flights of the beet leafhopper (*Circulifer tenellus*) and the ensuing occurrence of the beet curly top virus, which was prevalent in most local beet fields. Cumulative degree days during the second half of the year (July through December) were slightly below the mean for that period.

Table 9 summarizes the weather conditions over the last five years and lists the historic record extremes for the Malheur Experiment Station. Air temperature extremes for 1992 ranged from a high of 105°F on Aug 15 to a low of -11°F on December 6. The total number of days on which the minimum temperature was >0°F and ≤32°F was 16 percent below the mean of the four previous years.

Table 1. Precipitation in inches for 1992 at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	------------------------ Inches											------------------------
1							.17				.15	.05
2							.01				.03	.78
3										.16		.07
4			.05									
5									.02		.10	
6	.28											
7			.20				.04					
8											.06	.11
9				.02							.24	.15
10				.11		.03						.03
11		.06										
12		.03		.10					.01		.15	.02
13		.32		.16		.89						
14	.03	.01				.01						
15												
16		.02				.30						
17	.05			.06								
18				.05							.01	
19		.02				.06						
20		.34			.21		.08				.12	.02
21		.02		.24			.04					
22		.54									.24	
23							.02	.01				
24												
25									.06			
26												
27												.17
28	.17										.05	
29	.05					.14				.14		.08
30										.65		.03
31												
Monthly tot:												
1992	.58	1.36	.25	.74	.21	1.43	.36	.01	.09	.95	1.15	1.51
10 yr mean	.81	.92	1.29	.71	.99	.84	.23	.37	.46	.51	1.26	1.07
50 yr mean	1.21	.97	.93	.72	.99	.84	.18	.38	.47	.72	1.19	1.26

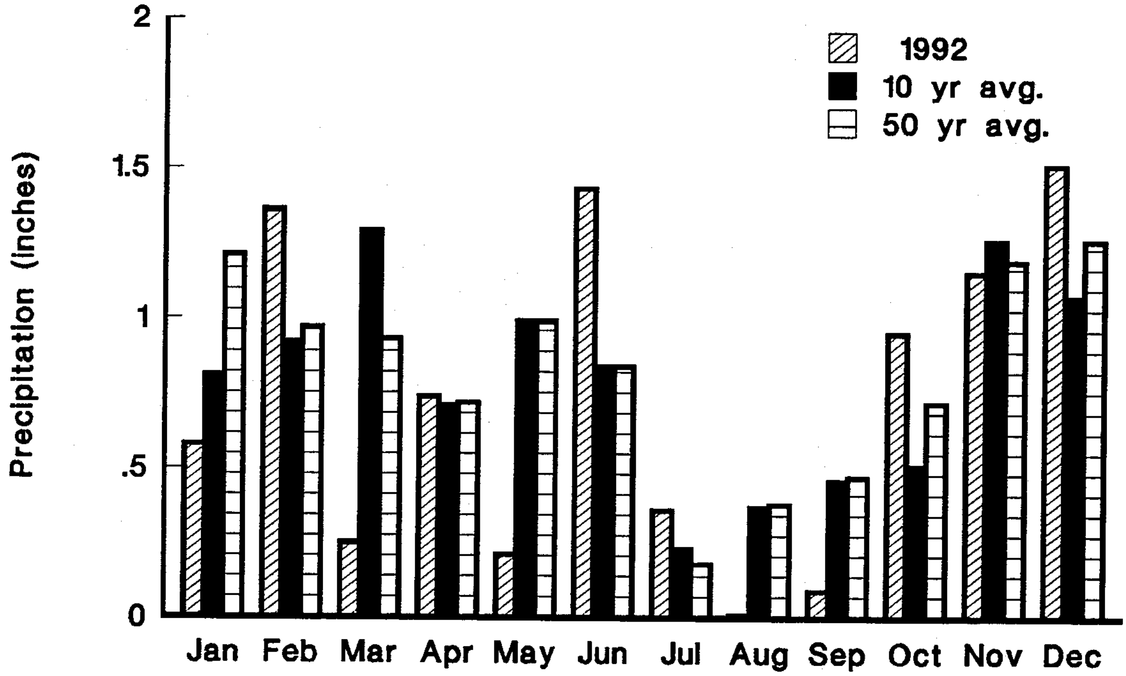


Figure 1. A comparison of the average monthly precipitation for 1992 to the 10- and 50-year averages at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Table 2. Annual precipitation 1983 through 1992 and 50-year average at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	50 yr mean
	inches										
Ann precip.	16.87	9.49	7.89	8.64	9.81	7.58	9.15	7.21	9.25	8.64	9.86

Table 3. Ten-year fall and winter and 50-year average precipitation at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Month	1982 / 83	1983 / 84	1984 / 85	1985 / 86	1986 / 87	1987 / 88	1988 / 89	1989 / 90	1990 / 91	1991 / 92	1992	50 yr mean
	inches											
Oct	2.06	.33	.63	.71	.12	.00	.00	.86	.49	1.01	.95	.72
Nov	.91	2.08	1.59	1.05	.22	1.40	2.45	.24	.69	1.71	1.15	1.19
Dec	3.08	3.57	.84	.92	.22	1.46	1.48	.01	.29	.43	1.51	1.26
Jan	1.46	.58	.11	.96	1.24	1.25	.88	.44	.59	.58		1.21
Feb	1.48	.72	.36	2.29	.77	.14	1.27	.35	.44	1.36		.97
Mar	3.73	1.36	.89	1.24	1.37	.26	2.17	.72	.88	.25		.93
Fall[1]	6.05	5.98	3.14	2.68	.56	2.86	3.93	1.12	1.47	3.15	3.61	3.17
Spr.[2]	6.67	2.66	1.28	4.49	3.38	1.65	4.32	1.50	1.91	2.19		3.11
Sea.[3]	12.72	8.64	4.42	7.17	3.94	4.51	8.25	2.62	3.38	5.34		6.28

[1] Fall = Total precipitation for fall quarter (October through December).
[2] Spr. = Total precipitation for spring quarter (January through March).
[3] Sea. = Total precipitation for season (October through March).

Table 4. Monthly high, low, and mean air temperature and 4-inch soil temperature in degrees Fahrenheit at Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air Temp.												
1992 high	53	64	73	85	94	100	99	105	90	93	58	47
1992 low	33	23	29	25	37	43	42	37	31	28	12	-11
1992 mean	31	40	49	54	67	70	71	74	61	53	36	26
10 yr. mean	24	32	44	52	59	68	74	73	62	51	37	25
49 yr. mean	26	34	43	51	59	67	75	73	63	51	38	29
Soil Temp.												
1992 high	40	55	67	78	88	96	92	96	86	76	54	34
1992 low	30	34	41	44	50	57	63	65	59	48	31	32
1992 mean	32	41	53	59	72	78	79	82	71	59	41	33
10 yr. mean	31	36	46	57	65	75	82	81	70	58	42	32
25 yr. mean	32	36	46	58	66	75	83	81	71	56	42	33

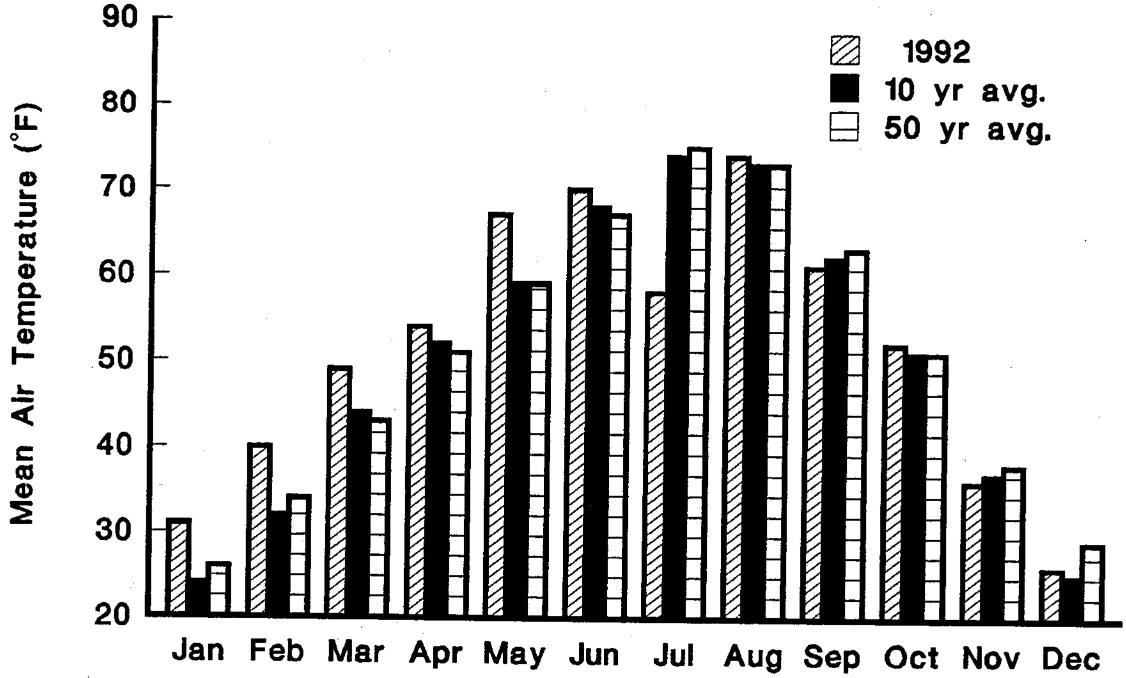


Figure 2. A comparison of the average monthly air temperature for 1992 to the 10- and the 50-year averages at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

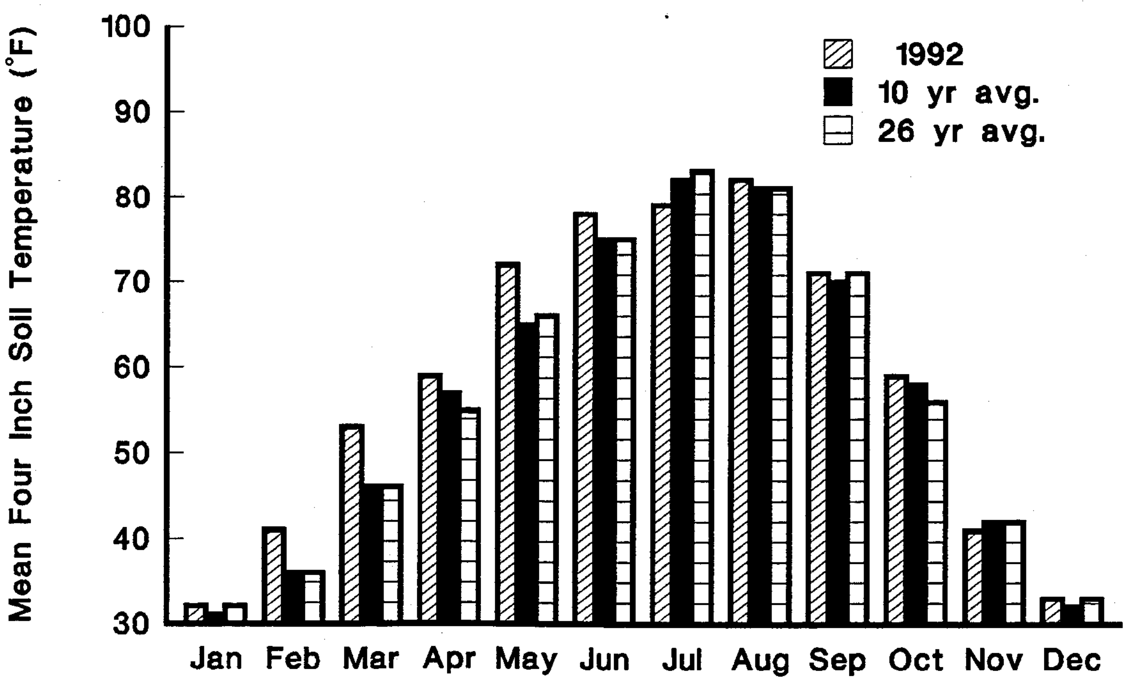


Figure 3. A comparison of the average monthly soil temperature for 1992 to the 10- and 26-year averages at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Table 5. Total monthly and 10-year average evaporation in inches (from a standard 10" deep by 47½" diameter pan) and total monthly and 10-year average wind in miles (measured at 6" above the pan) for the seven month irrigation season (April 1 through October 31) at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Evaporation in inches / wind in miles											
Month	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	10 yr mean
April											
Evap.[1]	5.46	7.14	7.22	5.80	8.13	5.69	5.79	7.03	3.68	5.70	6.16
Wind[2]	3030	4405	2823	2308	2354	1889	1925	1832	2693	1797	2551
May											
Evap.	8.99	7.61	8.93	8.31	9.55	8.76	8.74	10.07	6.53	11.23	8.87
Wind	3073	3425	2787	2321	2423	2599	2620	2506	2677	2237	2667
June											
Evap.	10.23	9.64	10.86	10.91	9.51	11.17	10.78	10.05	9.03	8.37	10.06
Wind	2707	2985	2492	1792	1898	2357	1872	1824	2184	1711	2182
July											
Evap.	10.60	11.69	12.68	12.00	11.46	13.35	12.84	12.12	12.87	10.13	11.97
Wind	2284	2152	2111	2130	2161	2014	1707	1556	1680	1671	1947
August											
Evap.	9.55	11.39	10.58	11.61	11.08	11.25	9.73	7.88[3]	11.11	9.86	10.40
Wind	1829	2139	2430	1740	1938	1879	1481	1276	1358	1580	1765
September											
Evap.	8.59	7.13	5.73	5.05	8.30	7.01	6.65	8.54	8.01	6.70	7.17
Wind	2717	2251	2268	1413	1620	1604	1465	1357	1316	1583	1759
October											
Evap.	4.26	3.89	3.47	3.95	4.92	4.80	3.76	2.99	4.22	4.15	4.04
Wind	2102	2290	2237	1544	1131	1294	1311	1427	1786	1158	1628
Season total:											
Evap.	57.68	58.49	59.47	57.63	62.95	62.03	58.29	59.48	55.45	56.14	58.76
Wind	17742	19647	17148	13248	13714	13636	12385	11778	13649	11737	14468

[1] Evap. = Evaporation in inches
[2] Wind = Wind in miles per 24 hour period
[3] Due to an accidental draining of the evaporation pan at this station, the value reported is from the Parma Experiment Station, University of Idaho, Parma, Idaho.

Table 6. Dates of last occurrence in spring and first occurrence in fall of low temperatures for past 20-years at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Year	Last spring date and first fall date when minimum temperature was ≤ than threshold							
	Spring				Fall			
	≤24°F	≤28°F	≤32°F	≤36°F	≤24°F	≤28°F	≤32°F	≤36°F
1973	Apr 8	Apr 8	May 11	Jun 18	Nov 2	Oct 4	Oct 3	Oct 3
1974	Mar 24	Apr 14	May 18	May 21	Nov 5	Oct 6	Oct 6	Sep 28
1975	Apr 2	May 25	May 25	May 26	Oct 24	Oct 24	Oct 8	Oct 8
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
Mean	Mar 15	Apr 7	May 1	May 18	Oct 31	Oct 15	Oct 5	Sep 27

Table 7. Number of days during the year that the minimum air temperature was greater than the threshold temperature during the past 20 years at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Year	Number of days minimum air temperature was greater than the threshold			
	>24°F	>28°F	>32°F	>36°F
1973	208	179	145	107
1974	226	175	141	130
1975	205	152	136	135
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
Mean	230	191	157	132

Table 8. Annual cumulative degree days (lower threshold = 50°F, upper threshold = 86°F) for seven years 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
7 yr.	0	7	55	242	546	1080	1821	2499	2927	3101	3114	3114

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

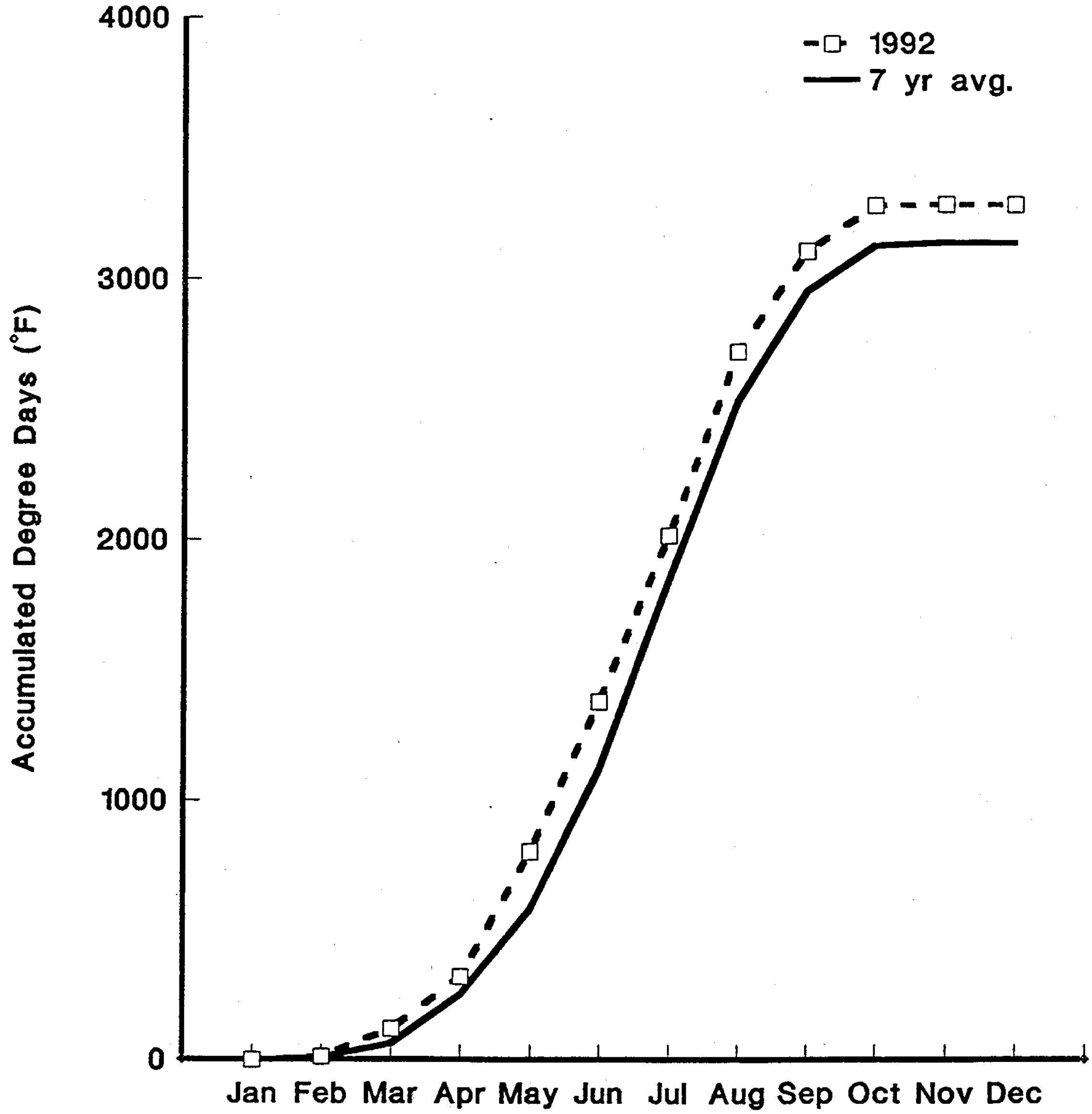


Figure 4. A comparison of the cumulative degree days for 1992 to the seven year average at Malheur Experiment Station, Oregon State University, Ontario, Oregon.

Table 9. Five-year weather summary and record extremes for Malheur Experiment Station, Oregon State University, Ontario, Oregon.

	1988	1989	1990	1991	1992
Total precipitation (inches)	7.58	9.18	7.26	9.25	8.64
Total snowfall (inches)	34.8	25.1	5.7	6.5	15.5
First fall snowfall:					
Date	Nov 7	Nov 23	Dec 25	Oct 29	Nov 12
Depth (inches)	1.4	0.1	1.0	0.5	0.5
Greatest amount of snow on ground:					
Date	Dec 25,31	Feb 18	Dec 28	Jan 10,11	Dec 9
Depth (inches)	9.0	17.0	2.0	4.0	8.0
Coldest day of year:					
Date	Dec 27-30	Feb 5-6	Dec 22	Jan 2	Dec 6
Air temperature (°F)	-6	-24	-21	-3	-11
Hottest day of year:					
Date	Jul 26,31	Jul 28	Aug 8	Jul 5, Aug 10,23	Aug 15
Air temperature (°F)	102	103	106	99	105
Number of days air temperature was:					
≤0°F	7	15	9	2	3
>0°F & ≤32°F	138	141	137	139	118
≥90°F & <100°F	53	34	50	52	39
≥100°F	8	7	10	0	11
Soil Temperature extremes @4 inches:					
Date	Jul 26,31	Jul 28	Oct 7	Jul 29-31, Aug 8,20	Aug 15
Highest (°F)	97	95	96	93	96
Date	Jan 4	Dec 14,27, 31	Dec 24-26	Jan 3	Jan 22
Lowest (°F)	29	28	12	12	30
Wind run extremes:					
Total days run ≥125 miles			25	31	13
Total days run ≥200 miles			4	3	0
Date of greatest wind run			Apr 24	Apr 11	Nov 22
Wind run in miles			301	278	197

Record extremes:

Maximum air temperature: 108°F, August 4, 1961
Minimum air temperature: -26°F, January 21 and 22, 1962
Minimum 4" soil temperature: 12°F, December 24 through 26, 1990
Greatest amount of precipitation in 24 hour period: 1.52 inches, September 14, 1959
Greatest amount of snowfall in 24 hour period: 10.0 inches, November 30, 1975