Northwestern Agricultural Research Center
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Montana Agricultural Experiment Station
Montana State University

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CLIMATOLOGY

Weather information as recorded at the Northwestern Agricultural Research Center, Kalispell, Montana. Tables include weather reported for the 2000 crop year (September 2000-August 2001) and for the calendar year 2001.

CLIMATOLOGICAL DATA
NORTHWEST AGRICULTURAL RESEARCH CENTER
Kalispell, Montana

Crop Year 2001 (September 2000-August 2001) was dry with temperatures running close to the established averages in most months. Total precipitation for the crop year, 16.32", was nearly 18% below average (19.8 for 1949-2001). Precipitation was significantly below average for November 2000-January 2001, and for July and August 2001.

The winter of 2000-2001 was somewhat mild for this location. The minimum recorded temperature was -9° F. Temperatures from November-December 2000 and February 2001 were below average with above average snow cover.

The 2001 growing season (April – August) received 7.93" of rain, 20% below average. February, April and June 2001 had above average precipitation.

Accumulated growing degree days amounted to 1993 (Base 50) for the crop year vs. 1841 for the 1949-2000 average. We began keeping records for growing degree days at Base 32 in CY01. Base 32 growing degree days totaled 4764.5.

The last spring frost was May 20, 2001 – two days earlier than the average of May 22. The first killing frost in the fall was September 29, 16 days later than the average date of September 13. Temperatures for April through August ran close to the average with the exception of April and June, which were slightly cooler.

Following is a list of tables giving a complete description of the weather for the crop year (September 2000 - August 2001) and calendar 2001 (January - December).

Table 1. Summary of Climatic Data by Months for the 2000-2001 Crop Year - September 2000 - August 2001 and Averages for the Period 1949-2001 at the Northwestern Agricultural Research Center Kalispell, Montana

ITEM	Sept. 2000	Oct. 2000	Nov. 2000	Dec. 2000	Jan. 2001	Feb. 2001	Mar. 2001	Apr. 2001	May 2001	June 2001	July 2001	Aug. 2001	Total
Precipitation (inches)													2000-01 Total
Current Year	1.40	1.23	0.62	1.23	0.75	1.54	1.03	2.62	0.57	3.29	0.91	0.54	15.73
													49-01 Average
Avg. 1949 to Crop Year 01	1.56	1.37	1.55	1.61	1.46	1.17	1.18	1.54	2.35	2.96	1.59	1.50	19.84
Average Temperature (F)													2000-01 Average
Current Year	52	33.5	27.5	18.4	24	20.6	33.6	40.5	53.4	54.8	63.1	64.6	40.50
													49-01 Average
Mean 1949 to 1999-2001	53.6	43.0	32.6	25.4	22.5	27.6	33.9	43.2	51.7	58.1	63.9	63	43.21

Last killing frost in spring

Spring 2001	May 20	30°F
Avg. 1949-2001	May 22	

First killing frost in fall

Fall 2001	September 29	32°F
Avg. 1949-2001	September 13	

Frost Free Period

2000-2001	131 days
Avg. 1949-2001	114 days

Growing Degree Days (base 50): 1993.5 days May 2001 - October 2001
1840.8 days 1949-2001 Average

Growing Degree Days (base 32): 4723.5 days May 2001 - October 2001
1949-2001 average not available: Base 32 GDD records initiated YR2001

Maximum summer temperature 92°F on August 23, 2001
Minimum winter temperature -9°F on December 21, 2000 and February 8, 2001

In this summary 32 degrees is considered a killing frost.

Table 2. Summary of temperature data at the Northwestern Agricultural Research Center on a crop year basis September 1949 through August 31, 2001

Average temperature by month and year - Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
1949-50	54.1	41.5	38.5	25.0	4.2	25.6	31.2	41.9	49.7	57.0	64.0	62.5	41.3
1950-51	53.8	45.9	31.5	29.5	20.2	27.7	27.0	42.1	50.0	54.2	64.7	60.4	42.3
1951-52	50.6	40.8	30.8	16.9	18.0	26.6	29.3	45.8	52.4	56.7	61.8	62.8	41.0
1952-53	56.0	45.5	30.4	27.6	36.0	32.9	37.2	41.2	49.5	54.6	64.3	63.1	44.9
1953-54	56.1	46.2	37.0	31.3	21.1	31.2	29.6	40.8	52.5	54.9	63.4	60.1	43.7
1954-55	52.9	41.5	38.8	28.8	25.7	22.1	24.5	39.1	47.7	58.8	62.7	62.2	42.1
1955-56	52.5	44.6	23.5	21.8	23.3	20.9	31.5	44.2	54.0	59.0	64.8	62.0	41.8
1956-57	55.2	44.1	30.9	28.5	10.2	23.4	33.3	43.7	55.6	59.7	65.4	62.4	42.7
1957-58	55.8	41.4	32.1	32.4	29.1	30.4	32.2	43.6	59.6	62.3	65.2	67.9	46.0
1958-59	55.5	44.6	32.8	28.2	24.7	23.1	35.3	45.2	48.1	59.9	64.5	61.0	43.6
1959-60	53.0	43.9	25.5	27.6	19.4	25.2	32.3	44.3	50.6	59.6	68.8	60.6	42.6
1960-61	55.0	45.2	34.4	24.9	27.8	37.0	38.3	42.0	52.6	64.7	66.2	67.8	46.3
1961-62	49.6	42.3	28.2	23.6	17.4	25.7	30.9	47.2	51.5	58.6	62.1	62.1	41.6
1962-63	54.7	44.7	38.0	32.5	11.8	33.1	38.7	43.2	51.4	59.4	63.0	64.9	44.6
1963-64	58.7	47.4	35.8	24.0	28.5	28.3	30.6	42.8	51.1	58.7	64.3	58.9	44.1
1964-65	51.2	43.7	33.7	22.1	30.2	28.7	28.6	45.2	50.6	57.6	64.6	63.6	43.3
1965-66	46.4	47.6	35.0	28.8	26.3	27.7	34.5	42.9	54.3	56.0	64.5	61.7	43.8
1966-67	59.3	43.4	33.4	30.2	31.0	33.2	32.9	40.6	52.2	59.4	66.1	67.2	45.7
1967-68	61.0	45.9	33.8	25.2	23.3	32.8	41.2	42.0	49.8	59.0	64.6	61.3	45.0
1968-69	53.8	42.9	33.4	19.9	13.1	24.0	29.6	47.1	53.9	58.8	62.3	63.6	41.9
1969-70	56.0	40.0	35.2	27.7	21.9	29.9	32.8	40.2	53.2	62.0	64.8	62.6	43.9
1970-71	48.7	40.1	31.3	26.2	23.6	29.9	33.2	43.6	52.5	54.9	61.9	68.2	42.8
1971-72	49.5	40.4	34.1	22.2	17.0	27.3	38.5	40.6	51.9	59.3	61.5	65.9	42.4
1972-73	50.2	40.3	33.7	19.9	20.7	27.8	37.7	42.2	51.5	57.5	65.1	64.5	42.6
1973-74	53.3	44.1	29.3	30.8	21.0	32.3	33.6	42.7	48.0	61.5	64.8	61.6	43.6
1974-75	52.8	43.6	34.8	30.1	21.5	21.5	29.9	37.6	48.6	55.9	69.1	59.8	42.1
1975-76	52.1	42.9	35.4	27.5	27.7	29.9	31.0	43.4	51.9	54.5	63.4	61.3	43.4
1976-77	55.2	42.4	33.1	28.6	20.0	30.9	34.4	45.0	49.7	61.5	62.6	62.8	43.9
1977-78	51.7	42.5	30.4	22.0	21.6	26.1	34.3	43.7	48.1	59.1	63.4	60.3	41.9
1978-79	53.7	43.7	27.2	18.8	4.1	24.9	34.7	42.3	51.5	59.4	65.0	65.4	40.9
1979-80	56.9	46.6	30.7	33.0	16.3	29.0	32.6	47.1	54.8	56.9	63.5	58.6	43.8
1980-81	54.1	45.3	35.8	32.2	30.1	31.3	38.5	44.5	52.5	53.8	62.8	66.4	45.6
1981-82	55.3	43.2	36.0	27.0	21.6	24.5	37.5	39.4	49.8	59.8	61.1	63.0	43.2
1982-83	53.4	41.0	29.1	25.9	30.3	33.8	37.9	42.4	51.9	57.6	59.6	65.4	44.0
1983-84	50.4	42.9	36.6	11.1	27.6	32.4	38.3	42.2	48.7	56.4	65.3	64.6	43.0
1984-85	49.5	40.0	32.6	20.6	19.2	19.0	30.8	44.8	53.7	57.6	68.3	60.2	41.4
1985-86	47.8	40.8	18.6	18.3	25.4	25.6	40.6	43.8	53.7	63.9	59.9	66.1	42.0
1986-87	50.2	43.0	30.3	24.9	22.2	27.9	35.0	47.8	55.6	61.6	62.9	59.8	43.4
1987-88	56.1	43.3	35.3	25.4	20.5	30.3	37.8	45.7	51.4	60.9	63.7	63.9	44.5
1988-89	53.4	43.4	36.3	23.3	27.5	12.4	28.8	44.2	49.6	59.8	65.4	61.9	42.2
1989-90	52.7	42.7	35.8	25.3	30.5	24.5	34.8	45.2	49.8	57.2	65.2	64.8	44.0
1990-91	59.1	41.9	36.1	16.5	18.3	34.6	32.8	42.4	50.3	55.1	64.0	65.2	43.0
1991-92	54.4	40.6	32.1	29.3	28.7	34.5	39.7	45.1	53.5	55.5	61.2	61.8	44.7
1992-93	51.1	44.7	33.1	19.4	14.7	18.4	33.7	43.6	56.0	56.5	56.6	59.7	40.6
1993-94	51.4	44.4	25.0	27.4	32.9	20.6	37.5	45.4	54.0	57.3	66.4	63.0	43.8
1994-95	56.3	42.8	29.7	27.1	23.6	33.7	33.1	42.6	51.6	56.3	63.1	59.5	43.3
1995-96	54.9	41.1	34.9	26.7	17.4	24.0	29.0	43.2	46.6	58.5	65.4	62.5	42.0
1996-97	52.3	42.1	27.3	19.8	19.8	28.0	32.3	38.3	52.3	57.8	62.8	63.8	41.4
1997-98	55.6	43.7	33.0	27.9	25.1	33.0	34.9	44.5	54.1	56.0	68.4	65.6	45.2
1998-99	59.7	42.3	37.0	27.4	30.4	32.2	37.5	41.6	48.8	55.8	60.9	65.5	44.9
1999-00	51.3	42.9	38.1	31.0	25.8	26.3	36.9	43.4	50.4	56.2	63.9	63.4	44.1
2000-01	52.0	33.5	27.5	18.4	24.0	20.6	33.6	40.5	53.4	54.8	63.1	64.6	40.5
	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
MEAN	53.6	43.0	32.6	25.4	22.5	27.6	33.9	43.2	51.7	58.1	63.9	63.0	43.2

Mean temperature for all years = 43.2

Table 3. Summary of temperature data at the Northwestern Agricultural Research Center on a crop year basis, September 1, 1949 thru August 31, 2001.

Average maximum temperature by month and year
Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
1949-50	71.4	52.4	45.7	32.1	14.4	34.6	38.4	52.3	63.1	70.1	78.6	79.5	52.7
1950-51	70.9	55.8	38.2	36.3	28.7	36.6	37.3	57.9	63.2	66.6	82.4	77.0	54.2
1951-52	64.2	47.5	37.2	23.6	25.9	35.7	39.5	61.8	65.7	70.2	79.2	79.5	52.5
1952-53	73.4	62.6	40.6	33.2	41.3	39.1	46.8	51.5	62.5	66.8	83.3	79.5	56.7
1953-54	72.3	61.0	45.6	36.7	29.1	38.4	40.0	51.0	67.2	67.0	80.1	74.4	55.2
1954-55	66.4	53.4	45.9	34.9	31.8	31.2	33.9	48.1	60.5	74.7	76.9	82.4	53.3
1955-56	67.6	55.5	30.8	29.2	30.7	30.1	39.7	57.4	67.5	73.3	81.2	77.8	53.4
1956-57	71.0	53.7	37.6	35.5	19.0	33.2	43.3	55.3	70.2	72.4	82.1	80.0	54.4
1957-58	74.3	50.5	40.1	38.5	33.7	37.9	43.5	54.4	77.5	75.7	80.8	85.5	57.7
1958-59	69.7	57.9	39.6	34.1	31.8	31.9	43.9	57.9	61.5	74.3	83.2	76.3	55.2
1959-60	64.0	53.6	33.9	33.3	27.5	34.1	43.4	56.1	63.0	74.8	88.7	74.1	53.9
1960-61	72.1	57.8	41.1	29.8	35.0	43.1	48.2	51.6	65.3	82.0	83.7	86.3	58.0
1961-62	62.3	53.3	35.1	30.4	26.0	33.4	40.5	60.7	62.7	74.2	79.2	77.5	52.9
1962-63	71.7	54.7	43.8	37.9	19.9	41.4	48.9	55.7	67.1	71.8	79.6	82.5	56.3
1963-64	74.6	59.4	43.4	30.2	35.1	37.7	39.7	53.3	63.5	71.4	80.3	72.9	55.1
1964-65	63.9	55.0	41.0	28.9	35.1	36.9	41.0	57.6	64.3	71.4	80.8	77.1	54.4
1965-66	57.5	61.1	42.6	35.4	31.8	35.3	45.4	54.8	69.8	69.1	81.2	78.4	55.2
1966-67	74.9	55.1	41.1	35.8	36.7	40.9	41.3	52.6	66.0	73.3	84.8	87.2	57.5
1967-68	78.9	55.8	41.3	30.8	31.5	40.8	52.6	54.2	63.4	72.2	82.7	75.7	56.7
1968-69	65.9	53.1	40.6	27.3	20.8	32.5	40.9	59.5	68.7	72.0	78.9	83.0	53.6
1969-70	70.4	49.7	43.0	32.8	28.5	36.2	42.5	49.7	67.9	75.5	79.1	80.9	54.7
1970-71	62.5	52.2	40.0	34.1	30.6	38.6	41.6	56.2	66.4	67.3	78.0	87.5	54.6
1971-72	64.2	53.1	41.2	30.9	27.1	35.9	47.9	51.7	64.7	72.4	76.9	83.3	54.1
1972-73	64.0	51.3	41.4	28.6	30.6	38.5	47.7	53.8	65.8	69.6	83.7	83.2	54.9
1973-74	67.6	56.3	36.8	36.5	28.5	39.6	43.5	53.1	59.2	76.2	80.3	77.6	54.6
1974-75	70.9	61.4	43.2	37.4	32.0	31.5	39.4	48.1	61.2	68.5	85.5	73.0	54.3
1975-76	69.4	52.3	40.4	35.1	36.2	37.6	40.1	54.3	66.2	66.3	79.0	74.4	54.3
1976-77	73.2	57.7	42.1	36.1	28.0	39.1	42.7	60.2	61.9	77.0	76.6	77.4	56.0
1977-78	64.7	55.4	38.5	29.4	28.8	35.5	45.5	54.3	58.1	72.6	77.5	74.2	52.9
1978-79	65.7	59.2	35.9	28.2	13.7	33.2	45.3	52.5	64.3	73.9	81.5	82.8	53.0
1979-80	74.1	59.5	37.8	39.2	25.2	35.9	40.8	60.4	66.9	69.0	77.0	73.2	54.9
1980-81	66.9	59.0	43.9	39.2	34.0	38.9	49.7	54.8	63.3	63.8	78.1	85.0	56.4
1981-82	70.8	54.1	44.9	34.2	29.7	33.3	45.8	50.5	62.5	74.3	75.0	80.6	54.6
1982-83	69.2	53.2	36.9	33.0	36.8	42.2	47.5	55.2	66.4	70.6	73.1	82.9	55.6
1983-84	65.1	56.0	43.7	19.9	34.6	40.8	46.8	54.2	60.4	69.1	82.8	83.3	54.7
1984-85	63.9	52.2	40.4	28.2	25.3	29.1	42.7	56.8	68.7	73.2	88.0	75.0	53.6
1985-86	60.4	51.3	26.7	25.2	34.0	36.6	51.6	55.1	66.1	78.5	73.0	84.1	53.6
1986-87	59.9	54.3	38.0	30.9	29.5	34.2	43.4	61.3	67.9	75.7	76.5	74.9	53.9
1987-88	73.5	59.9	43.0	32.6	29.0	39.3	46.1	58.5	63.8	74.1	79.5	82.6	56.8
1988-89	69.0	62.0	42.7	30.3	35.3	21.8	36.1	56.6	61.1	72.6	81.6	75.0	53.7
1989-90	68.5	54.0	42.4	30.5	36.4	33.9	44.8	57.3	60.5	68.9	79.7	79.5	54.7
1990-91	77.9	53.0	43.8	24.1	25.6	42.5	41.6	54.0	61.7	65.5	78.2	81.6	54.1

Table 3. Summary of temperature data at the Northwestern Agricultural Research Center on a crop year basis, September 1, 1949 thru August 31, 2001.

Average maximum temperature by month and year
Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
1991-92	70.9	56.1	38.6	33.7	35.1	42.7	52.7	57.7	67.7	67.8	73.1	78.0	56.2
1992-93	64.9	57.4	38.0	27.2	22.4	27.0	43.7	52.8	69.7	67.8	66.2	73.8	50.9
1993-94	66.6	56.8	33.5	33.3	38.9	30.2	48.9	57.4	66.7	70.5	83.0	85.0	55.9
1994-95	74.0	54.1	36.4	33.1	29.3	43.3	42.9	52.7	63.9	67.6	75.5	74.1	53.9
1995-96	70.0	50.4	43.0	32.2	25.3	33.1	38.7	54.1	55.1	70.5	81.0	78.1	52.6
1996-97	64.3	53.2	33.9	25.7	26.9	34.2	40.9	48.4	64.3	68.6	75.6	78.5	51.2
1997-98	68.5	53.5	42.3	33.4	32.7	41.1	43.9	56.1	67.2	65.7	82.3	82.5	55.8
1998-99	75.5	54.8	42.8	33.3	36.0	38.5	47.9	54.3	60.2	66.5	76.4	80.7	55.6
1999-00	67.8	55.5	46.0	35.2	32.6	35.0	44.3	55.4	62.3	69.0	80.1	81.7	55.4
2000-01	65.5	55.0	35.0	27.0	31.0	29.6	43.5	50.3	66.5	66.7	78.4	82.6	52.6
MEAN	68.6	55.3	40.0	32.0	29.9	36.1	43.6	54.8	64.6	71.1	79.6	79.5	54.6

Mean temperature for all years = 54.6

Table 4. Summary of temperature data at the Northwestern Agricultural Research Center on crop year basis September 1, 1949 through August 31, 2001.

Average minimum temperature by month and year
Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
1949-50	36.7	35.0	31.2	17.8	-6.0	16.6	23.9	31.5	36.3	43.9	49.4	45.5	30.2
1959-51	36.6	36.0	24.8	22.6	11.7	18.8	16.6	26.2	36.7	41.7	46.9	43.7	30.2
1951-52	37.0	34.0	24.4	10.1	10.0	17.4	19.1	29.8	39.1	43.1	44.3	46.1	29.5
1952-53	38.6	28.3	20.2	21.9	30.6	26.7	27.5	30.9	36.5	42.3	45.3	46.7	33.0
1953-54	39.8	31.4	28.4	25.9	13.1	24.0	19.2	30.6	37.7	42.8	46.7	45.7	32.1
1954-55	39.3	29.5	31.6	22.7	19.5	13.0	15.0	30.0	34.9	42.8	48.5	42.0	30.7
1955-56	37.3	33.6	16.1	14.4	15.9	11.7	23.3	30.9	40.5	44.7	48.2	46.1	30.2
1956-57	39.4	34.4	24.2	21.5	1.4	13.6	23.2	32.0	40.9	47.0	48.7	44.8	30.9
1957-58	37.2	32.3	24.1	26.2	24.5	22.8	20.9	32.8	41.7	48.8	49.5	50.3	34.3
1958-59	41.2	31.2	26.0	22.2	17.5	14.2	26.6	32.4	34.7	45.4	45.8	45.6	31.9
1959-60	42.0	34.1	17.0	21.8	11.2	16.3	21.1	32.4	38.1	44.3	48.8	47.0	31.2
1960-61	37.9	32.5	27.6	19.9	20.6	30.9	28.4	32.3	39.8	47.4	48.7	49.2	34.6
1961-62	36.8	31.2	21.2	16.8	8.7	17.9	21.2	33.7	40.3	43.0	45.0	46.6	30.2
1962-63	37.6	34.6	32.2	27.1	3.7	24.7	28.4	30.6	35.7	47.0	46.4	46.9	32.9
1963-64	42.7	35.3	28.1	17.7	21.8	18.9	21.4	32.2	38.6	46.0	48.3	44.9	33.0
1964-65	38.4	32.3	26.4	15.3	25.3	20.4	16.2	32.7	36.9	43.8	48.4	50.0	32.2
1965-66	35.2	34.0	27.4	22.1	20.8	20.0	23.6	30.9	38.7	42.8	47.7	45.0	32.4
1966-67	43.6	31.7	25.6	24.6	25.3	25.5	24.5	28.6	38.4	45.4	47.4	47.2	34.0
1967-68	43.1	35.9	26.3	19.4	15.0	24.8	29.7	29.8	36.1	45.7	46.4	46.8	33.3
1968-69	41.7	32.6	26.1	12.5	5.4	15.4	18.2	34.6	39.0	45.5	45.7	43.5	30.0
1969-70	41.6	30.3	27.4	22.6	15.3	23.4	23.0	30.7	38.5	48.2	50.5	44.3	33.0
1970-71	34.9	27.9	22.5	18.3	16.5	21.0	24.8	31.0	38.6	42.3	45.7	48.8	31.0
1971-72	34.7	27.6	26.9	13.5	7.7	18.6	29.0	29.0	39.2	46.3	45.8	48.5	30.6
1972-73	36.4	29.2	25.9	11.1	11.0	17.4	27.8	29.6	36.4	44.4	46.5	45.8	30.1
1973-74	38.9	32.0	21.8	25.2	13.5	25.1	23.6	32.4	36.7	46.9	49.5	45.6	32.6
1974-75	34.7	25.7	26.3	22.9	10.9	11.5	20.4	27.1	36.1	43.3	52.7	46.5	29.8
1975-76	34.7	33.4	30.3	20.0	19.1	22.2	22.0	32.4	37.6	42.6	47.8	48.3	32.5
1976-77	37.2	27.2	24.1	21.1	12.0	22.6	26.1	29.9	37.4	46.0	48.5	48.2	31.7
1977-78	38.6	29.5	22.2	14.6	14.5	16.7	23.2	33.1	38.1	45.6	49.2	46.4	31.0
1978-79	41.7	28.3	18.4	9.3	-5.6	16.5	24.0	32.1	38.7	44.9	48.5	48.0	28.7
1979-80	39.7	33.7	23.6	26.8	7.5	22.1	24.5	33.7	42.7	44.7	50.0	44.0	32.8
1980-81	41.3	31.6	27.7	25.1	26.2	23.8	27.2	34.2	41.7	43.7	47.6	47.8	34.8
1981-82	39.7	32.2	27.0	19.8	13.5	15.7	29.2	28.4	37.2	45.3	47.3	45.4	31.7
1982-83	37.6	28.8	21.4	18.7	23.7	25.3	28.4	29.5	37.5	44.7	46.1	48.0	32.5
1983-84	35.6	29.7	29.5	2.4	20.6	24.0	29.9	30.2	37.1	43.6	47.8	46.0	31.4
1984-85	35.2	27.7	24.7	13.0	13.2	9.0	18.8	32.7	38.7	42.0	48.5	45.5	29.1
1985-86	35.2	30.2	10.6	11.4	16.9	14.5	29.6	32.5	41.3	49.3	46.8	48.1	30.5
1986-87	40.5	31.6	22.6	18.8	14.9	21.6	26.6	34.2	43.3	47.4	49.4	44.7	33.0
1987-88	38.7	26.5	27.6	18.1	11.5	21.3	29.5	33.0	39.0	47.7	47.9	45.2	32.2
1988-89	38.6	32.9	29.8	16.3	19.7	2.9	21.4	31.8	38.1	46.9	49.3	48.7	31.4
1989-90	36.9	31.3	29.3	20.1	24.7	15.2	24.7	33.2	39.1	45.4	50.6	50.0	33.4
1990-91	40.4	30.9	28.4	8.8	11.0	26.6	24.0	30.8	39.0	44.7	49.8	48.8	31.9
1991-92	37.9	25.1	25.6	25.0	22.4	26.3	26.8	32.6	39.2	43.2	49.3	45.7	33.3
1992-93	37.4	32.0	28.1	11.6	7.0	9.8	23.8	34.5	42.3	45.2	47.0	45.6	30.4
1993-94	36.3	32.0	16.6	21.5	27.0	11.0	26.2	33.4	41.3	44.1	49.8	48.3	32.3
1994-95	38.6	31.6	23.0	21.1	17.9	24.2	23.4	32.5	39.3	45.1	50.8	45.0	32.7
1995-96	39.9	31.9	26.9	21.3	9.5	14.9	19.3	32.4	38.1	46.6	49.8	46.9	31.5
1996-97	40.3	31.0	20.7	13.9	12.7	21.8	23.7	28.3	40.3	47.0	50.1	49.2	31.6
1997-98	42.8	34.0	23.7	22.4	17.6	25.0	25.9	33.0	41.1	46.3	54.5	48.8	34.6
1998-99	43.9	29.8	31.3	21.6	24.9	25.9	27.2	29.0	37.4	45.1	45.3	50.3	34.3

Table 4. Summary of temperature data at the Northwestern Agricultural Research Center on crop year basis
September 1, 1949 through August 31, 2001.
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Average minimum temperature by month and year
Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
1999-00	34.8	30.3	30.2	24.8	19.0	17.6	29.5	31.4	38.4	43.4	47.6	45.1	32.7
2000-01	38.4	30.0	19.0	12.0	17.0	11.6	23.6	30.7	40.3	43.0	63.1	46.5	31.3
MEAN	38.6	31.3	25.0	18.8	15.2	19.2	24.1	31.4	38.7	45.0	48.4	46.7	31.9

Mean temperature for all years = 31.9

Table 5. Summary of precipitation records at the Northwestern Agricultural Research Center on a crop year basis

Total precipitation in inches by month and year

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	TOTAL
1949-50	1.03	1.05	1.67	0.92	2.62	1.13	2.31	0.84	0.15	3.90	3.12	0.75	19.49
1950-51	0.52	2.30	1.16	2.48	0.94	1.29	0.62	2.32	3.77	2.26	1.03	2.86	21.55
1951-52	1.49	5.62	1.01	3.31	1.03	0.98	0.97	0.17	1.32	3.95	0.56	0.69	21.10
1952-53	0.13	0.05	0.60	0.98	1.84	1.14	0.98	2.07	2.00	3.31	T	1.62	14.72
1953-54	0.71	0.03	0.87	1.30	2.65	0.79	0.83	0.79	1.52	2.98	2.91	3.79	19.17
1954-55	1.09	0.54	1.00	0.43	1.00	1.31	0.44	0.82	1.18	1.86	3.08	0.00	12.75
1955-56	1.64	1.89	1.97	2.38	1.76	1.53	0.87	1.28	1.06	4.20	2.13	3.21	23.92
1956-57	1.16	1.10	0.53	0.96	1.47	1.14	0.75	1.22	1.75	2.51	0.52	0.78	13.89
1957-58	0.10	1.59	0.96	1.76	1.56	2.67	0.97	1.47	2.20	2.56	0.84	0.58	17.26
1958-59	1.99	1.16	2.90	2.77	1.95	1.33	0.75	1.62	4.10	1.75	T	0.91	21.23
1959-60	4.22	3.36	4.32	0.34	1.67	1.10	1.01	1.23	3.27	0.69	0.13	2.43	23.77
1960-61	0.55	1.44	1.72	1.24	0.65	1.46	1.96	2.26	4.02	1.45	0.76	0.64	18.15
1961-62	3.40	1.22	1.77	2.09	1.33	1.15	1.59	0.96	2.59	1.15	0.11	0.72	18.08
1962-63	0.58	1.85	1.31	0.91	1.69	1.21	0.85	1.07	0.57	5.00	1.44	2.10	18.58
1963-64	1.46	0.75	0.95	1.70	1.46	0.41	1.57	0.87	3.33	3.86	3.01	1.64	21.01
1964-65	2.27	0.85	1.62	3.62	2.25	0.64	0.24	2.55	0.81	2.30	1.15	4.74	23.04
1965-66	1.72	0.21	1.31	0.55	1.42	0.67	0.53	0.76	1.18	6.57	2.49	1.64	19.05
1966-67	0.79	1.34	3.33	1.68	1.50	0.62	1.27	0.99	1.30	2.53	0.02	0.01	15.38
1967-68	0.91	1.88	0.62	1.16	0.79	1.15	0.68	0.57	3.92	2.22	1.00	3.42	18.32
1968-69	4.51	2.39	1.59	3.12	3.05	0.75	0.69	1.39	1.19	5.21	0.70	0.09	24.68
1969-70	1.54	1.90	0.31	1.14	3.10	0.89	1.49	0.76	1.97	4.37	3.08	0.44	20.99
1970-71	1.79	1.38	1.75	0.99	1.84	0.77	0.69	0.58	2.45	4.42	1.31	1.11	19.08
1971-72	0.94	0.87	1.70	1.62	1.10	1.65	2.11	0.95	1.48	3.28	1.77	0.98	18.45
1972-73	1.38	1.84	0.80	2.19	0.52	0.56	0.70	0.45	1.13	2.14	0.01	0.63	12.35
1973-74	1.37	1.41	2.95	1.94	1.35	1.32	1.40	3.36	1.82	1.80	1.01	0.62	20.35
1974-75	0.80	0.12	1.10	1.31	1.56	1.08	1.50	1.27	1.50	1.40	1.08	4.26	16.98
1975-76	1.18	2.96	0.85	1.39	0.91	1.12	0.34	1.92	1.90	2.49	1.49	3.42	19.97
1976-77	0.96	0.62	0.73	0.86	0.83	0.71	1.40	0.41	2.90	0.52	3.60	1.50	15.04
1977-78	2.84	0.56	1.62	4.10	2.15	0.99	0.72	2.54	3.56	2.63	3.90	3.34	28.95
1978-79	1.90	0.15	0.96	0.91	1.70	1.45	0.82	2.33	2.67	1.23	0.40	1.79	16.31
1979-80	1.03	1.75	0.50	1.03	1.53	2.03	0.97	1.88	5.48	3.89	1.08	2.45	23.62
1980-81	1.20	0.83	0.78	2.58	1.81	1.85	2.17	1.75	3.86	4.70	1.17	0.96	23.66
1981-82	0.77	0.56	1.49	1.91	2.38	1.48	1.16	1.60	1.25	2.41	2.06	1.17	18.24
1982-83	2.37	0.75	1.39	1.60	0.93	0.85	1.71	2.41	1.20	2.96	3.66	1.16	20.99
1983-84	1.70	1.13	1.96	2.57	0.80	2.19	1.81	1.93	2.91	2.07	0.31	0.55	19.93
1984-85	2.15	2.25	1.40	1.29	0.31	1.28	0.90	1.31	2.81	1.89	0.35	1.62	17.56
1985-86	5.35	1.55	1.61	0.51	2.39	2.33	0.50	1.34	2.92	1.83	2.09	0.81	23.23
1986-87	3.63	0.80	1.78	0.63	0.38	0.46	3.47	1.15	1.89	1.95	4.85	0.98	21.97
1987-88	0.81	0.12	0.91	1.18	0.98	1.03	0.77	1.36	3.60	1.98	1.07	0.13	13.94
1988-89	2.30	0.62	1.39	1.69	1.39	1.48	2.29	1.09	2.70	2.05	2.70	3.69	23.39
1989-90	1.50	2.29	3.75	1.92	0.96	1.00	1.76	1.63	3.74	2.68	2.34	2.44	26.01
1990-91	T	2.32	1.37	2.60	1.41	0.41	0.72	1.21	2.72	5.36	0.77	1.15	20.04
1991-92	0.80	0.75	2.26	0.58	1.17	0.61	0.83	1.18	1.65	5.34	2.24	0.94	18.35
1992-93	1.21	1.07	2.37	1.53	1.68	0.60	0.73	3.77	2.22	4.00	7.00	1.19	27.37
1993-94	1.54	0.83	1.23	1.27	1.43	1.49	0.11	2.01	1.79	2.59	0.10	0.23	14.62
1994-95	0.46	2.12	1.89	1.07	1.17	0.90	2.33	2.25	1.44	5.63	1.91	1.47	22.64
1995-96	1.21	2.75	2.33	1.91	2.22	1.18	1.19	3.32	4.58	2.05	0.95	0.80	24.49
1996-97	2.67	1.58	3.99	3.52	1.50	1.62	1.18	1.69	2.62	3.41	0.99	1.94	26.71
1997-98	2.36	0.94	0.33	0.42	0.77	0.33	2.64	1.80	5.14	4.64	1.18	0.72	21.27
1998-99	1.48	0.71	1.11	1.47	1.05	1.18	0.90	0.55	1.32	2.74	1.63	1.93	16.07
1999-00	0.36	1.72	2.33	1.08	1.46	1.81	1.30	2.21	0.89	1.80	0.84	0.35	16.15
2000-01	1.40	1.23	0.62	1.23	0.75	1.54	1.03	2.62	0.57	3.29	0.91	0.54	15.73
MEAN	1.56	1.37	1.55	1.61	1.46	1.17	1.18	1.54	2.31	2.96	1.59	1.50	19.80
	SEPT	OCT	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	TOTAL

Mean precipitation for all crop years = 19.80

Table 6. Precipitation by Day for Crop Year September 2000 - August 2001
Northwest Agriculture Research Center, Kalispell Montana

DATE	SEPT. 2000	OCT. 2000	NOV. 2000	DEC. 2000	JAN. 2001	FEB. 2001	MAR. 2001	APR. 2001	MAY 2001	JUNE 2001	JULY 2001	AUG. 2001	
1	0.08		0.02		0.06	T		0.21	0.30		0.11	0.51	
2	0.48								0.04	0.07			
3	0.19	0.24		0.01				1.00	T				
4			T		0.10	0.13		0.18		0.70			
5	0.01	T	0.13			0.52				0.02		0.03	
6	0.10		T			T		0.01		0.13	0.08		
7	0.03									0.03	0.07		
8			T			T		0.46					
9	0.07			0.15		T		0.39		0.04			
10	0.06			0.04	T	0.08		0.04		0.27			
11	0.23			T	0.04	0.02		0.15		0.02			
12				T		0.01				0.34			
13		0.03		0.11	0.03	0.02				0.52			
14		0.14		0.12	0.01		0.41	T		0.16		T	
15		0.06		0.27	0.01	0.31	0.03	0.02	0.20	0.17			
16						T				0.03			
17			T	0.09		0.26			0.14		0.01		
18			0.01		0.03	0.01				0.27	0.06		
19		0.10			0.06	0.01		0.13		0.15			
20	0.10				0.12				0.10				
21	0.05	0.39				0.09					0.25		
22		0.05		0.17	0.14	0.01							
23				0.22		0.06					0.01		
24				0.01		0.01				0.06			
25					0.14	T				0.01	0.03		
26			T	0.01			0.27						
27				T						T			
28		0.01	T				0.20	0.03		0.27			
29		0.04							0.09	0.03	0.09	T	
30	T	0.17	0.46	0.03			0.02						
31					0.01		0.10				0.20		
													YTD
TOTAL	1.40	1.23	0.62	1.23	0.75	1.54	1.03	2.62	0.57	3.29	0.91	0.54	15.73

Table 7. Frost free period at the Northwestern Agricultural Research Center from 1950 - 2001

YEAR	DATE LAST FREEZE	TEMPERATURE DEGREE F	DATE FIRST FREEZE	TEMPERATURE DEGREES F	FROST FREE SEASON
1950	June 10	32	Sept. 11	29	93
1951	June 1	29	Sept. 15	29	106
1952	June 14	32	Sept. 8	29	86
1953	May 23	32	Sept. 16	31	116
1954	May 29	31	Sept. 30	26	124
1955	May 25	28	Sept. 13	31	111
1956	May 3	26	Sept. 2	32	122
1957	May 23	30	Sept. 9	30	109
1958	May 14	31	Sept. 27	31	136
1959	June 11	32	Aug. 30	30	80
1960	June 18	32	Sept. 6	32	80
1961	May 6	32	Sept. 12	29	129
1962	May 30	32	Sept. 3	25	96
1963	May 22	28	Sept. 18	32	119
1964	May 25	26	Sept. 11	28	109
1965	June 7	30	Sept. 6	31	91
1966	May 18	26	Sept. 30	28	135
1967	May 26	28	Sept. 23	32	120
1968	May 20	32	Sept. 21	32	124
1969	June 13	28	Sept. 6	32	85
1970	May 11	32	Sept. 10	31	122
1971	July 7	32	Sept. 14	28	69
1972	May 4	32	Sept. 12	32	131
1973	May 22	31	Sept. 2	31	103
1974	May 18	31	Sept. 2	30	107
1975	May 25	32	Sept. 12	32	110
1976	May 21	30	Sept. 8	30	110
1977	May 16	29	Sept. 27	28	133
1978	May 23	31	Sept. 17	28	116
1979	May 30	31	Oct. 1	32	123
1980	June 4	32	Sept. 24	31	111
1981	May 5	28	Sept. 24	25	142
1982	May 30	31	Sept. 15	23	108
1983	May 15	31	Sept. 6	31	114
1984	June 2	32	Sept. 13	30	103
1985	May 13	26	Sept. 7	32	117
1986	May 16	31	Sept. 7	31	114
1987	May 22	28	Sept. 17	29	117
1988	May 3	30	Sept. 12	30	131
1989	May 21	32	Sept. 9	29	110
1990	May 10	31	Oct. 6	24	149
1991	May 27	32	Sept. 19	32	115
1992	May 17	30	Aug. 24	32	99
1993	May 4	32	Sept. 13	29	132
1994	April 30	31	Sept. 12	32	135
1995	May 27	32	Sept. 21	22	117
1996	May 21	31	Sept. 23	27	125
1997	May 21	32	Oct. 8	30	140
1998	May 19	31	Oct. 5	30	139
1999	June 7	30	Sept. 12	29	96
2000	June 1	32	Sept. 22	32	112
2001	May 20	30	Sept. 29	30	131
Mean	May 23	30	Sept. 12	30	114

Table 8. **Temperature Extremes at the Northwestern Agricultural Research Center January 1950 - August 2001**

	Minimum		Maximum	
Year	Date	Degrees F	Date	Degrees F
1950	Jan. 30	-40	Aug. 31	88
1951	Jan. 28	-25	Aug. 2	92
1952	Jan. 1	-14	Aug. 31	90
1953	Jan. 6	8	July 12	97
1954	Jan. 20	-32	July 6	90
1955	Mar. 5	-20	June 22	96
1956	Feb. 16	-25	July 22	90
1957	Jan. 26	-34	July 13	91
1958	Jan. 1	2	Aug. 11	94
1959	Nov. 16	-30	July 23	96
1960	Mar. 3	-32	July 19	98
1961	Jan. 2	0	Aug. 4	100
1962	Jan. 21	-32	Aug. 16	92
1963	Jan. 30	-24	Aug. 9	94
1964	Dec. 17	-28	July 8	91
1965	Mar. 24	-10	July 31	89
1966	Mar. 4	-7	Aug. 2,25	91
1967	Jan. 24	2	Aug. 19	95
1968	Jan. 21	-23	July 7	94
1969	Jan. 25	-13	Aug. 24	97
1970	Jan. 15	-14	Aug. 21,25	92
1971	Jan. 12	-8	Aug. 6, 9	96
1972	Jan. 28	-24	Aug. 9,10	92
1973	Jan. 11	-22	July 11	97
1974	Jan. 5	-18	June 16,20	93
1975	Jan. 12, Feb. 9	-16	July 12	96
1976	Feb. 5	-4	July 27	90
1977	Dec. 31	-11	June 7	97
1978	Dec. 31	-31	July 16	91
1979	Jan. 1	-31	July 20	97
1980	Jan. 29	-20	July 23	92
1981	Feb. 21	-21	Aug. 26,27	97
1982	Feb. 9,10	-23	Aug. 8	91
1983	Dec. 25	-29	Aug. 8	97
1984	Jan. 18	-14	July 27	97
1985	Jan. 30	-24	July 9, 11, 23	94
1986	Nov. 10	-8	May 30	93
1987	Jan. 16, Dec. 31	-4	July 27	95
1988	Jan. 6	-17	July 22, Aug. 6	92
1989	Feb. 4, 5	-20	Aug. 1	96
1990	Dec. 30	-33	Aug. 16	94
1991	Jan. 2, 3	-11	Aug. 10	92
1992	Jan. 20	10	Aug. 15	93
1993	Feb. 18	-19	May 13	91
1994	Feb. 8	-25	Aug. 15	97
1995	Jan. 4	-11	Aug. 6	88
1996	Jan. 31	-32	July 19	91
1997	Jan. 13	-14	Aug. 4	92
1998	Jan. 12	-20	Aug. 6 & 7	92
1999	Jan. 24 & 25	2	Aug. 4	92
2000	Dec. 21	-9	July 23	96
2001	Feb. 8	-9	Aug. 18	92

Table 9. Summary of Temperature Records at the Northwestern Agricultural Research Center January 1950 - December 2001

AVERAGE TEMPERATURE BY MONTH AND YEAR - DEGREES FAHRENHEIT

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	MEAN
1950	4.2	25.6	31.2	41.9	49.7	57.0	64.0	62.5	53.8	45.9	31.5	29.5	41.4
1951	20.2	27.7	27.0	42.1	50.0	54.2	64.7	60.4	50.6	40.8	30.8	16.9	40.5
1952	18.0	26.6	29.3	45.8	52.4	56.7	61.8	62.8	56.0	45.5	30.4	27.6	42.7
1953	36.0	32.9	37.2	41.2	49.5	54.6	64.3	63.1	56.1	46.2	37.0	31.3	45.8
1954	21.1	31.2	29.6	40.8	52.5	54.9	63.4	60.1	52.9	41.5	38.8	28.8	43.0
1955	25.7	22.1	24.5	39.1	47.7	58.8	62.7	62.2	52.5	44.6	23.5	21.8	40.4
1956	23.3	20.9	31.5	44.2	54.0	59.0	64.8	62.0	55.2	44.1	30.9	28.5	43.2
1957	10.2	23.4	33.3	43.7	55.6	59.7	65.4	62.4	55.8	41.4	32.1	32.4	43.0
1958	29.1	30.4	32.2	43.6	59.6	62.3	65.2	67.9	55.5	44.6	32.8	28.2	46.0
1959	24.7	23.1	35.3	45.2	48.1	59.9	64.5	61.0	53.0	43.9	25.5	27.6	42.7
1960	19.4	25.2	32.3	44.3	50.6	59.6	68.8	60.6	55.0	45.2	34.4	24.9	43.4
1961	27.8	37.0	38.2	42.0	52.6	64.7	66.2	67.8	49.6	42.3	28.2	23.6	45.0
1962	17.4	25.7	30.9	47.2	51.5	58.6	62.1	62.1	54.7	44.7	38.0	32.5	43.8
1963	11.8	33.1	38.7	42.3	51.4	59.4	63.0	64.9	58.7	47.4	35.8	24.0	44.2
1964	28.5	28.3	30.6	42.8	51.1	58.7	64.3	58.9	51.2	43.7	33.7	22.1	42.8
1965	30.2	28.7	28.6	45.2	50.6	57.6	64.6	63.6	46.4	47.6	35.0	28.8	43.9
1966	26.3	27.7	34.5	42.9	54.3	56.0	64.5	61.7	59.3	43.4	33.4	30.2	44.5
1967	31.0	33.2	32.9	40.6	52.2	59.4	66.1	67.2	61.0	45.9	33.8	25.1	45.7
1968	23.3	32.8	41.2	42.0	49.8	59.0	64.6	61.3	53.8	42.9	33.4	19.9	43.7
1969	13.1	24.0	29.6	47.1	53.9	58.8	62.3	63.6	56.0	40.0	35.2	27.7	42.6
1970	21.9	29.9	32.8	40.2	53.2	62.0	64.8	62.6	48.7	40.1	31.3	26.2	42.8
1971	23.6	29.9	33.2	43.6	52.5	54.9	61.9	68.2	49.5	40.4	34.1	22.0	42.8
1972	17.0	27.3	38.5	40.6	51.9	59.3	61.5	65.9	50.2	40.3	33.7	19.9	42.2
1973	20.7	27.8	37.7	42.2	51.5	57.5	65.1	64.5	53.3	44.1	29.3	30.8	43.7
1974	21.0	32.3	33.6	42.7	48.0	61.5	64.8	61.6	52.8	43.6	34.8	30.1	43.9
1975	21.5	21.5	29.9	37.6	48.6	55.9	69.1	59.8	52.1	42.9	35.4	27.5	41.8
1976	27.7	29.9	31.0	43.4	51.9	54.5	63.4	61.3	55.2	42.4	33.1	28.6	43.5
1977	20.0	30.9	34.4	45.0	49.7	61.5	62.6	62.8	51.7	42.5	30.4	22.0	42.8
1978	21.6	26.1	34.3	43.7	48.1	59.1	63.4	60.3	53.7	43.7	27.2	18.8	41.7
1979	4.1	24.9	34.7	42.3	51.5	59.4	65.0	65.4	56.9	46.6	30.7	33.0	42.9
1980	16.3	29.0	32.6	47.1	54.8	56.9	63.5	58.6	54.1	45.3	35.8	32.2	43.9
1981	30.1	31.3	38.5	44.5	52.5	53.8	62.8	66.4	55.3	43.2	36.0	27.0	45.1
1982	21.6	24.5	37.5	39.4	49.8	59.8	61.1	63.0	53.4	41.0	29.1	25.9	42.2
1983	30.3	33.8	37.9	42.4	51.9	57.6	59.6	65.4	50.4	42.9	36.6	11.1	43.3
1984	27.6	32.4	38.3	42.2	48.7	56.4	65.3	64.6	49.5	40.0	32.6	20.6	43.2
1985	19.2	19.0	30.8	44.8	53.7	57.6	68.3	60.2	47.8	40.8	18.6	18.3	39.9
1986	25.4	25.6	40.6	43.8	53.7	63.9	59.9	66.1	50.2	43.0	30.3	24.9	44.0
1987	22.2	27.9	35.0	47.8	55.6	61.6	62.9	59.8	56.1	43.2	35.3	25.4	44.4
1988	20.5	30.3	37.8	45.7	51.4	60.9	63.7	63.9	53.8	47.5	36.3	23.3	44.6
1989	27.5	12.4	28.8	44.2	49.6	59.8	65.4	61.9	52.7	42.7	35.8	25.3	42.2
1990	30.5	24.5	34.8	45.2	49.8	57.2	65.2	64.8	59.2	41.9	36.1	16.5	43.8
1991	18.3	34.6	32.8	42.4	50.3	55.1	64.0	65.2	54.4	40.6	32.1	29.3	43.3
1992	28.7	34.5	39.7	45.1	53.5	55.5	61.2	61.8	51.1	44.7	33.1	19.4	44.0
1993	14.7	18.4	33.7	43.6	56.0	56.5	56.6	59.7	51.4	44.4	25.0	25.4	40.5
1994	32.9	20.6	37.5	45.4	54.0	57.3	66.4	66.6	56.3	43.3	32.5	27.1	45.0
1995	23.6	33.7	33.1	42.6	51.6	56.3	63.1	59.5	54.9	41.1	34.9	26.7	43.4
1996	17.4	24.0	29.0	43.2	46.6	58.5	65.4	62.5	52.3	42.1	27.3	19.8	40.7
1997	19.8	28.0	32.3	38.3	52.3	57.8	62.8	63.8	55.6	43.7	33.0	27.9	42.9
1998	25.1	33.0	34.9	44.5	54.1	56.0	68.4	65.6	59.7	42.3	37.0	27.4	45.7
1999	30.4	32.2	37.5	41.6	48.8	55.8	60.9	65.5	51.3	42.9	38.1	31.0	44.7
2000	25.8	26.3	36.9	43.4	50.4	56.2	63.9	63.4	52.0	33.5	27.5	18.4	41.5
2001	24.0	20.6	33.6	40.5	53.4	54.8	63.1	64.6	57.3	42.0	36.6	27.1	43.1
MEAN	22.5	27.6	33.9	43.1	51.7	58.1	63.9	63.1	53.7	43.1	32.6	25.4	43.2

Table 10. Summary of precipitation records at the Northwestern Agricultural Research Center 1950-2001

Total Precipitation (inches) by Months and Years

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1950	2.62	1.13	2.31	0.84	0.15	3.90	3.12	0.75	0.52	2.30	1.16	2.48	21.28
1951	0.94	1.29	0.62	2.32	3.77	2.26	1.03	2.86	1.49	5.62	1.01	3.31	26.52
1952	1.03	0.98	0.97	0.17	1.32	3.95	0.56	0.69	0.13	0.05	0.60	0.98	11.43
1953	1.84	1.14	0.98	2.07	2.00	3.31	T	1.62	0.71	0.03	0.87	1.30	15.87
1954	2.65	0.79	0.83	0.79	1.52	2.98	2.91	3.79	1.09	0.54	1.00	0.43	19.32
1955	1.00	1.31	0.44	0.82	1.18	1.86	3.08	--	1.64	1.89	1.97	2.38	17.57
1956	1.76	1.53	0.87	1.28	1.06	4.20	2.13	3.21	1.16	1.10	0.53	0.96	19.79
1957	1.47	1.14	0.75	1.22	1.75	2.51	0.52	0.78	0.10	1.59	0.96	1.76	14.55
1958	1.56	2.67	0.97	1.47	2.20	2.56	0.84	0.58	1.99	1.16	2.90	2.77	21.67
1959	1.95	1.33	0.75	1.62	4.10	1.75	T	0.91	4.22	3.36	4.32	0.34	24.65
1960	1.67	1.10	1.01	1.23	3.27	0.69	0.13	2.43	0.55	1.44	1.72	1.24	16.48
1961	0.65	1.46	1.96	2.26	4.02	1.45	0.76	0.64	3.40	1.22	1.77	2.09	21.68
1962	1.33	1.15	1.59	0.96	2.59	1.15	0.11	0.72	0.58	1.85	1.31	0.91	14.25
1963	1.69	1.21	0.85	1.07	0.57	5.00	1.44	2.10	1.46	0.75	0.95	1.70	18.79
1964	1.46	0.41	1.57	0.87	3.33	3.86	3.01	1.64	2.27	0.85	1.62	3.62	24.51
1965	2.25	0.64	0.24	2.55	0.81	2.30	1.15	4.74	1.72	0.21	1.31	0.55	18.47
1966	1.42	0.67	0.53	0.76	1.18	6.57	2.49	1.64	0.79	1.34	3.33	1.68	22.40
1967	1.50	0.62	1.27	0.99	1.30	2.53	0.02	0.01	0.91	1.88	0.62	1.16	12.81
1968	0.79	1.15	0.68	0.57	3.92	2.22	1.00	3.42	4.51	2.39	1.59	3.12	25.36
1969	3.05	0.75	0.69	1.39	1.19	5.21	0.70	0.09	1.54	1.90	0.31	1.14	17.96
1970	3.10	0.89	1.49	0.76	1.97	4.37	3.08	0.44	1.79	1.38	1.75	0.99	22.01
1971	1.84	0.77	0.69	0.58	2.45	4.42	1.31	1.11	0.94	0.87	1.70	1.62	18.30
1972	1.10	1.65	2.11	0.95	1.48	3.28	1.77	0.98	1.38	1.84	0.80	2.19	19.53
1973	0.52	0.56	0.70	0.45	1.13	2.14	0.01	0.63	1.37	1.41	2.95	1.94	13.81
1974	1.35	1.32	1.40	3.36	1.82	1.80	1.01	0.62	0.80	0.12	1.10	1.31	16.01
1975	1.56	1.08	1.50	1.27	1.50	1.40	1.08	4.26	1.18	2.96	0.85	1.39	20.03
1976	0.91	1.12	0.34	1.92	1.90	2.49	1.49	3.42	0.96	0.62	0.73	0.86	16.76
1977	0.83	0.71	1.40	0.41	2.90	0.52	3.60	1.50	2.84	0.56	1.62	4.10	20.99
1978	2.15	0.99	0.73	2.54	3.56	2.63	3.90	3.34	1.90	0.15	0.96	0.91	23.76
1979	1.70	1.45	0.82	2.33	2.67	1.23	0.40	1.79	1.03	1.75	0.50	1.03	16.70
1980	1.53	2.03	0.97	1.88	5.48	3.89	1.08	2.45	1.20	0.83	0.78	2.58	24.70
1981	1.81	1.85	2.17	1.75	3.86	4.70	1.17	0.96	0.77	0.56	1.49	1.91	23.00
1982	2.38	1.48	1.16	1.60	1.25	2.41	2.06	1.17	2.37	0.75	1.39	1.60	19.62
1983	0.93	0.85	1.71	2.41	1.20	2.96	3.66	1.16	1.70	1.13	1.96	2.57	22.24
1984	0.80	2.19	1.81	1.93	2.91	2.07	0.31	0.55	2.15	2.25	1.40	1.29	19.66
1985	0.31	1.28	0.90	1.31	2.81	1.89	0.35	1.62	5.35	1.55	1.61	0.51	19.49
1986	2.39	2.33	0.50	1.34	2.92	1.83	2.09	0.81	3.63	0.80	1.78	0.63	21.05
1987	0.38	0.46	3.47	1.15	1.89	1.95	4.85	0.98	0.81	0.12	0.91	1.18	18.15
1988	0.98	1.03	0.77	1.36	3.60	1.98	1.07	0.13	2.30	0.62	1.39	1.69	16.92
1989	1.39	1.48	2.29	1.09	2.70	2.05	2.70	3.69	1.50	2.29	3.75	1.92	26.85
1990	0.96	1.00	1.76	1.63	3.74	2.68	2.34	2.44	T	2.32	1.37	2.60	22.84
1991	1.41	0.41	0.72	1.21	2.72	5.36	0.77	1.15	0.80	0.75	2.26	0.58	18.14
1992	1.17	0.61	0.83	1.18	1.65	5.34	2.24	0.94	1.21	1.07	2.37	1.53	20.14
1993	1.68	0.60	0.73	3.77	2.22	4.00	7.00	1.19	1.54	0.83	1.23	1.27	26.06
1994	1.43	1.49	0.11	2.01	1.79	2.59	0.10	0.23	0.46	2.12	1.89	1.07	15.29
1995	1.17	0.90	2.33	2.25	1.44	5.63	1.91	1.47	1.21	2.75	2.33	1.91	25.30
1996	2.22	1.18	1.19	3.32	4.58	2.05	0.95	0.80	2.67	1.58	3.99	3.52	28.05
1997	1.50	1.62	1.18	1.69	2.62	3.41	0.99	1.94	2.36	0.94	0.33	0.42	19.00
1998	0.77	0.33	2.64	1.80	5.14	4.64	1.18	0.72	1.48	0.71	1.11	1.47	21.99
1999	1.05	1.18	0.90	0.55	1.32	2.74	1.63	1.93	0.36	1.72	2.33	1.08	16.79
2000	1.46	1.81	1.30	2.21	0.89	1.80	0.84	0.35	1.40	0.62	0.46	1.23	14.37
2001	0.75	1.54	1.03	2.62	0.57	3.29	0.91	0.54	0.32	1.80	1.44	0.59	15.40
MEAN	1.46	1.17	1.18	1.54	2.31	2.96	1.59	1.50	1.55	1.37	1.55	1.60	19.78

Table 11A. Summary of growing degree day (GDD) data at the Northwestern Agricultural Research Center
May 1, 1949 - October 2001. GDD = Temp Max + Temp Min:2-50 (Base 50)
Max Temp> 86°F substitued with 86; Min Temo < 50°F substitued with 50

Average growing degree days by month and year.

YEAR	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	TOTAL
1949		314.0	356.5	467.0	499.5	322.0	57.5	2016.5
1950		208.0	308.0	459.5	465.0	314.0	97.5	1852.0
1951		223.0	251.5	488.5	411.5	212.5	33.0	1620.0
1952		243.5	309.0	458.5	472.5	358.0	199.0	2040.5
1953		194.5	252.5	503.5	455.5	336.0	172.0	1914.0
1954		270.5	255.0	473.5	387.0	248.0	61.5	1695.5
1955		165.0	364.5	439.5	502.5	263.0	103.5	1838.0
1956		282.0	351.5	491.0	437.5	316.5	98.0	1976.5
1957		312.5	350.5	509.5	466.0	366.0	60.0	2064.5
1958		427.5	398.0	504.5	553.0	295.0	136.0	2314.0
1959		187.0	370.0	499.5	417.5	211.0	68.0	1753.0
1960		202.5	380.5	563.0	383.0	334.0	132.5	1995.5
1961		248.0	479.5	537.5	548.5	190.0	99.5	2103.0
1962		201.0	367.5	454.0	438.0	326.0	86.5	1873.0
1963		265.0	335.0	468.0	508.5	378.0	150.0	2104.5
1964		219.5	324.5	484.5	357.0	208.0	88.0	1681.5
1965		222.0	328.5	488.5	453.5	126.0	173.0	1791.5
1966		306.5	291.0	495.0	445.5	375.0	97.0	2010.0
1967		255.0	354.5	538.0	545.0	444.0	101.5	2238.0
1968		207.5	348.0	497.0	407.0	243.0	57.5	1760.0
1969		293.5	338.5	460.5	503.5	306.5	38.0	1940.5
1970		281.5	391.0	472.5	474.5	196.5	72.5	1888.5
1971		259.0	263.0	434.0	553.5	217.0	100.0	1826.5
1972		228.5	348.5	425.0	505.5	226.0	87.0	1820.5
1973		259.5	320.5	515.0	497.0	266.5	106.5	1965.0
1974		152.5	390.5	476.0	432.5	314.0	179.0	1944.5
1975		180.0	283.5	563.0	362.5	290.5	77.5	1757.0
1976		251.0	247.0	463.0	400.0	347.5	119.5	1828.0
1977		184.0	419.0	431.5	428.0	224.5	93.0	1780.0
1978		131.0	348.0	442.0	375.0	243.5	145.0	1684.5
1979		225.5	368.5	484.5	510.5	362.0	163.0	2114.0
1980		268.0	290.0	438.5	361.0	254.0	151.0	1762.5
1981		209.0	210.5	445.5	517.0	312.5	73.0	1767.5
1982		195.0	369.5	402.5	473.0	282.0	66.5	1788.5
1983		259.5	315.5	358.5	510.5	229.0	98.5	1771.5
1984		162.0	294.5	511.0	511.0	214.0	108.5	1801.0
1985		294.5	347.0	562.0	394.5	162.0	67.0	1827.0
1986		247.5	456.5	363.0	529.0	152.0	86.0	1834.0
1987		287.5	404.0	434.5	388.5	352.5	154.0	2021.0
1988		218.5	397.0	449.0	503.0	276.5	197.5	2041.5
1989		178.5	350.5	516.0	388.5	276.5	80.0	1790.0
1990		165.5	296.0	485.0	459.0	417.5	75.0	1898.0
1991		175.0	243.0	464.0	499.5	312.5	170.5	1864.5
1992		277.0	410.5	375.0	441.5	223.0	140.0	1867.0
1993		301.5	273.5	260.0	383.0	249.5	114.0	1581.5
1994		261.5	315.0	512.5	529.5	361.0	82.0	2061.5
1995		219.5	275.0	427.5	381.5	303.5	39.0	1646.0
1996		91.5	322.0	498.0	435.5	214.5	108.5	1670.0
1997		229.0	295.5	423.0	465.5	280.5	69.5	1763.0
1998		267.5	235.5	567.5	517.0	375.5	85.5	2048.5
1999		163.5	256.5	411.5	499.5	270.0	91.0	1692.0
2000	109.5	193.0	286.5	464.5	487.5	241.5	95.0	1877.5
2001	65.5	260.5	262.5	454.5	500.0	370.0	80.5	1993.5
MEAN	87.5	227.6	323.4	459.5	450.4	275.9	102.0	1840.8

Base 50 Mean Growing Degree Days for All Years : 1840.8

Table 11B. Summary of growing degree day (GDD) data at the Northwestern Agricultural Research Center
April 1, 2001 through October 31, 2001. GDD = Temp Max + Temp Min : 2 - 32
Max Temp > 86F substituted with 86; Min Temp < 32F substituted with 32

Average growing degree days by month and year.

YEAR	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	TOTAL
2001	300.0	668.0	685.0	960.0	997.0	759.5	354.0	4723.5
MEAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Mean growing degree days for all years = 0.0

Table 12. Summary of snow data at the Northwestern Agricultural Research Center on a crop year basis, September 1, 1949 thru August 31, 2001: Average snow accumulation by month and year

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	TOTAL
1949-50	0.00	0.00	1.50	17.40	25.20	7.30	4.00	0.00	0.00	0.00	0.00	0.00	55.40
1950-51	0.00	0.00	4.00	7.00	15.10	14.80	7.80	10.00	T	0.00	0.00	0.00	58.70
1951-52	0.00	5.50	6.60	47.20	0.00	10.00	1.80	0.00	T	0.00	0.00	0.00	71.10
1952-53	0.00	0.00	1.00	7.00	8.40	13.10	0.00	0.00	0.00	0.00	0.00	0.00	29.50
1953-54	0.00	0.00	0.00	9.30	30.90	5.00	5.60	4.00	0.00	0.00	0.00	0.00	54.80
1954-55	0.00	0.00	2.00	2.50	16.30	13.10	4.50	0.00	0.00	0.00	0.00	0.00	38.40
1955-56	0.00	T	14.60	18.40	21.50	19.20	3.20	0.00	0.00	0.00	0.00	0.00	76.90
1956-57	0.00	1.50	2.10	3.40	20.50	15.50	0.00	0.00	0.00	0.00	0.00	0.00	43.00
1957-58	0.00	0.30	5.50	3.70	0.00	27.10	6.20	0.00	0.00	0.00	0.00	0.00	42.80
1958-59	0.00	0.00	2.10	21.50	13.70	15.10	0.00	0.00	0.00	0.00	0.00	0.00	52.40
1959-60	0.00	0.00	27.80	0.00	0.00	16.50	4.50	0.00	0.00	0.00	0.00	0.00	48.80
1960-61	0.00	0.00	1.60	13.40	5.40	1.80	0.00	0.00	0.00	0.00	0.00	0.00	22.20
1961-62	0.00	5.00	20.00	23.50	17.90	8.60	3.80	0.00	0.00	0.00	0.00	0.00	78.80
1962-63	0.00	0.00	0.00	2.70	24.70	8.60	2.00	4.00	0.00	0.00	0.00	0.00	42.00
1963-64	0.00	0.00	1.40	16.80	16.90	5.30	15.00	0.40	2.00	0.00	0.00	0.00	57.80
1964-65	0.00	T	8.10	19.30	17.20	8.00	3.40	1.50	T	0.00	0.00	0.00	57.50
1965-66	T	0.00	3.00	0.00	0.00	9.00	0.70	0.00	0.00	0.00	0.00	0.00	12.70
1966-67	0.00	0.00	19.30	12.00	7.80	6.00	9.30	0.00	0.00	0.00	0.00	0.00	54.40
1967-68	0.00	0.00	5.70	11.00	9.30	2.10	0.00	2.70	0.00	0.00	0.00	0.00	30.80
1968-69	0.00	0.00	7.50	21.00	28.80	8.70	3.00	0.00	0.00	0.00	0.00	0.00	69.00
1969-70	0.00	4.00	1.50	10.30	29.20	5.50	7.50	0.00	0.00	0.00	0.00	0.00	58.00
1970-71	T	0.00	8.50	9.50	0.00	4.00	3.50	T	0.00	0.00	0.00	0.00	25.50
1971-72	0.00	3.00	5.50	18.40	15.50	9.20	8.00	4.00	0.00	0.00	0.00	0.00	63.60
1972-73	0.50	4.50	6.00	8.30	4.50	T	T	0.00	0.00	0.00	0.00	0.00	23.80
1973-74	0.00	0.00	9.50	0.00	6.40	6.00	8.00	T	0.00	0.00	0.00	0.00	29.90
1974-75	0.00	0.00	0.00	10.00	22.70	15.75	12.70	0.00	0.00	0.00	0.00	0.00	61.15
1975-76	0.00	3.00	8.75	16.00	15.25	4.50	0.75	0.00	0.00	0.00	0.00	0.00	48.25
1976-77	0.00	0.00	1.00	5.00	13.00	2.50	11.75	2.00	0.00	0.00	0.00	0.00	35.25
1977-78	0.00	0.00	16.50	48.05	30.10	16.50	6.00	1.50	0.00	0.00	0.00	0.00	118.65
1978-79	0.00	0.00	9.60	18.85	22.35	19.78	8.12	3.10	0.00	0.00	0.00	0.00	81.80
1979-80	0.00	0.00	1.65	4.30	14.30	9.05	9.05	0.05	0.00	0.00	0.00	0.00	38.40
1980-81	0.00	0.00	0.75	9.25	6.00	8.90	3.30	0.00	1.75	0.00	0.00	0.00	29.95
1981-82	0.00	0.00	0.50	19.13	25.70	7.60	4.30	4.00	0.00	0.00	0.00	0.00	61.23
1982-83	0.00	0.00	6.25	17.15	6.40	5.20	0.75	0.00	0.00	0.00	0.00	0.00	35.75
1983-84	0.00	0.00	3.85	28.00	8.60	4.80	0.50	0.00	0.05	0.00	0.00	0.00	45.80
1984-85	0.00	10.55	3.00	17.00	4.25	16.00	5.50	1.00	0.00	0.00	0.00	0.00	57.30
1985-86	0.00	0.00	10.50	7.25	14.50	13.00	3.07	0.00	0.00	0.00	0.00	0.00	48.32
1986-87	0.00	0.00	13.50	4.25	7.00	1.50	13.50	0.00	0.00	0.00	0.00	0.00	39.75
1987-88	0.00	0.00	4.00	11.50	8.50	5.50	4.00	1.00	0.00	0.00	0.00	0.00	34.50
1988-89	0.00	0.00	9.50	15.00	9.50	18.75	6.00	0.00	0.00	0.00	0.00	0.00	58.75
1989-90	0.00	0.00	4.00	15.00	5.50	16.75	8.50	1.00	0.00	0.00	0.00	0.00	50.75
1990-91	0.00	0.00	3.75	32.75	17.00	1.00	1.50	1.00	0.00	0.00	0.00	0.00	57.00
1991-92	0.00	7.25	9.50	3.50	8.75	1.50	0.33	1.00	0.00	0.00	0.00	0.00	31.83
1992-93	0.00	0.00	4.07	23.50	15.00	9.00	1.00	0.00	0.00	0.00	0.00	0.00	52.57
1993-94	0.00	0.00	2.85	9.90	1.50	22.00	0.00	2.00	0.00	0.00	0.00	0.00	38.25
1994-95	0.00	0.50	7.27	13.20	2.04	0.00	9.25	0.50	0.00	0.00	0.00	0.00	32.76
1995-96	0.00	0.00	6.00	10.50	23.30	1.00	13.25	0.00	0.00	0.00	0.00	0.00	54.05
1996-97	0.00	1.50	37.00	42.80	12.50	21.30	11.30	2.60	0.00	0.00	0.00	0.00	129.00
1997-98	0.00	0.00	0.50	5.01	9.00	2.25	9.50	0.00	0.00	0.00	0.00	0.00	26.26
1998-99	0.00	0.00	0.75	8.00	5.00	5.19	3.25	2.75	0.00	0.00	0.00	0.00	24.94
1999-00	0.00	0.00	0.00	4.00	13.00	12.75	2.38	8.50	0.00	0.00	0.00	0.00	40.63
2000-01	0.00	0.00	4.50	14.25	8.48	19.90	4.50	14.00	0.00	0.00	0.00	0.00	65.63
MEAN	0.01	0.90	6.43	13.78	12.78	9.64	4.92	1.40	0.07	0.00	0.00	0.00	49.93

Mean snowfall for all years = 49.93

WEED AND SMALL GRAIN MANAGEMENT FOR WESTERN MONTANA
754

The Weed and Small Grain Management Project (754) includes research related to weeds and weed management in all crops as well as small grain varietal and agronomic investigations.

PROJECT TITLE: Montana Statewide Spring Oat Cultivar Performance

PROJECT LEADER: Tom Blake, Barley Breeder, Bozeman

PROJECT PERSONNEL: P.F. Hensleigh, Plant Sciences, Bozeman
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OBJECTIVES:

To evaluate the agronomic performance of new and existing cultivars and experimental lines of oats under various growing conditions and environments of Montana.

RESULTS:

The 2001 Montana Statewide Spring Oat Yield trial was grown at five dryland locations (Table 1 to 5) and four irrigated/high rainfall sites (Tables 6 to 10) in replicated multi-row plots. Yield, test weight, Julian heading date, and plant height are summarized across locations in Tables 1 and 6.

Yields at **Bozeman** were slightly higher in 2001 compared to the previous year. On average, yields were 185 bu/a and ranged from a low of 173 for Ajay to a high of 204 for ABSP 9-2. Test weights were exceptional and averaged 39 lb/bu.

Oat yields at **Havre** in 2001 were less than 40% of the long-term average for the station. Yields only averaged 19 bu/A, ranging from a low of 14.3 bu/A for Ajay to a high of 24.9 bu/A for Otana. Topsoil moisture at planting was very marginal and successful stand establishment for all spring crops was credited primarily to no-till seeding. Crop year precipitation was 72% of normal. Precipitation from oat seeding to harvest was 4.19 inches of which only 3.26 came in events greater than 0.1 inches. Growing season temperature means were 108% of normal with 44 days over 90F in comparison to a long-term mean of 26.3 days over 90F. Wind was relentless at 110% of normal with new all-time monthly peak velocity records set during both May and July.

Dryland yields at **Huntley** were less than the previous year, with average yields being 57 and 36 bu/A during 2000 and 2001, respectively. Dryland yields this season ranged from a low of 28 for Killdeer to a high of 43 for Rio Grande. Average test weights were similar to last years, and averaged 39 lb/bu. Plants headed earlier and were generally shorter compared to the previous year. Irrigated yields were excellent and averaged 209 bu/A. Yields ranged from 190 bu/A for Whitestone to 241 bu/A for 90AB1322. Test weights were good, averaging 35 lb/bu.

Disease infections were low at **Kalispell** due to limited precipitation during the 2001 production season. However, the lack of rainfall did not seem to limit yields. With an average yield of 190 bu/A, yields were 45 bu/A greater in 2001 compared 2000. Oat yields ranged from a low of 165 bu/acre for Ajay to yields exceeding 200 bu/acre for cultivars ABSP9-2 and CDC Pacer. The greatest test weight was 36 lbs/bu from cultivars CDC Pacer, Killdeer, and Otana. Heading dates ranged from 175-182 days. Plant height ranged from 29 to 44 inches and lodging was minor.

Dry and windy conditions prevailed at **Moccasin** during most of the growing season. However, oat yields were still acceptable and averaged 86 bu/A. Yields ranged from a low of 77 bu/A for Otana to a high of 96 bu/A for Rio Grande. Test weights were also acceptable, averaging 33 lb/bu. Heading date ranged from 181 to 190 days and plant height ranged from 26 inches for Ajay to 32 inches for CDC Pacer, Otana, and Whitestone.

Sidney conducted three trials including recrop, dryland, and irrigated nurseries. Yields in the dryland study were approximately 8 bu/A greater than that of the recrop nursery. The recrop nursery averaged 92.8 bu/A and ranged from a low of 81 bu/A for 89AB4088 to a high of 101 bu/A for Celsia. The Dryland nursery averaged 110 bu/A and ranged from 90 bu/A for Ajay to 123 bu/A for ABSP19-9. In the irrigated nursery, yields averaged 151 bu/A, ranging from 138 bu/A for 89AB4088 to 171 bu/A for CDC Pacer. Test weights were very good with both the recrop and dryland nurseries, averaging 36 and 37 lb/bu respectively. However, the irrigated nursery had lowest test weights, averaging 31 lb/Bu.

SUMMARY:

The Statewide Oat dryland trial average yield was 72 bu/A. On average, Ajay produced the lowest yield of 65 bu/A while Monida had the greatest yield of 76 bu/A. Test weights were excellent and averaged 36 lb/bu. Test weights ranged from a low of 34 lb/bu for Celsia to a high of 38 for 89AB4088.

The Statewide Oat irrigated nursery had an average yield of 184 bu/A. Yield ranged from a low of 171 for Ajay to a high of 202 for CDC Pacer. Test weights were good, averaging 35 lb/A. Test weights ranged from a low of 34 lb/bu for 90Ab1322 to a high of 36.8 lb/bu for ABSP 9-2.

FUTURE PLANS:

The Montana Statewide Oat Yield Trial will be continued in 2002.

Table 1. 2001 SPRING OATS STATEWIDE DRYLAND OVERALL SUMMARY
(Days from January 1)

ID	PEDIGREE	Yield bu/ac	Test Weight lb/bu	Heading Date	Plant Height inches
CI483126	Monida	76.0	35.9	180.7	26.7
CDCPACER	CDC PACER	74.0	37.2	177.5	28.9
87AB5125	Ogle/75Ab861	73.9	35.9	179.7	23.6
ABSP19-9	83Ab3083/Monida	73.6	37.0	178.4	24.6
90Ab1322	80Ab1322/Monida	73.1	35.5	178.1	22.2
81Ab5792	Rio Grande	73.0	35.4	175.8	24.5
PI583735	Celsia	72.8	34.6	179.7	27.3
PI591810	Whitestone	72.5	36.3	178.0	26.5
Site Mean	SITE MEAN	72.2	36.4	177.6	25.3
ABSP 9-2	83/Ab3119/Monida	71.8	37.4	177.0	25.1
87Ab4983	Ogle/Border	69.8	37.2	175.3	22.3
89AB4088	75Ab861/IL 75-3402	69.4	38.1	176.0	25.2
ND930122	Killdeer	69.4	36.7	174.7	25.8
CI 9252	Otana	67.2	37.7	177.2	31.3
PI537436	Ajay	65.8	35.2	178.3	20.9

Table 2. 2001 SPRING OAT STATEWIDE DRYLAND REPORT – YIELD (bu/ac)

ID	PEDIGREE	Havre Dryland	Moccasin Recrop	Huntley Dryland	Sidney Recrop	Sidney Dryland	Avg	BYX	RSQ
81Ab5792	Rio Grande	36.3	96.6	43.7	92.8	95.4	73.0	0.84	0.92
87AB5125	Ogle/75Ab861	33.4	95.8	41.4	95.8	102.9	73.9	0.95	0.96
87Ab4983	Ogle/Border	33.0	84.4	39.7	95.9	96.0	69.8	0.88	0.96
89AB4088	75Ab861/IL 75-3402	38.3	82.5	38.0	81.6	106.6	69.4	0.87	0.99
90Ab1322	80Ab1322/Monida	37.5	84.9	35.6	90.8	116.5	73.1	1.02	1.00
ABSP 9-2	83/Ab3119/Monida	29.7	88.7	33.7	95.8	111.4	71.8	1.08	0.99
ABSP19-9	83Ab3083/Monida	36.7	90.3	32.6	85.5	122.9	73.6	1.09	0.97
CDCPACER	CDC PACER	37.5	80.5	33.2	96.8	121.8	74.0	1.09	0.98
CI 9252	Otana	33.6	76.9	31.3	91.9	102.4	67.2	0.95	0.99
CI483126	Monida	37.7	83.5	40.7	100.4	117.8	76.0	1.03	0.99
ND930122	Killdeer	35.8	92.8	28.2	91.1	99.1	69.4	0.97	0.96
PI537436	Ajay	34.5	80.0	35.5	89.0	90.2	65.8	0.81	0.97
PI583735	Celsia	32.1	79.3	33.5	101.0	118.3	72.8	1.12	0.99
PI591810	Whitestone	36.6	86.6	37.2	91.1	111.0	72.5	0.97	1.00
Site Mean	SITE MEAN ********	35.2	85.9	36.0	92.8	110.5	72.2	1.00	1.00
C.V.	C.V. (S/Mean) * 100	12.94	5.0	16.30	10.74	8.35	***	***	***
F-Value		0.92	***	***	0.86	5.53	***	***	***
L.S.D.	L.S.D. (.05)	7.65	2.8	ns	16.73	15.07	***	***	***

Table 3. 2001 SPRING OAT STATEWIDE DRYLAND REPORT – TEST WEIGHT (lb/bu)

ID	PEDIGREE	Havre Dryland	Moccasin Recrop	Huntley Dryland	Sidney Recrop	Sidney Dryland	Avg	BYX	RSQ
81Ab5792	Rio Grande	34.0	30.9	39.8	35.7	36.8	35.4	1.52	0.98
87AB5125	Ogle/75Ab861	35.3	32.7	38.6	36.0	36.7	35.9	0.99	0.98
87Ab4983	Ogle/Border	34.9	36.4	40.2	36.5	38.2	37.2	0.76	0.65
89AB4088	75Ab861/IL 75-3402	37.4	35.7	41.7	36.2	39.3	38.1	1.07	0.87
90Ab1322	80Ab1322/Monida	36.1	29.0	38.1	36.5	37.8	35.5	1.47	0.72
ABSP 9-2	83/Ab3119/Monida	37.0	34.4	40.6	37.3	37.7	37.4	1.01	0.97
ABSP19-9	83Ab3083/Monida	37.0	34.3	40.1	36.0	37.7	37.0	0.96	0.94
CDCPACER	CDC PACER	36.0	34.8	40.0	36.2	39.2	37.2	0.97	0.88
CI 9252	Otana	36.8	35.5	40.7	38.0	37.5	37.7	0.85	0.90
CI483126	Monida	35.9	32.2	37.2	36.0	38.0	35.9	0.87	0.71
ND930122	Killdeer	35.0	35.0	40.5	36.0	36.8	36.7	0.96	0.84
PI537436	Ajay	35.5	30.6	38.8	34.7	36.3	35.2	1.33	0.93
PI583735	Celsia	32.2	33.4	36.0	34.5	36.8	34.6	0.60	0.48
PI591810	Whitestone	36.2	34.7	39.7	35.2	35.8	36.3	0.81	0.77
Site Mean	SITE MEAN ********	35.7	33.6	39.4	36.1	37.1	36.4	1.00	1.00
C.V.	C.V. (S/Mean) * 100	1.84	***	1.1	2.30	1.85	***	***	***
F-Value		13.18	***	***	3.75	10.57	***	***	***
L.S.D.	L.S.D. (.05)	1.10	***	0.8	1.39	1.12	***	***	***

Table 4. 2001 SPRING OAT STATEWIDE DRYLAND REPORT – HEADING DATE
(Days from January 1)

ID	PEDIGREE	Havre Dryland	Moccasin Recrop	Huntley Dryland	Sidney Recrop	Sidney Dryland	Avg	BYX	RSQ
81Ab5792	Rio Grande	182.3	182.0	164.7	176.3	173.7	175.8	1.10	0.96
87AB5125	Ogle/75Ab861	182.3	189.0	169.0	182.0	176.0	179.7	1.12	0.93
87Ab4983	Ogle/Border	183.0	182.0	163.0	176.0	172.7	175.3	1.22	0.95
89AB4088	75Ab861/IL 75-3402	181.3	182.0	165.0	177.7	174.0	176.0	1.07	0.99
90Ab1322	80Ab1322/Monida	182.7	182.0	169.0	180.3	176.7	178.1	0.86	0.98
ABSP 9-2	83/Ab3119/Monida	181.0	182.0	168.3	178.0	175.7	177.0	0.84	0.99
ABSP19-9	83Ab3083/Monida	182.7	183.0	167.7	182.3	176.3	178.4	1.01	0.98
CDCPACER	CDC PACER	181.0	182.0	168.0	181.3	175.0	177.5	0.92	0.98
CI 9252	Otana	180.7	181.0	167.0	181.7	175.7	177.2	0.93	0.95
CI483126	Monida	182.3	190.0	171.3	182.7	177.3	180.7	1.01	0.89
ND930122	Killdeer	179.0	180.0	163.0	177.0	174.3	174.7	1.05	0.97
PI537436	Ajay	183.0	182.0	167.7	182.0	176.7	178.3	0.98	0.97
PI583735	Celsia	181.7	187.0	171.0	182.7	176.3	179.7	0.92	0.93
PI591810	Whitestone	181.7	182.0	167.3	182.0	177.0	178.0	0.96	0.96
Site Mean	SITE MEAN ********	181.8	183.3	167.3	180.1	175.4	177.6	1.00	1.00
C.V.	C.V. (S/Mean) * 100	0.59	14.0	0.4	0.40	0.39	***	***	***
F-Value		3.18	***	***	37.37	19.56	***	***	***
L.S.D.	L.S.D. (.05)	1.80	ns	1.0	1.21	1.12	***	***	***

Table 5. 2001 SPRING OAT STATEWIDE DRYLAND REPORT – PLANT HEIGHT (in)

ID	PEDIGREE	Havre Dryland	Moccasin Recrop	Huntley Dryland	Sidney Recrop	Sidney Dryland	Avg	BYX	RSQ
81Ab5792	Rio Grande	18.9	31.0	22.5	26.1	24.0	24.5	1.01	0.85
87AB5125	Ogle/75Ab861	17.8	30.0	20.6	25.5	24.2	23.6	1.09	0.91
87Ab4983	Ogle/Border	17.8	28.0	19.1	23.4	23.4	22.3	0.92	0.88
89AB4088	75Ab861/IL 75-3402	18.8	31.0	22.1	26.4	28.0	25.2	1.16	0.97
90Ab1322	80Ab1322/Monida	15.0	27.0	20.8	23.5	24.9	22.2	1.11	0.96
ABSP 9-2	83/Ab3119/Monida	18.0	30.0	21.4	27.8	28.5	25.1	1.25	0.98
ABSP19-9	83Ab3083/Monida	18.5	28.0	22.7	25.7	28.2	24.6	0.97	0.94
CDCPACER	CDC PACER	22.5	32.0	26.2	29.9	34.0	28.9	1.04	0.86
CI 9252	Otana	24.9	32.0	29.9	36.1	33.7	31.3	0.89	0.74
CI483126	Monida	21.2	27.0	23.6	30.8	30.8	26.7	0.87	0.69
ND930122	Killdeer	20.4	31.0	22.9	27.6	27.0	25.8	1.00	0.96
PI537436	Ajay	14.3	26.0	20.0	23.4	20.7	20.9	1.01	0.90
PI583735	Celsia	22.4	27.0	25.1	32.4	29.5	27.3	0.73	0.59
PI591810	Whitestone	19.7	32.0	26.1	26.4	28.1	26.5	1.00	0.86
Site Mean	SITE MEAN ********	19.3	29.4	23.1	27.5	27.4	25.3	1.00	1.00
C.V.	C.V. (S/Mean) * 100	7.19	10.3	8.1	6.17	9.13	***	***	***
F-Value		12.80	***	***	14.20	5.32	***	***	***
L.S.D.	L.S.D. (.05)	2.33	ns	3.1	2.85	4.09	***	***	***

Table 6. 2001 SPRING OATS STATEWIDE IRRIGATED OVERALL SUMMARY

ID	PEDIGREE	Yield bu/ac	Test Weight lb/bu	Heading Date	Plant Height inches
CDCPACER	CDC PACER	202.6	35.7	179.1	38.0
ABSP 9-2	83/Ab3119/Monida	199.4	36.8	178.2	34.1
90Ab1322	80Ab1322/Monida	194.8	34.1	179.5	29.9
ND930122	Killdeer	191.8	35.5	176.3	33.4
ABSP19-9	83Ab3083/Monida	189.7	35.0	181.3	33.5
87AB5125	Ogle/75Ab861	187.1	34.8	180.1	32.8
Site Mean	SITE MEAN ********	184.0	35.0	178.9	33.8
PI583735	Celsia	182.2	34.3	180.4	36.6
CI483126	Monida	180.8	33.8	181.2	37.0
PI591810	Whitestone	180.5	35.5	180.2	35.6
CI 9252	Otana	179.5	36.3	178.5	39.5
81Ab5792	Rio Grande	177.9	33.6	177.4	30.7
89AB4088	75Ab861/IL 75-3402	177.4	36.5	176.9	33.6
87Ab4983	Ogle/Border	177.3	35.5	176.5	29.3
PI537436	Ajay	171.1	33.5	180.0	28.2

Table 7. 2001 SPRING OAT STATEWIDE IRRIGATED REPORT – YIELD (bu/ac)

ID	PEDIGREE	Kalispell High Moisture	Sidney Irrigated	Huntley Irrigated	Bozeman Irrigated	Avg	BYX	RSQ
81Ab5792	Rio Grande	173.6	146.8	205.5	185.8	177.9	0.98	0.92
87AB5125	Ogle/75Ab861	193.0	152.9	218.6	183.7	187.1	1.12	0.99
87Ab4983	Ogle/Border	178.4	145.0	205.9	179.8	177.3	1.03	0.99
89AB4088	75Ab861/IL 75-3402	193.0	138.1	199.4	179.1	177.4	1.11	0.94
90Ab1322	80Ab1322/Monida	191.9	153.8	241.1	192.4	194.8	1.43	0.93
ABSP 9-2	83/Ab3119/Monida	211.0	161.1	221.1	204.5	199.4	1.08	0.96
ABSP19-9	83Ab3083/Monida	193.0	153.7	224.5	187.8	189.7	1.19	0.98
CDCPACER	CDC PACER	209.2	171.1	230.1	199.9	202.6	1.01	0.99
CI 9252	Otana	189.2	139.9	198.0	190.9	179.5	1.05	0.90
CI483126	Monida	190.1	151.1	200.1	182.1	180.8	0.87	0.98
ND930122	Killdeer	191.5	160.9	214.6	200.2	191.8	0.92	0.95
PI537436	Ajay	165.2	143.9	202.0	173.1	171.1	0.94	0.89
PI583735	Celsia	182.8	152.5	217.0	176.5	182.2	1.06	0.92
PI591810	Whitestone	194.7	151.2	190.2	185.9	180.5	0.74	0.80
Site Mean	SITE MEAN ********	189.8	151.6	209.5	185.1	184.0	1.00	1.00
C.V.	C.V. (S/Mean) * 100	7.32	6.90	7.7	6.96	***	***	***
F-Value		2.31	2.14	***	5.38	***	***	***
L.S.D.	L.S.D. (.05)	23.30	17.56	26.2	18.09	***	***	***

Table 8. 2001 SPRING OAT STATEWIDE IRRIGATED REPORT – TEST WEIGHT

ID	PEDIGREE	Kalispell High Moisture	Sidney Irrigated	Huntley Irrigated	Bozeman Irrigated	Avg	BYX	RSQ
81Ab5792	Rio Grande	31.1	31.0	33.5	38.9	33.6	1.05	0.89
87AB5125	Ogle/75Ab861	33.2	31.2	35.5	39.3	34.8	1.02	0.96
87Ab4983	Ogle/Border	34.5	32.5	34.6	40.5	35.5	1.01	0.97
89AB4088	75Ab861/IL 75-3402	35.9	33.0	35.4	41.8	36.5	1.10	0.97
90Ab1322	80Ab1322/Monida	31.6	31.0	34.2	39.4	34.1	1.11	0.93
ABSP 9-2	83/Ab3119/Monida	35.5	33.3	36.9	41.5	36.8	1.03	0.99
ABSP19-9	83Ab3083/Monida	33.8	32.2	35.5	38.5	35.0	0.80	0.97
CDCPACER	CDC PACER	36.1	31.7	35.2	39.7	35.7	0.96	0.94
CI 9252	Otana	36.1	33.0	35.9	40.3	36.3	0.90	0.99
CI483126	Monida	33.7	29.8	33.6	38.2	33.8	1.01	0.98
ND930122	Killdeer	36.3	30.2	35.0	40.7	35.5	1.24	0.92
PI537436	Ajay	31.8	30.3	33.3	38.5	33.5	1.05	0.98
PI583735	Celsia	34.1	30.8	34.3	38.1	34.3	0.88	0.98
PI591810	Whitestone	34.8	30.8	35.4	40.9	35.5	1.23	0.99
Site Mean	SITE MEAN ********	34.2	31.5	34.9	39.5	35.0	1.00	1.00
C.V.	C.V. (S/Mean) * 100	2.12	2.48	4.1	2.36	***	***	***
F-Value		17.79	6.31	***	4.81	***	***	***
L.S.D.	L.S.D. (.05)	1.21	1.31	2.3	1.90	***	***	***

Table 9. 2001 SPRING OAT STATEWIDE IRRIGATED REPORT – HEADING DATE
(Days from January 1)

ID	PEDIGREE	Kalispell High Moisture	Sidney Irrigated	Huntley Irrigated	Bozeman Irrigated	Avg	BYX	RSQ
81Ab5792	Rio Grande	177.0	178.7	176.3	177.5	177.4	0.52	0.89
87AB5125	Ogle/75Ab861	180.0	182.0	179.0	179.5	180.1	0.67	0.83
87Ab4983	Ogle/Border	177.0	178.3	173.3	177.3	176.5	1.17	0.92
89AB4088	75Ab861/IL 75-3402	177.3	179.0	173.3	178.0	176.9	1.32	0.90
90Ab1322	80Ab1322/Monida	179.3	181.0	178.0	179.5	179.5	0.68	0.98
ABSP 9-2	83/Ab3119/Monida	179.0	179.7	175.3	178.8	178.2	1.02	0.88
ABSP19-9	83Ab3083/Monida	182.7	183.0	178.7	180.8	181.3	1.02	0.83
CDCPACER	CDC PACER	179.0	181.7	176.0	179.8	179.1	1.30	0.97
CI 9252	Otana	179.7	181.7	174.0	178.8	178.5	1.79	0.97
CI483126	Monida	181.3	183.0	180.0	180.5	181.2	0.67	0.83
ND930122	Killdeer	177.0	178.3	172.3	177.5	176.3	1.41	0.87
PI537436	Ajay	178.0	182.7	179.7	179.5	180.0	0.61	0.31
PI583735	Celsia	180.3	182.7	178.3	180.3	180.4	0.98	0.98
PI591810	Whitestone	179.7	182.0	179.3	179.8	180.2	0.58	0.72
Site Mean	SITE MEAN ********	179.1	181.0	176.6	179.0	178.9	1.00	1.00
C.V.	C.V. (S/Mean) * 100	0.32	0.33	0.7	0.33	***	***	***
F-Value		26.67	27.92	***	26.20	***	***	***
L.S.D.	L.S.D. (.05)	0.97	0.99	2.1	0.82	***	***	***

Table 10. 2001 SPRING OAT STATEWIDE IRRIGATED REPORT – PLANT HEIGHT (in)

ID	PEDIGREE	Kalispell High Moisture	Sidney Irrigated	Huntley Irrigated	Bozeman Irrigated	Avg	BYX	RSQ
81Ab5792	Rio Grande	29.5	26.5	36.0	30.8	30.7	0.88	0.94
87AB5125	Ogle/75Ab861	29.3	26.4	41.2	34.3	32.8	1.47	0.99
87Ab4983	Ogle/Border	27.7	25.7	33.5	30.3	29.3	0.76	0.99
89AB4088	75Ab861/IL 75-3402	29.3	29.4	39.4	36.1	33.6	1.12	0.95
90Ab1322	80Ab1322/Monida	28.1	25.2	34.6	31.6	29.9	0.93	0.99
ABSP 9-2	83/Ab3119/Monida	30.1	29.9	40.4	36.1	34.1	1.13	0.96
ABSP19-9	83Ab3083/Monida	32.2	29.8	37.3	34.7	33.5	0.73	0.99
CDCPACER	CDC PACER	36.5	33.1	42.4	40.0	38.0	0.91	0.97
CI 9252	Otana	39.1	33.7	43.9	41.1	39.5	0.92	0.89
CI483126	Monida	36.6	31.6	40.7	38.9	37.0	0.83	0.87
ND930122	Killdeer	30.3	30.8	37.4	35.1	33.4	0.74	0.92
PI537436	Ajay	25.2	23.4	34.7	29.4	28.2	1.15	1.00
PI583735	Celsia	34.4	32.0	42.7	37.2	36.6	1.04	0.98
PI591810	Whitestone	31.4	31.6	42.8	36.7	35.6	1.19	0.94
Site Mean	SITE MEAN ********	31.4	29.2	39.2	35.3	33.8	1.00	1.00
C.V.	C.V. (S/Mean) * 100	5.03	6.44	6.8	4.02	***	***	***
F-Value		18.58	8.87	***	25.96	***	***	***
L.S.D.	L.S.D. (.05)	2.65	3.16	4.3	1.99	***	***	***

PROJECT TITLE: Montana Statewide Spring Oat Variety Performance.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Scott Halley, Research Associate, NWARC.
Tom Blake, Barley Breeder, Bozeman.
Pat Hensleigh, Research Associate, Bozeman.

OBJECTIVES:

To evaluate the agronomic performance of oat varieties in environments and cropping systems representative of northwestern Montana.

RESULTS:

Due to climatic conditions in the region during the 2001 production season, small amounts of natural disease inoculum were produced and disease infections were at very low levels. No disease evaluation was recorded. Precipitation was limited from July 1 through harvest. Lack of rainfall did not seem to limit yields. Oat yields ranged from a low of 165 bu/acre for cultivar Ajay (Table 1) to yields exceeding 200 bu/acre for cultivars ABSP9-2 and CDC Pacer. The greatest test weight was 36 lbs/bu from cultivars CDC Pacer, Killdeer, and Otana. Julian heading dates ranged from 175-182 days. Plant height ranged from 29 to 44 inches. Most cultivars measured from 29 to 36 inches in height at harvest. No concernable lodging was measured. The oats nursery was planted on April 25, and harvested on August 16.

SUMMARY:

Despite limited precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights. Several cultivars exhibited superior yield performance and agronomic traits that may make them superior for planting in northwestern Montana.

FUTURE PLANS:

Cultivars will continue to be evaluated at Kalispell in an attempt to identify those cultivars best adapted to District 1.

Table 1. Agronomic data from the State Oat Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Cultivar	Yield	Test Wt	Height	Heading Date	Lodging	Protein
	Bu/A	Lbs/Bu	Inches	Julian	%	%
ABSP9-2	211.0	35.5	30.1	179	0.7	11.67
CDC PACER	209.2	36.1	36.5	179	2.7	11.59
WHITESTONE	194.7	34.8	31.3	180	0.7	12.18
87AB5125	193.0	33.2	29.2	180	0	12.79
ABSP19-9	193.0	33.8	32.2	183	0	12.48
89AB4088	193.0	35.9	29.2	177	1	13.33
90Ab1322	191.9	31.6	28.1	179	0	12.79
KILLDEER	191.5	36.3	30.3	177	0.3	14.20
MONIDA	190.1	33.7	36.6	181	4.0	13.10
OTANA	189.2	36.1	39.1	180	1.0	14.28
CELSIA	182.8	34.1	34.4	180	1.0	11.86
87Ab4983	178.3	34.5	27.7	177	0	12.90
RIO GRANDE	173.6	31.1	29.5	177	12.2	11.14
AJAY	165.2	31.8	25.2	178	0.0	14.26
Mean	189.8	34.2	31.4	179	1.7	12.75
LSD p=0.05	23.3	1.2	2.6	2.1	5.9	
C.V.	7	2	5	1	208	
Replicate Prob(F)	0.0245	0.0627	0.1985	0.0626	0.3204	
Treatment Prob(F)	0.0333	<0.0001	<0.0001	<0.0001	0.0198	

PROJECT TITLE: Agronomic Performance Evaluation of Intrastate Spring Barley Cultivars.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Scott Halley, Research Associate, NWARC.
Tom Blake, Barley Breeder, Bozeman.
Pat Hensleigh, Research Associate, Bozeman.

OBJECTIVES:

To evaluate new and existing spring barley cultivars for agronomic performance and disease resistance in environments and cropping systems representative of northwestern Montana.

RESULTS:

Due to climatic conditions in the region during the 2001 production season, no disease evaluations were recorded from this nursery. Precipitation events were limited after early July through harvest. However, the lack of rainfall did not seem to reduce yields. Barley yields ranged from less than 150 bu/acre for Coors 40, MT990132, Legacy, Morex, and Coors 46 to yields exceeding 190 bu/acre for Merit, MT990244, MT960101, MT990249, MT981030, MT970116, MT970026, Gallatin, and MT981238 (Table 1). All test weights were excellent with several test weights over 54 lbs/bu. Many of the greatest test weights also correlated with the greatest yields. Julian heading dates ranged from 172 days for Coors 40 and MT970074 to 182 days for MT960101, Galena, and Coors 57. Lodging existed in only a few entries. Experimental lines MT960228 and MT960222 had lodging ratings above 60%. Plant height ranged from 26 to 38 inches. Most entries measured from 29 to 33 inches in height at harvest. Plump percentages were excellent, almost all exceeding 90 percent. The nursery was planted on April 25 and harvested on August 17.

SUMMARY:

Despite below average precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights. Although all yields were excellent, several cultivars exhibited superior yield performance and agronomic traits that may make them superior for planting in northwestern Montana.

FUTURE PLANS:

Continue barley evaluations for the purpose of identifying cultivars best suited for District 1.

Table 1. Agronomic data from the Intrastate Spring Barley Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Experimental Line	Yield Bu/A	Test Wt Lbs/Bu	Head Date Julian	Height Inches	Lodging %	Plump %	Protein %
MERIT	197.6	52.5	178	33.9	11.4	94.0	13.10
MT990244	193.7	54.6	173	30.6	0.0	92.4	14.36
MT960101	193.7	53.4	182	31.1	5.7	86.4	12.67
MT990249	193.7	54.6	173	30.6	0.0	92.4	14.17
MT981030	192.9	54.5	181	33.6	23.2	88.8	12.19
MT970116	190.9	54.9	176	35.6	10.5	94.7	12.02
MT970026	190.7	54.9	176	33.5	7.5	94.3	12.96
GALLATIN	190.6	54.4	177	33.5	4.8	92.0	12.99
MT981238	190.3	54.1	175	35.7	4.9	87.2	13.30
CALGARY	189.9	53.3	177	31.0	1.3	90.4	13.56
N96/1116	189.0	52.5	181	29.2	0.0	97.4	12.27
MT981210	185.3	53.3	179	31.4	4.2	94.9	13.07
MTLB 5	185.2	53.7	178	32.8	19.1	85.5	13.44
MT910189	184.7	52.2	175	32.0	17.3	92.8	13.15
MT970110	184.1	53.9	180	33.1	7.8	90.6	12.79
MT981004	182.2	52.1	177	30.3	22.7	79.5	12.72
MT960099	181.5	52.3	179	28.5	3.7	91.2	12.47
HARRINGTON	181.0	52.5	178	33.3	13.8	86.9	12.70
BARONESSE	180.9	52.4	180	31.8	19.8	92.4	13.20
MT981091	180.5	53.5	175	32.4	5.5	88.4	12.90
MT990074	179.4	53.0	172	32.3	7.1	93.4	14.02
COORS 53	178.4	50.4	180	28.1	0.0	96.1	12.22
MT970229	178.3	54.2	179	31.2	0.0	96.5	12.79
LEWIS	176.5	53.5	177	32.9	16.2	87.7	13.22
MTLB 6	176.3	53.4	176	33.6	1.3	92.5	13.39
STARK	176.3	54.3	173	35.3	19.8	94.7	13.09
MT990172	175.9	53.1	175	32.8	22.2	87.9	13.23
CDC BOLD	175.7	52.6	178	31.4	0.3	88.0	12.41
CONLON	174.2	52.0	179	33.0	10.0	81.3	12.57
H3860224	172.3	53.2	179	30.4	5.4	95.4	13.03
BZ594-20	171.0	53.3	173	29.0	1.3	95.4	12.23
MT990041	170.2	51.8	178	33.6	6.3	92.7	12.88
STRATUS	169.4	48.9	179	29.8	4.9	80.6	12.35
GALENA	169.1	52.8	182	29.8	0.0	92.4	12.26
MT981006	168.3	51.8	176	29.8	21.3	78.2	12.91
NORD1958	168.3	53.6	179	28.7	3.9	93.2	12.88
BZ596117	168.0	54.8	179	33.2	13.3	91.0	13.34
MT981080	167.8	51.2	178	31.8	23.3	86.1	12.54
MT960226	167.2	52.7	176	30.8	35.7	82.7	12.34
MT990106	167.1	51.1	178	30.7	5.5	92.4	13.41
COORS 56	167.0	53.1	176	28.6	0.0	91.9	12.99
COORS 57	166.8	49.7	182	25.6	2.3	84.3	12.42
MT970148	166.2	52.0	177	30.8	5.0	88.4	12.62
MT950186	165.1	53.0	177	30.9	18.2	89.5	13.14
MT981177	164.0	52.3	177	31.7	24.2	91.4	13.41
VALIER	163.0	53.0	178	32.5	13.4	94.4	13.12

Table 1 continued. Agronomic data from the Intrastate Spring Barley Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Experimental Line	Yield Bu/A	Test Wt Lbs/Bu	Head Date Julian	Height Inches	Lodging %	Plump %	Protein %
MT981212	162.3	51.7	176	31.6	6.0	87.8	13.26
MT990084	161.1	51.0	177	31.6	28.8	91.3	13.24
MT960100	160.5	51.8	181	29.1	7.2	82.3	12.72
MT960228	160.3	53.2	178	30.8	64.8	88.3	12.14
MT990156	159.7	51.9	174	30.7	8.8	93.5	12.46
COORS 37	159.6	53.1	180	29.9	2.3	93.5	13.08
MT981042	159.2	52.9	180	31.5	41.1	76.5	13.20
MT981039	158.7	53.0	181	30.8	37.5	90.0	12.93
B2L20-36	158.1	50.7	173	31.1	3.3	90.4	12.51
MT990023	157.9	51.7	177	33.6	24.8	93.4	12.59
GARNETT	151.2	51.4	178	32.9	10.0	95.9	12.81
MT960222	150.0	52.1	177	31.1	61.3	85.2	12.78
COORS 40	146.2	48.7	172	26.5	2.1	82.1	13.08
MT990132	142.0	50.6	178	31.8	36.6	83.7	12.12
LEGACY	141.3	50.5	176	33.8	29.9	79.6	12.99
MT970155	137.4	51.9	178	29.9	7.3	90.0	13.87
MOREX	136.8	48.5	173	37.9	48.3	72.1	13.42
COORS 46	133.7	50.4	176	28.7	0	81.3	na
Mean	170.5	52.5	177	31.5	13.7	89.2	12.72
LSD p=0.05	39.8	2.2	2.2	2.9	22.7		
C.V.	13	2	1	6	101.2		
Replicate Prob (F)	0.0051	<0.0001	0.0001	<0.0001	<0.0001		
Treatment Prob (F)	0.2783	<0.0001	<0.0001	<0.0001	<0.0001		

PROJECT TITLE: Agronomic Performance Evaluation of Advanced Spring Wheat Experimental Lines.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Scott Halley, Research Associate, NWARC.
Luther Talbert, Spring Wheat Breeder, Bozeman.
Susan Lanning, Research Associate, Bozeman.

OBJECTIVES:

To evaluate advanced spring wheat experimental lines for agronomic performance and disease resistance in environments and cropping systems representative of northwestern Montana.

RESULTS:

Due to climatic conditions in the region during the 2001 production season, small amounts of natural disease inoculum were produced and disease infections were at very low levels. No disease evaluation was recorded from this nursery. Yields ranged from a high of 149.7 bu/A for MT 9806 to a low of 87.9 bu/A for MTHW9905. Twenty-two cultivars posted yields greater than 130 bu/acre. Test weights were excellent. Twenty cultivars had test weight of 64 lbs/bushel or greater. Only MT 0008 had a test weight that would be considered less than desirable at 58.7 lbs/bushel. Julian heading dates ranged from 169 to 180 days representing a longer period of heading than previous years. Generally lodging was not a problem except for MT 0039, MTHW 0001, CI 17429, and CI 10003 at nearly 20% or greater. With the exception of MTHW 0001, the greatest lodging was associated with cultivar heights over 39 inches. Several other entries measured some minor lodging of 4 to 14.5%. The trial average height was 34 inches. The nursery was planted on April 25 and harvested on August 23.

SUMMARY:

Despite below normal amounts of precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights from several experimental lines that may make them excellent choices for planting in northwestern Montana.

FUTURE PLANS:

Continue to spring wheat evaluations for the purpose of identifying those cultivars best suited for district 1.

Table 1. Agronomic data from the Advanced Spring Wheat Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Experimental Line	Yield	Test Wt	Heading Date	Plant Height	Lodging
	Bu/A	Lbs/Bu	Julian	Inches	%
MT 9806	149.7	62.4	176	33.0	0.0
MTHW9904	144.6	64.9	173	36.1	1.3
MT 0039	143.6	63.0	180	41.6	22.5
MT 9874	142.5	61.9	178	33.6	2.0
WB 926	142.1	62.6	172	32.0	0.0
MT 0012	139.3	63.5	172	32.3	0.0
SCHOLAR	138.6	61.6	176	35.7	1.8
KLASIC	138.1	64.6	170	28.6	0.0
REEDER	138.0	61.7	174	35.3	8.5
GM40004	136.8	64.0	173	31.5	0.0
MT 0031	135.8	63.3	174	38.2	9.4
HANK	135.5	60.0	173	30.6	0.0
MT 9918	134.1	62.7	173	35.7	3.0
MTHW0001	133.0	64.1	174	34.5	19.3
MT 9923	132.3	63.3	176	34.9	0.0
MT 9905	132.3	63.2	178	34.6	0.0
MTHW0002	131.9	62.3	173	31.8	1.2
MT 0076	131.8	63.7	172	33.8	0.0
MT 0066	131.8	63.4	173	38.7	0.7
MT 9955	130.2	63.5	173	31.8	0.0
NEWANA	130.0	61.8	176	30.2	1.3
MTHW9420	130.0	Na	173	31.5	0.0
MT 9960	128.8	64.9	177	35.4	0.0
GM40003	128.5	64.8	170	32.4	0.0
SLW97606	128.4	65.3	177	33.1	0.0
GM40002	128.0	64.8	169	32.0	0.3
MT 0042	128.0	63.5	172	36.7	2.8
MT 0063	127.6	Na	174	35.6	0.0
MT 0054	126.0	63.7	171	35.3	0.0
MT 0053	125.9	62.6	174	38.1	0.0
AMIDON	125.5	62.9	176	39.1	2.6
BZ996472	125.2	64.2	171	30.6	0.0
MT 0050	123.7	64.0	173	36.6	2.0
MT 0007	121.7	63.4	173	36.7	0.7
MCNEAL	121.5	62.5	177	33.3	0.0
MT 0013	121.4	62.4	173	28.9	0.0
MTHW9716	121.2	63.2	172	33.6	10.2
MT 0064	121.1	65.2	173	37.0	0.0
MT 0021	120.8	64.4	174	36.2	0.5
ERNEST	120.4	64.2	175	38.3	1.7
BZ991210	120.3	Na	172	33.3	2.6
MTHW9901	120.2	64.1	175	37.8	6.5
MT 0032	117.1	63.6	174	36.9	1.5
BZ991019	117.1	62.7	170	32.0	0.0

Continued

Cultivar	Yield	Test Wt	Head Date	Plant Height	Lodging
	Bu/A	Lbs/Bu	Julian	Inches	%
BZ996434	116.9	62.9	172	31.6	5.3
HI-LINE	116.6	63.4	174	31.4	0.0
LEW	116.4	64.0	177	41.3	39.8
MTHW9710	115.7	61.9	172	32.1	11.9
MT 0018	115.7	64.2	174	36.3	0.0
THATCHER	115.6	na	176	39.4	26.3
MT 9931	113.8	64.0	175	31.5	0.0
MT 9929	113.8	62.9	174	30.3	0.0
MTHW0005	113.7	63.0	174	33.0	8.4
MT 0037	113.3	64.6	171	29.0	0.0
MT 9755	109.2	63.4	173	30.2	5.3
MTHW9908	107.3	62.1	174	30.0	8.2
FORTUNA	106.8	64.3	175	38.6	14.5
MT 0008	106.5	58.7	173	34.0	0.0
CONAN	104.3	62.5	175	31.8	0.0
GM40019	97.8	63.4	174	28.4	0.0
MT 0069	93.0	63.5	173	37.1	7.0
MTHW9905	87.9	62.2	174	33.4	3.0
MT 0009	na	61.9	174	30.4	0.0
GM40020	na	64.2	170	30.2	0.0
Mean	125.3	60.25	174	34.0	4.0
LSD p=0.05	26.2		2.2	3.2	11.9
C.V.	11		1	6	184
Replicate Prob(F)	<0.0001		<0.0001	<0.0001	0.0108
Treatment Prob(F)	0.0825		<0.0001	<0.0001	<0.0001

PROJECT TITLE: Agronomic Performance Evaluation of Intrastate Winter Wheat Cultivars

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Scott Halley, Research Associate, NWARC.
Phil Bruckner, Winter Wheat Breeder, Bozeman.
Jim Berg, Research Associate, Bozeman.

OBJECTIVES:

To evaluate new and existing winter wheat cultivars for agronomic performance and disease resistance in environments and cropping systems representative of northwestern Montana.

RESULTS:

Pythium appeared several weeks after winter dormancy had broken and developed aggressively. The symptoms were a severe yellowing of the plants and general lackluster appearances. A 1-3 rating scale with 3 being severe was used to quantify differences. All plots had considerable injury. Winter wheat yields ranged from a low of less than 60 bu/acre for Rampart and Morgan to highs exceeding 80 bu/acre for MT 9951, Blizzard, MTR 9997, Utah 100, Tiber, MT 9904, and MT 9982 (Table 1). All test weights were excellent with several weights exceeding 63 lbs/bu. Julian heading dates ranged from 150 days for Halt to 164 days for Norstar with a mean heading date of 157 days. Plant height ranged from 20.5 inches for Halt and NuHorizon to 38.3 inches from Norstar. Plant heights were less than previous years and there was no lodging in the trial. The nursery was planted on September 25, 2000 and harvested on August 16, 2001.

SUMMARY:

Despite limited precipitation during head filling, reserve subsoil moisture permitted good yields and test weights. Although most yields were good, several varieties exhibited superior yield performance and agronomic traits that may make them favorable choices for planting in northwestern Montana.

FUTURE PLANS:

Continue winter wheat evaluations for the purpose of identifying those cultivars best suited for production in District 1.

Table 1. Agronomic data from the Intrastate Winter Wheat Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Cultivar	Yield	Test Wt	Heading Date	Height	Disease Score	Winter Survival	Protein
	Bu/A	Lbs/Bu	Julian	Inches	1-3	%	%
MT9951	89.4	62.3	160	29.5	1.3	100	12.3
BLIZZARD	88.0	62.4	159	27.1	1.3	99	13.5
MTR9997	85.6	62.8	159	26.8	1.7	100	13.7
UTAH 100	84.9	61.5	160	31.3	2.0	99	13.0
TIBER	84.9	63.1	160	31.9	1.3	100	13.4
MT9904	82.0	61.9	157	26.1	1.7	99	13.1
MT9982	80.9	62.3	160	26.9	1.0	99	12.7
MT9989	79.2	60.8	159	28.2	1.0	100	12.4
ELKHORN	78.7	62.1	161	33.7	2.0	98	13.1
BZ96-919	77.5	62.6	161	22.5	2.0	100	12.7
NORSTAR	77.1	62.8	164	38.3	2.0	100	12.7
GOLDEN SPIKE	76.9	62.3	161	28.5	1.7	97	12.3
JUDITH	76.6	60.8	158	26.9	1.3	98	12.8
MT9513	76.5	61.6	160	26.7	2.0	100	13.4
HARDING	75.3	61.7	158	26.1	2.0	99	13.4
BZ96-895	75.2	63.4	155	25.3	1.7	100	13.0
NEELEY	75.0	61.2	161	29.2	2.5	100	11.8
NUSKY	75.0	62.2	159	26.9	2.0	100	13.3
NUPLAINS	74.7	63.8	155	23.1	1.7	99	13.3
BZ97-761	74.5	62.1	158	27.5	1.3	100	13.1
MT9949	74.3	61.4	158	28.7	1.7	100	13.1
BIGHORN	73.9	62.8	160	23.3	1.7	99	13.4
N95L1229	73.6	61.9	157	23.7	1.7	99	13.2
BIG SKY	73.2	63.3	159	28.2	2.0	99	13.7
PROMONTORY	71.8	63.9	156	26.9	1.3	99	13.2
GARY	71.7	62.2	158	27.4	1.7	100	12.2
NUWEST	71.5	62.3	159	27.0	1.7	100	13.1
MT9929	71.4	62.6	158	24.8	1.7	100	13.6
MANNING	71.4	62.4	155	26.9	2.5	99	13.1
ERHARDT	71.2	63.0	157	25.2	1.5	100	14.0
WINDSTAR	70.2	61.8	156	27.2	2.0	100	13.2
DW RED	69.6	62.6	156	26.0	2.0	100	13.1
MTW9911	69.6	61.1	156	25.2	2.0	100	13.3
ROCKY	69.5	63.2	156	26.1	1.7	100	13.0
NUFRONTEIR	69.2	62.9	153	24.4	2.3	99	11.7
MT9909	68.9	61.5	158	24.8	1.7	100	13.4
PROWERS 99	68.5	63.6	156	25.6	2.0	100	13.3
HALT	67.9	61.7	150	20.5	1.0	100	13.4
QUANTU 542	67.8	62.8	154	27.9	1.3	100	14.2
MT9426	66.8	62.0	160	23.7	1.3	100	13.0
MT99116	66.5	61.7	157	24.4	2.0	100	12.9
VANGUARD	66.4	62.0	154	27.9	1.7	100	14.5
MCGUIRE	65.4	61.9	153	24.5	1.7	100	14.4

Continued

Table 1 continued. Agronomic data from the Intrastate Winter Wheat Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Cultivar	Yield	Test Wt	Heading Date	Height	Disease Score	Winter Survival	Protein
	Bu/A	Lbs/Bu	Julian	Inches	1-3	%	%
CULVER	65.3	61.6	152	25.1	1.3	100	13.8
CDC FALCON	62.5	60.8	157	21.7	1.3	100	13.0
RANSOM	61.1	61.7	158	26.0	2.0	100	13.3
NUHORIZON	60.0	62.9	152	20.5	2.0	100	12.9
RAMPART	59.8	61.6	155	26.4	1.0	100	14.2
MORGAN	59.6	61.8	162	25.8	2.0	99	13.4
Mean	72.8	62.2	157	26.5	1.7	99	13.1
Effic. Rel. RCBD	116.8	127.2	101.5	115.4	99.1		
LSD p=0.05	8.82	0.33	2.15	2.13	0.74	NS	
LSD p=0.01	11.69	0.44	2.84	2.82	0.98	NS	
C.V.	8	1	1	5	28	1	
Replicate Prob (F)	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.3975	
Treatment Prob (F)	<0.0001	<0.0001	<0.0001	<0.0001	0.0546	0.5334	

PROJECT TITLE: Agronomic Performance Evaluation of Soft White Winter Wheat Cultivars.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Scott Halley, Research Associate, NWARC.
Phil Bruckner, Winter Wheat Breeder, Bozeman.
Jim Berg, Research Associate, Bozeman.

OBJECTIVES:

To evaluate the agronomic performance of soft white winter wheat cultivars in environments and cropping systems representative of northwestern Montana.

RESULTS:

There was only minor winter injury in the trials this year. However, border plots that were not treated with seed treatments exhibited severe winter injury early in the spring. Disease developed throughout the rest of the nursery several weeks after winter dormancy had broken. The symptoms were a severe yellowing of the plants and a general lackluster appearance. The disease was diagnosed in Bozeman as being Pythium. All plots showed considerable injury. Stephens and Neeley exhibited the greatest injury. Yields were reduced in 2001 from prior years. Rod and Stephens were the two greatest yielders at slightly greater than 75 bu/acre. Hill 81 and Daws yielded less than 60 bu/acre. Test weights averaged 60.1 lbs/bu. Rod and Eltan had test weights under 58 lbs/bu. Heading date ranged from 157 to 164 days. Plant height ranged from just over 23 to nearly 30 inches. The nursery was planted on September 25, 2000 and harvested on August 16, 2001.

SUMMARY:

Despite limited precipitation during head filling, reserve subsoil moisture permitted average yields and test weights. Several cultivars exhibited superior yield performance and agronomic traits that may make them an excellent choice for planting in northwestern Montana.

FUTURE PLANS:

Continue to evaluate soft white winter wheat cultivars for adaptation in District 1.

Table 1. Agronomic data from the Soft White Winter Wheat Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Cultivar	Yield	Test Wt	Heading Date	Height	Disease Damage	Winter Injury	Protein
	Bu/A	Lbs/Bu	Julian	Inches	1-3	%	%
STEPHENS	78.0	60.3	163	24.8	2.7	100.0	11.91
ROD	77.1	57.3	163	23.9	1.3	100.0	11.82
LEWJAIN	74.9	59.7	164	23.7	1.7	100.0	12.13
KMOR	74.7	59.0	162	24.4	2.0	100.0	12.12
BRUEHL	74.6	58.0	164	25.5	1.3	99.0	12.52
ELTAN	73.2	57.4	163	24.1	2.0	100.0	11.92
KW3683	68.2	60.4	157	25.9	1.0	100.0	12.82
MADSEN	65.5	59.6	162	24.0	1.0	99.0	12.70
LAMBERT	64.9	61.0	157	26.5	1.0	100.0	12.36
CASHUP	64.9	61.6	161	23.0	1.0	100.0	12.48
MACVICAR	64.8	61.5	160	24.7	1.7	100.0	12.37
NEELEY	63.9	61.1	161	29.5	2.3	99.0	11.84
MALCOM	63.8	61.1	158	24.8	1.0	99.0	12.67
MAC-1	61.7	61.5	158	25.9	1.0	99.0	12.88
HILL 81	59.0	61.3	162	25.9	1.0	100.0	12.88
DAWS	57.7	60.7	161	23.3	1.7	100.0	12.62
Mean	67.7	60.1	161	25.0	1.5	99.7	12.37
LSD p=0.05	9.3	0.6	1.7	1.6	0.6	NS	
C.V.	8	1	1	4	26	1	
Replicate Prob(F)	0.0004	0.5301	0.0774	0.0982	0.3798	0.7140	
Treatment Prob(F)	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	0.7140	

PROJECT TITLE:	Early Generation Winter Wheat Screening for TCK (Dwarf Bunt) Fungus (*Tilletia controversa* Kuhn).
PROJECT LEADERS:	Bob Stougaard, Weed Scientist, NWARC.
PROJECT COOPERATORS:	Scott Halley, Research Associate, NWARC. Phil Bruckner, Winter Wheat Breeder, Bozeman. Jim Berg, Research Associate, Bozeman

OBJECTIVES:

To evaluate early generation winter wheat lines for agronomic performance and resistance to both introduced and natural TCK inoculum.

RESULTS:

Rainfall events were limited from early July through harvest.

There was only minor winter injury in the trial this year. Pythium developed throughout the nursery several weeks after winter dormancy had broken and this may have reduced the damage caused by TCK. Although TCK levels were less than previous years, differences were measured. 94X126E119, 93X234cE20-4, and 93X234cE50-6 had the greatest infection levels. Yields average 67.8 bu/acre for all lines. A low yield of 49.1 bu/acre was measured for 94X126E84 compared to a high yield of 101.3 bu/acre for 93X553E59-2. Test weights were generally good averaging 62.4 bu/acre. 93X500cE32-6 and 93X500cE73-5 had test weights under 60 lbs/bushel. Plant heights were short in 2001 with an average of 25.7 inches. Only three lines had heights exceeding 30 inches. Heading date ranged from 151 to 165 days.

SUMMARY:

Environmental conditions permitted an opportunity for screening of experimental lines for TCK fungus tolerance. These observations will further the selection process toward the release of cultivars suitable for planting in TCK prone areas.

FUTURE PLANS:

Continue to evaluate experimental winter wheat lines for resistance to TCK fungus.

Table 1. Agronomic data from the TCK Winter Wheat Screening Nursery grown at the Northwestern Agricultural Research Center Kalispell, MT.

Experimental Line	Yield	TWT	TCK Score	Height	Disease Score	Winter Survival	Heading Date
	Bu/acre	Lbs/bu	1-3	Inches	1-3	%	Julian
Yuma	61.8	62.3	1	21.7	2	100	151
Promontory	55.3	64.2	0	24.4	1	100	157
94X126E8	63.6	62.8	0	27.2	2	90	156
94X126E13	56.9	62.7	1	21.7	2	100	161
Promontory	56.1	64.3	0	24.8	1	97	157
94X126E29	57.9	62.1	0	24.4	1	100	158
94X126E31	55.0	61.1	0	22.8	2	100	161
94X126E35	61.0	62.5	0	25.6	1	100	160
94X126E40	63.9	62.8	0	25.6	2	100	159
94X126E43	72.2	62.6	1	26.0	1	100	158
94X126E45	63.8	62.0	0	24.0	1	97	158
94X126E62	64.8	62.6	1	25.6	1	100	158
94X126E64	60.8	63.5	0	25.2	2	100	160
94X126E66	52.4	62.0	0	23.2	1	100	161
94X126E68	na	62.4	0	20.9	2	100	155
94X126E70	53.3	61.6	1	20.5	2	100	161
94X126E80	57.4	62.3	1	23.6	1	100	160
94X126E84	49.1	63.4	1	22.8	2	97	155
94X126E87	62.1	62.4	0	24.0	2	100	161
94X126E90	60.7	62.9	1	23.6	1	100	158
94X126E95	59.9	62.1	0	23.6	2	100	160
94X126E98	62.2	62.1	0	23.6	1	100	158
94X126E101	65.5	62.4	1	24.8	1	100	161
94X126E108	68.3	62.7	0	24.0	1	100	158
94X126E119	60.8	62.8	2	22.8	2	100	159
94X126E126	61.1	62.0	1	24.4	1	97	160
94X126E139	74.7	62.7	1	26.8	1	100	158
94X126E143	70.3	62.1	0	25.2	1	100	160
94X126E158	64.5	63.0	1	22.8	2	100	158
94X126E161	65.7	62.4	1	22.8	1	97	157
94X126E165	58.0	62.5	1	23.6	2	100	161
94X126E169	52.1	62.5	1	25.2	1	100	159
94X126E173	56.3	62.6	1	22.8	1	100	161
94X126E184	51.3	63.8	0	22.8	1	100	158
94X126E186	56.0	63.2	0	25.6	2	100	159
94X126E192	62.1	62.7	0	23.6	1	95	162
94X126E194	58.1	63.0	1	23.6	1	100	158
94X126E197	60.4	62.3	1	25.2	1	100	159
94X126E203	67.4	63.1	0	27.6	1	100	159
93X231cE18-2	61.3	61.7	0	26.4	2	100	158
93X231cE21-1	73.1	61.8	1	26.8	1	95	161
93X231cE21-4	77.6	62.0	1	26.8	1	100	160
93X231cE25-6	71.1	61.6	1	28.7	1	100	158
93X231cE26-3	73.9	62.5	0	27.2	1	100	159
93X231cE36-2	80.5	63.5	0	26.8	3	97	158
93X231cE36-3	70.7	63.5	0	27.6	1	97	158
93X231cE51-3	59.8	62.7	0	27.6	1	100	157
93X231cE61-3	55.3	61.3	1	27.6	1	100	158

Continued

Experimental Line	Yield Bu/acre	TWT Lbs/bu	TCK Score 1-3	Height Inches	Disease Score 1-3	Winter Survival %	Heading Date Julian
93X234cE20-3	61.8	61.9	1	26.8	1	95	161
Neeley	69.7	63.5	1	27.2	1	100	161
Yuma	60.5	62.6	1	22.4	1	100	151
Promontory	61.9	64.4	0	25.2	1	100	157
93X234cE20-4	70.3	61.6	2	28.0	2	100	161
93X234cE30-3	71.4	62.6	0	26.8	1	100	158
93X234cE34-2	76.9	62.8	1	21.7	1	100	161
93X234cE50-6	78.0	62.0	2	23.2	1	100	161
93X234cE60-2	78.8	62.1	1	23.2	1	100	158
93X234cE65-6	76.1	63.3	1	22.8	2	100	158
93X234cE71-4	81.2	61.9	1	29.5	1	100	160
93X234cE76-2	65.1	62.9	0	23.2	2	97	161
93X542cE5-2	65.0	62.5	0	24.4	2	100	162
93X542cE7-2	60.8	62.1	0	25.6	2	100	162
93X542cE7-4	59.4	62.3	0	24.4	2	100	163
93X542cE15-1	63.0	63.2	0	26.8	2	100	154
93X542cE30-4	68.1	62.6	1	29.1	2	100	158
93X542cE33-2	70.2	63.2	1	28.7	1	100	156
93X542cE35-1	72.6	62.2	0	26.8	2	100	162
93X542cE58-1	87.6	62.3	0	29.1	1	100	162
93X542cE63-2	79.6	63.2	0	30.3	2	100	160
93X542cE63-3	84.6	63.3	0	30.7	1	100	160
93X542cE67-1	90.6	61.7	0	29.9	2	100	162
93X542cE67-6	93.5	61.8	1	28.7	2	100	162
93X542cE71-1	88.9	62.7	1	29.1	1	100	158
93X553E59-2	101.3	60.8	0	34.6	2	100	162
93X500cE32-6	50.7	59.6	0	24.4	2	100	158
93X500cE73-5	75.6	59.4	0	25.2	2	100	164
93X502cE5-5	78.8	63.2	0	27.2	2	100	161
93X510cE4-5	71.6	62.4	0	25.2	1	100	158
93X510cE5-3	76.2	63.3	0	26.4	2	100	161
93X510cE39-3	68.8	60.1	0	26.0	1	100	162
93X510cE42-2	69.2	61.1	0	24.8	1	100	165
94X128E10-2	74.6	63.3	0	26.4	2	100	164
94X128E10-4	76.9	62.8	0	28.7	2	100	164
94X128E10-6	82.6	63.0	0	28.7	3	100	162
94X128E13-4	73.8	62.9	1	27.6	1	100	162
94X128E16-2	77.5	63.3	0	26.0	1	100	161
94X128E16-6	81.1	62.8	0	25.6	2	97	161
94X128E40-2	84.1	61.9	1	27.6	1	100	161
94X128E40-3	81.6	61.0	0	25.6	1	97	162
94X128E47-2	68.1	62.7	1	27.2	2	100	163
94X128E47-6	59.1	63.0	0	25.6	2	100	161
93X619cE18-2	51.2	62.0	1	29.1	1	100	158
93X619cE33-3	58.4	61.9	1	26.4	1	100	157
93X619cE33-6	58.4	61.9	0	26.0	1	97	157
93X88E22-4	59.0	61.3	2	29.5	2	100	157
93X88E33-2	61.5	61.2	1	27.2	2	100	158
93X88E50-1	60.6	61.6	1	25.2	2	100	158
Yuma	72.2	61.7	2	25.2	1	100	151
Promontory	79.2	63.4	0	26.8	2	100	158
Mean	67.08	62.4	0.51	25.7	1.4	99.4	159

PROJECT TITLE: Wild Oat Control in Spring Wheat with Reduced Herbicide Rates.

PROJECT LEADER: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Qingwu Xue, Post Doctoral Scientist, NWARC.

OBJECTIVES: To determine the consistency of wild oat control with reduced herbicide rates.

RESULTS:

McNeal spring wheat was planted on April 18, 2001 at a rate of 60 lbs/acre on 6-inch rows to a depth of 1.75 inches. Plots were 10 X 15 ft with four replicates arranged in a randomized complete block design. Wild oat was planted in all plots to improve the consistency of weed pressure.

Achieve was applied at a range of rates on May 24. The rates represent twice the normal use rate (2X) and normal labeled rate (1X), as well as 1/2X and 1/4X rates. Nontreated and handweeded controls were included for comparison. Treatments were applied with a CO_2 backpack sprayer in 20 gallons water per acre at 30 psi. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. The spring wheat was in the four to five leaf stage. Wild oat was 1.5 to 8 leaf but mostly 4 to 5 leaf and 1 to 3 inches tall. An application of Harmony Extra plus 2,4-D was applied on May 30 to control broadleaf weeds.

All measured variables responded to herbicide rate. Wild oat biomass and dockage decreased as herbicide rates increased. Dockage ranged from 15% in the nontreated control to 1.98 % with the 2X rate of Achieve. Correspondingly, spring wheat yield and test weight increased as herbicide rates increased. Yields ranged from 36 to 89 bu/A; illustrating the negative effect that wild oat competition has on grain yield. The impact on test weight was not as dramatic and ranged from a low of 59.81 to a high of 62.24 lb/bu. Wheat protein actually decreased as wild oat control improved and is probably related to competition for soil water. Even though herbicide rate responses were observed, wild oat control was unacceptable even with the 2X rate of Achieve.

SUMMARY:

Twice the labeled rate failed to provide acceptable control of wild oat this year. This underscores the variable response associated with herbicides as well as the potential risks associated with using reduced rates. These results also demonstrate the negative consequences of allowing wild oat to compete with spring wheat.

FUTURE PLANS:

Continue to evaluate integrated approaches for the control of wild oat.

Achieve Rate	Wild Oat Biomass	Wild Oat Dockage	Spring Wheat Yield	Spring Wheat Protein	Spring Wheat TWT
lb ai/A	(g/m^2)	(%)	(bu/A)	(%)	lb/bu
0.000	545	15.56	36.60	14.47	59.81
0.046 (1/4X)	475	11.56	47.70	14.11	59.98
0.089 (1/2X)	412	9.84	50.60	13.84	59.88
0.178 (1X)	177	3.26	70.70	13.38	61.02
0.356 (2X)	120	1.98	73.40	13.44	61.24
Handweeded	0	0.00	89.10	13.31	60.41
LSD	73	1.88	6.50	0.35	0.63

Assure II Comparison for Wild Oat Control in Canola

The study site, NWARC field R-3, was previously in alfalfa. The site was fall plowed after herbicide application to control the alfalfa and perennial grasses. Spring tillage included an early season disking, and another disking followed by soil packing immediately prior to seeding. Canola, *Brassica napus* (L.), cultivar Pioneer 46A76, was planted on April 25, 2001 at a planting rate of 8 lbs/acre with a Hege double disk drill in 6-inch rows to a depth of 0.5 inches. A dry fertilizer blend, 91-52-60-10, was applied prior to seedbed preparation. Ammonium sulfate, 48-0-0-55, was hand broadcast on May 22. The soil consisted of a Creston Silt Loam, organic matter 2.9% and pH of 6.9. Plots were 10 X 15 ft with three replicates arranged in a randomized complete block design. Wild oat (*Avena fatua* L.) was planted in 6-inch rows, 1.5 inches deep, in the center of all plots to improve the consistency of weed pressure and establish a wild oat population of 6 plants ft^{-2}.

Treatments were applied on May 25, at 1:30 p.m. with a CO_2 backpack sprayer in 20 gallons water per acre at 30 psi. Teejet XR11002 nozzles spaced 20 inches apart were used for applications on a day with average wind speed of 0-3 mph, a 81° F air temperature, 78° F soil temperature, 10% cloud cover, good soil moisture, and a relative humidity of 22 percent. The canola had 2 to 3 true leaves and was 0.5 to 1.5 inches tall. Wild oat was 2 to 7 leaf stage with two tillers and 1 to 3 inches tall.

Control of wild oat at the June 13 rating date was excellent with all treatments. The Select with 28% UAN treatment had greater control than the low rate of Assure II treatment. This difference had disappeared by June 22. All control was excellent compared to the check. There was no crop injury at either rating date. Yield of all treatments were much greater than the check but not different from other treatments. Test weights were not different and all dockages were much less than the check.

Assure II for Wild Oat Control in Canola

HERBICIDE	APPLIC. RATE	WILD OAT CONTROL		CROP INJURY		YIELD	TEST WT	DOCKAGE
		6-13	6-22	6-13	6-22			
	lb ai/a	%		%		bu/acre	lbs/bu	%
Check		0.0	0.0	0	0	812.5	49.6	8.7
Assure II	0.048	87.3	91.3	0	0	1670.7	50.1	1.8
COC % v/v	1.25							
Muster	0.019							
Assure II	0.048	88.3	91.3	0	0	1828.9	50.6	1.6
COC % v/v	1.25							
28 % UAN % v/v	2.5							
Muster	0.019							
Assure II	0.034	86.7	86.7	0	0	1713.0	50.8	1.9
COC % v/v	1.25							
28 % UAN % v/v	2.5							
Muster	0.019							
Poast	0.281	91.7	88.0	0	3.3	1724.3	50.8	1.6
COC % v/v	1.25							
Muster	0.019							
Poast	0.281	91.7	96.0	0	6.7	1788.7	50.2	1.9
COC % v/v	1.25							
28% UAN % v/v	2.5							
Muster	0.019							
Select	0.094	93.3	96.3	0	10.0	1703.6	50.4	1.8
COC % v/v	1.25							
Muster	0.019							
Select	0.094	96.7	99.3	0	0	1873.1	50.6	1.7
COC % v/v	1.25							
28 % UAN % v/v	2.5							
Muster	0.019							
LSD (P=.05)		7.29	12.94	0	NS	343.6	NS	1.74
CV		5	9	0	172	12	1	37
Replicate Prob (F)		0.5689	0.3933	1.0	0.1679	0.0280	0.3079	0.9883
Treatment Prob (F)		0.0001	0.0001	1.0	0.0726	0.0004	0.1075	0.0001

PROJECT TITLE: Bedstraw Control in Peppermint

PROJECT LEADER: Bob Stougaard, Weed Scientist

PROJECT PERSONNEL: Qingwu Xue, Postdoctoral Research Scientist
Dale Sonstelie, Mint Producer

OBJECTIVES:

Bedstraw has historically been one of the most difficult to control of all weeds which infest peppermint. Therefore, research was undertaken to evaluate new and established herbicides for the control of bedstraw. This study evaluated Spartan, Starane, Stinger, and Tough applied at three rates, for the control of bedstraw.

MATERIALS and METHODS:

The study was located in an established stand of peppermint at the Dale Sonstelie farm. The soil consisted of a Swims Silty Clay Loam and the crop received supplemental irrigation throughout the growing season. Plots were 10 x 15 feet with three replicates in a randomized complete block design. Catchweed bedstraw, *Galium aparine* L., was planted in very wet soil 0.75 inches deep in 6 in rows down the center of the plots on April 18 into dormant peppermint at a rate of 12 pls ft^{-2} to establish an equal plant density among the plots. Spartan 75 DF (sulfentrazone), was applied on April 23 to dormant peppermint. Applications of Starane 1.5 EC (fluroxypyr), Tough 3.75 EC (pyridate) + nonionic surfactant at 0.25 % v/v, and Stinger 3 SL (clopyralid) were made to bedstraw 2-8 inches tall, average height 4 inches, on June 8. All herbicide applications were applied with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart and an operating pressure of 30 psi were used for all herbicide applications.

RESULTS:

Crop injury was most noticeable with applications of Spartan and Starane. Injury with Starane was most severe immediately after application, but appeared to dissipate by seasons end. Symptoms included discoloration and cupping of the leaves, as well as stunted growth. Injury from Spartan applications took the form of mint stand reductions. Injury was not detected with the remaining herbicides.

Stinger failed to suppress bedstraw at any of the rates evaluated. Correspondingly, Stinger treatments had some of the lowest mint hay yields. Starane, Tough, and Spartan all provided some control of bedstraw, the level of which increased as rates increased. Averaged over rates, Tough provided the greatest reduction in bedstraw dry weight, followed by Starane and Spartan, respectively. In addition, control of speedwell, common groundsel and prickly lettuce were also observed with Starane. However low densities prevented an accurate assessment. Mint hay yields reflected the level of bedstraw control achieved with the four products. Highest yields were obtained with Tough treatments, followed by Starane, Spartan and Stinger, respectively.

Herbicide Efficacy on Bedstraw in Peppermint Study

HERBICIDE	RATE	CROP INJURY			BEDSTRAW CONTROL			MINT DRY WEIGHT	BEDSTRAW DRY WEIGHT
	lb ai/a	%			%			tons/a	
		6-5	6-27	7-18	6-5	6-27	7-18	7-23	7-23
Untreated		0.	0	0	0	0	0	1.31	1.04
STARANE	0.06	16.7	0	3.3	36.7	40	16.7	1.62	0.91
STARANE	0.125	26.7	8.3	0	66.7	63.3	58.3	1.87	0.37
STARANE	0.25	33.3	13.3	3.3	73.3	83.3	93	2.36	0.06
TOUGH	0.46	0	3.3	3.3	80	60	45	2.33	0.48
TOUGH	0.58	3.3	0	0	90	86.7	81.7	2.02	0.24
TOUGH	0.93	6.7	0	0	86.7	90	91	2.07	0.08
STINGER	0.12	3.3	0	0	0	0	0	1.32	1.18
STINGER	0.14	6.7	3.3	0	0	0	0	1.22	1.41
STINGER	0.18	6.7	3.3	0	0	0	0	1.16	1.55
SPARTAN	0.09	16.7	3.3	3.3	16.7	16.7	3.3	1.68	0.83
SPARTAN	0.14	16.7	3.3	3.3	36.7	48.3	31.7	1.09	0.67
SPARTAN	0.18	10	6.7	3.3	88.3	90	81.7	1.81	0.17
Handweeded		0	0	0	33.3	100	100	1.92	.01
LSD (P=0.05)		13.3	8.7	5.0	35.7	55.8	21.4	0.7	0.5
CV		76	161	180	49	28	30	25	50
Replicate Prob (F)		.1762	.21	.0001	.2884	.0429	.3693	.2560	.3386
Treatment Prob (F)		.0002	.1086	.4786	.0001	.0001	.0001	.0098	.0001

PROJECT TITLE: Dill Tolerance to Herbicides

PROJECT LEADER: Bob Stougaard, Weed Scientist

PROJECT PERSONNEL: Qingwu Xue, Postdoctoral Research Scientist

OBJECTIVES:

There is increased interest in the production of dill as an essential oil crop. However, the lack of herbicide options severely restricts the production of this crop and the ultimate growth as a major commodity in this region of the state. This study was initiated to screen various herbicide classes for tolerance toward dill.

MATERIALS and METHODS:

The area for the study was previously cropped to spring wheat. Tillage consisted of plowing in the fall, and two passes with field cultivator and a packing operation prior to seeding in the spring. Dill seed (*Anethum graveolens*), cultivar 'Mammoth' was planted on May 8 with a double disk drill at 8.5 lbs/acre pls at 0.5-inch depth in a seedbed with excellent soil moisture. The soil was a Swims silty clay loam. Plots were 10 x 15 ft with 4 replicates arranged in a randomized complete block design.

Sonalan and Prowl herbicides were applied at 1:30 p.m. prior to seeding on May 3. The Sonalan and Prowl herbicides were incorporated with two, right angle passes of a spring-tooth cultivator set to a depth of two inches. All other herbicides except for Lorox at 0.5 lb ai/a rate were applied on June 1. The 0.5 lb ai/a Lorox application was made to five-inch high dill on June 29. All herbicide applications were made with a CO2 backpack sprayer pressurized to 30 psi delivering an output of 20 gpa. Teejet XR11002 nozzles spaced 20 inches apart were used for application.

RESULTS:

Treatments that demonstrated the greatest crop tolerance included Sonalan, Prowl, Assure II, Discover, Caparol, Lorox, the low rate of 2,4-D, and MCPA. Further research is warranted to evaluate a wider range of rates of several herbicides and also combinations of herbicides that would provide full spectrum control of monocots and dicots.

Herbicide Tolerance of Dill

Herbicide	Rate	Crop Injury	Plant Height	Dry Matter
		6-15-01	7-19-01	14% Moisture
		%	Cm	Lbs/acre
Check		0.0	65.5	4955
Sonalan	0.75 lb ai/a	0.0	76.0	5836
Prowl	0.743 lb ai/a	2.5	83.0	5779
Assure II	0.048 lb ai/a	2.5	86.5	5615
NIS	0.25% v/v			
Discover	0.05 lb ai/a	2.5	77.0	5394
DSV-Score	0.4% v/v			
Caparol	0.5 lb ai/a	6.3	72.3	4993
Caparol	0.75 lb ai/a	0.0	73.8	5402
Lorox	0.5 lb ai/a	0.0	73.8	4699
Pursuit	0.047 lb ai/a	62.5	50.5	2204
NIS	0.25% v/v			
Pursuit	0.063 lb ai/a	82.5	33.8	1220
NIS	0.25% v/v			
Raptor	0.031 lb ai/a	52.5	58.5	3634
NIS	0.25% v/v			
Raptor	0.039 lb ai/a	70.0	49.5	2936
NIS	0.25% v/v			
Harmony Extra	0.014 lb ai/a	85.0	30.8	1209
NIS	0.25% v/v			
Harmony Extra	0.019 lb ai/a	97.5	33.0	491
NIS	0.25% v/v			
Express	0.009 lb ai/a	87.5	35.0	1703
NIS	0.25% v/v			
Express	0.014 lb ai/a	87.5	25.0	889
NIS	0.25% v/v			
2,4-D Amine	0.475 lb ai/a	7.5	57.5	4298
2,4-D Amine	0.713 lb ai/a	15.0	51.8	3549
MCPA Amine	0.25 lb ai/a	2.5	69.0	5433
MCPA Amine	0.5 lb ai/a	7.5	77.3	5722
LSD (P=.05)		21.1	18.2	998
CV		44	22	19
Replicate Prob (F)		0.3432	0.0897	0.0043
Treatment Prob (F)		0.0001	0.0001	0.0001

PROJECT TITLE: Wild Oat Herbicide Screening Trial in Spring Wheat.

PROJECT LEADER: Bob Stougaard, Weed Scientist, NWARC.

PROJECT COOPERATORS: Scott Halley, Research Associate, NWARC.

OBJECTIVES: To evaluate new and existing wild oat herbicides for efficacy and crop tolerance.

RESULTS:

Spring wheat cultivar Clearfield 1210, was planted on April 19, 2001 at a rate of 75 lbs/acre on 6-inch rows to a depth of 1.75 inches. A fertilizer blend of 91-52-60-10 was applied prior to seedbed preparation. Plots were 10 X 15 ft with three replicates arranged in a randomized complete block design. Wild oat was planted in the center of all plots to improve the consistency of weed pressure. Treatments were applied on May 25 with a CO_2 backpack sprayer in 20 gallons water per acre at 30 psi. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. The spring wheat was in the four to five leaf stage. Wild oat was 2 to 8 leaf but mostly 4 to 5 leaf and 1.5 to 3 inches tall. An application of Bronate was applied by backpack to non-tank mixed control plots of Puma, Discover, Everest, and Assert on June 1 to control broadleaf weeds. A maintenance spray, Buctril 2EC at 1 pint/acre was applied at 7:30 a.m. in 7.8 gpa water, on June 15 by tractor sprayer to control Clearfield canola that had been windblown from a neighboring trial.

This study compares two groups of herbicide mode of action; Puma and Discover represent ACC-ase inhibitors while Everest and Assert represent ALS inhibitors. Crop injury was observed, but was not correlated with herbicide mode of action. Crop injury was noted with Puma and Everest treatments at the June 1 rating date. However, injury symptoms dissipated as the season progressed. In contrast to the crop injury ratings, wild oat control was correlated with herbicide mode of action. The ACC-ase inhibitors, Puma and Discover, both failed to provide acceptable wild oat control. Wild oat control with Puma alone was rated fair and with Puma tank mixes poor on June 21. Control decreased by July 18 with all Puma applications. Discover and Discover tank mixes measured similar results with all applications giving poor control. Everest and Assert treatments essentially gave complete control by July 18.

SUMMARY:

Wild oat control was excellent when ALS inhibitors were applied. However wild oat control was poor with the ACC-ase class of herbicides. Either spring weather conditions were not favorable for the ACC-ase class of herbicides or wild oat resistance may be developing in western Montana.

FUTURE PLANS:

Continue to evaluate wild oat herbicides for performance and crop tolerance.

Wild Oat Control in Spring Wheat

HERBICIDE	APPLIC. RATE	CROP INJURY				WILD OAT CONTROL		YIELD	TEST WT	DOCKAGE
		6-1	6-13	6-21	7-18	6-21	7-18	8-22		
	lb ai/a	%				%		bu/acre	lbs/bu	%
Check		0	0	0	0	0	0	44.7	60.5	7.9
Aim	0.008	10.0	0	0	0	56.7	30.0	58.0	60.5	4.5
Puma	0.078									
MCPA Ester	0.25									
Aim	0.008	13.3	0	0	0	40.0	35.0	51.9	60.2	5.2
Puma	0.078									
MCPA Ester	0.25									
Harmony GT	0.019									
Puma	0.078	16.7	3.3	0	0	83.3	66.7	66.3	60.9	2.3
Aim	0.008	1.7	0	0	0	26.7	13.3	53.3	60.3	4.8
Discover	0.031									
MCPA Ester	0.25									
DSV-Score	0.4									
Aim	0.008	0	0	0	0	30.0	20.0	54.1	60.5	5.6
Discover	0.031									
MCPA Ester	0.25									
Harmony GT	0.019									
DSV-Score	0.4									
Discover	0.031	0	0	0	0	70.0	23.3	50.8	60.4	3.6
DSV-Score	0.4									
Aim	0.008	11.7	0	10	0	86.7	99.0	72.6	60.7	0.5
Everest	0.28									
2,4-D Ester	0.25									
NIS	0.25									
Aim	0.008	3.3	0	0	0	90.0	99.0	77.3	61.4	0.7
Everest	0.028									
2,4-D Ester	0.25									
Harmony GT	0.019									
NIS	0.25									
Everest	0.028	10.0	6.7	5	3.3	90.0	99.0	77.1	61.7	0.6
NIS	0.25									
Aim	0.008	3.3	0	0	0	90.0	97.7	74.1	61.4	0.5
Assert	0.375									
NIS	0.25									
MCPA Ester	0.25									
Aim	0.008	3.3	0	3.3	0	90.0	99.0	74.9	61.1	0.8
Assert	0.375									
Harmony GT	0.019									
NIS	0.25									
MCPA Ester	0.25									
Assert	0.375	0	0	0	0	90.0	99.0	76.6	61.6	0.5
NIS	0.25									
LSD (P=.05)		8.4	3.7	5.0	NS	31.2	24.2	9.4	1.0	1.5
CV		88	288	209	625	28	24	9	1	31
Replicate Prob (F)		.011	.230	.602	.383	.178	.052	.159	.050	.612
Treatment Prob (F)		.001	.031	.008	.478	.001	.001	.001	.041	.001

Henbit Control in Spring Wheat

The study, conducted on spring wheat, *Triticum aestivum* (L.) cultivar McNeal, was located at the NWARC station field P-2. The soil consisted of a Swims silty clay loam. Plots were 10 X 15 ft with 3 replicates in a randomized complete block design. The plots were seeded with a double disk drill with 7-inch spacing on April 20 at a seeding rate of 78 lbs/acre 1.5-2 inches deep. Previous crop was spring wheat. A fertilizer blend was broadcast prior to seeding delivering 40-40-30-10 lbs of N-P-K-S respectively followed with 125 lbs of 11-52-0 applied with the seeding operation.

The herbicides, Rave 58.8 WG (triasulfuron + dicamba-Na), Amber 75 WG (triasulfuron), Peak 57 WG (prosulfuron), Ally 60 DF (metsulfuron), and Finesse 75 DF (metsulfuron +chlorsulfuron), were applied to spring wheat eight inches tall in the 6 to 7 leaf stage. The wheat averaged 2-3 tillers. Applications were made when henbit, *Lamium amplexicaule* L., was at the 3-4 leaf growth stage, about 2-4 inches tall, at 11:00 a.m. on June 5 with a CO_2 backpack sprayer in 20 gallons water per acre at 30 psi pressure. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. Environmental conditions at application time were air temperature of 53° F, relative humidity of 67%, wind gusts to 4 mph, soil temperature of 54° F, and excellent soil moisture.

Both Finesse treatments injured the spring wheat. Injury was evident at both the 6-15 and 6-22 rating date. The Peak treatment at 0.0089 lb/acre rate provided less control than all other treatments at 6-15 rating date and 6-22 rating date except for Rave alone which also provided less control than all other treatments. No differences in yield or test weights were measured between any of the treatments or the control.

Rave Study

[1]HERBICIDE	APPLIC. RATE	CROP INJURY		HENBIT CONTROL		[2]YIELD	TEST WT
		6-15	6-22	6-15	6-22	8-23	
	lb ai/a	%		%		bu/acre	lbs/bu
Check		0	0	0	0	71.0	63.8
Rave	0.111	0	0	66.7	66.7	73.8	63.9
Rave	0.148	3.3	0	53.3	71.7	67.8	63.7
Finesse	0.014	20.0	13.3	70.0	96.0	69.7	63.8
Finesse	0.019	20.0	15.0	68.3	98.0	70.3	63.8
Rave Ally	0.073 0.0013	0	0	73.3	94.3	73.4	63.7
Rave Ally	0.073 0.0019	5.0	0	76.7	89.3	67.1	64.0
Rave Ally	0.073 0.0025	3.3	3.3	65.0	88.3	71.8	64.0
Rave Ally	0.111 0.0013	5.0	3.3	76.7	90.0	71.6	63.9
Rave Ally	0.111 0.0019	0	0	70.0	90.0	72.1	63.7
Rave Ally	0.111 0.0025	6.7	0	73.3	97.0	68.7	63.7
Amber Ally	0.013 0.0013	3.3	0	73.3	96.0	69.6	63.9
Amber Ally	0.013 0.0019	8.3	3.3	70.0	92.7	72.0	63.9
Peak Ally	0.0089 0.0013	0	0	46.7	65.0	77.6	64.1
Peak Ally	0.0089 0.0019	3.3	0	66.7	83.3	75.8	63.8
Peak Ally	0.0133 0.0013	3.3	0	66.7	80.0	73.5	63.7
LSD (P=.05)		8.46	4.90	23.49	19.36	NS	NS
CV		99	123	22	14	10	1
Replicate Prob (F)		0.4291	0.6598	0.4461	0.4384	0.6574	0.0004
Treatment Prob (F)		0.0002	0.0001	0.0001	0.0001	0.9581	0.5341

[1]All treatments were applied with NIS added at 0.25% v/v.
[2]Corrected to 13% moisture.

PROJECT TITLE: Peppermint Tolerance to Starane

PROJECT LEADER: Bob Stougaard, Weed Scientist

PROJECT COOPERATORS: Qingwu Xue, Postdoctoral Research Scientist
Dale Sonstelie, Mint Producer

OBJECTIVES:

Previous research has demonstrated adequate crop tolerance for applications of Starane to spearmint. This study was initiated to determine if similar levels of tolerances would exist for peppermint.

MATERIAL and METHODS:

The study was conducted on an established peppermint field located at the Dale Sonstelie farm. The soil consisted of a Swims Silty Clay Loam and the crop received supplemental irrigation throughout the growing season. Plots were 10 x 15 feet with three replicates in a randomized complete block design. Starane 1.5 EC (fluroxypyr) was applied to peppermint at the two, four, and six-inch height growth stages on May 28, June 8, and June 28, respectively. All herbicide applications were applied with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart and an operating pressure of 30 psi were used for all herbicide applications. An application of 1/2 lb of Sinbar 80WP (terbacil) and 1/2 pint of Stinger 3 SL (clopyralid) was applied to dormant peppermint on April 23 to reduce competition from weeds not controlled by Starane. All remaining weeds were controlled by hand removal.

RESULTS:

Crop injury increased with rate and as application was delayed. Severe symptoms included a gray-blue cast to the foliage, cupping of the upper-most leaves, and stunted growth. Most injury symptoms were transitory with the exception of stunting, which was readily observable up to harvest. Mint fresh and dry weight, as well as oil yields, decreased as rates increased. The reduction in dry weight and oil yield was most pronounced with the late applications. However, differences were nonsignificant. The lack of significant oil yield reductions indicates that peppermint may have a greater tolerance then spearmint for applications of Starane.

Peppermint Tolerance to Starane

HERBICIDE	RATE	CROP INJURY			DRY WEIGHT	OIL YIELD
	lb ai/a	%			tons/a	lbs/a
		6-5	6-27	7-18	8-7	
Untreated		0	0	0	1.89	51.6
2-inch growth stage						
STARANE	0.060	0	0	0	1.91	59.2
STARANE	0.125	0	0	0	1.65	51.9
STARANE	0.250	16.7	10	13.3	1.74	51.7
STARANE	0.375	13.3	10	10.0	1.52	48.4
4-inch growth stage						
STARANE	0.060	15.0	0	6.7	1.83	49.0
STARANE	0.125	33.3	3.3	5.0	1.75	55.0
STARANE	0.250	36.7	11.7	10.0	1.64	44.0
STARANE	0.375	38.3	13.3	5.0	1.71	45.9
6-inch growth stage						
STARANE	0.060	na	na	13.3	1.80	49.6
STARANE	0.125	na	na	18.3	1.57	42.4
STARANE	0.250	na	na	30.0	1.53	42.4
STARANE	0.375	na	na	48.3	1.25	37.7
LSD (P=.05)		15.7	11.1	15.1	0.34	NS
CV		79	176	73	12	18
Replicate Prob (F)		0.5655	0.0404	0.0929	0.0349	0.0284
Treatment Prob (F)		0.0001	0.071	0.0001	0.0330	0.2909

Alfalfa Tolerance to Raptor

The study was conducted on newly seeded alfalfa, *Medicago sativa* (L.), at the NWARC station field R-2. The soil consisted of a Creston silt loam with a pH of 7.5 and organic matter of 3.5 percent. Plots were 10 X 15 ft with 3 replicates arranged as a randomized complete block design.

Raptor 1 EC (imazamox), treatments were applied at the three-trifoliate leaf stage to three-inch alfalfa on June 5 at 2:30 p.m. with a CO_2 backpack sprayer in 20 gallons water per acre at 30 psi pressure. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. Environmental conditions at application time were air temperature of 60° F, relative humidity of 49%, an average wind speed of 4 mph with gusts to 11 mph, soil temperature of 67° F, and excellent soil moisture. The principal weed species was henbit, *Lamium amplexicaule* L., which was mostly 2-4 inches tall in the 3-leaf stage. Shepherdspurse, *Capsella bursa-pastoris* (L.) Medik., and green foxtail, *Setaria virdis* (L.) P. Beauv., were dispersed at much lower densities throughout the plots.

All treatments show injury at the 6-19 rating date. Addition of MSO and /or the higher rate of Raptor also increased injury. At the 6-27 rating date injury was still evident with the Raptor tank mixed with Poast and the 0.048 lb ai/a rate treatments except for one treatment mixed with crop oil concentrate (COC). By the 7-9 rating date, injury was no longer measurable. All tank mix applications gave 100% control of shepherdspurse and green foxtail at all rating dates. Henbit control was excellent throughout the season with all treatments. Alfalfa yield was reduced when the 0.048 lb ai/a rate was used with MSO and also when the 0.032 lb ai/a rate was tank mixed with methylated seed oil (MSO) and Poast. Neutral Detergent Fiber was increased over the check when Raptor, at 0.032 lb ai/a, was mixed with COC. This treatment also increased Acid Detergent Fiber over the check. Protein was not different among any treatments. Raptor, at 0.032 lb ai/a with COC, had reduced feed value compared to the check. Raptor, at 0.048 lb ai/a with COC, had greater relative feed value compared to Raptor treatments at 0.048 lb ai/a with MSO and Raptor at 0.032 lb ai/a with COC and Poast.

Raptor Alfalfa Study

HERBICIDE	APPLIC. RATE	CROP INJURY			HENBIT CONTROL			YIELD	ALFALFA	[1]NEUTRAL DETERGENT FIBER	[1]ACID DETERGENT FIBER	[1]PROTEIN	RELATIVE FEED VALUE
		6-19	6-27	7-09	6-19	6-27	7-09						
	lb ai/a	%			%			tons/a	DM				
Check		0	0	0	0	0	0	1.65	94.82	44.26	32.81	18.72	133.1
RAPTOR NIS UAN 28%	0.032 0.25% v/v 2.5% v/v	21.7	5	3.3	90	100	96	1.67	94.85	43.52	33.25	20.09	134.8
RAPTOR COC UAN 28%	0.032 1% v/v 2.5% v/v	21.7	10	0	86.7	100	95.	1.71	95.08	48.86	37.37	18.30	114.1
RAPTOR MSO UAN 28%	0.032 1% v/v 2.5% v/v	26.7	15	5	90	100	96.7	1.62	95.10	41.83	31.57	21.67	144.3
RAPTOR NIS UAN 28%	0.048 0.25% v/v 2.5% v/v	33.3	21.7	5	86.7	100	96.7	1.65	94.93	43.73	33.39	20.69	134.0
RAPTOR COC UAN 28%	0.048 1% v/v 2.5% v/v	33.3	15	0	85	100	93.3	1.66	95.02	41.06	30.95	22.42	147.2
RAPTOR MSO UAN 28%	0.048 1% v/v 2.5% v/v	53.3	36.7	8.3	90	100	98.3	1.47	94.96	44.75	34.38	21.22	129.7

Continued

HERBICIDE	APPLIC. RATE	CROP INJURY			HENBIT CONTROL			YIELD	ALFALFA	[1]NEUTRAL DETERGENT FIBER	[1]ACID DETERGENT FIBER	[1]PROTEIN	RELATIVE FEED VALUE
		6-19	6-27	7-09	6-19	6-27	7-09						
	lb ai/a		%			%		tons/a	DM				
RAPTOR	0.032	30	25	10	90	100	94.3	1.64	95.24	46.31	35.05	19.74	124.3
COC	1% v/v												
UAN 28%	2.5% v/v												
Poast	0.28												
RAPTOR	0.032	33.3	23.3	8.3	83.3	100	92.3	1.48	95.17	43.98	33.59	20.51	132.9
MSO	1% v/v												
UAN 28%	2.5% v/v												
Poast	0.28												
LSD (P=.05)		12.6	17.4	NS	8.8	0	6.1	0.15	NS	3.47	3.02	NS	16.1
CV		26	60	145	7	0	4	5	1	5	5	8	7
Replicate Prob (F)		.1516	.0432	.633	.5214	1	.9614	0.0185	0.0303	0.0258	0.0168	0.3171	0.0264
Treatment Prob (F)		.0001	.0123	.4069	.0001	1	.0001	0.0393	0.1849	0.0091	0.0152	0.0995	0.0183

[1]Dry matter basis

FORAGE INVESTIGATION
755

The Forage Investigation Project (755) includes research related to all types of forage for hay and grazing from seeding to data collection to publications.

YEAR / PROJECT: 2001/ 755

TITLE: **Intrastate Alfalfa Yield Trials - Irrigated & Dryland**

PROJECT LEADER: Dennis Cash, MSU-Bozeman

COOPERATORS: Duane Johnson / Louise Strang, MSU-NWARC

Alfalfa varieties were established each spring at dryland and irrigated sites in 1998, 2000, and 2001. The 1998 trials were harvested twice and terminated. The 2000 trials were harvested 3 times. A new trial was planted 5/3/01 at an irrigated site and harvested once during the growing season and again after frost in the fall.

In the 1998 dryland trial, 'Enhancer', 'Imperial', and 'Ripin' were the leading producers, with over 16 tons/acre from 1998 to 2001 (Table 1b). In the 1998 irrigated trial, the most productive cultivars were 'Magnum V' and 'Rebound' with 4-year yields of over 21 tons/acre (Table 2b).

In the 2000 dryland trial there were no significant yield differences among the cultivars in 2001(Table 3a) or in the total yields from 2000 to 2001 (Table 3b). In the 2000 irrigated trial, 'ZX9450A' from ABI Alfalfa produced over 8 tons/acre in 2001 (Table 4a) and over 11 tons/acre from 2000-2001 (Table 4b).

The new 2001 dryland trial failed to establish due to dry, windy conditions in May. The 2001 irrigated trial, which was planted on heavier soil, established well. First-year yields ranged from 2.62 tons/acre ('Riley') to 3.16 tons/acre ('Shaw') (Table 5).

Table 1a. 2001 Summary of the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Dryland.

VARIETY	MTNo	FD[1]	VW[2]	Stand	Vigor	Dry Matter Yield Harvest-1	Harvest-2	2001 TOTAL
				%	(0-5)	t/a	t/a	t/a
Innovator+Z	281	3	HR	**94**	**4.3**	**3.55**	**1.73**	**5.28**
Imperial	280	3	R	**98**	**4.8**	**3.46**	**1.81**	**5.27**
Focus	358	4	R	**96**	**4.0**	**3.44**	**1.75**	**5.19**
Ripin	349	4	R	**94**	**4.5**	**3.25**	**1.83**	**5.08**
Enhancer	348	4	R	**98**	**4.3**	**3.21**	**1.85**	**5.06**
53V08	346	3	HR	**95**	**4.8**	**3.30**	**1.75**	**5.04**
Reno	357	4	R	93	**4.3**	**3.36**	**1.64**	**5.00**
TMF Multiplier II	359	-	-	91	**4.3**	**3.38**	**1.60**	**4.98**
Oneida VR	309	3	HR	**96**	**4.8**	**3.25**	**1.72**	**4.97**
Mountaineer	355	4	R	**96**	**4.0**	**3.42**	**1.54**	**4.96**
Magnum V	347	4	R	**98**	**4.8**	**3.21**	**1.67**	**4.87**
631	350	4	R	**94**	**4.0**	**3.23**	**1.64**	**4.87**
Rebound	356	4	HR	**94**	**4.3**	**3.19**	**1.67**	**4.86**
Enhancer MiRi	SC982	4	R	**100**	**4.3**	**3.26**	**1.60**	**4.86**
ZX9852	352	-	-	**94**	**4.5**	3.10	**1.73**	**4.83**
A-395	362	3	R	**96**	3.5	**3.27**	**1.55**	**4.82**
Riley	122	4	LR	81	**4.3**	**3.31**	**1.50**	**4.81**
Emperor	351	4	HR	**99**	**4.3**	3.05	**1.74**	**4.79**
PS595-106	361	-	-	**96**	**4.3**	**3.24**	**1.54**	**4.78**
Rambo	353	3	HR	**96**	3.5	3.15	**1.62**	**4.77**
Enhancer PI	SC981	4	R	**97**	**4.0**	**3.20**	**1.52**	**4.72**
Wrangler	146	2	LR	**95**	3.8	**3.30**	1.38	**4.68**
NL 90732	360	-	-	**94**	3.3	**3.23**	1.34	4.57
NL 91229	363	-	-	**96**	3.8	3.08	1.40	4.48
Ladak 65	2	-	-	**94**	2.8	3.02	1.34	4.35
			mean	95	4.1	3.26	1.62	4.87
			LSD(0.05)	7	1.0	0.40	0.36	0.66
			CV(s/mean)%	5.3	18.0	8.8	16.1	9.8

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Seeding date: 4/23/98

Seeding rate: 8 lbs PLS/acre

Fertilizer: 4/30/98 - 37 lbs/a N + 177 lbs/a P_2O_5, 4/3/99 - 13 lbs/a N + 62 lbs P_2O_5, 4/3/01 -13 lbs/a N + 62 lbs P_2O_5

Pesticide: Sencor 4 (1-lb AI/a) - 10/20/99 & 10/2/00; Poast (1-qt/a) + 2,4-D amine (0.75 lb/a)

Table 1b. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1998-2001.

CULTIVAR	MTNO	1998	1999	2000	2001	Total
			forage yield - tons/acre			
Enhancer	348	**2.18**	**5.18**	**4.43**	**5.06**	**16.85**
Imperial	280	1.71	**4.98**	**4.25**	**5.27**	**16.16**
Ripin	349	**1.93**	**4.69**	**4.45**	**5.08**	**16.14**
Innovator+Z	281	1.71	**4.54**	**4.24**	**5.28**	**15.77**
53V08	346	**1.53**	**4.10**	**4.89**	**5.04**	**15.55**
Emperor	351	**1.84**	**4.38**	**4.36**	**4.79**	**15.36**
Magnum V	347	**2.10**	**4.37**	3.82	**4.87**	**15.16**
Reno	357	1.50	**4.40**	**4.02**	**5.00**	**14.92**
Mountaineer	355	1.61	**4.43**	**3.91**	**4.96**	**14.90**
Riley	122	1.31	**4.54**	**3.98**	**4.81**	**14.63**
Oneida VR	309	1.49	**4.13**	**3.98**	**4.97**	**14.56**
ZX9852	352	1.59	3.91	**4.17**	**4.83**	**14.50**
TMF Multiplier II	359	1.32	**4.16**	**4.03**	**4.98**	**14.49**
Focus	358	1.47	**3.98**	3.78	**5.19**	**14.42**
Rambo	353	**1.88**	**4.13**	3.61	**4.77**	**14.39**
Wrangler	146	**1.53**	**4.26**	3.60	**4.68**	**14.07**
PS595-106	361	1.36	**4.06**	3.81	**4.78**	14.00
631	350	**1.76**	3.95	3.35	**4.87**	13.93
A-395	362	1.50	3.88	3.64	**4.82**	13.84
Rebound	356	1.59	3.43	3.77	**4.86**	13.64
Ladak 65	2	1.43	**4.40**	3.38	4.35	13.56
NL 91229	363	1.40	3.65	3.40	4.48	12.93
Enhancer MiRi	SC982	1.23	3.19	3.48	**4.86**	12.76
Enhancer PI	SC981	1.29	3.15	3.11	**4.72**	12.28
NL 90732	360	1.58	3.08	2.96	4.57	12.18
mean		1.59	4.12	3.86	4.87	14.44
LSD(0.05)		0.45	1.19	1.03	0.67	2.80
CV(s/mean) %		20.1	20.9	19.3	9.9	14.0

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Table 2a. 2001 Summary of the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated.

VARIETY	MTNo	FD[1]	VW[2]	Stand	Vigor	Dry Matter Yield Harvest-1	Harvest-2	2001 Total
				%	*(0-5)*[3]	*t/a*	*t/a*	*t/a*
631	350	4	R	**69**	**5**	**3.06**	1.88	**4.93**
Rebound	356	4	HR	**81**	**5**	**2.79**	**2.09**	**4.87**
Enhancer	348	4	R	**68**	4	**2.89**	1.91	**4.80**
Magnum V	347	4	R	40	4	**2.84**	1.92	**4.76**
Focus	358	4	R	**76**	4	**2.93**	1.70	**4.63**
53V08	346	3	HR	41	4	**2.79**	1.82	**4.61**
Emperor	351	4	HR	**54**	4	**2.80**	1.76	**4.55**
Reno	357	4	R	**64**	4	**2.75**	1.76	4.51
Oneida VR	309	3	HR	46	4	2.69	1.81	4.50
PS595-106	361	--	--	45	4	**2.75**	1.75	4.50
Rambo	353	3	HR	**75**	4	**2.74**	1.70	4.44
Imperial	280	3	R	35	4	2.70	1.73	4.43
NL 90732	360	--	--	**75**	4	2.71	1.71	4.42
TMF Multiplier II	359	--	--	**49**	4	2.69	1.67	4.35
ZX9852	352	--	--	**64**	4	2.54	1.78	4.31
A-395	362	3	R	**55**	4	**2.74**	1.57	4.31
Ripin	349	4	R	**50**	4	2.54	1.70	4.24
NL 91229	363	--	--	**48**	4	2.42	1.65	4.07
Enhancer PI	SC981	4	R	34	4	2.39	1.66	4.05
Innovator+Z	281	3	HR	**68**	3	2.34	1.62	3.95
Mountaineer	355	4	R	**53**	3	2.23	1.70	3.93
Enhancer MiRi	SC982	4	R	40	4	2.29	1.63	3.91
Wrangler	146	2	LR	30	3	2.14	1.52	3.66
Ladak 65	2	2	--	25	2	2.26	1.35	3.60
Millennia	354	4	R	36	3	1.89	1.61	3.50
Riley	122	4	LR	18	3	1.75	1.25	3.00
mean				51	4	2.56	1.70	4.26
LSD(0.05)				34	1	0.35	0.14	0.42
CV(s/mean) %				46.7	21.8	9.8	5.6	6.9

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

[3]0=dead; 5=very vigorous plants

Table 2b. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1998 to 2001.

Cultivar	MTNo	Dry Matter Yield 1998	1999	2000	2001	1998-2001 Total
		t/a	t/a	t/a	t/a	t/a
Magnum V	347	**3.40**	**6.96**	**6.20**	**4.76**	**21.31**
Rebound	356	3.00	**6.91**	**6.44**	**4.87**	**21.22**
Enhancer	348	**3.05**	**7.06**	**6.05**	**4.80**	**20.96**
631	350	**3.17**	**6.77**	**5.98**	**4.93**	**20.84**
53V08	346	2.92	**7.14**	**5.93**	**4.61**	**20.60**
PS595-106	361	2.91	**7.03**	**6.01**	4.50	**20.44**
Oneida VR	309	2.93	**7.00**	**5.92**	4.50	**20.35**
Ripin	349	**3.32**	6.54	5.86	4.24	**19.95**
Reno	357	2.93	**6.62**	5.85	4.51	**19.90**
Imperial	280	2.84	**6.60**	**6.01**	4.43	19.87
NL 90732	360	2.99	6.40	5.64	4.42	19.45
Focus	358	2.71	6.37	5.67	**4.63**	19.38
Emperor	351	2.91	6.25	5.40	**4.55**	19.11
TMF Multiplier II	359	2.81	6.36	5.57	4.35	19.09
Enhancer PI	SC981	2.76	6.50	5.73	4.05	19.04
Mountaineer	355	2.76	6.42	5.56	3.93	18.94
ZX9852	352	2.89	6.10	5.52	4.31	18.83
A-395	362	2.87	6.35	5.28	4.31	18.80
Rambo	353	2.73	6.37	5.20	4.44	18.74
Innovator+Z	281	2.70	6.41	5.61	3.95	18.67
NL 91229	363	2.69	6.23	5.58	4.07	18.57
Enhancer MiRi	SC982	2.45	6.40	5.13	3.91	17.89
Wrangler	146	2.64	6.22	4.95	3.66	17.47
Ladak 65	2	2.35	5.98	4.70	3.60	16.63
Millennia	354	**3.17**	3.91	4.80	3.50	15.74
Riley	122	2.16	5.78	4.60	3.00	15.54
mean		2.85	6.41	5.58	4.26	19.13
LSD(0.05)		0.40	0.56	0.54	0.42	1.43
CV(s/mean) x100		9.9	6.2	6.9	6.9	5.3

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Table 3a. 2001 Summary of the 2000 Intrastate Alfalfa Yield Trial at Kalispell - Dryland

Cultivar	FD[1]	VW[2]	Stand	Vigor[3]	Harvest-1	Harvest-2	Harvest-3	Total
			% of plot	*(0-5)*	*t/a*	*t/a*	*t/a*	*t/a*
Cooper			94	4	**3.81**	1.30	0.75	5.85
Select	4	R	**99**	4	**3.76**	1.37	0.66	5.78
Plumas	4	R	95	4	**3.83**	1.30	0.62	5.75
Masterpiece	4	R	**98**	4	**3.81**	1.24	0.64	5.68
Wrangler	2	LR	**99**	4	**3.74**	1.29	0.60	5.62
Ultra Eureka			**99**	4	**3.83**	1.19	0.50	5.52
Shaw			94	**5**	**3.83**	1.27	0.41	5.52
ZX9450A			**98**	4	**3.72**	1.32	0.44	5.48
5246			84	4	3.32	1.33	0.80	5.45
Millennia	4	R	**99**	4	**3.68**	1.25	0.37	5.30
53V08	3	HR	**96**	4	3.46	1.27	0.56	5.28
Ladak 65			**100**	4	**3.56**	1.18	0.48	5.22
AmeriGraze 401+Z	4	R	**98**	**5**	**3.55**	1.24	0.41	5.20
Riley	4	LR	89	3	3.28	1.21	0.69	5.18
WinterCrown	3	R	**98**	**5**	3.37	1.29	0.42	5.08
631	4	R	**98**	**5**	3.41	1.17	0.37	4.94
4200			**98**	**5**	3.34	1.17	0.40	4.90
Innovator +Z	3	HR	**100**	4	3.38	1.15	0.33	4.86
mean			96	4	3.59	1.25	0.52	5.37
LSD(0.05)			5	1	0.37	NS	NS	NS
CV(s/mean) %			3.6	17.0	7.2	18.3	45.9	11.0

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Harvest-1: 6/25/01

Harvest-2: 8/1/01

Harvest-3: 10/1/01

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

[3]0=dead; 5=very vigorous plants

Table 3b. . Total dry matter yields for the 2000 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 2000 to 2001.

Cultivar	2000	2001	Total Yield
	t/a	*t/a*	*t/a*
Select	**1.05**	5.78	6.83
Cooper	0.91	5.85	6.76
Shaw	**1.13**	5.52	6.66
Plumas	0.88	5.75	6.63
Wrangler	0.91	5.62	6.54
Masterpiece	0.83	5.68	6.51
Ultra Eureka	0.90	5.52	6.42
ZX9450A	0.93	5.48	6.41
Millennia	**1.08**	5.30	6.38
5246	0.92	5.45	6.37
WinterCrown	**1.05**	5.08	6.13
53V08	0.82	5.28	6.10
Riley	0.90	5.18	6.08
AmeriGraze 401+Z	0.87	5.20	6.06
Ladak 65	0.82	5.22	6.03
631	0.93	4.94	5.87
4200	0.85	4.90	5.76
Innovator +Z	0.85	4.86	5.70
mean	0.92	5.37	6.29
LSD(0.05)	0.19	NS	NS
CV(s/mean)%	14.2	11.0	10.8

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Table 4a. 2001 Summary of the 2000 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated

Cultivar	FD[1]	VW[2]	Stand	Vigor	Harvest-1 Yield	Harvest-2 Yield	Harvest-3 Yield	Total Yield
			%*	(0-5)**	t/a	t/a	t/a	t/a
ZX9450A			**99**	4.3	**3.63**	**2.15**	**2.37**	**8.15**
Plumas	4	R	**99**	4.8	**3.61**	**2.09**	2.07	**7.77**
Millennia	4	R	**100**	4.0	**3.52**	**2.06**	2.04	**7.62**
WinterCrown	3	R	**99**	4.3	3.32	**2.11**	**2.18**	**7.61**
Select	4	R	**100**	4.0	**3.58**	1.94	2.09	**7.60**
Ultra			**100**	4.3	**3.65**	**2.01**	1.94	**7.59**
631	4	R	**98**	4.5	**3.46**	**2.10**	2.02	**7.58**
AmeriGraze 401+Z	4	R	**100**	4.8	**3.53**	**2.02**	2.02	**7.57**
Masterpiece	4	R	**100**	4.3	**3.48**	**2.04**	2.00	**7.52**
Shaw			**99**	4.0	**3.52**	1.89	2.01	7.42
Cooper			96	4.0	**3.50**	1.83	1.98	7.31
53V08	3	HR	**99**	4.0	3.32	**2.04**	1.94	7.30
4200			**99**	4.8	3.08	**2.10**	2.00	7.18
Innovator +Z	3	HR	**99**	4.3	3.34	1.94	1.80	7.08
5246			89	4.3	3.16	1.70	1.84	6.69
Wrangler	2	LR	**99**	4.3	3.08	1.68	1.56	6.32
Riley	4	LR	93	3.5	3.05	1.55	1.69	6.29
Ladak 65			**100**	3.8	3.12	1.55	1.32	5.98
mean			98	4.2	3.39	1.93	1.94	7.25
LSD(0.05)			3	NS	0.30	0.21	0.27	0.69
CV(mean			2.1	12.9	6.3	7.6	9.7	6.7

**0=dead; 5=very vigorous plants

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Harvest-1: 6/22/01

Harvest-2: 7/27/01

Harvest-3: 10/1/01

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

[3]0=dead; 5=very vigorous plants

Table 4b. . Total dry matter yields for the 2000 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 2000 to 2001.

Cultivar	2000 Yield *t/a*	2001 Yield *t/a*	2000-01 Total Yield *t/a*
ZX9450A	**3.05**	**8.15**	**11.20**
Plumas	**3.03**	**7.77**	**10.79**
Select	**2.97**	**7.60**	**10.57**
Millennia	**2.90**	**7.62**	**10.52**
Ultra	**2.87**	**7.59**	**10.46**
Masterpiece	**2.87**	**7.52**	**10.38**
631	**2.76**	**7.58**	**10.33**
WinterCrown	2.66	**7.61**	10.26
Shaw	**2.85**	7.42	10.26
AmeriGraze 401+Z	2.68	**7.57**	10.24
Cooper	2.68	7.31	9.99
4200	2.59	7.18	9.77
Innovator +Z	2.68	7.08	9.76
53V08	2.45	7.30	9.75
5246	2.17	6.69	8.86
Wrangler	2.38	6.32	8.70
Riley	2.33	6.29	8.62
Ladak 65	2.34	5.98	8.32
mean	2.68	7.25	9.93
LSD(0.05)	0.33	0.69	0.91
CV(s/mean)%	8.73	6.7	6.4

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Table 5. 2001 Summary of the 2001 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated.

Variety	MTNO	FD[1]	VW[2]	Stand %	First Harvest t/a	Second Harvest t/a	Total t/a
Shaw	328	--	--	94	1.69	**1.47**	**3.16**
Cooper	335	--	--	**96**	1.62	**1.53**	**3.15**
Plumas	336	4	R	**98**	1.62	**1.46**	**3.08**
Goliath	373	4	R	**98**	1.67	1.39	**3.06**
DAK 9901	377	--	--	**98**	1.53	**1.51**	**3.04**
Mariner II	374	2	MR	**95**	1.55	**1.44**	**2.99**
Reliance	375	3	HR	**99**	1.66	1.27	**2.93**
Abound	379	3	HR	**96**	1.58	1.34	**2.92**
WL 327	383	4	R	**98**	1.54	1.38	**2.92**
A 30-06	382	3	HR	**96**	1.53	1.36	**2.89**
DK A42-15	381	4	HR	**98**	1.43	**1.44**	2.87
Wrangler	146	2	LR	**98**	1.54	1.31	2.84
Alliant	380	4	R	**98**	1.51	1.32	2.83
Ameristand 403T	372	4	HR	**98**	1.45	1.37	2.81
WBRR	384	--	--	91	1.43	1.33	2.76
Monument II	376	--	--	**98**	1.49	1.19	2.67
Ascend 552	378	--	--	**95**	1.43	1.24	2.67
Ladak 65	2	--	--	93	1.51	1.12	2.63
Riley	122	4	LR	85	1.41	1.21	2.62
mean				96	1.54	1.35	2.89
LSD(0.05)				5	NS	0.13	0.28
CV(s/mean)				3.6	10.8	7.0	6.8

Harvest-1: 7/27/01
Harvest-2: 10/2/01

[1] Fall Dormancy rating

[2] Vert Wilt resistance

TITLE: **Perennial Forage Legume Trial – Irrigated**
PROJECT LEADER: Leon Welty, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

In 1999, a trial was initiated to evaluate advances in sainfoin, cicer milkvetch, and birdsfoot trefoil variety development. Two alfalfa varieties and 2 alfalfa/sainfoin mixtures were included for comparison.

Fifty lbs/a P_2O_5 and 11 lbs/a N were applied 5/1/01. The sainfoins (except 'Eski') and alfalfa entries had the most vigorous early stand growth. The trefoils and Eski sanfoin had the poorest stands.

The study was harvested June 22, July 26, and Oct. 2. The alfalfas, '97-1', 'Remont', and 'RDWY' sainfoins and the alfalfa/sainfoin mixtures were the most productive (Table 1). Over the three years, RDWY produced significantly more forage than any other entry (Table 2).

Table 1. 2001 Montana Perennial Forage Legume Species/Variety Evaluation

Entry	Stand	Vigor	Harvest-1	Harvest-2	Harvest-3	2001 TOTAL
	*(1-5)**	*(1-5)***	*tons/acre*	*tons/acre*	*tons/acre*	*tons/acre*
Alf+Snfn 3+16	4.5	4.5	**3.56**	**2.01**	**1.68**	**7.25**
Ladak 65	4.5	4.5	**3.97**	1.50	1.55	**7.02**
AC Grazeland alfalfa	4.3	4.8	**3.43**	1.72	**1.84**	**6.99**
RDWY Sainfoin	4.8	4.0	**3.47**	**1.85**	1.55	**6.87**
Alf+Snfn 3+8	4.3	5.0	3.30	**1.94**	1.59	**6.83**
Remont Sainfoin	3.5	4.5	3.38	1.75	1.47	**6.59**
97-1 Sainfoin	4.3	4.3	**3.50**	1.71	1.36	**6.56**
WYPX 2-94 Sainfoin	4.5	3.3	**3.91**	1.56	0.73	6.20
Lutana Cicer Milkvetch	3.5	4.0	2.18	1.09	0.70	3.96
Windsor Cicer Milkvetch	3.3	4.3	1.99	1.02	0.90	3.91
Monarch Cicer Milkvetch	4.0	4.3	2.09	0.98	0.62	3.69
L-2 Synthetic B.Trefoil	3.3	3.5	2.01	1.06	0.43	3.49
Eski Sainfoin	2.0	3.0	2.34	0.76	0.33	3.43
Tretana B.Trefoil	2.8	3.0	1.38	0.70	0.25	2.32
mean	3.8	4.1	2.89	1.40	1.07	5.36
LSD(0.05)	0.8	0.8	0.56	0.17	0.25	0.78
CV(s/mean)x100	15.6	14.3	13.4	8.7	16.7	10.1

* 1=total occupancy; 5=plot empty
** 1=vigorous plants; 5=weak
Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Table 2. Montana Perennial Forage Legume Species/Variety Evaluation 1999-2001

Forage Yields

Entry	1999	2000	2001	1999-01 Total Yield
	t/a	*t/a*	*t/a*	*t/a*
RDWY Sainfoin	**3.78**	**7.04**	**6.87**	**17.69**
97-1 Sainfoin	3.42	5.86	**6.56**	15.85
Alf+Snfn 3+16	3.29	4.95	**7.25**	15.47
WYPX 2-94 Sainfoin	3.15	6.03	6.20	15.38
Remont Sainfoin	3.03	5.38	**6.59**	15.00
Ladak 65	3.13	4.19	**7.02**	14.34
Alf+Snfn 3+8	2.97	4.40	**6.83**	14.19
AC Grazeland alfalfa	3.00	3.93	**6.99**	13.93
L-2 Synthetic B.Trefoil	1.24	3.31	3.49	8.05
Lutana Cicer Milkvetch	0.22	3.12	3.96	7.31
Windsor Cicer Milkvetch	0.38	2.99	3.91	7.27
Monarch Cicer Milkvetch	0.33	3.21	3.69	7.21
Eski Sainfoin	0.74	2.66	3.43	6.83
Tretana B.Trefoil	0.63	2.92	2.32	5.87
mean	2.09	4.28	5.36	11.74
LSD(0.05)	0.29	0.57	0.78	1.38
CV(s/mean)x100	9.6	9.3	10.1	8.2

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield

TITLE: **Timothy Trial - Irrigated**
PROJECT LEADER: DuaneJohnson, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

In 1999, a trial was initiated to compare forage yield of 3 Timothy cultivars with 4 Orchard grass cultivars. The study was fertilized with 80 lbs/a N on April 7, 2001.

The plots were harvested June 21, and Oct.2, 2001. The 'Colt' and 'TM8903' timothy produced more forage than the other cultivars (Table 1). This was the first year in which more forage was obtained from the timothy than the orchardgrass (Table 2).

Table 1. Dry matter yields of Timothy and orchardgrass cultivars at Kalispell in 2001.

CULTIVAR	SPECIES	1st Harvest YIELD	2nd Harvest YIELD	2001 YIELD
		t/a	*t/a*	*t/a*
TM8903	Timothy	**4.16**	1.15	**5.31**
Colt	Timothy	**3.72**	0.96	**4.68**
TM9710-02	Timothy	3.51	0.91	4.43
OG9202	Orchardgrass	2.78	1.22	4.00
Haymate	Orchardgrass	2.78	0.97	3.75
Benchmark	Orchardgrass	2.22	1.16	3.38
OG9503	Orchardgrass	2.48	0.91	3.38
mean		3.09	1.04	4.13
LSD(0.05)		0.53	NS	0.67
CV(s/mean)x100		11.5	16.5	10.9

1st Harvest: 6/21/01
2nd Harvest: 10/2/01
Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

Table 2. Total dry matter yields of Timothy and orchardgrass cultivars at Kalispell from 1999 - 2001.

CULTIVAR	SPECIES	1999	2000	2001	1999-2001 TOTAL
		t/a	*t/a*	t/a	*t/a*
OG9202	Orchardgrass	**3.96**	**6.91**	4.00	**14.87**
Benchmark	Orchardgrass	**4.06**	**6.80**	3.38	**14.24**
OG9503	Orchardgrass	**3.70**	**6.90**	3.38	**13.98**
TM9710-02	Timothy	**3.69**	5.61	4.43	**13.72**
Haymate	Orchardgrass	**3.79**	6.03	3.75	**13.56**
TM8903	Timothy	2.58	5.19	**5.31**	13.08
Colt	Timothy	2.61	5.02	**4.68**	12.30
mean		3.48	6.06	4.13	13.68
LSD(0.05)		0.72	0.77	0.67	1.59
CV(s/mean)%		13.9	8.5	10.9	7.8

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

TITLE: **IRRIGATED FORAGE GRASSES**
PROJECT LEADER: DuaneJohnson, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

In 2001, a trial was initiated to compare forage yield of 32 forage grass cultivars. Seeding rates were 11.5 lbs/a for meadow brome, 9.2 lbs/a for smooth and Alaska brome, perennial ryegrass, Festulolium, big, and little bluestem, 7.7 lbs/a for fescues, 6.1 lbs/a for orchardgrass, 4.6 lbs/a for timothy, and 3.8 lbs/a for bluegrass. The plots were harvested 8/10/01 and 10/3/01. Stand establishment was good except for the bluegrass (Table 1). 'Hakari' Alaska brome had produced significantly more forage than any other cultivar by the first cutting. 'Blizzard' Alaska brome and 'Hykor' festulolium produced the most fall regrowth. Hakari, Hykor, and 'Mustang' perennial ryegrass had the highest total first year yields. No yield data was obtained for big and little bluestem because of inadvertent mowing.

Table 1. Dry matter yields of forage grass cultivars planted at Kalispell in 2001.

IRRIGATED FORAGE GRASSES
Kalispell, 2001

Cultivar	Species	Source	Stand	*8/10* Yield	*10/3* Yield	Total Yield
			%	*t/a*	*t/a*	*t/a*
Hakari	brome, Alaska	Barenbrug	**93.8**	**2.70**	0.66	**3.35**
Hykor	Festulolium	DLF-Jenks	**100.0**	2.09	**0.94**	**3.03**
Mustang	perennial ryegrass	DLF-Jenks	**100.0**	2.19	0.82	**3.01**
Laura	fescue, meadow	DLF-Jenks	**97.5**	1.91	0.77	2.68
Blizzard	brome, Alaska	DLF-Jenks	90.0	1.62	**1.04**	2.66
Pauite	orchardgrass	check	**96.3**	1.95	0.69	2.64
Intensiv	orchardgrass	Barenbrug	**98.8**	1.99	0.58	2.57
Fawn	fescue, tall	check	**98.8**	1.64	0.86	2.50
Martin 2	fescue, tall	Cabeco	**97.5**	1.61	0.87	2.48
Forager	fescue, tall	check	**100.0**	1.63	0.84	2.46
OG 9204	orchardgrass	Allied	**100.0**	1.75	0.62	2.37
Profile	orchardgrass	DLF-Jenks	**98.8**	1.70	0.52	2.22
Potomac	orchardgrass	check	**97.5**	1.68	0.53	2.21
Linn	perennial ryegrass	check	**100.0**	1.57	0.63	2.20
Fure	fescue, meadow	DLF-Jenks	**98.8**	1.50	0.67	2.17
Manchar	brome, smooth	check	**96.3**	1.84	0.26	2.10
Bilbo	timothy	DLF-Jenks	91.3	1.66	0.35	2.01
Mb-1	bromegrass, meadow	exp.	**93.8**	1.42	0.56	1.98
Paddock	bromegrass, meadow	check	**93.8**	1.44	0.53	1.97
TM 9501	timothy	Allied	**92.5**	1.56	0.41	1.97
Joliette	timothy	Bruce	91.3	1.64	0.31	1.95
Fleet	bromegrass, meadow	check	**92.5**	1.38	0.46	1.85
Climax	timothy	check	88.8	1.50	0.30	1.80
Magna	brome, smooth	check	**95.0**	1.65	0.15	1.80
Mb-2	bromegrass, meadow	exp.	91.3	1.31	0.48	1.79
Regar	bromegrass, meadow	check	**95.0**	1.15	0.43	1.58
Vega	timothy	DLF-Jenks	87.5	1.13	0.27	1.40
Park	bluegrass, Kentucky	check	56.3	0.90	0.40	1.30
Platini	bluegrass, forage	DLF-Jenks	38.8	0.66	0.32	0.98
Sherman	bluegrass, big	L & H	43.8	0.38	0.24	0.62
		mean	90.5	1.57	0.55	2.12
		LSD(0.05)	7.7	0.37	0.16	0.45
		CV(s/mean)%	6.0	16.8	20.1	14.9

Yield values in **bold** within a column are not significantly different (P=0.05) from the highest yield.

TITLE: **Spring Cereal Forage Trial - Dryland**
PROJECT LEADER: Dave Wichman, Gail Sharp, MSU-CARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Six barley, 3 oat cultivars, 1 spelt, 1 triticale, and 1 emmer cultivar, and 1 spring wheat/spring pea mixture were planted in a randomized complete block design with 4 replicates on April 24, 2001. Seeding rates were 50 lbs/a for the barley and oats, 70 lbs/a for the triticale, spelt, emmer, and wheat/pea mixture, and 60 lbs/a for the wheat.

'Triple Crown' and 'Otana' oats and 'SK3P' spelt produced the most dry matter (Table 1). Hulless 'Paul' oat produced less than Triple Crown, but not significantly less than Otana. The triticale and spelt were harvested July 10 and the other species July 11, at the milk to soft dough stage. Forage yield averaged 4009 lbs/acre dry matter.

Table 1. Results of the Spring Cereal Forage Trial in 2001at the Northwestern Agricultural Research Center, Kalispell, MT.

VARIETY	SPECIES	STAND* %	PLANT HEIGHT inches	HEADING *date*	HARVEST *date*	YIELD *lbs/a*
TripleCrown	Oat	**94**	34	6/29	7/11	**4810**
Otana	Oat	**94**	33	7/2	7/11	**4529**
SK3P	Spelt	88	**39**	6/29	7/10	**4404**
Paul	Oat	**95**	30	7/2	7/11	4243
Haybet	Barley	84	27	6/28	7/11	4062
Washford	Barley	88	25	7/3	7/11	4061
Pronghorn	Triticale	**95**	37	7/1	7/10	3996
Lewis	Barley	**91**	23	6/28	7/11	3944
Logan	Barley	85	24	6/30	7/11	3893
Lucile	Emmer	**96**	35	7/1	7/11	3884
Westford	Barley	86	29	6/29	7/11	3752
93ST59	SW/SP	**95**	34	7/1	7/11	3675
GooseWheat	Wheat	**94**	25	7/3	7/11	3577
MH981060	Barley	89	22	7/1	7/11	3290
mean		91	30	6/30		4009
LSD(0.05)		5	2	NS		517
CV(s/mean)		4.0	5.0	4.4		9.0

* as of 5/24/01

Values in **bold** within a column are not significantly different (P=0.05) from the highest value.

TITLE: **2001 Uniform Pea Forage Trial - Dryland**
PROJECT LEADER: Dave Wichman, Karnes Neill, MSU-CARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Four pea cultivars, alone and mixed with 'Haybet' barley were planted in a randomized complete block design with 4 replicates on April 24, 2001. Seeding rates were 8 seeds/ft^2 for peas, 14 seeds/ft^2 for barley, 6 pea and 6 barley seeds/ft^2 for the mixtures.

Granger, Sioux, and Trapper peas were harvested July 10 and Melrose and the pea/barley mixtures were harvested July 13. Peas were harvested at the second podding node, and the barley and mixtures were harvested at barley anthesis. The 'Melrose'/Haybet, 'Granger'/Haybet and 'Sioux'/Haybet' mixtures produced the most dry matter. Forage yield averaged 3870 lbs/acre dry matter.

2001 Uniform Pea Forage Trial
Kalispell, 2001

Entry	Stand Pea	Stand Barley	First Bloom	Heading	Pod 1st node	Anthesis	Canopy Height Pea	Canopy Height Barley	Dry Matter Yield Pea	Dry Matter Yield Barley	TOTAL YIELD
	#/sqft		day	day	day	day	in		lbs/a		lbs/a
Granger/Haybet	7.9	12.9	66	69	73	79	**38**	28	1760	3263	**5023**
Sioux/Haybet	10.9	11.5	67	68	**75**	79	31	27	2517	1904	**4422**
Melrose/Haybet	9.3	11.5	**68**	68	**74**	79	32	28	2208	2206	**4415**
Haybet	--	**26.6**	--	69	--	79	--	25	--	**4055**	**3972**
Trapper/Haybet	11.5	10.4	62	68	73	79	31	27	1816	2152	**3918**
Granger	11.9	--	66	--	**75**	--	29	--	**3746**	--	3692
Melrose	13.8	--	66	--	73	--	25	--	**3522**	--	3653
Trapper	**14.6**	--	63	--	72	--	24	--	**3183**	--	3184
Sioux	**18.5**	--	66	--	73	--	20	--	2554	--	2554
mean	12.3	14.6	65	68	73	79	28	27	2663	2716	3870
LSD(0.05)	4.0	3.4	1	NS	2	NS	4	NS	734	919	881
CV(s/mean)%	21.8	14.5	1.4	2.9	1.6	0.6	9.1	8.2	18.6	21.2	15.4

Values in **bold** within a column are not significantly different (P=0.05) from the highest value.

TITLE: **Millet Forage Trial - Dryland**
PROJECT LEADER: Dave Wichman, MSU-CARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Six millet cultivars were planted in a randomized complete block design with 4 replicates on May 22, 2001. Seeding rate was 17 lbs/a.

'Cerise Red Proso', 'White Proso', and 'Golden German' millets produced the most dry matter. 'Pearl' millet produced significantly less than the other cultivars. All plots were harvested Aug. 3, after heading. Forage yield averaged 2.04 tons/acre dry matter.

Millet Trial
NorthWestern Agricultural Research Center, Kalispell, MT
Crop Year 2001

Variety	Stand	Heading	Ht	Forage Yield
	%	*day*	*(in)*	*(t/a)*
Cerise Red Proso Millet	94	66	**32**	**2.42**
White Proso	88	69	29	**2.41**
Golden German Millet	88	**76**	27	**2.24**
Red Millet	**99**	75	25	2.17
Siberian Foxtail Millet	**99**	74	27	2.13
Pearl Millet	93	**76**	19	0.87
mean	93	73	26	2.04
LSD(0.05)	4	1	3	0.25
CV(s/mean)%	3.0	1.3	7.7	8.2

Values in **bold** within a column are not significantly different (P=0.05) from the highest value.

MISCELLANEOUS AND PULSE CROP INVESTIGATIONS
758

The Miscellaneous Crops Project (758) includes research related to miscellaneous and pulse crops to include peas, lentils, canola, mint, etc., from seeding to data collection to publications.

TITLE: **2001 Western Regional Lentil Yield Trial – Dryland**
PROJECT LEADER: Fred Muehlbauer, WSU
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Thirteen lentil varieties were seeded on April 27, 2001. Experimental design was a randomized complete block with 4 replicates. All plots were fertilized with 11 lbs. N/a and 52 lbs. P_2O_5/a on 5/1/01. Stand establishment was variable among the plots.

Precipitation from April through June was 1.5 inches above the same period in 2000. Lentil yields in 2001 were 41% higher than the average 2000 yields. The highest yielding variety ('Crimson') produced 1232 lbs/acre.

Agronomic data from the Western Regional Lentil Yield Trial at Kalispell, MT in 2001.

Cultivar	Stand	First bloom	Maturity	Yield	Seed Size
	%	*days**	*days**	*lbs/a*	*#/lb*
Crimson	89	59.8	**97.0**	1232	**11340**
LC8601817P	88	56.0	94.2	1023	9650
LC8602354T	89	57.0	**96.5**	991	9732
Laird	81	59.3	**98.2**	896	8523
LC7601086E	90	58.9	**97.7**	888	**10160**
LC460266B	88	56.0	93.9	883	7323
LC7601599T	66	56.3	**97.3**	869	**11380**
LC7601106E	84	57.7	**97.9**	811	**10330**
LC8601787P	85	58.0	94.5	770	**10570**
LC460197L	84	58.5	**98.5**	753	7994
LC660829L	82	55.9	93.1	732	8737
LC7601080R	80	59.0	**98.5**	728	8174
LC460212L	76	59.0	**97.2**	721	7490
mean	83	58	96	869	9339
LSD(0.05)	NS	NS	3.1	NS	1577
CV(s/mean)%	13.3	5.1	2.2	28.4	11.75

*Days since planting
Values in **bold** are not significantly different from the highest value.

TITLE: **2001 Statewide Lentil Yield Trial – Dryland**

PROJECT LEADER: Karnes Neill, MSU-CARC

COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Ten lentil varieties were seeded on April 24, 2001. Experimental design was a randomized complete block with 4 replicates. All plots were fertilized with 11 lbs. N/a and 52 lbs. P_2O_5/a on 5/1/01. Stand establishment was good except for 'Crimson'.

Precipitation from April through June was 1.5 inches above the same period in 2000. Lentil yields in 2001 were twice the average 2000 yields. 'CDC Richlea' produced significantly more grain than any other variety.

STATEWIDE LENTIL TRIAL

Kalispell, 2001

Cultivar	Stand	First Flower	Maturity	Canopy Height.	Grain Yield	Seed Size
	%	*day**	*day**	*in*	*lbs/a*	*#/lb*
CDC Richlea	**93**	62	102	**12**	**2133**	9114
Red Chief	**94**	66	97	**12**	1500	8384
Eston	88	67	99	11	1425	14480
Laird	**93**	70	102	9	1407	7144
Toni	**91**	64	99	11	1382	12540
Pardina	**91**	58	97	11	1377	11590
Crimson	83	62	100	10	1294	13930
Brewer	**94**	67	97	**12**	1203	8150
French Green	**94**	64	97	11	1103	16230
Indianhead	**90**	60	**103**	**13**	1027	**22560**
mean	91	64	99	11	1385	12412
LSD(0.05)	5	NS	1	2	531	1091
CV(s/mean)%	3.9	10.0	1.0	10.6	26.1	6.0

Seeding date: 4/24/01

*Days after seeding.

TITLE: **2001 Western Regional Dry Pea Yield Trial – Dryland**
PROJECT LEADER: Fred Muehlbauer, WSU
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

'Lifter' and 'Franklin' and four experimental pea varieties were seeded on April 27, 2001. Experimental design was a randomized complete block with 4 replicates. All plots were fertilized with 11 lbs N/a, 52 lbs P_2O_5/a, and 17 lbs S/a on 5/1/01. Precipitation from April through June was 1.5 inches above the same period in 2000.

Pea yields in 2001 were 12% higher than the average 2000 yields. The highest yielding variety, 'PS610324', a green afila-type, produced 1876 lbs/acre. This yield was not significantly higher than Lifter or Franklin. 'P610152' produced significantly less than any other variety.

Agronomic data from the Western Regional Dry Pea Yield Trial at Kalispell, MT in 2001.

Cultivar	First Bloom	Maturity	Yield	Seed Size
	*day**	*day**	*lbs/a*	*#/lb*
PS610324	55	91	**1876**	1843
Franklin	**61**	91	**1773**	1705
PS710909	56	92	**1766**	1907
Lifter	**59**	94	**1735**	1988
PS7101149	53	90	1393	1954
PS610152	**60**	91	825	2123
mean	57	92	1561	1920
LSD(0.05)	3	NS	374	NS
CV(s/mean)%	2.9	3.8	12.2	11.8

Seeding date: 4/27/01
*days after seeding

TITLE: **Spokane Seed Dry Pea Yield Trial, 2001**

Seven pea varieties were seeded on April 27, 2001. Experimental design was a randomized complete block with 4 replicates. All plots were fertilized with 11 lbs N/a, 52 lbs P_2O_5/a, and 17 lbs S/a on 5/1/01. Precipitation from April through June was 1.5 inches above the same period in 2000.

Pea yields averaged 1874 lbs/a. 'Cruiser', 'Midas', and 'Universal' produced significantly more grain than 'Franklin'.

SPOKANE SEED DRY PEA YIELD TRIAL 2001

Kalispell, 2001

Cultivar	Stand	First Bloom	Nodes to 1stflw	Height	Maturity	Yield	Seed Weight
	%	*day**		*inches*	*day**	*lbs/a*	*#/lb*
Universal	94	60	15	**25**	92	**2325**	2028
Cruiser	91	58	14	**23**	92	**2177**	1764
Midas	89	59	16	**23**	92	**2016**	2014
Lifter	85	57	12	20	93	**1833**	1970
Eiffel	89	59	14	16	93	**1766**	1816
Keoma	93	57	15	19	92	**1755**	1883
Franklin	88	59	14	18	92	1247	2085
mean	90	58		21	92	1874	1937
LSD(0.05)	NS	NS		5	NS	613	NS
CV(s/mean)%	6.4	4.8		16.4	1.0	21.4	11.7

Seeding date: 4/24/01

Harvest date: 7/26/01

*days after seeding

TITLE: **CANOLA PRIMING STUDY**
PROJECT LEADER: Grant Jackson, MSU-WTARC
COOPERATOR: Duane Johnson, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

This trial tested the effect of priming on the seed of 4 canola cultivars as regards stand establishment, maturation time, and seed yield. Planting date was 5/3/01. The design was a split plot with cultivars as main plots and primed and non-primed treatments as subplots within each cultivar. Plots consisted of eight 14-foot rows with 6" row spacing. No irrigation was applied.

Stand counts were taken on 5/3/01. No significant differences were found among cultivars, priming treatments, or the interaction between them. 'Rider' and 'Minot' flowered later than '357' and 'LG3235', and the primed seed flowered earlier than seed that was not primed. All plots were harvested 8/29/01. Main effect yield means were not significantly different, but the interactions were. Primed seed of 357 yielded more than the unprimed seed, whereas unprimed Rider produced more than the primed seed.

First Flower (*days after seeding)*

Variety	Treatment: Control	Treatment: Primed	means		
357	52.4	50.9	51.6		
Rider	54.9	54.4	**54.6**		
Minot	54.2	53.5	**53.8**	LSD(0.05) cultivar means	1.3
LG3235	52.4	51.8	52.1	LSD(0.05) treatment means	0.5
				LSD(0.05) interactions	NS
means	**53.5**	52.6			

Stand (plants/sqft)

Variety	Treatment: Control	Treatment: Primed	means		
357	31.0	25.0	28.0		
Rider	28.8	36.8	32.8	LSD(0.05) cultivar means	NS
Minot	29.8	24.8	27.3	LSD(0.05) treatment means	NS
LG3235	32.2	25.5	28.8	LSD(0.05) interactions	NS
means	30.4	28.0			

Yield (lbs/a)

Variety	Treatment: Control	Treatment: Primed	means		
357	978	**1193**	1086		
Rider	**1260**	1048	1154	LSD(0.05) cultivar means	NS
Minot	923	955	939	LSD(0.05) treatment means	NS
LG3235	**1115**	985	1050	LSD(0.05) interactions	191
means	1069	1045			

TITLE: **CANOLA VARIETY PERFORMANCE TRIAL**
PROJECT LEADER: Grant Jackson, MSU-WTARC
COOPERATOR: Duane Johnson, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

This trial compared the yield performance of 25 canola cultivars. Planting date was 5/2/01. The design was a randomized complete block with 4 replicates. Plots consisted of eight 15-foot rows with 6" row spacing.

Stand counts were taken on 5/2/01. All plots were harvested 8/29/01. No significant (P=0.05) differences were found among cultivars for stand counts, bloom date, or yield.

CANOLA VARIETY PERFORMANCE TRIAL
Kalispell, 2001

	STAND	FIRST BLOOM	HEIGHT	YIELD
Entry	*pl/sqft*	*day after seeding*	*in*	*lbs/a*
243CL	21	55	32	1286
CA1867	28	54	32	1251
223RR	25	55	**33**	1242
IMC203RR	29	54	**33**	1241
MinotRR	25	55	31	1154
CrackerJ	35	55	29	1118
IMC206RR	31	55	31	1116
Goliath	28	55	**33**	1103
IMC105	37	56	32	1084
357RR	37	54	31	1018
RaiderRR	32	56	32	1013
CA1812RR	28	56	31	1006
IMC207	27	53	32	988
5033RR	31	54	30	944
CL2061RR	32	56	31	933
DK2338RR	30	55	32	907
401	33	55	31	891
5001RR	18	53	31	885
Hudson	28	56	30	884
46 NR	18	55	26	844
IMC205	31	56	**33**	843
IMC302	19	56	**36**	828
5034	32	54	29	801
KAB 36	33	55	32	698
RiderRR	25	54	**34**	640
mean	29	55	31	989
LSD(0.05)	NS	NS	4	NS
CV(s/mean)%	35.2	4.4	8.0	31.6

Canola Irrigation Study:
Kalispell and Corvallis, Montana, 2001

An irrigation study was initiated May, 15 and 16, 2001 in Kalispell and Corvallis, Montana. Poor stand establishment due to wind damage and soil crusting prevented stand establishment. Trials at both locations were reseeded June 1, 2001. Initial seed rates of 5 lbs/a were increased to 7 lbs/ acre to compensate for late planting. All plots were pre-irrigated and fertilized at 65:40:40:20 (preplant)+ 45:0:0:0 (postemerge) at Kalispell and 100:40:40:20 (preplant)+ 45:0:0:0 (postemerge) at Corvallis. Herbicides included Assure II at recommended rates. Plots at Kalispell were 10' X 40' replicated 4 times using a line-source gradient sprinkler line. Plots at Corvallis were 5' X 40' with similar replications. Four cultivars were used: IMC 205, Helios, IMC High Oleic (OH) and Cheetah. Cheetah and IMC OH were used because of potential for oleic oil variation induced by stress. Oil analysis has not been completed but we expect to do so in March-April of 2002. Currently, we are awaiting the delivery of a gas chromatograph. Studies at Corvallis received 2 inches of irrigation water 3 feet from the line source weekly after first true leaves. Irrigation at Kalispell used the same system and applied 1.5 inches per week until first bud and irrigation was increased to 2 inches per week applied at a rate of one inch, twice weekly. Irrigations were made early morning to minimize wind drift.

The hypothesis for the study was that water stress impacts yield of canola but that it may also impact oil quality. Given the great diversity of genetic modifications being made to canola in the United States and North America, this was an important issue. The hypothesis further stated that stress may be induced by over-irrigation as well as under-irrigation.

Plot yields were adjusted to an area of 20 square feet per plot and transposed to yield per acre for this report. Results, using standard analysis of variance, show significant differences in cultivars, irrigation, and locations. A summary oif the analysis of variance is provided in Table 1.

Table 1. ANOVA for yield in irrigated canola.

Source	df	MS	F	P
CULTIVAR	3	138984	7.44	0.0002
IRRIGATION	3	108899	5.83	0.0011
LOCATION	1	2438460	130.58	0.0000
C X I	9	18660	1	0.4458
C X L	3	71997	3.86	0.0116
I X L	3	248803	13.32	0.0000
RESIDUAL	105	18674		
TOTAL	127			

Since cultivar yields were not affected by irrigation, Table 2 shows results of irrigation on yield. Irrigation was most effective at increasing yield at 11.5 inches of total available water. A location by irrigation interaction was observed with Corvallis showing highest yields at the higher irrigation levels. Yields at Kalispell were significantly higher than Corvallis.

Table 2. Irrigation Impact on yield

Irrigation level (inches)	Yield (kg/ha)	Yield (lbs/a)
8.25	2,096.18	1,865.60
11.75	2,574.49	2,291.30
14.50	2,726.16	2,426.28
18.0	2,139.99	1,904.59

In Table 3, cultivar differences were noted. There was an interaction of yield response by location. Data from Corvallis showed no significant differences among cultivars. General yields at Kalispell are given in Table 3.

Table 3. Irrigated yield differences by cultivar

Cultivar	Mean (lbs/a)	(kg/ha)
IMC 205	1,909.14	2,145.10
Helios	2,380.44	2,674.65
IMC HO	2,404.86	2,700.97
Cheetah	1,794.27	2,016.04

Summary

Using an irrigation gradient significant differences in yield for cultivars, irrigation treatments, locations and cultivar by location interactions were noted. The highest yielding cultivars were Helios and IMCHO. The highest yields by irrigation occurred at 14.5 inches of total water applied.

TITLE: **Chamomile Trial**
PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Roman chamomile (*Chamaemelum nobile*) was direct seeded at 6.52 g/1000 linear ft on May 3, 2000. The trial contained 4 replicates of 3 plots each consisting of 8-15' rows with 1' row spacing. The Roman chamomile was not harvested until 2001. The plots were harvested on 8/14, 8/27, and 8/30/01 by clipping the tops and distilling the fresh clippings.

The 8/14 harvest yielded the most oil - 8.1 lbs./acre.

TITLE: **Echinacea Trial**
PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

E. angustifolia, and *E. pallida* were direct seeded at 9-seeds/linear ft. on May 4, 1999. Stand counts were made June 11, 2001.Topgrowth was harvested 7/24/01 using a research plot forage harvester. Flowers were separated from leaves and stems. Roots were dug up, cleaned and dried and weighed to determine yield.

E. pallida plots contained 53% more plants than *E. angustifolia* plots. Topgrowth yield of *E. pallida* was 2.5 times that of *E. angustifolia*. Differences in flower yield, however, were not significant. Average root mass of *E. pallida* was 75% more than the average root mass of *E. angustifolia*. Disease symptoms were minimal.

Echinacea Trial - 2001

SPECIES	STAND *pl/plot*	FLOWERS *lbs/a*	TOPS *lbs/a*	ROOTS *lbs/a*
E.pallida	22.0	88	7651	1215
E.angustifolia	14.4	80	3062	694
mean	18.2	84.0	5357	955
LSD(0.05)	2.3	NS	1507	623
P-VALUE	0.00	0.45	0.00	0.09
CV(s/mean)%	10.7	23.5	23.8	55.2

TITLE: **Edamame Soybean Trial**
PROJECT LEADER: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Edamame is a soybean consumed as a green vegetable. It is the second highest consumable next to rice in Japan. The beans are harvested when pods are fully expanded and before the pods turn from green to yellow. The pods are boiled in salt water for 4-6 minutes and the beans eaten from the pods.

Japanese standards require the edamame pods to be bright green in color, be free from obvious defects (bruising, insect damage, pathogens, minimal single bean pods), have a sugar content (measured by Brix) no less than 8.5%, an aroma when cooked which is scented (a mild jasmine odor is preferred) and a pale pubescence on the pod.

Edamame were planted June 1, 2001 at the Northwest Ag Research Center under dryland conditions to increase seed and for observation. The plantings were not replicated due to limited seed. Plots were seeded at the recommended 65 lbs/a. Two cultivars were evaluated: Sayamusume (white seeded) and Musume Dada (black seeded). The black seeded variety is considered the premier edamame. Preliminary results show yields of 3,800 lbs/a for Sayamusume and yields of 3,000 lbs/a for Musume Dada. Pod quality was judged to be excellent.

Currently, seed costs for these edamame varieties is prohibitive for most producers ($10/lb for Sayamusume or similar variety and $25-30/lb for Musume Dada). The crop has a market in Asia as well as a further developing market along the East and West Coasts. Current market values range from $0.35/lb to $1.00/lb for conventional or $3.00/lb for organic. For more information, Washington State University has an excellent website: http://agsyst.wsu.edu/EdamameReport2000.pdf

TITLE: **Artichoke Trial**
PROJECT LEADER: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Globe artichokes were evaluated in a preliminary trial to determine feasibility. Globe artichokes are a growing market dominated by production in California. California has several advantages ranging from the perennial production which allows growers to harvest from March to June and again from September to December. However, there is a window of opportunity in late July and August for Montana 'chokes when artichokes are not plentiful in the marketplace. Values range from $14 for <12S or >24S (less than 12 or greater than 24 artichokes per box) to $18-20 for 18S (18 artichokes per box). Price premiums are greatest in late summer and late winter.

In 2001, we planted "Emerald" artichokes- a choke designed primarily for annual production as transplants (seeded in March and transplanted in mid-April) and direct seeded (seeded in late April). Plots were designed with 1 plant per square foot, ½ plant per square foot and ¼ plant per square foot. Highest yields of 12s-18s artichokes/ carton were obtained with the ¼ plant per square foot spacing. These are considered the premium size. The closer the spacing, the greater the number of baby artichokes (36s-40s). These are an emerging market primarily in gourmet applications. All artichokes grown at the NWARC were grown without surface irrigation. Sub irrigation was not monitored.

TITLE: **Quinoa Trial**
PROJECT LEADER: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC
COOPERATOR: Sarah Ward, Colorado State University

Quinoa is an alternative grain grown primarily in the high Andes. Nutritionally sound, quinoa has become popular as a side dish, a main entrée and as a dessert. It is prepared like rice and can replace rice in almost any dish. The flavor is somewhat nutty and is dependent on variety.

In 2001, The NWARC planted 220 entries of quinoa in a replicated study. These entries were provided as a part of a graduate research program at Colorado State University. The entries consisted of parents and all possible hybrid combinations of these parents. Hybrids have been demonstrated to yield 3-4 times the yield of inbred parents. Plots were planted as single rows at a rate of 3 lbs/a on May 15, 2001. All plots were fertilized at a rate of 85N:40P:60K. All plots were grown under a solid set sprinkler with water applied at a rate of 1 inch per week.

The hybrids selected and their parents generally failed to set seed at Creston. The parents selected were not adapted to the relatively low elevation and higher heat load experienced during 2001. One parental line and its progeny were successful in seed production.

TITLE: **1997 SPEARMINT CULTIVAR/PROPAGATION TRIAL**

PERSONNEL: 1997-2000 - Leon E. Welty, Professor of Agronomy, MSU, Kalispell, MT
2001 - Duane L. Johnson, Assoc. Professor of Agronomy, MSU, Kalispell, MT
Louise Strang, Research Specialist, MSU, Kalispell, MT

OBJECTIVE: Evaluate new spearmint cultivars / propagation methods for vigor, hay and oil production.

DURATION: 1997-2001

PROCEDURES: Nuclear plants of Native, N-83-5, and Scotch 770 spearmint were provided by the following propagators:

Summit – stem-cut
Starkel – meristem
Lake – nodal

The meristem and nodal tissue propagated material was planted 5/20/97, and the stem-cut material was planted 5/29/97. The entries were planted in a randomized complete block design in 20-ft long plots consisting of 4 rows of 20 plants with 20-inch row spacing. Appropriate management practices (irrigation, fertility, and weed and pest control) were employed to insure maximum mint oil production.

Stands were rated for occupancy on 6/1/01. All plots were harvested 7/25/01 at the early to mid bloom stage and on 9/27/01 at the vegetative (*M. spicata)* and mid bloom (*M.* cardiaca) stages. Yield was determined by swathing a 100-ft^2 area of each plot, drying a 500-g subsample to determine dry matter content, and drying a 20-lb. sample for distillation. Oil was distilled and collected by steam distillation with a research still at the NWARC. A.M. Todd Company conducted oil quality analyses.

RESULTS AND DISCUSSION: Scotch 770 had the least vigorous early season growth **(Table 1)**. Meristem propagated plots had better stand occupancy than those derived from the nodal and stem cut sources.

At the first cutting, there were no significant differences in oil content among the entries **(Table 2)**. Because of extensive stand loss, Scotch 770 produced very little herbage or oil for the first cutting. Meristem propagated entries produced significantly more dry matter than the non-meristem derivatives. At the second cutting, Scotch 770 had recovered slightly, but not enough to compete with the yields of the Native and N-83-5 spearmint, in spite of its superior oil content. There were no differences among propagation types at the second harvest **(Table 3**).

Rust symptoms did not appear this year. Powdery mildew was just showing up by the second cutting.

Total oil yields for 2001 are shown in **Table 4**. The meristem-derived plants produced more dry matter (more stand vigor) than the nodal derived plants. There was no significant effect of propagation source on oil yield. Scotch 770, which was the top oil producer the previous year, produced less than 27% as much oil as the

Native and N-83-5 lines. Total oil yields from 1997-2001 (**Table 5, Figure 1**) show that N-83-5 has produced more oil than Native. The spearmint oil from the nodal propagated plants exceeded the average of the stem-cut entries.

Differences in major quality components in first cutting oil are summarized in **Table 6a**. The Native and N-83-5 spearmints had reached the early bloom stage, and the Scotch was at the mid bloom stage. Scotch 770 had higher limonene levels than Native or N-83-5. Second harvest oil quality is summarized in **Table 6b**. Native and N-83-5 were less mature than at first harvest, reflected by slightly lower carvone levels.

Note: Values in **bold** are not significantly (P>0.10) lower than the highest value in the same column.

Table 1. Occupancy (% of plot covered) of spearmint cultivar/propagation sources on 6/1/01.

	Propagation Source			
Cultivar	Stem cut	Meristem	Nodal	means
Native	51	64	43	**53**
N-83-5	39	56	40	45
Scotch 770	4	9	6	6
Means	31	**43**	29	

LSD(0.10) Cultivar: 8
Propagation: 8
Interaction: NS

Table 2. Hay yield, oil content, and oil yield of entries at first harvest – 7/25/01.

HAY YIELD (tons/acre)[1/]

Cultivar	Stem cut	Meristem	Nodal	means
	Propagation Source			
Native	2.90	3.21	2.73	**2.95**
N-83-5	2.83	3.04	2.67	**2.84**
Scotch 770	0.21	0.61	0.14	0.32
means	1.98	**2.28**	1.85	

LSD(0.10) Cultivar: 0.30
Propagation: 0.30
Interaction: NS

OIL CONTENT (%dm)

Cultivar	Stem cut	Meristem	Nodal	means
	Propagation Source			
Native	1.0	1.1	1.1	1.1
N-83-5	1.1	1.2	1.1	1.1
Scotch 770	0.8	1.2	1.6	1.2
means	1.0	1.1	1.3	

LSD(0.10) Cultivar: NS
Propagation: NS
Interaction: NS

OIL YIELD (lbs/acre)[1/]

Cultivar	Stem cut	Meristem	Nodal	means
	Propagation Source			
Native	58.5	66.9	57.8	**61.1**
N-83-5	62.8	66.8	58.0	**62.5**
Scotch 770	9.1	12.4	4.7	8.7
means	**43.5**	**48.7**	40.2	

LSD(0.10) Cultivar: 6.7
Propagation: 6.7
Interaction: NS

[1/] All spearmints were in the bud stage on 7/25/01.

Table 3. Hay yield, oil content, and oil yield of cultivars at second harvest – 9/27/01.

HAY YIELD (tons/acre) [1/]

	Propagation Source			
	Stem cut	Meristem	Nodal	means
Native	1.61	1.65	1.59	**1.61**
N-83-5	1.67	1.67	1.55	**1.63**
Scotch 770	0.61	0.76	0.33	0.57
Means	1.30	1.36	1.16	

LSD(0.10) Cultivar: 0.21
Propagation: NS
Interaction: NS

OIL CONTENT (%dm)

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	0.78	0.80	0.93	0.83
N-83-5	0.98	0.83	1.00	0.93
Scotch 770	1.18	1.40	1.18	**1.25**
Means	0.98	1.01	1.03	

LSD(0.10) Cultivar: 0.18
Propagation: NS
Interaction: NS

OIL YIELD (lbs/acre) [1/]

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	24.3	26.4	28.2	**26.3**
N-83-5	29.1	26.9	30.6	**28.9**
Scotch 770	16.8	19.9	8.4	15.0
Means	23.4	24.4	22.4	

LSD(0.10) Cultivar: 5.6
Propagation: NS
Interaction: NS

[1/]Native spearmints were at the early bud stage and Scotch at the mid bloom stage on 9/27/01.

Table 4. Total hay and oil yields from the Spearmint Cultivar/Propagation Trial at Kalispell in 2001.

TOTAL HAY YIELD 2001 (t/a)

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	4.52	4.85	4.32	**4.56**
N-83-5	4.50	4.70	4.22	**4.47**
Scotch 770	0.82	1.36	0.48	0.89
Means	**3.28**	**3.64**	3.01	

LSD(0.10) Cultivar: 0.48
Propagation: 0.48
Interaction: NS

TOTAL OIL YIELD 2001 (lbs/acre)

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	82.8	93.4	86.1	**87.4**
N-83-5	91.9	93.8	88.6	**91.4**
Scotch 770	25.9	32.3	13.1	23.8
Means	66.9	73.1	62.6	

LSD(0.10) Cultivar: 10.1
Propagation: NS
Interaction: NS

Table 5. **Total oil yields 1997-2001 (lbs/acre).**

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	372.0	395.6	412.4	393.3
N-83-5	415.8	413.6	431.0	**420.1**
Scotch 770	392.2	405.1	424.0	**407.1**
Means	393.3	**404.8**	**422.5**	

LSD(0.10) Cultivar: 20.2
Propagation: 20.2
Interaction: NS

Table 6a. Quality components of 3 spearmint cultivars and 3 propagation types for the first harvest, 2001.

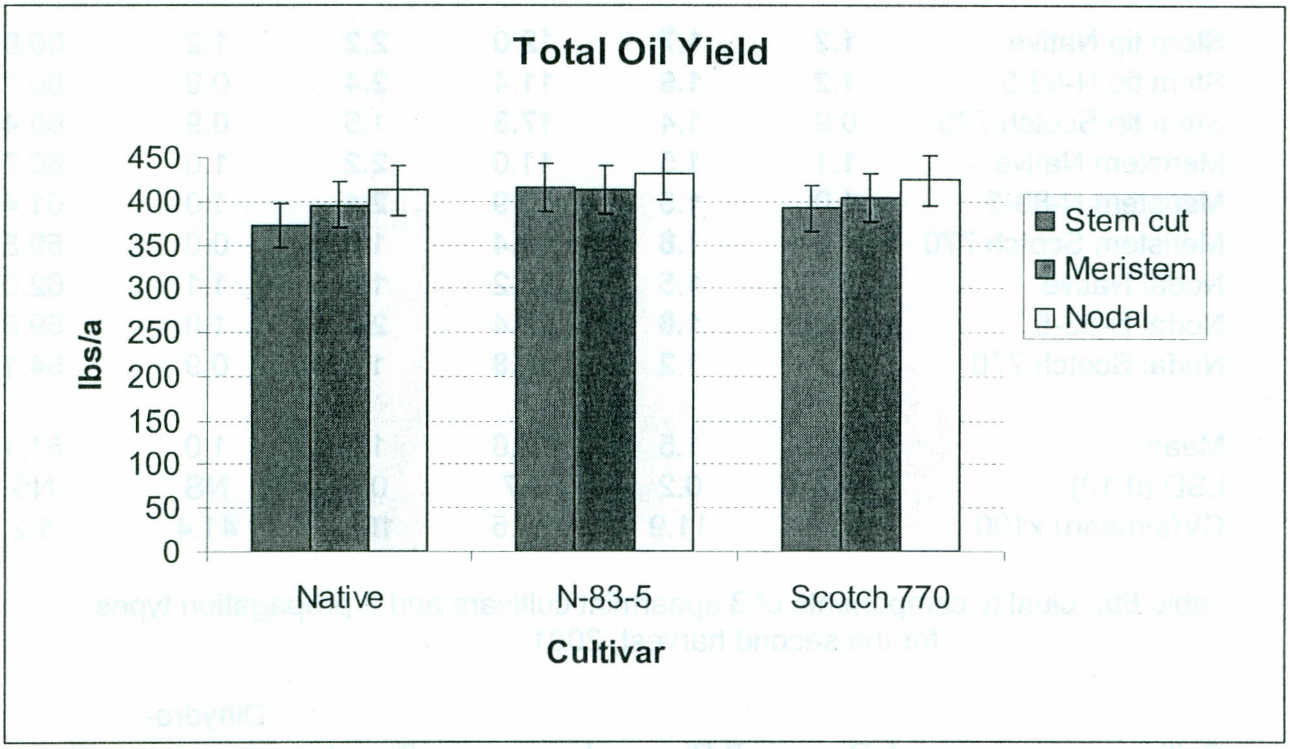
Cultivar	A:Pinene	B:Pinene	Limonene	Cineole	Dihydro-Carvone	Carvone
Stem tip Native	**1.2**	**1.7**	12.0	**2.2**	1.2	60.8
Stem tip N-83-5	**1.2**	**1.6**	11.4	**2.4**	0.9	60.7
Stem tip Scotch 770	0.9	1.4	**17.3**	1.6	0.9	60.4
Meristem Native	**1.1**	1.5	11.0	**2.2**	1.6	60.7
Meristem N-83-5	1.0	1.5	10.9	**2.1**	1.0	61.4
Meristem Scotch 770	1.0	**1.6**	**19.4**	1.6	0.6	59.8
Nodal Native	**1.1**	1.5	12.2	1.8	1.1	62.0
Nodal N-83-5	**1.2**	**1.6**	11.4	**2.4**	1.0	59.8
Nodal Scotch 770	0.7	1.2	**16.8**	1.2	0.9	64.1
Mean	1.1	1.5	13.6	1.9	1.0	61.1
LSD (0.10)	0.2	0.2	3.7	0.4	NS	NS
CV(s/mean) x100	14.6	11.9	22.5	16.1	41.4	4.2

Table 6b. Quality components of 3 spearmint cultivars and 3 propagation types for the second harvest, 2001.

Cultivar	A:Pinene	B:Pinene	Limonene	Cineole	Dihydro-carvone	Carvone
Stem tip Native	1.1	1.5	12.4	2.1	**1.4**	60.1
Stem tip N-83-5	1.1	1.4	10.9	2.3	1.0	60.3
Stem tip Scotch 770	0.8	1.3	18.7	1.6	0.7	60.9
Meristem Native	1.1	1.4	12.8	2.3	**1.4**	60.4
Meristem N-83-5	1.1	1.5	12.1	2.3	1.0	60.5
Meristem Scotch 770	1.0	1.4	17.5	1.5	1.1	63.9
Nodal Native	1.1	1.5	11.7	2.0	1.1	59.5
Nodal N-83-5	**1.2**	1.6	11.6	**2.7**	1.0	58.8
Nodal Scotch 770	1.0	1.5	**20.7**	1.5	1.0	61.4
Mean	1.1	1.4	14.3	2.0	1.1	60.6
LSD (0.10)	0.1	NS	1.3	0.3	0.3	NS
CV(s/mean) x100	11.4	8.7	7.6	11.5	19.1	3.5

Analysis by A.M.Todd Co.

Figure 1. Total oil yields for entries in the Spearmint Cultivar/Propagation Trial at Kalispell from 1997 to 2001.



TITLE: **EFFECT OF FREEZING TEMPERATURES ON THE SURVIVAL OF MINT CULTIVARS/SELECTION LINES.**

PERSONNEL: 1997-2000 - Leon E. Welty, Professor of Agronomy, MSU, Kalispell, MT
2001 - Duane L. Johnson, Assoc. Professor of Agronomy, MSU, Kalispell, MT
Louise Strang, Research Specialist, MSU, Kalispell, MT

OBJECTIVE: Identify *Mentha* cultivars/selection lines with superior stolon tolerance to subfreezing temperatures, and evaluate them for oil yield and quality.

DURATION: 1997-2001

PROCEDURES: Nuclear plants from 27 mint lines were planted in 2-row plots between 5/21/97 and 6/3/98 in a randomized block design with 2 replicates (**Table 1**). In 1998 and 1999 stolons were removed from each plot in the fall and subjected to freezing temperatures from 5^{o} F to 20^{o} F. Because of the small number of replicates, these results could be viewed as only a suggestion of which mint lines may have special cold temperature tolerance. Based on the fall 1999 stolon freezer tests, 'Black Mitcham', 'Todd's Mitcham', 'Native', 'N-83-5', and 'Scotch' might be considered. In 1999 the 'Arctic' mint (believed to be a naturally occurring mutant of Scotch) did demonstrate more cold tolerance than many other entries. This mint, however, produces an atypical oil with no current commercial value.

Stands were rated for occupancy on June 1, 2001. Heights, maturity stages, and insect damage were noted at harvest time, Aug. 1. The mint was dried, steam distilled and oil yields were calculated. Major oil components were analyzed by A.M. Todd Company.

RESULTS AND DISCUSSION: There was considerable variation in winter stand survival and vigor as observed on 6/1/01 (**Table 2**). The two surviving *longifolia* entries again had the most robust stands, followed by the *suaveolens* and Native entries. The Scotch spearmint lines had the weakest early stands.

All plots were harvested 8/2/01 (**Table 2**). Plant heights ranged from 12 inches (Scotch, 'Scotch 770', 'Scotch 227') to 33 inches (*longifolia-hymaliensis*). Black Mitcham 'UK-2' and 'MIRC92', 'M-83-7', 'Todd's Mitcham', and 'Murray Mitcham' were the least mature (mid-bud stage) and the spearmints, *longifolia,* and *suaveolens* lines were the most mature, having reached full bloom. The two *longifolia* produced the most dry matter, and the Scotch, Scotch 227, and Scotch 770 produced the least. Stem-cut Scotch 770, Black Mitcham, Todd's Mitcham, Roberts Mitcham, and M-83-7 produced the highest concentration of oil per unit dry matter. The *longifolia* and *suaveolens* lines had the lowest oil content. Of the peppermint entries, the Black Mitcham meristem propagated line from Summit, the McClelland 'Mc96-9' line, 'Robert's Mitcham', and Murray Mitcham produced the most oil. Of the spearmints, Native, 'Scotch 213', and 'Arctic' were the top producers, yielding as much oil as the Black Mitcham entries. Over the 4 years that this trial has been conducted, the highest total oil yields have come from the Black

Mitcham MIRC92 and Mc96-7 lines, the Scotch 213 and the Arctic entries (**Figures 1&2**).

Oil quality is summarized in **Table 3**. The meristem propagated Black Mitcham (source - Starkel), MIRC92 line, Mc96-7, and Mc96-19 Black Mitcham lines had the highest menthol levels. All peppermint entries had less than 3% menthofuran concentration. The Native spearmint lines tended to have higher dihydrocarvone, myrcene, and cineole levels than the Scotch lines. The Scotch type mints had higher limonene, octanol, and carvone levels than the Native. The Arctic mint had a carvone level intermediate between Native and Scotch, higher dihydrocarvone and limonene, and lower myrcene and cineole than the other spearmints.

Table 1. Entries in the *Mentha* cold tolerance study at NWARC.

Species	Cultivar	Propagation Method	Source	Propagator
piperita	Black Mitcham	meristem	MIRC	Summit
piperita	Black Mitcham	meristem	MIRC	Starkel
piperita	Black Mitcham	nodal	MIRC-92	Lake
piperita	Black Mitcham	nodal	McClelland	Lake
piperita	Black Mitcham	nodal	English (UK) 1	Lake(Margetts-Roberts)
piperita	Black Mitcham	nodal	English (UK) 2	Lake
piperita	Black Mitcham	nodal	McClelland	Lake(Mc96-7)
piperita	Black Mitcham	nodal	McClelland	Lake(Mc96-19)
piperita	Black Mitcham	stem cut	MIRC	Summit
piperita	Black Mitcham	meristem	McClelland	Starkel/Clarke
piperita	M-83-7	stemcut	MIRC	Summit
piperita	Murray Mitcham	stem cut	MIRC	Summit
piperita	Roberts Mitcham	stem cut	MIRC	Summit
piperita	Todd's Mitcham	stem cut	MIRC	Summit
cardiaca	Scotch	stemcut	MIRC	Summit
cardiaca	Scotch 213	stem cut	MIRC	Summit
cardiaca	Scotch 227	stem cut	MIRC	Summit
cardiaca	Scotch 770	meristem	MIRC	Starkel
cardiaca	Scotch 770	stem cut	MIRC	Summit
cardiaca	Arctic	nodal	I.P.Callison	Lake
spicata	N-83-5	stem cut	MIRC	Summit
spicata	Native	meristem	MIRC	Starkel
spicata	Native	stem cut	MIRC	Summit
longifolia	*hymaliensis*	stem cut	Davis	Grey
longifolia	*polyadenia*	stem cut	Davis	Lake (S.Africa)
longifolia		nodal	NCGR	Lake (Netherlands)
suaveolens	rotundifolia	nodal	NCGR	Lake (Minnesota)

Table 2. Height, growth stages, and yield components of entries in the cold tolerance trial at Kalispell in 2001.

Cultivar	Method	Source	Prop.	Cover[1] %plot	Height inches	Stage *	Hay Yield t/a	Oil Content %dm	Oil Yield lbs/a	Total Oil 1998-2001 lbs/a
Scotch 213	stem	MIRC	Summit	25	17	fblm	3.40	1.5	**110.0**	**326.3**
Arctic	nodal	Callison	Lake	50	16	eblm	3.14	1.5	**90.2**	**288.7**
Black M.	nodal	Mc96-7	Lake	23	14	fb	2.33	1.6	76.6	**271.5**
Black M.	nodal	MIRC92	Lake	38	16	mb	2.94	1.5	82.6	**270.9**
Black M.	nodal	Mc96-9	Lake	25	16	fb	2.87	1.5	**88.7**	263.5
Black M.	stem	MIRC	Summit	23	15	fb	2.33	**1.8**	85.5	261.9
Black M.	meris.	MIRC	Summit	20	13	fb	2.19	**2.0**	**88.3**	260.7
Roberts M	stem	MIRC	Summit	40	16	fb	2.48	**1.8**	**87.3**	260.6
Murray M.	stem	MIRC	Summit	43	17	mb	2.96	1.5	**91.2**	254.3
Black M.	nodal	UK-2	Lake	23	14	mb	2.46	1.6	78.8	249.8
Native	meris.	MIRC	Starkel	63	24	mblm	3.86	1.2	**91.1**	242.4
M-83-7	stem	MIRC	Summit	38	16	mb	2.24	**1.8**	79.3	237.7
Scotch 770	stem	MIRC	Summit	15	12	fblm	0.88	**1.8**	25.0	226.6
Black M.	nodal	Mc96-19	Lake	20	16	fb	2.90	1.3	77.0	226.6
Black M.	meris.	MIRC	Starkel	35	17	fb	2.90	1.4	82.8	223.8
Scotch 770	meris.	MIRC	Starkel	23	15	fblm	1.92	1.3	50.0	220.5
Black M.	nodal	UK-1	Lake	45	15	fb	2.52	1.6	78.9	211.6
Todd's M.	stem	MIRC	Summit	40	15	mb	2.28	**1.8**	79.9	209.9
Native	nodal	MIRC	Lake	50	24	fblm	3.28	1.3	**87.4**	177.6
N-83-5	stem	MIRC	Summit	45	22	fblm	3.42	1.1	75.1	174.8
Native	stem	MIRC	Summit	78	25	fblm	3.88	1.2	**90.6**	157.1
Scotch	stem	MIRC	Summit	8	12	mblm	0.32	1.7	11.0	154.2
Scotch 227	stem	MIRC	Summit	10	12	fblm	0.98	1.2	22.7	142.7
long-hymal.	stem	Davis	Grey	**100**	**33**	fblm	**6.20**	0.2	28.0	119.6
longifolia	nodal	NCGR	Lake	**95**	**32**	fblm	**5.41**	0.3	25.9	87.3
suaveolens	nodal	NCGR	Lake	70	22	fblm	2.53	0.1	2.2	25.0
		mean		40	18		2.83	1.4	68.7	213.3
		LSD(0.10)		14	2		0.83	0.3	23.1	58.9
		CV(s/mean) %		20.6	7.4		17.2	11.8	19.7	16.1

[1] Evaluated 6/1/01.

* *pb=prebud; eb=early bud; mb=mid bud; fb=full bud; eblm=early bloom; mblm=med bloom; fblm=full bloom*

Data entries in **bold** are not significantly different from the highest value.

Table 3. Quality components of mint oil from the *Mentha* Cold Tolerance Study (GC %Area).

Peppermint

Species	Cultivar	Method	Source	Menthol	Neo-menthol	Menthone	D-iso-menthone	Mentho-furan	Total Esters	Pulegone
piperita	Black Mitcham	stem-cut	MIRC	36.6	2.7	27.2	**3.3**	2.1	4.2	**0.17**
piperita	Black Mitcham	meristem	MIRC	34.5	2.5	30.8	**3.4**	2.5	3.6	**0.25**
piperita	Black Mitcham	meristem	Starkel	**39.8**	2.8	24.3	3.0	1.8	4.3	0.12
piperita	Black Mitcham	nodal	MIRC-92	**37.3**	3.0	26.2	3.2	2.5	5.0	**0.21**
piperita	Murray Mitcham	stem-cut	MIRC	35.2	2.6	30.3	**3.5**	1.3	4.2	0.11
piperita	Todd's Mitcham	stem-cut	MIRC	34.5	2.7	30.4	**3.5**	1.6	4.0	0.16
piperita	Roberts Mitcham	stem-cut	MIRC	36.1	2.7	29.2	**3.5**	1.6	4.5	0.13
piperita	M-83-7	stem-cut	MIRC	33.5	2.6	30.4	**3.5**	1.5	4.1	0.12
piperita	Black Mitcham	nodal	Mc96-9	36.4	2.5	28.1	**3.3**	2.3	3.9	**0.22**
piperita	Black Mitcham	nodal	UK-1	36.2	2.7	27.0	3.2	2.1	4.2	**0.17**
piperita	Black Mitcham	nodal	UK-2	33.7	2.5	29.8	**3.4**	2.1	4.4	0.13
piperita	Black Mitcham	meristem	Mc96-7	**37.0**	2.6	26.8	3.1	**2.9**	3.9	**0.25**
piperita	Black Mitcham	nodal	Mc96-19	**39.0**	2.8	24.8	3.0	2.4	4.3	0.09
			mean	36.1	2.7	28.1	3.3	2.1	4.2	0.16
			LSD(0.10)	3.1	NS	NS	0.3	0.3	NS	0.09
			CV(s/mean)%	4.8	8.6	10.5	4.2	7.7	13.5	30.7

Spearmint

Species	Cultivar	Method	Source	Dihydro-carvone	Myrcene	Limonene	Cineole	Octanol	Sabinene Hydrate	Carvone
spicata	Native	stem-cut	MIRC	2.08	2.67	13.1	**2.23**	0.85	3.2	57.7
spicata	N-83-5	stem-cut	MIRC	1.05	**3.93**	11.7	**2.21**	0.95	3.6	60.2
spicata	Native	meristem	MIRC	1.76	3.51	11.6	**2.34**	0.87	3.4	60.8
spicata	Native	stem-cut	Clarke	0.91	3.50	14.0	1.86	0.78	3.8	56.9
cardiaca	Scotch	stem-cut	MIRC	0.79	1.29	17.4	1.29	1.60	0.5	**63.9**
cardiaca	Scotch 213	stem-cut	MIRC	0.98	1.20	15.9	1.41	**2.27**	0.4	**66.7**
cardiaca	Scotch 227	stem-cut	MIRC	0.58	1.11	**21.3**	1.40	**2.11**	0.4	60.1
cardiaca	Scotch 770	stem-cut	MIRC	0.82	1.33	20.2	1.30	1.63	0.6	61.8
cardiaca	Scotch 770	meristem	MIRC	0.95	1.07	18.8	1.32	**2.09**	0.4	**63.8**
cardiaca	Arctic	nodal	Callison	**3.61**	0.71	**24.3**	0.45	0.90	12.4	61.1
			mean	1.35	2.03	16.8	1.58	1.40	2.9	61.3
			LSD(0.10)	0.88	0.41	3.8	0.18	0.33	NS	3.5
			CV(s/mean)%	35.0	10.9	12.0	6.2	12.7	189.4	3.1

Data entries in **bold** are not significantly different from the highest value.

Figure 1. Total oil yields of peppermint entries in the *Mentha* Cold Tolerance Trial, 1998-2001

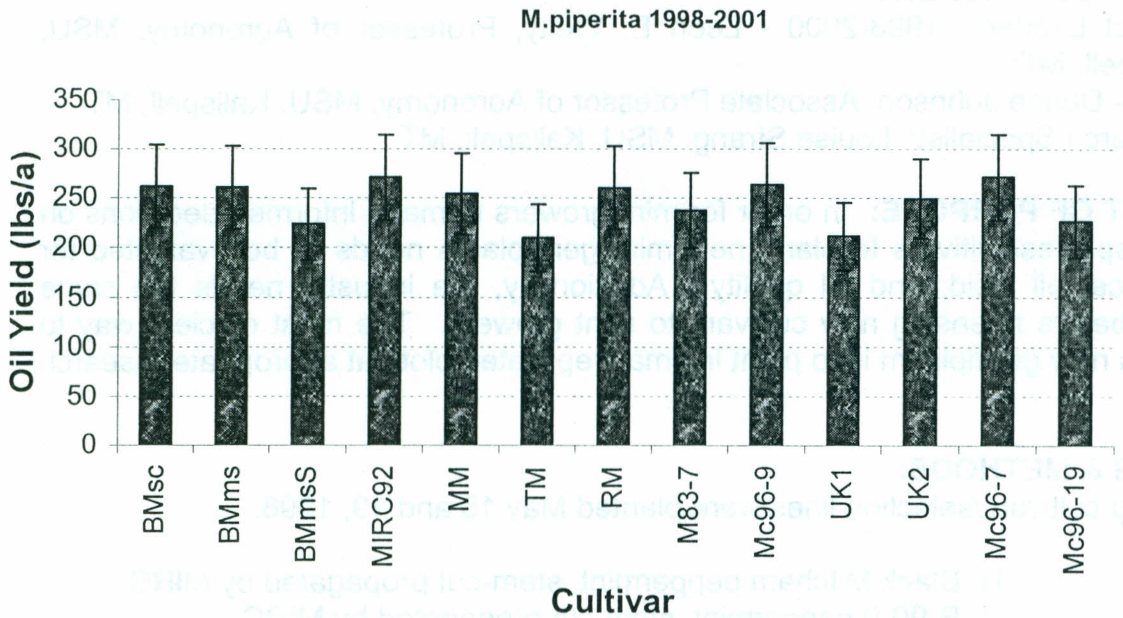
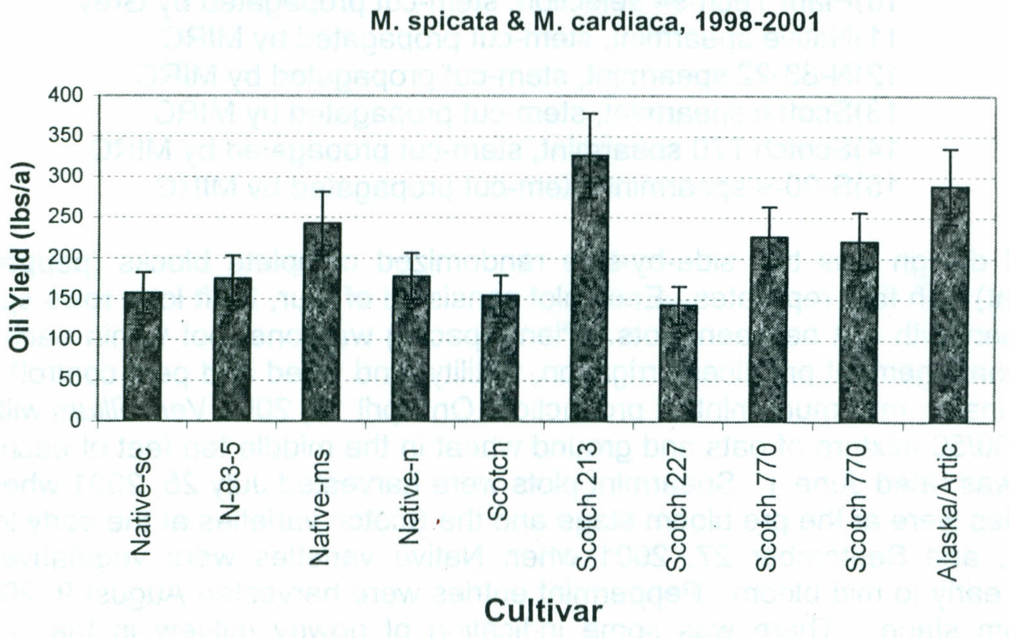


Figure 2. Total oil yields of spearmint entries in the Mint Cold Tolerance Trial from 1998-2001.



TITLE: EVALUATION OF MIRC MINT GERMPLASM - 1998-2001

PRINCIPAL RESEARCHERS:

Project Leader: 1998-2000 - Leon E. Welty, Professor of Agronomy, MSU, Kalispell, MT;
2001 - Duane Johnson, Associate Professor of Agronomy, MSU, Kalispell, MT.
Research Specialist: Louise Strang, MSU, Kalispell, MT

STATEMENT OF PURPOSE: In order for mint growers to make informed decisions on which mint species/cultivars to plant, new mint germplasm needs to be evaluated for pest tolerance, oil yield, and oil quality. Additionally, the industry needs the same information before releasing new cultivars to mint growers. The most efficient way to evaluate this new germplasm is to plant in small replicated plots at appropriate research centers.

MATERIALS & METHODS:
The following cultivars/selection lines were planted May 18 and 19, 1998:

1) Black Mitcham peppermint, stem-cut propagated by MIRC
2) B-90-9 peppermint, stem-cut propagated by MIRC
3) Murray Mitcham peppermint, stem-cut propagated by MIRC
4) M-83-14 peppermint, stem-cut propagated by MIRC
5) 92(B-37 x M0110) peppermint, stem-cut propagated by MIRC
6) Lewis McKellip selection, nodal propagated by MIRC
7) UK-1 peppermint, nodal propagated by Lake
8) UK-2 peppermint, nodal propagated by Lake
9) McClelland selection, meristem propagated by Starkel
10) Plant Tech-94 selection, stem-cut propagated by Grey
11) Native spearmint, stem-cut propagated by MIRC
12) N-83-22 spearmint, stem-cut propagated by MIRC
13) Scotch spearmint, stem-cut propagated by MIRC
14) Scotch 770 spearmint, stem-cut propagated by MIRC
15) S-90-9 spearmint, stem-cut propagated by MIRC

Experimental design was two side-by-side randomized complete blocks (peppermint and spearmint) with four replicates. Each plot consisted of four, 20-ft long rows spaced 22 inches apart with 3 ft between plots. Plant spacing was one foot within each row. Appropriate management practices (irrigation, fertility, and weed and pest control) were employed to insure maximum mint oil production. On April 10, 2000 *Verticillium* wilt was seeded in a 50/50 mixture of oats and ground wheat in the middle ten feet of each plot. Stand vigor was rated June 1. Spearmint plots were harvested July 25, 2001 when the Native varieties were at the pre bloom stage and the Scotch varieties at the early to mid bloom stage, and September 27, 2001 when Native varieties were vegetative and Scotch were early to mid bloom. Peppermint entries were harvested August 9, 2001 at the pre bloom stage. There was some indication of downy mildew in the second harvest of the Scotch. Plant height and growth stage was determined immediately before harvest. Yield was determined by swathing a 100-ft^2 area of each plot, drying a 500-g subsample to determine dry matter content, and drying a 20-lb. sample for distillation. Oil was distilled and collected by steam distillation with a research still at the NWARC. Oil samples from the MIRC entries were analyzed for quality by gas chromatography at I.P. Callison & Sons, and the other entries at A.M. Todd Company.

RESEARCH PROJECT GOALS AND OBJECTIVES:

Determine peppermint and spearmint germplasm response to an Intermountain environment in terms of pest tolerance, oil yield and oil quality.

RESULTS AND DISCUSSION:

Spring stand evaluation indicated the Black Mitcham, B-90-9, and Murray Mitcham MIRC entries and the UK-1, McKellip, and Plant Tech 94 selections had the most vigorous spring stands of the peppermints. The hybrid entry, 92(B-37 x M0110) had lost most of its plants. Native and N-83-22 had the best stand retention of the spearmints, while the Scotch, Scotch 770, and S-90-9 had the poorest stands (Table 1).

No rust symptoms were observed in 2001. Some Scotch spearmint plots showed mild symptoms of powdery mildew at the second harvest. No *Verticillium* wilt was observed.

In this third post-establishment year of the study, there was variation in yield parameters among MIRC peppermint cultivars and selection groups (Table 2, Figure 1). No peppermint entry produced significantly more dry matter than Black Mitcham, and Murray Mitcham, M-83-14, and 92(B-37xM0110) produced significantly less. M-83-14 had less oil as percent of dry matter than the other entries. B-90-9, Black Mitcham, the McKellip selection, the two English lines, and the Plant Tech-94 selection produced the most oil, and 92(B-37xM0110) produced significantly less oil than any other entry. No new introduction or selection line surpassed the Black Mitcham from the MIRC mother block in oil production.

Of the spearmint entries, Native and N-83-22 produced more dry matter than the Scotch lines (Table 3). Scotch had the highest concentration of oil on a dry matter basis, and N-83-22 had the lowest. Native produced more than twice as much oil over the two harvests as the other varieties. This is the first year in which Native has produced more oil than Scotch (Table 4, Figure 2). The higher oil concentration of the Scotch lines could not compensate for the reduction in stand vigor. The Scotch spearmint lines experienced dramatic stand reductions, while the Native lines retained vigorous stands.

Quality data for MIRC peppermint entries are summarized in Table 5, and quality analyses for the other peppermint entries in Table 6. B-90-9 had the highest menthol, menthofuran, and total alcohol levels of the MIRC entries, indicating more "mature" oil than the other peppermints. Visual maturity ratings put it and the parental 'Black Mitcham' at the "pre bloom" stage, while 'Murray Mitcham' and its derivatives were at the "full bud" stage. M-83-14 had the highest menthone and lowest menthol levels of any variety, indicating less mature oil. Only one replicate of the hybrid 92(B-37xM0110) survived. Its chemical profile was intermediate between Murray Mitcham and Black

Mitcham. Spearmint quality data is summarized in Table 7. The Native lines have higher levels of eucalyptol than the Scotch lines, and Scotch lines have higher levels of limonene, octanol, and carvone.

CONCLUSION: None of the new cultivars or selections in the trial has shown significant improvement in oil yield over the parental lines. Black Mitcham, B-90-9, the Plant Tech 94 and McKellip selections and the two UK lines produced significantly more oil in 2001 than Murray Mitcham, M-83-14, and 92(B-37xM0110), which had lost most of its stand. Native spearmint produced twice as much oil over the two harvests as any other spearmint line. Stands of Scotch and its derivatives were severely depleted over the winter of 2000-2001.

Table 1. Stand evaluation of peppermint and spearmint entries at Kalispell, MT on June 1, 2001.

Selection/Cultivar	**Source**	*6/1/01* Cover *% of plot*	Vigor *(0-5)*[1]
PEPPERMINT			
Black Mitcham	stem-cut/MIRC	18	**1.8**
B-90-9	stem-cut/MIRC	23	**1.5**
Murray Mitcham	stem-cut/MIRC	15	**1.5**
M-83-14	stem-cut/MIRC	13	1.3
92 (B-37 x M0110)	stem-cut/MIRC	3	0.5
Lewis McKellip	nodal/MIRC	20	**1.8**
UK-1	nodal/Lake	19	**2.0**
UK-2	nodal/Lake	16	1.0
McClelland	meristem/Starkel	9	1.0
Plant Tech 94	stem-cut/Grey	14	**1.8**
	LSD (0.10)	NS	0.7
SPEARMINT			
Native	stem-cut/MIRC	**65**	**4.8**
N-83-22	stem-cut/MIRC	**65**	**5.0**
Scotch	stem-cut/MIRC	7	2.5
Scotch 770	stem-cut/MIRC	10	2.5
S-90-9	stem-cut/MIRC	8	2.3
	LSD (0.10)	6	0.9

Planted 5/19/98
[1/] 0=dead; 5=very vigorous plants

Table 2. Height, total dry matter, oil concentration, and oil yield of peppermint entries in the 1998 Mint Germplasm Trial at Kalispell, MT in 2001.

Selection/Cultivar	**Source**	Height	Hay Yield	Oil Content	Oil Yield
		inches	*tons/a*	*% dm*	*lbs/a*
Black Mitcham	stem-cut/MIRC	**22**	**2.32**	**1.8**	**113.0**
Lewis McKellip	nodal/MIRC	**24**	**2.38**	**1.8**	**100.8**
B-90-9	stem-cut/MIRC	20	**2.03**	**2.0**	**99.9**
Plant Tech-94	stem-cut/Grey	**22**	**2.15**	**1.9**	**96.1**
UK-1	nodal/Lake	**22**	**2.25**	**1.8**	**95.9**
UK-2	nodal/Lake	21	**2.10**	**1.8**	**89.3**
McClelland	meris. -Starkel	21	**1.85**	**2.0**	82.2
M-83-14	stem-cut/MIRC	21	1.75	1.1	61.5
Murray Mitcham	stem-cut/MIRC	20	1.17	**1.8**	45.6
92 (B-37 x M0110)	stem-cut/MIRC	12	0.25	0.5	12.2
	mean	20	1.82	1.6	79.6
	LSD (0.10)	3	0.58	0.5	24.1
	CV(s/mean) %	12.9	26.2	27.7	25.1

Planted 5/19/98
Harvested 8/9/01

Table 3. Height, total dry matter, oil concentration and oil yield of spearmint entries in the MIRC Mint Germplasm Trial established at Kalispell, MT in 1998.

First Harvest 7/25/01			Hay	Oil	Oil
Selection/Cultivar	**Source**	Height	Yield	Content	Yield
		inches	*t/a*	*%dm*	*lbs/a*
Native	stem-cut/MIRC	**23**	**2.93**	1.0	**63.5**
N-83-22	stem-cut/MIRC	**23**	**2.99**	0.5	29.4
S-90-9	stem-cut/MIRC	12	0.57	**1.6**	19.5
Scotch	stem-cut/MIRC	11	0.42	**2.1**	16.1
Scotch 770	stem-cut/MIRC	10	0.40	**1.5**	13.9
	LSD (0.10)	2	0.28	0.8	18.4
	CV(s/mean x100)	11.4	15.4	45.5	50.9

Second Harvest 9/27/01		Hay	Oil	Oil
Selection/Cultivar	**Source**	Yield	Content	Yield
		t/a	*%dm*	*lbs/a*
Native	stem-cut/MIRC	**0.91**	1.0	**17.8**
Scotch	stem-cut/MIRC	0.41	**1.5**	**12.5**
S-90-9	stem-cut/MIRC	0.50	1.1	10.9
N-83-22	stem-cut/MIRC	**1.02**	0.5	10.6
Scotch 770	stem-cut/MIRC	0.24	**1.4**	7.1
LSD (0.10)		0.30	0.3	5.9
CV(s/mean x100)		39.3	23.8	39.8

Planted 5/19/98

Table 4. Total dry matter and oil yields for peppermint and spearmint entries in the Mint Germplasm Trial at Kalispell, MT from 1998 to 2001.

Peppermint	1998	1998	1999	1999	2000	2000	2001	2001	Total	Total
Selection/Cultivar	Hay	Oil	Hay	Oil	Hay	Oil	Hay	Oil	Hay	Oil
	t/a	*lbs/a*	*t/a*	*lbs/a*	*t/a*	*lbs/a*	*t/a*	*lbs/a*	*t/a*	*lbs/a*
B-90-9	**1.98**	**61.2**	**3.45**	**91.9**	**3.00**	**92.1**	**2.03**	**99.9**	**10.45**	**345.0**
Black Mitcham	**2.09**	**59.7**	**3.54**	**85.6**	**2.94**	**84.5**	**2.32**	**112.9**	**10.91**	**342.7**
Lewis McKellip	**2.15**	**55.1**	**3.89**	**89.2**	**3.19**	79.2	**2.38**	**100.8**	**11.61**	**324.3**
Plant Tech 94	1.73	49.5	**3.49**	**87.7**	**3.15**	**82.8**	**2.15**	**96.1**	**10.52**	**316.1**
UK-1	1.83	50.3	3.21	70.6	**2.92**	72.3	**2.25**	**95.9**	10.21	289.1
UK-2	1.60	46.9	3.09	66.9	2.72	72.6	**2.10**	**89.3**	9.50	275.6
McClelland	**1.98**	52.4	**3.66**	70.4	2.68	65.0	**1.85**	82.2	10.17	269.9
M-83-14	**2.05**	**55.4**	**3.37**	66.6	**3.10**	62.9	1.75	61.5	**10.27**	246.2
Murray Mitcham	1.87	47.2	2.87	61.7	**3.17**	71.8	1.17	45.6	9.08	226.3
92 (B-37 x M0110)	1.67	37.3	1.61	36.8	0.57	15.2	0.25	12.2	4.10	101.4
mean	1.89	51.5	3.22	72.7	2.75	69.8	1.82	79.6	9.68	273.7
LSD (0.10)	0.23	8.0	0.54	15.0	0.41	10.6	0.58	24.1	1.37	42.9
CV(s/mean x 100)	10.3	12.8	7.1	17.1	12.3	12.9	26.2	25.1	11.8	13.0
Spearmint										
Scotch 770	1.39	**38.0**	3.58	**116.6**	3.41	**115.0**	0.64	21.0	8.36	**268.8**
Scotch	**1.76**	**44.5**	4.14	**110.6**	3.58	**104.2**	0.83	28.5	9.67	**265.9**
Native	**1.84**	34.6	**5.34**	77.0	**4.85**	95.6	**3.84**	**81.2**	**12.04**	208.1
S-90-9	1.41	26.3	3.33	74.4	3.59	92.2	1.07	30.5	8.33	193.6
N-83-22	1.57	17.7	4.54	38.8	4.08	69.7	**4.01**	40.0	10.18	124.3
mean	1.59	32.2	4.19	83.5	3.90	95.3	2.08	40.2	9.72	212.1
LSD (0.10)	0.27	7.4	0.34	14.1	0.46	16.3	0.52	21.7	1.00	25.1
CV(s/mean x 100)	12.5	13.7	12.2	13.3	9.4	13.6	20.0	42.6	8.1	9.3

Table 5. Oil quality constituents of peppermint entries in the MIRC Mint Germplasm Trial at Kalispell, MT in 2001.

Selection/Cultivar	Menthone	Menthyl acetate	Menthol	Pulegone	Menthofuran	Total ketones	Total alcohols
				GC Area %			
Black Mitcham	22.1	2.1	37.2	0.48	3.2	26.4	44.7
B-90-9	21.6	1.9	**38.3**	0.67	**4.1**	26.1	**46.4**
Murray Mitcham	25.9	2.2	36.0	0.28	2.0	30.4	43.9
M-83-14	**27.6**	2.0	35.0	0.63	2.4	**32.3**	43.0
92 (B-37 x M0110)	23.5	2.4	36.6	0.50	2.1	28.2	45.1
mean	24.1	2.1	36.6	0.51	2.8	28.7	44.6
LSD (0.10)	1.6	NS	1.1	NS	0.3	1.8	1.3
CV(s/mean)%	5.1	13.0	2.3	41.8	8.7	4.8	2.2

Table 6. Oil quality constituents of additional peppermint entries in the MIRC Mint Germplasm Trial at Kalispell, MT in 2001.

Selection/Cultivar	Menthone	Menthyl acetate	Menthol	Pulegone	Menthofuran	Total ketones	Total alcohols
				GC Area %			
Lewis McKellip	22.3	2.0	**40.1**	**0.67**	**4.20**	25.7	**48.4**
UK-1	**25.4**	1.9	37.9	0.40	3.20	**29.0**	46.0
UK-2	**25.7**	2.0	37.9	0.35	3.03	**29.2**	46.2
McClelland	22.8	2.3	**40.4**	0.51	3.23	26.3	**49.0**
Plant Tech 94	23.2	1.7	**39.7**	**0.70**	**4.05**	26.6	**47.8**
mean	23.9	1.9	39.2	0.53	3.54	27.3	47.4
LSD(0.10)	1.5	NS	1.1	0.12	0.35	1.6	1.3
CV(s/mean)%	5.0	16.9	2.3	18.1	7.8	4.6	2.2

Table 7. Oil quality constituents of spearmint entries in the Mint Germplasm Trial at Kalispell, MT in 2001.

	GC % area						
First Harvest -						Dihydro-	
Selection/Cultivar	A-Pinene	B-Pinene	Limonene	Eucalyptol*	3-Octanol	carvone	Carvone
Native	0.78	0.90	11.8	**1.69**	0.88	**1.79**	57.4
N-83-22	0.61	0.68	12.3	**1.56**	1.01	0.82	54.3
Scotch	0.61	0.76	**17.6**	0.91	**1.69**	0.97	**62.2**
Scotch 770	0.59	0.74	**17.0**	0.69	**1.48**	0.91	**61.3**
S-90-9	0.64	0.79	**17.1**	0.89	**1.46**	0.81	59.0
mean	0.65	0.77	15.1	1.15	1.30	1.06	58.8
LSD (0.10)	NS	NS	4.2	0.30	0.52	0.36	2.7
CV(s/mean)%	17.8	14.7	20.4	18.9	29.3	26.7	3.6
Second Harvest -							
Native	0.67	0.83	12.5	**1.54**	1.11	**1.35**	**53.7**
N-83-22	0.65	0.82	14.5	**1.58**	0.92	0.71	51.7
Scotch	0.69	0.87	**19.8**	1.18	**1.94**	1.02	**55.7**
Scotch 770	0.78	0.93	**21.2**	0.88	**1.88**	**1.24**	**55.2**
S-90-9	0.68	0.87	18.9	1.11	1.51	**1.68**	**55.3**
mean	0.69	0.86	17.4	1.26	1.47	1.20	54.3
LSD (0.10)	NS	NS	2.2	0.25	0.25	0.53	2.1
CV(s/mean)%	9.6	6.9	9.8	15.4	13.3	34.4	3.0

* 1,8 Cineole

Figure 1. Oil yields of peppermint lines in the Mint Cultivar Trial established in 1998.

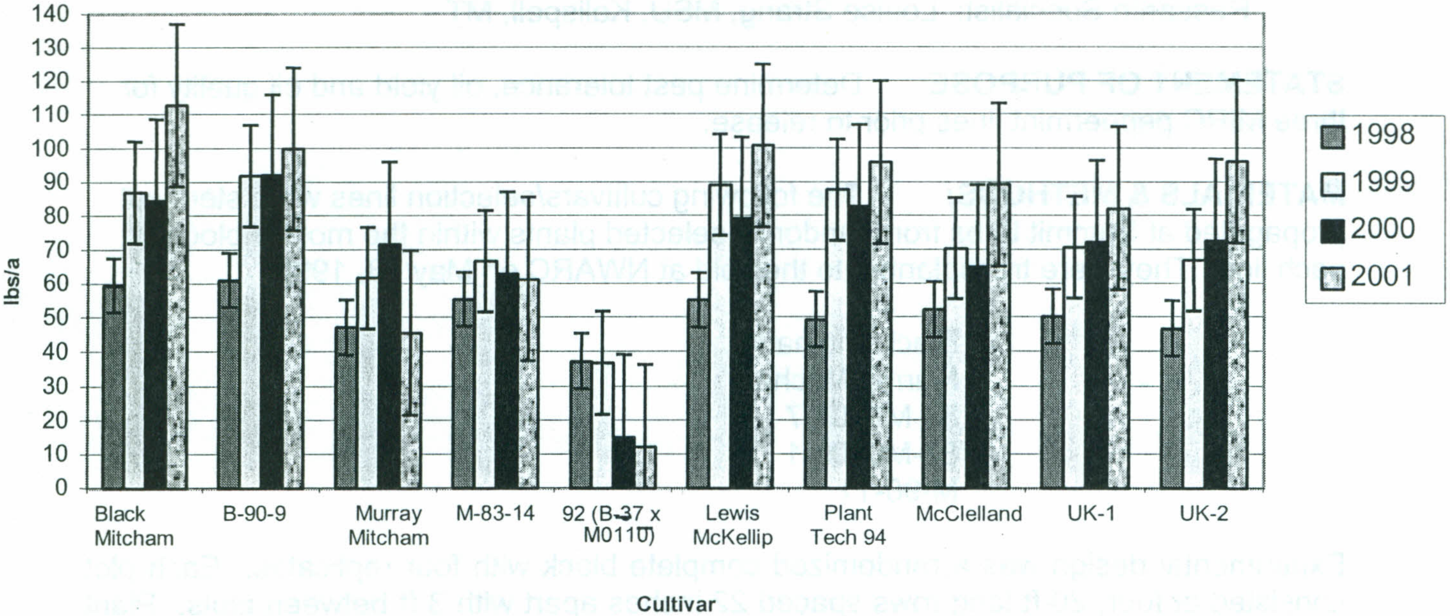
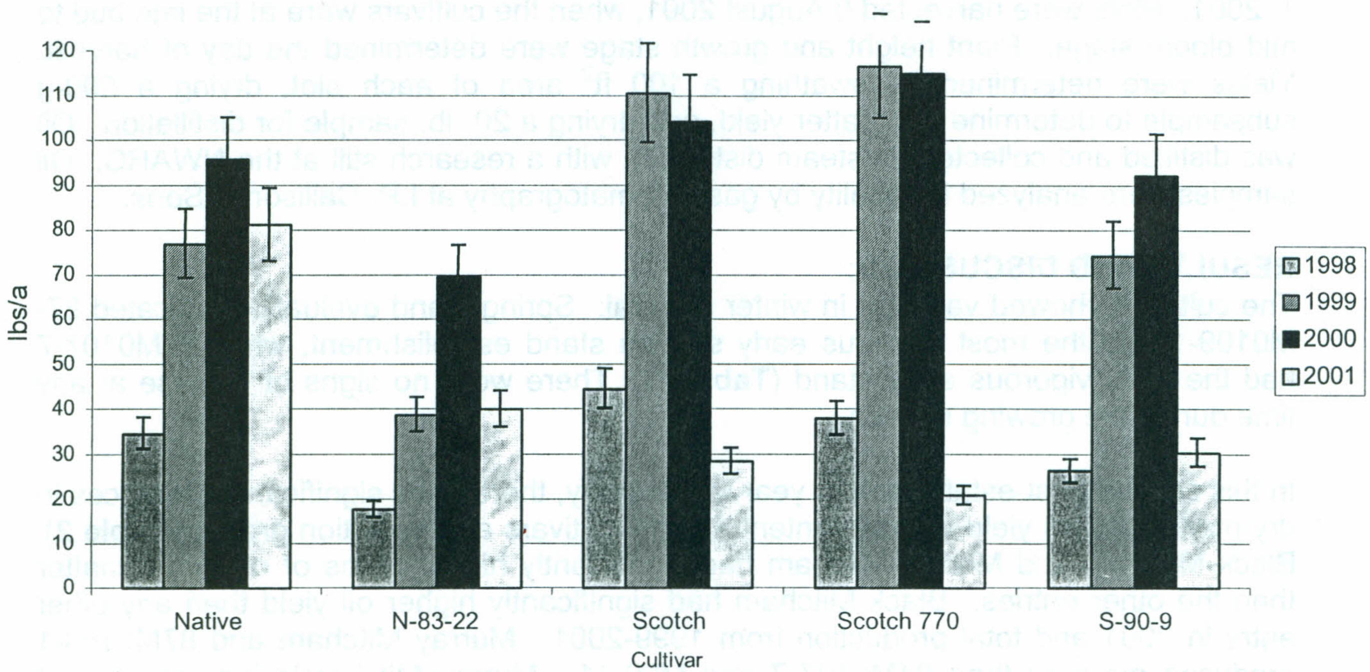


Figure 2. Oil yields of spearmint lines in the Mint Cultivar Trial established in 1998.



TITLE: EVALUATION OF MIRC PEPPERMINT GERMPLASM - 1999-2001

PRINCIPAL RESEARCHERS:

Project Leader: 1999-2000 - Leon E. Welty, Professor of Agronomy, MSU, Kalispell, MT
2001 - Duane Johnson, Associate Professor of Agronomy, MSU, Kalispell, MT.
Research Specialist: Louise Strang, MSU, Kalispell, MT

STATEMENT OF PURPOSE: Determine pest tolerance, oil yield and oil quality for three MIRC peppermint lines prior to release.

MATERIALS & METHODS: The following cultivars/selection lines were stem-cut propagated at Summit Labs from randomly selected plants within the mother block of each line. They were transplanted to the field at NWARC on May 18, 1999:

Black Mitcham
Murray Mitcham
84-M0107-7
87-M0109-1
M-90-11

Experimental design was a randomized complete block with four replicates. Each plot consisted of four, 20-ft long rows spaced 22 inches apart with 3 ft between plots. Plant spacing was one foot within each row. Appropriate management practices (irrigation, fertility, and weed and pest control) were employed to insure maximum mint oil production. On 10 April 2000, *Verticillium* wilt was seeded in a 50/50 mixture of oats and ground wheat in the middle ten feet of each plot. Stand occupancy was rated June 1, 2001. Plots were harvested 8 August 2001, when the cultivars were at the late bud to mid bloom stage. Plant height and growth stage were determined the day of harvest. Yields were determined by swathing a 100 ft^2 area of each plot, drying a 500-g subsample to determine dry matter yield, and drying a 20- lb. sample for distillation. Oil was distilled and collected by steam distillation with a research still at the NWARC. Oil samples were analyzed for quality by gas chromatography at I.P. Callison & Sons.

RESULTS AND DISCUSSION:
The cultivars showed variation in winter survival. Spring stand evaluation indicated 87-M0109-1 had the most vigorous early season stand establishment, while 84M0107-7 had the least vigorous early stand (**Table 1**). There were no signs of disease at any time during the growing season.

In this second post-establishment year of the study, there were significant differences in dry matter and oil yield and oil content among cultivars and selection groups (**Table 2**). Black Mitcham and Murray Mitcham had significantly higher ratios of oil to dry matter than the other entries. Black Mitcham had significantly higher oil yield than any other entry in 2001 and total production from 1999-2001. Murray Mitcham and 87M0109-1 produced more oil than 84M0107-7 and M90-11. Murray Mitcham's lack of vigor at establishment was followed by more vigorous growth the second and third seasons (**Figure 1**). We have not yet been able to evaluate the entries in the presence of disease pressure.

Analysis of the chemical constituents of the oil is summarized in **Table 3**. Black Mitcham contained the highest menthol level followed by Murray Mitcham. Black Mitcham matured faster than the other varieties, being at the mid bloom stage at harvest. M90-11 was the slowest to mature, being still at the bud stage. 84M0107-7 had the least "mature" oil with the lowest menthol and highest menthone levels.

CONCLUSION: The experimental entry 87M0109-1 had the most vigorous growth and healthiest stand of any variety. It surpassed all entries in dry matter production in 2001 and in total hay yield over the duration of the trial. Black Mitcham, however, produced more oil than the other entries. 84M0107-7 and M90-11 were the poorest oil producers. There were no signs of disease at any time during the growing season.

Table 1. Stand establishment evaluation of peppermint entries in the 1999 MIRC Peppermint Trial at Kalispell, MT on June 1, 2001.

Selection/Cultivar	Cover	Vigor	Stolon Spread
	% of plot	*(1-5)*[1]	*(1-5)*[2]
Black Mitcham	64	3.3	2.5
84-M0107-7	38	3.0	2.8
M-90-11	63	3.0	3.0
87-M0109-1	**86**	**5.0**	**3.8**
Murray Mitcham	55	2.8	2.8
mean	61	3.4	3.0
LSD(0.10)	21	0.8	0.6
CV(s/mean) %	27.3	17.6	14.8

Planted 5/18/99

1/ 1=dead; 5=very healthy, vigorous growth
2/ 1=no visible spread from crowns; 5=extensive spreading

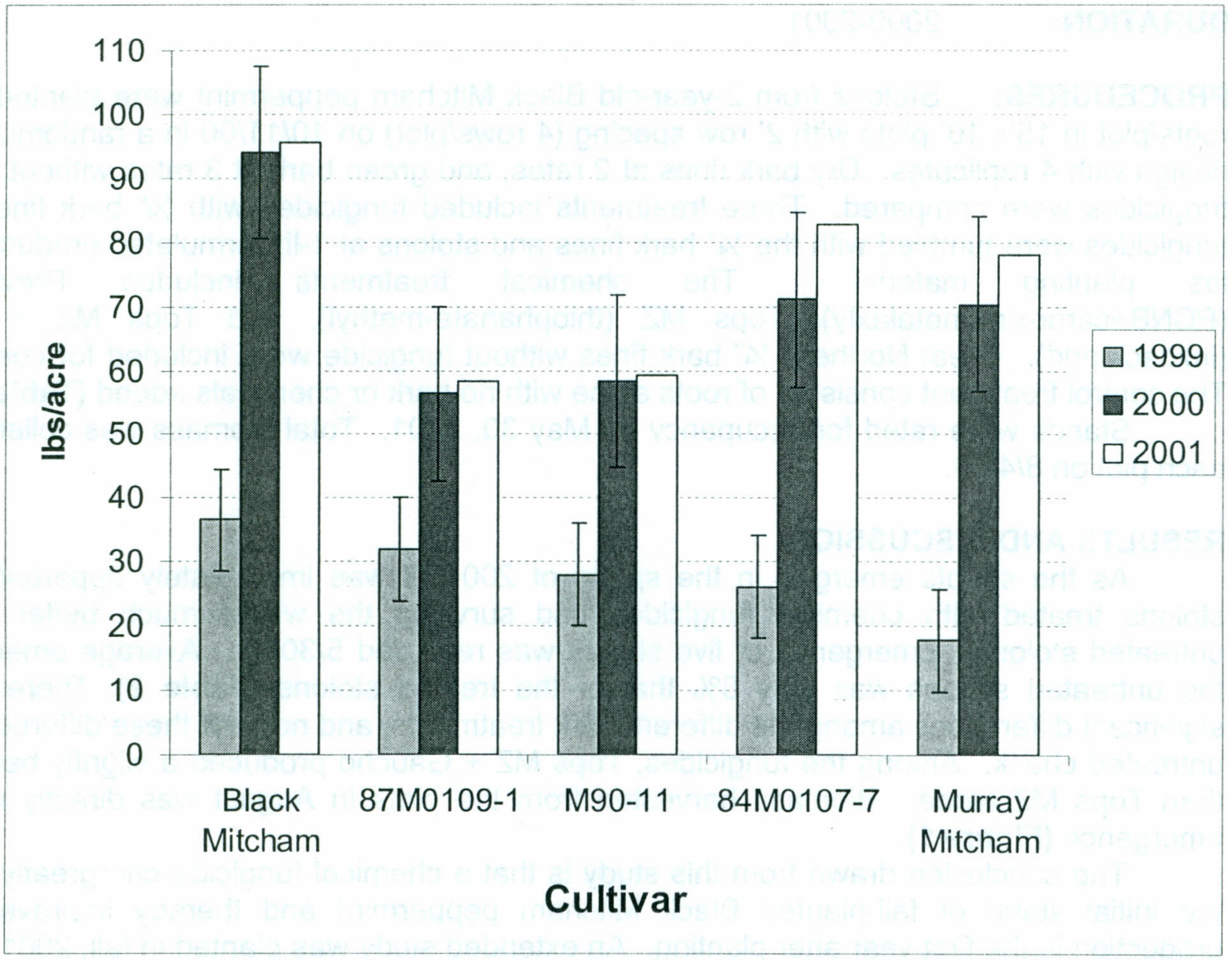
Table 2. Plant height, dry matter yield, and oil yield of peppermint entries in the 1999 MIRC Peppermint Trial at Kalispell, MT on 8 August, 2001 and total yields for the duration of the trial.

Selection/Cultivar	Height	Hay Yield	Oil Content	Oil Yield	1999-2001 Hay Yield	1999-2001 Oil Yield
	inches	*t/a*	*%dm*	*lbs/a*	*t/a*	*lbs/a*
Black Mitcham	28	2.52	**1.9**	**95.4**	7.40	**226.0**
87-M0109-1	**36**	**3.51**	1.2	82.7	**9.60**	185.7
Murray Mitcham	27	2.21	**1.8**	77.9	6.36	166.0
M90-11	31	2.73	1.1	59.4	8.10	145.6
84-M0107-7	31	2.92	1.0	58.3	8.38	140.6
mean	31	2.78	1.4	74.7	7.97	172.8
LSD (0.10)	3	0.37	0.2	10.5	1.08	20.8
CV(s/mean x100)	7.6	10.6	12.4	11.1	10.8	9.6

Table 3. Levels of oil quality components (GC % area) of entries in the 1999 MIRC Peppermint Trial harvested at Kalispell, MT on 8 August 2001.

	GC % area						
Line/Cultivar	Menthone	Mentho-furan	D Iso-menthone	Menthyl acetate	Neo-menthol	Menthol	Pulegone
Black Mitcham	20.4	**4.0**	3.2	**1.8**	**2.7**	**37.1**	0.9
84M0107-7	**37.2**	0.7	14.7	0.9	1.6	16.9	0.4
M90-11	22.3	3.2	11.8	**1.8**	1.4	23.1	**2.3**
87M0109-1	32.3	1.2	**15.6**	1.4	2.0	19.1	0.9
Murray Mitcham	24.9	2.5	3.7	1.5	**2.7**	33.4	0.6
mean	27.4	2.3	9.8	1.5	2.1	25.9	1.0
LSD (0.10)	1.6	0.4	0.8	0.2	0.2	1.7	0.4
CV(s/mean) %	4.8	13.0	6.9	13.0	8.2	5.3	31.0

Figure 1. Oil yields of entries in the MIRC Peppermint Cultivar Trial, from 1999-2001 at Kalispell, MT.



TITLE: **PEPPERMINT STOLON SURVIVAL STUDY**

PERSONNEL: Leon E. Welty, Professor of Agronomy, MSU, Kalispell, MT - 2000; Duane L. Johnson, Assoc. Professor of Agronomy, MSU, Kalispell, MT - 2001 Louise Strang, Research Specialist, MSU, Kalispell, MT

OBJECTIVE: Compare winter survival of peppermint stolons planted with green and dry bark fines with and without the addition of chemical fungicides.

DURATION: 2000-2001

PROCEDURES: Stolons from 2-year-old Black Mitcham peppermint were planted at 2 lbs roots/plot in 15'x 10' plots with 2' row spacing (4 rows/plot) on 10/11/00 in a randomized block design with 4 replicates. Dry bark fines at 2 rates, and green bark at 3 rates without chemical fungicides were compared. Three treatments included fungicides with ¼" bark fines. The fungicides were tumbled with the ¼" bark fines and stolons at 1-lb formulated product per 100 lbs planting material. The chemical treatments included Prevail HB (PCNB+carboxin+metalaxly), Tops MZ (thiophanate-methyl), and Tops MZ + Gaucho (imidacloprid). Great Northern ¼" bark fines without fungicide were included for comparison. The control treatment consisted of roots alone with no bark or chemicals added **(Table 1**).

Stands were rated for occupancy on May 30, 2001. Total biomass was collected from each plot on 8/4/00.

RESULTS AND DISCUSSION:

As the shoots emerged in the spring of 2001, it was immediately apparent that the stolons treated with chemical fungicides had survived the winter much better than the untreated stolons. Emergence of live shoots was recorded 5/30/01. Average emergence of the untreated stolons was only 8% that of the treated stolons (**Table 2**). There were no significant differences among the different bark treatments, and none of these differed from the untreated check. Among the fungicides, Tops MZ + Gaucho produced a slightly better stand than Tops MZ alone. Biomass harvested from the plots in August was directly related to emergence **(Figure 1)**.

The conclusion drawn from this study is that a chemical fungicide can greatly enhance the initial stand of fall-planted Black Mitcham peppermint and thereby improve mint oil production in the first year after planting. An extended study was planted in fall, 2001, in which 3 *Mentha* cultivars and 5 fungicide treatments will be compared.

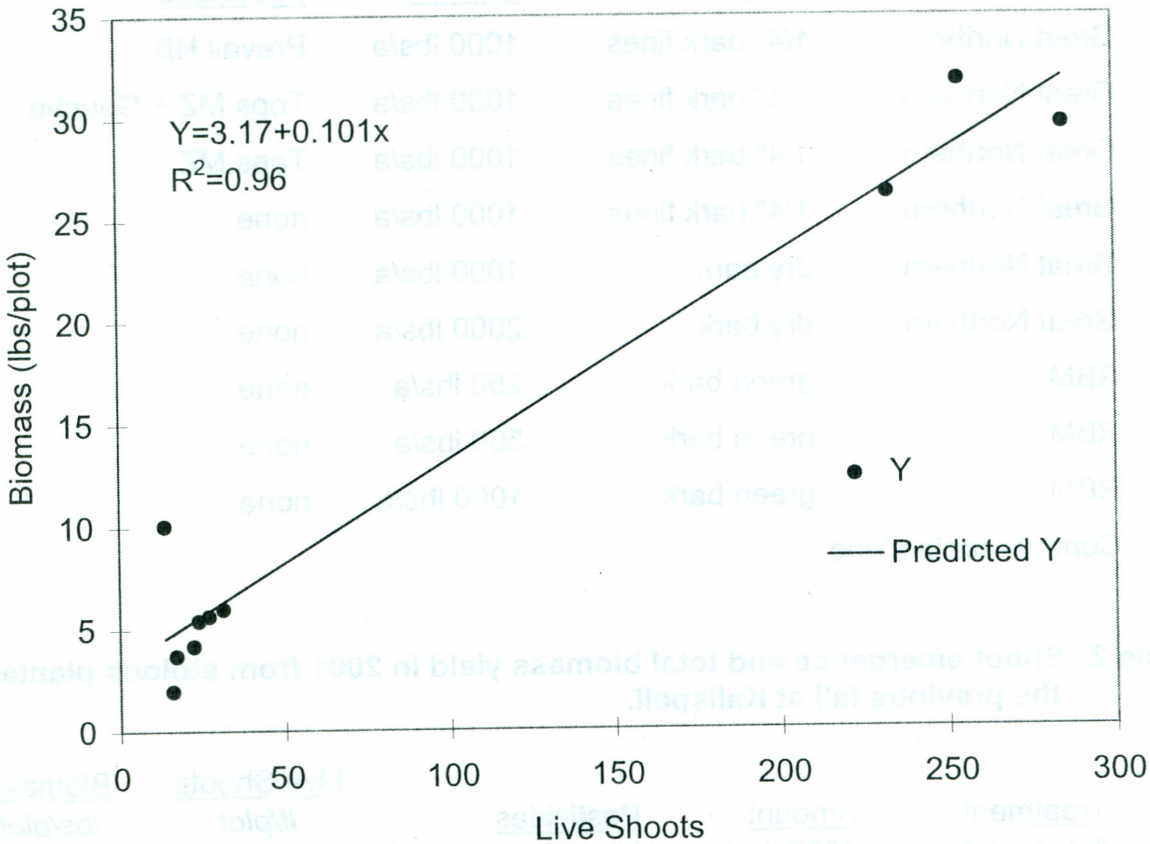
Table 1. Stolon treatments used in the Stolon Survival study at Kalispell, 2000-2001.

Source	Type	Amount	Pesticides
Great Northern	1/4" bark fines	1000 lbs/a	Prevail HB
Great Northern	1/4" bark fines	1000 lbs/a	Tops MZ + Gaucho
Great Northern	1/4" bark fines	1000 lbs/a	Tops MZ
Great Northern	1/4" bark fines	1000 lbs/a	none
Great Northern	dry bark	1000 lbs/a	none
Great Northern	dry bark	2000 lbs/a	none
RBM	green bark	250 lbs/a	none
RBM	green bark	500 lbs/a	none
RBM	green bark	1000 lbs/a	none
Control - roots alone			

Table 2. Shoot emergence and total biomass yield in 2001 from stolons planted the previous fall at Kalispell.

Treatment	Amount	Pesticides	Live Shoots #/plot	Biomass lbs/plot
1/4" bark fines	1000 lbs/a	Prevail HB	**254**	**31.8**
1/4" bark fines	1000 lbs/a	Tops MZ + Gaucho	**285**	**29.6**
1/4" bark fines	1000 lbs/a	Tops MZ	233	**26.3**
1/4" bark fines	1000 lbs/a	none	31	6.0
dry bark	1000 lbs/a	none	14	10.1
dry bark	2000 lbs/a	none	27	5.7
green bark	250 lbs/a	none	24	5.4
green bark	500 lbs/a	none	16	2.0
green bark	1000 lbs/a	none	17	3.7
control - roots alone			22	4.2
		mean	100	13.4
		LSD (0.10)	34	7.0
		CV(s/mean)	31.1	46.9

Figure 1. Relationship between shoot emergence and biomass yield.



TITLE: **<u>Dill Harvest Timing Trial</u>**
PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Dill (cv. Mammoth) was seeded at 8 lbs PLS/acre on 5/10/01. Plots were 8-10' rows with one-ft spacing arranged in a randomized complete block design with 4 replicates. Treatments were 6 harvest dates between 8/16 and 8/31/01. Fifty square feet of each plot were harvested and a 20-lb sample distilled fresh to compare oil yield and quality from plants of different maturity levels.

The 2 earliest harvests produced more oil than the later harvests (Table 1, Figure 1). Oil quality analysis is presented in Table 2 and Figure 2. Carvone levels exceeded 35% beginning on 8/24, when oil yield was 49.1 lbs/a.

Table 1. Plant height, dry matter and oil yields of dill harvested on 6 dates in 2001.

Harvest	Harvest Date	Plant Height	Dry Matter Yield	Oil Yield
		inches	*t/a*	*lbs/a*
HD-1	8/16	45	1.97	52.2
HD-2	8/20	**53**	1.91	56.4
HD-3	8/22	**54**	1.83	45.2
HD-4	8/24	**55**	2.03	49.1
HD-5	8/27	**56**	1.84	32.6
HD-6	8/31	48	**2.63**	35.8
	mean	52	2.03	45.2
	LSD (0.05)	4	.56(P=.06)	NS
	CV(s/mean)%	4.5	18.2	32.4

Table 2. Oil quality components of dill harvested on 6 dates in 2001.

Harvest	Harvest Date	a-pinene	d-phellandrene	d-limonene	e-menthene	d-carvone
		Area %				
HD-1	8/16	**1.01**	**35.03**	21.60	**13.32**	21.54
HD-2	8/20	0.85	**30.19**	19.58	10.48	31.52
HD-3	8/22	0.85	**35.60**	18.64	9.36	27.40
HD-4	8/24	0.72	**28.13**	18.92	9.57	**36.20**
HD-5	8/27	0.58	19.85	17.52	10.32	**40.38**
HD-6	8/31	0.71	**29.38**	16.30	8.53	**37.18**
	mean	0.79	29.70	18.76	10.26	32.37
	LSD(0.05)	0.11	8.82	NS	2.03	4.45
	CV(s/mean) %	9.1	19.7	13.0	13.1	9.1

Figure 1. Effect of harvest timing on oil yield.

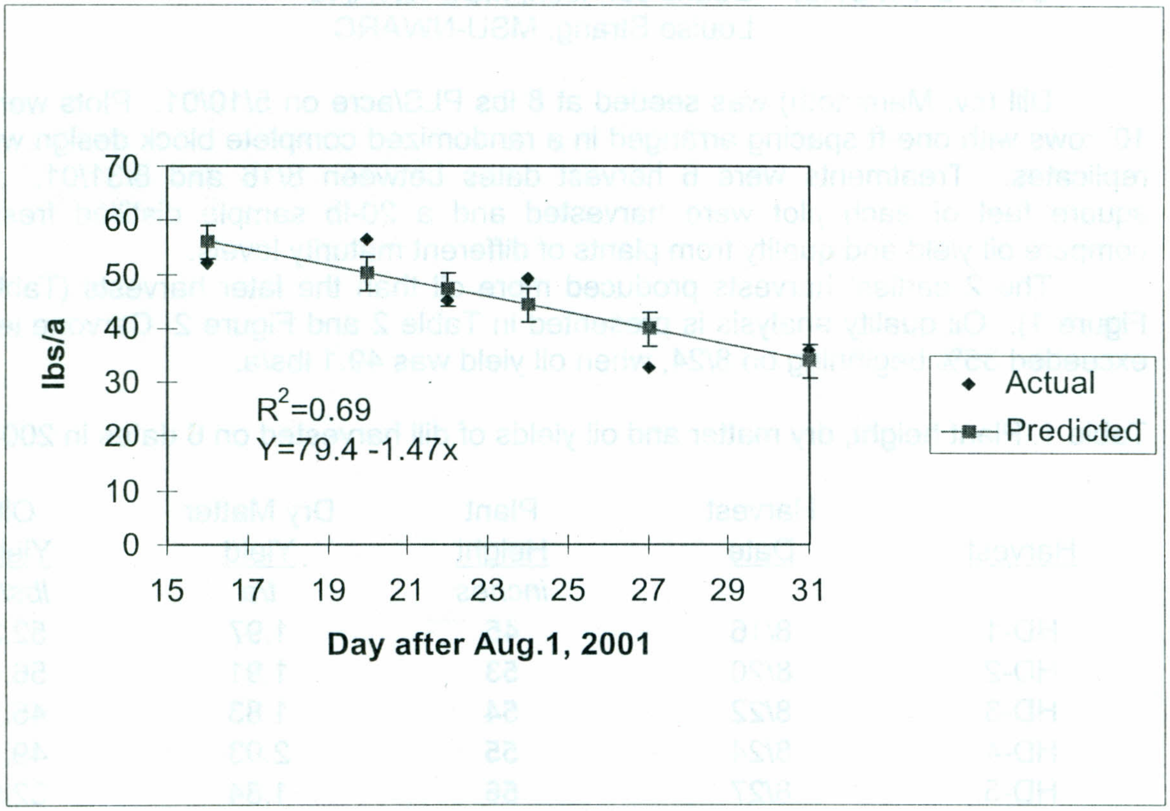
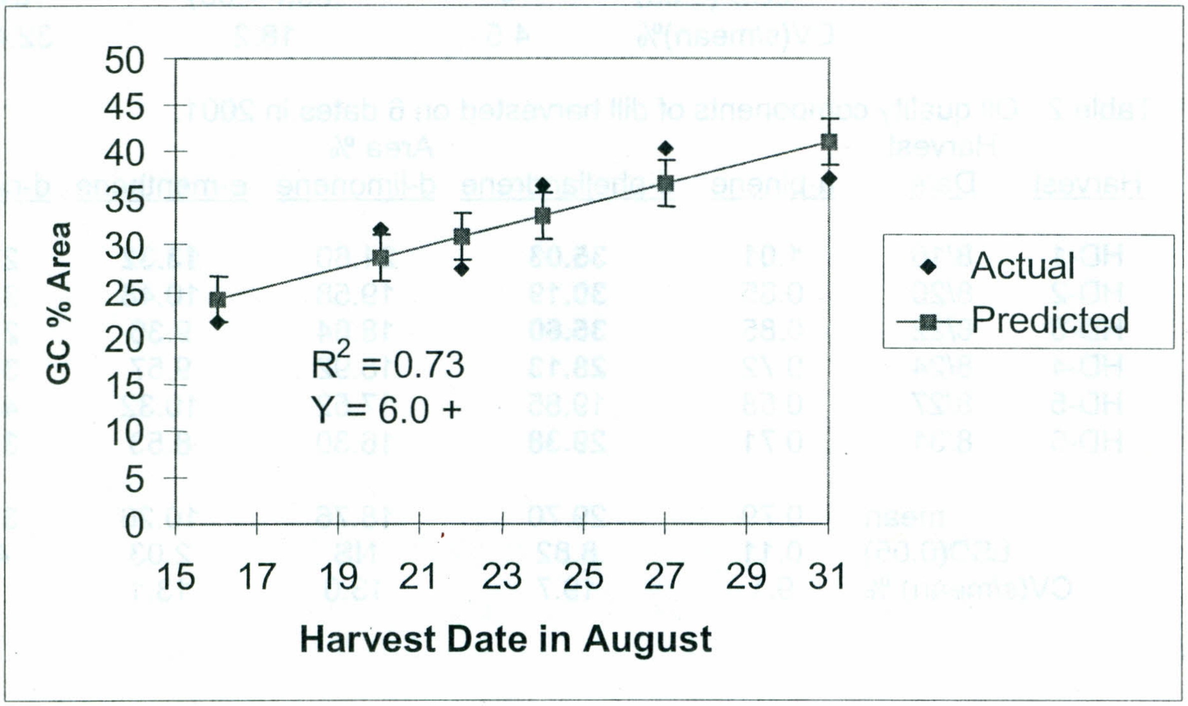


Figure 2. Effect of harvest timing on carvone level of dill oil.



TITLE: **Dill Planting Pattern and Seeding Rate Trial**

PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Dill (cv. Mammoth) was seeded at 4 and 10 lbs/acre on 5/11/01. Plots were 8-15' long rows with 6-inch, 12-inch, and 30-inch row spacing or broadcast seeded. The 8 treatments were arranged in a randomized complete block design with 4 replicates. Fifty-six square feet of each plot was harvested 8/23-24/01 and distilled fresh. On the Average, oil yield from the 12-inch and 30-inch spacing was significantly higher than yield from the broadcast seeding (Table 1). Broadcast seeding at the 10-lb seeding rate produced twice the oil as broadcasting at the 4-lb rate. Oil quality analyses (Table 2) revealed immature oil. The highest carvone level was found in the low rate wide spacing treatment. The lower seeding rate combined with regular wide row spacing allowed less crowding and faster, more uniform maturity.

Table 1. Yields of dill oil from 4 planting patterns and 2 seeding rates at Kalispell in 2001.

Dry Matter Yield (t/a)

Planting Pattern	Seeding Rate 10 lbs/a	Seeding Rate 4 lbs/a	mean	LSD(0.05)	
broadcast	1.91	1.94	1.93	pattern	NS
12" row spacing	2.28	2.27	2.28	rate	NS
6" row spacing	2.03	2.42	2.23	pattern x rate	NS
30" row spacing	2.90	1.83	2.36		
mean	2.28	2.11			

Oil Content (% dry matter)

Planting Pattern	Seeding Rate 10 lbs/a	Seeding Rate 4 lbs/a	mean	LSD(0.05)	
broadcast	**0.26**	0.11	0.18	pattern	NS
12" row spacing	**0.20**	**0.22**	0.21	rate	NS
6" row spacing	0.14	**0.21**	0.18	pattern x rate	0.08
30" row spacing	**0.22**	**0.24**	0.23		
mean	0.21	0.19			

Table 1 (cont.)

Oil Yield (lbs/a)

Planting Pattern	Seeding Rate 10 lbs/a	4 lbs/a	mean	LSD(0.05)	
broadcast	**31.6**	16.0	23.8	pattern	8.3
12" row spacing	**30.0**	**34.9**	**32.4**	rate	NS
6" row spacing	21.6	**30.4**	**26.0**	pattern x rate	11.7
30" row spacing	**36.5**	**30.1**	**33.3**		
mean	29.9	27.8			

Table 2. Oil quality components of dill oil from 4 planting patterns and 2 seeding rates at Kalispell in 2001.

DILL PLANTING PATTERN and SEEDING RATE

Kalispell, 2001

a-Pinene (GC area %)

Planting Pattern	Seeding Rate: 10 lbs/a	4 lbs/a	mean	LSD(0.05)	
broadcast	1.14	1.23	**1.18**	pattern	0.18
6" row spacing	1.39	1.05	**1.22**	rate	0.13
12" row spacing	1.26	1.07	**1.17**	pattern x rate	NS
30" row spacing	1.12	0.82	0.97		
mean	**1.23**	1.04			

d-Phellandrene (GC area %)

Planting Pattern	Seeding Rate: 10 lbs/a	4 lbs/a	mean	LSD(0.05)	
broadcast	43.72	**49.49**	**46.61**	pattern	4.25
6" row spacing	**54.76**	**40.09**	**47.43**	rate	3.01
12" row spacing	45.24	**42.23**	**43.74**	pattern x rate	6.01
30" row spacing	42.84	33.75	38.30		
mean	**46.64**	41.39			

d-Carvone (GC area %)

Planting Pattern	Seeding Rate: 10 lbs/a	4 lbs/a	mean	LSD(0.05)	
broadcast	15.23	9.24	12.23	pattern	3.87
6" row spacing	8.93	19.04	13.99	rate	2.74
12" row spacing	12.70	16.51	14.61	pattern x rate	5.48
30" row spacing	18.21	**25.19**	**21.70**		
mean	13.77	**17.49**			

TITLE: **Dill Planting Date Trial**
PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Dill (cv. Mammoth) was seeded at 16 lbs PLS/acre on 10/5/00 and at 8 lbs PLS/a on 11/3/2000, 4/18/01, 5/10/01, and 5/31/01. Plots were 8-10' rows with one-ft spacing arranged in a randomized complete block design with 4 replicates. Treatments were the 5 seeding dates. Fifty square feet of each plot were harvested when buds on the primary umbels were swollen and beginning to turn light brown. A 20-lb sample from each plot was distilled fresh to compare oil yield and quality from different planting dates.

The 5/31 planting never matured beyond the flowering stage as of 9/7/01, so it was not harvested. The 2 spring plantings produced more oil than the fall plantings although the 5/10 planting produced significantly less dry matter than the 10/5 planting (Table 1). The oil content (oil % of dry matter) was significantly higher for the 5/10 planting than for the earlier plantings. Spring stand counts were highest for the 11/3/00 planting, and the 10/5 seeding had the tallest plants at harvest (Table 1). There were no significant differences in oil quality components among the planting dates (Table 2). Carvone levels averaged 27% indicating immature oil.

Table 1. Stand, height, dry matter, and oil yield of dill planted at 4 different dates from fall 2000 to spring 2001.

Planting Date	Spring Stand	Plant Height	Dry Matter Yield	Oil Content	Oil Yield
	pl/sqft	*in*	*t/a*	*%dm*	*lbs/a*
5-Oct-00	12.4	**64**	2.00	0.11	25.7
3-Nov-00	**26.5**	53	**2.74**	0.12	32.6
18-Apr-01	15.3	53	**3.54**	0.16	**44.0**
10-May-01	13.7	56	1.48	**0.31**	**49.8**
mean	17.0	56	2.44	0.17	38.0
LSD(0.05)	5.3	6	1.05	0.05	14.8
CV(s/mean)	16.1	6.6	21.9	15.8	19.9

Table 2. Oil quality components of dill planted at 4 different dates from fall 2000 to spring 2001.

Planting	GC Area %				
Date	a-pinene	d-phellandrene	d-limonene	e-menthene	d-carvone
5-Oct-00	0.86	31.11	22.34	8.80	23.38
3-Nov-00	0.76	35.80	18.65	7.39	27.96
18-Apr-01	0.82	36.29	18.78	8.21	27.45
10-May-01	0.74	31.31	20.99	9.99	29.94
mean	0.80	33.63	20.19	8.60	27.18
LSD (0.05)	NS	NS	NS	NS	NS
CV(s/mean)%	21.8	17.0	16.2	21.4	14.6

TITLE: **Nitrogen Fertility of Dill**

PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Duane Johnson, MSU-NWARC
Louise Strang, MSU-NWARC

Dill (cv. Mammoth) was seeded at 8 lbs PLS/a on 5/10/01. Plots were 8-15' rows with one-ft spacing arranged in a randomized complete block design with 4 replicates. Treatments were 4 N fertilizer rates, applied as 34-0-0, and an unfertilized check. The fertilizer treatments were applied 7/13/01. Fifty square feet of each plot were harvested 8/24/01, when buds on the primary umbels were swollen and beginning to turn light brown. A 12-lb sample from each plot was distilled fresh to compare oil yield and quality from different fertilizer rates.

There were no significant differences in dry matter or oil yields among the fertilizer treatments (Table 1). The 100-N treatment had less oil content (oil % of dry matter) than the other treatments, with no apparent explanation. There were no significant differences in oil quality components among the N-rates (Table 2). Carvone levels averaged 16%, indicating very immature oil.

Table 1. Dry matter and oil yield of dill grown with different rates of N fertilizer.

N fert	DMYld	Oil Cont	Oil yld
lbs/a	*t/a*	*%DM*	*lbs/a*
0-N	3.29	**0.21**	43.9
50-N	3.04	**0.21**	42.2
100-N	3.48	0.14	31.2
150-N	3.46	**0.20**	43.8
mean	3.32	0.19	40.3
LSD (0.05)	NS	0.05	NS
CV(s/means)	17.9	16.5	26.2

Table 2. Oil quality components of dill grown under different rates of N fertilizer.

			GC Area %		
N fert	a-pinene	d-phellandrene	d-limonene	e-menthene	d-carvone
lbs/a					
0-N	1.09	43.0	20.9	10.5	16.0
50-N	1.08	42.2	21.9	10.4	16.2
100-N	0.97	41.4	20.5	12.4	16.3
150-N	1.10	43.7	20.3	10.5	15.9
mean	1.06	42.6	20.9	10.9	16.1
LSD (0.05)	NS	NS	NS	NS	NS
CV(s/mean)%	5.9	5.6	6.5	16.1	11.9