Northwestern Agricultural Research Center
of the
Department of Research Centers
Montana Agricultural Experiment Station
Montana State University

FIFTY-SECOND ANNUAL REPORT
2000

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TABLE OF CONTENTS

FORAGE CROP INVESTIGATIONS (755)

MISCELLANEOUS AND PULSE CROP INVESTIGATIONS (758)

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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 1999-August 2000) and for the calendar year 2000.

CLIMATOLOGICAL DATA
NORTHWEST AGRICULTURAL RESEARCH CENTER
Kalispell, Montana

The 1999/2000 crop year was dry with temperatures running close to the established averages in most months. Total precipitation from September 1999 through August 2000 was nearly 20% below average. Accumulated growing degree days were 25% below average (1413 for the crop year vs. 1867 for the 1949-2000 average). Precipitation was significantly below average for September and December 1999, and for May through August 2000.

The 2000 growing season (April – August) received 6.09" of rain, 29% below average. April was the only month with above average precipitation.

The last spring frost was June 1, 1999 – 8 days later than the average of May 22. The first killing frost in the fall was September 22, nine days later than the average date of September 13. Temperatures for April through August ran close to the average with the exception of May and June, which were slightly cooler.

The winter of 2000-2001 was mild for this location. The minimum recorded temperature was 2° F. Temperatures from November through January were above average with some snow cover, so perennial and winter annual crops should survive with minimal damage. With below average precipitation in 2000 and about half the average snow pack at higher elevations, abundant spring moisture is required for good crop performance in 2001.

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

Table Summary of climatic data by months for 1999-2000 cr year (September through August) and averages for period 1949-2000 at the Northwestern Agricultural Research Center, Kalispell, Montana

ITEM	Sept. 1999	Oct. 1999	Nov. 1999	Dec. 1999	Jan. 2000	Feb. 2000	Mar. 2000	Apr. 2000	May 2000	June 2000	July 2000	Aug. 2000	Total	Average
Precipitation (inches)														
Current Year	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	1.35
Avg. 1949 to 1999-2000	1.57	1.37	1.57	1.62	1.48	1.16	1.19	1.51	2.34	2.95	1.61	1.52	19.89	1.66
Average Temperature (F)														
Current Year	51.3	42.9	38.1	31	25.8	26.3	36.9	43.4	50.4	56.2	63.9	63.4		44.13
Mean 1949 to 1999-2000	53.6	43.2	32.7	25.5	22.5	27.8	33.9	43.1	51.7	58.1	63.9	63		43.25

Last killing frost in spring

2000	June 1: 32 degrees F
Avg. 1949-2000	May 23

First killing frost in fall

2000	September 22: 32 degrees
Avg. 1949-2000	September 12

Frost Free Period

2000	112 days
Avg. 1949-2000	114 days

Growing Degree Days (base 50): 1671.5 days in 2000: May 1 - October 31
1872.3 days - average for 1949 - 2000

Maximum summer temperature 96 degrees F on July 23, 2000
Minimum winter temperature 2 degrees F on January 24, February 20 & 21

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 1, 1949 through August 31, 2000.

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
MEAN	53.6	43.2	32.7	25.5	22.5	27.8	33.9	43.2	51.6	58.1	63.9	63.0	43.3

Mean temperature for all years = 43.3

Table 3. Summary of temperature data at the Northwestern Agricultural Research Center on a crop year basis, September 1, 1949 thru August 31, 2000.

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
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
MEAN	68.7	55.3	40.1	32.1	29.9	36.2	43.6	54.9	64.6	71.2	79.6	79.4	54.6

Mean temperature for all years = 54.6

Table 4. Summary of temperature data at the Northwestern Agricultural Research Center on crop year basi
September 1, 1949 through August 31, 1999.

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
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
MEAN	38.6	31.3	25.2	18.9	15.1	19.4	24.1	31.4	38.6	45.0	48.2	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
MEAN	1.54	1.34	1.57	1.62	1.48	1.16	1.19	1.51	2.34	2.95	1.61	1.52	19.88

Mean precipitation for all crop years = 19.50

Table 6. **Precipitation By Day for September 1999 - August 2000**
Northwestern Agricultural Research Center, Kalispell

DATE	SEPT. 1999	OCT. 1999	NOV. 1999	DEC. 1999	JAN. 2000	FEB. 2000	MAR. 2000	APR. 2000	MAY 2000	JUNE 2000	JULY 2000	AUG. 2000	YTD
1	0.00	0.00	0.08	0.01	0.03	T				0.25			
2	0.00	0.00	0.00	T	0.01	0.05							
3	0.12	0.00	0.00	T	0.13				0.06	0.01	0.03		
4	0.00	0.00	T	0.00	0.04	0.14			0.07		0.34		
5	0.00	0.00	T	0.00			0.01	0.50			0.02	0.06	
6	0.00	0.00	0.25	T					T		0.01		
7	0.00	0.00	0.03	0.00			0.01	0.09			0.27		
8	0.00	0.09	0.01	0.00	T	T							
9	0.00	0.32	T	0.11	T	0.05			0.04	T			
10	0.00	0.13	0.00		T		T		0.16	T	0.04		
11	0.00	0.00	0.00	0.03	0.10		0.02		T	0.07		0.13	
12	0.00	0.13	0.00	0.10	0.06	T	0.10			0.10		0.05	
13	0.00	0.00	0.19	0.00		0.12	0.02		0.11	0.27			
14	0.00	0.02	0.05	0.04	0.26	0.02	0.10	1.10					
15	0.00	0.00	0.00	0.13	0.04	0.37	T	0.12		0.11			
16	0.00	0.00	0.00	0.36	0.04			0.01		0.24			
17	0.00	0.00	0.00	0.00	0.08		0.14	0.15		0.07			
18	0.00	0.00	0.90	0.12					0.14				
19	0.00	0.00	0.00	0.00			0.02		T	0.23			
20	0.00	0.00	0.00	T	0.01				0.11	0.28			
21	0.00	0.00	0.00	0.00	0.25								
22	0.00	0.00	T	0.00	T	T				T			
23	0.00	0.00	0.00	0.00	0.01	0.05	0.30	0.05			0.13		
24	0.00	0.00	0.00	0.00		0.26							
25	0.00	0.00	0.37	0.00		0.53				0.17		0.09	
26	0.10	0.14	0.43	0.00	0.20	0.02							
27	0.12	0.45	0.02	0.00	0.16	0.01							
28	0.00	0.36	T	T	0.02	0.19	0.22	0.05	0.17				
29	0.02	0.08	0.00	T			0.16	0.14					
30	0.00	0.00	0.00	0.00			0.20					0.02	
31		0.00		0.18					0.03				
TOTAL	0.36	1.72	2.33	1.08	1.44	1.81	1.30	2.21	0.89	1.80	0.84	0.35	16.13

Table 7. Frost free period at the Northwestern Agricultural Research Center from 1950 - 2000

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
Mean for years	May 23	30	Sept. 12	30	114

Table 8. Temperature Extremes from 1950 through 2000 at Northwestern Agricultural Research Center, Kalispell, Motnana

	Maximum		Minimum	
Year	Date	Degrees Fahrenheit	Date	Degrees Fahrenheit
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	Jan. 24, Feb. 20 & 21	2	July 23	96

Table 9. Summary of Temperature Records at the Northwestern Agricultural Research Center
January 1950 - December 2000

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	42.5	26.5	19.5	42.2
MEAN	22.5	27.8	33.9	43.2	51.6	58.1	63.9	63.1	53.6	43.3	32.5	25.4	43.2

Table 10. Summary of precipitation records at Northwestern Agricultural Research Center
Total Precipitation (inches) by Months and Years: 1950 - 2000

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	1.23	0.62	1.23	15.14
MEAN	1.48	1.16	1.19	1.51	2.34	2.95	1.61	1.52	1.57	1.37	1.55	1.62	19.88

Table 11. Summary of growing degree day (GDD) data at the Northwestern Agricultural Research Center, May 1, 1949 through October 31, 2000. GDD = Temp Max + Temp Min : 2 - 50
Max Temp > 86F substituted with 86; Min Temp < 50F substituted with 50
Average growing degree days by month and year.

YEAR	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	193.0	189.5	464.5	487.5	241.5	95.5	1671.5
MEAN	232.0	327.7	468.4	459.1	281.2	103.9	1872.3

ı growing degree days for all year = 1872.3

Table 12. Summary of snow data September 1, 1949 through August 31, 2000
at the Northwestern Agricultural Research Center

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
MEAN	0.01	0.90	6.47	13.77	12.86	9.44	4.93	1.15	0.07	0.00	0.00	0.00	49.62

Mean snowfall for all years = 49.62

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: Agronomic performance evaluation of Intrastate Spring Barley Cultivars.

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Tom Blake, Barley Breeder and Pat Hensleigh, Research Associate Bozeman, MT.

OBJECTIVES:

To evaluate spring barley experimental lines and cultivars for yield, test weight, harvest moisture, Julian heading date, height, lodging, plump, and protein in environments and cropping systems representative of northwestern Montana with specific evaluation to be made for disease acclimated to barley produced in this region.

RESULTS:

Due to climatic conditions in the region during the 2000 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. Precipitation events were limited after early July through harvest. Lack of rainfall did not seem to reduce yields. Barley yields ranged from a low of 168 bu/acre for Morex, Coors C37, 2B965038, and 6B932978 to greatest yields exceeding 200 bu/acre for B2L20-36, MT960099, MT970026, MT981090, and MT981177 (Table 1). All test weights were excellent. Greatest test weight was 56.2 lbs/bu from MT970116. All harvest moistures were of acceptable levels. Julian heading dates ranged from 168-169 days for Stark, MT981201, B2L20-36, B2L20-42, and Morex to 178 days for MT981039 and Galena. Concernable lodging existed in only two entries. Experimental lines 6B932978 and MT981039 had lodging ratings above three, scale zero to nine. Plant height ranged from 26 to 41 inches. Most entries measured from 29 to 33 inches in height at harvest. Plump percentages were excellent, all exceeding 90 percent. MT981006, MT981238, MTLB 5, Lewis, MT981213, MTLB 6, Valier, and Morex had protein percentages above 15. MT981004, MT970148, and 2B965038 had proteins below 13.5 percent. The nursery was planted on April 7 and harvested on August 14.

SUMMARY:

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

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

Experimental Line	[1]Yield Bu/A	[2]Test Wt Lbs/Bu	[2]Moist %	Hd Date Julian	Height Inches	Lodging 0-9	Plump %	[2]Protein %
MT970026	208.8	55.9	10.5	172	36	0	96.8	14.33
MT981177	203.1	55.4	10.7	171	31	0	94.6	13.87
MT981091	202.1	54.7	11.4	173	30	0	93.3	14.24
MT970155	201.3	55.4	10.5	175	32	1	97.2	14.70
B2L20-36	201.0	51.9	9.8	169	35	0	94.2	14.77
MT981006	200.5	54.2	10.2	173	31	3	96.2	15.25
MT960099	200.2	54.3	10.8	175	29	0	94.9	13.78
Stark	199.5	55.5	10.5	168	35	0	97.3	14.85
MT981248	197.3	54.5	10.2	171	34	0	96.5	15.15
Harrington	197.3	55.2	10.7	173	35	0	97.0	13.98
MT950186	196.9	55.5	10.5	173	35	0	95.3	13.86
MT981116	196.3	54.7	10.7	169	33	0	96.2	14.67
MT981242	195.6	55.0	10.8	172	33	0	93.5	14.17
MT960225	195.3	55.3	10.4	173	34	0	94.4	13.72
MT981029	195.0	54.1	10.7	175	31	0	98.4	14.39
MT981080	194.9	54.1	10.5	175	32	0	96.9	14.76
MT981083	194.4	53.5	10.1	174	29	8	90.4	13.68
MT981210	194.1	55.3	10.4	174	33	0	96.1	14.84
MT981004	194.0	54.7	10.9	173	31	0	97.3	13.42
MT960100	193.9	55.8	10.6	176	28	0	96.2	14.18
MT970229	193.9	55.9	11.2	176	32	0	98.2	13.91
MT981030	193.0	55.7	10.7	177	33	0	98.3	13.86
MT960226	192.7	55.2	10.2	173	31	3	97.6	13.61
MT910189	192.3	56.1	11.8	171	33	5	97.5	13.67
MT960228	190.7	54.8	10.6	172	32	0	97.7	13.84
MT981042	190.1	55.7	11.3	174	31	0	96.7	14.50
MT981238	189.8	55.0	11.1	172	35	0	94.8	15.12
MT970228	188.7	54.2	10.8	175	32	0	95.7	14.29
MT970148	188.4	54.0	10.5	173	31	0	93.8	13.17
MT960101	187.1	55.2	10.7	176	30	0	95.5	13.96
MT981055	187.0	54.7	10.4	174	33	0	94.8	14.86
Logan	186.7	54.4	11.1	171	31	0	96.1	14.49
MT970110	186.7	54.5	10.6	176	34	0	98.4	14.64
Coors C32	186.0	55.4	11.4	175	26	0	96.5	14.10
B2L20-42	185.7	52.0	9.9	169	35	0	97.2	14.00
MT970116	185.6	56.2	11.2	172	35	0	98.6	14.85
MT970205	185.5	54.5	11.3	176	31	0	96.8	13.71
Baronesse	184.6	54.5	10.3	176	30	0	97.0	13.55
Galantine	184.5	55.1	11.6	173	35	0	93.9	13.92
MT981212	184.2	55.4	10.1	172	34	0	97.4	14.32
MT981201	184.1	55.0	10.4	169	34	0	96.8	14.20
AC99 11	182.5	55.0	10.1	174	30	0	98.3	13.58
MTLB 5	182.2	54.7	11.0	173	33	0	96.2	15.05
MT940214	182.1	55.2	11.2	174	30	0	97.2	14.15
Merit	181.5	53.7	11.2	176	33	0	97.4	14.72
Lewis	180.9	55.5	11.6	174	33	0	96.4	15.33

Continued

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	Moist %	Hd Date Julian	Height Inches	Lodging 0-9	Plump %	Protein %
MT981213	180.2	54.9	10.6	173	34	0	95.2	15.18
MT960222	179.8	54.9	10.7	175	34	5	98.2	13.88
MT981009	179.4	54.8	10.6	173	32	8	91.0	14.22
MTLB 6	179.4	54.5	10.6	173	31	0	96.2	15.07
MTLB 13	179.4	54.3	11.0	173	32	0	92.9	14.62
Valier	179.0	54.6	11.6	174	32	0	95.0	15.25
Moravian 22	178.9	52.8	10.7	179	29	0	97.9	14.11
MT981222	178.8	54.8	11.0	172	36	2	95.7	14.88
MT970107	178.6	56.0	12.7	174	36	2	98.4	14.62
Galena	176.5	54.6	11.3	178	28	0	96.1	14.15
MT981180	172.4	55.5	11.0	171	37	1	92.2	14.70
MT981025	171.3	55.2	10.7	175	31	0	95.1	14.47
2B965119	170.7	54.3	10.6	173	31	0	97.1	14.11
6B932978	167.6	52.6	10.1	172	35	30	94.4	14.56
2B965038	167.5	54.4	11.2	175	30	0	99.1	13.46
Coors C37	167.4	54.6	10.6	178	29	0	98.7	14.02
MT981039	165.1	55.2	10.8	178	32	33	96.9	14.32
[3]Morex	161.9	52.4	10.2	169	41	0	93.1	15.19
Mean	186.7	54.7	10.8	173.5	32.4	NA	96.1	14.33
[3]LSD p=0.05	15.0		1.2	1.9	4	14.3		
C.V.	5		7	1	2.2	556		
Replicate F	20.38		5.78	1.20	4.58	0.39		
Replicate Prob (F)	<0.0001		0.0040	0.3058	0.0120	0.6749		
Treatment F	3.70		1.33	12.26	9.91	1.25		
Treatment Prob (F)	<0.0001		<0.0001	<0.0001	<0.0001	0.1449		

[1]Yields adjusted to 13 % moisture.
[2]Test weight, plump, and protein (composite sample) 1 replicate only
[3]Six-rowed cultivar
[4]Data analyzed as RCBD with GLM of SAS

PROJECT TITLE: Agronomic performance evaluation of Spring Malt Barley Cultivars near Ronan, MT.

PROJECT LEADERS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.

PROJECT COOPERATORS: Tom Blake, Barley Breeder and Pat Hensleigh, Research Associate Bozeman, MT.
Jack Stivers, Lake Co. Extension Agent, Westland Seed, Inc., and Tobol Farms Ronan, MT.

OBJECTIVES:

To evaluate two and six row spring malt barley cultivars for yield, test weight, harvest moisture, plump, and protein in environments and cropping systems representative of western Montana.

RESULTS:

Irrigation water and stored soil moisture replaced normal rainfall during the growing season. While lack of precipitation limited crop disease development, a summer hailstorm may have limited yields, particularly for the six row varieties. Barley yields ranged from a low of 112 and 114 bu/acre for cultivars Galena and Moravian 22 to high yields of 146, 147, and 155 for Baronesse, Menuet, and GS 1750, respectively (Table 1). All test weights exceeded 50 lbs/bu. The greatest test weight was 54.4 lbs/bu from cultivar Gallatin. GS 1750 and Gallatin had moistures levels above 14 percent. Plump percentages all exceeded 85 %. MTLB 05, Merit, B2L20-36, and Morex had protein percentages below 14 percent. Moravian 22 had a protein of 16.48 percent, but Baronesse, Gallatin, Foster, and Galena had protein percentages above 15. The nursery was planted on April 7 and harvested on August 10.

SUMMARY:

Despite limited rainfall events during head filling, reserve subsoil moisture permitted excellent yields, test weights and plumps. Although all yields were excellent, several cultivars exhibited superior yield performance. Protein percentages of some cultivars were greater than desirable for malting.

FUTURE PLANS:

None.

Table 1. Agronomic data from the Off-station Spring Malt Barley Nursery grown at the Tobol Farm in Cooperation with Westland Seed Inc. Ronan, MT.

Variety	[1]Yield Bu/A	[2]Test Wt Lbs/Bu	Moist %	Plump %	[2]Protein %
GS 1750	155.3	53.1	14.0	94.6	14.82
Menuet	146.9	53.7	12.8	89.9	14.10
Baronesse	146.2	52.9	12.9	91.7	15.77
Busch Agri 1202	142.6	52.6	13.3	93.4	14.53
Chinook	136.3	53.6	13.3	94.6	14.13
MT910189	134.0	52.7	13.2	93.1	14.41
[3]Stander	131.4	51.8	13.5	92.7	14.53
Harrington	128.7	53.7	13.7	96.2	14.73
MTLB 05	128.2	53.5	13.7	91.8	13.75
Coors 37	127.0	54.0	13.3	97.3	14.90
Klages	126.0	52.4	12.8	85.7	14.25
Merit	123.3	52.7	13.1	92.7	13.84
Gallatin	122.7	54.4	14.6	92.8	15.17
[3]Excel	119.7	52.3	13.0	93.9	14.57
B2L20-36	119.3	51.9	12.9	90.6	13.99
B2L20-42	117.7	50.9	13.2	91.8	14.36
[3]Foster	116.3	52.7	13.5	92.7	15.23
[3]Morex	115.5	52.8	13.4	90.2	12.38
Moravian 22	113.6	52.1	13.0	97.2	16.48
Galena	111.5	52.6	13.8	95.9	15.65
Mean	128.1	52.8	13.3	92.9	14.58
[4]LSD p=0.05	29.5	2.2	1.1		
C.V.	14	2	5		
Replicate F	18.96	0.55	10.19		
Replicate Prob (F)	<0.0001	0.5827	0.0003		
Treatment F	1.4	1.18	1.42		
Treatment Prob (F)	0.1830	0.3195	0.1756		

[1]Yields adjusted to 13 % moisture.
[2]Plump and protein (composite sample) 1 replicate only
[3]Six-rowed cultivar
[4]Data analyzed as RCBD with GLM of SAS

PROJECT TITLE:	Montana State Oat Cultivars agronomic performance evaluation.
PROJECT LEADERS:	Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
PROJECT COOPERATORS:	Tom Blake, Barley Breeder and Pat Hensleigh, Research Associate Bozeman, MT.

OBJECTIVES:

To evaluate of oat cultivars for yield, test weight, harvest moisture, Julian heading date, plant height, lodging, and protein in environments and cropping systems representative of northwestern Montana with specific evaluation to be made for disease acclimated to oats produced in this region.

RESULTS:

Due to climatic conditions in the region during the 2000 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 after early July through harvest. While limiting crop disease, lack of rainfall did not seem to limit yields or oat lodging. Oat yields ranged from a low of 97 bu/acre for cultivar AC Belmont (Table 1) to greatest yields exceeding 200 bu/acre for cultivar 90AB1322. The greatest test weight was 43 lbs/bu from cultivars Provena and Paul. All harvest moistures were of acceptable levels. Julian heading dates ranged from 175-182 days. Plant height ranged from 29 to 44 inches. Most cultivars measured from 29 to 33 inches in height at harvest. Concernable lodging existed in several cultivars. Cultivars Monida, Whitestone, ND93122, Celsia, and AC Belmont had lodging ratings above 50 %. The lodging was somewhat erratic but likely affected yields and test weights. Percent protein was inversely related to yield. Cultivar Provena and experimental line 95A11633 had proteins above 20 percent. Several other cultivars exceeded 17 percent. The oats nursery was planted on April 7, and harvested on August 22.

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:

Continued oats evaluations for the purpose of identifying cultivars best suited for production in Montana.

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

Cultivar	Yield	Test Wt[1]	Moist[2]	Height	Head Date	Lodging	Protein[1]
	Bu/A	Lbs/Bu	%	Inches	Julian	%	%
90AB1322	212.4	32.6	9	30.4	177.3	3.3	13.2
RIO GRANDE	187.6	32.8	9	31.9	174.3	31.7	13.5
87AB5125	179.4	30.3	9	34.6	178.3	18.3	13.6
AJAY	177.1	32.1	9	28.6	179.0	20.0	14.6
ABSP19-9	168.6	32.9	9	35.8	180.3	15.0	14.0
MONIDA	164.1	29.3	9	39.2	181.0	50.0	13.8
OTANA	162.5	34.1	9	43.6	178.0	15.0	14.4
ABSP9-2	143.1	33.3	9	33.6	176.7	43.3	14.4
WHITESTONE	130.7	33.7	9	34.8	177.7	82.0	14.3
PROVENA	128.8	42.7	9.8	32.3	179.3	0.0	21.0
ND930122	124.2	35.3	9	37.9	174.7	88.0	14.1
CELSIA	121.6	30.4	9	39.6	180.0	91.7	14.1
95A11633	119.9	35.1	9	32.8	179.0	1.7	20.8
LAMONT	113.1	38.8	9.3	37.9	182.0	6.7	18.6
PAUL	104.5	42.6	9.9	38.3	178.0	30.0	17.1
AC BELMONT	96.6	34.1	9	35.7	177.7	53.3	17.1
Mean	145.9	34.4	9.1	35.5	178	NA	15.5
LSD p=0.05[3]	52.1	2.3		3.2	0.9	36.9	
C.V.	21	4		5	1	64	
Replicate F	0.03	2.57		1.29	4.55	0.96	
Replicate Prob(F)	0.9738	0.0934		0.2912	0.0188	0.3946	
Treatment F	3.45	23.76		12.21	41.41	5.86	
Treatment Prob(F)	0.0019	<0.0001		<0.0001	<0.0001	<0.0001	

[1]Test weight and protein (composite sample) 1 replicate only
[2]Moisture 1st replicate only. Oats moisture scale calibrated to 9% minimum
[3]Data analyzed as RCBD with SAS GLM

PROJECT TITLE: Agronomic performance evaluation of Advanced Yield Winter Wheat Experimental Lines.

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Phil Bruckner, Winter Wheat Breeder and Jim Berg, Research Associate Bozeman, MT.

OBJECTIVES:

To evaluate advanced winter wheat experimental lines for yield, test weight, harvest moisture, Julian heading date, plant height, lodging, winter survival, and protein in environments and cropping systems representative of northwestern Montana with specific evaluation to be made for diseases acclimated to winter wheat produced in this region.

RESULTS:

Due to climatic conditions in the region during the 2000 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. Precipitation was nearly absent after early July through harvest. While limiting crop disease, lack of significant precipitation did not seem to reduce yields. Winter wheat yields ranged from a low of 90 bu/acre for Morgan to highs, exceeding 120 bu/acre, for MT9953, MT9904, Judith, MT9833, MT9982, MT9993, and MT99116 (Table1). MT9953 produced 130.3 bu/acre. All test weights were excellent. The greatest test weight was 63.5 lbs/bu from MT9990. All harvest moistures were of acceptable levels (range 9.2 to 11.4 percent). Julian heading dates ranged from 157 to 163 days with a mean heading date of 160 days. Plant height ranged from 36 to 48 inches. Most lines measured from 39 to 44 inches in height at harvest. MT9940, MT9955, MTR99101, Morgan, MT9954, MT9908, MT9909, and MT9949 had lodging ratings of 85, 68, 67, 63, 52, 50, 47, and 42 percent, respectively. Only three lines had less than 100 percent winter survival. Protein above 13 percent was determined from MT9904, MT9833, MT9990, MT9927, MT9940, and PI564761. Low protein was 11.3 percent. The nursery was planted on September 23, 1999 and harvested on August 16, 2000.

SUMMARY:

Despite below average amounts of precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights. Although most yields were excellent, several experimental lines exhibited superior yield performance and agronomic traits that may make them favorable choices for planting in northwestern Montana. Several lines also exhibited levels of lodging that would make them unacceptable for most operations.

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

Experimental Line	[1]Yield	[2]Test Wt	Moist	Heading Date	Height	Lodging	Winter Survival	[2]Protein
	Bu/A	Lbs/Bu	%	Julian	Inches	%	%	%
MT9953	130.3	62.3	11.1	160	46.7	12	100	11.5
MT9904	127.7	62.3	10.6	159	45.0	0	100	13.5
JUDITH	124.7	60.8	10.6	158	43.7	0	100	11.8
MT9833	120.6	62.2	10.9	159	44.4	0	100	13.3
MT9982	120.5	61.4	10.9	160	41.6	5	100	11.8
MT9993	120.3	63.4	11.3	160	43.7	0	98	12.4
MT99116	120.2	61.8	10.8	158	36.1	0	100	12.7
RAMPART	119.5	62.8	11.1	158	43.4	20	100	12.8
MT9989	117.4	60.0	10.7	158	44.0	13	100	11.8
MTR99101	116.6	62.5	10.9	161	44.9	67	100	12.2
MT9978	115.7	62.9	10.1	159	42.5	3	100	12.8
NEELEY	115.3	62.4	10.9	161	42.9	9	100	12.3
MT9952	114.9	62.6	11.2	159	47.1	0	100	12.5
MT99115	113.1	61.8	10.5	157	35.6	0	100	11.3
ERHARDT	112.6	62.9	10.9	160	42.2	7	100	13.1
MTR9997	112.0	62.0	11.6	159	43.0	2	100	12.4
MT9938	111.6	62.3	10.4	161	40.8	10	100	12.6
MT9923	109.8	61.8	11.0	160	41.3	2	100	12.1
MT9936	109.7	61.1	9.9	159	39.1	12	100	12.4
MT9926	107.9	62.2	11.1	160	39.0	38	98	12.4
MT9908	107.5	59.7	10.1	160	40.3	50	100	11.9
MT9927	107.4	62.3	10.7	161	39.3	2	100	13.0
MT9954	106.7	62.1	11.0	159	44.5	52	100	11.7
MT9964	106.5	61.1	9.8	160	41.5	22	100	11.3
MT9970	106.3	60.7	10.6	158	40.7	0	100	12.2
MT9990	106.0	63.5	10.6	161	39.6	0	98	13.2
MT9939	105.2	61.4	10.8	158	41.7	0	100	12.1
MT9955	104.0	60.4	10.3	163	44.9	68	100	12.3
MT9949	103.7	61.1	10.8	158	42.4	42	100	12.3
MT9929	101.9	62.5	11.4	162	40.3	10	100	12.9
MT9951	101.3	61.9	10.8	161	48.1	5	100	11.6
MTW9911	99.9	58.6	9.2	160	43.7	18	100	12.2
MT9909	96.9	60.0	9.4	159	39.6	47	100	12.2
MT9907	96.9	61.1	10.5	158	41.2	28	100	11.6
MT9940	93.7	60.3	9.6	161	40.7	85	100	13.1
MORGAN	89.9	61.6	10.8	160	41.9	63	100	12.7
Mean	110.4	61.6	10.6	160	42.1	NA	100	12.3
[3]LSD p=0.05	18.4		1.0	1.6	2.3	25.6	1.3	
C.V.	10		6	1	3	81	1	
Replicate F	2.86		5.37	6.42	1.47	4.69	3.18	
Replicate Prob (F)	0.0638		0.0067	0.0028	0.2370	0.0122	0.0476	
Treatment F	2.07		2.30	5.32	12.87	7.12	1.00	
Treatment Prob (F)	0.0049		0.0015	<0.0001	<0.0001	<0.0001	0.4870	

[1]Yields adjusted to 13 % moisture.
[2]Test weight and protein (composite sample) 1 replicate only
[3]Data analyzed as RCBD with GLM of SAS

PROJECT TITLE: Agronomic performance evaluation of Intrastate Winter Wheat Cultivars.

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Phil Bruckner, Winter Wheat Breeder and Jim Berg, Research Associate Bozeman, MT.

OBJECTIVES:

To evaluate new and existing winter wheat varieties for yield, test weight, harvest moisture, Julian heading date, plant height, lodging, winter survival, and protein in environments and cropping systems representative of northwestern Montana.

RESULTS:

Rainfall events were nearly absent after early July through harvest. While limiting crop disease, lack of significant precipitation did not seem to reduce yields. Winter wheat yields ranged from a low of 78 bu/acre for Norstar to highs, exceeding 130 bu/acre, for Promontory, Pronghorn, BZ96-919, SD92107, ID537, and Culver (Table 1). All test weights were excellent. The greatest test weight was 64.4 lbs/bu from Rocky. All harvest moistures were of acceptable levels. Julian heading dates ranged from 155-163 days with a mean heading date of 159 days. Plant height ranged from 33 to 51 inches. Most trial entries measured from 29 to 33 inches in height at harvest. Morgan, ID550, Manning, MTW9441, Nuwest, and Elkhorn had lodging ratings of 88, 80, 67, 52, 45, and 45 percent, respectively. Only two entries had less than 100 percent winter survival. SD92107, Prowers, Vanguard, Rampart, Erhardt, Blizzard, Elkhorn, and Norstar had proteins over 13 percent. McGuire and Redwin had protein 14 percent or greater. The nursery was planted on September 23, 1999 and harvested on August 17, 2000.

SUMMARY:

Despite limited precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights. Although most yields were excellent, several varieties exhibited superior yield performance and agronomic traits that may make them favorable choices for planting in northwestern Montana. Several entries exhibited levels of lodging that would make them unacceptable for many operations. SD92107, Prowers, Vanguard, and McGuire may produce an economic advantage when protein premiums or discounts apply.

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

Cultivar	[1]Yield	[2]Test Wt	Moist	Heading Date	Height	Lodging	Winter Survival	[2]Protein
	Bu/A	Lbs/Bu	%	Julian	Inches	%	%	%
PROMONTORY	137.4	63.8	10.9	158	40.3	8	100	11.3
PRONGHORN	135.4	63.5	11.1	155	44.1	0	100	12.9
BZ96-919	133.8	61.9	10.2	159	36.4	0	100	11.3
SD92107	132.9	62.5	10.4	160	43.4	3	100	13.4
[3]ID537	132.2	60.0	10.0	159	46.5	3	100	12.7
CULVER	130.1	62.4	10.4	156	38.8	25	100	12.6
AKRON	129.7	62.3	10.6	157	40.4	7	100	11.4
UTAH 100	129.1	60.6	9.8	160	45.5	0	100	11.5
MT9822	128.8	62.5	10.8	156	43.6	0	100	11.7
[3]GM10001	125.8	63.3	10.9	156	38.7	0	100	10.7
[3]NUPLAINS	125.4	64.4	10.9	158	36.1	0	100	12.0
QUANTUM 542	124.7	62.3	10.9	156	44.2	8	100	11.7
BZ96-895	124.4	61.6	10.5	158	37.0	0	100	11.5
PROWERS	124.3	64.8	11.1	156	44.6	7	100	13.0
MT9426	123.8	62.0	10.5	160	36.7	15	100	12.0
VANGUARD	123.7	63.6	10.7	157	44.1	17	100	13.1
MTS9720	123.0	62.0	10.5	159	39.4	5	100	12.3
JUDITH	122.3	61.2	10.3	158	43.2	7	100	11.7
MCGUIRE	122.2	63.2	10.5	157	40.2	0	100	14.0
MT9513	120.6	60.3	9.9	159	41.9	27	97	12.6
NEELEY	120.2	62.2	10.3	160	43.7	0	100	12.2
[3]GM10003	117.8	62.5	10.5	156	34.4	0	100	10.6
[3]MTW9724	116.9	60.0	10.1	160	43.2	13	100	11.9
WINDSTAR	116.7	60.7	10.0	158	39.1	10	100	12.0
[3]BZ97-761	116.3	63.1	10.7	158	41.5	0	100	12.6
HALT	116.3	62.2	10.1	155	35.2	0	100	12.0
S94-4	115.2	61.0	10.0	159	34.5	0	100	11.7
MT98110	115.1	60.2	10.0	159	38.6	12	100	12.3
ROCKY	115.0	64.4	11.3	157	43.2	7	100	12.5
MT9857	114.5	61.4	10.4	160	38.7	0	100	12.6
BIGHORN	114.1	62.7	10.6	158	36.5	0	100	12.0
ID513	113.9	62.6	10.5	159	38.5	42	100	12.2
RAMPART	113.3	63.3	10.8	159	41.5	28	100	13.2
MTS9882	113.1	62.6	10.7	159	34.9	0	100	11.1
TIBER	112.4	63.4	10.7	160	44.5	0	100	12.6
ERHARDT	112.4	63.2	10.7	159	38.8	0	100	13.1
[3]GM10002	111.4	63.0	10.9	156	32.7	0	100	11.8
[3]NUWEST	111.1	61.9	10.5	159	41.6	45	100	12.4
BIG SKY	110.6	63.5	10.3	160	43.4	0	100	12.8
MANNING	107.5	62.4	9.7	158	42.3	67	100	11.7
[3]GOLDEN SPIKE	106.9	61.8	10.2	160	41.2	37	100	10.9
RANSOM	104.9	61.0	10.3	160	42.7	0	100	12.7
BLIZZARD	104.3	63.4	10.5	160	47.4	37	100	13.3
[3]MTH9441	103.2	61.5	10.6	160	41.6	52	100	12.7
REDWIN	101.2	63.5	10.6	161	43.4	0	100	14.2
[3]ID550	97.4	61.1	9.8	159	43.0	80	100	11.6

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	Moist	Heading Date	Height	Lodging	Winter Survival	Protein
	Bu/A	Lbs/Bu	%	Julian	Inches	%	%	%
MORGAN	91.1	61.7	9.4	160	40.7	88	100	12.5
ELKHORN	90.7	62.8	10.4	160	46.9	45	98	13.5
NORSTAR	77.9	62.5	10.6	163	51.6	28	100	13.2
Mean	116.5	62.3	10.4	158.5	41.0	NA	NA	12.3
[4]LSD p=0.05	19.9		0.6	1.9	2.6	23.0	1.5	
C.V.	11		3	1	4	96	1	
Replicate F	9.95		2.83	0.48	6.49	6.82	0.6	
Replicate Prob (F)	0.0001		0.0641	0.6189	0.0023	0.0017	0.5536	
Treatment F	2.93		3.46	6.33	16.85	7.26	0.98	
Treatment Prob (F)	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	0.5287	

[1]Yields adjusted to 13 % moisture
[2]Test weight and protein (composite sample) 1 replicate only
[3]Hard White Wheat
[4]Data analyzed as RCBD with GLM of SAS

PROJECT TITLE: Agronomic performance evaluation of Winter Wheat Cultivars near Ronan, MT.

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Phil Bruckner, Winter Wheat Breeder and Jim Berg, Research Associate Bozeman, MT.
Jack Stivers, Lake Co. Extension Agent, Lakes Seed Inc. Ronan, MT.

OBJECTIVES:

To evaluate winter wheat cultivars for yield, test weight, harvest moisture, and protein in environments and cropping systems representative of western Montana.

RESULTS:

Winter wheat yields ranged from a low of 86 and 83 bu/acre for Erhardt and McGuire to greatest yields of 135 and 125 bu/acre for cultivars MT 9426 and Stephens, respectively (Table 1). All test weights exceeded 61 lbs/bu. Test weights over 64 lbs/bu were produced by Neeley, MT 9426, Nuplains, and Promontory. Neeley, Hill 81, Mac-1, Nuplains, and Malcom had slower moisture dry down than other cultivars. Percent protein in McGuire was 17.7 percent protein followed by several cultivars over 15 percent. Low protein was determined in Malcom at 12 percent. The irrigated nursery was planted on September 23, 1999 and harvested on August 8, 2000.

SUMMARY:

Despite below normal amounts of precipitation during head filling, reserve subsoil moisture and supplemental water permitted excellent yields and test weights. Several cultivars exhibited superior yield performance and produced excellent proteins. Consideration for future planting of these selections may be warranted.

Table 1. Agronomic data from the offstation winter wheat nursery grown at the Lake Farm in cooperation with Lake Seed Inc. Ronan, MT.

Cultivar	[1]Yield Bu/A	Test Wt Lbs/Bu	[2]Moisture %	[2]Protein %
MT 9426	135.3	64.5	13.0	12.6
STEPHENS	125.2	63.5	14.5	11.7
QUANTUM 542	122.7	63.4	12.6	15.5
PROMONTORY	122.6	64.6	13.2	13.1
BIGHORN	121.7	62.9	12.6	15.2
MT 9513	120.1	62.6	14.7	12.7
MAC-1	118.8	62.7	15.8	13.6
[3]MALCOLM	118.3	61.6	15.5	12.0
DAWS	116.7	62.2	13.9	12.4
MADSEN	116.6	62.3	12.5	13.5
MTS9720	115.7	62.6	13.3	12.8
NEELEY	113.2	64.5	16.0	13.8
MTS9882	113.2	63.9	13.6	13.5
JUDITH	108.0	63.1	13.3	13.3
[3]HILL 81	108.0	NA	15.6	12.2
MTW9441	107.0	62.4	15.0	14.5
HALT	106.3	63.0	14.6	14.4
RAMPART	105.0	63.4	10.4	14.7
VANGUARD	105.0	63.7	12.8	14.8
[4]NUWEST	103.1	62.9	14.6	13.7
ROCKY	101.9	63.4	13.9	14.2
TIBER	101.1	63.7	14.2	15.1
PRONGHORN	99.1	63.0	13.4	15.4
BIGSKY	98.3	63.3	12.3	15.8
NORSTAR	93.5	63.7	14.2	13.6
MORGAN	92.8	62.5	12.0	13.6
[4]NUPLAINS	91.8	64.2	15.8	15.0
ELKHORN	88.0	63.1	11.6	15.5
ERHARDT	85.9	64.0	12.2	14.8
MCGUIRE	83.2	61.5	12.1	17.7
Mean	107.9	63.2	13.6	14.0
[5]LSD p=0.05	18.4	1.4		
C.V.	10	1		
Replicate F	4.68	0.52		
Replicate Prob (F)	0.0131	0.5965		
Treatment F	3.79	1.99		
Treatment Prob (F)	<0.0001	0.0133		

[1]Yields adjusted to 13 % moisture.
[2]Moisture and protein (composite sample) 1 replicate only
[3]Soft white winter wheat
[4]Hard white winter wheat
[5]Data analyzed with GLM of SAS

PROJECT TITLE: Agronomic performance evaluation of Soft White Winter Wheat Cultivars.

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Phil Bruckner, Winter Wheat Breeder and Jim Berg, Research Associate Bozeman, MT.

OBJECTIVES:

To evaluate new and existing soft white winter wheat varieties for yield, test weight, harvest moisture, Julian heading date, plant height, lodging, winter survival, and protein in environments and cropping systems representative of northwestern Montana with specific evaluation to be made for disease acclimated to wheat produced in this region.

RESULTS:

Due to climatic conditions in the region during the 2000 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. Rainfall events were nearly absent after early July through harvest. While limiting crop disease, lack of precipitation did not seem to reduce yields. Winter wheat yields ranged from a low of 98 bu/acre for Stephens to greatest of 137.5 bu/acre for Lambert. Average yield exceeded 120 bu/acre (Table 1). The greatest test weight was 61 lbs/bu from Neeley. However, Rod, Kmor, and Cashup had test weights under 58 lbs/bu. All harvest moistures were of acceptable levels (range 8.9 to 10.9 percent). Julian heading dates ranged from 158 to 162 days with a mean heading date of 160 days. Plant height ranged from 34 to 43 inches. Most cultivars measured from 35 to 38 inches in height at harvest. Eltan, Lewjain, and Stephens had lodging ratings of 53, 40, and 85 percent, respectively. Only three entries had less than 100 percent winter survival. Protein percentages ranged from 9.9 for Lambert, MacVicar and Kmor to 11.3 and 11.4 for Mac-1 and Neeley, respectively. The nursery was planted on September 23, 1999 and harvested on August 14, 2000.

SUMMARY:

Despite limited precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights. Although most yields were excellent, several cultivars exhibited superior yield performance and agronomic traits that may make them an excellent choice for planting in northwestern Montana. Several cultivars exhibited levels of lodging that would make them unacceptable for most operations.

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

Cultivar	[1]Yield	[2]Test Wt	Moist	Heading Date	Height	Lodging	Winter Survival	[2]Protein
	Bu/A	Lbs/Bu	%	Julian	Inches	%	%	%
LAMBERT	137.5	59.6	10.5	159	41.2	0	100	9.9
BRUNDAGE	130.0	57.9	10.4	156	34.0	0	100	10.3
ROD	129.3	54.9	8.9	161	36.0	0	100	10.5
ELTAN	128.0	59.7	10.5	164	36.4	53	100	10.1
W301	124.9	59.1	10.3	158	36.2	0	100	10.5
[3]MAC1	124.7	59.9	10.7	158	38.1	0	100	11.3
HILL 81	122.8	60.0	10.8	161	38.7	0	100	10.0
DAWS	119.5	59.3	10.5	160	35.0	0	98	10.2
LEWJAIN	118.7	58.9	10.2	162	33.9	40	100	10.3
MACVICAR	118.4	58.1	10.3	159	36.7	0	100	9.9
MALCOM	118.2	57.3	9.5	159	36.2	0	100	10.1
MADSEN	115.8	58.2	10.5	161	36.6	0	100	11.1
[4]NEELEY	114.3	61.0	10.9	162	43.4	0	97	11.4
KMOR	113.0	55.4	9.5	161	35.6	7	100	9.9
CASHUP	110.5	57.1	9.3	160	35.0	12	97	10.0
STEPHENS	97.8	58.6	10.4	162	38.5	85	100	10.2
Mean	120.2	58.4	10.2	160	37.0	NA	NA	10.4
[5]LSD p=0.05	10.1		0.8	1.7	1.9	22.4	3.0	
C.V.	5		5	1	3	109	2	
Replicate F	23.51		4.5	3.89	1.18	1.65	0.16	
Replicate Prob(F)	<0.0001		0.0195	0.0315	0.3197	0.2089	0.8546	
Treatment F	7.1		4.38	10.82	14.23	10.47	1.25	
Treatment Prob(F)	<0.0001		0.0003	<0.0001	<0.0001	<0.0001	0.2899	

[1]Yields adjusted to 13 % moisture
[2]Test weight and protein (composite sample) 1 replicate only
[3]New for 2000
[4]Hard Red Wheat
[5]Data analyzed as RCBD with GLM of SAS

PROJECT TITLE: Agronomic performance evaluation of Winter Wheat Experimental Lines in the presence of introduced and natural TCK smut fungus (*Tilletia controversa* Kuhn).

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Phil Bruckner, Winter Wheat Breeder and Jim Berg, Research Associate Bozeman, MT.

OBJECTIIVES:

To evaluate early generation winter wheat lines for yield, test weight, harvest moisture, height, lodging, winter survival, and TCK smut fungus tolerance to both introduced and natural TCK smut fungus (Dwarf Bunt) infection in environments and cropping systems representative of northwestern Montana.

RESULTS:

Rainfall events were limited after early July through harvest. While limiting most crop disease, lack of precipitation did not seem to reduce yields. Climatic conditions were favorable during the 2000 production season for the development of TCK fungus. Several lines exhibited acceptable levels of tolerance to the presence of TCK fungus (Table1). Winter wheat yields ranged from a low of 66 bu/acre for experimental line 93X231cE13 to greatest yields exceeding 130 bu/acre for cultivars/lines Promontory, 93X542cE33, and 93X542cE46. The greatest test weight was 64.1 lbs/bu from cultivar Promontory. Lines 93X542cE67, 93X553E59, 93X553E63, 93X500cE32, 93X500cE71, 93X500cE73, and 93X510cE49 with test weights of 57.6, 56.5, 57.5, 57.1,5 1.7, 56.5, and 57.9 lbs/acre respectively, had test weights lower than desirable. Some of the low test weights appear to be related to the moderate to severe levels of the TCK fungus. All harvest moistures were of acceptable levels. Concernable lodging existed in several lines including 93X542cE75, 93X542cE79, 94X128E10, 94X128E47, and 92X24E22-1. The greatest amount of lodging occurred in lines with moderate to high infestations of TCK fungus. Plant height ranged from 32 to 45 inches. Mean height was 40 inches. All cultivars/lines had 100 percent winter survival. The nursery was planted on September 23, 1999 and harvested on August 17, 2000.

SUMMARY:

Despite limited precipitation during head filling, reserve subsoil moisture permitted excellent yields, and test weights. 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 fungus susceptible growing regions.

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

Experimental Line	[1]Yield Bu/A	Test Wt Lbs/Bu	Moist %	[2]TCK Score 1-3	Height Inches	Lodging %	Winter Survival %
Promontory	135.1	63.8	11.4	1	39.4	0	100
Promontory	134.0	64.1	11.4	1	38.6	0	100
93X542cE33	131.4	59.9	11.0	1	40.2	20	100
93X542cE46	130.4	60.9	10.9	1	40.9	20	100
93X553E454	129.4	60.4	10.8	1	41.7	0	100
93X542cE30	128.6	59.7	10.8	1	40.6	20	100
93X542cE24	125.6	60.6	10.8	1	39.8	15	100
93X234cE50	125.5	61.4	10.8	3	39.4	25	100
94X128E40	125.0	60.9	11.1	1	37.0	0	100
93X542cE71	124.2	61.4	10.9	1	43.3	0	100
Blizzard	123.5	62.4	11.0	1	44.9	15	100
93X234cE20	123.4	62.1	11.0	2	42.1	0	100
93X542cE28	122.0	60.4	10.4	2	43.7	0	100
93X234cE40	121.9	62.8	11.2	1	39.8	0	100
Promontory	120.8	62.1	10.3	1	39.4	0	100
94X128E47	120.0	61.1	10.8	2	40.6	85	100
92X24E1-2	119.2	61.7	11.0	1	40.2	0	100
93X234cE60	119.0	61.1	10.9	2	37.4	15	100
92X24E37-1	118.7	61.5	10.9	3	38.2	40	100
93X542cE15	117.9	60.2	10.8	1	40.9	5	100
92X24E80-2	116.7	60.8	9.7	1	40.6	40	100
94X128E48	116.3	61.9	10.7	2	35.8	0	100
93X234cE34	115.2	62.5	10.6	1	36.6	5	100
Yuma	114.9	61.5	11.0	2	35.8	0	100
93X553E55	114.3	59.4	9.5	1	43.7	0	100
94X128E13	114.1	60.8	9.7	1	38.2	0	100
93X231cE25	113.9	61.7	10.8	2	40.6	0	100
Yuma	113.8	59.7	10.6	2	32.7	0	100
93X234cE23	113.4	63.2	11.1	1.5	44.1	5	100
93X231cE36	113.4	62.6	11.3	3	41.3	0	100
93X542cE7	113.2	60.5	10.6	1	37.8	0	100
93X231cE18	113.1	61.6	11.1	1	44.9	0	100
93X542cE12	112.7	60.8	11.1	1	39.8	20	100
93X553E59	112.7	56.5	9.4	3	42.1	0	100
93X231cE9	112.5	62.2	11.3	1	41.3	0	100
93X542cE5	111.8	59.2	9.2	1	36.6	0	100
93X231cE21	111.7	60.3	10.8	3	41.3	10	100
93X500cE73	111.2	56.5	9.3	2	41.7	0	100
93X542cE50	111.0	60.3	10.4	1	41.3	0	100
93X542cE63	111.0	60.5	10.9	1	40.6	0	100
92X24E53-2	110.9	59.3	9.5	3	40.9	40	100
93X234cE76	110.9	60.6	10.8	1	39.8	0	100
93X231cE23	110.3	60.4	10.9	1	40.2	0	100
93X361E42	110.1	62.9	10.2	2	39.8	0	100
93X502cE5	109.8	60.5	10.7	1	39.4	0	100
93X542cE58	109.3	59.7	10.8	1	40.2	0	100

Continued

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

Experimental Line	Yield Bu/A	Test Wt Lbs/Bu	Moist %	TCK Score 1-3	Height Inches	Lodging %	Winter Survival %
94X128E28	109.2	60.5	11.0	1	39.4	0	100
93X234cE30	107.9	61.7	11.1	2	42.9	0	100
93X234cE91	107.3	62.4	11.1	3	38.6	0	100
93X619cE33	106.7	59.7	10.5	1	39.4	0	100
93X288E33-3	106.6	59.7	10.6	3	37.4	10	100
93X542cE9	106.5	62.3	11.1	2	42.1	20	100
93X542cE35	106.4	58.8	10.5	1	39.0	0	100
93X542cE79	106.3	60.9	10.6	1	39.4	90	100
93X234cE65	105.0	61.4	10.7	1	44.1	0	100
93X553E46	104.8	58.3	10.1	2	37.0	0	100
93X510cE5	104.7	60.2	10.1	1	35.4	0	100
93X231cE51	104.5	60.1	10.4	2	40.9	0	100
93X619cE11	104.4	58.4	10.3	1	41.7	0	100
93X231cE61	103.5	59.2	10.8	3	41.7	0	100
93X231cE5	103.4	60.2	10.1	1	39.4	0	100
93X231cE26	103.0	61.0	10.4	3	40.6	0	100
93X231cE38	102.7	60.9	10.9	3	40.9	0	100
93X500cE71	102.2	51.7	8.5	1	42.1	45	100
93X231cE58	102.0	61.1	11.0	3	45.3	0	100
93X361E12	101.9	63.5	11.3	1.5	40.9	0	100
94X128E16	101.8	59.3	9.6	1	36.2	0	100
93X553E63	100.6	57.5	9.8	2	44.5	0	100
93X619cE18	100.5	58.8	10.5	1	41.3	0	100
94X128E22	99.3	60.4	10.7	2	42.5	0	100
93X234cE71	99.3	61.1	11.1	3	42.1	0	100
93X619cE24	98.9	58.5	10.5	1	42.5	0	100
93X500cE32	98.7	57.1	8.9	1	39.4	0	100
93X542cE67	98.0	57.6	9.8	1	39.4	0	100
93X234cE58	97.6	61.8	11.3	3	41.3	0	100
93X510cE49	97.2	57.9	9.5	2	35.4	15	100
93X510cE39	96.7	58.3	8.8	2	37.8	0	100
93X502cE52	96.3	59.2	10.6	1	37.0	0	100
92X24E22-1	95.6	59.3	10.4	3	40.6	95	100
93X231cE55	95.3	60.0	10.7	3	39.4	5	100
93X542cE13	93.8	60.3	11.0	1	41.7	30	100
93X234cE85	93.1	59.1	10.9	3	31.9	0	100
93X542cE75	92.9	60.5	10.7	2	41.7	80	100
93X510cE4	92.8	58.5	10.5	2	37.8	0	100
94X128E10	92.7	60.1	9.0	1	40.9	95	100
93X510cE42	86.1	59.0	9.8	1	35.4	0	100
93X619cE46	82.5	61.9	10.3	2	35.8	95	100
Neeley	80.5	58.6	10.7	2	42.5	0	100
93X361E2	80.2	60.4	11.0	3	40.6	10	100
93X231cE13	66.4	60.1	10.7	3	37.0	0	100
Mean	108.4	60.3	11.6	NA	40.0	NA	100

[1]Yields adjusted to 13 % moisture.

[2]TCK damage rating. 1). Zero to slight. 2). Moderate. 3). Severe.

Seed Size Herbicide Study

The objective of this study is to determine if weed management of wild oat, *Avena fatua* (L.), in spring wheat, *Triticum aestivum* (L.), can be favorably affected by using sized seed and different rates if Achieve herbicide.

Spring wheat, cultivar 'McNeal', was planted on April 12, 2000 in station field R-2, a field that was previously cropped to alfalfa. A fall chisel plow operation was performed to kill the alfalfa. Spring seedbed preparation included disking, field cultivating, and packing. Wild oat seed was planted to establish stands with a population density of 21 plants ft^{-2}. The seed was hand-broadcast and incorporated with a field cultivator to a depth up to 3 inches and packed. Wheat was seeded in 6-inch rows with a Hege plot double-disc drill at a planting rate of 16 seeds ft^{-2}. Seed lots were prepared by hand sieving NWARC research center-raised seed. Size was determined by removing seed that was held above a 8, 7, 6, and 5/ 64 inch sieve sequentially. As a second factor, five application rates of Achieve, 0, 0.023, 0.046, 0.089, 0.178 lb ai A^{-1} and a hand-weeded check were compared. Soil moisture conditions were good. A fertilizer blend application of 65-30-15 was made to the trial area, a Creston Silt Loam soil. Plots were 10 x 15 ft arranged in a split-plot randomized complete block design with four replicates. Achieve, rate 0.046 lb ai A^{-1} was applied to the hand-weeded plot on May 5 as a control and to lessen the amount of hand weeding. Rate applications of Achieve were applied by CO_2 backpack sprayer in 20 gallons of water per acre with Teejet XR11002 nozzles spaced 20 inches apart on May 18 beginning at 10 a.m. A small amount of dew was present, wind speed 0-3 mph, relative humidity 44%, excellent soil moisture, and air and soil temperature 62 and 68ºF, respectively. A broadcast application of Bronate at 2 pints/acre was to control broadleaf weeds on May 25. Sevin insecticide was applied after the crop was established to control a cereal leaf beetle infestation.

Yield and yield components of spring wheat were very linear, lowest at the 5/64 seed size increasing with each increment of achieve rate. Hand weeded treatment yield was greater than the largest achieve rate yield when the 5/64 size seed was planted. Yield of other seed sizes had a less linear effect by the achieve rate. Largest achieve rate had the greatest yield with the 6/64 seed size equaling the handweeded treatment. In the 7/64 seed size, differences between Achieve rates were lessened but the linearity still existed. When 8/64 size seed was used a rate of 0.089 lb ai A^{-1} of Achieve measured the greatest yield. The hand weeded plot yield was equal to the 0.46 lb ai A^{-1}. Test weight differences were minimal. Protein was positively affected at 5/64 seed size as Achieve rates increased and slightly increased at 6/64 seed size and greater Achieve rates.

Achieve rate also had a linear effect on wild oat populations, reducing plants m^{-2} as rate increased. Achieve rates had similar affects on other wild oat yield parameters. Seed size had less affect on wild oat yield parameters although wild oat biomass was reduced with the greatest achieve rate at the 7 and 8/64 seed size.

This trial will be repeated in 2001 to evaluate under a differing environment at NWARC.

Seed Size Herbicide Spring Wheat Data

Seed Size[1]	Achieve Rate	Spring Wheat Plants	Heads	Biomass	Yield	Test Weight	Protein
	lb ai A^{-1}	m^{-2}	m^{-2}	g m^{-2}	kg ha^{-2}	kg m^{-3}	%
5/64	0.0	145	206	452	2148	780	15.9
5/64	0.023	161	212	455	2442	780	15.7
5/64	0.046	140	259	582	3121	776	15.9
5/64	0.089	157	298	726	3459	781	16.0
5/64	0.178	142	323	751	4169	778	16.0
5/64	Handweeded	176	410	1061	4747	779	16.0
6/64	0.0	137	265	486	2442	778	15.8
6/64	0.023	136	255	562	3548	785	15.8
6/64	0.046	157	340	850	4129	785	15.8
6/64	0.089	141	289	735	3968	784	15.9
6/64	0.178	138	318	815	5071	785	15.8
6/64	Handweeded	136	298	820	5012	783	15.9
7/64	0.0	149	242	629	3003	784	16.0
7/64	0.023	123	211	514	3245	782	16.0
7/64	0.046	157	324	813	3771	784	16.0
7/64	0.089	163	337	828	4236	785	15.9
7/64	0.178	135	363	946	4485	783	16.1
7/64	Handweeded	146	336	856	4631	784	16.2
8/64	0.0	141	194	433	2830	784	16.1
8/64	0.023	155	271	633	3912	792	15.8
8/64	0.046	123	314	793	4391	784	15.8
8/64	0.089	149	341	843	4767	789	15.9
8/64	0.178	140	320	810	4688	781	15.9
8/64	Handweeded	129	289	789	4393	782	16.3

[1] Seed collected above sized sieve

Seed Size Herbicide Wild Oat Data

Seed Size [1]	Achieve Rate	Wild Oat Plants	Wild Oat Heads	Wild Oat Biomass
	lb ai A^{-1}	m^{-2}	m^{-2}	g m^{-2}
5/64	0.0	213	378	381
5/64	0.023	175	321	231
5/64	0.046	136	290	197
5/64	0.089	58	127	79
5/64	0.178	23	42	33
5/64	Handweeded	0	0	0
6/64	0.0	121	260	310
6/64	0.023	173	356	279
6/64	0.046	135	294	225
6/64	0.089	53	120	84
6/64	0.178	18	45	50
6/64	Handweeded	0	0	0
7/64	0.0	148	255	270
7/64	0.023	156	316	242
7/64	0.046	108	197	142
7/64	0.089	80	149	80
7/64	0.178	6	11	7
7/64	Handweeded	0	0	0
8/64	0.0	233	390	339
8/64	0.023	238	448	397
8/64	0.046	158	348	251
8/64	0.089	36	84	75
8/64	0.178	18	30	16
8/64	Handweeded	0	0	0

[1] Seed collected above sized sieve

Seed Size Addition Study

The objective of the this study is to determine if weed management in spring wheat, *Triticum aestivum* L., can be improved without the use of herbicide for control of wild oat, *Avena fatua* L., by comparing two planting rates and two seed sizes with a typical commercially available certified but unsized seed lot.

Spring wheat, cultivar 'McNeal', was planted on April 12, 2000 in station field R-2, a field that was previously cropped to alfalfa. A fall chisel plow operation was performed to kill the alfalfa. Spring seedbed preparation included disking, field cultivating, and packing. Wild oat seed was planted to establish stands at population densities of 0, 8, 16, and 32 ft^{-2}. The seed was hand-broadcast and incorporated with a field cultivator to a depth up to 3 inches and packed. Wheat was seeded in 6-inch rows with a Hege plot double-disc drill at two planting rates, 16 and 26 seeds ft^{-2}. Three seed sizes were also planted. A bulk seed size was planted that represented a commercial lot of locally raised seed. The same lot was sized into lots representing large seed, seed held above a 7/64 inch sieve, and small seed, seed passing through a 6/64 inch sieve. Soil moisture conditions were good. A fertilizer blend application of 65-30-15 was made to the trial area. The soil was a Creston Silt Loam. Plots were 10 x 15 ft arranged in a split-plot randomized complete block design with four replicates. A broadcast application of Bronate at 2 pints/acre was applied to control broadleaf weeds on May 25. Sevin insecticide was applied after the crop was established to control a cereal leaf beetle infestation.

As wild oat density increased from 0 to 32 plants ft^{-2} spring wheat yield components, heads and biomass, decreased. Yield also decreased. Seed size interacted with planting rate differently at each population density. At 0 plants ft^{-2} wild oat density bulk and large seed had equal yields at 16 seeds ft^{-2} planting rate. At 26 seeds ft^{-2} planting rate large seed produce greater yield. Large seed produced the greatest yield at wild oat density of 8 plants ft^{-2} with a 16 seeds ft^{-2} wheat planting rate. Both bulk and large seed size measured greatest yield at wheat planting rate of 26 seeds ft^{-2} at 8 plants ft^{-2} wild oat density. At 16 plants ft^{-2} wild oat density results were similar to 8 plants ft^{-2} wild oat density. Yield increased at both planting rates from small to bulk to large seed size. Wheat populations reflected planting rates and were reduced as wild oat density increased. This affect was more dramatic when lower planting rate was used. Test weight and protein were affected less although proteins were greater when wild oats were present and a greater seeding rate was used.

At wild oat density of 8 plants ft^{-2} greatest seeding rate decreased wild oat head and biomass. At wild oat densities of 16 and 32 plants ft^{-2} only bulk and large seed reduced wild oat densities. Both wild oat seed weight (yield) and seed count were reduced when greater seeding rate was used.

A repeat of the trial will be made in 2001 to evaluate seeding rate and seed size under a differing environment.

Seed Size Addition Spring Wheat Data

Wild Oat	Spring Wheat							
Density	Planting Rate	Seed Size[1]	Plants	Heads	Biomass	Yield	Test Weight	Protein
Plants ft^{-2}	Seeds ft^{-2}		m^{-2}	m^{-2}	$g\ m^{-2}$	$kg\ ha^{-2}$	$kg\ m^{-3}$	%
0	16	Small	173	426	1182	5323	784	16.1
0	16	Bulk	151	415	1194	5731	788	16.1
0	16	Large	157	476	1319	5861	807	15.9
0	26	Small	232	469	1120	5731	780	15.9
0	26	Bulk	227	428	1141	5636	783	16.1
0	26	Large	236	488	1292	6178	785	15.9
8	16	Small	142	297	697	3269	779	15.6
8	16	Bulk	132	355	882	4120	786	15.7
8	16	Large	139	311	796	4438	786	15.8
8	26	Small	201	350	782	4258	791	16.0
8	26	Bulk	217	389	954	4873	785	15.9
8	26	Large	212	356	897	4819	785	16.0
16	16	Small	158	289	546	2924	783	15.9
16	16	Bulk	152	288	693	3422	781	15.8
16	16	Large	140	277	691	3622	791	16.2
16	26	Small	207	290	633	3512	781	15.9
16	26	Bulk	248	335	769	4038	788	16.4
16	26	Large	239	314	732	4174	777	16.1
32	16	Small	138	198	397	1930	782	15.7
32	16	Bulk	126	176	376	2279	777	15.8
32	16	Large	140	197	484	2555	775	15.9
32	26	Small	209	274	401	2367	779	15.8
32	26	Bulk	216	284	570	2874	786	16.0
32	26	Large	196	268	623	3254	784	16.0

[1] Large = > 7/64 sieve size, Small =< 6/64 sieve size, Bulk = commercial lot-no specific sizing.

Seed Size Addition Wild Oat Data

Spring Wheat		Wild Oat					
Planting Rate	Seed Size[1]	Density	Final Stand	Heads	Biomass	Seed Weight	Seed Count
Seeds ft^{-2}		Plants ft^{-2}	Plants m^{-2}	m^{-2}	g m^{-2}	g m^{-2}	m^{-2}
16	Small	0	0	0	0	0	0
16	Bulk	0	0	0	0	0	0
16	Large	0	0	0	0	0	0
26	Small	0	0	0	0	0	0
26	Bulk	0	0	0	0	0	0
26	Large	0	0	0	0	0	0
16	Small	8	80	241	403	160	7902
16	Bulk	8	66	204	363	138	6802
16	Large	8	101	243	412	168	8186
26	Small	8	67	185	320	128	6466
26	Bulk	8	60	162	250	97	4772
26	Large	8	77	171	278	107	5374
16	Small	16	170	361	602	244	12201
16	Bulk	16	134	304	448	179	8986
16	Large	16	176	364	521	211	10650
26	Small	16	210	389	551	225	11802
26	Bulk	16	147	248	311	125	6231
26	Large	16	159	279	354	140	7202
16	Small	32	251	466	625	262	13058
16	Bulk	32	317	502	600	248	12759
16	Large	32	311	457	541	227	11541
26	Small	32	348	525	549	232	12339
26	Bulk	32	286	440	416	171	8799
26	Large	32	345	470	436	185	9735

[1] Large = > 7/64 sieve size, Small =< 6/64 sieve size, Bulk = commercial lot-no specific sizing.

PROJECT TITLE:	Agronomic performance evaluation of Advanced Spring Wheat Experimental Lines.
PROJECT COOPERATORS:	Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC. Luther Talbert, Spring Wheat Breeder and Susan Lanning, Research Associate Bozeman, MT.

OBJECTIVES:

To evaluate advanced spring wheat experimental lines for yield, test weight, harvest moisture, Julian heading date, plant height, lodging, and protein in environments and cropping systems representative of northwestern Montana with specific evaluation to be made for disease acclimated to spring wheat produced in this region.

RESULTS:

Due to climatic conditions in the region during the 2000 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. Precipitation was nearly absent after early July through harvest. While limiting crop disease, lack of significant precipitation did not seem to reduce yields. Spring wheat yields ranged from a low of less than 100 bu/acre for MT9937, MT9912, and MT9913 to high yields, exceeding 139 bu/acre, for MTHW002, MTHW9420, Klasic, and MTHW0004 (Table 1). All test weights were excellent. The test weights of eleven lines exceeded 64 lbs/bu. All harvest moistures were of acceptable levels (range 8.0 to 11.9 percent). Julian heading dates ranged from 162 to 174 days, mean heading date of 171 days. Plant height ranged from 21 to 40 inches. Experimental line MTHW0003 had lodging ratings of 48 percent but still yielded extremely well at 131 bu/acre. Only 3 other lines had any lodging. The nursery was planted on April 7 and harvested on August 22.

SUMMARY:

Despite below normal amounts of precipitation during head filling, reserve subsoil moisture permitted excellent yields and test weights. Although most yields were excellent, several experimental lines exhibited superior yield performance and agronomic traits that may make them excellent choices for planting in northwestern Montana.

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

Experimental Line	[1]Yield	[2]Test Wt	Moisture	Head Date	Plant	Lodging	[2]Protein
	Bu/A	Lbs/Bu	%	Julian	Height	%	%
[3]MTHW0004	141.4	61.0	11.0	169	30.8	1	12.6
[3]KLASIC	139.8	63.8	10.9	163	21.3	0	13.8
[3]MTHW9420	139.6	63.2	10.7	170	31.4	0	13.2
[3]MTHW0002	139.2	62.3	10.9	171	30.1	0	12.6
MT9706	134.2	62.6	10.7	172	35.0	0	16.0
[3]MTHW0001	131.1	63.0	11.2	170	32.8	0	13.5
[3]MTHW0003	130.7	62.9	11.1	173	34.6	48	12.3
MT9719	130.0	64.0	8.9	171	29.0	0	15.6
MT9955	128.7	62.6	10.6	172	31.6	0	14.9
MT9960	128.6	64.5	11.4	172	34.3	0	15.1
WESTBRED 926	128.3	62.8	10.5	165	30.2	0	15.2
GMHR2	128.2	62.1	10.7	173	29.5	0	12.9
MT9923	127.5	64.1	11.0	174	31.9	0	15.2
MT9712	127.1	64.0	11.1	174	36.7	0	15.4
[3]MTHW9915	126.6	62.8	11.0	170	30.3	0	13.3
[3]MTHW9901	126.4	63.6	11.1	172	34.4	0	13.7
NEWANA	126.3	62.9	11.6	175	30.7	0	14.1
[3]MTHW9908	125.3	61.8	10.9	167	31.0	0	13.7
[3]GMHW1	125.2	62.5	11.3	172	27.8	0	12.7
MT9954	125.2	62.3	10.9	173	34.3	0	14.4
MT9874	124.6	61.7	10.4	174	33.2	0	14.6
[3]GMHW3	124.2	64.2	10.8	163	30.6	0	13.2
[3]MTHW9905	123.4	63.4	11.0	170	31.6	0	13.6
MCNEAL	123.3	62.3	10.4	172	32.4	0	15.4
MT9806	123.2	63.1	10.5	172	31.4	0	15.1
MT9918	123.1	61.2	10.9	170	35.2	0	15.5
MT9748	122.8	63.4	10.6	172	33.6	0	15.3
[3]ARGENT	122.7	63.0	10.8	171	35.3	0	15.5
BR2306	122.6	62.4	11.7	170	31.8	0	14.0
SCHOLAR	122.1	62.7	10.8	173	35.6	0	15.6
[3]MTHW9904	122.0	64.7	11.4	171	33.6	0	14.2
AMIDON	121.7	62.2	11.0	173	38.2	0	15.1
HANK	121.1	62.3	10.8	169	29.8	0	14.7
LEW	121.1	63.9	8.0	175	40.0	6	14.4
[3]GMHW2	121.1	64.4	10.4	162	30.2	0	14.5
[3]MTHW9804	121.0	63.3	10.7	168	28.7	0	14.0
HI-LINE	120.9	62.9	10.2	171	30.4	0	15.5
[3]MTHW9710	120.4	62.1	10.8	168	31.5	0	14.9
[3]MTHW9701	119.7	62.4	10.5	171	27.0	0	13.1
MT9739	119.0	62.0	10.5	172	37.3	0	16.2
ERNEST	118.7	63.4	11.0	172	36.9	0	15.9
MT9905	118.5	64.5	11.9	174	32.4	0	14.4
REEDER	118.1	62.7	11.3	172	32.2	0	15.8
[3]MTHW9716	117.1	63.1	10.9	166	30.6	0	14.5
MT9931	117.0	63.1	10.7	172	31.4	0	15.1
MT9755	116.5	62.7	10.4	170	30.6	0	15.3

Continued

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

Cultivar	Yield	Test Wt	Moisture	Head Date	Plant	Lodging	Protein
	Bu/A	Lbs/Bu	%	Julian	Height	%	%
SLW97606	116.5	64.1	11.4	175	32.7	0	16.5
GMHR1	116.3	61.9	10.5	167	29.8	0	15.4
BZ994484	115.4	62.6	10.4	164	31.0	0	16.0
MT9929	115.1	62.3	10.7	171	31.5	0	15.9
CONAN	114.8	62.3	11.0	170	29.9	0	15.3
MT9959	113.9	64.4	11.7	173	34.4	0	15.9
MT9925	112.9	62.7	10.9	173	35.2	0	15.0
PARSHALL	112.6	63.0	10.8	172	39.8	0	16.5
FORTUNA	111.9	63.0	10.7	173	40.9	6	15.3
MTRWA116	111.5	62.9	10.9	169	29.7	0	15.3
MT9958	111.2	64.2	11.5	173	33.5	0	16.0
MT9956	110.8	63.6	11.7	172	30.8	0	15.6
THATCHER	110.7	60.9	11.0	176	42.7	2	14.9
[3]MTHW9906	109.9	63.7	11.0	171	30.4	0	15.1
[3]BZ996472	103.2	63.5	11.3	167	29.7	0	14.2
MT9937	99.0	61.8	11.0	171	32.9	0	16.0
MT9912	97.6	61.5	10.0	172	32.3	0	17.0
MT9913	95.7	61.5	10.9	171	32.0	0	16.8
Mean	120.8	62.9	10.9	171	32.5	NA	14.8
[4]LSD p=0.05	15.9		2.0	2.3	2.4	8.2	
C.V.	8		7	1	5	521	
Replicate F	1.3		0.67	13.51	2.13	0.5	
Replicate Prob(F)	0.2761		0.5148	<0.0001	0.1235	0.6070	
Treatment F	2.64		1.33	12.90	15.68	4.25	
Treatment Prob(F)	<0.0001		0.0881	<0.0001	<0.0001	<0.0001	

[1]Yields adjusted to 13 % moisture.
[2]Test weight and protein (composite sample) 1 replicate only
[3]Hard white spring wheat
[4]Data analyzed with GLM of SAS

PROJECT TITLE: Agronomic performance evaluation of Spring Wheat Cultivars near Ronan, MT.

PROJECT COOPERATORS: Bob Stougaard, Weed Scientist and Scott Halley, Research Associate NWARC.
Luther Talbert, Spring Wheat Breeder and Susan Lanning, Research Associate Bozeman, MT.
Jack Stivers, Lake Co. Extension Agent, Westland Seed, Inc., and Tobol Farms Ronan, MT.

OBJECTIVES:

To evaluate spring wheat cultivars for yield, test weight, harvest moisture, and protein in environments and cropping systems representative of western Montana.

RESULTS:

The irrigated nursery received damage from a summer hailstorm that may have reduced yields. Spring wheat yields ranged from a low of 80.2 bu/acre for cultivar Amidon to high yields of 97.4 and 97.9 bu/acre for Westbred 926 and ID377S, respectively (Table 1). All test weights exceeded 60 lbs/bu except for cultivar Westbred Express, which had a test weight of 59.4 lbs/bu. Average trial harvest moisture was 13.4 percent (range 12.1-14.3 percent). Hi-line and Lew had proteins above 16 percent. Proteins below 14 percent were determined from Penawawa, Westbred 926, Vanna, and Westbred 936. The trial was planted on April 5, 2000 and harvested on August 8, 2000.

SUMMARY:

Although all yields were good and some proteins were excellent, some cultivars may warrant additional consideration for future planting because of increased protein when protein premiums and discounts exist.

Table 1. Agronomic data from the offstation spring wheat nursery grown at the Tobol Farm in Cooperation with Westland Seed Inc. Ronan, MT.

Cultivar	[1]Yield Bu/A	Test Wt Lbs/Bu	Moist %	[2]Protein %
ID377S	97.9	61.7	13.6	14.9
WESTBRED 926	97.4	62.4	14.0	13.6
REEDER	95.6	61.3	13.3	15.9
[3]MTHW9710	95.6	61.3	13.3	15.5
CONAN	93.9	60.9	13.5	14.2
FORTUNA	93.1	62.2	14.3	NA
GRANDIN	92.9	61.9	13.7	15.4
[4]VANNA	92.0	61.5	12.5	13.3
FERGUS	91.9	62.5	14.0	14.0
SCHOLAR	91.9	62.5	14.0	15.8
MT 9955	89.3	62.0	14.2	15.8
HI-LINE	89.1	61.8	13.2	16.3
MCNEAL	87.2	62.2	14.2	15.7
[3]MTHW9420	87.2	62.2	14.2	14.9
WESTBRED 936	86.4	61.1	13.5	13.1
WESTBRED EXPRESS	84.7	59.4	12.2	14.1
ERNEST	83.8	60.7	12.1	15.6
NEWANA	82.2	61.6	13.2	NA
LEW	82.2	61.6	13.2	16.0
RAMBO	82.2	61.6	13.2	14.0
[4]PENAWAWA	82.0	60.7	12.9	13.9
AMIDON	80.2	61.9	13.1	14.3
Mean	89.2	61.6	13.4	14.8
[5]LSD p=0.05	17.7	1.8	NS	
C.V.	12	2	8	
Replicate F	15.28	10.82	6.73	
Replicate Prob (F)	<.0001	0.0002	0.0029	
Treatment F	2.19	2.10	0.93	
Treatment Prob (F)	0.0150	0.0201	0.5534	

1Yields adjusted to 13 % moisture.
[2]Protein (composite sample) 1 replicate only
[3]Hard white spring wheat
[4]Soft white spring wheat
[5]Data analyzed with GLM of SAS

MONTANA WHEAT AND BARLEY COMMITTEE PROGRESS REPORT

PROJECT TITLE: Potassium Fertilization for Stem Solidness and Wheat Stem Sawfly Management.

PROJECT PERSONNEL: Bob Stougaard, Northwestern Agricultural Research Center.
Gregg Carlson, Northern Agricultural research Center.
Phil Bruckner, Plant Science and Plant Pathology Dept.
Sharron Quisenberry, MAES.

OBJECTIVES:

To determine if potassium additions will enhance the expression and degree of stem solidness and reduce sawfly cutting in winter wheat cultivars.

RESULTS:

Two studies were established in the fall of 1999 at Loma, MT based on the previous year's results. The first study evaluated the effect of 0 and 30 lb/A K_2O via KCL banded below the seed on seven different winter wheat cultivars. The cultivars included four hollow-stem genotypes (Neeley, Tiber, Rocky, Morgan), two intermediate genotypes (MTS9720, MTS9882), and one solid stem genotype (Rampart).

As was the case in the previous year, the addition of potassium enhanced stem solidness in some but not all genotypes (Table 1). Potassium did decrease inside stem diameter of MTS9882 and Morgan, but increased stem diameter in Neeley. Potassium failed to improve resistance to stem cutting. In addition, potassium did not have any influence on plant height, yield, or test weight (Table 1). Potassium also failed to affect sawfly infestation levels (Table 1.) The effect of genotype was much more important than the effect of K in determining stem solidness and resistance to stem cutting. Rampart had by far the greatest stem solidness and resistance to stem cutting.

The second study was established to evaluate the rate response of seed-placed potassium in MTS9720. KCL was band applied at rates of 0, 10, 15, 20, and 30 lb K_2O per acre to confirm the relationship between potassium rate and stem solidness. MTS9720 was the chosen for this study because it previously had shown the greatest response to K additions. MTS9720 showed increased stem solidness in response to K rates in the 10 to 20 lb/A range (Table 2). However, there was no effect on stem cutting, plant, yield, or test weight. There was a trend for a reduction in the number of live larvae as potassium rates increased (Table 2). However, there was not a corresponding consequence on percent infestation numbers or larvae mortality.

SUMMARY:

Potassium had only small effects on stem solidness and does not appear to have much potential as a management tool to reduce damage from wheat stem sawfly.

FUTURE PLANS: None.

Table 1. The effect by variety of potassium rate on stem inside diameter, number of stems cut, stem height, yield, test weight, percent stems infested with larvae, and mortality of stem larvae.

Variety*	Potassium Rate	Stem Diameter 1st Internode	Stem Diameter 2nd Internode	Stem Numbers Cut	Stem Height	Yield	Test Wt	Protein	Infestation	Stem Larvae Live	Stem Larvae Dead
	lb/acre	mm	mm	%	cm	bu/acre	lb/acre	%	%	Count	Count
[1]Neeley	0	1.87**	2.26	4.37	66.65	43	62.3	11.2	78	0	2
	30	2.10	2.26	4.75	62.37	41	62.5	12.5	68	2	1
[1]Tiber	0	1.68	2.06	3.50	68.55	41	62.7	12.2	67	1	2
	30	1.84	2.22	3.00	69.42	41	62.7	12.3	53	2	1
[1]Rocky	0	1.67	2.18	1.75	69.65	42	63.9	13.1	42	0	1
	30	1.80	2.15	1.37	66.70	46	64.0	12.8	27	0	0
[1]Morgan	0	1.60**	2.03**	3.62	70.20	40	61.7	12.7	72	1	2
	30	1.18	1.74	3.75	68.77	36	61.8	12.5	64	0	3
[2]MTS9720	0	1.43	1.92	2.75	67.85	41	61.5	11.3	65	1	3
	30	1.48	1.93	2.87	66.52	41	61.8	11.5	55	0	2
[3]MTS9882	0	0.53**	0.90**	2.50	63.77	43	62.2	11.6	72	0	3
	30	0.21	0.60	2.37	59.60	39	62.0	13.1	72	1	3
[3]Rampart	0	0.30	0.09	1.12	66.95	37	61.6	11.3	42	0	3
	30	0.08	0.14	1.00	68.82	39	61.9	11.1	46	0	2

* Hollow-stem = 1, intermediate = 2, and solid stem = 3 genotypes.

** Indicates a significant difference due to the application of potassium on the respective variety.

Table 2. The effect of potassium rate on stem inside diameter, stem height, yield, test weight, percent stems infested with larvae, and mortality of stem larvae.

Potassium Rate	Stem Diameter 1st Internode	Stem Diameter 2nd Internode	Stem Height	Yield	Test Wt	Protein	Infestation	Stem Larvae Live	Stem Larvae Dead
lb/acre	mm		cm	bu/acre	lb/acre	%	%	Count	
0	2.07	2.11	58	34	61.5	13.2	67	1.50	0.00
10	1.82*	1.89*	59	32	61.4	13.0	60	1.00*	0.00
15	1.88*	1.98*	56	32	61.5	12.8	67	0.66*	3.00
20	1.90*	1.88*	60	34	61.8	13.0	68	0.75*	1.25
30	2.01*	1.96*	59	36	62.0	13.2	58	0.00*	1.00

* Indicates a significant difference due to the application of potassium relative to the nontreated control.

Aim Tank-mix Study

Spring wheat, *Triticum aestivum* (L.), cultivar WB 926, was planted on May 1, 2000 at a planting rate of 78 lbs/acre. This cultivar was planted with a double disk drill in 7-inch rows to a depth of 1.5 inches in NWARC station field R-13. A fertilizer application of 202 lbs of 29-14-0 preceded planting. The soil consisted of a Flathead Fine Sandy Loam. Plots were 10 X 15 ft with three replicates in a randomized complete block design.

The herbicides were applied on May 28 at 12:30 p.m. with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart were used for applications on a day with zero to three mph wind, a 60° F air temperature, 60° F soil temperature, cloudy skies, excellent soil moisture, and a relative humidity of 33 percent. The spring wheat was in the four-leaf to one tiller stages. Wild oats, *Avena fatua* (L.), varied from one to three leaf stages. Common lambsquarters, *Chenopodium album* (L.), wild buckwheat, *Polygonum convolulus* (L.), and field pennycress, *Thlaspi arvense* (L.) were present at the two-leaf stage. Henbit, *Lamium amplexicaule* (L.), was present at the one leaf stage.

Crop injury was not observed by any of the wild oat herbicides when applied without Aim. Aim applied alone resulted in moderate and transient injury. The degree of crop injury associated with Aim varied considerably, depending on the tank-mix partner. The greatest degree of injury was observed when combined with Achieve, and is most likely attributed to the surfactant used with this treatment. A similar response was noted with Discover, but to a lesser extent.

Wild oat control varied among the treatments evaluated. When applied alone, the greatest control was observed with Discover and Achieve treatments. Neither product displayed antagonism or synergism when combined with Aim. Puma was slightly less effective and also failed to demonstrate any interaction when combined with Aim. Hoelon provided moderate wild oat control and appears to be antagonized when combined with Aim. The opposite was true for Assert, which benefited in control when tank-mixed with Aim. Grain yields and test weight values were generally reflective of the level of wild oat control obtained.

Aim Tank-mix Study

HERBICIDE	APPLIC. RATE	CROP INJURY		WILD OAT CONTROL		YIELD	TEST WT	DOCKAGE
		6-5	6-19	6-19	7-23	9-13		
		%		%		BU/ACRE	LBS/BU	%
PUMA	10 OZ/A	0.0	0.0	93.3	91.7	143.2	60.8	0.38
PUMA	10 OZ/A	15.0	0.0	95.0	89.3	133.7	60.8	0.19
AIM	0.008 LB A/A							
MCPA-ESTER	0.375 LB A/A							
ASSERT	0.375 LB A/A	0.0	6.7	76.7	71.7	115.4	59.7	0.43
NIS	0.25 % V/V							
ASSERT	0.375 LB A/A	16.7	11.7	88.3	86.7	125.3	60.5	0.30
NIS	0.25 % V/V							
AIM	0.008 LB A/A							
MCPA-ESTER	0.375 LB A/A							
ACHIEVE	7.5 OZ/A	0.0	0.0	95.0	98.0	141.1	60.4	0.26
SUPERCHGE	0.5 % V/V							
AMS	15 LB/100 GAL							
ACHIEVE	7.5 OZ/A	30.0	3.3	98.3	97.0	133.4	60.9	0.31
SUPERCHGE	0.5 % V/V							
AMS	15 LB/100 GAL							
AIM	0.008 LB A/A							
MCPA-ESTER	0.375 LB A/A							
DISCOVER	3.2 OZ/A	0.0	0.0	92.7	98.0	138.8	60.8	0.27
SCORE	0.8 % V/V							
DISCOVER	3.2 OZ/A	20.7	0.0	96.7	98.0	145.7	61.1	0.13
SCORE	0.8 % V/V							
AIM	0.008 LB A/A							
MCPA-ESTER	0.375 LB A/A							
HOELON	1 LB A/A	1.7	0.0	85.0	82.0	127.6	61.0	0.28
NIS	0.25 % V/V							
HOELON	1 LB A/A	18.3	0.0	78.3	40.0	87.2	59.2	0.73
NIS	0.25 % V/V							
AIM	0.8 % V/V							
MCPA-ESTER	0.008 LB A/A							
AIM	0.8 % V/V	7.7	0.0	0.0	0.0	30.1	56.6	1.11
MCPA-ESTER	0.008 LB A/A							
CHECK	NA	0.0	0.0	0.0	0.0	48.3	57.4	1.35
LSD (P=.05)		3.5	4.0	11.8	18.5	17.7	1.6	0.55
Standard Deviation		2.0	2.4	7.0	10.9	10.4	0.9	0.32
CV		22	131	9	15	9	2	67
Replicate F		0.5	2.3	5.0	1.6	13.8	3.6	1.8
Replicate Prob (F)		0.6117	0.1190	0.0165	0.2240	0.0002	0.0479	0.1893
Treatment F		80.2	7.4	79.1	34.4	41.5	8.1	4.3
Treatment Prob (F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0022

Assure Comparison Study

Spring canola, *Brassica napus* (L.), was planted on April 19, 2000 at a planting rate of 4.12 lbs/acre. This roundup ready cultivar, Hyola, was planted with a double disk drill in six-inch rows to a depth of one inch in NWARC station field R-8. The site consisted of a Creston Silt Loam soil with a pH of 7.5 and organic matter of 3.5 percent. Plots were 10 X 15 ft with three replicates in a randomized complete block design.

The herbicides were applied on May 30 at 9:00 a.m. with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart were used for applications on a day with no wind, a 62° F air temperature, 60° F soil temperature, no clouds, excellent soil moisture, and a relative humidity of 46 percent. The canola was three inches high in the three to six leaf stage, mean of four leaves. Wild oats, *Avena fatua* (L.), varied from three-leaf to eight-tiller stage. Common lambsquarters, *Chenopodium album* (L.) was present at four leaves as was three inch Russian thistle, *Salsola iberica* (Sennen and Pau).

Poast and Select provided greater than 90 percent control of wild oat. Assure provided the poorest control of wild oat and may be related to number of wild oat tillers present. The addition of 28 percent UAN to all herbicides improved wild oat control. Although wild oat control varied among the herbicides evaluated, there were no differences in yield or wild oat dockage.

Assure Comparison Study

HERBICIDE	APPLIC. RATE	WILD OAT CONTROL 6-26-00	WILD OAT CONTROL 7-23	YIELD	DOCKAGE
		%	%	CWT/ACRE	%
ASSURE	7 OZ/A	68.3	77.7	1222.5	13.6
COC	0.125 % V/V				
MUSTAR	0.4 OZ/A				
ASSURE	7 OZ/A	83.3	84.3	1413.7	9.0
COC	0.125 % V/V				
28%	2 QT/A				
MUSTAR	0.4 OZ/A				
ASSURE	5 OZ/A	63.3	61.0	1225.4	10.7
COC	0.125 % V/V				
28%	2 QT/A				
MUSTAR	0.4 OZ/A				
POAST	1.5 PT/A	91.3	91.7	1472.9	10.4
COC	2 PT/A				
MUSTAR	0.4 OZ/A				
POAST	1.5 PT/A	95.0	99.3	1077.0	8.0
COC	2 PT/A				
28%	2 QT/A				
MUSTAR	0.4 OZ/A				
SELECT	6 OZ/A	94.7	98.3	1471.7	6.8
COC	2 PT/A				
MUSTAR	0.4 OZ/A				
SELECT	6 OZ/A	97.7	100.0	1375.0	5.8
COC	2 PT/A				
28%	2 QT/A				
MUSTAR	0.4 OZ/A				
CHECK	NA	0.0	0.0	826.2	22.7
LSD (P=.05)		10.2	12.8	717.1	11.1
Standard Deviation		5.8	7.3	399.0	6.3
CV		8	10	32	58
Replicate F		0.188	2.449	0.999	1.33
Replicate Prob (F)		0.6241	0.1225	0.3993	0.2958
Treatment F		93.962	63.675	0.945	2.166
Treatment Prob (F)		0.0001	0.0001	0.5112	0.1035

BASF Fungicide Study

Spring wheat, *Triticum aestivum* (L.), cultivar WB 926, was planted on May 1, 2000 at a planting rate of 78 lbs/acre. This cultivar was planted with a double disk drill in 7-inch rows to a depth of 1.5 inches in NWARC station field R-13. A fertilizer application of 202 lbs of 29-14-0 preceded planting. The soil consisted of a Flathead Fine Sandy Loam. Plots were 10 X 15 ft with 3 replicates in a randomized complete block design.

The fungicides were applied on June 20 at 3:30 p.m. when the flag leaf was half extended. Treatments were applied with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart were used for applications on a day with no wind, a 73° F air temperature, 72° F soil temperature, sunny skies, excellent soil moisture, and a relative humidity of 31 %.

Disease pressure was nonexistent due to the abnormally dry and hot weather conditions. Tan spot was present, but at very low levels and no treatment differences were observed. Crop injury was not observed with any of the treatments and this is reflected in the yield and test weight data.

HERBICIDE	APPLIC. RATE	YIELD	TEST WT	PROTEIN
		9-13		
		BU/ACRE	LBS/BU	%
BAS500	0.15 LB A/A	122.81	60.86	12.43
MSO	1 % V/V			
BAS500	0.20 LB A/A	123.98	61.05	12.57
MSO	1 % V/V			
TILT	0.11 LB A/A	122.00	61.04	12.33
QUADRIS	0.15 LB A/A	123.44	61.14	11.90
CHECK	NA	120.96	60.96	12.03
LSD (P=.05)		9.5	0.6	0.8
Standard Deviation		5.1	0.3	0.4
CV		4	1	4
Replicate F		19.212	0.745	14.637
Replicate Prob(F)		0.0009	0.5050	0.0021
Treatment F		0.166	0.301	1.267
Treatment Prob(F)		0.9495	0.8691	0.3585

Connect Alfalfa Study

The study, conducted on alfalfa, *Medicago sativa* (L.), was located at the NWARC station field R-5. 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 in a randomized complete block design.

The herbicides, two trifoliate alfalfa leaf stage applications, were applied on May 30 at 9:00 a.m. with a CO_2 backpack sprayer in 20 gallons water per acre. The four trifoliate leaf stage applications were sprayed on June 6 at 9:00 a.m. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. The two trifoliate application day had no wind, a 62° F air temperature, 60° F soil temperature, no clouds, excellent soil moisture, and a relative humidity of 46 percent. The four trifoliate application day had wind gusts to 8 mph, a 54° F air temperature, 60° F soil temperature, and a relative humidity of 92 percent. An application of Poast (sethoxydim) was made on June 1 for the control of green foxtail (*Setaria viridis* (L.) Beauv.). At the two trifoliate leaf alfalfa application stage, wild buckwheat (*Polygonum convolulus* (L.) was at 1 to 2 leaf stage, and prostrate knotweed, *Polygonum aviculare* (L.) was at the 4 leaf stage. At the four trifoliate leaf alfalfa application stage, wild buckwheat (*Polygonum convolulus* (L.) was at 1 to 4 leaf stage, and prostrate knotweed, *Polygonum aviculare* (L.) was at the 4 to 6 leaf stage.

There were no clear relationships between rate, application timing, and formulation as it pertained to crop injury. Crop injury ratings were difficult to assess owing to an erratic alfalfa stand. Generally, crop injury was most severe with the early applications and increased with rate. However, this was not always consistent. The TADS formulation appeared to be less injurious relative to the EC formulation of Buctril. All treatments provided excellent control of wild buckwheat. Control of prostrate knotweed was less complete. Knotweed control was always more complete with the earlier applications and with the use of higher rates. The EC formulation provided better knotweed control compared to the TADS formulation.

Connect Alfalfa Study

HERBICIDE	APPLIC. RATE	GROWTH STAGE TRIFOLIATE LEAVES	CROP INJURY 6-4			PROSTRATE KNOTWEED 6-12		WILD BUCKWHEAT 6-12	
			6-4	6-12	6-19	6-12	6-19	6-12	6-19
			%			% CONTROL		% CONTROL	
BUCTRIL	0.25 LB A/A	2	10.0	6.7	8.3	73.3	70.0	100.0	100.0
BUCTRIL	0.25 LB A/A	4	0.0	13.3	15.0	56.7	53.3	100.0	100.0
BUCTRIL	0.5 LB A/A	2	26.7	25.0	15.0	93.3	90.0	100.0	100.0
BUCTRIL	0.5 LB A/A	4	0.0	16.7	11.7	71.7	90.0	100.0	100.0
TADS	0.25 LB A/A	2	15.0	16.7	16.7	63.3	61.7	100.0	100.0
COC	1 % V/V								
TADS	0.5 LB A/A	2	15.0	10.0	13.3	80.0	73.3	100.0	70.0
COC	1 % V/V								
TADS	0.25 LB A/A	4	0.0	8.3	8.3	45.0	56.7	100.0	100.0
COC	1 % V/V								
TADS	0.5 LB A/A	4	0.0	20.0	15.0	65.0	70.0	100.0	100.0
COC	1 % V/V								
CHECK	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSD (P=.05)			10.3	9.8	12.7	31.3	31.0	0.0	30.0
Standard Deviation			6.0	5.6	7.3	18.1	17.9	0.0	17.3
CV			81	44	64	29.7	28.5	0.0	20.2
Replicate F			2.052	0.378	0.224	11.166	5.521	0.000	1.000
Replicate Prob (F)			0.1610	0.6911	0.8017	0.0009	0.0150	1.0000	0.3897
Treatment F			8.071	5.418	1.530	6.525	6.748	0.000	11.278
Treatment Prob (F)			0.0002	0.0020	0.2229	0.0008	0.0006	1.000	0.0001

Connect Mint Study

The study, conducted on spearmint, *Mentha spicata* (L.), was located at the NWARC station field R-4. 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 three replicates in a randomized complete block design.

The herbicides were applied to 6-inch spearmint on May 22 at 9:00 a.m. with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. The application day had zero to five mph wind, a 62° F air temperature, 58° F soil temperature, good soil moisture, and a relative humidity of 49 percent.

Crop injury was minor this year. There did appear to be a rate response, with injury increasing as use rate increased. However, there was no difference in injury between the two formulations. As last year, Basagran appeared to reduce the degree of injury associated with bromoxynil treatments. However, it is difficult to assess this trend. The 0.25 ai rate was used in the tank-mix. The same rate applied alone failed to demonstrate significant injury. None of the treatments evaluated resulted in significant yield reductions.

Connect Mint Study

HERBICIDE	APPLIC. RATE	CROP INJURY 6-6	CROP INJURY 6-19	FRESH WEIGHT 7-7	DRY WEIGHT
		%		TONS/ACRE	TONS/ACRE
BUCTRIL	0.25 LB A/A	1.7	0.0	15.37	4.05
BUCTRIL	0.50 LB A/A	8.3	0.0	17.55	4.62
BUCTRIL	0.25 LB A/A	0.0	0.0	19.38	5.10
BASAGRAN	1 QT/A				
UAN	2 QT/A				
TADS	0.25 LB A/A	1.7	0.0	18.46	4.86
TADS	0.50 LB A/A	5.0	0.0	18.65	4.91
TADS	0.25 LB A/A	0.0	0.0	18.14	4.78
COC	1 % V/V				
TADS	0.50 LB A/A	8.3	0.0	18.14	4.78
COC	1 % V/V				
TADS	0.25 LB A/A	0.0	0.0	17.02	4.48
COC	1 % V/V				
BASAGRAN	1 QT/A				
UAN	2 QT/A				
CHECK			0.0	18.96	4.99
LSD (P=.05)		4.7	0.0	3.0	0.8
Standard Deviation		2.7	0.0	1.7	0.5
CV		99	0.0	10	10
Replicate F		0.452	0.0	10.354	10.360
Replicate Prob (F)		0.6448	1.0	0.0015	0.0015
Treatment F		5.179	0.0	1.471	1.472
Treatment Prob (F)		0.0031	1.0	0.2472	0.2468

Dry weight calculated as 26.34 % of harvest sample (shrink calculation mean of four samples)

Discover Tank-mix Study

Spring wheat, *Triticum aestivum* (L.), cultivar WB 926, was planted on May 1, 2000 at a planting rate of 78 lbs/acre. This cultivar was planted with a double disk drill in seven inch rows to a depth of 1.5 inches in NWARC station field R-13. A fertilizer application of 202 lbs of 29-14-0 preceded planting. The soil consisted of a Flathead Fine Sandy Loam. Plots were 10 X 15 ft with three replicates in a randomized complete block design.

The herbicides were applied on May 28 at 12:30 p.m. with CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart were used for applications on a day with zero to three mph wind, a 60° F air temperature, 60° F soil temperature, cloudy skies, excellent soil moisture, and a relative humidity of 33 percent. The spring wheat was in the 4 leaf to 1 tiller stage. Wild oats, *Avena fatua* (L.), varied from one to three leaf stage. Common lambsquarters, *Chenopodium album* (L.), wild buckwheat, *Polygonum convolulus* (L.), and field pennycress, *Thlaspi arvense* (L.) were present at the 2-leaf stage. Henbit, *Lamium amplexicaule* (L.), was present at the 1 leaf stage.

Crop injury was not observed with any of the treatments. Discover provided greater than 95 percent control of wild oat regardless of the tank-mix partner. However, there was a slight trend for reduced control when applied in combination with 2,4-D amine. Wild oat pressure was very high as evidenced by the yield of the nontreated control treatment.

Discover Tank-mix Study

HERBICIDE	APPLIC. RATE	CROP INJURY	WILD OAT CONTROL	YIELD	TEST WEIGHT
		5-6	7-23	9-13	
		%	%	BU/ACRE	LBS/BU
DISCOVER	56 G A/HA	0.0	97.0	147.71	60.44
HARMONY EXTRA	21 G A/HA				
2.4-D AMINE	420 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	97.7	153.05	60.66
HARMONY EXTRA	21 G A/HA				
MCPA AMINE	420 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	98.7	137.86	60.89
HARMONY EXTRA	21 G A/HA				
BRONATE	280 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	99.0	146.24	61.03
HARMONY EXTRA	21 G A/HA				
STARANE	1 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	96.7	139.27	60.63
DPX-M6316	26.25 G A/HA				
2.4-D AMINE	420 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	97.3	142.40	61.18
DPX-M6316	26.25 G A/HA				
MCPA AMINE	420 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	98.7	149.34	61.03
DPX-M6316	26.25 G A/HA				
BRONATE	280 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	95.0	139.64	60.70
EXPRESS	8.75 G A/HA				
2.4-D AMINE	420 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	97.3	138.55	61.01
EXPRESS	8.75 G A/HA				
MCPA AMINE	420 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	99.7	132.96	60.72
EXPRESS	8.75 G A/HA				
BRONATE	280 G A/HA				
SCORE	0.8 % V/V				
DISCOVER	56 G A/HA	0.0	99.3	144.90	60.53
SCORE	0.8 % V/V				
CHECK	NA	0.0	0.0	45.63	56.46
LSD (P=.05)		0.0	2.8	18.7	1.1
Standard Deviation		0.0	1.7	11.0	1.0
CV		0.0	2	8	1
Replicate F		0.0	0.307	5.279	1.960
Replicate Prob (F)		1.0	0.7384	0.0134	0.1647
Treatment F		0.0	856.544	20.203	11.536
Treatment Prob (F)		1.0	0.0001	0.0001	0.0001

Milestone Alfalfa Study

The study, conducted on alfalfa, *Medicago sativa* (L.), was located at the NWARC station field R-8. 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 three replicates in a randomized complete block design.

The herbicides were applied on March 30 at 2:00 p.m. with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles, spaced 20 inches apart, were used for applications on a day with a 0-3 mph wind, a 46° F air temperature, 42° F soil temperature, no clouds, very good soil moisture, and a relative humidity of 70 percent. The alfalfa was in the dormant to one trifoliate leaf stage with a plant density of three to four crowns per sq. ft. Shepherdspurse, *Capsella bursa-pastoris* (L.) Medic., was the dominant weed species mostly in the one to three inch stage of growth. *Poa annua* (L.), annual bluegrass, at 3-leaf stage and henbit, *Lamium amplexicaule* (L.), were also present.

Weed pressures were sporadic and at such low densities that visual weed control ratings were precluded. Crop injury was initially observed and consisted of stunting. However, there was no consistent relationship to the rate used and the injury observed. This initial stunting may be related to the fact that the alfalfa was not completely dormant when the treatments were applied. As the season progressed, injury symptoms dissipated. Although the lack of weed pressure prevented an assessment of herbicide efficacy, Milestone appears to demonstrate acceptable tolerance toward alfalfa.

Milestone Alfalfa Study

HERBICIDE	APPLIC. RATE	CROP INJURY 5-1	5-14	6-5
			%	
DPX-R6447	2 OZ A/A	11.7	0.0	0.0
DPX-R6447	3 OZ A/A	18.3	0.0	0.0
DPX-R6447	4 OZ A/A	18.3	0.0	0.0
DPX-R6447	6 OZ A/A	23.3	0.0	0.0
DPX-R6447	2 OZ A/A	15.0	0.0	0.0
VELPAR	4 OZ A/A			
DPX-R6447	3 OZ A/A	23.3	3.3	0.0
VELPAR	4 OZ A/A			
DPX-R6447	4 OZ A/A	16.7	3.3	0.0
VELPAR	4 OZ A/A			
DPX-R6447	6 OZ A/A	21.7	0.0	0.0
VELPAR	4 OZ A/A			
CHECK		6.7	0.0	0.0
LSD (P=.05)		9.3	4.4	0.0
Standard Deviation		5.4	2.6	0.0
CV		31	344	0.0
Replicate F		4.723	2.286	0.0
Replicate Prob (F)		0.0244	0.1339	1.0
Treatment F		3.181	1.000	0.0
Treatment Prob (F)		0.0233	0.4726	1.0

Prowl Spearmint Study

The study, conducted on spearmint, *Mentha spicata* (L.), was located at the NWARC station field R-4. 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 three replications in a randomized complete block design.

The study area was over-seeded on October 4, 1999 with redroot pigweed, *Amaranthus retroflexus* (L.), and green foxtail, *Setaria viridis* (L.) Beauv. Dormant fall applications were applied on October 26, 1999 at 2:00 p.m. with a wind speed of three MPH, an air temperature of 54° F, 48° F soil temperature, good soil moisture, and a relative humidity of 70 percent. Dormant spring applications were applied on March 24, 2000 at 1:00 p.m. The dormant spring application day had a wind of three mph, 48° F air temperature, 52° F soil temperature, good soil moisture, 45 percent cloud cover and a relative humidity of 52 percent. Treatments were applied with a CO_2 backpack sprayer in 20 gallons of water per acre. Teejet XR11002 nozzles, spaced 20 inches apart, were used for all applications.

Although weeds were seeded into the area, weed pressure was minor, preventing an assessment of treatment efficacy. Crop injury was not observed with any of the treatments. There were no significant differences in either fresh or dry mint hay yields. These results indicate that Prowl can safely be used prior to the labeled pre-harvest interval.

Prowl Spearmint Study

HERBICIDE	APPLICATION RATE	APPLICATION TIMING	FRESH WEIGHT	DRY WEIGHT
			7-7	
			TONS/ACRE	TONS/ACRE
PROWL	0.825 LB AI/A	FALL	14.45	4.66
PROWL	1.5 LB AI/A	FALL	14.68	4.74
PROWL	2 LB AI/A	FALL	14.89	4.80
SINBAR	1.25 LB PR/A	FALL	16.11	5.20
PROWL	0.825 LB AI/A	SPRING	14.22	4.59
PROWL	1.5 LB AI/A	SPRING	14.12	4.56
PROWL	2 LB AI/A SPRING	SPRING	15.14	4.88
SINBAR	1.25 LB PR/A	SPRING	15.23	4.92
CHECK	NA		15.94	5.14
LSD (P=.05)			3.1	0.8
Standard Deviation			1.8	0.5
CV			10	10
Replicate F			2.475	2.475
Replicate Prob (F)			0.1157	0.1158
Treatment F			0.688	0.688
Treatment Prob (F)			0.6971	0.6971

Raptor Application Rate Screen on 'Fidel' Winter Wheat for Downy Brome

Winter wheat, *Triticum aestivum* (L.), cultivar Fidel, was planted on September 24, 1999 at a planting rate of 74 lbs/acre. This cultivar was planted with a double disk drill in 6-inch rows to a depth of 1.75 inches in NWARC station field R-2. Plots were 10 X 15 with three replicates in a randomized complete block design. Downy brome, *Bromus tectorum* (L), was hand broadcast at a rate of 30 lbs per acre prior to wheat planting. Due to uniformity problems, an additional planting of downy brome was made on September 30 at a rate of 11 lbs per acre. This downy brome seeding was made with a grain drill perpendicular to the winter wheat seeding. The soil consisted of a Creston Silt Loam.

The herbicides were applied on November 3, 1999 at 2:00 p.m. (fall application) and April 18, 2000 at 11:30 a.m. (spring application) with a CO^2 backpack sprayer in 20 gallons water per acre at a pressure of 40 psi. Teejet XR11002 nozzles spaced 20 inches apart were used for applications. The weather conditions at fall application time had zero wind, a 54° F air temperature, 40° F soil temperature, 90 percent cloud cover, excellent soil moisture, and a relative humidity of 40 percent. Winter wheat was in the two-leaf stage and downy brome was emergence to one leaf stage at a plant density of $23/ft^2$ for fall treatments. The weather conditions at spring application time had zero to three mph wind, a 60° F air temperature, 59° F soil temperature, clear skies, excellent soil moisture, and a relative humidity of 53 percent. For the spring treatments, the winter wheat had three tillers, seven-leaf growth stage, and was six inches tall. The downy brome also had three tillers, seven to ten leaves and was two inches tall. An application of Harmony Extra, 0.5 oz/acre, and 2,4-D, 3/4 pint /acre, were applied to control broadleaf weeds.

'Fidel', developed by American Cyanmid, has resistance to the compound imazamox, marketed as Raptor. Imazamox is unique in that it has activity on downy brome and dramatically would increase wheat management options when used in combination with cultivars that are be bred with similar tolerance characteristics of Fidel.

Downey brome control was visually rated on June 27. Plant and tissue data were collected from two quads per plot, total area 0.27 m^2. The trial was designed as a factorial (application timing and treatment) and analyzed as a randomized complete block.

Raptor Application Rate Screen on 'Fidel' Winter Wheat for Downy Brome

TREATMENT	APPLICATION RATE	DOWNY BROME CONTROL %	DOWNY BROME PLANTS M^2	DOWNY BROME DRY WT G/M^2	DOWNY BROME 20 PANICLE SEED G	DOWNY BROME 20 PANICLE SEED NUMBER	WINTER WHEAT PLANTS M^2	WINTER WHEAT HEADS M^2	WINTER WHEAT DRY WT G/M^2	WINTER WHEAT YIELD KG/HA	WINTER WHEAT TEST WT KG/M^3	WINTER WHEAT DOCKAGE %
FALL												
UNTREATED		0	296	139	4.7	1548	141	333	959	5695	793	2.57
RAPTOR	0.008 LB A/A	73	224	86	3.5	1093	215	342	963	7387	790	0.13
RAPTOR	0.016 LB A/A	68	199	67	2.8	896	211	318	847	7031	791	0.90
RAPTOR	0.024 LB A/A	68	189	35	2.7	866	139	339	959	7046	801	0.00
RAPTOR	0.032 LB A/A	91	108	16	2.1	691	165	321	946	6697	808	0.00
RAPTOR	0.040 LB A/A	93	129	24	2.2	738	179	380	1066	7144	789	0.37
RAPTOR	0.048 LB A/A	94	106	20	2.5	731	113	290	845	7136	802	0.37
HANDWEEDED		98	38	1	0.0	0	127	405	1390	7439	800	0.00
SPRING												
UNTREATED		0	356	168	5.1	1714	190	370	1001	6324	790	2.27
RAPTOR	0.008 LB A/A	69	178	50	2.2	809	120	297	815	7277	797	0.63
RAPTOR	0.016 LB A/A	78	258	36	1.4	551	101	270	803	6587	795	0.00
RAPTOR	0.024 LB A/A	83	139	10	1.5	558	219	373	1051	7152	789	0.13
RAPTOR	0.032 LB A/A	95	189	15	0.8	340	172	376	1096	7384	799	0.07
RAPTOR	0.040 LB A/A	95	79	3	0.3	149	117	313	920	6864	799	0.47
RAPTOR	0.048 LB A/A	99	45	2	0.1	72	220	333	907	6832	797	0.37
HANDWEEDED		100	37	2	0.0	0	128	373	1086	7288	787	0.80
LSD (P=.05)		12	NS	33	0.7	195	160	NS	413	1279	12	0.94
Standard Deviation		7	96	20	0.4	116	96	92	248	766	7	0.56
CV		10	60	48	18	15	60	27	25	11	1	105
Replicate F		0.714	3.976	0.261	0.995	1.575	3.976	8.410	14.523	8.503	32.235	3.914
Replicate Prob (F)		0.4978	0.0294	0.7720	0.3834	0.2261	0.0294	0.0013	0.0001	0.0012	0.0001	0.0309
Treatment F		55.401	0.571	18.462	39.498	47.789	0.571	0.500	1.014	1.075	1.901	6.141
Treatment Prob (F)		0.0001	0.8740	0.001	0.0001	0.0001	0.874	0.9207	0.4679	0.4179	0.0656	0.0001

Raptor was applied in combination with 0.25% v/v NIS and 28% UAN at 1 qt/acre

Spartan Mint Tolerance Study

The study, conducted on spearmint, *Mentha spicata* (L.), was located at the NWARC station field R-4. 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 three replicates in a randomized complete block design.

The herbicides were applied to dormant spearmint on March 24 at 1:00 p.m. with a CO_2 backpack sprayer in 20 gallons water per acre. Teejet XR11002 nozzles spaced 20 inches apart and operating pressures of 30 psi were used for applications. The application day had a three mph wind, 48° F air temperature, 52° F soil temperature, good soil moisture, 45 percent cloud cover and a relative humidity of 52 percent.

There were no visible injury symptoms present. Although it was not significant, mint fresh and dry weights tended to decline as the rate of Spartan increased. However, it appears that either the 0.141 or 0.094 rate would provide an acceptable level of crop tolerance. Spearmint is generally more susceptible to herbicide injury as compared to peppermint. Therefore trials on peppermint are advised.

Spartan Mint Tolerance Study

HERBICIDE	APPLIC. RATE	FRESH WEIGHT 7-7 TONS/ACRE	DRY WEIGHT TONS/ACRE
SPARTAN	0.094 LB A/A	16.28	4.29
SPARTAN	0.141 LB A/A	15.22	4.01
SPARTAN	0.188 LB A/A	14.53	3.83
CHECK	NA	17.90	4.71
LSD (P=.05)		3.1	0.8
Standard Deviation		1.5	0.4
CV		9	9
Replicate F		0.156	0.156
Replicate Prob (F)		0.8592	0.8591
Treatment F		2.805	2.805
Treatment Prob (F)		0.1306	0.1306

Dry weight calculated as 26.34 % of harvest sample (shrink calculation mean of four samples)

Starane Mint Tolerance Study

The study, conducted on spearmint, *Mentha spicata* (L.), was located at the NWARC station field R-4. 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 three replicates in a randomized complete block design.

The initial herbicide applications were applied to 2-inch spearmint on May 3 at 7:30 a.m. The first application day had no wind, 45° F air temperature, 48° F soil temperature, good soil moisture, 100 percent cloud cover, and a relative humidity of 66 percent. A mist began at 8:30 a.m. for a 15 minute period. The second growth stage, four inches, received herbicides on May 14 at 9:00 a.m. The second application day had no wind, 58° F air temperature, 49° F soil temperature, good soil moisture, 30 percent cloud cover, and a relative humidity of 66 percent. The last growth stage application, six inches, received herbicides on May 22 at 9:00 a.m. The final application day had 0 to 5 mph wind, 62° F air temperature, 58° F soil temperature, good soil moisture, 10 percent cloud cover, and a relative humidity of 49 percent. All herbicide was 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.

Crop injury increased with rate and did not appear to be affected by crop growth stage. 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. However, only three treatments produced oil yields significantly less than the nontreated check. These included the 0.375 rate at the 4 and 6-leaf stage and the 0.250 rate when applied at the 4-leaf stage.

Although some injury does occur, yield reductions were noted in only a few treatments. The gains achieved in weed control may offset this injury. Spearmint is generally more susceptible to herbicide injury as compared to peppermint. Therefore trials in peppermint should be investigated as well.

Starane Mint Tolerance Study

HERBICIDE	APPLIC. RATE	GROWTH STAGE	CROP INJURY			FRESH WEIGHT	DRY WEIGHT	OIL
			5-14	6-6	6-19	7-7		
	LBS A/A	INCHES		%		TONS/ACRE	TONS/ACRE	LBS/ACRE
STARANE	0.060	2	20.0	3.3	0.0	15.56	4.10	38.58
STARANE	0.125	2	26.7	10.0	6.7	14.67	3.86	42.51
STARANE	0.250	2	31.7	11.7	8.3	13.93	3.67	33.31
STARANE	0.375	2	36.7	16.7	10.0	13.32	3.51	32.35
STARANE	0.060	4	0.0	0.0	0.0	13.79	3.63	32.71
STARANE	0.125	4	0.7	5.0	1.7	16.48	4.34	37.75
STARANE	0.250	4	0.0	21.7	13.3	13.90	3.66	30.44
STARANE	0.375	4	0.0	41.7	28.3	11.96	3.15	26.94
STARANE	0.060	6	0.0	3.3	0.0	16.40	4.32	41.07
STARANE	0.125	6	0.0	10.0	6.7	15.39	4.05	38.07
STARANE	0.250	6	0.0	23.3	16.7	15.27	4.02	39.09
STARANE	0.375	6	0.7	23.3	28.3	12.81	3.37	30.27
CHECK			0.7	0.0	0.0	16.56	4.36	37.23
LSD (P=.05)			4.2	10.0	9.4	2.4	0.6	6.3
Standard Deviation			2.5	5.9	5.6	1.5	0.4	3.7
CV			28	45	61	10	10	11
Replicate F			4.555	2.030	6.869	9.984	9.846	5.371
Replicate Prob (F)			0.0210	0.1532	0.0044	0.0008	0.0008	0.0118
Treatment F			95.776	12.360	9.683	3.085	3.085	4.767
Treatment Prob (F)			0.0001	0.0001	0.0001	0.0091	0.0091	0.0006

Dry weight calculated as 26.34 % of harvest sample (shrink calculation mean of four samples)

FORAGE INVESTIGATION
755

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

YEAR / PROJECT: 2000/ 755
TITLE: **Intrastate Alfalfa Yield Trials - Irrigated & Dryland**
PROJECT LEADER: Dennis Cash, MSU-Bozeman
COOPERATORS: Leon Welty / Louise Strang, MSU-NWARC

Alfalfa varieties were established each spring at dryland and irrigated sites in 1997,1998, and 2000. The 1997 dryland trial was harvested three times, the 1998 trial four times, and the 2000 trial twice. The 1997 irrigated trial was harvested twice, the 1998 trial 3 times, and the 2000 trial twice. The 1997 trials were terminated after the last harvests. Precipitation from April through September was below normal following a drier than average fall and winter. Cool temperatures prevailed in May and June with heat units well below average for this period.

The 1997 dryland trial survived the winter with excellent stands, except for 'Riley', which had established poorly the seeding year. Riley also had the lowest yield for 2000, followed by '5301' (Table 1a). '5396', 'DK 140', '3L 102', and 'Oneida VR' were the most productive cultivars in 2000. These four entries plus 'Rhino' and '645' produced the most forage over the 4-year duration of the trial (Table 1b).

The 1997 irrigated trial was sprayed with 2 qt/a Roundup on 6/1/00 because of a serious weed problem. Regrowth was set back and the second harvest postponed until Aug.2 followed by termination of the study. 'Ladak 65' and Riley had the least vigorous stands at the beginning of the growing season. DK 140 and 5396 had the highest yields in 2000 and Riley had the lowest (Table 2a). These rankings also applied to the 1997-2000 total yields (Table 2b).

The 1998 dryland trial was harvested 4 times. Good stands were maintained with the exception of Riley and 'Millennia'. In spite of a weak stand, Riley was one of the more productive cultivars in 2000 along with 'Imperial', 'Innovator+Z', Oneida VR, '53V08', 'Enhancer', 'Ripin', 'Emperor', 'ZX9852', 'Reno', and 'TMF Multiplier II' (Table 3a). Millennia, 'NL 90732', and Enhancer PI had the lowest yields. Since 1998, Enhancer and Ripin have produced over 11 tons/acre (Table 3b). The poorest producers have been NL 90732, Millennia, and the coated Enhancer entries (SC981 & SC982). The coated seed had significantly lower yields than the uncoated Enhancer every year.

The 1998 irrigated trial averaged 5.58 tons/acre (Table 4a). Highest yielding cultivars included 'Rebound', Magnum V', 'Enhancer', 'Imperial', 'PS595-106', '631', '53V08', and 'Oneida VR'. Lowest yielding cultivars were 'Wrangler', 'Millennia', 'Ladak 65', Riley, and the coated Enhancer (SC982). From 1998 to 2000 'Magnum V', 'Rebound', and Enhancer produced over 16 tons of forage per acre (Table 4b). Ladak 65, Riley and Millennia produced the least total forage.

Two new trials were planted 25 April 2000. In the dryland trial, '5246' and Riley established poorly. Total yields were highest (over 1 ton/acre) for Shaw, Millennia, Select, and 'WinterCrown' (Table 5). In the irrigated trial, good stands were established for all cultivars except Riley and 5246. The trial was harvested 7/26 and after frost on 9/27. Mean yields were 1.25 tons/acre for the first harvest and 1.43 tons/acre for the fall harvest (Table 6). Highest yielding cultivars were 'ZX9450A', 'Plumas', 'Select', Millennia, 'Ultra', 'FG 3R139', 'Shaw', and 631.

Table 1a. Total dry matter yields for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - in 2000.

					Dry Matter Yield				
								2000	1997-00
VARIETY	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	TOTAL	TOTAL
				%	t/a	t/a	t/a	t/a	t/a
5396	345	-	-	94	2.38	1.64	1.42	5.45	19.63
DK 140	342	4	R	93	2.27	1.51	1.36	5.14	18.81
3L 102	336	-	-	93	2.25	1.47	1.28	5.00	18.21
Oneida VR	309	3	HR	93	2.18	1.44	1.31	4.93	18.14
Ace	337	4	R	93	2.12	1.43	1.26	4.81	17.31
Rhino	339	3	R	93	2.21	1.43	1.17	4.80	18.28
645	341	3	R	94	2.15	1.43	1.23	4.80	18.21
DK 142	343	4	R	93	2.09	1.41	1.16	4.67	17.75
DK 143	344	3	R	93	2.06	1.36	1.22	4.63	17.23
Wrangler	146	2	LR	93	2.10	1.31	1.19	4.60	17.79
Cimarron 31	338	4	LR	93	2.03	1.33	1.14	4.50	16.71
Ladak 65	2	-	-	91	2.05	1.26	1.11	4.41	16.50
5301	340	-	-	90	1.96	1.21	0.99	4.16	15.58
Riley	122	4	LR	78	1.79	1.02	1.02	3.83	13.76
mean				91	2.12	1.37	1.20	4.69	17.42
LSD (0.05)				6	0.17	0.18	NS	0.55	1.68
CV(s/mean) x100				4.7	5.6	9.2	15.8	8.2	6.7

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Seeding date: 5/9/97

Seeding rate: 8 lbs PLS/acre

Fertilizer: 13 lbs N + 62 lbs P_2O_5 - 4/2/99

Pesticide: Sencor 4 (1-qt/a) - 10/20/99

Table 1b. Total dry matter yields for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1997 to 1999.

Cultivar	MTNo	FD[1]	VW[2]	1997	1998	1999	**2000** TOTAL	**1997-00** TOTAL
							t/a	*t/a*
5396	345	-	-	2.13	6.57	5.48	5.45	19.63
DK 140	342	4	R	2.39	6.30	4.98	5.14	18.81
Rhino	339	3	R	2.38	5.95	5.15	4.80	18.28
3L 102	336	-	-	2.27	5.93	5.01	5.00	18.21
645	341	3	R	2.28	6.01	5.12	4.80	18.21
Oneida VR	309	3	HR	2.19	5.79	5.23	4.93	18.14
Wrangler	146	2	LR	2.06	5.68	5.45	4.60	17.79
DK 142	343	4	R	2.40	6.27	4.41	4.67	17.75
Ace	337	4	R	2.02	6.00	4.48	4.81	17.31
DK 143	344	3	R	2.24	5.83	4.53	4.63	17.23
Cimarron 31	338	4	LR	2.26	5.29	4.66	4.50	16.71
Ladak 65	2	-	-	2.03	5.14	4.92	4.41	16.50
5301	340	-	-	2.14	5.33	3.95	4.16	15.58
Riley	122	4	LR	1.52	4.15	4.26	3.83	13.76
mean				2.17	5.73	4.83	4.69	17.42
LSD(0.05)				0.23	0.47	0.79	0.55	1.68
CV(s/mean) %				7.4	5.7	11.4	8.2	6.7

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Seeding date: 4/26/96

Seeding rate: 8 lbs PLS/acre

Fertilizer: 13 lbs N + 62 lbs P_2O_5 4/2/99

Pesticide: Sencor 4 (1-qt/a) - 10/20/99

Table 2a. Total dry matter yields (tons/acre) for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated -2000.

					Dry Matter Yield			
								1997-2000
VARIETY	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	TOTAL	TOTAL
				%	t/a	t/a	t/a	t/a
DK 140	342	4	R	94	2.06	2.28	4.34	20.43
5396	345	--	--	91	2.04	2.04	4.08	19.90
3L 102	336	--	--	93	1.89	2.08	3.98	18.85
Ace	337	4	R	93	1.97	1.97	3.95	18.86
DK 142	343	4	R	93	1.81	2.13	3.94	19.00
Rhino	339	3	R	95	1.93	2.00	3.93	18.48
Oneida VR	309	3	HR	94	1.92	1.96	3.88	18.15
645	341	3	R	90	2.01	1.86	3.86	18.12
5301	340	--	--	91	1.78	1.99	3.77	18.49
DK 143	344	3	R	93	1.73	1.96	3.70	18.18
Wrangler	146	2	LR	93	1.88	1.66	3.54	16.93
Cimarron 31	338	4	LR	91	1.69	1.79	3.48	16.91
Ladak 65	2	--	--	88	1.69	1.42	3.10	15.20
Riley	122	4	LR	86	1.44	1.28	2.72	13.24
mean				92	1.85	1.89	3.73	17.91
LSD(0.05)				3	0.14	0.18	0.28	1.01
CV(s/mean) x100				2.7	5.3	6.8	5.3	4.0

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Seeded 5/9/97

Seeding rate: 8 lbs/a

Fertilizer: 13 lbs N/a, 62 lbs P_2O_5/a

Table 2b. Total dry matter yields (tons/acre) for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1997 to 2000.

VARIETY	MTNo	FD[1]	VW[2]	1997	1998	1999	2000	TOTAL 1997-2000
DK 140	342	4	R	3.13	6.51	6.45	4.34	20.43
5396	345	--	--	2.93	6.34	6.57	4.08	19.91
DK 142	343	4	R	3.03	6.26	5.77	3.94	19.00
Ace	337	4	R	2.91	5.87	6.15	3.95	18.87
3L 102	336	--	--	3.00	5.99	5.89	3.98	18.85
Rhino	339	3	R	2.97	5.53	6.07	3.93	18.49
5301	340	--	--	3.26	5.88	5.58	3.77	18.49
DK 143	344	3	R	2.93	5.94	5.61	3.70	18.17
Oneida VR	309	3	HR	2.75	5.80	5.73	3.88	18.15
645	341	3	R	2.78	5.49	5.99	3.86	18.12
Wrangler	146	2	LR	2.56	5.17	5.67	3.54	16.93
Cimarron 31	338	4	LR	2.91	5.20	5.31	3.48	16.91
Ladak 65	2	--	--	2.44	4.58	5.08	3.10	15.20
Riley	122	4	LR	2.05	3.95	4.52	2.72	13.24
mean				2.83	5.61	5.74	3.73	17.91
LSD(0.05)				0.27	0.42	0.37	0.28	1.01
CV(s/mean) x100				6.6	5.3	4.5	5.3	4.0

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Seeded 5/9/97
Fertilizer preplant - 44 lbs/a N + 208 lbs/a P_2O_5
: 4/2/99 - 13 lbs/a N + 62 lbs/a P_2O_5

Table 3a. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 2000.

CULTIVAR	MTNO	STAND	Harv-1 YIELD	Harv-2 YIELD	Harv-3 YIELD	Harv-4 YIELD	2000 TOTAL	1998-2000 TOTAL
		%	t/a	t/a	t/a	t/a	t/a	t/a
53V08	346	93	1.93	1.24	1.05	0.67	4.89	11.16
Ripin	349	89	1.81	1.15	0.95	0.54	4.45	11.07
Enhancer	348	93	1.90	1.14	0.88	0.51	4.43	11.81
Emperor	351	94	1.74	1.18	0.98	0.47	4.36	10.57
Imperial	280	94	1.79	1.14	0.90	0.42	4.25	10.97
Innovator+Z	281	93	1.79	1.14	0.89	0.42	4.24	10.49
ZX9852	352	93	1.47	1.14	1.00	0.56	4.17	9.68
TMF Multiplier II	359	85	1.59	1.12	0.90	0.42	4.03	9.51
Reno	357	90	1.70	1.07	0.82	0.43	4.02	9.91
Oneida VR	309	94	1.77	1.03	0.76	0.42	3.98	9.58
Riley	122	78	1.61	1.02	0.92	0.43	3.98	9.82
3L115	355	93	1.68	1.06	0.73	0.43	3.91	9.94
Magnum V	347	96	1.75	1.02	0.72	0.35	3.82	10.30
PS595-106	361	90	1.60	1.10	0.83	0.29	3.81	9.23
3L171	358	93	1.58	1.05	0.78	0.37	3.78	9.23
Rebound	356	93	1.55	1.04	0.75	0.43	3.77	8.78
A-395	362	91	1.58	1.02	0.71	0.33	3.64	9.02
Rambo	353	93	1.45	1.05	0.79	0.32	3.61	9.63
Wrangler	146	91	1.64	0.98	0.69	0.30	3.60	9.39
Enhancer MiRi	SC982	95	1.46	1.04	0.71	0.27	3.48	7.87
NL 91229	363	89	1.44	0.92	0.68	0.37	3.40	8.55
Ladak 65	2	88	1.68	0.86	0.65	0.19	3.38	9.20
631	350	90	1.46	1.01	0.63	0.24	3.35	8.37
Enhancer PI	SC981	93	1.35	0.92	0.59	0.25	3.11	7.68
NL 90732	360	90	1.35	0.86	0.53	0.22	2.96	7.62
Millennia	354	64	0.71	0.71	0.53	0.26	2.20	5.80
mean		90	1.59	1.04	0.78	0.38	3.79	9.43
LSD(0.05)		7	0.32	0.22	0.30	0.18	0.96	2.09
CV(s/mean) %		5.6	14.3	15.3	27.1	33.3	17.9	15.8

Stand estimates: 4/20/00

Pesticide: 10/12/00 - Sencor 4F 1 qt (1 lb) AI/a

HA = 62 ft^2

Harvest 1: 6/1/00	bud
Harvest 2: 7/10/00	early bud
Harvest 3: 8/11/00	late bud
Harvest 4: 10/4/00	frozen

Table 3b. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1998-2000.

CULTIVAR	MTNO	1998	1999	2000	Total
			forage yield - tons/acre		
Enhancer	348	2.18	5.18	4.43	11.80
Ripin	349	1.93	4.69	4.45	11.07
Emperor	351	1.84	4.38	4.36	10.57
53V08	346	1.53	4.10	4.89	10.52
Innovator+Z	281	1.71	4.54	4.24	10.49
Imperial	280	1.60	4.95	4.25	10.39
Magnum V	347	2.10	4.37	3.82	10.29
3L115	355	1.61	4.43	3.91	9.95
Reno	357	1.50	4.40	4.02	9.91
Riley	122	1.31	4.54	3.98	9.82
ZX9852	352	1.59	3.91	4.17	9.67
Rambo	353	1.88	4.13	3.61	9.62
Oneida VR	309	1.49	4.13	3.98	9.59
TMF Multiplier II	359	1.32	4.16	4.03	9.51
Wrangler	146	1.53	4.26	3.60	9.39
3L171	358	1.47	3.98	3.78	9.23
PS595-106	361	1.36	4.06	3.81	9.23
Ladak 65	2	1.43	4.40	3.38	9.20
631	350	1.76	3.95	3.34	9.05
A-395	362	1.50	3.88	3.64	9.02
Rebound	356	1.59	3.43	3.77	8.78
NL 91229	363	1.33	3.66	3.41	8.40
Enhancer MiRi	SC982	1.23	3.12	3.48	7.83
Enhancer PI	SC981	1.29	3.29	3.11	7.70
NL 90732	360	1.58	3.08	2.96	7.61
Millennia	354	1.91	1.70	2.20	5.80
mean		1.60	4.03	3.79	9.40
LSD(0.05)		0.45	1.19	1.03	2.29
CV(s/mean) %		20.1	20.9	19.3	17.3

Table 4a. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 2000.

					Dry Matter Yield				
									1998-2000
VARIETY	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	TOTAL	TOTAL
				%	t/a	t/a	t/a	t/a	t/a
Rebound	356	--	--	96	2.13	2.61	1.70	6.44	16.35
Magnum V	347	--	--	93	2.21	2.32	1.67	6.20	16.56
Enhancer	348	4	R	90	2.14	2.26	1.66	6.05	16.16
Imperial	280	3	R	93	2.26	2.16	1.60	6.01	15.45
PS595-106	361	--	--	91	2.19	2.17	1.66	6.01	15.95
631	350	4	R	95	2.12	2.25	1.61	5.98	15.92
53V08	346	3	HR	93	2.18	2.26	1.50	5.93	15.99
Oneida VR	309	3	HR	93	2.15	2.15	1.62	5.92	15.85
Ripin	349	4	R	94	2.00	2.22	1.64	5.86	15.71
Reno	357	--	--	94	1.94	2.35	1.56	5.85	15.39
Enhancer PI	SC981			89	1.97	2.27	1.50	5.73	14.99
3L171	358	--	--	93	1.86	2.27	1.55	5.67	14.75
NL 90732	360	--	--	93	1.90	2.15	1.59	5.64	15.02
Innovator+Z	281	3	HR	91	1.96	2.13	1.53	5.61	14.71
NL 91229	363	--	--	90	1.94	2.18	1.47	5.58	14.50
TMF Multiplier II	359	--	--	90	1.93	2.07	1.58	5.57	14.74
3L115	355	--	--	94	1.93	2.04	1.59	5.56	15.02
ZX9852	352	--	--	94	1.87	2.17	1.48	5.52	14.51
Emperor	351	4	HR	93	1.92	2.04	1.44	5.40	14.56
A-395	362	3	R	93	1.93	1.89	1.47	5.28	14.49
Rambo	353	3	HR	95	1.85	1.81	1.54	5.20	14.30
Enhancer MiRi	SC982			88	1.88	1.78	1.47	5.13	13.98
Wrangler	146	2	LR	91	1.89	1.71	1.35	4.95	13.81
Millennia	354	4	R	85	1.37	2.14	1.30	4.80	11.88
Ladak 65	2	2	--	86	1.96	1.58	1.16	4.70	13.03
Riley	122	4	LR	86	1.67	1.67	1.27	4.60	12.54
mean				91	1.97	2.10	1.52	5.58	14.85
LSD(0.05)				4	0.23	0.34	0.12	0.54	1.23
CV(s/mean) x100				3.4	8.2	11.3	5.8	6.9	5.9

Table 4b. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1998 to 2000.

				Dry Matter Yield			
							1998-2000
Cultivar	MTNo	FD[1]	VW[2]	1998	1999	2000	Total
				t/a	*t/a*	*t/a*	*t/a*
Magnum V	347	--	--	3.40	6.96	6.20	16.56
Rebound	356	--	--	3.00	6.91	6.44	16.35
Enhancer	348	4	R	3.05	7.06	6.05	16.17
53V08	346	3	HR	2.92	7.14	5.93	15.99
PS595-106	361	--	--	2.91	7.03	6.01	15.94
631	350	4	R	3.17	6.77	5.98	15.92
Oneida VR	309	3	HR	2.93	7.00	5.92	15.85
Ripin	349	4	R	3.32	6.54	5.86	15.72
Imperial	280	3	R	2.84	6.60	6.01	15.45
Reno	357	--	--	2.93	6.62	5.85	15.39
NL 90732	360	--	--	2.99	6.40	5.64	15.02
Enhancer PI	SC981			2.76	6.50	5.73	14.99
3L171	358	--	--	2.71	6.37	5.67	14.75
TMF Multiplier II	359	--	--	2.81	6.36	5.57	14.74
3L115	355	--	--	2.76	6.42	5.56	14.74
Innovator+Z	281	3	HR	2.70	6.41	5.61	14.72
Emperor	351	4	HR	2.91	6.25	5.40	14.56
ZX9852	352	--	--	2.89	6.10	5.52	14.51
NL 91229	363	--	--	2.69	6.23	5.58	14.50
A-395	362	3	R	2.87	6.35	5.28	14.49
Rambo	353	3	HR	2.73	6.37	5.20	14.29
Enhancer MiRi	SC982			2.45	6.40	5.13	13.98
Wrangler	146	2	LR	2.64	6.22	4.95	13.81
Ladak 65	2	2	--	2.35	5.98	4.70	13.03
Riley	122	4	LR	2.16	5.78	4.60	12.54
Millennia	354	4	R	3.17	3.91	4.80	11.88
mean				2.85	6.41	5.58	14.84
LSD(0.05)				0.40	0.56	0.54	1.23
CV(s/mean) x100				9.9	6.2	6.9	5.9

[1] *Fall Dormancy rating*
[2] *Vert Wilt resistance*

Table 5. Total dry matter yields for the 2000 Intrastate Alfalfa Yield Trial at Kalispell - Dryland.

Cultivar	Stand	Harvest-1	Harvest-2	Total
	% of plot	*t/a*	*t/a*	*t/a*
Shaw	88	0.80	0.34	1.13
Millennia	96	0.76	0.33	1.08
Select	90	0.74	0.31	1.05
WinterCrown	94	0.75	0.30	1.05
ZX9450A	95	0.72	0.21	0.93
631	96	0.72	0.21	0.93
5246	55	0.54	0.38	0.92
MT 9503	85	0.66	0.25	0.91
Wrangler	91	0.65	0.26	0.91
Ultra Eureka	95	0.70	0.21	0.90
Riley	74	0.61	0.30	0.90
Plumas	93	0.64	0.24	0.88
AmeriGraze 401+Z	96	0.68	0.19	0.87
4200	94	0.66	0.19	0.85
Innovator +Z	98	0.67	0.18	0.85
FG 3R139	90	0.61	0.23	0.83
53V08	89	0.61	0.22	0.82
Ladak 65	93	0.63	0.19	0.82
mean	89	0.67	0.25	0.92
LSD(0.05)	7	0.10	NS	0.19
CV(s/mean) %	5.6	10.6	38.1	14.2

Harvest-1: 7/26/00
Harvest-2: 10/4/00

Table 6. Total dry matter yields for the 2000 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated.

Cultivar	*6/20* Stand(%)	*7/26* Yield	*9/27* Yield	Total Yield
	%	*t/a*	*t/a*	*t/a*
ZX9450A	98	1.44	1.61	3.05
Plumas	98	1.38	1.65	3.03
Select	98	1.40	1.57	2.97
Millennia	99	1.35	1.55	2.90
Ultra	99	1.39	1.48	2.87
FG 3R139	100	1.33	1.54	2.87
Shaw	90	1.32	1.53	2.85
631	100	1.33	1.44	2.76
Innovator +Z	98	1.23	1.45	2.68
MT 9503	89	1.21	1.47	2.68
AmeriGraze 401+Z	98	1.28	1.40	2.68
WinterCrown	98	1.27	1.39	2.66
4200	95	1.24	1.35	2.59
53V08	94	1.17	1.28	2.45
Wrangler	98	1.18	1.20	2.38
Ladak 65	98	1.18	1.16	2.34
Riley	71	0.97	1.37	2.33
5246	45	0.90	1.27	2.17
mean	92	1.25	1.43	2.68
LSD(0.05)	6	0.12	0.24	0.33
CV(mean	4.5	6.6	11.9	8.7

Pesticide: 10/12/00 - Sencor 4F 1 qt (1 lb) AI/a

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.

Two qts/acre of Roundup Ultra were applied March 30. An irregular irrigation pattern affected growth in parts of the 3rd and 4th replicates. 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 16, July 24, and Sept. 26. 'RDWY' sainfoin was most productive (Table 1). 'Eski' sainfoin, 'Tretana' birdsfoot trefoil, and the cicer milkvetches produced the least amount of forage. Over the two years RDWY produced significantly more forage than any other entry. The 'WYPX 2-94' and '97-1' sainfoins, produced more than the alfalfas, trefoils and milkvetches.

Table 1. Stand occupancy, plant height at first harvest, and total dry matter yields for perennial forage legumes at Kalispell in 2000.

Entry	Stand	Height	1st Harv.	2nd Harv.	3rd Harv.	2000 Total	'99-00 Total
	%	*in.*	*t/a*	*t/a*	*t/a*	*t/a*	*t/a*
RDWY Sainfoin	98	38	3.15	2.20	1.69	7.04	10.82
WYPX 2-94 Sainfoin	90	34	2.93	1.72	1.39	6.03	9.18
97-1 Sainfoin	90	35	2.75	1.74	1.37	5.86	9.28
Remont Sainfoin	88	35	2.31	1.75	1.32	5.38	8.41
Alfalfa+Sainfoin 3+16	93	35	1.89	1.61	1.45	4.95	8.23
Alfalfa+Sainfoin 3+8	85	30	1.54	1.47	1.40	4.40	7.37
Ladak 65 alfalfa	91	26	1.41	1.41	1.38	4.19	7.33
AC Grazeland alfalfa	94	27	1.09	1.51	1.34	3.93	6.94
L-2 Synthetic B.Trefoil	35	17	1.14	1.21	0.96	3.31	4.55
Monarch Cicer Milkvetch	70	28	1.65	0.81	0.74	3.21	3.52
Lutana Cicer Milkvetch	66	26	1.57	0.81	0.75	3.12	3.34
Windsor Cicer Milkvetch	51	28	1.25	0.82	0.92	2.99	3.36
Tretana B.Trefoil	25	16	1.18	0.88	0.86	2.92	3.55
Eski Sainfoin	35	31	1.14	0.84	0.68	2.66	3.40
mean	72	29	1.79	1.34	1.16	4.28	6.38
LSD(0.05)	16	3	0.38	0.17	0.24	0.57	0.73
CV(s/mean)x100	15.8	8.0	14.8	8.8	14.4	9.3	8.1

TITLE: **Timothy Trial - Irrigated**
PROJECT LEADER: Leon Welty, 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 and with 70 lbs/a N on July 24, 2000. It was sprayed with 1-lb AI/a 2,4-D and 0.5 lb AI/a dicamba on April 10, 2000. The orchard grass cultivars had more vigorous early season stands than the Timothy.

The plots were harvested May 24, June 28, Aug. 2, and Sept.7, 2000. The 'Benchmark', 'OG9202', and 'OG9503' orchard grass produced more forage than any Timothy cultivar (Table 1). The 'TM9710-02', however, produced more than the other cultivars of the species, and almost as much as 'Haymate' in 2000 and in total yield since establishment.

Table 1. Stand occupancy and dry matter yields of Timothy and orchardgrass cultivars at Kalispell in 2000.

			1st Harv	2nd Harv	3rd Harv	4th Harv	2000	1999-2000
CULTIVAR	SPECIES	STAND	YIELD	YIELD	YIELD	YIELD	YIELD	TOTAL
		% occ	*t/a*	*t/a*	*t/a*	*t/a*	*t/a*	*t/a*
OG9202	Orchard	91	3.01	1.72	1.32	0.86	6.91	10.87
OG9503	Orchard	93	3.04	1.72	1.27	0.88	6.90	10.60
Benchmark	Orchard	95	2.96	1.82	1.17	0.85	6.80	10.85
Haymate	Orchard	91	2.56	1.64	1.09	0.73	6.03	9.81
TM9710-02	Timothy	86	2.61	1.36	0.89	0.75	5.61	9.30
TM8903	Timothy	78	2.39	1.39	0.84	0.58	5.19	7.78
Colt	Timothy	78	2.15	1.46	0.83	0.59	5.02	7.63
mean		87	2.67	1.59	1.06	0.75	6.06	9.55
LSD(0.05)		9	0.33	0.20	0.25	0.13	0.77	1.33
CV(s/mean)x100		7.2	8.4	8.7	15.9	11.7	8.5	9.4

1st Harvest 5/24/00
2nd Harvest 6/28/00
3rd Harvest 8/2/00
4th Harvest 9/7/00

TITLE: **Safflower Forage Trial - Dryland**
PROJECT LEADER: Dave Wichman, MSU-CARC
COOPERATORS: Leon Welty, MSU-NWARC
Louise Strang, MSU-NWARC

Seven safflower cultivars/selection lines were planted in a randomized complete block design with 4 replicates on May 9, 2000. 'Centennial' at high and low seeding rate was included as a check variety. Other entries included '98B1544' at 2 seeding rates, seed from the Sidney 98 World Bulk collection and two Moccasin spineless selections. The trial was fertilized with 73 lbs/a N and 35 lbs/a P_2O_5 on May 2.

The 2 Moccasin lines were the first to head out, followed by Centennial and the World Bulk (Table 1). The 98B1544 was the last to head. This line and the World Bulk were tallest, and Centennial at the 20-lb seeding rate was shortest. The safflower was harvested with a small-plot forage harvester Aug.17, when the plants were at the mid-bloom to mid-wilt stage. Forage yield averaged 2.82 tons/acre dry matter. Differences among entries were not significant.

Table 1. Stand counts, days to heading, plant height, maturity stage at harvest, and forage yield of safflower lines at Kalispell in 2000.

PEDIGREE	STAND	HEAD	HEIGHT	STAGE	YIELD
	pl/ft	*days*	*inches*		*t/a*
98B1544-99DLi2 LR	3.6	84.5	34	mbl	3.16
Mocc99 TP	2.6	72.3	31	e.wilt	2.87
98B1544 99DLi2	4.7	82.8	34	mbl	2.83
Centennial LR	2.6	79.0	32	e.wilt	2.82
Centennial 20 lbs	3.2	79.0	30	e.wilt	2.78
Mocc LS99	2.7	71.0	31	mw	2.76
WB 98 Sidney	1.4	77.3	34	fbl	2.51
mean	3.0	78.0	32		2.82
LSD(0.05)	0.7	3.1	2		NS
CV(s/mean) %	16.1	2.7	5.0		12.7

Seeding date: 5/9/00
Harvest date: 8/17/00

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.

YEAR / PROJECT: 2000 / 758

TITLE: **2000 Regional Dry Pea and Lentil Yield Trials – Dryland**

PROJECT LEADERS: Fred Muehlbauer, WSU
Karnes Neill, MSU-CARC

COOPERATORS: Leon Welty, MSU-NWARC
Louise Strang, MSU-NWARC

Seven dry pea and twenty lentil varieties were seeded on April 18, 2000. Experimental design for each nursery was a randomized complete block with 4 replicates. All plots were fertilized with 44 lbs. N/a and 200 lbs. P_2O_5/a on 5/2/00. On 5/17/00 Poast and Dash (1-qt./a) were applied to the peas and lentils for weed control. On 6/1/00 another application of Poast + Dash was applied at the same rate because of volunteer grain emergence. Good stands were obtained for all but the fourth replication of peas, which had erosion problems.

Precipitation from April through July was 5.74 inches, 32% below average and 8% lower than in 1999. Fall and winter precipitation was normal. May and June temperatures were below normal for this location, but July, when the seed is maturing, was normal. Dry weather stress from May through July hindered seed production and resulted in poor yields.

Lentil yields in 2000 were 59% lower than the average 1999 yields. The highest yielding variety produced only 767 lbs/acre (Tables 1&2).

Average pea yields in 2000 were 54% lower than the average of all entries in 1999. No experimental cultivar produced more dry peas than 'Fallon' (Table 3). (This data is the means of only 3 replicates. Data from the fourth replicate was discarded because of poor stands.)

Table 1. Agronomic data from the Western Regional Lentil Yield Trial at Kalispell, MT in 2000.

Cultivar	Color	Emergence	Stand	First bloom	Maturity	Height	Seed size	Yield
		*days**	*%*	*days**	*days**	*inches*	*#/lb*	*lbs/a*
LC660529P	yellow	16.8	86	61.5	98.3	14	12314	767
LC7601086E	yellow	16.5	89	64.8	98.0	13	11900	709
LC460266B	yellow	16.3	91	62.0	97.8	15	8271	677
LC7601089E	yellow	16.3	89	64.8	98.3	14	12219	671
LC660844L	yellow	16.0	88	64.8	98.3	15	8734	652
LC660829L	yellow	16.3	89	62.3	97.5	15	8203	598
LC460197L	yellow	16.5	89	62.8	99.3	15	7971	596
LC7601599T	red	17.3	83	69.5	98.0	13	13078	554
LC7601563P	yellow	16.5	85	68.8	98.0	12	13302	554
LC460212L	yellow	16.5	93	66.5	98.5	13	8180	516
LC7601682T	yellow	16.8	79	60.8	97.3	14	13725	466
mean		16.5	87	64.4	98.1	14	10718	615
LSD(0.05)		0.6	5	2.3	0.9	1	555	159
CV(s/mean)%		2.7	3.9	2.5	0.6	6.3	3.6	17.9

**Days since planting - 4/18/00*

Table 2. Agronomic data from the Statewide Lentil Trial at Kalispell, MT in 2000.

Cultivar	Emergence	Stand	First Bloom	Maturity	Height	Seed Size	Yield
	*day**	*%*	*day**	*day**	*inches*	*#/lb*	*lbs/a*
Brewer	16	91	62	98	15	8649	714
Pardina	16	86	64	98	12	13021	648
French Green	17	86	70	99	14	16717	630
CDC Richlea	16	89	70	99	15	9944	625
Laird	16	91	71	104	18	6689	624
Eston	16	86	67	98	14	15655	623
Crimson	17	85	69	98	13	15547	617
Red Chief	16	90	62	98	14	8762	610
Indianhead	17	81	76	104	15	23223	344
mean	16	87	68	99	14	13134	604
LSD(0.05)	1	4	3	1	1	616	162
CV(s/mean)%	2.5	3.2	2.6	0.7	6.7	3.2	18.3

Seeding date: 4/18/00
*Days after seeding.

Table 3. Agronomic data from the Western Regional Dry Pea Yield Trial at Kalispell, MT in 2000.

Cultivar	Emerg	Stand	First Bloom	Nodes to 1st flw	Height	Maturity	Seed Weight	Yield
	*day**	*%*	*day**		*inches*	*day**	*#/lb*	*lbs/a*
PS610509	17	87	65	15	17	99	1799	1595
PS610152	17	88	58	11	15	97	2430	1536
Fallon	16	88	64	14	19	97	2212	1470
PS610324	17	87	65	15	20	98	2320	1374
PS510718	16	92	65	12	24	98	2690	1289
PS610150	16	87	58	14	15	97	2370	1284
PS510737	17	85	65	14	15	98	2569	1249
mean	16	88	63	14	18	98	2341	1400
LSD(0.05)	1	NS	1	NS	3	1	118	240
CV(s/mean)%	1.9	3.4	0.8	13.1	10.5	0.5	3.4	9.5

Seeding date: 4/18/00
*days after seeding

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

Two species of chamomile, German (*Matricaria recutita*) and Roman (*Chamaemelum nobile*), were direct seeded at 4.25 g/ and 6.52 g/1000 linear ft, respectively, on May 3, 2000. The species were planted in 2 separate randomized complete blocks separated by oats to deter cross-pollination. Each plot consisted of 8-15' rows with 1' row spacing. The annual German chamomile was harvested in 2000, and the perennial Roman was maintained without harvesting until 2001. Treatments consisted of 3 harvest/distillation regimes, each replicated 4 times:

1) hand raking the blossoms from the plants 3 times and distilling the dry flowers;
2) clipping the tops of the plants twice with a swather, drying, and distilling the dry clippings;
3) clipping the tops and distilling the fresh clippings 3 times.

Treatment #2, clipping twice and distilling dry, yielded the most oil (5.1 lbs./acre), and the raked treatment produced the least (2.3 lbs./acre) (Table 1). These yields are only rough estimates. The small amount of material distilled and the viscosity of the oil make accurate measurement very difficult.

Table 1. Total dry matter and oil yields of German chamomile at Kalispell in 2000.

Treatment		Total Dry Matter	Total Oil Yield
Harvest	Distillation	*lbs/a*	*lbs/a*
clip	dry	4860	5.1
clip	green	4711	4.2
rake	dry	5461	2.3
	mean	5011	3.8
	LSD(0.10)	NS	1.7
	CV(s/mean)	11.1	32.9

TITLE: **Dill Seeding Rate Trial**

PROJECT LEADER: Nancy Callan, MSU-WARC
COOPERATORS: Leon Welty, MSU-NWARC
Louise Strang, MSU-NWARC

Dill (cv. Mammoth) was seeded at 2, 4, 8, 12, and 16 lbs/acre on 5/9/00. Plots were 8-15' long rows with one-ft spacing arranged in a randomized complete block design with 4 replicates. Twenty square feet of each plot was harvested 9/8/00 and distilled fresh. On 9/18/00 another portion of each plot was harvested and distilled to compare oil yield and quality from slightly more mature plants.

Oil yield from the first harvest was 24% higher than yield from the second harvest (Table 1). No significant yield differences were found among the different seeding rates. Oil quality analyses are pending.

Table 1. Yields of dill oil from 5 seeding rates on 2 harvest dates at Kalispell in 2000.

DILL SEEDING RATE STUDY
Kalispell, 2000

SEEDING RATE	*6/21* STAND	*9/7* MATURITY	HEIGHT	*9/8/00* DRY MAT YIELD	*9/8/00* OIL YIELD	*9/11* STAND	*9/19/00* DRY MAT YIELD	*9/19/00* OIL YIELD
lbs/a	*pl/ft*	*(1-10)**	*in*	*t/a*	*lbs/a*	*pl/ft*	*t/a*	*lbs/a*
2	8.4	3	48	3.31	48.1	9.3	3.50	46.9
4	14.5	4	50	3.99	54.3	15.7	3.75	42.8
8	25.2	2	49	2.83	50.2	30.4	3.42	42.8
12	36.5	4	48	3.46	45.5	37.9	3.19	29.0
16	43.4	5	45	3.66	51.7	44.0	3.55	37.4
mean	25.6	4	48	3.45	50.0	27.5	3.48	39.8
LSD(0.05)	4.0	NS	NS	NS	NS	5.8	NS	NS
CV(s/mean)%	10.1	36.1	5.7	16.8	22.7	13.6	19.4	42.7

* 1=least mature, 10=most mature

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

Three species of *Echinacea*, *E. angustifolia,* and *E. pallida* were direct seeded at 9-seeds/linear ft. on May 4, 1999. Tops and roots of *E. purpurea* were harvested in 2000, and tops and roots of the other species will be harvested in 2001.

Flower heads were removed from half of the *E. angustifolia* and *E. pallida* plots on July 7. On Aug. 10 the top halves of the plants were removed from half the *E. purpurea* plots and the flower heads only from the other half of the plots. Four plots in an adjacent demonstration nursery were left intact. There was no difference in either top growth or root yields between the flower and top removal treatments (Table 1). The plots with no removal were in an area with more observable plant disease (presumably *Sclerotinia)* so we cannot draw any valid comparisons with the "dead headed" plots.

The plant material is currently being analyzed by Nutritional Labs.

Table 1. Top growth and root yields of *E. purpurea* at Kalispell in 2000.

	Topgrowth[1/]	Root[2/]
Treatment	*lbs/a*	*lbs/a*
Flowers only	6737	2043
Top half	6951	2012
No removal	2698	1101
mean	5462	1719
LSD(0.05)	1508	484
CV(s/mean)%	16.0	16.3

Feverfew

Four feverfew plots were established in 1999 from transplants received from WARC. The plots were harvested at the early bloom stage on 6/29/00. A sub sample from each plot was weighed fresh then dried to obtain dry matter yield. The dry matter was then screened to separate the "tea grade" material from the rest of the sample.

The four plots yielded an average of 4200 lbs/a tea-grade feverfew.

TITLE: **St. John's Wort**

PROJECT LEADER: Leon Welty, MSU-NWARC

RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

One plot consisting of 4-20 ft. rows spaced 3 ft. apart remained from the 1998 planting. Samples were taken from the top 6" and the bottom of the plants to 4" stubble, at 4 weekly intervals beginning at the early bloom stage (6/30/00). The harvested material was dried and saved for analyses by Nutritional Labs. Yields from the top 6" ranged from 0.59 t/a (prebloom) to 1.76 t/a (full bloom). Total dry matter yields (whole plants) ranged from 3.33 t/a to 4.68 t/a. Hypericin content is being analyzed by Nutritional Labs. All regrowth was destroyed following the last harvest.

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

PROJECT LEADER: Leon Welty, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

The following propagators provided nuclear plants of Native, N-83-5, and Scotch 770 spearmint:

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.

Stands were rated for occupancy on 5/17/00. All plots were harvested 7/5/00 at the early to mid bud stage and on 9/14/00 at the late bud to mid bloom stage. Yields were determined by swathing a 99-ft2 area of each plot, drying a 500-g sub sample to determine dry matter content, and drying a 20-lb. sample for distillation. Oil was collected by steam distillation with a research still at the NWARC. A.M. Todd Company conducted oil quality analyses.

Scotch 770 had the least vigorous early season growth. N-83-5 and Native produced more vigorous spring stands (Table 1). Propagation method had no significant effect on spring vigor.

At each cutting, Scotch 770 had 48% to 64% higher oil content than Native and its derivative N-83-5 (Table 2). The nodal and meristem propagated Native and Scotch 770 had higher concentrations of oil than the stem-cut propagated. Native and N-83-5 produced significantly more dry matter than Scotch 770. In the second cutting, meristem Scotch 770 produced more oil than the other entries. Scotch 770 produced less oil than Native and N-83-5 in the first harvest and 41% and 26% more oil in the second harvest. There were no differences among propagation sources in the first harvest, but meristem and nodal Native and meristem Scotch 770 produced more oil than the stem cut types of these cultivars at the second harvest. Perhaps Scotch 770's slow establishment prevented it from reaching its production potential until later in the season.

Rust symptoms did not appear this year. Powdery mildew was just showing up by the second cutting. As in the first harvest, Scotch 770 produced the least hay (Table 3). Scotch 770 had 64% higher oil content than the other cultivars and also had the highest oil yield of the three cultivars. The interaction between cultivar and propagation type was significant. There was no effect of propagation source on oil yield of N-83-5. Stem cut Native produced less oil than meristem and nodal Native. Meristem Scotch 770 produced more oil than the non-meristem Scotch.

Total oil yields for 2000 (Table 4) are displayed graphically in Figure 1. The nodal derived plants did not differ significantly in oil yield regardless of cultivar. Scotch 770 meristem produced more oil than the Native lines. Native stem cut produced significantly less oil than stem cutting derived N-83-5 or Scotch 770. Total oil yields from 1997-2000 show significant differences among cultivars and propagation sources

(Table 5, Figure 2). Scotch 770 was most productive, followed by N-83-5. Native was the least productive.

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

Table 1. Occupancy (% of plot covered) of spearmint cultivar/propagation sources on 5/17/00.

	Propagation Source			
Cultivar	Stem cut	Meristem	Nodal	means
Native	86.3	91.3	87.5	88.3
N-83-5	82.5	88.8	86.3	85.8
Scotch 770	43.8	37.5	38.8	40.0
Means	70.8	72.5	70.8	

LSD(0.10) Cultivar: 8.2
Propagation: NS
Interaction: NS

Table 2. Hay yield, oil content, and oil yield of entries at first harvest – 7/5/00.

HAY YIELD (tons/acre)[1/]

Cultivar	Propagation Source: Stem cut	Meristem	Nodal	means
Native	2.34	2.46	2.39	2.40
N-83-5	2.38	2.52	2.41	2.44
Scotch 770	1.41	1.45	1.16	1.34
means	2.04	2.14	1.99	

LSD(0.10) Cultivar: 0.15
Propagation: NS
Interaction: NS

OIL CONTENT (%dm)

Cultivar	Propagation Source: Stem cut	Meristem	Nodal	means
Native	0.86	0.87	0.97	0.90
N-83-5	0.93	0.87	0.90	0.90
Scotch 770	1.25	1.29	1.46	1.33
means	1.01	1.01	1.11	

LSD(0.10) Cultivar: 0.14
Propagation: NS
Interaction: NS

OIL YIELD (lbs/acre)[1/]

Cultivar	Propagation Source: Stem cut	Meristem	Nodal	means
Native	41.2	43.3	51.1	45.2
N-83-5	45.3	42.8	42.9	43.7
Scotch 770	34.7	36.0	32.4	34.3
means	40.4	40.7	42.1	

LSD(0.10) Cultivar: 6.2
Propagation: NS
Interaction: NS

[1/] All spearmints were in the early to mid bud stage on 7/5/00.

Table 3. Hay yield, oil content, and oil yield of cultivars at second harvest – 9/14/00.

HAY YIELD (tons/acre) [1/]

	Propagation Source			
	Stem cut	Meristem	Nodal	means
Native	2.45	2.44	2.40	2.43
N-83-5	2.49	2.64	2.39	2.50
Scotch 770	2.08	2.02	1.75	1.95
Means	2.34	2.37	2.18	

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

OIL CONTENT (%dm)

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	0.91	1.11	1.13	1.05
N-83-5	1.16	1.04	1.21	1.14
Scotch 770	1.54	1.92	1.95	1.80
Means	1.20	1.36	1.43	

LSD(0.10) Cultivar: 0.10
Propagation: 0.10
Interaction: 0.17

OIL YIELD (lbs/acre) [1/]

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	41.5	51.1	53.6	48.7
N-83-5	55.3	52.4	56.8	54.8
Scotch 770	62.6	76.5	67.2	68.8
Means	53.1	60.0	59.2	

LSD(0.10) Cultivar: 4.4
Propagation: 4.4
Interaction: 7.7

[1/] All spearmints were in the early to late bud stage on 9/14/00.

Table 4. Total hay and oil yields from the Spearmint Cultivar/Propagation Trial at Kalispell in 2000.

TOTAL HAY YIELD 2000(t/a)

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	4.79	4.90	4.79	4.83
N-83-5	4.87	5.16	4.79	4.94
Scotch 770	3.49	3.48	2.90	3.29
Means	4.38	4.51	4.16	

LSD(0.10) Cultivar: 0.28
Propagation: NS
Interaction: NS

TOTAL OIL YIELD 2000 (lbs/acre)

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	82.6	94.3	104.7	93.9
N-83-5	100.6	95.2	99.7	98.5
Scotch 770	97.3	108.6	99.5	101.8
Means	93.5	99.4	101.3	

LSD(0.10) Cultivar: NS
Propagation: NS
Interaction: 12.1

Table 5. **Total oil yields 1997-2000 (lbs/acre).**

	Propagation Source			
	Stem cut	Meristem	Nodal	Means
Native	289.2	302.3	333.0	308.2
N-83-5	322.6	319.8	344.3	328.9
Scotch 770	366.3	372.8	410.9	383.3
Means	326.0	331.6	362.7	

LSD(0.10) Cultivar: 16.2
Propagation: 16.2
Interaction: NS

Table 6a. Quality components of 3 spearmint cultivars and 3 propagation types for the first harvest, 2000.

Cultivar	A:Pinene	B:Pinene	Limonene	Cineole	Dihydro-Carvone	Carvone
Stem tip Native	1.0	1.5	12.3	2.1	1.6	55.9
Stem tip N-83-5	1.1	1.5	11.3	2.2	1.1	55.2
Stem tip Scotch 770	1.1	1.6	21.4	1.4	0.7	58.9
Meristem Native	1.1	1.6	12.8	2.3	1.4	53.2
Meristem N-83-5	1.1	1.6	12.5	2.2	1.1	54.0
Meristem Scotch 770	1.1	1.6	18.7	1.2	1.0	61.8
Nodal Native	1.1	1.5	11.8	1.8	1.3	55.0
Nodal N-83-5	1.2	1.6	12.2	2.3	1.3	52.6
Nodal Scotch 770	1.0	1.5	19.8	1.1	1.0	62.0
Mean	1.1	1.6	14.7	1.8	1.2	56.5
LSD (0.10)	NS	NS	1.1	0.2	0.2	2.9
CV(s/mean) x100	7.8	6.7	6.1	8.4	16.0	4.3

Table 6b. Quality components of 3 spearmint cultivars and 3 propagation types for the second harvest, 2000.

Cultivar	A:Pinene	B:Pinene	Limonene	Cineole	Dihydro-carvone	Carvone
Stem tip Native	1.1	1.6	10.1	2.7	2.7	57.1
Stem tip N-83-5	1.0	1.5	9.3	2.8	1.6	59.0
Stem tip Scotch 770	0.9	1.4	16.8	1.8	1.4	64.1
Meristem Native	1.2	1.6	10.4	2.7	2.2	57.1
Meristem N-83-5	1.1	1.5	9.0	2.7	1.4	58.6
Meristem Scotch 770	1.0	1.5	16.8	1.6	1.8	64.0
Nodal Native	1.0	1.4	10.2	2.2	1.5	60.1
Nodal N-83-5	1.1	1.6	10.0	2.8	1.7	58.3
Nodal Scotch 770	1.0	1.4	17.8	1.6	1.7	63.4
Mean	1.0	1.5	12.3	2.3	1.8	60.2
LSD (0.10)	0.1	NS	1.3	0.2	0.3	2.2
CV(s/mean) x100	9.3	8.0	8.7	8.8	14.2	3.0

Analysis by A.M.Todd Co.

Figure 1. Total oil yields for entries in the Spearmint Cultivar/Propagation Trial at Kalispell in 2000.

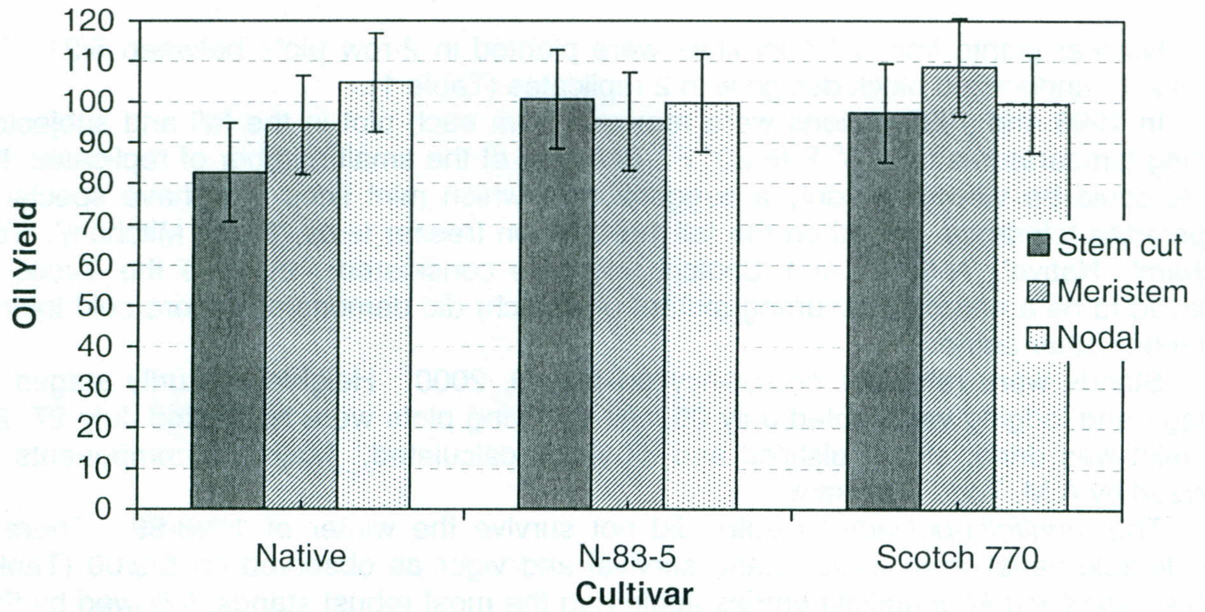
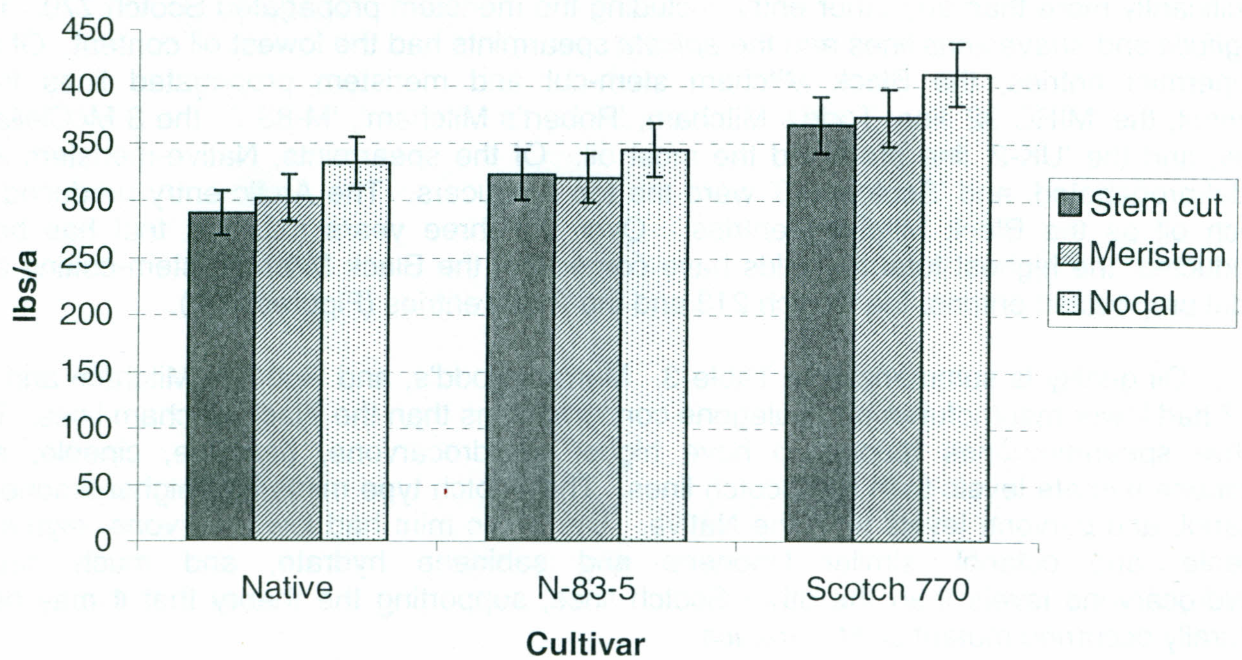


Figure 2. Total oil yields for entries in the Spearmint Cultivar/Propagation Trial at Kalispell from 1997 to 2000.



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

PROJECT LEADER: Leon Welty, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

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° F to 20° 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.

Stands were rated for occupancy on May 9, 2000. Heights, maturity stages, pest damage and lodging were noted July 25. All surviving plots were harvested July 27, 2000. The mint was dried, steam distilled and oil yields calculated. Major oil components were analyzed by A.M. Todd Company.

The *longifolia-polyadenia* entry did not survive the winter of 1998-99. There was considerable variation in winter stand survival and vigor as observed on 5/9/00 (Table 2). The two *surviving M. longifolia* entries again had the most robust stands, followed by the *M. piperita* entries. The *M.cardiaca* spearmint lines had the weakest early stands.

All plots were harvested 7/27/00 (Table 2). Plant heights ranged from 21 inches (stem-cut 'Scotch 770') to 46 inches (the Dutch *longifolia*). 'Murray Mitcham' was the least mature, having barely started to bud, and the *cardiaca, longifolia,* and *suaveolens* lines were the most mature, having reached full bloom. The two *longifolia*s, the N-83-5 and the meristem Native produced the most dry matter, and the *cardiaca* lines produced the least. Stem-cut Scotch 770 produced the highest concentration of oil per unit dry matter, significantly more than any other entry, including the meristem propagated Scotch 770. The *longifolia* and *suaveolens* lines and the *spicata* spearmints had the lowest oil content. Of the peppermint entries, the Black Mitcham stem-cut and meristem propagated lines from Summit, the 'MIRC-92' line, Todd's Mitcham, 'Robert's Mitcham', 'M-83-7', the 3 McClelland lines, and the 'UK-2' line produced the most oil. Of the spearmints, Native-meristem and nodal-propagated, and 'Scotch 213' were the top producers. The Arctic entry produced as much oil as the Black Mitcham entries. Over the three years that this trial has been conducted, the highest total oil yields have come from the Black Mitcham stem-cutting and nodal propagated entries, the Scotch 213 and the Arctic entries (Figures 1&2).

Oil quality is summarized in Table 3. Murray, Todd's, and Robert's Mitcham and M-83-7 had lower menthofuran and pulegone concentrations than the Black Mitcham lines. The Native spearmint lines tended to have higher dihydrocarvone, myrcene, cineole, and sabinene hydrate levels than the Scotch lines. The Scotch type mints had higher limonene, octanol, and carvone levels than the Native. The Arctic mint had lower carvone, myrcene, cineole, and octanol, similar limonene and sabinene hydrate, and much higher dihydrocarvone levels than the other Scotch lines, supporting the theory that it may be a naturally occurring mutant of *M. cardiaca*.

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 1	Lake(Margetts-Roberts)
piperita	Black Mitcham	nodal	English 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	stem cut	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	stem cut	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. Heights, growth stages, and yield components of entries in the cold tolerance trial at Kalispell in 2000.

Cultivar	Method	Source	Prop.	Cover[1]	Height	Stage	Hay Yield	Oil Content	Oil Yield	Total Oil 1998-2000
				%plot	*inches*	*	*t/a*	*%dm*	*lbs/a*	*lbs/a*
Black M.	stem	MIRC	Summit	83	32	fb	3.13	1.3	78.6	176.4
Black M.	meris.	MIRC	Summit	85	31	fb	2.84	1.4	79.1	172.3
Black M.	meris.	MIRC	Starkel	88	33	mb	2.75	1.1	60.1	141.0
Black M.	nodal	MIRC92	Lake	90	35	fb	3.13	1.3	80.3	188.3
Murray M.	stem	MIRC	Summit	88	32	pb	3.02	1.0	60.5	163.1
Todd's M.	stem	MIRC	Summit	78	30	mb	2.96	1.2	68.1	130.0
Roberts M	stem	MIRC	Summit	85	31	pb	3.03	1.1	65.8	173.4
M-83-7	stem	MIRC	Summit	88	30	mb	3.07	1.1	65.4	158.4
Black M.	nodal	Mc96-7	Lake	85	33	mb	2.64	1.3	66.6	174.7
Black M.	nodal	UK-1	Lake	88	30	eb	2.75	0.7	40.0	132.8
Black M.	nodal	UK-2	Lake	88	29	mb	2.59	1.3	67.1	171.0
Native	stem	MIRC	Summit	78	38	eblm	4.08	0.7	49.9	114.1
N-83-5	stem	MIRC	Summit	80	37	eblm	5.68	0.4	48.1	99.8
Native	meris.	MIRC	Starkel	88	35	eblm	5.63	0.5	58.1	151.3
Scotch	stem	MIRC	Summit	35	26	fblm	1.63	1.7	54.5	143.2
Scotch 213	stem	MIRC	Summit	65	26	fblm	2.09	1.3	62.2	216.3
Scotch 227	stem	MIRC	Summit	33	28	fblm	1.85	1.1	39.2	120.0
Scotch 770	stem	MIRC	Summit	38	21	fblm	1.23	2.1	51.2	155.3
Scotch 770	meris.	MIRC	Starkel	78	27	fblm	1.96	1.2	47.3	170.5
longifolia-hymal.	stem	Davis	Grey	95	39	fblm	5.76	0.3	34.7	65.0
longifolia	nodal	NCGR	Lake	95	46	fblm	6.27	0.2	26.0	61.4
suaveolens	nodal	NCGR	Lake	78	27	fblm	3.00	0.2	9.9	21.6
Black M.	nodal	Mc96-9	Lake	83	30	mb	2.70	1.4	73.2	195.0
Native	nodal			73	38	mblm	4.44	0.7	62.3	83.9
Black M.	nodal	Mc96-19	Lake	88	35	mb	2.86	1.3	72.8	149.6
Arctic	nodal	Callison	Lake	75	27	fb	3.14	1.1	68.1	198.4
		mean		78	32		3.24	1.0	57.3	143.3
		LSD(0.10)		12	4		0.92	0.3	15.4	41.9
		CV(s/mean) %		9.4	7.8		16.6	16.8	15.8	17.1

[1] Evaluated 5/9/00.

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

Ta 3. Quality components of mint oil from the *Mentha* Cc Tolerance Study (GC%).

Peppermint

Species	Cultivar	Method	Source	Menthol	Neo-menthol	Menthone	D-iso-menthone	Mentho-furan	Esters	Pulegone
piperita	Black Mitcham	stem-cut	MIRC	34.8	3.2	27.2	3.1	1.8	4.9	0.45
piperita	Black Mitcham	meristem	MIRC	23.2	2.0	19.2	2.2	1.6	4.0	0.71
piperita	Black Mitcham	meristem	Starkel	36.9	3.1	26.7	3.0	1.3	4.8	0.21
piperita	Black Mitcham	nodal	MIRC-92	32.5	3.0	25.5	2.9	1.8	4.9	0.43
piperita	Murray Mitcham	stem-cut	MIRC	34.1	3.3	30.2	3.3	1.0	5.2	0.16
piperita	Todd's Mitcham	stem-cut	MIRC	31.1	3.2	30.8	3.3	1.2	4.9	0.24
piperita	Roberts Mitcham	stem-cut	MIRC	32.4	3.0	30.3	3.3	1.0	4.6	0.14
piperita	M-83-7	stem-cut	MIRC	33.4	3.5	29.2	3.4	1.0	5.3	0.21
piperita	Black Mitcham	nodal	Mc96-9	34.1	2.9	26.6	3.0	1.8	4.9	0.35
piperita	Black Mitcham	nodal	UK-1	33.2	3.2	26.6	2.9	1.2	5.0	0.17
piperita	Black Mitcham	nodal	UK-2	33.1	3.0	28.4	3.2	1.5	4.8	0.21
piperita	Black Mitcham	meristem	Mc96-7	36.2	3.4	24.7	2.9	1.9	4.8	0.43
piperita	Black Mitcham	nodal	Mc96-19	33.9	2.9	26.0	2.8	1.6	4.8	0.33
			mean	33.0	3.1	27.0	3.0	1.4	4.8	0.31
			LSD(0.10)	NS	NS	NS	NS	0.6	NS	0.12

Spearmint

Species	Cultivar	Method	Source	Dihydro-carvone	Myrcene	Limonene	Cineole	Octanol	Sabinene Hydrate	Carvone
spicata	Native	stem-cut	MIRC	2.10	2.99	13.5	2.09	0.94	2.68	54.6
spicata	N-83-5	stem-cut	MIRC	1.55	3.86	12.1	2.09	0.90	3.34	55.4
spicata	Native	meristem	MIRC	2.05	4.07	13.6	2.29	0.88	2.89	54.4
spicata	Native	stem-cut	Clarke	1.35	3.97	14.0	2.20	0.92	3.95	54.7
cardiaca	Scotch	stem-cut	MIRC	1.05	0.69	19.1	1.35	1.88	0.48	61.5
cardiaca	Scotch 213	stem-cut	MIRC	1.75	0.65	16.0	1.28	2.23	0.37	63.9
cardiaca	Scotch 227	stem-cut	MIRC	1.85	0.98	19.6	1.21	2.12	0.30	59.8
cardiaca	Scotch 770	stem-cut	MIRC	1.60	1.11	20.4	1.24	1.83	0.35	58.5
cardiaca	Scotch 770	meristem	MIRC	1.70	1.82	15.6	1.51	1.46	1.13	59.5
cardiaca	Arctic	nodal	Callison	5.59	0.60	19.2	0.99	0.72	0.42	45.2
			mean	1.67	2.23	16.0	1.69	1.46	1.72	58.0
			LSD(0.10)	0.25	0.93	3.1	0.39	0.41	0.85	4.8

Other Species

Species	Cultivar	Method	Source	Dihydro-carvone	Myrcene	Limonene	Cineole	Octanol	Sabinene Hydrate	Carvone
longifolia	hymaliensis	stem-cut	Davis	0.26	0.91	6.2	2.25	0.71	0.92	11.8
longifolia		nodal	NCGR	0.16	0.55	3.5	1.37	0.30	0.65	25.3
suaveolens	rotundifolia	nodal	NCGR	0.24	0.65	7.1	0.52	0.30	0.34	8.3
			mean	1.56	0.68	9.0	1.28	0.51	0.58	22.6
			LSD(0.10)	0.54	NS	6.8	0.86	NS	NS	9.2

TITLE: **1998 Mint Cultivar Trial**
PROJECT LEADER: Leon Welty, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

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.

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 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 vigor was rated May 17 and August 8. Spearmint plots were harvested July 9 at the early to mid bud stage, and September 14, 2000 at the early to mid bloom stage. Peppermint entries were harvested August 8, 2000 at the early bloom stage. There were some indications of downy mildew in the second spearmint harvest. Plant height and growth stage was determined immediately before harvest. Yields were determined by swathing a 99-ft2 area of each plot, drying a 500-g subsample to determine dry matter content, and drying a 20-lb. sample for distillation. Oil was collected by steam distillation with a research still at the NWARC. Oil samples were analyzed for quality by gas chromatography at RCB International.

Spring stand evaluation indicated the UK-1 and UK-2 selection peppermints and Native and N-83-22 spearmints had the best stand retention, while the 92(B-37xM0110) cross, Scotch and Scotch 770 had the poorest stands (Table 1).

No rust symptoms were observed in 2000, but some spearmint plots showed mild symptoms of powdery mildew at the second harvest. The Scotch-derived cultivars seemed more susceptible than the Native lines. No *Verticillium* wilt was observed.

In this second post-establishment year of the study, there was variation in yield parameters among peppermint cultivars and selection groups (Table 2, Figure 1). No peppermint entry produced significantly more dry matter than Black Mitcham, and 92(B-37xM0110) produced significantly less. B-90-9 had a higher amount of oil as percent of dry matter than the other entries. B-90-9, Black Mitcham, 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, the parent Native produced the most dry matter. The Scotch lines produced less hay than the Native lines (Table 3). Scotch 770 had the highest concentration of oil on a dry matter basis, and Native and N-83-22 had the lowest. Scotch and Scotch 770 produced the most oil over the two harvests, and N-83-22 produced the least (Figure 2). Scotch 770 produced 115 lbs./acre of spearmint oil, 20% more than Native and 65% more than N-83-22. None of the new peppermint or spearmint cultivars or selections showed significant improvement in oil yield over the parental lines (Table 4).

Quality data for peppermint entries are summarized in Table 5. B-90-9 was similar to Black Mitcham in menthone, menthol, pulegone, ketones, and alcohol levels, but similar to Murray Mitcham in menthyl acetate level. M-83-14 was similar to Murray Mitcham in menthone, menthol, ketones, and alcohols. The hybrid 92(B-37xM0110) was similar to Murray Mitcham in menthone, menthyl acetate, pulegone, menthofuran, and ketones, but similar to Black Mitcham in menthol and total alcohols. Spearmint quality data is summarized in Table 6. The Native lines had higher levels of cineole than the Scotch lines, and Scotch lines had higher levels of limonene, octanol, and carvone.

Table 1. Stand evaluation of peppermint and spearmint entries at Kalispell, MT on May 17, 2000.

Selection/Cultivar	Source	5/17/00 Cover (0-5)[1/]	*8/8/00* Vigor *(0-5)*[2/]
PEPPERMINT			
Black Mitcham	stem-cut/MIRC	4.0	4.3
B-90-9	stem-cut/MIRC	4.0	4.8
Murray Mitcham	stem-cut/MIRC	4.0	4.0
M-83-14	stem-cut/MIRC	4.0	5.0
92 (B-37 x M0110)	stem-cut/MIRC	2.0	3.8
Lewis McKellip	nodal/MIRC	4.0	5.0
UK-1	nodal/Lake	5.0	5.0
UK-2	nodal/Lake	4.5	5.0
McClelland	meristem/Starkel	4.5	5.0
Plant Tech 94	stem-cut/Grey	4.5	5.0
	LSD(0.10)	1.0	0.5
SPEARMINT			
Native	stem-cut/MIRC	4.0	5.0
N-83-22	stem-cut/MIRC	3.5	4.0
Scotch	stem-cut/MIRC	2.0	3.0
Scotch 770	stem-cut/MIRC	2.0	2.0
S-90-9	stem-cut/MIRC	2.5	2.5
	LSD(0.10)	1.5	1.0

Planted 5/19/98

[1]/0=plot empty, 5=plot totally occupied
[2]/ 0=dead, 5=strong, vigorous plants

Table 2. Heights, total dry matter, oil concentration, and oil yield of peppermint entries in the 1998 Mint Cultivar Trial at Kalispell, MT in 2000.

Selection/Cultivar	Source	Height	Hay Yield	Oil Content	Oil Yield
		inches	*t/a*	*%dm*	*lbs/a*
B-90-9	stem-cut/MIRC	36	3.00	1.6	92.1
Black Mitcham	stem-cut/MIRC	37	3.01	1.4	84.7
Plant Tech-94	stem-cut/Grey	39	3.15	1.3	82.8
Lewis McKellip	nodal/MIRC	38	3.19	1.3	79.2
UK-2	nodal/Lake	35	2.72	1.4	72.6
UK-1	nodal/Lake	36	2.92	1.3	72.3
Murray Mitcham	stem-cut/MIRC	36	3.17	1.1	71.8
McClelland	meris.-Starkel	38	2.68	1.2	65.0
M-83-14	stem-cut/MIRC	38	3.10	1.0	62.9
92 (B-37 x M0110)	stem-cut/MIRC	21	0.57	1.3	15.2
	LSD(0.10)	4	0.41	0.2	10.6
	CV(s/mean) %	10.1	12.3	14.4	12.6

Planted 5/19/98
Harvested 8/8/00

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

First Harvest 7/5/00

Selection/Cultivar	Source	Height	Hay Yield	Oil Content	Oil Yield
		inches	*t/a*	*%dm*	*lbs/a*
Scotch 770	stem-cut/MIRC	21	1.71	1.6	54.0
S-90-9	stem-cut/MIRC	22	2.04	1.3	48.8
Native	stem-cut/MIRC	30	2.56	0.9	46.9
Scotch	stem-cut/MIRC	23	1.89	1.2	46.8
N-83-22	stem-cut/MIRC	28	2.08	1.1	45.0
	LSD(0.10)	2	0.25	0.2	NS
	CV(s/mean x100)	5.8	9.7	14.7	16.4

Second Harvest 9/14/00

Selection/Cultivar	Source	Hay Yield	Oil Content	Oil Yield
		t/a	*%dm*	*lbs/a*
Scotch 770	stem-cut/MIRC	1.69	1.8	61.0
Scotch	stem-cut/MIRC	1.68	1.7	57.5
Native	stem-cut/MIRC	2.29	1.1	48.8
S-90-9	stem-cut/MIRC	1.64	1.4	43.4
N-83-22	stem-cut/MIRC	2.00	0.6	24.7
LSD(0.10)		0.22	0.2	7.6
CV(s/mean x100)		9.5	10.6	12.9

Planted 5/19/98

Table 4. Total dry matter and oil yields for peppermint and spearmint entries in the 1998 Mint Cultivar Trial at Kalispell, MT from 1998 to 2000.

Peppermint Selection/Cultivar	1998 Hay t/a	1998 Oil lbs/a	1999 Hay t/a	1999 Oil lbs/a	2000 Hay t/a	2000 Oil lbs/a	Total Hay t/a	Total Oil lbs/a
Black Mitcham	2.09	59.7	3.54	87.1	3.01	84.7	8.64	231.5
B-90-9	1.98	61.2	3.45	91.9	3.00	92.1	8.42	245.1
Murray Mitcham	1.87	47.2	2.87	61.7	3.17	71.8	7.91	180.7
M-83-14	2.05	55.4	3.37	66.6	3.10	62.9	8.52	184.8
92 (B-37 x M0110)	1.67	37.3	1.61	36.8	0.57	15.2	3.85	89.2
Lewis McKellip	2.15	55.1	3.89	89.2	3.19	79.2	9.23	223.5
UK-1	1.83	50.3	3.21	70.6	2.92	72.3	7.96	193.2
UK-2	1.60	46.9	3.09	66.9	2.72	72.6	7.40	186.4
McClelland	1.98	52.4	3.66	70.4	2.68	65.0	8.32	187.8
Plant Tech 94	1.73	49.5	3.49	87.7	3.15	82.8	8.37	220.0
mean	1.89	51.5	3.22	72.9	2.75	69.8	7.86	194.2
LSD(0.10)	0.23	8.0	0.54	15.0	0.41	10.6	0.88	24.3
CV(s/mean x 100)	10.3	12.8	14.0	17.1	12.3	12.6	9.3	10.4
Spearmint								
Native	1.84	34.6	5.34	77.0	4.85	95.6	12.04	208.1
N-83-22	1.57	17.7	4.54	38.8	4.08	69.7	10.18	124.3
Scotch	1.76	44.5	4.14	110.6	3.58	104.2	9.67	265.9
Scotch 770	1.39	38.0	3.58	116.6	3.41	115.0	8.36	268.8
S-90-9	1.41	26.3	3.33	74.4	3.59	92.2	8.33	193.6
mean	1.59	32.2	4.19	83.5	3.90	95.3	9.72	212.1
LSD(0.10)	0.27	7.4	0.34	14.1	0.46	16.3	1.00	25.1
CV(s/mean x 100)	12.5	13.7	12.2	13.3	9.4	13.6	8.1	9.3

Table 5. Oil quality constituents of peppermint entries in the 1998 Mint Cultivar Trial at Kalispell, MT in 2000.

Selection/Cultivar	Menthone	Menthyl acetate	Menthol	Pulegone	Mentho-furan	Total ketones	Total alcohols
				GC Area %			
Black Mitcham	20.1	4.40	37.6	1.62	4.40	25.5	41.4
B-90-9	20.0	3.75	37.7	1.76	5.31	25.4	41.7
Murray Mitcham	25.9	3.76	35.9	0.72	2.11	30.8	39.6
M-83-14	25.4	3.26	36.1	1.44	3.04	31.1	40.3
92 (B-37 x M0110)	25.9	3.93	36.9	0.75	2.15	30.6	41.3
Lewis McKellip	20.9	3.95	36.9	1.35	5.15	23.8	47.6
UK-1	24.4	3.82	35.2	0.88	3.68	27.6	45.8
UK-2	23.6	3.96	35.7	0.90	3.53	26.9	46.6
McClelland	20.3	4.02	37.3	1.24	4.63	23.5	48.2
Plant Tech 94	20.8	3.88	37.2	1.35	5.18	24.0	47.9
mean	22.7	3.87	36.6	1.20	3.92	26.9	44.0
LSD(0.10)	1.4	0.31	1.2	0.19	0.59	1.5	1.4
CV(s/mean)%	5.2	6.6	2.8	13.3	12.5	4.6	2.7

Table 6. Oil quality constituents of spearmint entries in the 1998 Mint Cultivar Trial at Kalispell, MT in 2000.

First Harvest - Selection/Cultivar	A-Pinene	B-Pinene	Limonene	Cineole	3-Octanol	Dihydro-carvone	Carvone
				GC Area %			
Native	0.97	0.82	11.9	1.53	1.08	1.89	55.5
N-83-22	0.89	0.74	12.8	1.47	0.99	1.07	52.7
Scotch	1.01	0.93	21.0	1.08	2.17	0.87	59.5
Scotch 770	0.90	0.85	18.4	0.91	2.16	1.18	63.8
S-90-9	0.85	0.83	16.1	1.15	1.66	1.53	61.7
mean	0.92	0.83	16.0	1.23	1.61	1.31	58.6
LSD(0.10)	NS	0.10	1.7	0.17	0.17	0.21	4.1
CV(s/mean)%	12.8	9.2	8.2	11.2	8.2	12.9	5.5
Second Harvest							
Native	1.03	0.86	10.8	2.36	0.92	2.43	57.8
N-83-22	1.12	0.90	13.8	2.42	0.80	1.45	52.2
Scotch	0.92	0.88	19.8	1.76	2.15	1.54	61.5
Scotch 770	0.94	0.89	19.5	1.57	2.25	1.65	62.7
S-90-9	0.95	0.94	18.8	1.74	1.55	3.93	58.1
mean	0.99	0.90	16.5	1.97	1.53	2.20	58.5
LSD(0.10)	0.14	NS	2.1	0.21	0.09	0.58	2.6
CV(s/mean)%	11.0	8.3	9.9	8.3	4.9	20.8	3.6

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

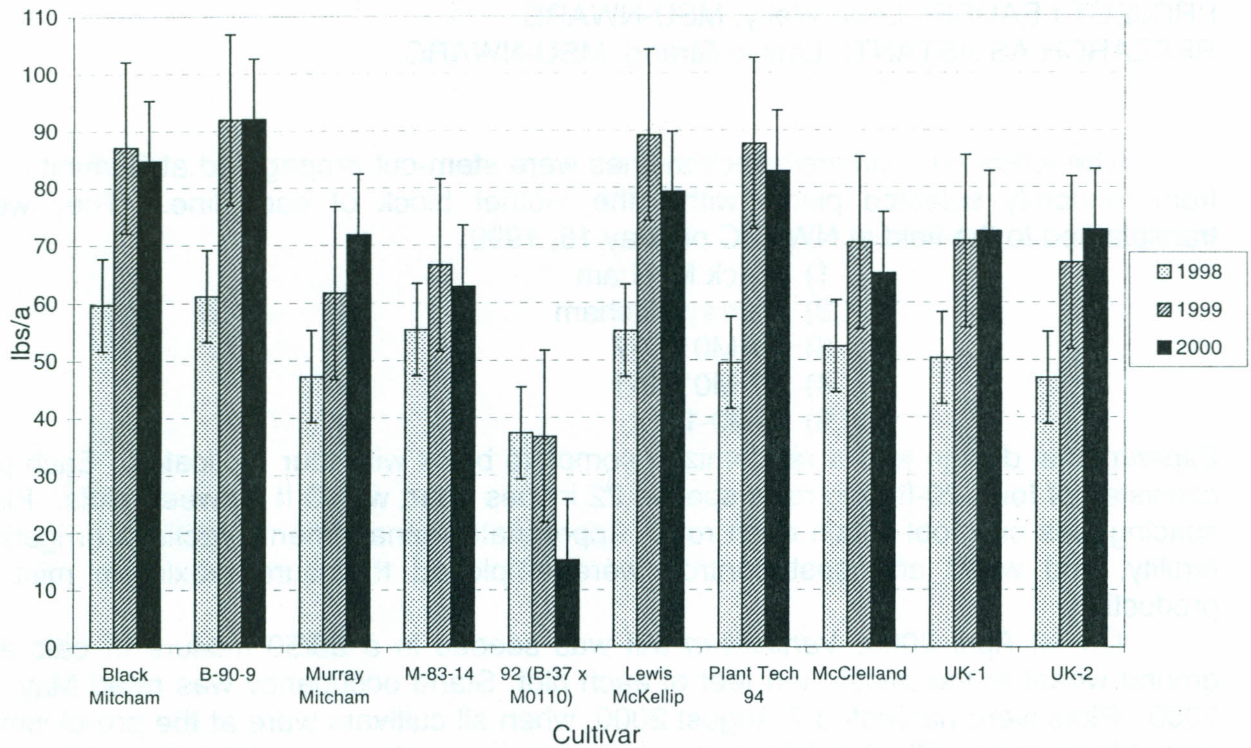
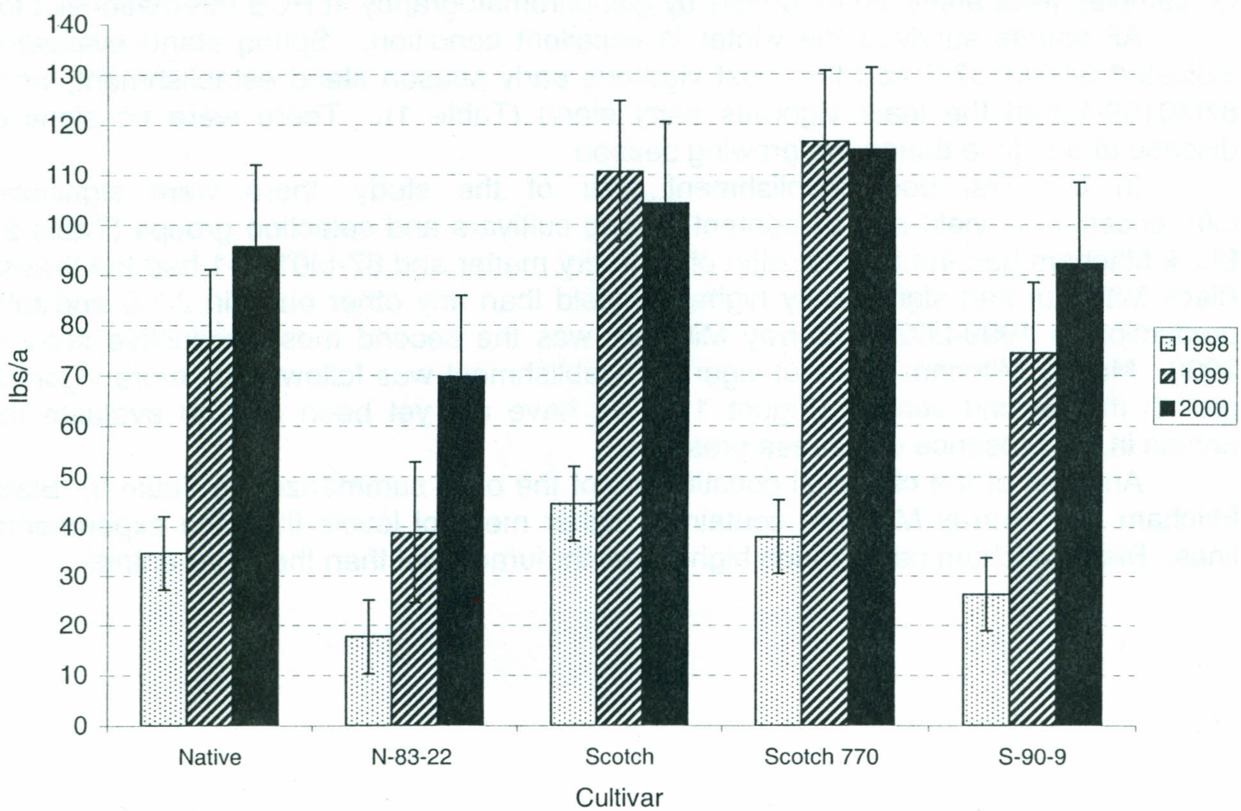


Figure 2. Oil yields of spearmint lines in the Mint Cultivar Trial established in 1998.



TITLE: **Evaluation Of MIRC Peppermint Germplasm - 1999**
PROJECT LEADER: Leon Welty, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

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:

1) Black Mitcham
2) Murray Mitcham
3) 84-M0107-7
4) 87-M0109-1
5) 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 May 17, 2000. Plots were harvested 7 August 2000, when all cultivars were at the pre-bloom to early bloom stage. Plant height and growth stage was determined the day of harvest. Yields were determined by swathing a 99 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 were analyzed for quality by gas chromatography at RCB International, Ltd.

All entries survived the winter in excellent condition. Spring stand evaluation indicated 84-M0107-7 had the most vigorous early season stand establishment, while 87M0109-1 had the least vigorous early stand (Table 1). There were no signs of disease at any time during the growing season.

In this first post-establishment year of the study, there were significant differences in oil yield and oil content among cultivars and selection groups (Table 2). Black Mitcham had the highest ratio of oil to dry matter and 87-M0109-1 had the lowest. Black Mitcham had significantly higher oil yield than any other entry in 2000 and total production in 1999-2000. Murray Mitcham was the second most productive entry in 2000. Murray Mitcham's lack of vigor at establishment was followed by more vigorous growth the second season (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 and Murray Mitcham contained higher menthol levels than the experimental lines. Black Mitcham had a much higher menthofuran level than the other entries.

Table 1. Stand establishment evaluation of peppermint entries in the 1999 MIRC Peppermint Trial at Kalispell, MT on May 17 and Aug.4, 2000.

Selection/Cultivar	5/17 Cover *% of plot*	*8/4* Vigor *(0-5)*[1]	*8/4* Stolon Spread *(0-5)*[2]
Black Mitcham	89	4.5	4.5
84-M0107-7	95	5.0	5.0
M-90-11	84	5.0	4.0
87-M0109-1	81	5.0	4.0
Murray Mitcham	84	5.0	4.0
LSD(0.10)	3	0.3	0.3
CV(s/mean) %	2.8	5.3	6.0

Planted 5/18/99

1/ 0=dead; 5=very healthy, vigorous growth
2/ 0=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 7 August, 2000 and total yields for the duration of the trial.

Selection/Cultivar	Height *inches*	Hay Yield *t/a*	Oil Content *%dm*	Oil Yield *lbs/a*	1999-2000 Hay Yield *t/a*	1999-2000 Oil Yield *lbs/a*
Black Mitcham	38	3.60	1.3	94.0	4.88	130.6
87-M0109-1	43	4.22	1.7	56.3	5.45	82.4
M-90-11	41	4.06	1.7	58.3	5.37	86.3
84-M0107-7	45	4.34	0.8	71.0	6.10	103.0
Murray Mitcham	37	3.46	1.0	70.4	4.15	88.1
LSD(0.10)	3	NS	0.2	13.5	0.81	17.2
CV(s/mean x100)	5.9	13.5	10.4	15.3	12.4	13.9

Planted 5/18/99
Harvested 8/7/00

Table 3. Levels of oil quality components (GC % area) of entries in the 1999 MIRC Peppermint Trial harvested at Kalispell, MT on 7 August 2000.

Line/Cultivar	GC % area						
	Menthone	Mentho-furan	D Iso-menthone	Menthyl acetate	Neo-menthol	Menthol	Pulegone
Black Mitcham	20.7	4.8	3.0	3.7	3.3	37.1	1.6
84M0107-7	33.6	1.3	13.2	2.1	2.3	25.2	0.7
M90-11	20.2	2.7	11.3	3.3	1.8	28.3	2.4
87M0109-1	28.2	0.9	14.3	3.1	3.5	24.3	1.2
Murray Mitcham	25.0	2.2	3.9	3.4	3.2	36.0	0.8
mean	25.5	2.4	9.1	3.1	2.8	30.2	1.3
LSD(0.10)	1.8	0.4	1.4	0.4	0.4	2.1	0.3
CV(s/mean) %	5.7	12.2	12.3	9.7	10.6	5.4	17.3

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