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

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CLIMATOLOGY

Weather information as recorded at the Northwestern Agricultural Research Center, Kalispell, Montana. Tables include weather reported for the 1999 crop year (September 1998-August 1999) and for the calendar year 1999.

CLIMATOLOGICAL DATA
NORTHWESTERN AGRICULTURAL RESEARCH CENTER
Kalispell, MT

The 1998/1999 crop year began with drier and warmer than average conditions from September through March, and remained dry until June. Total precipitation from September 1998 through August 1999 was 20% below average and accumulated growing degree-days were 5% below average. April and May were unusually dry, with 2-inches less precipitation than average for these months. The 1999 growing season (April – August) received 8.17 inches of rain, 19% below average, and the mean temperature for this period was 2°F below average. August was the only month with above average precipitation. The last spring frost was 14 days later than average, and the first fall frost was 2 days earlier than average, resulting in a 14% shorter than average frost-free period. Maximum snow cover was 7 inches in December and February. The only sub-zero air temperatures occurred December 20-23.

Because of the dry winter, fields could be worked in early spring, and small grain planting was on schedule in mid April. Dry weather prevailed March through May, so *Pythium* was not a major disease problem on cereal grains this year. Spring wheat yields averaged 100 Bu/acre. August was warmer than normal, providing abundant heat units in mid summer and good harvest conditions.

Alfalfa and mint stands were in good condition in the spring. Some winterkill was evident in mint plots, which was related to fall harvest date. Alfalfa yields were below normal because of the cool, dry spring.

This crop year is beginning with better moisture conditions than last year. The first frost occurred on 12 September, within 2 days of the average date. Precipitation from September through February was normal for the period and average temperature was 1° F above normal. Snowfall was 8% below normal as of the end of February.

Following is a list of tables giving a complete description of the weather for the crop year (September 1998 - August 1999) and calendar 1999 (January - December).

Table 1. Summary of climatic data by months for 1998-99 crop year (September through August and averages for the period 1949-99 at the Northwestern Agricultural Research Center, Kalispell, Montana.

Table 2. Summary of temperature data at the Northwestern Agricultural Research Center on a crop year basis, September 1, 1949 through August 31, 1999. (Average)

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Table 1. Summary of climatic data by months for 1998-99 crop year (September thru August) and averages for the period 1949-99 at the Northwestern Agricultural Research Center, Kalispell, MT.

ITEM	Sept. 1998	Oct. 1998	Nov. 1998	Dec. 1998	Jan. 1999	Feb. 1999	Mar. 1999	Apr. 1999	May 1999	June 1999	July 1999	Aug. 1999	Total or Average
Precipitation (inches)													
Current Year	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
Avg. 1949 to 1998-99	1.59	1.36	1.56	1.63	1.48	1.15	1.18	1.50	2.37	2.97	1.64	1.56	19.99
Mean Temperature (F)													
Current Year	59.7	42.3	37.0	27.4	30.4	32.2	37.5	41.6	48.8	55.8	65.4	62.5	45.1
Avg. 1949 to 1998-99	53.7	43.2	32.4	25.4	22.5	27.8	33.8	43.2	51.7	58.2	63.9	62.9	43.2
Last killing frost in spring													
1999					June 7 (30 degrees)								
Avg. 1949-99					May 24								
First killing frost in fall													
1999					September 12 (29 degrees)								
Avg. 1949-99					September 12								
Frost Free Period													
1999					96 days								
Avg. 1949-99					114 days								
Growing Degree Days (base 50):					1677.0 days	1999: May 1 - October 31							
					1876.1 days	1949-1999 Average							
Maximum summer temperature					92 degrees F on August 4, 1999								
Minimum winter temperature					2 degrees F on January 24 & 25, 1999								

In this summary 32 degrees is considered a killing frost.

summary.wk1

Table 2. Summary of temperature data at the Northwestern Agricultural Resarch Center on a crop year basis September 1, 1949 through August 31, 1999

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	30.3	24.9	22.2	27.9	35	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	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	56.5	56.6	59.7	40.6
1993-94	51.4	44.4	25	27.4	32.9	20.6	37.5	45.4	54	57.3	66.4	63	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	29	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	32.3	38.3	52.3	57.8	62.8	63.8	41.4
1997-98	55.6	43.7	33	27.9	25.1	33	34.9	44.5	54.1	56	68.4	65.6	45.2
1998-99	59.7	42.3	37	27.4	30.4	32.2	37.5	41.6	48.8	55.8	60.9	65.5	44.9
MEAN	53.7	43.2	32.6	25.4	22.5	27.8	33.8	43.2	51.9	58.2	63.9	63	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 through August 31, 1999

Average maximum temperature by month and year
Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	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
MEAN	68.7	55.3	40.0	32.0	29.8	36.2	43.6	54.9	64.7	71.3	79.6	79.4	54.6

Mean maximum temperature for all years =54.6

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

Average minimum temperature by month and year
Degrees Fahrenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	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
MEAN	38.6	31.3	25.1	18.8	15.1	19.4	24.0	31.4	38.6	45.0	48.2	46.7	31.9

Mean minimum temperature for all years = 31.9

Table 5. Summary of precipitation records at the Northwestern Agricultural Research Center on a crop year basis. September 1, 1949 through August 31, 1999

	Total precipitation in inches by month and year												
YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	MEAN
1949-50	1.0	1.1	1.7	0.9	2.6	1.1	2.3	0.8	0.2	3.9	3.1	0.8	19.5
1950-51	0.5	2.3	1.2	2.5	0.9	1.3	0.6	2.3	3.8	2.3	1.0	2.9	21.6
1951-52	1.5	5.6	1.0	3.3	1.0	1.0	1.0	0.2	1.3	4.0	0.6	0.7	21.1
1952-53	0.1	0.1	0.6	1.0	1.8	1.1	1.0	2.1	2.0	3.3	T	1.6	14.7
1953-54	0.7	0.0	0.9	1.3	2.7	0.8	0.8	0.8	1.5	3.0	2.9	3.8	19.2
1954-55	1.1	0.5	1.0	0.4	1.0	1.3	0.4	0.8	1.2	1.9	3.1	0.0	12.8
1955-56	1.6	1.9	2.0	2.4	1.8	1.5	0.9	1.3	1.1	4.2	2.1	3.2	23.9
1956-57	1.2	1.1	0.5	1.0	1.5	1.1	0.8	1.2	1.8	2.5	0.5	0.8	13.9
1957-58	0.1	1.6	1.0	1.8	1.6	2.7	1.0	1.5	2.2	2.6	0.8	0.6	17.3
1958-59	2.0	1.2	2.9	2.8	2.0	1.3	0.8	1.6	4.1	1.8	T	0.9	21.2
1959-60	4.2	3.4	4.3	0.3	1.7	1.1	1.0	1.2	3.3	0.7	0.1	2.4	23.8
1960-61	0.6	1.4	1.7	1.2	0.7	1.5	2.0	2.3	4.0	1.5	0.8	0.6	18.2
1961-62	3.4	1.2	1.8	2.1	1.3	1.2	1.6	1.0	2.6	1.2	0.1	0.7	18.1
1962-63	0.6	1.9	1.3	0.9	1.7	1.2	0.9	1.1	0.6	5.0	1.4	2.1	18.6
1963-64	1.5	0.8	1.0	1.7	1.5	0.4	1.6	0.9	3.3	3.9	3.0	1.6	21.0
1964-65	2.3	0.9	1.6	3.6	2.3	0.6	0.2	2.6	0.8	2.3	1.2	4.7	23.0
1965-66	1.7	0.2	1.3	0.6	1.4	0.7	0.5	0.8	1.2	6.6	2.5	1.6	19.1
1966-67	0.8	1.3	3.3	1.7	1.5	0.6	1.3	1.0	1.3	2.5	0.0	0.0	15.4
1967-68	0.9	1.9	0.6	1.2	0.8	1.2	0.7	0.6	3.9	2.2	1.0	3.4	18.3
1968-69	4.5	2.4	1.6	3.1	3.1	0.8	0.7	1.4	1.2	5.2	0.7	0.1	24.7
1969-70	1.5	1.9	0.3	1.1	3.1	0.9	1.5	0.8	2.0	4.4	3.1	0.4	21.0
1970-71	1.8	1.4	1.8	1.0	1.8	0.8	0.7	0.6	2.5	4.4	1.3	1.1	19.1
1971-72	0.9	0.9	1.7	1.6	1.1	1.7	2.1	1.0	1.5	3.3	1.8	1.0	18.5
1972-73	1.4	1.8	0.8	2.2	0.5	0.6	0.7	0.5	1.1	2.1	0.0	0.6	12.4
1973-74	1.4	1.4	3.0	1.9	1.4	1.3	1.4	3.4	1.8	1.8	1.0	0.6	20.4
1974-75	0.8	0.1	1.1	1.3	1.6	1.1	1.5	1.3	1.5	1.4	1.1	4.3	17.0
1975-76	1.2	3.0	0.9	1.4	0.9	1.1	0.3	1.9	1.9	2.5	1.5	3.4	20.0
1976-77	1.0	0.6	0.7	0.9	0.8	0.7	1.4	0.4	2.9	0.5	3.6	1.5	15.0
1977-78	2.8	0.6	1.6	4.1	2.2	1.0	0.7	2.5	3.6	2.6	3.9	3.3	29.0
1978-79	1.9	0.2	1.0	0.9	1.7	1.5	0.8	2.3	2.7	1.2	0.4	1.8	16.3
1979-80	1.0	1.8	0.5	1.0	1.5	2.0	1.0	1.9	5.5	3.9	1.1	2.5	23.6
1980-81	1.2	0.8	0.8	2.6	1.8	1.9	2.2	1.8	3.9	4.7	1.2	1.0	23.7
1981-82	0.8	0.6	1.5	1.9	2.4	1.5	1.2	1.6	1.3	2.4	2.1	1.2	18.2
1982-83	2.4	0.8	1.4	1.6	0.9	0.9	1.7	2.4	1.2	3.0	3.7	1.2	21.0
1983-84	1.7	1.1	2.0	2.6	0.8	2.2	1.8	1.9	2.9	2.1	0.3	0.6	19.9
1984-85	2.2	2.3	1.4	1.3	0.3	1.3	0.9	1.3	2.8	1.9	0.4	1.6	17.6
1985-86	5.4	1.6	1.6	0.5	2.4	2.3	0.5	1.3	2.9	1.8	2.1	0.8	23.2
1986-87	3.6	0.8	1.8	0.6	0.4	0.5	3.5	1.2	1.9	2.0	4.9	1.0	22.0
1987-88	0.8	0.1	0.9	1.2	1.0	1.0	0.8	1.4	3.6	2.0	1.1	0.1	13.9
1988-89	2.3	0.6	1.4	1.7	1.4	1.5	2.3	1.1	2.7	2.1	2.7	3.7	23.4
1989-90	1.5	2.3	3.8	1.9	1.0	1.0	1.8	1.6	3.7	2.7	2.3	2.4	26.0
1990-91	T	2.3	1.4	2.6	1.4	0.4	0.7	1.2	2.7	5.4	0.8	1.2	20.0
1991-92	0.8	0.8	2.3	0.6	1.2	0.6	0.8	1.2	1.7	5.3	2.2	0.9	18.4
1992-93	1.2	1.1	2.4	1.5	1.7	0.6	0.7	3.8	2.2	4.0	7.0	1.2	27.4
1993-94	1.5	0.8	1.2	1.3	1.4	1.5	0.1	2.0	1.8	2.6	0.1	0.2	14.6
1994-95	0.5	2.1	1.9	1.1	1.2	0.9	2.3	2.3	1.4	5.6	1.9	1.5	22.6
1995-96	1.2	2.8	2.3	1.9	2.2	1.2	1.2	3.3	4.6	2.1	1.0	0.8	24.5
1996-97	2.7	1.6	4.0	3.5	1.5	1.6	1.2	1.7	2.6	3.4	1.0	1.9	26.7
1997-98	2.4	0.9	0.3	0.4	0.8	0.3	2.6	1.8	5.1	4.6	1.2	0.7	21.3
1998-99	1.5	0.7	1.1	1.5	1.1	1.2	0.9	0.6	1.3	2.7	1.6	1.9	16.1
MEAN	1.6	1.4	1.6	1.6	1.5	1.1	1.2	1.5	2.4	3.0	1.6	1.5	20.0

Mean precipitation for all crop years = 20.0

Table 6. Precipitation by day for crop year, September 1, 1998 through August 31, 1999.
Northwestern Agricultural Research Center, Kalispell, Montana

Month ▶ / Day ▼	SEPT. 1998	OCT. 1998	NOV. 1998	DEC. 1998	JAN. 1999	FEB. 1999	MAR. 1999	APRIL 1999	MAY 1999	JUNE 1999	JULY 1999	AUG. 1999
1				0.35			0.03			0.6	0.79	
2		0.13	0.03	T			0.01		0.04	0.01	0.04	
3		0.42		T		0.01			0.04	0.05	0	
4							0.07	0.09	T	0.02	0	0.04
5			0.03		0.35	T	0.1	0.01			0.06	T
6			0.09	0.01	0.06		0.01				0	
7					0.1	0.11					0	
8	0.01				0.11	0.02			0.02		0	0.09
9					0.04			0.07	0.02	0.18	0	
10	0.2					0.05	0.35	0.02	0.67	0.01	0	
11					0.12	T				0.03	0	0.02
12				0.02					0.04		0	0.70
13			0.05	T					T		0	0.01
14		0.05	T	T					0.03		0	0.08
15		0.07	0.14						0.03		0.05	0.05
16			0.1	T	0.02	T			0.22		0.02	0.25
17					0.06	0.08			0.01	0.12	0	
18	0.19			T	0.08				0.04	0.08	0.16	
19	T					0.08			0.12	0.19	0	0.04
20	0.43				0.03	0.01					0	0.33
21			0.08	T	0.02			T		0.03	0	
22			0.03	T	0.03	0.05		0.33		0.25	0	
23				T	T	0.03					0	
24			0.28	0.03		0.06					0	
25	0.01		0.04	0.18						0.27	0.51	
26	0.64			0.41		0.18	0.14	0.03		0.58	0	
27			0.13	T	0.03		0.03			0.12	0	
28				0.1		0.5				0.04	0	
29		0.04	0.11				T			0.06	0	
30				0.37			T		0.04	0.1	0	0.07
31							0.16				0	0.25
Month Total	1.48	0.71	1.11	1.47	1.05	1.18	0.9	0.55	1.32	2.74	1.63	1.93

Total precipitation for crop year: 16.07

Table 7. Frost free period at the Northwestern Agricultural Research Center: 1950 - 1999

YEAR	DATE OF LAST FREEZE	TEMPERATURE DEGREES F	DATE OF FIRST FREEZE	TEMPERATURE DEGREES F	FROST FREE DAYS FOR 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
Mean	May 23	30	Sept. 12	30	114

Table 8. Temperature extremes from 1950 through 1999 at Northwestern Agricultural Research Center, Kalispell, Montana

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

Table 9. Summary of average temperature records for calendar years 1950 - 1999 recorded at the Northwestern Agricultural Research Center, Kalispell, Montana

Average temperature by month and year
Degrees Fahrenheit

YEAR	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	38.3	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	43.2	51.4	59.4	63.0	64.9	58.7	47.4	35.8	24.0	44.3
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	25.2	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	22.2	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
7980	16.3	29.0	32.6	47.1	54.8	56.9	63.5	58.6	54.1	45.3	35.8	32.2	43.8
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	43.3	35.3	25.4	44.4
1988	20.5	30.3	37.8	45.7	51.4	60.9	63.7	63.9	53.4	43.4	36.3	23.3	44.2
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	59.1	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	27.4	40.6
1994	32.9	20.6	37.5	45.4	54.0	57.3	66.4	63.0	56.3	42.8	29.7	27.1	44.4
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
MEAN	22.5	27.8	33.8	43.2	51.7	58.2	63.9	63.0	53.6	43.2	32.5	25.5	43.2

Table 10. Summary of precipitation records for calendar years 1950 - 1999 recorded at the Northwestern Agricultural Research Center, Kalispell, Montana

Total precipitation by month and year

YEAR	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	0.00	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	0.72	2.54	3.56	2.63	3.90	3.34	1.90	0.15	0.96	0.91	23.75
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
7980	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	0.36	1.72	2.33	1.08	1.05	1.18	0.90	0.55	1.32	2.74	1.63	1.93	16.79
MEAN	1.47	1.16	1.21	1.51	2.36	2.94	1.61	1.51	1.60	1.40	1.56	1.65	19.97

Table 11. Summary of growing degree day (GDD) data at the Northwestern Agricultural Resear
May 1, 1949 through October 31, 1999. 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	243.5	567.5	517.0	375.5	85.5	2056.5
1999	163.5	256.5	396.5	499.5	270.0	91.0	1677.0
MEAN	232.8	330.6	468.2	458.5	281.9	104.1	1876.1

Mean growing degree days for all years = 1876.1

Table 12. Summary of snow data September 1, 1949 through August 31, 1999 at the Northwestern Agricultural Research Center

Average snow accumulation by month and year

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	MEAN
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
MEAN	0.01	0.93	6.60	13.97	12.86	9.38	4.98	1.00	0.08	0.00	0.00	0.00	49.80

Mean snowfall for all years = 49.8

WEED AND SMALL GRAIN MANAGEMENT FOR WESTERN MONTANA
754

The Weed and Small Grain Management Project (754) includes research related to all types of weeds and small grains from seeding to data collection to publications.

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Current winter wheat management options for controlling downy brome and jointed goatgrass are severely limited. American Cyanamid (AC) has developed a herbicide capable of controlling these two weeds, but is also lethal to wheat. A winter wheat cultivar with resistance to imazamox was identified by AC's research group in France and has been made available to Montana State University for research purposes.

A study was established near Great Falls in a winter wheat-chemfallow rotation to evaluate the effects of imazamox rate, application timing, and crop seeding rate for the management of jointed goatgrass. The herbicide resistant winter wheat 'Fidel' was no-till seeded at 60 and 120 pounds per acre with a Concord air-drill. Imazamox treatments were applied at the normal rate plus six reduced rates in the fall and spring. A non-treated and handweeded check were included to fully document the efficacy of imazamox on jointed goatgrass in cropping systems and environments representative of Montana wheat production areas.

The best control of jointed goatgrass was obtained with higher seeding rates and fall applications. Further, the 1X rate is not warranted. This is only one year of data and more trials are needed to determine rate response and economic consequences. Economically, the average return, between the highest and lowest treatments was $56/A (data not shown). This technology appears to be economically viable. This is especially true when you consider that some producers plant, fertilize, then spray out the entire stand with Roundup if severely infested with goatgrass. Conclusions may have been different if the winter wheat stand did not sustain substantial cold-induced winterkill. A full stand of wheat could have proven more competitive and results more definitive.

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Site Description

Crop: Winter Wheat
Planting Method: Air Drill
Row Spacing, Unit: 12"

Variety: Fidel
Rate, Unit: 60 & 120 Lbs./A
Soil Moisture: Good

Planting Date: 9-17-1998
Depth, Unit: 2"
Harvest Date: 8-5-1999

Plot Width, Unit: 10 FT
Site Location: Great Falls
Plot Maintenance:

Plot Length, Unit: 15 FT

Reps: 4
Study Design: Split-Plot

Fertility:	9-17-98	120 Lbs. N as Anhydrous
	9-17-99	10 Lbs. N, 30 Lbs. P, and 10 Lbs. K with seed
Weed Control:		Hand weeded throughout season

Soil Description

Texture: Silt Loam

Soil Name: Lawther Silty Loam

Application Information

Application Date:	10-12-1998	4-21-1999
Time of Day:	1:00 PM	7:00 AM
Application Method:	BACKPACK	BACKPACK
Application Timing:	POST	POST
Air Temp., Unit:	54 F	42 F
% Relative Humidity:	57	36
Wind Velocity, Unit:	5 MPH	0 MPH
Dew Presence (Y/N):	N	N
Soil Temp., Unit:	56 F	43 F
Soil Moisture:	EXCELLENT	GOOD
% Cloud Cover:	20	10

Plant Species	Plant Stage	
Winter Wheat	3 Leaf	6 Tiller
Jointed Goatgrass	2 Leaf	5 Tiller

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	JGG CONTROL PERCENT 5-27-99	JGG HEADS #/FT2 6-22-99	JGG DRY WT GRMS/FT2 6-22-99	JGG SUBSAMPL #/300GRM 8-16-99	JGG DOCKAGE PERCENT
1	60 LBS/A			0.0	93.2	39.6	305.5	5.3
1	FALL							
1	RAPTOR	0	lb ai/A					
2	60 LBS/A			33.3	57.3	28.5	368.3	7.2
2	FALL							
2	RAPTOR	.003	lb ai/A					
2	NIS	.25	% v/v					
2	UAN	1	qt pr/A					
3	60 LBS/A			79.0	16.0	6.4	27.7	0.5
3	FALL							
3	RAPTOR	.006	lb ai/A					
3	NIS	.25	% v/v					
3	UAN	1	qt pr/A					
4	60 LBS/A			80.0	5.8	1.9	89.3	1.2
4	FALL							
4	RAPTOR	.012	lb ai/A					
4	NIS	.25	% v/v					
4	UAN	1	qt pr/A					
5	60 LBS/A			98.0	1.5	0.7	3.0	0.0
5	FALL							
5	RAPTOR	.024	lb ai/A					
5	NIS	.25	% v/v					
5	UAN	1	qt pr/A					
6	60 LBS/A			97.5	0.3	0.1	7.0	0.1
6	FAL							
6	RAPTOR	.032	lb ai/A					
6	NIS	.25	% v/v					
6	UAN	1	qt pr/A					
7	60 LBS/A			97.5	0.3	0.2	0.0	0.0
7	FALL							
7	RAPTOR	.040	lb ai/A					
7	NIS	.25	% v/v					
7	UAN	1	qt pr/A					
8	60 LBS/A			89.0	1.1	0.6	1.0	0.0
8	FALL							
8	RAPTOR	.048	lb ai/A					
8	NIS	.25	% v/v					
8	UAN	1	qt pr/A					

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	JGG CONTROL PERCENT 5-27-99	JGG HEADS #/FT2 6-22-99	JGG DRY WT GRMS/FT2 6-22-99	JGG SUBSAMPL #/300GRM 8-16-99	JGG DOCKAGE PERCENT
9	60 LBS/A			94.3	1.6	0.7	43.3	0.7
9	FALL							
9	HANDWEEDED							
10	60 LBS/A			0.0	90.9	39.9	252.3	4.4
10	SPRING							
10	RAPTOR	0	lb ai/A					
11	60 LBS/A			0.0	104.9	54.2	429.3	7.2
11	SPRING							
11	RAPTOR	.003	lb ai/A					
11	NIS	.25	% v/v					
11	UAN	1	qt pr/A					
12	60 LBS/A			56.0	62.8	21.2	339.7	5.3
12	SPRING							
12	RAPTOR	.006	lb ai/A					
12	NIS	.25	% v/v					
12	UAN	1	qt pr/A					
13	60 LBS/A			78.3	34.3	24.5	215.5	3.2
13	SPRING							
13	RAPTOR	.012	lb ai/A					
13	NIS	.25	% v/v					
13	UAN	1	qt pr/A					
14	60 LBS/A			92.7	5.4	4.5	26.0	0.3
14	SPRING							
14	RAPTOR	.024	lb ai/A					
14	NIS	.25	% v/v					
14	UAN	1	qt pr/A					
15	60 LBS/A			95.3	0.4	2.2	6.3	0.1
15	SPRING							
15	RAPTOR	.032	lb ai/A					
15	NIS	.25	% v/v					
15	UAN	1	qt pr/A					
16	60 LBS/A			84.3	0.5	1.4	9.7	0.1
16	SPRING							
16	RAPTOR	.040	lb ai/A					
16	NIS	.25	% v/v					
16	UAN	1	qt pr/A					

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	JGG CONTROL PERCENT 5-27-99	JGG HEADS #/FT2 6-22-99	JGG DRY WT GRMS/FT2 6-22-99	JGG SUBSAMPL #/300GRM 8-16-99	JGG DOCKAGE PERCENT
17	60 LBS/A			95.3	0.1	4.9	0.8	0.0
17	SPRING							
17	RAPTOR	.048	lb ai/A					
17	NIS	.25	% v/v					
17	UAN	1	qt pr/A					
18	60 LBS/A			84.3	4.8	2.5	8.7	0.1
18	SPRING							
18	HANDWEEDED							
19	120 LBS/A			0.0	61.2	31.5	201.3	3.5
19	FALL							
19	RAPTOR	0	lb ai/A					
20	120 LBS/A			66.5	9.9	4.7	93.3	1.6
20	FALL							
20	RAPTOR	.003	lb ai/A					
20	NIS	.25	% v/v					
20	UAN	1	qt pr/A					
21	120 LBS/A			83.3	3.3	1.5	4.7	0.0
21	FALL							
21	RAPTOR	.006	lb ai/A					
21	NIS	.25	% v/v					
21	UAN	1	qt pr/A					
22	120 LBS/A			93.3	1.3	0.6	2.3	0.0
22	FALL							
22	RAPTOR	.012	lb ai/A					
22	NIS	.25	% v/v					
22	UAN	1	qt pr/A					
23	120 LBS/A			98.3	1.0	0.4	0.3	0.0
23	FALL							
23	RAPTOR	.024	lb ai/A					
23	NIS	.25	% v/v					
23	UAN	1	qt pr/A					
24	120 LBS/A			98.0	0.6	0.3	0.0	0.0
24	FALL							
24	RAPTOR	.032	lb ai/A					
24	NIS	.25	% v/v					
24	UAN	1	qt pr/A					

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	JGG CONTROL PERCENT 5-27-99	JGG HEADS #/FT2 6-22-99	JGG DRY WT GRMS/FT2 6-22-99	JGG SUBSAMPL #/300GRM 8-16-99	JGG DOCKAGE PERCENT
25	120 LBS/A			95.5	0.3	0.2	1.5	0.0
25	FALL							
25	RAPTOR	.040	lb ai/A					
25	NIS	.25	% v/v					
25	UAN	1	qt pr/A					
26	120 LBS/A			98.0	0.0	0.0	18.3	0.3
26	FALL							
26	RAPTOR	.048	lb ai/A					
26	NIS	.25	% v/v					
26	UAN	1	qt pr/A					
27	120 LBS/A			86.3	2.2	0.6	1.3	0.0
27	FALL							
27	HANDWEEDED							
28	120 LBS/A			0.0	80.3	37.7	191.3	3.2
28	SPRING							
28	RAPTOR	0	lb ai/A					
29	120 LBS/A			27.5	37.2	23.9	119.3	2.0
29	SPRING							
29	RAPTOR	.003	lb ai/A					
29	NIS	.25	% v/v					
29	UAN	1	qt pr/A					
30	120 LBS/A			56.7	38.9	16.3	22.3	0.3
30	SPRING							
30	RAPTOR	.006	lb ai/A					
30	NIS	.25	% v/v					
30	UAN	1	qt pr/A					
31	120 LBS/A			89.3	10.1	5.2	17.5	0.2
31	SPRING							
31	RAPTOR	.012	lb ai/A					
31	NIS	.25	% v/v					
31	UAN	1	qt pr/A					
32	120 LBS/A			94.0	1.5	3.2	0.0	0.0
32	SPRING							
32	RAPTOR	.024	lb ai/A					
32	NIS	.25	% v/v					
32	UAN	1	qt pr/A					

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	JGG CONTROL PERCENT 5-27-99	JGG HEADS #/FT2 6-22-99	JGG DRY WT GRMS/FT2 6-22-99	JGG SUBSAMPL #/300GRM 8-16-99	JGG DOCKAGE PERCENT
33	120 LBS/A			94.8	0.1	0.9	1.8	0.0
33	SPRING							
33	RAPTOR	.032	lb ai/A					
33	NIS	.25	% v/v					
33	UAN	1	qt pr/A					
34	120 LBS/A			95.5	0.1	1.8	0.3	0.0
34	SPRING							
34	RAPTOR	.040	lb ai/A					
34	NIS	.25	% v/v					
34	UAN	1	qt pr/A					
35	120 LBS/A			86.0	0.1	9.0	1.3	0.0
35	SPRING							
35	RAPTOR	.048	lb ai/A					
35	NIS	.25	% v/v					
35	UAN	1	qt pr/A					
36	120 LBS/A			93.8	2.1	2.3	2.0	0.0
36	SPRING							
36	HANDWEEDED							
LSD (P=.05)				17.62	23.41	13.27	231.68	4.15
Standard Deviation				12.46	16.56	9.39	163.82	2.93
CV				17.18	81.51	90.33	209.74	225.25
Treatment F				29.834	14.667	9.828	2.265	2.112
Treatment Prob(F)				0.0001	0.0001	0.0001	0.0015	0.0034

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	W WHEAT PLANTS #/FT2 6-22-99	W WHEAT HEADS #/FT2 6-22-99	W WHEAT DRY WT GRMS/FT2 6-22-99	W WHEAT YIELD BU/A 8-5-99	W WHEAT TWT LBS/BU 8-17-99	W WHEAT PROTEIN PERCENT
1	60 LBS/A			15.4	65.0	167.2	85.5	59.2	11.88
1	FALL								
1	RAPTOR	0	lb ai/A						
2	60 LBS/A			12.6	73.1	191.0	90.9	58.7	11.93
2	FALL								
2	RAPTOR	.003	lb ai/A						
2	NIS	.25	% v/v						
2	UAN	1	qt pr/A						
3	60 LBS/A			10.4	73.2	198.0	101.7	59.4	12.20
3	FALL								
3	RAPTOR	.006	lb ai/A						
3	NIS	.25	% v/v						
3	UAN	1	qt pr/A						
4	60 LBS/A			15.0	86.4	221.3	105.4	60.1	11.97
4	FALL								
4	RAPTOR	.012	lb ai/A						
4	NIS	.25	% v/v						
4	UAN	1	qt pr/A						
5	60 LBS/A			13.5	84.0	239.2	104.3	59.3	12.30
5	FALL								
5	RAPTOR	.024	lb ai/A						
5	NIS	.25	% v/v						
5	UAN	1	qt pr/A						
6	60 LBS/A			14.0	85.3	215.1	102.9	59.5	12.40
6	FALL								
6	RAPTOR	.032	lb ai/A						
6	NIS	.25	% v/v						
6	UAN	1	qt pr/A						
7	60 LBS/A			11.8	66.4	158.4	96.8	58.9	12.30
7	FALL								
7	RAPTOR	.040	lb ai/A						
7	NIS	.25	% v/v						
7	UAN	1	qt pr/A						
8	60 LBS/A			7.9	60.1	154.7	80.0	56.5	12.60
8	FALL								
8	RAPTOR	.048	lb ai/A						
8	NIS	.25	% v/v						
8	UAN	1	qt pr/A						

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	W WHEAT PLANTS #/FT2 6-22-99	W WHEAT HEADS #/FT2 6-22-99	W WHEAT DRY WT GRMS/FT2 6-22-99	W WHEAT YIELD BU/A 8-5-99	W WHEAT TWT LBS/BU 8-17-99	W WHEAT PROTEIN PERCENT
9	60 LBS/A			11.8	80.2	221.7	107.9	59.8	12.00
9	FALL								
9	HANDWEEDED								
10	60 LBS/A			10.8	64.3	157.4	86.4	59.9	11.87
10	SPRING								
10	RAPTOR	0	lb ai/A						
11	60 LBS/A			11.7	64.3	140.4	78.4	59.6	11.90
11	SPRING								
11	RAPTOR	.003	lb ai/A						
11	NIS	.25	% v/v						
11	UAN	1	qt pr/A						
12	60 LBS/A			10.3	68.0	192.0	94.1	59.4	12.00
12	SPRING								
12	RAPTOR	.006	lb ai/A						
12	NIS	.25	% v/v						
12	UAN	1	qt pr/A						
13	60 LBS/A			11.3	65.4	165.5	91.5	59.5	12.02
13	SPRING								
13	RAPTOR	.012	lb ai/A						
13	NIS	.25	% v/v						
13	UAN	1	qt pr/A						
14	60 LBS/A			8.8	61.0	161.4	101.6	59.6	12.43
14	SPRING								
14	RAPTOR	.024	lb ai/A						
14	NIS	.25	% v/v						
14	UAN	1	qt pr/A						
15	60 LBS/A			12.5	63.5	171.7	104.8	59.5	12.17
15	SPRING								
15	RAPTOR	.032	lb ai/A						
15	NIS	.25	% v/v						
15	UAN	1	qt pr/A						
16	60 LBS/A			10.8	87.7	215.5	104.0	60.2	11.90
16	SPRING								
16	RAPTOR	.040	lb ai/A						
16	NIS	.25	% v/v						
16	UAN	1	qt pr/A						

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	W WHEAT PLANTS #/FT2 6-22-99	W WHEAT HEADS #/FT2 6-22-99	W WHEAT DRY WT GRMS/FT2 6-22-99	W WHEAT YIELD BU/A 8-5-99	W WHEAT TWT LBS/BU 8-17-99	W WHEAT PROTEIN PERCENT
17	60 LBS/A			10.0	64.7	165.8	96.9	59.7	11.83
17	SPRING								
17	RAPTOR	.048	lb ai/A						
17	NIS	.25	% v/v						
17	UAN	1	qt pr/A						
18	60 LBS/A			16.6	76.8	184.6	96.4	59.7	12.27
18	SPRING								
18	HANDWEEDED								
19	120 LBS/A			15.9	81.6	166.7	90.2	59.7	11.65
19	FALL								
19	RAPTOR	0	lb ai/A						
20	120 LBS/A			13.8	80.4	193.5	94.5	58.7	12.27
20	FALL								
20	RAPTOR	.003	lb ai/A						
20	NIS	.25	% v/v						
20	UAN	1	qt pr/A						
21	120 LBS/A			23.7	85.4	181.0	105.7	60.2	11.67
21	FALL								
21	RAPTOR	.006	lb ai/A						
21	NIS	.25	% v/v						
21	UAN	1	qt pr/A						
22	120 LBS/A			13.7	96.4	239.8	101.5	59.8	12.33
22	FALL								
22	RAPTOR	.012	lb ai/A						
22	NIS	.25	% v/v						
22	UAN	1	qt pr/A						
23	120 LBS/A			20.1	117.7	228.2	99.8	60.1	12.07
23	FALL								
23	RAPTOR	.024	lb ai/A						
23	NIS	.25	% v/v						
23	UAN	1	qt pr/A						
24	120 LBS/A			22.8	123.4	248.2	100.3	60.5	11.60
24	FALL								
24	RAPTOR	.032	lb ai/A						
24	NIS	.25	% v/v						
24	UAN	1	qt pr/A						

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	W WHEAT PLANTS #/FT2 6-22-99	W WHEAT HEADS #/FT2 6-22-99	W WHEAT DRY WT GRMS/FT2 6-22-99	W WHEAT YIELD BU/A 8-5-99	W WHEAT TWT LBS/BU 8-17-99	W WHEAT PROTEIN PERCENT
25	120 LBS/A			20.4	105.1	233.4	99.9	60.2	11.80
25	FALL								
25	RAPTOR	.040	lb ai/A						
25	NIS	.25	% v/v						
25	UAN	1	qt pr/A						
26	120 LBS/A			16.6	88.1	194.4	98.9	59.7	12.00
26	FALL								
26	RAPTOR	.048	lb ai/A						
26	NIS	.25	% v/v						
26	UAN	1	qt pr/A						
27	120 LBS/A			16.1	101.3	226.4	99.1	58.9	12.17
27	FALL								
27	HANDWEEDED								
28	120 LBS/A			18.4	104.3	207.4	91.7	60.1	11.12
28	SPRING								
28	RAPTOR	0	lb ai/A						
29	120 LBS/A			12.1	92.1	206.9	91.7	60.0	11.52
29	SPRING								
29	RAPTOR	.003	lb ai/A						
29	NIS	.25	% v/v						
29	UAN	1	qt pr/A						
30	120 LBS/A			27.8	104.9	241.4	96.6	60.4	11.87
30	SPRING								
30	RAPTOR	.006	lb ai/A						
30	NIS	.25	% v/v						
30	UAN	1	qt pr/A						
31	120 LBS/A			14.3	85.7	197.5	96.4	59.8	11.67
31	SPRING								
31	RAPTOR	.012	lb ai/A						
31	NIS	.25	% v/v						
31	UAN	1	qt pr/A						
32	120 LBS/A			18.3	114.4	237.1	102.9	60.6	11.55
32	SPRING								
32	RAPTOR	.024	lb ai/A						
32	NIS	.25	% v/v						
32	UAN	1	qt pr/A						

CONTINUED...

Jointed Goatgrass Management with Herbicide Resistant Winter Wheat

Trt No	Treatment Name	Rate	Rate Unit	W WHEAT PLANTS #/FT2 6-22-99	W WHEAT HEADS #/FT2 6-22-99	W WHEAT DRY WT GRMS/FT2 6-22-99	W WHEAT YIELD BU/A 8-5-99	W WHEAT TWT LBS/BU 8-17-99	W WHEAT PROTEIN PERCENT
33	120 LBS/A			20.6	98.9	214.9	102.2	60.3	11.55
33	SPRING								
33	RAPTOR	.032	lb ai/A						
33	NIS	.25	% v/v						
33	UAN	1	qt pr/A						
34	120 LBS/A			18.9	100.3	229.3	99.7	60.4	11.90
34	SPRING								
34	RAPTOR	.040	lb ai/A						
34	NIS	.25	% v/v						
34	UAN	1	qt pr/A						
35	120 LBS/A			16.5	113.9	218.4	99.3	60.2	11.47
35	SPRING								
35	RAPTOR	.048	lb ai/A						
35	NIS	.25	% v/v						
35	UAN	1	qt pr/A						
36	120 LBS/A			20.4	108.7	250.6	105.8	60.4	11.73
36	SPRING								
36	HANDWEEDED								
LSD (P=.05)				7.15	34.79	60.89	11.10	1.38	0.609
Standard Deviation				5.06	24.60	43.05	7.85	0.97	0.431
CV				33.39	28.65	21.42	8.06	1.63	3.61
Treatment F				3.255	2.187	2.059	3.285	2.255	2.180
Treatment Prob(F)				0.0001	0.0023	0.0045	0.0001	0.0016	0.0024

Cereal Grain Seed Size Effects on Wild Oat Competition

The overall goal of this project is to improve weed management through the development of competitive cropping systems. The objective of the research is to determine if the use of large cereal grain seed sizes, in combination with increased seeding rates, will confer a competitive advantage to the crop. If successful, this would reduce crop yield losses due to weeds and increase the effectiveness of herbicide reduced rates.

The main component of this research was the effect of seed size in a competitive cropping system. With the use of sieves, a lot of McNeal spring wheat was separated into three seed sizes identified as large, small, and a bulk composite with thousand kernel weights of 43.6, 23.3, and 37.5 grams respectively. A second variable was added when each seed size was planted at two populations (16 and 26 plants/ft2). Wild oat populations of 0,8, 16, and 32 plants/ft2 were then superimposed over the previously described treatments to document the competitive ability of each seed size.

From the onset of this investigation, large seed appeared more competitive from a standpoint of emergence, seedling growth, and overall plant color (hardy vs pale green). This advantage carried through the season and was reflected in accumulated data. Spring wheat dry weight at soft dough was considerably reduced in the small seeded treatments. At the same time, wild oat plants, panicles, and overall biomass was significantly less across wheat and wild oat populations for the large seeded treatments. The large and bulk seed were found to be much higher yielding than the smalls in all scenarios. Also, grain dockage as wild oat contamination was much higher in the small seeded plots. The higher seeding rate proved more competitive across most of the measured variables.

Cereal Grain Seed Size Effects on Wild Oat Competition

Trt No	Treatment Name	W OATS PLANTS #/FT2 7-26-99	W OATS HEADS #/FT2 7-26-99	W OATS SEED WT GRMS/FT2 7-26-99	W OATS SEEDS #/FT2 7-26-99	W OATS DRY WT GRAM/FT2 7-26-99	W OATS DOCKAGE PERCENT
1	0 plnt/ft2 16 plnt/ft2 Large	0.0	0.0	0.0	0.0	0.0	0.2
2	0 plnt/ft2 16 plnt/ft2 Small	0.0	0.0	0.0	0.0	0.0	0.3
3	0 plnt/ft2 16 plnt/ft2 Bulk	0.0	0.0	0.0	0.0	0.0	0.1
4	0 plnt/ft2 26 plnt/ft2 Large	0.0	0.0	0.0	0.0	0.0	0.4
5	0 plnt/ft2 26 plnt/ft2 Small	0.0	0.0	0.0	0.0	0.0	0.3
6	0 plnt/ft2 26 plnt/ft2 Bulk	0.0	0.0	0.0	0.0	0.0	0.9
7	8 plnt/ft2 16 plnt/ft2 Large	4.6	12.9	4.8	459.4	19.0	9.5
8	8 plnt/ft2 16 plnt/ft2 Small	9.0	28.1	11.6	1037.6	43.2	18.4
9	8 plnt/ft2 16 plnt/ft2 Bulk	6.1	17.7	6.9	643.2	26.4	11.5
10	8 plnt/ft2 26 plnt/ft2 Large	6.2	14.1	4.4	410.5	15.4	7.6
11	8 plnt/ft2 26 plnt/ft2 Small	7.0	19.0	6.6	530.0	24.9	12.4
12	8 plnt/ft2 26 plnt/ft2 Bulk	11.3	24.0	8.8	736.6	32.6	8.4
13	16 plnt/ft2 16 plnt/ft2 Large	11.5	30.2	10.6	834.4	37.6	12.6

CONTINUED...

Cereal Grain Seed Size Effects on Wild Oat Competition

Trt No	Treatment Name	W OATS PLANTS #/FT2 7-26-99	W OATS HEADS #/FT2 7-26-99	W OATS SEED WT GRMS/FT2 7-26-99	W OATS SEEDS #/FT2 7-26-99	W OATS DRY WT GRAM/FT2 7-26-99	W OATS DOCKAGE PERCENT
14	16 plnt/ft2 16 plnt/ft2 Small	14.3	34.0	12.4	952.6	46.7	28.4
15	16 plnt/ft2 16 plnt/ft2 Bulk	12.4	29.7	9.9	700.9	39.1	16.5
16	16 plnt/ft2 26 plnt/ft2 Large	16.0	32.5	9.1	551.3	31.8	8.0
17	16 plnt/ft2 26 plnt/ft2 Small	13.9	32.3	10.3	768.0	39.2	16.8
18	16 plnt/ft2 26 plnt/ft2 Bulk	15.3	27.5	8.6	611.5	32.0	8.0
19	32 plnt/ft2 16 plnt/ft2 Large	22.7	40.7	12.0	809.7	41.9	21.1
20	32 plnt/ft2 16 plnt/ft2 Small	28.7	57.9	16.7	1269.0	63.3	35.5
21	32 plnt/ft2 16 plnt/ft2 Bulk	29.5	46.8	15.3	1038.4	54.0	25.1
22	32 plnt/ft2 26 plnt/ft2 Large	27.0	36.0	9.7	616.3	34.7	15.1
23	32 plnt/ft2 26 plnt/ft2 Small	26.4	47.0	12.8	923.6	45.5	26.1
24	32 plnt/ft2 26 plnt/ft2 Bulk	27.7	42.3	12.0	710.7	42.2	19.2
LSD (P=.05)		8.93	11.97	4.39	315.46	13.22	5.76
Standard Deviation		6.32	8.47	3.10	189.21	9.35	4.07
CV		52.34	35.47	30.62	25.04	33.5	32.31
Treatment F		10.627	17.076	4.401	4.225	17.120	24.137
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0002	0.0001	0.0001

Cereal Grain Seed Size Effects on Wild Oat Competition

Trt No	Treatment Name	S WHEAT PLANTS #/FT2 7-26-99	S WHEAT HEADS #/FT2 7-26-99	S WHEAT DRY WT GRAM/FT2 7-26-99	S WHEAT YIELD BU/A 8-21-99	S WHEAT TWT LBS/BU	S WHEAT PROTEIN PERCENT
1	0 plnt/ft2 16 plnt/ft2 Large	14.2	38.1	99.8	68.1	60.9	14.02
2	0 plnt/ft2 16 plnt/ft2 Small	12.6	39.5	100.3	68.0	60.8	14.35
3	0 plnt/ft2 16 plnt/ft2 Bulk	11.6	36.6	87.9	70.6	61.1	14.56
4	0 plnt/ft2 26 plnt/ft2 Large	19.3	34.4	85.0	69.8	60.8	13.43
5	0 plnt/ft2 26 plnt/ft2 Small	17.3	38.3	85.2	71.2	60.9	14.02
6	0 plnt/ft2 26 plnt/ft2 Bulk	17.4	41.5	95.2	67.0	60.8	13.55
7	8 plnt/ft2 16 plnt/ft2 Large	13.9	33.6	77.1	56.3	60.5	14.21
8	8 plnt/ft2 16 plnt/ft2 Small	13.2	23.7	44.0	41.1	59.4	14.71
9	8 plnt/ft2 16 plnt/ft2 Bulk	12.2	27.2	65.7	53.7	60.3	14.27
10	8 plnt/ft2 26 plnt/ft2 Large	21.2	38.3	82.4	59.0	60.9	14.38
11	8 plnt/ft2 26 plnt/ft2 Small	17.3	27.6	56.6	52.3	60.1	14.30
12	8 plnt/ft2 26 plnt/ft2 Bulk	17.3	32.7	75.5	68.2	60.5	14.54
13	16 plnt/ft2 16 plnt/ft2 Large	12.7	24.6	55.6	53.4	60.3	13.65

CONTINUED...

Cereal Grain Seed Size Effects on Wild Oat Competition

Trt No	Treatment Name	S WHEAT PLANTS #/FT2 7-26-99	S WHEAT HEADS #/FT2 7-26-99	S WHEAT DRY WT GRAM/FT2 7-26-99	S WHEAT YIELD BU/A 8-21-99	S WHEAT TWT LBS/BU	S WHEAT PROTEIN PERCENT
14	16 plnt/ft2 14 16 plnt/ft2 14 Small	9.8	19.1	38.5	33.3	59.0	14.37
15	16 plnt/ft2 15 16 plnt/ft2 15 Bulk	11.8	24.6	52.2	46.3	60.3	14.35
16	16 plnt/ft2 16 26 plnt/ft2 16 Large	21.0	30.5	64.1	57.8	60.8	14.13
17	16 plnt/ft2 17 26 plnt/ft2 17 Small	18.9	24.8	40.8	41.7	59.8	14.18
18	16 plnt/ft2 18 26 plnt/ft2 18 Bulk	18.8	28.7	61.0	57.5	60.5	14.23
19	32 plnt/ft2 19 16 plnt/ft2 19 Large	10.6	16.4	37.0	37.5	60.3	13.93
20	32 plnt/ft2 20 16 plnt/ft2 20 Small	10.5	14.7	26.0	23.0	58.8	13.92
21	32 plnt/ft2 21 16 plnt/ft2 21 Bulk	12.5	18.4	38.9	42.4	59.6	14.15
22	32 plnt/ft2 22 26 plnt/ft2 22 Large	21.0	27.6	53.5	43.4	59.9	13.90
23	32 plnt/ft2 23 26 plnt/ft2 23 Small	14.9	22.0	29.1	32.4	58.8	14.35
24	32 plnt/ft2 24 26 plnt/ft2 24 Bulk	16.5	29.9	50.8	40.4	59.8	14.02
LSD (P=.05)		4.85	7.68	19.72	10.44	0.86	0.776
Standard Deviation		3.43	5.43	13.94	7.38	0.61	0.549
CV		22.48	18.83	22.28	14.13	1.01	3.88
Treatment F		4.435	8.042	10.552	14.377	5.018	1.299
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.2068

Effects of Crop Seeding Rates and Broadcast Seeding Patterns on Wild Oat Management

Weed competition can be lessened by improving the competitiveness of cereal grain crops. Several factors can be reconfigured to aid this endeavor. Greater crop densities and narrow row spacings increase crop leaf area and canopy development. This in turn shades weeds and suppresses their growth and development. The use of pneumatic fertilizer spreaders which broadcast cereal grain seed offers a means by which row spacings can indirectly be narrowed. The objective of this study was to evaluate the combined effects of greater seeding rates plus broadcast seeding patterns for the suppression of wild oat.

Gallatin spring barley was seeded at 60, 110, and 150 lbs/A in conventional 6 inch drill row spacings or broadcast patterns. These treatments were superimposed on wild oat seeded densities of 0, 8, 16, and 32 pure-live seeds per square foot.

Wild oat dry weight, percent infestation, and grain dockage decreased as spring barley density increased. Barley grain yield declined as wild oat populations increased. However, barley plant populations did not significantly impact final grain yield as experienced in previous years. Also different from prior research was the fact that planting pattern appeared to be a non-factor in wild oat vegetative and reproductive growth. Final grain yield across treatments found the drill treatments significantly higher than those broadcasted.

Site Description

Crop: Barley | Variety: Gallatin | Planting Date: 5-5-99
Planting Method: Drill and Broadcast | Rate, Unit: 60, 110, & 150 Lbs/A
Depth, Unit: Broadcast= 0-3", Drill= 1.5" | Row Spacing, Unit: Drill= 6"
Soil Moisture: Poor | Emergence Date: Broadcast= 5-15-99, Drill= 5-19-99
Harvest Date: 8-25-99

Plot Width, Unit: 10 FT | Plot Length, Unit: 15 FT | Reps: 4
Site Location: R-5 | Study Design: Split-Plot
Plot Maintenance:

Fertility:	4-14-99	58 Lbs. N and 28 Lbs. P
	6-16-99	34 Lbs. N
Weed Control:	6-11-99	Harmony Extra at 0.5 oz + 2, 4-D at 0.25 pt
Irrigation:	5- 5-99	.4" with wheel line
	5- 7-99	.6" with wheel line
	6-16-99	.6" with wheel line

***Wild oats broadcast seeded by hand on 5-5-99
***Broadcast seeded barley and wild oats incorporated with Phoenix harrow and cultipacked

Soil Description

Texture: Fine Sandy Loam | % OM: 2.2 | % Sand: 60 | % Silt: 30 | % Clay: 10
pH: 6.9 | CEC: 14.5 | Soil Name: Kalispell Fine Sandy Loam

Effects of Crop Seeding Rates and Broadcast Seeding Patterns on Wild Oat Management

Trt No	Treatment Name	W OATS PLANTS #/FT2 7-27-99	W OATS HEADS #/FT2 7-27-99	W OATS DRY WT GRAM/FT2 7-27-99	W OATS SEED CNT #/FT2 7-27-99	W OATS INFESTED PERCENT 7-30-99	W OAT DOCKAGE PERCENT
1	WILD OAT 0 BROADCAST BARLEY 16	0.2	0.3	0.1	0.6	5.8	0.2
2	WILD OAT 0 BROADCAST BARLEY 26	0.0	0.0	0.0	0.0	0.8	0.1
3	WILD OAT 0 BROADCAST BARLEY 36	0.3	0.4	0.3	2.7	1.0	0.1
4	WILD OAT 0 DRILL BARLEY 16	0.2	0.1	0.1	2.2	1.0	0.2
5	WILD OAT 0 DRILL BARLEY 26	0.2	0.2	0.2	3.3	0.8	0.2
6	WILD OAT 0 DRILL BARLEY 36	0.1	0.1	0.1	1.2	0.5	0.2
7	WILD OAT 8 BROADCAST BARLEY 16	4.4	8.2	12.8	217.1	27.5	3.5
8	WILD OAT 8 BROADCAST BARLEY 26	4.8	6.8	10.4	182.6	14.3	1.1
9	WILD OAT 8 BROADCAST BARLEY 36	5.2	6.1	8.4	162.3	26.8	1.3
10	WILD OAT 8 DRILL BARLEY 16	4.2	7.8	13.3	216.9	27.5	2.9
11	WILD OAT 8 DRILL BARLEY 26	5.1	7.2	10.9	176.0	18.8	2.0
12	WILD OAT 8 DRILL BARLEY 36	4.5	6.0	9.3	174.0	11.5	1.6
13	WILD OAT 16 BROADCAST BARLEY 16	8.9	13.9	21.6	386.7	36.3	5.4

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Effects of Crop Seeding Rates and Broadcast Seeding Patterns on Wild Oat Management

Trt No	Treatment Name	W OATS PLANTS #/FT2 7-27-99	W OATS HEADS #/FT2 7-27-99	W OATS DRY WT GRAM/FT2 7-27-99	W OATS SEED CNT #/FT2 7-27-99	W OATS INFESTED PERCENT 7-30-99	W OATS DOCKAGE PERCENT
14	WILD OAT 16 BROADCAST BARLEY 26	8.7	11.8	16.2	306.1	21.8	3.2
15	WILD OAT 16 BROADCAST BARLEY 36	6.8	8.6	9.8	190.0	17.0	2.5
16	WILD OAT 16 DRILL BARLEY 16	5.2	10.4	18.5	305.3	39.0	4.8
17	WILD OAT 16 DRILL BARLEY 26	8.5	13.9	20.0	351.8	26.5	2.9
18	WILD OAT 16 DRILL BARLEY 36	5.7	8.1	9.6	173.2	16.8	2.3
19	WILD OAT 32 BROADCAST BARLEY 16	19.9	29.1	38.8	698.7	55.5	8.4
20	WILD OAT 32 BROADCAST BARLEY 26	20.8	27.6	33.8	656.9	33.0	4.5
21	WILD OAT 32 BROADCAST BARLEY 36	19.0	23.5	24.8	493.3	23.8	3.1
22	WILD OAT 32 DRILL BARLEY 16	14.9	26.2	36.8	647.0	49.3	6.7
23	WILD OAT 32 DRILL BARLEY 26	15.8	20.8	28.9	543.9	40.0	5.0
24	WILD OAT 32 DRILL BARLEY 36	19.0	24.2	26.0	533.8	30.3	3.6
	LSD (P=.05)	5.65	6.45	8.11	147.41	14.25	1.44
	Standard Deviation	3.99	4.56	5.74	104.23	10.07	1.02
	CV	52.56	41.89	39.25	38.93	46.05	37.19
	Treatment F	12.051	17.501	17.900	18.946	9.806	19.404
	Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Effects of Crop Seeding Rates and Broadcast Seeding Patterns on Wild Oat Management

Trt No	Treatment Name	BARLEY PLANTS #/FT2 7-27-99	BARLEY HEADS #/FT2 7-27-99	BARLEY DRY WT GRAM/FT2 7-27-99	BARLEY YIELD BU/A 8-25-99	BARLEY TEST WT LBS/BU	BARLEY PLUMP PERCENT
1	WILD OAT 0 BROADCAST BARLEY 16	24.6	75.0	98.5	94.9	52.7	77.55
2	WILD OAT 0 BROADCAST BARLEY 26	20.3	65.2	78.7	88.3	52.3	73.03
3	WILD OAT 0 BROADCAST BARLEY 36	29.0	74.0	82.3	87.6	52.4	70.60
4	WILD OAT 0 DRILL BARLEY 16	14.3	46.7	69.0	97.1	53.1	81.63
5	WILD OAT 0 DRILL BARLEY 26	23.0	51.7	64.8	97.4	52.7	78.32
6	WILD OAT 0 DRILL BARLEY 36	28.0	56.0	72.3	96.7	52.8	79.05
7	WILD OAT 8 BROADCAST BARLEY 16	19.6	57.9	70.3	80.3	52.8	73.25
8	WILD OAT 8 BROADCAST BARLEY 26	23.3	62.9	84.6	90.2	52.8	73.55
9	WILD OAT 8 BROADCAST BARLEY 36	31.3	72.9	85.0	88.1	52.9	72.53
10	WILD OAT 8 DRILL BARLEY 16	14.5	49.8	65.2	87.8	52.9	78.30
11	WILD OAT 8 DRILL BARLEY 26	20.9	49.8	66.0	88.2	53.0	77.05
12	WILD OAT 8 DRILL BARLEY 36	28.4	57.9	68.9	90.8	52.6	67.85
13	WILD OAT 16 BROADCAST BARLEY 16	15.4	55.2	68.2	71.7	52.3	66.83

CONTINUED...

Effects of Crop Seeding Rates and Broadcast Seeding Patterns on Wild Oat Management

Trt No	Treatment Name	BARLEY PLANTS #/FT2 7-27-99	BARLEY HEADS #/FT2 7-27-99	BARLEY DRY WT GRAM/FT2 7-27-99	BARLEY YIELD BU/A 8-25-99	BARLEY TEST WT LBS/BU	BARLEY PLUMP PERCENT
14	WILD OAT 16 BROADCAST BARLEY 26	26.4	60.3	71.4	79.1	52.8	67.18
15	WILD OAT 16 BROADCAST BARLEY 36	30.2	67.2	73.9	80.9	52.7	69.80
16	WILD OAT 16 DRILL BARLEY 16	15.8	42.3	55.7	81.3	53.4	77.02
17	WILD OAT 16 DRILL BARLEY 26	22.1	52.4	63.5	84.7	53.3	75.80
18	WILD OAT 16 DRILL BARLEY 36	28.7	57.0	69.5	88.3	53.0	75.47
19	WILD OAT 32 BROADCAST BARLEY 16	17.8	46.1	52.5	63.1	52.4	64.08
20	WILD OAT 32 BROADCAST BARLEY 26	17.4	54.9	59.3	71.1	52.4	64.85
21	WILD OAT 32 BROADCAST BARLEY 36	33.0	66.1	73.7	74.7	52.3	65.22
22	WILD OAT 32 DRILL BARLEY 16	14.8	41.6	50.0	70.6	53.0	71.28
23	WILD OAT 32 DRILL BARLEY 26	23.2	46.7	58.1	74.7	53.0	70.20
24	WILD OAT 32 DRILL BARLEY 36	25.9	46.4	53.7	75.8	52.5	67.15
	LSD (P=.05)	9.98	13.87	18.45	9.54	0.85	7.184
	Standard Deviation	7.06	9.81	13.05	6.75	0.60	5.080
	CV	30.91	17.36	18.92	8.08	1.14	7.02
	Treatment F	2.698	4.015	3.106	7.771	1.072	3.994
	Treatment Prob(F)	0.0008	0.0001	0.0001	0.0001	0.3974	0.0001

Effects of Crop Seeding Rates and Banding Patterns on Wild Oat Management

Weed competition can be lessened by improving the competitiveness of cereal grain crops. Several factors can be reconfigured to aid in this endeavor. Greater crop densities and narrow row spacings increase crop leaf area and canopy development. The advent of air drills coupled with openers capable of placing seed in varying band widths offer a means by which row spacings can indirectly be narrowed. The objective of this study was to evaluate the combined effects of greater seeding rates plus wide banded seeding patterns for the suppression of wild oat.

Ernest spring wheat was seeded at 60 and 120 lbs/A in band widths of 3.5, 5, and 6.5 inches. Planting patterns were achieved by using a Concord air drill and Farmland double shoot openers equipped with various sweep widths and spreader attachments. These treatments were superimposed on wild oat densities of 0, 10, 20, and 30 plants per square foot. The oat variety Otana was used to simulate wild oat competition, which also allowed for the determination of wild oat grain yield.

As found in 1998, wild oat dry weight and grain yield decreased dramatically as spring wheat density was doubled. However, banding widths were less effective than the previous year with inconsistences in grain yield. Maximum biomass reduction was achieved at the 5 inch band width. Increasing the seeding rate resulted in significant increases in wheat spike density (19%), dry weight biomass (7%), and yield (6%). Increasing banding width had little to no effect on wheat spike density and plant biomass but did result in a 4 percent yield advantage. Wheat and wild oat stand establishment was considerably below target seeding rate as a result of multiple factors. Severe heat stress at grain fill resulted in poor seed fill as illustrated by test and thousand kernel weights.

Site Description

Crop: Spring Wheat Variety: Ernest Planting Date: 4-25-1999
Planting Method: Air Drill Depth, Unit: 2"
Rate, Unit: Spring wheat = 60 and 120 lbs/A, Wild oats = 10, 20, and 30 plants/A
Row Spacing, Unit: 3.5, 5, and 6.5" seed bands on 12" centers Soil Moisture: Good

Plot Width, Unit: 10 FT Plot Length, Unit: 50 FT Reps: 3
Site Location: NARC-Havre Study Design: RCB
Plot Maintenance:

Fertility:	70 Lbs N, 40 Lbs P, and 25 Lbs K
Weed Control:	Bronate at 1.5 pt/A
Previous Crop:	Fallow
Growing Season Precip:	8.6"

***Wild oats seeded parallel to spring wheat rows and Triple K incorporated at a 45 degree angle pre-plant.

Soil Description

Soil Name: Telstead Clay-Loam pH: 7.4

Effects of Crop Seeding Rates and Banding Patterns on Wild Oat Management

Trt No	Treatment Name	S WHEAT PLANTS #/FT2 7-21-99	S WHEAT HEADS #/FT2 7-21-99	S WHEAT DRY WT GRM/FT2 7-21-99	S WHEAT YIELD BU/A 9-30-99	S WHEAT TEST WT LBS/BU	S WHEAT PROTEIN PERCENT
1	WILD OAT 0 1" BAND WHEAT 60	9.6	43.4	85.0	38.5	55.8	17.40
2	WILD OAT 0 1" BAND WHEAT 120	15.0	47.0	82.4	38.4	56.0	16.97
3	WILD OAT 0 3" BAND WHEAT 60	12.4	42.2	83.6	40.4	56.4	16.60
4	WILD OAT 0 3" BAND WHEAT 120	18.8	45.3	83.5	38.8	55.7	17.30
5	WILD OAT 0 6" BAND WHEAT 60	13.5	44.8	87.2	41.9	56.4	16.67
6	WILD OAT 0 6" BAND WHEAT 120	14.7	49.6	84.2	39.8	55.5	17.40
7	WILD OAT 10 1" BAND WHEAT 60	10.3	36.4	72.7	35.0	57.0	16.20
8	WILD OAT 10 1" BAND WHEAT 120	15.8	40.3	73.0	37.4	57.2	15.73
9	WILD OAT 10 3" BAND WHEAT 60	9.8	36.5	73.3	35.0	57.0	16.03
10	WILD OAT 10 3" BAND WHEAT 120	8.6	42.9	77.3	38.9	56.5	16.33
11	WILD OAT 10 6" BAND WHEAT 60	12.4	35.3	66.1	35.0	56.9	16.37
12	WILD OAT 10 6" BAND WHEAT 120	20.0	45.7	78.7	38.7	57.1	15.70
13	WILD OAT 20 1" BAND WHEAT 60	12.5	30.4	54.7	30.7	57.6	16.10

CONTINUED...

Effects of Crop Seeding Rates and Banding Patterns on Wild Oat Management

Trt No	Treatment Name	S WHEAT PLANTS #/FT2 7-21-99	S WHEAT HEADS #/FT2 7-21-99	S WHEAT DRY WT GRM/FT2 7-21-99	S WHEAT YIELD BU/A 9-30-99	S WHEAT TEST WT LBS/BU	S WHEAT PROTEIN PERCENT
14	WILD OAT 20 1" BAND WHEAT 120	11.3	38.5	64.2	32.8	56.5	16.60
15	WILD OAT 20 3" BAND WHEAT 60	6.6	27.0	53.7	31.2	57.4	15.90
16	WILD OAT 20 3" BAND WHEAT 120	8.9	40.5	64.4	34.6	56.7	16.80
17	WILD OAT 20 6" BAND WHEAT 60	11.5	33.8	63.9	32.9	57.7	16.07
18	WILD OAT 20 6" BAND WHEAT 120	22.8	37.5	65.2	35.2	57.1	16.10
19	WILD OAT 30 1" BAND WHEAT 60	6.9	25.3	51.2	25.1	57.3	17.23
20	WILD OAT 30 1" BAND WHEAT 120	9.9	36.6	53.2	28.1	56.7	16.67
21	WILD OAT 30 3" BAND WHEAT 60	8.2	26.2	47.4	25.9	56.8	17.10
22	WILD OAT 30 3" BAND WHEAT 120	17.6	36.5	59.0	28.4	57.0	16.97
23	WILD OAT 30 6" BAND WHEAT 60	7.0	24.4	44.9	24.5	57.4	16.97
24	WILD OAT 30 6" BAND WHEAT 120	15.5	39.2	53.3	30.4	57.3	16.47
	LSD (P=.05)	10.14	7.66	10.89	3.58	0.92	1.039
	Standard Deviation	6.15	4.64	6.60	2.17	0.56	0.630
	CV	49.27	12.31	9.77	6.37	0.98	3.8
	Treatment F	1.499	6.981	12.208	16.618	3.409	2.077
	Treatment Prob(F)	0.1201	0.0001	0.0001	0.0001	0.0002	0.0174

Effects of Crop Seeding Rates and Banding Patterns on Wild Oat Management

Trt No	Treatment Name	W OAT PLANTS #/FT2 7-21-99	W OAT HEADS #/FT2 7-21-99	W OAT DRY WT GRM/FT2 7-21-99	W OAT QUAD WT GRAMS/FT2 7-21-99	W OAT YIELD BU/A 9-30-99
1	WILD OAT 0 1" BAND WHEAT 60	0.0	0.0	0.0	0.0	0.8
2	WILD OAT 0 1" BAND WHEAT 120	0.0	0.0	0.0	0.0	0.6
3	WILD OAT 0 3" BAND WHEAT 60	0.0	0.0	0.0	0.0	0.6
4	WILD OAT 0 3" BAND WHEAT 120	0.0	0.0	0.0	0.0	0.5
5	WILD OAT 0 6" BAND WHEAT 60	0.0	0.0	0.0	0.0	0.5
6	WILD OAT 0 6" BAND WHEAT 120	0.0	0.0	0.0	0.0	0.5
7	WILD OAT 10 1" BAND WHEAT 60	2.3	5.1	11.1	2.9	4.5
8	WILD OAT 10 1" BAND WHEAT 120	2.4	4.3	7.8	2.1	3.3
9	WILD OAT 10 3" BAND WHEAT 60	2.2	5.5	11.0	3.1	6.5
10	WILD OAT 10 3" BAND WHEAT 120	1.9	4.4	7.4	2.1	1.4
11	WILD OAT 10 6" BAND WHEAT 60	3.5	6.2	13.9	4.1	5.7
12	WILD OAT 10 6" BAND WHEAT 120	2.3	4.0	6.5	2.0	2.5
13	WILD OAT 20 1" BAND WHEAT 60	8.0	14.2	25.1	7.8	13.1

CONTINUED...

Effects of Crop Seeding Rates and Banding Patterns on Wild Oat Management

Trt No	Treatment Name	W OAT PLANTS #/FT2 7-21-99	W OAT HEADS #/FT2 7-21-99	W OAT DRY WT GRM/FT2 7-21-99	W OAT QUAD WT GRAMS/FT2 7-21-99	W OAT CLN YLD BU/A 9-30-99
14	WILD OAT 20 1" BAND WHEAT 120	7.5	11.5	19.0	5.7	6.5
15	WILD OAT 20 3" BAND WHEAT 60	5.0	11.5	22.4	7.2	10.5
16	WILD OAT 20 3" BAND WHEAT 120	5.9	9.0	13.9	4.3	6.4
17	WILD OAT 20 6" BAND WHEAT 60	5.6	11.3	21.5	6.6	11.4
18	WILD OAT 20 6" BAND WHEAT 120	7.8	10.0	15.3	4.6	7.7
19	WILD OAT 30 1" BAND WHEAT 60	9.1	14.8	35.1	10.6	17.7
20	WILD OAT 30 1" BAND WHEAT 120	12.3	20.6	32.5	10.1	10.1
21	WILD OAT 30 3" BAND WHEAT 60	11.5	19.6	38.6	11.7	17.0
22	WILD OAT 30 3" BAND WHEAT 120	8.1	14.0	23.8	7.5	12.5
23	WILD OAT 30 6" BAND WHEAT 60	9.9	20.1	39.2	12.7	20.7
24	WILD OAT 30 6" BAND WHEAT 120	10.3	13.5	20.3	6.5	12.6
	LSD (P=.05)	3.55	3.90	7.23	2.54	2.72
	Standard Deviation	2.15	2.37	4.38	1.52	1.65
	CV	44.7	28.47	28.85	24.51	22.76
	Treatment F	10.951	24.966	25.378	14.880	41.422
	Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001

Spring Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Favorable environmental conditions make pre-harvest sprouting in small grains an annual concern for District 1 producers. Sprout damaged grain results in substantial economic losses as kernels are no longer agronomically sound and the functional quality of the flour is negatively affected. This study was conducted to evaluate spring wheat class and cultivar susceptibility to pre-harvest sprouting and the effect of sprout damage on seed characteristics and quality.

Included in the study were five hard read (McNeal, Amidon, WPB 926, Hi-Line, and Scholar), five soft white (Owens, Vanna, sprite, Wawawai, and Penawawa), and five hard whites (Klassic, 377S, MTHW8182, MTHW9420, and MTHW9520) cultivars. In an attempt to initiate some level of sprouting in all cultivars, irrigation was applied daily beginning at physiological maturity to augment natural precipitation. Harvests began one week after the earliest cultivar reached physiological maturity and continued weekly for a total of six. Harvests were made over time to document when and to what degree sprout was occurring in each cultivar. The presence or absence of sprout damage was assessed with visible sprout observations and falling number determinations (FN) conducted by inspectors at the State Grain Lab. Other measured responses included test weight, % germination, protein, lodging, heading date, and physiological maturity.

Harvest maturity was identified on 8-17 for all three classes of wheat. As illustrated by the percent sprout damage data, hard red cultivars displayed exceptional resistance to sprouting well after harvest maturity. The soft white cultivars were susceptible to preharvest sprout with Sprite displaying no genetic resistance but Vanna and Penewawa providing some tolerance. The hard white cultivars were between the two extremes but more closely resembled the resistance of the hard reds. Klasic was very susceptible while the other four cultivars were only somewhat affected. Test weights decreased in all cultivars over time but at a faster rate in the soft whites in response to sprout damage. Falling numbers and seed viability decreased over harvest dates. Again, hard reds performed best followed by hard whites and soft whites.

Site Description

Crop: Spring Wheat
Variety: 5 Hard Reds, 5 Hard Whites, and 5 Soft Whites
Planting Date: 4-10-99
Planting Method: Disk Drill
Rate, Unit: 70 Lbs/A
Depth, Unit: 1.5"
Row Spacing, Unit: 6"
Soil Moisture: Good
Emergence Date: 4-23-99

Plot Width, Unit: 4.2 FT
Plot Length, Unit: 15 FT
Reps: 3
Site Location: Y-3
Study Design: RCB
Plot Maintenance:

Fertility:	4- 6-98	64 Lbs. N and 33 Lbs. P
	5-11-98	36 Lbs. N
Weed Control:	5- 7-98	Express at 0.25 oz + 2,4-D at 0.25 pt
	5-20-98	Achieve at .46 lbs.
Irrigation:	7-28-98	.12" daily through 9-12-98
Harvest Dates:	8-10-98, 8-17-98, 8-24-98, 8-31-98, 9-8-98, and 9-14-98	

Soil Description

Texture: Silty Loam % OM: 5.6 % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.9 Soil Name: Creston Silt Loam

Spring Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	SPR WHT HD DATE JULIAN	SPR WHT PHYS.MAT JULIAN	SPR WHT LODGE 0-9 8-10-98	SPR WHT LODGE 0-9 8-24-98	SPR WHT LODGE 0-9 8-31-98	SPR WHT LODGE 0-9 9-14-98
1	McNEAL	173.7	222.0	0.0	1.3	2.0	3.7
2	AMIDON	173.0	221.7	2.0	2.3	2.7	3.0
3	WESTBRED 926	167.3	218.0	0.0	1.7	2.7	4.0
4	HI-LINE	170.7	220.0	0.0	2.7	4.0	5.0
5	MT9433	174.0	223.0	2.0	2.3	2.7	3.3
6	OWENS	172.3	220.3	4.7	5.7	6.3	7.7
7	VANNA	173.3	218.0	0.3	4.3	5.3	5.7
8	SPRITE	171.3	218.0	5.7	6.3	7.3	7.0
9	WAWAWAI	170.0	219.0	4.0	4.3	5.0	5.7
10	PENAWAWA	174.3	219.7	1.0	3.7	4.3	6.0
11	KLASIC	163.3	214.3	1.0	2.7	4.0	5.0
12	377 S	170.0	220.3	3.0	4.0	4.7	5.3
13	MTHW8182	171.7	220.0	0.7	3.0	4.3	5.3
14	MTHW9420	168.3	218.0	1.3	4.7	5.3	6.3
15	MTHW9520	171.0	220.3	2.7	2.3	2.7	4.3
	LSD (P=.05)	1.85	1.95	1.58	1.20	1.44	1.41
	Standard Deviation	1.10	1.17	0.95	0.72	0.86	0.84
	CV	0.65	0.53	50.18	20.92	20.39	16.32
	Treatment F	21.194	9.727	10.689	12.303	9.293	7.457
	Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Spring Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	SPR WHT TWT LB/BU 8-10-98	SPR WHT TWT LB/BU 8-17-98	SPR WHT TWT LB/BU 8-24-98	SPR WHT TWT LB/BU 8-31-98	SPR WHT WTW LB/BU 9-8-98	SPR WHT TWT LB/BU 9-14-98
1	McNEAL	59.7	59.5	58.4	59.0	57.7	57.7
2	AMIDON	59.8	58.3	57.8	56.7	55.9	56.3
3	WESTBRED 926	56.6	56.4	55.8	56.8	54.9	54.4
4	HI-LINE	57.9	57.3	56.3	56.9	54.8	54.6
5	MT9433	60.2	59.4	58.7	58.6	57.5	57.6
6	OWENS	54.8	52.8	51.5	52.1	48.3	48.2
7	VANNA	56.3	54.5	54.8	54.5	52.7	52.3
8	SPRITE	54.5	54.6	53.0	52.7	46.9	49.0
9	WAWAWAI	58.1	57.0	56.1	55.5	53.5	53.3
10	PENAWAWA	58.3	56.0	55.7	55.9	54.7	53.0
11	KLASIC	53.9	53.7	52.5	52.8	51.0	50.3
12	377 S	56.4	57.3	55.2	55.7	53.8	52.5
13	MTHW8182	55.3	54.0	54.0	53.8	51.8	52.0
14	MTHW9420	54.7	56.1	54.4	54.8	51.3	52.7
15	MTHW9520	59.0	57.5	56.9	56.9	56.8	55.8
LSD (P=.05)		1.86	1.73	1.41	1.63	2.85	2.08
Standard Deviation		1.11	1.04	0.84	0.98	1.70	1.24
CV		1.95	1.84	1.52	1.76	3.18	2.32
Treatment F		10.865	11.572	18.974	13.479	10.423	15.891
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Spring Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	SPR WHT GERM PERCENT 8-10-98	SPR WHT GERM PERCENT 8-17-98	SPR WHT GERM PERCENT 8-24-98	SPR WHT GERM PERCENT 8-31-98	SPR WHT GERM PERCENT 9-8-98	SPR WHT GERM PERCENT 9-14-98
1	McNEAL	71.3	78.7	89.3	89.3	92.0	86.7
2	AMIDON	83.9	84.0	90.7	93.3	88.7	90.7
3	WESTBRED 926	78.7	80.7	85.3	89.3	88.7	91.3
4	HI-LINE	84.0	86.7	92.7	89.3	94.0	95.3
5	MT9433	84.7	86.0	91.3	86.7	89.3	90.5
6	OWENS	84.0	84.7	82.7	84.0	62.7	78.0
7	VANNA	92.0	87.3	86.7	92.7	90.7	88.0
8	SPRITE	84.7	84.0	86.0	75.3	54.0	62.7
9	WAWAWAI	86.0	87.3	79.3	85.3	79.3	82.0
10	PENAWAWA	96.7	88.7	90.0	94.0	91.3	84.5
11	KLASIC	78.7	77.3	76.7	83.3	66.7	64.0
12	377 S	90.7	82.7	89.3	92.0	83.3	82.7
13	MTHW8182	88.0	80.7	90.0	88.7	83.3	84.0
14	MTHW9420	93.3	84.0	86.0	88.1	81.3	84.7
15	MTHW9520	93.3	80.9	91.3	91.3	92.0	88.7
	LSD (P=.05)	11.60	10.23	8.75	10.15	14.51	9.27
	Standard Deviation	6.92	6.10	5.23	6.04	8.68	5.52
	CV	8.05	7.3	6.01	6.85	10.52	6.6
	Treatment F	2.779	0.916	2.353	1.910	5.828	8.501
	Treatment Prob(F)	0.0110	0.5539	0.0262	0.0745	0.0001	0.0001

Spring Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	SPR WHT SPROUT PERCENT 8-10-98	SPR WHT SPROUT PERCENT 8-17-98	SPR WHT SPROUT PERCENT 8-24-98	SPR WHT SPROUT PERCENT 8-31-98	SPR WHT SPROUT PERCENT 9-8-98	SPR WHT SPROUT PERCENT 9-14-98
1	McNEAL	0.07	0.00	0.17	0.07	0.00	0.00
2	AMIDON	0.00	0.00	0.00	0.00	0.20	0.00
3	WESTBRED 926	0.00	0.07	0.00	0.03	0.17	0.00
4	HI-LINE	0.00	0.00	0.00	0.00	0.63	0.00
5	MT9433	0.00	0.00	0.00	0.07	0.33	0.00
6	OWENS	1.53	1.67	4.77	4.83	5.58	9.90
7	VANNA	0.47	0.63	0.60	0.70	3.03	4.57
8	SPRITE	3.03	2.07	11.23	12.43	22.13	20.37
9	WAWAWAI	0.53	1.60	3.57	2.43	7.77	4.03
10	PENAWAWA	0.73	0.83	0.23	0.13	1.90	9.17
11	KLASIC	5.33	3.63	4.10	6.70	11.97	10.37
12	377 S	0.37	0.23	1.63	0.23	4.93	4.07
13	MTHW8182	0.40	0.63	0.30	0.47	3.13	2.23
14	MTHW9420	0.33	0.37	0.33	0.57	9.13	1.97
15	MTHW9520	0.03	0.00	0.50	0.07	0.57	0.80
LSD (P=.05)		1.107	1.488	4.405	4.724	7.082	5.989
Standard Deviation		0.662	0.890	2.634	2.825	4.219	3.574
CV		77.39	113.77	144.04	147.47	88.54	81.08
Treatment F		14.894	4.145	4.070	4.695	6.201	8.011
Treatment Prob(F)		0.0001	0.0007	0.0008	0.0002	0.0001	0.0001

Spring Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	SPR WHT FN 8-10-98	SPR WHT FN 8-17-98	SPR WHT FN 8-24-98	SPR WHT FN 8-31-98	SPR WHT FN 9-8-98	SPR WHT FN 9-14-98
1	McNEAL	531.0	531.0	493.3	499.0	435.0	505.7
2	AMIDON	521.3	479.3	503.3	400.7	351.7	427.7
3	WESTBRED 926	397.7	441.3	395.3	351.7	381.0	415.0
4	HI-LINE	531.0	482.0	484.0	501.0	317.3	390.0
5	MT9433	476.3	422.7	460.3	404.7	295.3	485.7
6	OWENS	271.3	268.3	190.3	217.3	84.9	65.3
7	VANNA	388.7	357.3	375.0	315.0	134.7	132.0
8	SPRITE	234.7	227.0	88.3	65.0	37.4	50.3
9	WAWAWAI	415.0	317.3	225.0	208.0	105.7	149.0
10	PENAWAWA	379.7	317.3	319.0	334.7	182.7	140.7
11	KLASIC	183.7	135.0	75.0	66.0	49.0	52.7
12	377 S	387.0	378.0	244.3	360.0	177.3	163.3
13	MTHW8182	387.0	351.3	343.0	334.7	133.0	168.3
14	MTHW9420	409.0	401.7	376.7	299.3	86.3	136.7
15	MTHW9520	515.0	478.3	411.0	477.7	338.7	309.0
	LSD (P=.05)	64.60	78.26	93.37	109.55	129.10	132.33
	Standard Deviation	38.63	46.80	55.84	65.51	76.91	78.83
	CV	9.61	12.56	16.81	20.33	37.09	32.92
	Treatment F	22.960	15.954	18.828	12.950	8.918	13.005
	Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Winter Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Favorable environmental conditions make pre-harvest sprouting in small grains an annual concern for District 1 producers. Sprout damaged grain results in substantial economic losses as kernels are no longer agronomically sound and the functional quality of the flour is negatively affected. This study was conducted to evaluate winter wheat class and cultivar susceptibility to pre-harvest sprouting and the effect of sprout damage on seed characteristics and quality.

Included in the study were five hard read (Judith, Rocky, Neeley, Tiber, and Kestrel), five soft white (Lewjain, Cashup, Malcolm, Stevens, and Daws), and one hard white (NuWest) cultivar. In an attempt to initiate some level of sprouting in all cultivars, irrigation was applied daily beginning at physiological maturity to augment natural precipitation. Harvests began one week after the earliest cultivar reached physiological maturity and continued weekly for a total of six. Harvests were made over time to document when and to what degree sprout was occurring in each cultivar. The presence or absence of sprout damage was assessed with visible sprout observations and falling number determinations (FN) conducted by inspectors at the State Grain Lab. Other measured responses included test weight, % germination, protein, lodging, heading date, and physiological maturity.

Harvest maturity was identified on 8-5 for the hard red and white cultivars and 8-12 for the soft whites. Hard red cultivars with the exception of Judith, along with the hard white (NuWest) were much more resistant to sprout damage then the soft whites as illustrated by the percent sprout damage measurements. In general for all cultivars, as percent sprout damage increased, test weight, viable seed, and falling numbers decreased. This was very pronounced in the soft white cultivars. Neeley, Tiber, and NuWest proved to be genetically equipped to resist preharvest sprouting with Lewjain and Stevens the most susceptible.

Site Description

Crop: Winter Wheat
Variety: 5 Hard Reds, 1 Hard White, and 5 Soft Whites
Planting Date: 9-26-97
Planting Method: Disk Drill
Rate, Unit: 70 Lbs/A
Depth, Unit: 1.5"
Row Spacing, Unit: 6"
Soil Moisture: Good
Emergence Date: 10-7-97

Plot Width, Unit: 4.2 FT
Plot Length, Unit: 15 FT
Reps: 3
Site Location: Y-3
Study Design: RCB
Plot Maintenance:

Fertility:	10- 8-97	36 Lbs. N and 45 Lbs. P
	3-26-98	36 Lbs. N
Weed Control:	5- 7-98	Harmony Extra at 0.3 oz + 2,4-D at 0.25 pt
Irrigation:	7-22-98	.12" daily through 9-2-98
Harvest Dates:	7-29-98, 8-5-98, 8-12-98, 8-19-98, 8-26-98, and 9-2-98	

Soil Description

Texture: Silty Loam % OM: 5.6 % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.9 Soil Name: Creston Silt Loam

Winter Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	WNTR WHT HD DATE JULIAN	WNTR WHT PHYS.MAT JULIAN	WNTR WHT LODGE 0-9 7-29-98	WNTR WHT LODGE 0-9 8-12-98	WNTR WHT LODGE 0-9 8-19-98	WNTR WHT LODGE 0-9 9-2-98
1	JUDITH	153.0	202.7	1.0	1.0	1.7	2.3
2	ROCKY	153.3	202.3	6.3	4.7	4.7	5.3
3	NEELEY	157.0	205.7	4.3	3.0	3.0	3.7
4	KESTREL	157.3	206.3	2.3	2.3	2.7	3.7
5	TIBER	157.0	207.0	4.3	4.0	4.0	4.7
6	NuWEST	157.0	205.7	0.7	0.3	0.3	2.3
7	LEWJAIN	162.7	218.3	0.0	0.7	1.7	4.3
8	STEVENS	160.0	214.3	2.0	3.0	3.7	4.7
9	DAWS	158.7	209.7	0.0	0.0	1.3	3.0
10	CASHUP	159.0	208.3	0.0	1.0	1.3	3.0
11	MALCOLM	157.3	207.0	0.0	0.0	0.3	1.0
LSD (P=.05)		1.73	1.30	0.91	1.04	1.22	1.64
Standard Deviation		1.02	0.76	0.53	0.61	0.72	0.96
CV		0.65	0.37	27.96	33.44	32.01	27.92
Treatment F		21.702	117.120	51.043	22.246	12.435	5.251
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0008

Winter Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	WNTR WHT TWT GRAMS 7-29-98	WNTR WHT TWT GRAMS 8-5-98	WNTR WHT TWT GRAMS 8-12-98	WNTR WHT TWT GRAMS 8-19-98	WNTR WHT TWT GRAMS 8-26-98	WNTR WHT TWT GRAMS 9-2-98
1	JUDITH	59.2	56.2	55.6	56.1	55.5	55.0
2	ROCKY	61.3	58.6	58.3	58.0	56.8	55.8
3	NEELEY	61.6	58.8	58.3	58.0	57.4	57.1
4	KESTREL	59.6	57.5	57.4	57.5	57.0	56.4
5	TIBER	61.9	60.0	57.9	58.6	57.9	56.2
6	NuWEST	59.9	58.6	57.9	58.2	57.8	57.1
7	LEWJAIN	55.3	52.3	51.7	51.0	51.0	46.8
8	STEVENS	57.7	55.3	54.1	53.8	52.8	50.0
9	DAWS	58.7	56.5	55.6	56.2	54.8	54.4
10	CASHUP	58.5	55.5	55.2	54.9	54.0	53.0
11	MALCOLM	56.1	52.8	53.1	53.0	53.1	52.3
LSD (P=.05)		1.22	1.19	1.00	1.17	0.89	1.63
Standard Deviation		0.72	0.70	0.59	0.69	0.52	0.96
CV		1.22	1.24	1.05	1.23	0.94	1.78
Treatment F		26.484	37.483	44.585	39.414	59.129	34.792
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Winter Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	WNTR WHT GERM PERCENT 7-29-98	WNTR WHT GERM PERCENT 8-5-98	WNTR WHT GERM PERCENT 8-12-98	WNTR WHT GERM PERCENT 8-19-98	WNTR WHT GERM PERCENT 8-26-98	WNTR WHT GERM PERCENT 9-2-98
1	JUDITH	93.3	97.3	92.7	94.7	92.7	90.7
2	ROCKY	96.0	98.0	96.0	97.3	96.0	90.0
3	NEELEY	92.7	94.0	95.3	93.3	92.0	95.3
4	KESTREL	97.3	96.7	94.7	98.0	94.7	92.0
5	TIBER	94.0	88.7	86.7	90.0	97.3	94.0
6	NuWEST	92.0	94.0	86.7	86.7	96.0	94.7
7	LEWJAIN	94.0	88.0	82.0	71.3	72.7	50.0
8	STEVENS	89.3	86.7	80.7	80.7	70.0	61.3
9	DAWS	89.3	84.0	76.0	75.3	75.3	56.0
10	CASHUP	91.3	92.0	86.0	86.7	78.7	76.7
11	MALCOLM	90.0	87.3	84.0	78.7	76.7	69.3
LSD (P=.05)		6.37	5.22	5.91	8.33	7.27	12.72
Standard Deviation		3.74	3.06	3.47	4.89	4.27	7.47
CV		4.04	3.35	3.98	5.65	4.99	9.44
Treatment F		1.468	7.450	10.856	10.353	19.257	15.845
Treatment Prob(F)		0.2227	0.0001	0.0001	0.0001	0.0001	0.0001

Winter Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	WNTR WHT SPROUT PERCENT 7-29-98	WNTR WHT SPROUT PERCENT 8-5-98	WNTR WHT SPROUT PERCENT 8-12-98	WNTR WHT SPROUT PERCENT 8-19-98	WNTR WHT SPROUT PERCENT 8-26-98	WNTR WHT SPROUT PERCENT 9-2-98
1	JUDITH	2.87	5.60	6.10	4.67	4.90	6.47
2	ROCKY	0.07	0.27	1.73	1.57	2.57	3.40
3	NEELEY	0.00	0.00	0.00	0.00	0.00	0.13
4	KESTREL	0.50	0.97	1.17	0.87	0.20	2.10
5	TIBER	0.00	0.00	0.00	0.00	0.00	0.07
6	NuWEST	0.13	0.63	0.67	0.37	0.63	0.43
7	LEWJAIN	1.07	14.37	13.97	14.03	19.53	16.10
8	STEVENS	2.33	11.83	13.60	8.93	15.70	16.27
9	DAWS	4.77	12.80	9.93	9.90	12.30	9.07
10	CASHUP	3.67	9.77	10.33	7.20	13.43	14.07
11	MALCOLM	6.80	12.53	13.20	10.47	10.80	11.40
LSD (P=.05)		1.690	2.699	3.788	3.641	2.584	4.230
Standard Deviation		0.992	1.585	2.224	2.138	1.517	2.484
CV		49.17	25.35	34.6	40.55	20.84	34.37
Treatment F		16.045	43.677	21.064	16.765	68.400	20.292
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Winter Wheat Cultivar Susceptibility to Preharvest Sprouting at Kalispell in 1998

Trt No	Treatment Name	WNTR WHT FN 7-29-98	WNTR WHT FN 8-5-98	WNTR WHT FN 8-12-98	WNTR WHT FN 8-19-98	WNTR WHT FN 8-26-98	WNTR WHT FN 9-2-98
1	JUDITH	454.0	255.0	222.0	209.7	166.0	123.7
2	ROCKY	507.3	434.7	423.3	348.0	181.7	183.3
3	NEELEY	531.0	480.7	480.7	544.0	409.0	404.3
4	KESTREL	481.3	372.3	383.0	379.3	301.3	212.7
5	TIBER	527.0	503.3	597.0	559.3	387.3	383.3
6	NuWEST	491.0	424.3	503.3	482.7	348.3	321.0
7	LEWJAIN	350.0	114.0	119.0	113.0	62.3	57.3
8	STEVENS	337.0	144.7	137.0	131.0	61.7	58.7
9	DAWS	375.3	166.7	183.3	172.0	85.3	85.0
10	CASHUP	376.0	180.3	188.7	148.3	66.0	66.3
11	MALCOLM	307.3	143.7	156.7	152.3	101.3	92.3
LSD (P=.05)		43.81	50.18	56.43	77.53	82.10	75.75
Standard Deviation		25.72	29.46	33.13	45.52	48.20	44.47
CV		5.97	10.07	10.74	15.46	24.43	24.61
Treatment F		31.064	79.309	80.741	43.622	24.711	26.573
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Assert Reduced Rate Study

This study was conducted to evaluate the efficacy of reduced rate applications of Assert to wild oat. Assert was applied as fractions of the labeled rate as follows: 0.12, 0.25, 0.37, 0.50, 0.75, and 1.0X, where 0.357 lb ai/A represents the current labeled rate. Nontreated and handweeded treatments were also included for comparison. Wild oat plant and panicle density, dry matter, and seed yield measurements were taken prior to harvest with plants ranging from boot to seed shatter stages. Plots were harvested to determine spring wheat yield and test weight.

While percent wild oat control increased with Assert rates, only 72 percent control was achieved at the 1X rate . Assert treatments did not significantly reduce wild oat plants or panicle numbers but did decrease biomass and seed production. The 0.75 rate resulted in a 45 and 77 percent reduction in wild oat dry weight and seed production respectively. Significant spring wheat yield responses existed for all Assert rates except the 1X rate compared to the nontreated check. While not apparent throughout the growing season, yield responses suggest the possibility of herbicide injury as yield increased from 40.5 bu/A (0.12 rate) to 51.5 bu/A (0.50 rate), only to decline thereafter to 36.9 bu/A (1X rate). Stand and seedling vigor suffered as a result of dry conditions possibly predisposing plants to herbicide injury.

Assert Reduced Rate Study

Site Description

Crop: Spring Wheat | Variety: McNeal | Planting Date: 4-6-1999
Planting Method: Disk Drill | Rate, Unit: 73 Lbs/A | Depth, Unit: 1.5"
Row Spacing, Unit: 7" | | Soil Moisture: Good
Emergence Date: 4-22-1999 | | Harvest Date: 8-20-1999

Plot Width, Unit: 10 FT | Plot Length, Unit: 15 FT | Reps: 3
Site Location: R-5 | | Study Design: RCB
Plot Maintenance:

Fertility:	4- 6-99	58 Lbs. N and 28 Lbs. P
	6-16-99	45 Lbs. N
Weed Control:	5- 3-99	Achieve at .18 lbs. on hand weeded plots
	5-20-99	Harmony Extra at 0.5 oz + 2,4-D at 0.25 pt
Irrigation:	5- 5-99	0.4" with wheel line
	5- 7-99	0.6" with wheel line
	6-16-99	0.6" with wheel line

***Wild oats seeded perpendicular to spring wheat rows at 27.2 Lbs/A of pure live seed.

Soil Description

Texture: Fine Sandy Loam | % OM: 3.7 | % Sand: 60 | % Silt: 30 | % Clay: 10
pH: 8.0 | Soil Name: Kalispell Fine Sandy Loam

Application Information

Application Date:	5-13-1999
Time of Day:	10:00 AM
Application Method:	BACKPACK
Application Timing:	POST
Air Temp., Unit:	58 F
Wind Velocity, Unit:	O MPH
Dew Presence (Y/N):	N
Soil Temp., Unit:	50 F
Soil Moisture:	EXCELLENT
% Cloud Cover:	GOOD

Plant Species	Plant Stage
Wild Oats	3 Leaf and 1 Tiller
Spring Wheat	3 Leaf and 1 Tiller

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Assert Reduced Rate Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	W OATS CONTROL PERCENT 6-29-99	W OATS PLANTS #/FT2 7-23-99	W OATS HEADS #/FT2 7-23-99	W OATS DRY WT GRAM/FT2 7-23-99	W OATS TKW GRAMS 7-23-99	W OATS SEEDS #/FT2 7-23-99
1	UNTREATED				0.0	23.0	54.7	65.2	20.3	582
2	ASSERT	.046	lb ai/A	3-LF	5.0	20.8	57.7	61.0	21.5	321
2	NIS	.25	% v/v	3-LF						
3	ASSERT	.089	lb ai/A	3-LF	11.7	19.6	57.8	48.8	21.0	330
3	NIS	.25	% v/v	3-LF						
4	ASSERT	.134	lb ai/A	3-LF	46.7	20.4	61.0	52.8	19.3	179
4	NIS	.25	% v/v	3-LF						
5	ASSERT	.178	lb ai/A	3-LF	48.3	27.4	60.3	42.0	19.7	160
5	NIS	.25	% v/v	3-LF						
6	ASSERT	.268	lb ai/A	3-LF	60.0	28.1	71.6	35.2	18.4	132
6	NIS	.25	% v/v	3-LF						
7	ASSERT	.357	lb ai/A	3-LF	71.7	21.9	57.3	27.2	17.3	146
7	NIS	.25	% v/v	3-LF						
8	HANDWEEDED				100.0	0.0	0.0	0.0	18.4	17
LSD (P=.05)					18.59	11.78	17.01	19.89	2.86	92.40
Standard Deviation					10.61	6.73	9.71	11.36	1.64	52.70
CV					24.73	33.39	18.47	27.34	8.39	22.61
Treatment F					33.009	5.059	15.181	10.267	2.318	32.57
Treatment Prob(F)					0.0001	0.0049	0.0001	0.0001	0.0855	0.0001

Assert Reduced Rate Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	S WHEAT PLANTS #/FT2 7-23-99	S WHEAT HEADS #/FT2 7-23-99	S WHEAT DRY WT GRAM/FT2 7-23-99	S WHEAT YIELD BU/A 8-20-99	S WHEAT TEST WT LBS/BU	S WHEAT TKW GRAMS
1	UNTREATED				11.7	18.1	32.5	24.8	60.2	36.93
2	ASSERT	.046	lb ai/A	3-LF	13.4	23.5	54.6	40.5	60.5	37.97
2	NIS	.25	% v/v	3-LF						
3	ASSERT	.089	lb ai/A	3-LF	11.2	23.7	53.1	40.0	60.3	37.60
3	NIS	.25	% v/v	3-LF						
4	ASSERT	.134	lb ai/A	3-LF	9.9	22.8	54.8	45.7	60.8	38.00
4	NIS	.25	% v/v	3-LF						
5	ASSERT	.178	lb ai/A	3-LF	12.2	26.3	61.1	51.5	61.0	38.50
5	NIS	.25	% v/v	3-LF						
6	ASSERT	.268	lb ai/A	3-LF	13.1	26.5	54.5	44.4	61.0	37.20
6	NIS	.25	% v/v	3-LF						
7	ASSERT	.357	lb ai/A	3-LF	11.8	28.4	59.0	36.9	60.9	36.80
7	NIS	.25	% v/v	3-LF						
8	HANDWEEDED				12.3	35.0	82.3	58.3	61.3	37.67
LSD (P=.05)					6.18	9.18	20.74	13.70	1.03	1.794
Standard Deviation					3.53	5.24	11.84	7.77	0.59	1.024
CV					29.5	20.53	20.97	18.16	0.96	2.73
Treatment F					0.283	2.637	3.933	4.969	1.237	0.959
Treatment Prob(F)					0.9500	0.0581	0.0140	0.0063	0.3467	0.4954

Achieve Reduced Rate Study

Achieve is a new post-emergence grass herbicide which has demonstrated excellent activity against wild oat. This study was conducted to evaluate the efficacy of reduced rate applications of Achieve to wild oat. Achieve was applied as fractions of the labeled rate as follows: 0.12, 0.25, 0.37, 0.50, 0.75, and 1.0X, where 0.178 lb ai/A represents the current labeled rate. Nontreated and handweeded treatments were also included for comparison. Wild oat plant and panicle density, dry matter, and seed yield measurements were taken prior to harvest with plants ranging from boot to seed shatter stages.

All wild oat parameters decreased as Achieve rates increased beginning at the 0.25 rate. The lowest rate (0.12) resulted in 12 percent visual wild oat control but did not significantly reduce any of the measured variables. The 0.25 rate achieved approximately 50 percent visual control and parameter reduction compared to the nontreated check. Complete control was not attained at the 1X treatment. Wild oat reductions were primarily a function of herbicide efficacy as crop stand and growth were inhibited by dry conditions and therefore not very competitive. Spring wheat yield increased with Achieve rates through the 0.37 rate then held constant. While significant differences did exist for yield, only the nontreated check and 0.12 rate treatments yielded significantly less than the handweeded check.

Achieve Reduced Rate Study

Site Description

Crop: Spring Wheat
Planting Method: Disk Drill
Row Spacing, Unit: 7"
Emergence Date: 4-22-1999

Variety: McNeal
Rate, Unit: 73 Lbs/A

Planting Date: 4-6-1999
Depth, Unit: 1.5"
Soil Moisture: Good
Harvest Date: 8-20-1999

Plot Width, Unit: 10 FT
Site Location: R-5
Plot Maintenance:

Plot Length, Unit: 15 FT

Reps: 3
Study Design: RCB

Fertility:	4- 6-99	58 Lbs. N and 28 Lbs. P
	6-16-99	45 Lbs. N
Weed Control:	5- 3-99	Achieve at .18 lbs. on hand weeded plots
	5-20-99	Harmony Extra at 0.5 oz + 2,4-D at 0.25 pt
Irrigation:	5- 5-99	0.4" with wheel line
	5- 7-99	0.6" with wheel line
	6-16-99	0.6" with wheel line

***Wild oats seeded perpendicular to spring wheat rows at 27.2 Lbs/A of pure live seed.

Soil Description

Texture: Fine Sandy Loam % OM: 3.7 % Sand: 60 % Silt: 30 % Clay: 10
pH: 8.0 Soil Name: Kalispell Fine Sandy Loam

Application Information

Application Date:	5-13-1999
Time of Day:	10:00 AM
Application Method:	BACKPACK
Application Timing:	POST
Air Temp., Unit:	58 F
Wind Velocity, Unit:	O MPH
Dew Presence (Y/N):	N
Soil Temp., Unit:	50 F
Soil Moisture:	EXCELLENT
% Cloud Cover:	GOOD

Plant Species	Plant Stage
Wild Oats	3 Leaf and 1 Tiller
Spring Wheat	3 Leaf and 1 Tiller

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Achieve Reduced Rate Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	W OAT CONTROL PERCENT 6-29-99	W OATS PLANTS #/FT2 7-23-99	W OATS HEADS #/FT2 7-23-99	W OATS DRY WT GRAM/FT2 7-23-99	W OATS SUB TKW GRAMS 7-23-99	W OATS SEEDS #/FT2 7-23-99
1	UNTREATED				0.0	25.3	64.7	60.9	20.6	455
2	ACHIEVE	.022	lb ai/A	3-LF	11.7	27.8	72.2	75.1	21.8	378
2	TF 8035	0.5	% v/v	3-LF						
3	ACHIEVE	.046	lb ai/A	3-LF	46.7	13.9	37.6	42.0	21.7	211
3	TF 8035	0.5	% v/v	3-LF						
4	ACHIEVE	.067	lb ai/A	3-LF	65.0	7.9	16.1	17.9	22.6	132
4	TF 8035	0.5	% v/v	3-LF						
5	ACHIEVE	.089	lb ai/A	3-LF	76.7	4.3	10.5	12.5	22.2	60
5	TF 8035	0.5	% v/v	3-LF						
6	ACHIEVE	.134	lb ai/A	3-LF	97.0	0.8	2.1	2.1	20.7	20
6	TF 8035	0.5	% v/v	3-LF						
7	ACHIEVE	.178	lb ai/A	3-LF	97.3	0.1	0.3	0.4	22.9	13
7	TF 8035	0.5	% v/v	3-LF						
8	HAND WEEDED				100.0	0.3	0.7	0.5	25.5	3
	LSD (P=.05)				10.41	5.63	16.88	20.66	5.78	158.10
	Standard Deviation				5.94	3.22	9.64	11.80	3.30	90.20
	CV				9.62	31.98	37.78	44.63	14.83	56.74
	Treatment F				130.458	36.555	27.575	18.526	0.667	11.255
	Treatment Prob(F)				0.0001	0.0001	0.0001	0.0001	0.6966	0.0001

Achieve Reduced Rate Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	S WHEAT PLANTS #/FT2 7-23-99	S WHEAT HEADS #/FT2 7-23-99	S WHEAT DRY WT GRAM/FT2 7-23-99	S WHEAT YIELD BU/A 8-20-99	S WHEAT TEST WT LBS/BU	S WHEAT TKW GRAMS
1	UNTREATED				10.6	15.8	33.4	30.2	60.4	35.97
2	ACHIEVE	.022	lb ai/A	3-LF	8.5	17.3	37.4	44.9	61.1	37.80
2	TF 8035	0.5	% v/v	3-LF						
3	ACHIEVE	.046	lb ai/A	3-LF	12.4	28.8	59.1	50.9	60.7	36.87
3	TF 8035	0.5	% v/v	3-LF						
4	ACHIEVE	.067	lb ai/A	3-LF	15.7	35.4	81.9	56.2	61.0	38.20
4	TF 8035	0.5	% v/v	3-LF						
5	ACHIEVE	.089	lb ai/A	3-LF	9.5	28.3	58.8	56.9	61.3	36.50
5	TF 8035	0.5	% v/v	3-LF						
6	ACHIEVE	.134	lb ai/A	3-LF	12.2	38.2	74.0	56.9	61.2	35.67
6	TF 8035	0.5	% v/v	3-LF						
7	ACHIEVE	.178	lb ai/A	3-LF	12.4	36.0	72.3	54.2	60.8	35.93
7	TF 8035	0.5	% v/v	3-LF						
8	HAND WEEDED				12.0	41.0	90.2	64.4	61.5	36.93
LSD (P=.05)					3.60	6.96	16.75	16.09	0.65	2.849
Standard Deviation					2.05	3.98	9.57	9.19	0.37	1.627
CV					17.6	13.21	15.09	17.73	0.61	4.43
Treatment F					3.464	16.805	13.411	3.817	2.684	0.934
Treatment Prob(F)					0.0228	0.0001	0.0001	0.0158	0.0550	0.5112

Fargo Tolerance with Broadcast Seeding in Spring Wheat

The use of pneumatic fertilizer spreaders by local producers to broadcast seed offers a quick means of seeding a large area. In the past, farmers would put down Fargo prior to seeding then plant the crop below the Fargo zone to minimize detrimental effects on the germinating crop. This study was initiated in response to inquiries about combining the two operations in a broadcast scenario. The concern was still having an active method to control wild oats without suffering stand reductions associated with cultivar susceptibility to Fargo.

The treatments consisted of two spring wheat varieties (McNeal and Hi-Line) seeded at two rates (60 and 120 lbs/A) with or without Fargo applied as a liquid at 1 quart/A. The objective was to document cultivar susceptibility to Fargo with differing management practices.

Significant differences did exist for spring wheat plants, dry weight, test weight, and yield. However, most of the separations were due to seeding rate and variety. While this is only one year of data, it suggests broadcasting Fargo and seed simultaneously as a possible option.

Site Description

Crop: Spring Wheat	Variety: McNeal and Hi-Line	Planting Date: 4-6-1999
Planting Method: Broadcast	Rate, Unit: 60 & 120 Lbs/A	Depth, Unit: 0-3"
Soil Moisture: Good	Emergence Date: 4-20-1999	Harvest Date: 8-25-1999
Plot Width, Unit: 10 FT	Plot Length, Unit: 15 FT	Reps: 3
Site Location: R-5		Study Design: RCB

Plot Maintenance: Seed and Fargo incorporated with Vibershank and packed.

Fertility:	4- 6-99	68 Lbs. N and 32 Lbs. P
	6-16-99	45 Lbs. N
Weed Control:	5-20-99	Harmony Extra at 0.5 oz + 2,4-D at 0.25 pt
	5-24-99	Achieve at 0.44 lbs
Irrigation:	5- 5-99	0.4" with wheel line
	5- 7-99	0.6" with wheel line
	6-16-99	0.6" with wheel line

Soil Description

Texture: Silt Loam % OM: 2.8 % Sand: 40 % Silt: 50 % Clay: 10
pH: 6.4 Soil Name: Creston Silt Loam

Application Information

Application Date:	4-6-1999
Time of Day:	10:00 AM
Application Method:	BACKPACK
Application Timing:	PREPLANT
Soil Moisture:	GOOD

Application Equipment

Sprayer	Speed	Nozzle	Nozzle	Nozzle	Nozzle	Boom

Fargo Tolerance with Broadcast Seeding in Spring Wheat

Trt No	Treatment Name	Rate	Rate Unit	S WHEAT PLANTS #/FT2 7-13-99	S WHEAT HEADS #/FT2 7-13-99	S WHEAT DRY WT GRAM/FT2 7-13-99	S WHEAT YIELD BU/A 8-21-99	S WHEAT TWT LBS/BU 9-14-99
1	McNeal	60		11.0	36.4	69.6	67.5	60.8
1	Far-Go	0	qt pr/A					
2	McNeal	60		10.6	37.2	69.2	63.9	60.6
2	Far-Go	1	qt pr/A					
3	McNeal	120		18.2	38.5	65.9	56.3	60.9
3	Far-Go	0	qt pr/A					
4	McNeal	120		13.8	34.7	57.8	64.5	60.8
4	Far-Go	1	qt pr/A					
5	Hi-Line	60		7.0	27.2	49.5	55.0	59.8
5	Far-Go	0	qt pr/A					
6	Hi-Line	60		8.4	28.9	47.0	49.2	60.0
6	Far-Go	1	qt pr/A					
7	Hi-Line	120		19.5	31.6	49.2	40.4	59.3
7	Far-Go	0	qt pr/A					
8	Hi-Line	120		16.2	33.3	50.8	45.4	59.7
8	Far-Go	1	qt pr/A					
LSD (P=.05)				4.60	7.65	14.19	12.83	0.81
Standard Deviation				2.63	4.37	8.10	7.33	0.46
CV				20.06	13.04	14.12	13.26	0.77
Treatment F				9.163	2.555	4.180	5.317	5.249
Treatment Prob(F)				0.0003	0.0641	0.0110	0.0039	0.0041

Fargo Tolerance with Broadcast Seeding in Barley

The use of pneumatic fertilizer spreaders by local producers to broadcast seed offers a quick means of seeding a large area. In the past, farmers would put down Fargo prior to seeding then plant the crop below the Fargo zone to minimize detrimental effects on the germinating crop. This study was initiated in response to inquiries about combining the two operations in a broadcast scenario. The concern was still having an active method to control wild oats without suffering stand reductions associated with cultivar susceptibility to Fargo.

The treatments consisted of two barley varieties (Gallatin and Menuet) seeded at two rates (60 and 120 lbs/A) with or without Fargo applied as a liquid at 1 quart/A. The objective was to document cultivar susceptibility to Fargo with differing management practices.

No differences existed between any treatment combinations for barley plants, spikes, dry weight, test weight, or yield. While this is only one year of data, it suggests broadcasting Fargo and seed simultaneously as a possible option.

Site Description

Crop: Barley
Variety: Gallatin and Menuet
Planting Date: 4-6-1999
Planting Method: Broadcast
Rate, Unit: 60 & 120 Lbs/A
Depth, Unit: 0-3"
Soil Moisture: Good
Emergence Date: 4-20-1999
Harvest Date: 8-25-1999

Plot Width, Unit: 10 FT
Plot Length, Unit: 15 FT
Reps: 3
Site Location: R-5
Study Design: RCB
Plot Maintenance: Seed incorporated with Vibershank and packed.

Fertility:	4- 6-99	68 Lbs. N and 32 Lbs. P
	6-16-99	45 Lbs. N
Weed Control:	5-20-99	Harmony Extra at 0.5 oz + 2,4-D at 0.25 pt
	5-24-99	Achieve at 0.44 lbs
Irrigation:	5- 5-99	0.4" with wheel line
	5- 7-99	0.6" with wheel line
	6-16-99	0.6" with wheel line

Soil Description

Texture: Silt Loam
% OM: 2.8
% Sand: 40
% Silt: 50
% Clay: 10
pH: 6.4
Soil Name: Creston Silt Loam

Application Information

Application Date:	4-6-1999
Time of Day:	10:00 AM
Application Method:	BACKPACK
Application Timing:	PREPLANT
Soil Moisture:	GOOD

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Fargo Tolerance with Broadcast Seeding in Barley

Trt No	Treatment Name	Rate	Rate Unit	BARLEY PLANTS #/FT2 7-13-99	BARLEY HEADS #/FT2 7-13-99	BARLEY DRY WT GRAM/FT2 7-13-99	BARLEY YIELD BU/A 8-25-99	BARELY TEST WT LBS/BU 9-14-99
1	Gallatin 60			7.7	44.2	73.8	69.1	51.6
1	Far-Go	0	qt pr/A					
2	Gallatin 60			9.0	49.5	77.9	69.3	51.7
2	Far-Go	1	qt pr/A					
3	Gallatin 120			15.0	48.1	65.1	65.0	51.5
3	Far-Go	0	qt pr/A					
4	Gallatin 120			13.5	43.1	56.3	63.6	51.4
4	Far-Go	1	qt pr/A					
5	Menuet 60			8.5	49.0	64.4	62.1	51.7
5	Far-Go	0	qt pr/A					
6	Menuet 60			11.2	50.2	63.9	64.9	51.6
6	Far-Go	1	qt pr/A					
7	Menuet 120			16.0	49.8	57.6	53.8	51.3
7	Far-Go	0	qt pr/A					
8	Menuet 120			13.6	48.3	60.4	56.4	51.1
8	Far-Go	1	qt pr/A					
LSD (P=.05)				6.12	22.14	22.89	11.70	0.55
Standard Deviation				3.50	12.64	13.07	6.68	0.31
CV				29.64	26.47	20.13	10.6	0.61
Treatment F				2.431	0.133	0.992	2.058	1.111
Treatment Prob(F)				0.0745	0.9939	0.4751	0.1186	0.4084

PROJECT TITLE: Broadleaf Herbicide Screen

PROJECT LEADER: Bob Stougaard, Weed Scientist, NWARC

PROJECT PERSONNEL: Doug Holen, Research Associate, NWARC

OBJECTIVES:

To evaluate crop tolerance and efficacy of standard broadleaf herbicides available for use in small grains when applied at the high and lower end of their respective labeled rates.

RESULTS:

WestBred 926 was broadcast seeded at 90 lb/A on 4-13-99. Herbicides were applied on 5-19-99 when most weeds were in the 1 to 3 leaf stage and the spring wheat was in the fourth leaf stage of growth.

The poorest control was obtained from banvel and starane treatments, principly due to the lack of volunteer canola control. The lower rate of aim also failed to provide acceptable weed control unless it was tank-mixed with 2,4-D. The sulfonylureas provided the best control of catchfly, as did the highest rate of banvel. Most treatments afforded acceptable control of wild buckwheat, the exceptions being MCPA and the lower rate of express.

Crop injury was initially visible in those plots treated with aim. However, most symptoms had disappeared by the time of the first scheduled rating. Crop injury was also notable with the high rate of bronate, express, and harmony extra. The handweeded plots were also treated with harmony extra, and similar crop injury symptoms were present here as well. Those treatments which yielded less than the handweeded check includes starane at both rates, the low rate of banvel, and three out of the four aim treatments.

SUMMARY:

All herbicides evaluated have strengths in term of being able to control specific weed species. However, the diverse species composition present in most small grain fields requires that broadleaf herbicides be tank-mixed in order to control the entire weed complex. This requires that farmers know which weed are present and the efficacy of available herbicides.

FUTURE PLANS:

This study will be continued in order to assess the strengths and weaknesses of small grain broadleaf herbicides.

Percent Control: 7-28-99

	Canola		Catchfly		W. Buckwheat	
Herbicide	1X	1/2X	1X	1/2X	1X	1/2X
Aim	92	85	74	89	93	95
Aim + 2,4-D	100	97	78	66	88	68
Bronate	100	98	64	82	94	90
Buctril	99	99	50	65	93	89
Banvel	80	56	92	100	100	99
Express	100	99	100	100	85	69
Harmony Ex	100	100	100	100	90	97
MCPA	100	100	95	95	43	17
2,4-D ester	100	100	92	86	90	88
Starane	70	63	95	92	98	96
Nontreated	0		0		0	
Handweeded	100		100		100	
LSD	11		34		20	

Percent Control: 7-28-99

	Canola		Catchfly		W. Buckwheat	
Herbicide	1X	1/2X	1X	1/2X	1X	1/2X
Aim	92	85	74	89	93	95
Aim + 2,4-D	100	97	78	66	88	68
Bronate	100	98	64	82	94	90
Buctril	99	99	50	65	93	89
Banvel	80	56	92	100	100	99
Express	100	99	100	100	85	69
Harmony Ex	100	100	100	100	90	97
MCPA	100	100	95	95	43	17
2,4-D ester	100	100	92	86	90	88
Starane	70	63	95	92	98	96
Nontreated	0		0		0	
Handweeded	100		100		100	
LSD	11		34		20	

PROJECT TITLE: Wild Oat Herbicide Screening Trial

PROJECT LEADER: Bob Stougaard, Weed Scientist, NWARC

PROJECT PERSONNEL: Doug Holen, Research Associate, NWARC

OBJECTIVES:

To evaluate crop tolerance, efficacy, and economic return of registered and experimental wild oat herbicides.

RESULTS:

Achieve, assert, avenge, discover, hoelon, MKH6562, and puma were applied at their respective 1X and 1/2X labeled use rates when wild oats were at the 3 leaf stage of development.

Of the currently registered products, achieve provided the most complete wild oat control, followed by assert, hoelon, puma, and avenge, respectively. Wild oat control was reduced when these products were applied at their 1/2X rate, especially so for hoelon, puma, and avenge. The reduction in control was reflected in spring wheat yield.

The experimental products, discover and MKH6562 provided excellent wild oat control regardless of the rate applied. As such, these products would be expected to provide more consistent wild oat control over a range of environments. For both experimental products, yields were higher for the 1/2X rate when compared to the 1X rate. In the case of MKH6562, this response was probably due to crop injury. However, crop injury was not observed with discover.

An economic analysis was conduct for all products. The cost per acre of discover and MKH6562 were estimated, as these products are not currently on the market. Dockage penalties were incurred for avenge, hoelon and puma at both rates, and for assert at the 1/2X rate. The most dramatic response was with the nontreated check, where dockage reduced per acre returns by 55 dollars. Adjusted gross returns were greatest for achieve when comparing among registered products.

SUMMARY:

All products provided commercially acceptable wild oat control when applied at the 1X rate with the exception of avenge. Reducing rates by half resulted in poorer control with most products. However achieve, assert, discover and MKH6562 continued to provided 90 percent control or better at the lower rates tested.

FUTURE PLANS:

This study will be repeated in order to determine the consistency of control and crop tolerance associated with wild oat herbicides.

	Wild oat plants #/10.76 ft		Wild oat dry Wt G/10.76 ft		Percent control (%)	
	1X	1/2X	1X	1/2X	1X	1/2X
Achieve	8	44	4	20	99	90
Assert	47	141	7	40	99	91
Avenge	116	109	128	189	50	10
Discover	27	50	7	13	98	96
Hoelon	37	75	13	72	90	72
MKH6562	112	62	15	11	99	99
Puma	25	82	9	55	91	66
Check	138		322		0	
LSD	50		56		15	

	Yield Bu/A		Dockage (%)		Dockage Discount ($)	
	1X	1/2X	1X	1/2X	1X	1/2X
Achieve	135	129	0.08	0.26	0	0
Assert	131	120	0.01	0.80	0	0.03
Avenge	86	60	4.80	7.23	0.33	0.58
Discover	134	143	0.03	0.10	0	0
Hoelon	131	115	0.71	1.08	0.03	0.03
MKH6562	132	139	0.03	0.11	0	0
Puma	133	114	0.51	1.81	0.03	0.09
Check	59		10.7		0.93	
LSD	21		2.19			

	Gross Return		Discount		Adjusted Gross	
	1X	1/2X	1X	1/2X	1X	1/2X
Achieve	302.62	288.28	302.62	288.28	281.87	275.91
Assert	293.21	268.35	293.21	264.75	264.72	248.07
Avenge	193.76	133.50	165.21	98.93	142.81	85.31
Discover	299.93	320.32	299.93	320.32	278.69	307.27
Hoelon	293.66	258.04	289.73	254.59	265.93	240.69
MKH6562	295.68	311.80	295.68	311.80	274.44	298.75
Puma	298.59	254.91	294.59	244.67	274.54	232.65
Check	133.05		77.81		77.81	

Gross: yield * grain price
Discount: (yield * (grain price - discount)
Adj Gross: (Yield * (grain price - discount)) - herbicide, application and surfactant cost.

Grain price: $2.24 - #2 HRSW, 12% protein, Nov. 23.

Application cost: $4.00/acre

Surfactant cost: $0.87/acre

Herbicide cost/acre (1X rate):

Achieve = 16.75
Assert = 23.62
Avenge = 17.53
Discover = 16.37 estimate
Hoelon = 19.80
MKH6562 = 16.37 estimate
Puma = 16.05

Imazamox Plant-back Study

This study was initially established to evaluate the efficacy of fall and spring applications of imazamox for downy brome control in herbicide resistant winter wheat. Fall treatments were applied on October 22, 1998 when the crop was at the 2 to 3 leaf stage. The entire study winter killed, precluding the completion of the initial objectives. As such, the entire area was seeded to McNeal spring wheat on April 6, 1999 to determine if residual herbicide concentrations might negatively impact "patching-in" spring wheat. The scheduled spring treatments were not applied, and instead, serve as nontreated control plots.

Fall applications of imazamox had no effect on spring wheat yield, regardless of the rate applied. This indicates that producers could safely rotate to spring wheat if faced with a similar situation. This study represents only a single soil type, and results might vary depending on pH and organic matter considerations.

Imazamox Plant-back Study

Site Description

Crop: Spring Wheat Variety: McNeal Planting Date: 4-6-1999
Planting Method: Double Disk Drill Rate, Unit: 73 Lbs/A
Depth, Unit: 1.5" Row Spacing, Unit: 7"
Soil Moisture: Good Emergence Date: 4-22-1999 Harvest Date: 8-20-1999

Plot Width, Unit: 10 FT Plot Length, Unit: 15 FT
Reps: 3 Site Location: R-5 Study Design: RCB
Plot Maintenance:

Fertility:	9-21-98	32 Lbs. N, 40 Lbs. P, and 15 Lbs. K
	4- 6-99	58 Lbs. N and 28 Lbs. P
Weed Control:	5-20-99	Harmony Extra at 0.5 oz + 2,4-D at 0.25 pt
Irrigation:	5- 5-99	0.4" applied with wheel line
	5- 7-99	0.6" applied with wheel line

Soil Description

Texture: Coarse Silty Mixed % OM: 2.8 % Sand: 40 % Silt: 50 % Clay: 10
pH: 6.4 Soil Name: Creston Silt Loam

Application Information

Application Date: 10-22-1998
Time of Day: 11:00 AM
Application Method: BACKPACK
Application Timing: POST
Air Temp., Unit: 45 F
% Relative Humidity: 68
Wind Velocity, Unit: 0 MPH
Dew Presence (Y/N): N
Soil Temp., Unit: 40 F
Soil Moisture: GOOD
% Cloud Cover: 0

Plant Species	Plant Stage
Winter wheat	2-3 Leaf

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Imazamox Plant-back Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	S WHEAT YIELD BU/A 8-20-99
1	UNTREATED			FALL	66.2
2	RAPTOR	.008	lb ai/A	FALL	64.9
2	NIS	.25	% v/v		
2	UAN 28%	1	qt pr/A		
3	RAPTOR	.016	lb ai/A	FALL	64.4
3	NIS	.25	% v/v		
3	UAN 28%	1	qt pr/A		
4	RAPTOR	.024	lb ai/A	FALL	66.7
4	NIS	.25	% v/v		
4	UAN 28%	1	qt pr/A		
5	RAPTOR	.032	lb ai/A	FALL	63.5
5	NIS	.25	% v/v		
5	UAN 28%	1	qt pr/A		
6	RAPTOR	.040	lb ai/A	FALL	63.2
6	NIS	.25	% v/v		
6	UAN 28%	1	qt pr/A		
7	RAPTOR	.048	lb ai/A	FALL	63.3
7	NIS	.25	% v/v		
7	UAN 28%	1	qt pr/A		
8	HANDWEEDED				66.2
9	UNTREATED			SPRING	65.3
10	RAPTOR	.008	lb ai/A	SPRING	66.8
10	NIS	.25	% v/v		
10	UAN 28%	1	qt pr/A		
11	RAPTOR	.016	lb ai/A	SPRING	72.1
11	NIS	.25	% v/v		
11	UAN 28%	1	qt pr/A		
12	RAPTOR	.024	lb ai/A	SPRING	66.4
12	NIS	.25	% v/v		
12	UAN 28%	1	qt pr/A		
13	RAPTOR	.032	lb ai/A	SPRING	62.3
13	NIS	.25	% v/v		
13	UAN 28%	1	qt pr/A		

CONTINUED...

Imazamox Plant-back Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	S WHEAT YIELD BU/A. 8-20-99
14	RAPTOR	.040	lb ai/A	SPRING	64.9
14	NIS	.25	% v/v		
14	UAN 28%	1	qt pr/A		
15	RAPTOR	.048	lb ai/A	SPRING	62.2
15	NIS	.25	% v/v		
15	UAN 28%	1	qt pr/A		
16	HANDWEEDED				66.2
17	RAPTOR	.024	lb ai/A	FALL	72.9
17	NIS	.25	% v/v		
17	UAN 28%	1	qt pr/A		
17	RAPTOR	.024	lb ai/A	SPRING	
17	NIS	.25	% v/v		
17	UAN 28%	1	qt pr/A		

LSD (P=.05)	8.57
Standard Deviation	5.14
CV	7.82
Treatment F	0.995
Treatment Prob(F)	0.4869

Roundup-Ready Canola Performance Study

A Roundup-Ready canola variety from Monsanto was used to determine the best herbicide application timing for minimizing weed competition. Examinations were also made to confirm the roundup resistance in canola from one week post emergence through the bud stage.

Data indicates the most effective application timings to be two and three weeks post emergence in terms of weed control. While canola dry weight and yield displayed no treatment differences, it is our perception that one week post emergence found little weed pressure and possible damage to canola. Applications after four weeks post emergence saw the canola canopy intercept most of the herbicide.

Site Description

Crop: Canola
Planting Method: Disk Drill
Depth, Unit: 1"
Soil Moisture: Good

Variety: Roundup-Ready

Emergence Date: 5-11-99

Planting Date: 4-27-99
Rate, Unit: 7 Lbs./A
Row Spacing, Unit: 6"
Harvest Date: 9-2-99

Plot Width, Unit: 10 FT
Site Location: R-9
Plot Maintenance:

Plot Length, Unit: 15 FT

Reps: 3
Study Design: RCB

Fertility:	4-13-99	92 Lbs. N and 42 Lbs. P
Weed Control:	5- 3-99	Assure II at 10 oz.

Soil Description

Texture: Silt Loam % OM: 4.2 % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.7 Soil Name: Creston Silt Loam

Application Information

Application Date:	5-19-1999	5-25-1999	6-1-1999	6-10-1999	6-17-1999
Time of Day:	1:30 PM	10:45 AM	11:30 AM	2:30 PM	2:00 PM
Application Method:	BACKPACK	BACKPACK	BACKPACK	BACKPACK	BACKPACK
Application Timing:	POST-EMER	2 WAE	3 WAE	4 WAE	5 WAE
Air Temp., Unit:	79 F	83 F	65 F	73 F	76 F
% Relative Humidity:	28	27	52	24	51
Wind Velocity, Unit:	2 MPH	4 MPH	2 MPH	2 MPH	6 MPH
Dew Presence (Y/N):	N	N	N	N	Y
Soil Temp., Unit:	70 F	74 F	64 F	75 F	83 F
Soil Moisture:	EXCELLENT	GOOD	EXCELLENT	GOOD	FAIR
% Cloud Cover:	40	10	90	80	40

Plant Species	Plant Stage				
Wild Buckwheat	1 Leaf	2 Leaf	2-3 Leaf	2-5 Inch	Climbing
Lambsquarters	2 Leaf	2 Leaf	4 Leaf	4 Inch	Pre-bud
Pennycress	2 Inch	3 Inch	Pre-bloom	Flower	Flower
Henbit	1 Leaf	2 Leaf	2 Inch	4 Inch	Pre-bloom
Chickweed	Emerge	4 Leaf	2 Inch	4 Inch	Pre-bloom
Spring Wheat	1 Leaf	2 Leaf	4 Leaf	Jointing	Pre-boot
Canola	Cotyledon	3 Inch	5 Inch	6-7 Inch	Bud

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Roundup-Ready Canola Performance Study

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	CANOLA DRY WT GRAM/FT2 7-2-99	WEEDS DRY WT GRAM/FT2 7-2-99	CANOLA YIELD LBS/A 9-2-99
1	Roundup	1	pt pr/A	1 WAE	58.3	0.1	1884
1	Ammon Sulf	3.4	lb pr/A				
2	Roundup	1	pt pr/A	2 WAE	64.6	0.0	1775
2	Ammon Sulf	3.4	lb pr/A				
3	Roundup	1	pt pr/A	3 WAE	64.6	0.2	2014
3	Ammon Sulf	3.4	lb pr/A				
4	Roundup	1	pt pr/A	4 WAE	49.9	2.7	2005
4	Ammon Sulf	3.4	lb pr/A				
5	Roundup	1	pt pr/A	5 WAE	49.1	5.0	1780
5	Ammon Sulf	3.4	lb pr/A				
6	Nontreated				34.2	16.5	1687
LSD (P=.05)					28.92	6.58	353.9
Standard Deviation					15.90	3.62	194.5
CV					29.74	89.0	10.47
Treatment F					1.599	9.348	1.408
Treatment Prob(F)					0.2464	0.0016	0.3012

Alfalfa Herbicide Screen

This study investigates weed control and seedling alfalfa crop tolerance to applications of Raptor, Pursuit, and Buctril formulations.

The old formulation of Buctril was compared to the newer version, TADS13169. These treatments were applied at the 2nd and 5th trifoliate stage of growth. These plots were sprayed with Poast in order to control the green foxtail populations present.

Crop injury with the 2nd trifoliate application was initially greater with the new formulation compared to the old formulation when applied at the 0.5 lb ai/A rate. Crop injury with the new formulation was a function of rate and was especially evident at the last crop injury rating.

Both formulations provided excellent control of common lambsquarters, chickweed, and wild buckwheat. However, control of prostrate pigweed was less complete. Prostrate pigweed control was a function of application timing, with the most complete control being obtained with the earliest application.

Pursuit and Raptor were applied only at the 5th trifoliate stage of growth. Overall, crop injury tended to be less with either Pursuit or Raptor. Pursuit and Raptor provided excellent control of common lambsquarters, wild buckwheat, prostrate pigweed, and green foxtail. Differences were noted for common chickweed control, with Pursuit providing greater control relative to Raptor. The addition of either Buctril or Select to Raptor improved chickweed control relative to Raptor alone. As Select is not known for having broadleaf weed activity, the enhanced control observed may be attributed to a "surfactant" effect.

Alfalfa Herbicide Screen

Site Description

Crop: Alfalfa Variety: Pioneer 54Q53 Planting Date: 4-26-1999
Planting Method: Disk Drill Rate, Unit: 12.1 Lbs/A
Depth, Unit: 0.5" Row Spacing, Unit: 7"
Soil Moisture: Good Emergence Date: 5-7-1999

Plot Width, Unit: 10 FT Plot Length, Unit: 15 FT Reps: 3
Site Location: R-3 Study Design: RCB
Plot Maintenance:

Fertility:	3-30-99	26 Lbs. N and 122 Lbs. P
Weed Control:	6-25-99	Poast + Dash on Buctril and TAD treatments
Irrigation:		Throughout season with wheel line

Soil Description

Texture: Silt Loam % OM: 3.0 % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.4 Soil Name: Creston Silt Loam

Application Information

Application Date:	6-1-1999	6-10-1999
Time of Day:	12:00 PM	9:30 AM
Application Method:	Backpack	Backpack
Application Timing:	2-Tri	5-Tri
Air Temp., Unit:	64 F	62 F
% Relative Humidity:	46	47
Wind Velocity, Unit:	2 MPH	3 MPH
Dew Presence (Y/N):	N	N
Soil Temp., Unit:	65 F	58 F
Soil Moisture:	Excellent	Good
% Cloud Cover:	90	5

Plant Species	Plant Stage	
Prostrate Pigweed	2-3" Rosette	2-4" Rosette
Green Foxtail	2 Inch	4 Inch
Wild Buckwheat	2-3 Leaf	6 Leaf
Chickweed	1 Inch	2 Inch
Lambsquarters	3 Inch	5 Inch
Alfalfa	2-3 Tri	5-6 Tri

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Alfalfa Herbicide Screen

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	ALFALFA CROP INJ PERCENT 6-6-99	ALFALFA CROP INJ PERCENT 6-15-99	ALFALFA CROP INJ PERCENT 6-24-99
1	Nontreated				0.0	0.0	0.0
2	Pursuit	2.16	oz pr/A	4-Tri	3.3	5.0	6.7
2	NIS	.25	% v/v				
2	UAN 32%	1	% v/v				
3	Raptor	5	oz pr/A	4-Tri	3.3	3.3	3.3
3	NIS	.25	% v/v				
3	UAN 32%	1	% v/v				
4	Raptor	5	oz pr/A	4-Tri	0.0	16.7	18.3
4	MSO	1.5	pt pr/A				
4	UAN 32%	1	% v/v				
5	Pursuit	2.16	oz pr/A	4-Tri	0.0	13.3	8.3
5	Buctril	1	pt pr/A				
5	NIS	.25	% v/v				
6	Raptor	5	oz pr/A	4-Tri	0.0	6.7	3.3
6	Buctril	1	pt pr/A				
6	NIS	.25	% v/v				
7	Pursuit	2.16	oz pr/A	4-Tri	0.0	16.7	15.0
7	Select	.125	lb ai/A				
7	NIS	.25	% v/v				
7	UAN 32%	1	% v/v				
8	Raptor	5	oz pr/A	4-Tri	0.0	10.0	0.0
8	Select	.125	lb ai/A				
8	NIS	.25	% v/v				
8	UAN 32%	1	% v/v				
9	Buctril	.25	lb ai/A	2-Tri	20.0	11.7	0.0
10	Buctril	.25	lb ai/A	4-Tri	0.0	11.7	3.3
11	Buctril	.5	lb ai/A	2-Tri	23.3	6.7	3.3
12	Buctril	.5	lb ai/A	4-Tri	0.0	13.3	10.0
13	TADS13169	.25	lb ai/A	2-Tri	26.7	13.3	6.7
13	COC	1	% v/v				

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Alfalfa Herbicide Screen

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	ALFALFA CROP INJ PERCENT 6-6-99	ALFALFA CROP INJ PERCENT 6-15-99	ALFALFA CROP INJ PERCENT 6-24-99
14	TADS13169	.5	lb ai/A	2-Tri	35.0	25.0	20.0
14	COC	1	% v/v				
15	TADS13169	.25	lb ai/A	4-Tri	0.0	15.0	10.0
15	COC	1	% v/v				
16	TADS13169	.5	lb ai/A	4-Tri	0.0	25.0	28.3
16	COC	1	% v/v				
LSD (P=.05)					11.24	13.15	15.70
Standard Deviation					6.74	7.89	9.42
CV					96.56	65.26	110.27
Treatment F					9.351	2.332	2.253
Treatment Prob(F)					0.0001	0.0236	0.0284

Alfalfa Herbicide Screen

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	COLQ CONTROL PERCENT 6-24-99	CHICKWD CONTROL PERCENT 6-24-99	W.BKWHT CONTROL PERCENT 6-24-99	PR.PIG CONTROL PERCENT 6-24-99	GRFT CONTROL PERCENT 6-24-99
1	Nontreated				0.0	0.0	0.0	0.0	0.0
2	Pursuit	2.16	oz pr/A	4-Tri	95.7	96.7	85.0	94.3	92.0
2	NIS	.25	% v/v						
2	UAN 32%	1	% v/v						
3	Raptor	5	oz pr/A	4-Tri	95.0	63.3	68.3	96.7	92.7
3	NIS	.25	% v/v						
3	UAN 32%	1	% v/v						
4	Raptor	5	oz pr/A	4-Tri	92.3	93.3	82.3	99.0	96.7
4	MSO	1.5	pt pr/A						
4	UAN 32%	1	% v/v						
5	Pursuit	2.16	oz pr/A	4-Tri	96.0	100.0	100.0	84.3	87.7
5	Buctril	1	pt pr/A						
5	NIS	.25	% v/v						
6	Raptor	5	oz pr/A	4-Tri	99.0	100.0	99.3	87.3	91.0
6	Buctril	1	pt pr/A						
6	NIS	.25	% v/v						
7	Pursuit	2.16	oz pr/A	4-Tri	95.0	100.0	89.7	97.3	96.0
7	Select	.125	lb ai/A						
7	NIS	.25	% v/v						
7	UAN 32%	1	% v/v						
8	Raptor	5	oz pr/A	4-Tri	92.7	100.0	83.3	99.3	98.3
8	Select	.125	lb ai/A						
8	NIS	.25	% v/v						
8	UAN 32%	1	% v/v						
9	Buctril	.25	lb ai/A	2-Tri	100.0	100.0	100.0	85.0	0.0
10	Buctril	.25	lb ai/A	4-Tri	76.7	98.3	100.0	31.7	0.0
11	Buctril	.5	lb ai/A	2-Tri	100.0	99.0	100.0	89.3	0.0
12	Buctril	.5	lb ai/A	4-Tri	100.0	100.0	100.0	31.7	0.0
13	TADS13169	.25	lb ai/A	2-Tri	100.0	96.7	100.0	100.0	0.0
13	COC	1	% v/v						

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Alfalfa Herbicide Screen

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	COLQ CONTROL PERCENT 6-24-99	CHICKWD CONTROL PERCENT 6-24-99	W.BKWHT CONTROL PERCENT 6-24-99	PR.PIG CONTROL PERCENT 6-24-99	GRFT CONTROL PERCENT 6-24-99
14	TADS13169	.5	lb ai/A	2-Tri	100.0	99.0	100.0	96.7	0.0
14	COC	1	% v/v						
15	TADS13169	.25	lb ai/A	4-Tri	100.0	100.0	100.0	43.3	0.0
15	COC	1	% v/v						
16	TADS13169	.5	lb ai/A	4-Tri	100.0	100.0	100.0	65.0	0.0
16	COC	1	% v/v						
LSD (P=.05)					11.26	23.45	14.40	34.52	6.84
Standard Deviation					6.75	14.07	8.63	20.70	4.10
CV					7.49	15.56	9.81	27.58	10.03
Treatment F					40.329	10.046	25.811	6.827	410.265
Treatment Prob(F)					0.0001	0.0001	0.0001	0.0001	0.0001

Alfalfa Herbicide Screen

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	COLQ CONTROL PERCENT 7-7-99	W.BKWHT CONTROL PERCENT 7-7-99	P.PIG CONTROL PERCENT 7-7-99	CHICKWD CONTROL PERCENT 7-7-99	GRFT CONTROL PERCENT 7-7-99
1	Nontreated				0.0	0.0	0.0	0.0	0.0
2	Pursuit	2.16	oz pr/A	4-Tri	99.3	96.0	97.7	95.0	95.0
2	NIS	.25	% v/v						
2	UAN 32%	1	% v/v						
3	Raptor	5	oz pr/A	4-Tri	99.3	83.3	97.3	63.3	96.0
3	NIS	.25	% v/v						
3	UAN 32%	1	% v/v						
4	Raptor	5	oz pr/A	4-Tri	96.7	96.7	98.3	61.7	96.0
4	MSO	1.5	pt pr/A						
4	UAN 32%	1	% v/v						
5	Pursuit	2.16	oz pr/A	4-Tri	97.7	100.0	97.3	99.3	94.0
5	Buctril	1	pt pr/A						
5	NIS	.25	% v/v						
6	Raptor	5	oz pr/A	4-Tri	100.0	100.0	96.7	99.3	95.0
6	Buctril	1	pt pr/A						
6	NIS	.25	% v/v						
7	Pursuit	2.16	oz pr/A	4-Tri	98.7	97.0	99.3	100.0	99.3
7	Select	.125	lb ai/A						
7	NIS	.25	% v/v						
7	UAN 32%	1	% v/v						
8	Raptor	5	oz pr/A	4-Tri	98.3	94.7	99.0	100.0	100.0
8	Select	.125	lb ai/A						
8	NIS	.25	% v/v						
8	UAN 32%	1	% v/v						
9	Buctril	.25	lb ai/A	2-Tri	100.0	100.0	95.0	100.0	0.0
10	Buctril	.25	lb ai/A	4-Tri	70.0	100.0	63.3	93.3	0.0
11	Buctril	.5	lb ai/A	2-Tri	100.0	100.0	86.7	93.3	0.0
12	Buctril	.5	lb ai/A	4-Tri	100.0	100.0	41.7	93.3	0.0
13	TADS13169	.25	lb ai/A	2-Tri	100.0	100.0	96.7	81.7	0.0
13	COC	1	% v/v						

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Alfalfa Herbicide Screen

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	COLQ CONTROL PERCENT 7-7-99	W.BKWHT CONTROL PERCENT 7-7-99	P.PIG CONTROL PERCENT 7-7-99	CHICKWD CONTROL PERCENT 7-7-99	GRFT CONTROL PERCENT 7-7-99
14	TADS13169	.5	lb ai/A	2-Tri	100.0	100.0	100.0	96.7	0.0
14	COC	1	% v/v						
15	TADS13169	.25	lb ai/A	4-Tri	95.0	97.3	23.3	96.7	0.0
15	COC	1	% v/v						
16	TADS13169	.5	lb ai/A	4-Tri	96.7	100.0	33.3	100.0	0.0
16	COC	1	% v/v						
LSD (P=.05)					18.92	5.89	26.95	33.73	3.98
Standard Deviation					11.35	3.53	16.16	20.23	2.38
CV					12.51	3.86	21.1	23.56	5.65
Treatment F					14.878	147.744	12.676	4.950	1289.861
Treatment Prob(F)					0.0001	0.0001	0.0001	0.0001	0.0001

Dormant Prowl Applications in Mint

This study investigates whether Prowl can be applied within the labeled preharvest interval while simultaneously providing acceptable levels of weed control and crop tolerance.

Prowl was applied over a range of rates as either fall(11-20-98)or spring(3-18-99)dormant applications to an established stand of peppermint. Sinbar also was applied at the same timings to serve as a standard check treatment. Crop injury was not observed with any of the treatments. Weed pressure was light and consisted primarily of common lambsquarters. Sinbar provided the greatest level of control regardless of application timing. Prowl applied in the spring generally provided better control relative to the fall applications. This response was especially evident with the weed fresh weight measurements. The level of weed control varied by use rate when applied in the fall, with the highest rate providing the best control. There were no differences in weed fresh weights when Prowl was applied in the spring.

Results indicate that Prowl can be applied within the preharvest interval and provide acceptable levels of weed control depending on the rate used and application timing.

Dormant Prowl Applications in Mint

Site Description

Crop: Peppermint
Variety: Black Mitchum
Planting Date: 4-24-1997
Emergence: 5-15-1997
Planting Method: Hand placement in furrows
Depth, Unit: 4"
Row Spacing, Unit: 22"
Soil Moisture: Good

Plot Width, Unit: 10 FT
Plot Length, Unit: 15 FT
Reps: 3
Site Location: R-3
Study Design: RCB
Harvest Date: 7-28-1999
Plot Maintenance:

Fertility:	4-2-99	100 Lbs. N, 52 Lbs. P, 60 Lbs. K and 24 Lbs. S
	7-6-99	52 Lbs. N
Weed Control:	5-3-99	Assure II at 10 oz.
Irrigation:		Throughout season as needed

Soil Description

Texture: Silt Loam
% OM: 3.0
% Sand: 40
% Silt: 50
% Clay: 10
pH: 7.4
Soil Name: Creston Silt Loam

Application Information

Application Date:	11-20-98	3-18-99
Time of Day:	3:00 PM	11:00 AM
Application Method:	BACKPACK	BACKPACK
Application Timing:	DORMANT	DORMANT
Air Temp., Unit:	44 F	48 F
% Relative Humidity:	54	20
Wind Velocity, Unit:	9 MPH	5 MPH
Dew Presence (Y/N):	N	N
Soil Temp., Unit:	41 F	41 F
Soil Moisture:	GOOD	GOOD
% Cloud Cover:	100	20

***No weeds present at either application date.

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Dormant Prowl Applications in Mint

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	COLQ CONTROL PERCENT 7-28-99	BRDLFS FW YLD TON/A 7-28-99	MINT DRY YLD TON/A 7-28-99
1	Prowl	.825	lb ai/A	Fall	49.7	0.49	2.4
2	Prowl	1.5	lb ai/A	Fall	68.3	0.19	2.5
3	Prowl	2	lb ai/A	Fall	95.0	0.08	2.4
4	Sinbar	1.25	lb pr/A	Fall	100.0	0.03	2.3
5	Prowl	.825	lb ai/A	Spring	65.3	0.08	2.4
6	Prowl	1.5	lb ai/A	Spring	92.0	0.07	2.3
7	Prowl	2	lb ai/A	Spring	88.3	0.08	2.5
8	Sinbar	1.25	lb pr/A	Spring	99.7	0.00	2.4
9	Untreated				0.0	0.61	2.4
	LSD (P=.05)				43.31	0.298	0.41
	Standard Deviation				25.02	0.172	0.24
	CV				34.21	95.11	9.88
	Treatment F				5.076	4.730	0.293
	Treatment Prob(F)				0.0028	0.0040	0.9583

Starane Tolerance in Spearmint

Stinger is widely used for weed control in both peppermint and spearmint production. Starane is chemically related to Stinger and may demonstrate tolerance toward mint. This study was initiated to determine if Starane could be safely used in spearmint. Spearmint was chosen for these initial screenings as it is typically more sensitive to herbicide injury relative to peppermint.

Starane was applied over a range of rates to three different growth stages of spearmint. Applications were made on 5/21, 6/2, and 6/10 when spearmint was 2, 4, and 6 inches tall, respectively. The first cutting was harvested on 7/7/99.

Crop injury was a function of use rate and was noticeable at all application timings. However, the crop generally recovered, with the improvement period being related to application timing. The crop recovered most quickly with the earliest application and was slowed as applications were delayed. Mint hay and oil yield reductions increased as application timing was delayed and as rates increased. However, oil yield reductions were not observed when Starane was applied at the earliest growth stage regardless of the rate used.

There were no treatment differences with respect to crop regrowth following the first cutting.

Spearmint appears to have tolerance toward Starane when applied early. Crop tolerance with later applications is a function of the rate applied. It is highly probable that peppermint would demonstrate even greater crop tolerance.

Starane Tolerance in Spearmint

Site Description

Crop: Spearmint
Variety: Native
Planting Date: 10-15-97
Planting Method: Mint Planter
Depth, Unit: 4"
Row Spacing, Unit: 20"
Soil Moisture: Good
Harvest Date: 7-9-99

Plot Width, Unit: 10 FT
Plot Length, Unit: 15 FT
Reps: 3
Site Loacation: R-4
Study Design: RCB
Plot Maintenance:

Fertility:	3-15-99	100 Lbs. N, 52 Lbs. P, and 24 Lbs. S
Weed Control:	3-22-99	Goal at 4 pt. + Stinger at 0.6 pt.
	5-19-99	Assure II at 10 oz.
Irrigation:		Throughout growing season with wheel line

Soil Description

Texture: Silt Loam % OM: 3.5 % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.5 Soil Name: Creston Silt Loam

Application Information

Application Date:	5-21-1999	6-2-1999	6-10-1999
Time of Day:	10:30 AM	9:45 AM	11:00 AM
Application Method:	BACKPACK	BACKPACK	BACKPACK
Application Timing:	POST	POST	POST
Air Temp., Unit:	63 F	67 F	61 F
% Relative Humidity:	54	49	45
Wind Velocity, Unit:	4 MPH	3.5 MPH	2 MPH
Dew Presence (Y/N):	N	Y	N
Soil Temp., Unit:	59 F	64 F	60 F
Soil Moisture:	GOOD	EXCELLENT	GOOD
% Cloud Cover:	40	95	10

Plant Species	Plant Stage
Mint (5-21-99)	2-4 Inch
Mint (6- 2-99)	4-6 Inch
Mint (6-10-99)	7-8 Inch

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Starane Tolerance in Spearmint

Trt No	Treatment Name	Rate	Rate Unit	Grow Stg	MINT CROP INJ PERCENT 6-10-99	MINT STUNT PERCENT 6-10-99	MINT CROP INJ PERCENT 6-21-99	MINT CROP INJ PERCENT 7-7-99	MINT OIL YLD LBS/A 7-9-99	MINT HAY YLD DRY T/A 7-9-99
1	Nontreated				0.0	0.0	0.0	0.0	34.1	3.6
2	Starane	0.06	lb ai/A	2"	0.0	0.0	0.0	0.0	34.1	3.7
3	Starane	0.125	lb ai/A	2"	0.0	16.7	0.0	0.0	38.2	3.7
4	Starane	0.250	lb ai/A	2"	0.0	30.0	0.0	0.0	34.0	3.0
5	Starane	0.375	lb ai/A	2"	3.3	26.7	0.0	0.0	32.1	2.9
6	Starane	0.06	lb ai/A	4"	23.3	6.7	3.3	5.0	29.5	3.3
7	Starane	0.125	lb ai/A	4"	31.7	8.3	8.3	5.0	29.8	2.8
8	Starane	0.250	lb ai/A	4"	40.0	6.7	5.0	0.0	30.6	3.2
9	Starane	0.375	lb ai/A	4"	38.3	6.7	5.0	5.0	26.3	3.5
10	Starane	0.06	lb ai/A	6"	0.0	0.0	0.0	0.0	30.1	3.5
11	Starane	0.125	lb ai/A	6"	0.0	0.0	11.7	6.7	30.8	3.7
12	Starane	0.250	lb ai/A	6"	0.0	0.0	18.3	13.3	25.5	3.2
13	Starane	0.375	lb ai/A	6"	0.0	0.0	31.7	28.3	22.1	2.5
LSD (P=.05)					10.23	6.60	8.05	6.10	7.60	0.41
Standard Deviation					6.07	3.92	4.78	3.62	4.51	0.24
CV					57.75	50.07	74.51	74.26	14.76	7.48
Treatment F					21.643	21.143	11.742	15.118	2.647	7.782
Treatment Prob(F)					0.0001	0.0001	0.0001	0.0001	0.0204	0.0001

Buctril and TAD13169 Tolerance in Spearmint

This study investigates spearmint tolerance to different rates and formulations of Buctril. The site was maintained weed-free by applying a dormant application of Goal plus Stinger on March 22, and Assure II on May 19, 1999. The site was fertilized and irrigated to maximize mint yields.

The old formulation was compared to a newer version, TAD13169. These formulations were applied on June 2, 1999 when the crop had 4 to 6 inches of growth. Initially, there was little difference in crop injury between the two formulations, with injury being a function of the rate used.

Interestingly, the addition of Basagran to either formulation resulted in a reduction in crop injury. Whether this antagonism would result in reduced weed control is unclear as weeds were not present at this site.

At the second rating, crop injury appeared to be less with the newer formulation when compared on a equivalent rate basis. The addition of crop oil concentrate to TAD13169 increased crop injury similar to that obtained with the old Buctril formulation. Crop injury was not evident at the last rating.

Site Description

Crop: Spearmint Variety: Native Planting Date: 10-15-97
Planting Method: Mint Planter Depth, Unit: 4"
Row Spacing, Unit: 20" Soil Moisture: Good

Plot Width, Unit: 10 FT Plot Length, Unit: 15 FT Reps: 3
Site Location: R-4 Study Design: RCB
Plot Maintenance:

Fertility:	3-15-99	100 Lbs. N, 52 Lbs. P, and 24 Lbs. S
Weed Control:	3-22-99	Goal at 4 pt + Stinger at 0.6 pt
	5-19-99	Assure II at 10 oz
Irrigation:		Throughout season with wheel line

Soil Description

Texture: Silt Loam % OM: 3.5 % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.5 Soil Name: Creston Silt Loam

Application Information

Application Date:	6-2-1999
Time of Day:	10:15 AM
Application Method:	Backpack
Application Timing:	4-6"
Air Temp., Unit:	67 F
% Relative Humidity:	47
Wind Velocity, Unit:	3 MPH
Dew Presence (Y/N):	Y
Soil Temp., Unit:	64 F
Soil Moisture:	Excellent
% Cloud Cover:	95

Plant Species	Plant Stage
Mint	4-6 Inch

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Buctril and TAD13169 Tolerance in Spearmint

Trt No	Treatment Name	Rate	Rate Unit	MINT CROP INJ PERCENT 6-10-99	MINT CROP INJ PERCENT 6-18-99	MINT CROP INJ PERCENT 6-21-99	MINT CROP INJ PERCENT 7-7-99
1	Buctril	.25	lb ai/A	18.3	3.3	5.0	0.0
2	Buctril	.5	lb ai/A	35.0	15.0	8.3	0.0
3	Buctril	.25	lb ai/A	6.7	1.7	0.0	0.0
3	Basagran	1	qt pr/A				
3	UAN 28%	2	qt pr/A				
4	TADS13169	.25	lb ai/A	11.7	1.7	1.7	0.0
5	TADS13169	.5	lb ai/A	33.3	8.3	5.0	0.0
6	TADS13169	.25	lb ai/A	26.7	8.3	6.7	0.0
6	COC	1	% v/v				
7	TADS13169	.5	lb ai/A	38.3	16.7	6.7	0.0
7	COC	1	% v/v				
8	TADS13169	.25	lb ai/A	16.7	13.3	8.3	0.0
8	COC	1	% v/v				
8	Basagran	1	qt pr/A				
8	UAN 28%	2	qt pr/A				
9	Nontreated			0.0	0.0	0.0	0.0
LSD (P=.05)				16.37	16.56	7.40	0.00
Standard Deviation				9.46	9.57	4.28	0.00
CV				45.6	126.02	92.37	0.0
Treatment F				6.034	1.300	1.797	0.000
Treatment Prob(F)				0.0012	0.3110	0.1514	1.0000

Herbicide Carryover in Peppermint

This study investigates the carryover potential of three imidazolinone herbicides - Assert, Pursuit, and AC-99263 (Raptor) to peppermint.

The three herbicides were applied in May of 1996. Peppermint stolens were planted in April of 1997 to determine the 12 month carryover potential over a two year period of 1997 and 1998. Peppermint stolens were also planted in April of 1998 to determine the 24 month carryover potential over a two year period of 1998 and 1999. Non-treated plots were included for each herbicide and rotation interval.

Pursuit and Assert caused mint yield reductions during the year of establishment when mint was established 12 months after application. However, mint yield reductions were not observed with Raptor. Mint generally recovered in the following year and yields were not significantly different from the nontreated check plots with the exception of Pursuit applied at the highest rate. No yield reductions were observed when mint was established 24 months after the initial herbicide applications.

The results of this study indicate that mint can safely be planted 24 months after these herbicides have been applied. Raptor appears to have the least carryover potential, and mint was successfully established 12 months after application. Caution is advised as this study represents only one soil type. Further, results might vary depending on mint variety, propagation technique, and stolen vigor.

Herbicide Carryover in Peppermint

Site Description

Crop: Peppermint — Variety: Black Mitchum
Planting Date: 12 month treatments: 4-24-1997 and 24 month treatments: 4-28-1998
Planting Method: Hand placement in furrows — Depth, Unit: 4"
Row Spacing, Unit: 22" — Soil Moisture: Good
Emergence: 12 month treatments: 5-15-1997 and 24 month treatments: 5-19-1998

Plot Width, Unit: 10 FT — Plot Length, Unit: 15 FT — Reps: 3
Site Location: R-3 — Study Design: RCB
Plot Maintenance:

Fertility:	4-21-97	100 Lbs. N, 52 Lbs. P, 60 Lbs. K and 24 Lbs. S
	7- 1-97	100 Lbs. N
	8-19-97	50 Lbs. N
	4- 2-98	100 Lbs. N, 52 Lbs. P, 60 Lbs. K and 24 Lbs. S
	5-20-98	100 Lbs. N and 10 Lbs. S
	7-29-98	50 Lbs. N
	4- 1-99	100 Lbs. N, 52 Lbs. P, 60 Lbs. K and 24 Lbs. S
	7- 6-99	52 Lbs. N
Weed Control:	5-16-97	Sinbar at 1 lb.
	5-30-97	Assure II at 15 oz.
	4-21-98	Assure II at 15 oz.
	6-24-98	Sinbar at 0.5 lb.
	5- 3-99	Assure II at 10 oz.
Irrigation:		Throughout season as needed

***Previous crop (1996) and treatments applied to spring wheat and lentils.

Soil Description

Texture: Silt Loam — % OM: 3.0 — % Sand: 40 % Silt: 50 % Clay: 10
pH: 7.4 — Soil Name: Creston Silt Loam

Application Information

Application Date:	5-3-96	5-24-96
Time of Day:	12:00 PM	11:00 AM
Application Method:	BACKPACK	BACKPACK
Application Timing:	12 & 24 MONTH PRE	12 & 24 MONTH PRE
Air Temp., Unit:	52 F	65 F
% Relative Humidity:	72	31
Wind Velocity, Unit:	0 MPH	3 MPH
Dew Presence (Y/N):	N	N
Soil Temp., Unit:	50 F	58 F
Soil Moisture:	GOOD	GOOD
% Cloud Cover:	0	10

Application Equipment

Sprayer Type	Speed MPH	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	GPA	Carrier	PSI
Backpack	2.5	Flatfan	11002XR	14"	20"	10'	20	H2O	20

Herbicide Carryover in Peppermint

Trt No	Treatment Name	Rate	Rate Unit	MINT CROP INJ PERCENT 7-4-97	MINT DRY MAT TON/ACRE 8-5-97	MINT CROP INJ PERCENT 5-26-98	MINT DRY MAT TON/ACRE 7-17-98	MINT DRY MAT TON/ACRE 8-26-98	MINT DRY MAT TON/ACRE 7-28-99
1	ASSERT 1 BARLEY 1 12 MO	.92	lb ai/A	66.7	0.59	36.7	2.62		
2	ASSERT 2 BARLEY 2 12 MO	.46	lb ai/A	45.0	0.90	8.3	3.33		
3	NONTREATED 3 BARLEY 3 12 MO			10.0	1.13	0.0	3.32		
4	PURSUIT 4 LENTILS 4 12 MO	.092	lb ai/A	55.0	0.59	18.3	2.33		
5	PURSUIT 5 LENTILS 5 12 MO	.046	lb ai/A	41.7	0.78	5.0	2.69		
6	NONTREATED 6 LENTILS 6 12 MO			10.0	1.04	0.0	3.04		
7	AC299263 7 LENTILS 7 12 MO	.063	lb ai/A	20.0	1.06	25.0	2.94		
8	AC299263 8 LENTILS 8 12 MO	.032	lb ai/A	20.0	1.06	13.3	3.12		
9	NONTREATED 9 LENTILS 9 12 MO			0.0	1.22	0.0	3.03		
10	ASSERT 10 BARLEY 10 24 MO	.92	lb ai/A					1.15	3.2
11	ASSERT 11 BARLEY 11 24 MO	.46	lb ai/A					1.24	3.5

CONTINUED...

Herbicide Carryover in Peppermint

Trt No	Treatment Name	Rate	Rate Unit	MINT CROP INJ PERCENT 7-4-97	MINT DRY MAT TON/ACRE 8-5-97	MINT CROP INJ PERCENT 5-26-98	MINT DRY MAT TON/ACRE 7-17-98	MINT DRY MAT TON/ACRE 8-26-98	MINT DRY MAT TON/ACRE 7-28-99
12	NONTREATED							1.10	3.1
12	BARLEY								
12	24 MO								
13	PURSUIT	.092	lb ai/A					1.16	3.0
13	LENTILS								
13	24 MO								
14	PURSUIT	.046	lb ai/A					1.13	3.3
14	LENTILS								
14	24 MO								
15	NONTREATED							1.10	3.3
15	LENTILS								
15	24 MO								
16	AC299263	.063	lb ai/A					1.12	3.1
16	LENTILS								
16	24 MO								
17	AC299263	.032	lb ai/A					1.21	3.2
17	LENTILS								
17	24 MO								
18	NONTREATED							1.19	3.0
18	LENTILS								
18	24 MO								
LSD (P=.05)				37.65	0.296	17.27	0.547	0.205	0.31
Standard Deviation				21.75	0.171	9.98	0.316	0.119	0.18
CV				72.96	18.4	84.18	10.77	10.26	5.64
Treatment F				3.353	5.443	4.949	3.304	0.506	1.860
Treatment Prob(F)				0.0189	0.0020	0.0032	0.0200	0.8348	0.1384

PROJECT TITLE: Agronomic performance evaluations of intrastate winter wheat nursery cultivars.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Phil Bruckner, Winter Wheat Breeder, Bozeman, MT
Jim Berg, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate Montana adapted cultivars and experimental lines for yield, lodging, quality, and disease resistance. Focal points of disease identification and documentation include stripe and leaf rust and tan spot reactions, which are common production concerns in northwest Montana.

RESULTS:

Poor emergence and light winterkill resulted in plant populations averaging 84 percent stand survival. However, a cool and dry extended spring resulted in extensive tillering with moderate disease pressure (tan spot). Conditions throughout grain fill were hot and dry with ample soil moisture present, resulting in light lodging pressure and an absence of foliar diseases. Yields were exceptional, ranging from 50 to 166 bu/A with a 49 entry mean of 144 bu/A. Test weights and proteins were average for this location at 60.3 lbs/bu and 11.4 percent respectively.

SUMMARY:

While not conducive to disease inoculation and infestation, climatic conditions were ideal for genetic yield expression in cultivars. With the exception of Fidel (soft red winter wheat), all entries yielded above 100 bu/A. with protein levels typical for this region ranging from 10 to 13 percent and averaging 11.3 percent. Lodging was light in severity with cultivar differences detected but not of agronomic importance.

FUTURE PLANS:

Winter wheat cultivars will continue to be evaluated at Kalispell to identify those with high yielding and disease resistance genetics for production in this region as well as across the state.

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

Planted: September, 24, 1998 Harvested: August 18, 1999

VARIETY	Yield Bu/A	Stand %	Test Wt Lb/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	Tan Spot 0-3	Protein %
QUANTUM 7424	166.47	86.54	59.77	17.27	153.50	34.93	1.33	2.43	10.90
MT 9426	166.25	89.29	60.77	16.57	158.11	35.18	.67	1.00	10.00
QUANTUM 7406	166.00	90.83	60.00	16.60	151.08	36.21	1.33	2.68	10.50
UTAH 100	165.31	85.41	60.57	18.17	158.58	35.72	.00	1.80	11.10
AP7510	161.60	90.35	60.17	16.00	151.21	32.28	.33	1.96	11.30
MANNING	161.29	90.72	58.50	14.77	156.61	35.93	2.00	2.02	10.50
MT9513	160.83	87.67	59.90	16.13	157.29	37.20	1.00	1.72	10.60
KESTREL	160.50	80.96	61.37	16.17	159.49	39.51	.67	1.42	11.70
NEELEY	157.62	82.22	61.30	16.07	159.71	39.11	.67	1.69	11.20
JUDITH	156.97	85.31	59.73	16.63	154.32	38.50	1.00	2.67	11.40
PROMONTORY	156.80	83.83	60.80	14.93	156.49	35.91	.00	2.02	11.10
MT 9409	155.66	83.94	60.03	17.33	158.71	39.93	.00	1.75	11.50
WINDSTAR	155.06	81.75	58.33	13.97	154.17	36.99	1.67	2.54	11.00
QUANTUM 542	154.93	76.07	60.53	17.43	154.83	40.70	1.67	1.95	11.10
MTS97104	154.78	77.68	59.47	15.20	163.64	35.10	1.00	2.05	11.30
MTS9720	153.87	86.34	59.80	16.27	160.38	37.36	1.00	2.64	11.00
MT9524	153.53	92.65	62.43	17.27	157.73	42.06	.00	.84	11.90
CULVER	153.24	90.67	60.13	15.23	152.26	35.81	1.67	2.00	11.10
BIGHORN	151.94	85.77	59.83	16.77	157.10	32.88	1.33	2.61	11.30
MTS9719	151.91	88.40	60.00	14.80	163.15	40.71	1.00	1.51	11.00
AKRON	148.70	84.62	59.90	17.73	153.68	35.55	2.67	2.44	10.10
ID513	148.17	90.89	59.50	16.77	159.50	34.76	1.00	1.91	10.70
NUWEST	147.70	81.23	60.50	16.07	158.41	38.10	.33	1.56	11.30
ND9257	147.61	80.04	59.20	15.30	156.24	39.81	2.00	1.92	10.80
MTW9724	145.96	86.65	59.30	15.63	157.82	37.02	1.00	2.57	10.70
TIBER	145.39	81.27	61.33	15.17	161.13	41.98	.00	1.15	12.20
BIG SKY	143.99	88.64	62.07	16.43	156.82	41.18	.33	1.39	12.00
ERHARDT	143.42	80.80	61.73	17.17	156.89	36.43	.67	2.40	12.00
PRONGHORN	142.63	87.98	59.63	15.10	152.39	40.40	3.33	1.24	11.30
ROCKY	141.92	88.31	60.67	16.60	154.89	40.75	2.33	2.05	10.80
BLIZZARD	141.66	82.30	61.83	15.70	161.60	41.92	.00	1.71	12.30
MTW9441	141.47	86.66	60.50	17.07	160.04	38.99	.67	1.32	11.10
ID537	139.59	84.80	59.77	14.80	160.86	39.25	.00	1.40	11.30
MCGUIRE	139.42	85.54	60.60	14.80	153.67	40.13	.67	2.23	12.30
HALT	139.26	76.19	60.17	14.17	151.71	32.49	1.00	2.12	11.60
SD89153	138.53	86.49	62.57	17.47	156.14	40.38	.67	.92	11.60
SD92107	134.63	91.80	58.33	15.13	155.81	39.67	1.00	2.17	12.10
MORGAN	134.55	77.42	59.60	15.60	161.74	37.36	.67	1.92	11.10
REDWIN	132.76	85.37	62.07	16.30	157.48	40.28	.67	1.96	12.50
NUPLAINS	132.72	86.09	61.37	15.23	155.17	32.58	.33	1.88	11.40
TANDEM	130.96	87.84	59.97	15.23	153.07	37.94	2.00	1.60	12.30
VANGUARD	130.60	85.90	59.77	14.83	155.69	37.85	1.33	1.61	12.60
SD93267	130.28	92.68	60.43	15.00	152.19	43.14	2.00	1.64	12.50
RANSOM	130.06	85.01	60.03	16.33	156.05	41.47	3.00	2.39	11.70
RAMPART	129.21	87.19	60.07	14.60	156.47	37.89	1.67	1.32	12.90
ROUGHRIDER	128.19	90.02	60.37	16.57	157.68	44.63	3.00	1.44	11.80
NORSTAR	126.03	70.80	61.63	18.17	164.92	48.43	3.00	1.03	12.30
ELKHORN	125.65	83.46	60.10	14.07	161.41	43.59	2.67	1.85	12.30
FIDEL	49.53	3.59	58.37	19.37	161.16	29.25	.00	.96	13.00
Mean	144.40	83.60	60.30	16.00	157.10	38.30	1.20	2.20	11.30
C.V.	3.98	4.07	0.60	4.81	0.50	2.13	43.8	22.6	
LSD (.05)	9.77	5.85	0.59	1.25	1.32	1.39	0.82	0.70	

PROJECT TITLE: Evaluations of advanced yield winter wheat nursery cultivars for disease resistance.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Phil Bruckner, Winter Wheat Breeder, Bozeman, MT
Jim Berg, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate predominately Montana experimental cultivars for yield, lodging, quality, and disease resistance. Focal points of disease identification and documentation include stripe and leaf rust and tan spot reactions, which are common production concerns in northwest Montana.

RESULTS:

Poor emergence and light winterkill resulted in plant populations averaging 89 percent stand survival. However, a cool and dry extended spring resulted in extensive tillering with moderate disease pressure (tan spot). Conditions throughout grain fill were hot and dry with ample soil moisture present, resulting in light lodging pressure and an absence of foliar diseases. Yields were exceptional ranging from 124 to 166 bu/A with a 36 entry mean of 147 bu/A. Test weights and proteins were average for this location at 60.2 lbs/bu and 11.7 percent respectively.

SUMMARY:

While not conducive to disease inoculation and infestation, climatic conditions were ideal for genetic yield expression in all cultivars. A 42 bu/A difference existed between the highest (MT9712) and lowest (MTS9873) yielding cultivars. Progress is apparent in the effort to create and identify cultivars superior to those currently recommended for production.

FUTURE PLANS:

Experimental winter wheat cultivars will continue to be evaluated at Kalispell to identify those with high yielding and disease resistance genetics for production in this region as well as across the state.

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

Planted: September 24, 1998 Harvested: August 20, 1999

VARIETY	Yld Bu/A	Stand %	Test Wt Lb/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	TanSpot 0-3	Protein %
MT9712	166.32	89.41	59.04	16.72	154.66	39.00	2.05	2.36	11.20
MTR98151	166.02	81.83	61.05	16.93	160.23	39.39	.28	1.35	11.10
MT98110	162.97	89.94	59.44	17.94	157.27	38.60	1.37	1.51	11.00
MT98128	161.81	92.24	59.90	17.59	156.57	37.78	1.01	1.81	10.60
NEELEY	159.16	85.87	61.34	17.27	162.04	39.96	.76	.92	11.30
MTR98140	159.07	88.11	59.51	17.53	157.05	38.52	.32	2.68	10.90
MTR98148	158.90	91.55	60.63	17.13	161.52	40.90	1.66	2.67	11.80
MT98121	156.18	88.03	60.32	18.05	162.53	39.60	1.05	1.59	10.90
MT9857	154.40	89.89	61.09	17.83	162.35	36.99	.63	1.02	11.90
MT98133	153.96	85.17	60.44	17.03	162.14	35.55	.04	1.11	11.30
JUDITH	152.66	88.25	59.26	17.26	154.41	38.86	1.32	2.65	11.20
MT9834	152.12	88.30	60.02	16.87	156.71	41.78	.60	1.35	11.60
MT9801	151.94	92.12	60.72	17.56	161.35	38.94	1.31	1.22	11.50
MTS9882	151.91	87.82	60.17	16.23	159.97	33.79	.66	2.06	11.00
MT98120	150.51	88.57	60.11	16.93	162.00	36.51	.72	1.89	10.80
Morgan	150.12	90.61	59.96	17.04	162.84	38.96	1.68	1.54	11.40
MT9805	149.28	91.90	60.35	16.65	159.34	40.88	.31	1.60	12.30
MT9844	147.99	86.49	60.85	17.94	155.84	39.20	.92	2.14	11.30
MT98122	146.84	88.73	60.12	18.31	159.67	38.23	.66	2.03	11.50
MT98113	146.70	85.11	60.94	18.20	159.29	36.46	.34	2.29	11.70
MT9822	146.41	90.37	60.49	16.26	152.99	40.27	.97	2.00	10.90
MT9802	146.24	89.27	60.50	18.37	161.85	37.78	.66	1.02	11.90
ERHARDT	146.04	88.07	61.93	17.47	158.47	37.42	.66	2.16	12.40
MT9811	145.95	90.03	60.57	18.18	159.80	39.48	3.66	1.48	11.20
MT9710	145.51	90.01	60.59	18.16	161.34	39.13	1.00	1.35	11.60
MT9859	145.14	91.01	62.19	18.51	162.48	37.96	.39	1.30	12.50
MT98127	144.32	82.63	61.12	18.24	157.60	36.44	2.02	3.03	11.50
MTS9860	141.98	87.73	59.04	15.40	163.60	40.88	1.43	.95	11.60
MT9833	140.06	91.83	60.27	17.41	157.63	42.95	.00	1.81	12.10
MTS9868	133.24	89.88	59.09	14.70	163.83	40.21	2.28	.78	12.60
MTS9871	132.52	93.15	59.79	17.02	156.20	34.38	.24	1.70	11.40
MTS9864	131.63	88.09	59.36	14.79	158.03	38.27	2.25	1.56	12.70
RAMPART	128.90	87.85	60.04	16.17	157.75	39.47	1.70	1.03	12.50
MTS9862	127.79	81.53	59.54	13.68	156.89	38.81	.07	1.65	14.10
MTS9869	126.41	89.47	59.12	14.86	162.97	42.42	2.64	.71	12.50
MTS9873	124.45	88.11	59.55	15.78	157.48	38.13	1.05	1.68	13.00
Mean	147.40	88.60	60.20	17.00	159.40	38.70	1.10	1.70	11.70
C.V.	3.70	4.17	0.68	4.44	0.57	2.55	73.4	23.3	
LSD (.05)	9.75	6.22	0.69	1.24	1.61	1.76	1.32	0.68	

PROJECT TITLE: Evaluation of soft white winter wheat nursery cultivars for disease resistance.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Phil Bruckner, Winter Wheat Breeder, Bozeman, MT
Jim Berg, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate soft white winter cultivars common to the Pacific Northwest for adaptability, quality, and disease resistance in northwestern Montana.

RESULTS:

Emergence problems and light winterkill resulted in plant populations averaging 90 percent stand survival. However, cool and dry spring conditions resulted in extensive tillering and little to no disease pressure. Conditions throughout grain fill were hot and dry with timely rainfall events and adequate soil moisture. Yields were exceptional ranging from 153 to 183 bu/A with a 15 entry mean of 170 bu/A. With the exception of Eltan, Neeley, and Stephens, lodging severity was very low and test weights were above average (mean = 59.3) for this nursery.

SUMMARY:

While not conducive to disease inoculation and infestation, climatic conditions were ideal for yield. Significant cultivar separations existed for yield where a 30 bu/A difference was documented between Lewjain (highest) and Eltan (lowest). While not as dramatic, significant cultivar differences were also noted for lodging susceptibility and test weights.

FUTURE PLANS:

Continued soft white winter wheat evaluations with this nursery in an attempt to identify cultivars best adapted to the soft white production areas in Montana.

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

Planted: September 24, 1998 Harvested: August 20, 1999

VARIETY	Yield Bu/A	Stand %	Test Wt Lbs/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	Protein %
LEWJAIN	182.70	94.33	60.07	15.90	166.00	34.50	.67	11.00
KMOR	182.13	93.33	59.03	14.83	164.00	35.43	1.00	
DAWS	178.13	88.33	60.30	15.43	163.67	35.03	.00	10.40
MACVICAR	177.63	88.33	58.83	14.33	162.00	34.17	.67	10.30
ROD	175.03	86.67	57.53	13.63	165.67	33.37	.67	10.40
HILL 81	172.17	97.67	60.47	15.90	164.00	37.13	.33	10.70
CASHUP	171.90	91.67	59.10	14.60	161.67	33.23	1.00	10.50
BRUNDAGE	171.20	92.67	59.53	15.80	155.33	33.87	.67	10.40
LAMBERT	169.23	90.00	59.20	14.23	161.33	36.47	1.00	10.20
MALCOLM	169.20	86.67	58.80	13.70	161.00	34.17	.33	10.20
MADSEN	168.27	91.67	58.93	15.00	164.33	35.17	.33	11.00
NEELEY	164.67	88.33	61.47	15.37	162.67	41.20	3.33	11.70
STEPHENS	160.63	89.33	59.67	15.07	166.67	37.13	2.33	10.40
W301	159.40	80.00	59.07	13.93	160.67	34.00	.67	11.30
ELTAN	152.50	90.00	58.10	17.30	166.33	37.13	6.67	10.70
Mean	170.32	89.93	59.34	15.00	163.02	35.47	1.31	10.70
C.V.	4.77	4.31	1.14	5.64	0.57	3.32	63.3	
LSD (.05)	13.59	6.49	1.13	1.42	1.56	1.97	1.39	

PROJECT TITLE: Early generation winter wheat screening for TCK.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Phil Bruckner, Winter Wheat Breeder, Bozeman, MT
Jim Berg, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate winter wheat germplasm responses to introduced and natural TCK (Dwarf Bunt) infection. Agronomic characteristics and additional disease reactions will be documented as well.

RESULTS:

Emergence problems and light winterkill resulted in plant populations averaging 80 percent stand survival. However, cool and dry spring conditions resulted in extensive tillering and little to no disease pressure. Documentation of genetic TCK responses were not possible as winter conditions prevented spore germination and plant infection. Conditions throughout grain fill were hot and dry with timely rainfall events and adequate soil moisture. Yields were high ranging from 113 to 160 bu/A with a 98 entry mean of 137 bu/A. Test weights were average (59.8 lbs/bu) with no significant lodging.

SUMMARY:

Growing season precipitation and temperatures resulted in high yields and average test weights in the absence of lodging and disease pressure. The winter of 1998-99 was not favorable for TCK infection in that continuous days of snow-cover never approached the approximated 60 needed to begin the fungus' life-cycle.

FUTURE PLANS:

NWARC will continue to conduct this nursery in an attempt to identify those early generation cultivars with tolerance or resistance to TCK while also evaluating all agronomic attributes.

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

Planted: September 24, 1998 Harvested: August, 18,1999

	Variety	Yield Bu/A	Stand %	Test Wt Lbs/Bu	Lodge 0-9	Ht Inch	Hd Date Julian
1	Judith	148.4	90.0	58.9	1.0	37.4	154.0
2	Promontory	139.4	75.0	61.3	0.0	35.0	156.0
3	Blizzard	152.2	85.0	62.9	0.0	39.8	162.0
4	Yuma	143.7	88.0	60.0	1.0	33.1	154.0
5	399 HBC197F/Meridian	151.8	95.0	60.4	1.0	32.3	162.0
6	400 HBC197F/Meridian	128.2	88.0	59.2	1.0	32.3	156.0
7	403 HBC197F/Meridian	155.4	72.0	60.0	1.0	33.5	157.0
8	404 Blizzard/Arapahoe	132.5	85.0	60.5	0.0	37.4	157.0
9	405 Blizzard/Arapahoe	151.5	80.0	59.9	1.0	36.2	155.0
10	406 Blizzard/Arapahoe	159.7	82.0	60.6	1.0	40.6	160.0
11	407 Blizzard/Arapahoe	141.1	75.0	59.6	1.0	39.4	156.0
12	408 Blizzard/Arapahoe	149.9	80.0	60.3	1.0	39.8	161.0
13	409 Jud/Bliz//Jud/Pion	139.8	70.0	59.2	0.0	38.6	155.0
14	410 Jud/Bliz//Jud/Pion	136.5	65.0	59.5	0.0	36.6	155.0
15	411 Jud/Bliz//Jud/Pion	155.9	80.0	57.6	2.0	36.2	160.0
16	412 Jud/Bliz//Jud/Pion	128.9	70.0	57.8	0.0	40.2	160.0
17	413 Jud/Bliz//Jud/Pion	139.7	75.0	57.8	0.0	40.6	162.0
18	414 Jud/Bliz//Jud/Pion	126.5	65.0	56.8	1.0	42.5	162.0
19	415 Jud/Bliz//Jud/Pion	146.2	50.0	58.3	1.0	38.6	157.0
20	416 Jud/Bliz//Jud/Pion	159.6	75.0	58.8	0.0	37.0	157.0
21	417 Jud/Bliz//Jud/Pion	156.1	75.0	58.3	0.0	42.5	162.0
22	418 Jud/Bliz//Jud/Pion	139.5	75.0	58.7	1.0	41.3	158.0
23	419 Jud/Bliz//Jud/Pion	131.2	82.0	58.5	1.0	36.2	157.0
24	420 Jud/Bliz//Jud/Pion	145.8	88.0	57.6	2.0	38.6	160.0
25	421 Jud/Bliz//Jud/Pion	157.3	83.0	57.7	2.0	37.8	158.0
26	422 Jud/Bliz//Jud/Pion	134.2	80.0	59.5	1.0	40.6	158.0
27	423 Jud/Bliz//Jud/Pion	150.3	83.0	58.5	1.0	42.5	162.0
28	424 Jud/Flm85//UT182016	142.9	75.0	60.4	1.0	37.8	165.0
29	425 8713/Arp//Bliz/Arp	152.6	93.0	60.2	1.0	35.4	154.0
30	426 8713/Arp//Bliz/Arp	138.3	98.0	60.0	0.0	31.9	154.0
31	427 8713/Arp//Bliz/Arp	150.2	90.0	59.4	1.0	32.3	154.0
32	428 8713/Arp//Bliz/Arp	145.1	89.0	60.2	0.0	29.5	155.0
33	429 8713/Arp//Bliz/Arp	142.0	95.0	60.1	0.0	34.6	153.0
34	430 8713/Arp//Bliz/Arp	146.4	90.0	60.0	1.0	29.1	156.0
35	431 8713/Arp//Bliz/Arp	137.4	88.0	59.4	2.0	31.5	154.0
36	432 8713/Arp//Bliz/Arp	135.7	85.0	60.8	0.0	33.1	153.0
37	433 Jud/Arp//A851020W	151.7	90.0	57.8	2.0	34.6	157.0
38	434 Jud/Arp//A851020W	138.0	85.0	59.2	0.0	35.0	162.0
39	435 Jud/Arp//A851020W	132.3	88.0	59.8	0.0	30.7	153.0
40	436 Jud/Arp//A851020W	130.5	88.0	59.6	0.0	37.0	160.0
41	437 Jud/Arp//A851020W	144.3	85.0	60.8	0.0	37.4	155.0
42	438 Jud/Arp//A851020W	120.1	85.0	59.3	0.0	39.8	164.0
43	439 Jud/Arp//A851020W	148.6	60.0	60.5	0.0	37.4	162.0
44	440 Jud/Arp//A851020W	119.1	60.0	60.8	0.0	37.4	164.0
45	441 Jud/Apr//A851020W	122.0	55.0	59.9	0.0	33.5	158.0
46	442 Arp/Kes//Jud/Bliz	136.4	60.0	60.7	1.0	39.0	158.0
47	443 Arp/Kes//Jud/Bliz	140.3	75.0	60.0	1.0	36.6	161.0
48	Judith	141.4	78.0	59.4	1.0	35.8	155.0
49	Promontory	136.4	70.0	61.1	0.0	33.9	157.0

CONTINUED...

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

Planted: September 24, 1998 Harvested: August, 18,1999

Variety		Yield Bu/A	Stand %	Test Wt Lbs/Bu	Lodge 0-9	Ht Inch	Hd Date Julian
50 Blizzard		138.5	85.0	62.0	0.0	39.4	162.0
51 Yuma		131.0	75.0	59.3	1.0	31.9	153.0
52 444	Arp/Kes//Jud/Bliz	142.7	75.0	60.5	2.0	35.8	157.0
53 445	Arp/Kes//Jud/Bliz	131.3	70.0	59.9	1.0	36.6	157.0
54 446	Arp/Kes//Jud/Bliz	132.1	75.0	59.3	0.0	36.2	159.0
55 447	Arp/Kes//Jud/Bliz	145.9	80.0	59.6	2.0	37.4	157.0
56 448	Arp/Kes//Jud/Bliz	141.4	70.0	59.9	2.0	37.8	156.0
57 449	Arp/Kes//Jud/Bliz	147.4	75.0	60.3	1.0	35.8	156.0
58 450	Arp/Kes//Jud/Bliz	144.5	80.0	59.6	1.0	37.0	158.0
59 453	Arp/Kes//Jud/Bliz	136.5	85.0	59.9	2.0	38.6	155.0
60 454	Arp/Kes//Jud/Bliz	144.6	85.0	59.4	2.0	37.0	158.0
61 455	Arp/Kes//Jud/Bliz	128.2	90.0	60.4	0.0	36.2	155.0
62 456	Arp/Kes//Jud/Bliz	139.0	85.0	59.7	1.0	35.8	162.0
63 457	Arp/Kes//Jud/Bliz	136.4	88.0	59.2	1.0	34.6	157.0
64 458	Arp/Kes//Jud/Bliz	129.6	85.0	59.8	1.0	35.0	155.0
65 459	Arp/Kes//Jud/Bliz	134.5	85.0	59.2	3.0	35.8	156.0
66 460	SD88191//Jud/Bliz	134.4	85.0	58.9	2.0	33.9	160.0
67 461	SD88191//Jud/Bliz	126.2	88.0	61.2	0.0	33.5	157.0
68 462	SD88191//Jud/Bliz	136.5	88.0	59.1	2.0	35.4	161.0
69 463	SD88191//Jud/Bliz	129.2	85.0	61.2	0.0	35.8	158.0
70 464	SD88191//Jud/Bliz	138.4	85.0	61.0	1.0	36.6	158.0
71 465	SD88191//Jud/Bliz	126.6	85.0	59.6	2.0	31.5	152.0
72 466	SD88191//Jud/Bliz	128.9	85.0	61.2	0.0	29.1	155.0
73 467	SD88191//Jud/Bliz	127.1	77.0	59.4	0.0	35.0	154.0
74 468	SD88191//Jud/Bliz	130.0	83.0	58.9	3.0	32.7	153.0
75 469	Sd88191//Jud/Bliz	132.0	85.0	59.2	1.0	32.3	153.0
76 470	SD88191//Jud/Bliz	113.2	90.0	60.8	1.0	34.6	157.0
77 471	Bliz/Arp//SD88191	126.7	93.0	60.1	1.0	28.7	152.0
78 472	Bliz/Arp//SD88191	135.2	98.0	61.4	3.0	29.9	152.0
79 473	Bliz/Arp//SD88191	136.2	93.0	61.7	0.0	37.0	154.0
80 474	Bliz/Arp//SD88191	138.4	90.0	58.3	0.0	29.9	154.0
81 475	Bliz/Arp//SD88191	125.3	95.0	59.8	0.0	37.8	157.0
82 476	Bliz/Arp//SD88191	137.2	95.0	57.4	1.0	31.5	160.0
83 477	Bliz/Arp//SD88191	136.9	98.0	58.1	1.0	31.9	157.0
84 478	Bliz/Arp//SD88191	131.6	92.0	61.1	0.0	37.4	156.0
85 479	Bliz/Arp//SD88191	129.9	80.0	59.8	1.0	40.9	157.0
86 480	Bliz/Arp//SD88191	128.9	85.0	59.9	3.0	40.9	154.0
87 481	Bliz/Arp//SD88191	130.2	75.0	60.2	0.0	35.4	156.0
88 482	Bliz/Rdwn//SD88191	126.4	80.0	61.2	0.0	36.6	156.0
89 483	Bliz/Rdwn//SD88191	131.4	82.0	60.9	0.0	38.2	155.0
90 484	Bliz/Rdwn//SD88191	124.7	84.0	61.7	0.0	34.3	157.0
91 485	Bliz/Rdwn//SD88191	136.5	85.0	61.3	0.0	36.6	157.0
92 486	Bliz/Rdwn//SD88191	128.7	83.0	61.1	0.0	38.2	157.0
93 487	Bliz/Rdwn//SD88191	133.7	75.0	58.5	1.0	32.3	161.0
94 488	McGuire/Tomahawk	116.0	70.0	61.2	0.0	31.5	152.0
95 489	Promontory/Judith	122.0	60.0	62.3	0.0	34.6	157.0
96 490	Promontory/Judith	119.7	45.0	59.4	1.0	34.3	156.0
97 491	Promontory/Judith	138.6	45.0	60.8	1.0	32.3	157.0
98 492	HBC197F/S86-740//	112.9	50.0	61.9	0.0	33.9	158.0
Mean		137.0	80.0	59.8	0.8	35.8	157.0

PROJECT TITLE: Evaluation of the advanced spring wheat nursery cultivars for disease resistance and agronomic characteristics.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Luther Talbert, Spring Wheat Breeder, Bozeman, MT
Susan Lanning, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate spring wheat cultivars and experimental lines for yield, lodging, quality, and disease resistance in northwestern Montana.

RESULTS:

Cool temperatures extended from March through June which resulted in slow emergence and seedling growth. Extensive vegetative growth (tillers) resulted from the extended spring-like climate. While dry throughout the growing season, no moisture stress was noted as soil moisture never reached the wilting point. High yields were recorded ranging from 96 to 130 bu/A with a 49 entry mean of 112 bu/A. Test weights were also high, ranging from 59.2 (MT 9754) to 64.1 (MT 9719) lbs/bu. Most cultivars displayed good lodging resistance under high yielding conditions with the exception of Fortuna, Thatcher, Lew, MT 9835, and MT 9836. Protein percentage across the nursery averaged 13.3. Climatic conditions resulted in no measurable disease infections.

SUMMARY:

Yield and test weight excelled in the absence of disease and significant lodging pressure. Proteins were average with only 12 of the entries exceeding 14 percent.

FUTURE PLANS:

Continued spring wheat evaluations for the purpose of identifying varieties best suited for production in Montana.

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

Planted: April 7, 1999 Harvested: August 30, 1999

VARIETY	Yield Bu/A	Test Wt Lbs/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	Protein %
MTHW9420	129.97	60.93	14.87	172.33	37.00	.67	11.8
BR 2306	129.53	61.97	18.03	173.33	39.77	.00	12.3
PRISTINE	126.87	63.50	15.80	170.33	37.93	.33	13.1
MT 9806	125.50	62.63	18.47	175.00	36.07	.67	13.5
NEWANA	124.83	62.00	18.57	177.67	35.53	.00	12.1
MT 9706	124.10	62.57	16.90	173.33	40.17	.67	13.9
MT 9675	123.23	60.63	17.00	178.00	39.00	.67	12.3
MCNEAL	122.83	61.90	15.77	175.67	38.73	.33	13.5
ZEKE	121.20	61.70	15.37	170.00	36.73	1.67	13.1
MT 9748	118.03	63.30	16.40	174.67	38.83	1.67	12.6
MT 9849	117.57	62.30	18.77	178.33	41.97	1.33	13.5
MT 9801	117.50	61.60	16.43	177.67	36.60	.67	13.1
MT 9755	117.00	61.03	16.07	171.67	35.80	.67	11.9
MTHW9603	117.00	59.80	16.10	174.33	36.73	.67	11.6
SCHOLAR	116.17	63.10	15.83	177.33	40.03	.33	14.0
HI-LINE	114.90	62.23	16.30	172.33	36.07	1.00	12.7
MT 9715	113.83	61.77	17.10	174.33	37.00	1.33	13.0
SDM50005	113.10	62.27	16.70	178.00	36.37	.00	13.0
MT 9874	112.60	61.60	17.23	179.33	37.80	.00	12.9
MT 9712	112.27	63.20	17.03	175.33	39.80	1.00	14.0
MT 9802	111.70	61.40	15.40	174.33	39.53	.67	14.3
GRANDIN	111.67	62.63	16.30	174.33	38.33	.33	14.7
MT 9834	111.63	60.60	17.10	179.33	35.67	.00	12.5
AMIDON	111.47	62.37	17.20	177.33	42.63	.00	13.7
MT 9772	110.97	62.63	16.80	176.67	42.23	1.33	14.4
MT 9754	110.43	59.23	17.17	174.33	33.23	2.33	13.2
MT 9720	110.43	63.30	17.97	175.67	35.53	1.00	13.6
MT 9850	110.40	61.77	18.83	178.33	40.93	.67	14.7
MT 9807	110.13	62.20	18.20	174.33	35.27	.00	13.5
REEDER	109.80	62.87	18.03	174.00	39.80	.33	13.8
MT 9835	109.77	62.17	17.63	172.00	35.67	4.00	12.9
MT 9836	109.50	62.27	17.07	173.00	34.90	3.33	12.7
MT 9719	109.43	64.10	17.47	172.67	35.80	.33	13.9
MT 9866	109.43	62.27	18.30	179.67	43.30	.00	13.6
MT 9735	109.33	61.63	17.53	175.33	36.20	2.00	12.6
MT 9771	108.90	62.43	15.83	176.67	42.37	.33	14.2
ERNEST	107.17	63.40	18.00	176.33	41.60	.33	13.7
MT 9739	106.60	62.60	17.17	175.67	41.73	.00	14.2
WESTBRED 926	106.17	61.57	14.80	171.00	35.17	.00	13.4
MTHW9701	105.03	61.03	16.50	173.67	32.43	.33	11.8
MT 9815	103.03	63.23	17.20	176.67	41.73	.67	14.5
CONAN	103.00	61.63	18.67	172.67	35.67	.00	13.2
THATCHER	102.80	61.67	17.53	179.00	45.97	3.67	13.6
MT 9875	102.30	62.07	14.77	175.00	37.67	.00	14.0
MT 9813	101.57	62.77	15.83	175.33	39.13	.00	14.6
PARSHALL	101.27	63.53	16.50	174.33	43.57	.00	14.0
LEW	98.03	62.77	17.43	179.00	40.67	4.33	13.4
BZ996472	96.90	63.50	16.90	170.33	33.87	1.67	12.8
FORTUNA	96.37	62.80	16.90	175.33	39.00	6.00	13.0
Mean	112.11	62.17	16.93	175.13	38.32	0.97	13.3
C.V.	6.44	0.91	4.96	0.55	2.23	72.6	
LSD(.05)	11.70	0.92	1.36	1.55	1.38	1.14	

PROJECT TITLE: Evaluation of preliminary hard white spring nursery cultivars for disease resistance.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Luther Talbert, Spring Wheat Breeder, Bozeman, MT
Susan Lanning, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate experimental hard white spring wheat cultivars for yield, lodging, quality, and disease resistance in northwestern Montana.

RESULTS:

Cool temperatures extending from March through June resulted in slow emergence and seedling growth. Extensive vegetative growth (tillers) resulted from the extended spring-like climate. While dry throughout the growing season, plant stress not was noted as soil available moisture never reached wilting point. Yields easily exceeded those recorded the previous two years ranging from 109 to 146 bu/A with a 30 entry mean of 124 bu/A. Test weights were high, ranging from 60.7 (Klasic) to 64.3 (MTHW9904) lbs/bu. The included hard red check variety 'Hi-Line' performed at 116 bu/A and 62.9 lbs/bu. While not severe, some lodging susceptibility differences were detected. Protein percentage across the nursery averaged 12.9. Climatic conditions resulted in no measurable disease infections.

SUMMARY:

Yields excelled in the absence of disease and lodging pressure. All but one experimental line surpassed the long term hard white check 'Klasic' and 19 out-yielded the hard red check Hi-Line. ID377S is currently the only spring type hard white currently grown in Montana and topped this nursery at 146 bu/A. The agronomic performance of hard whites have identified this class as a production option in western Montana.

FUTURE PLANS:

Continued hard white spring wheat evaluations for the purpose of identifying varieties best suited for production in Montana.

Table 1. Agronomic data from the Preliminary Hard White Spring Wheat Nursery grown at the Northwestern Agricultural Research Center in Kalispell, MT.

Planted: April 7, 1999 Harvested: August 27, 1999

VARIETY	Yield Bu/A	Test Wt Lbs/Bu	Moist %	Hd date Julian	Height Inch	Lodge 0-9	Protein %
ID377S	146.23	63.23	14.67	172.33	39.00	.33	12.1
MTHW9914	140.90	61.40	12.70	173.00	36.20	1.00	12.3
MTHW9910	139.63	61.83	12.73	173.00	36.47	1.33	12.1
MTHW9908	137.83	62.27	12.40	173.00	37.00	1.00	12.7
MTHW9915	137.17	62.37	13.17	172.33	35.93	.67	12.5
MTHW9911	136.03	61.53	13.17	176.33	37.80	2.33	12.4
MTHW9912	135.83	61.90	12.17	172.33	35.93	1.00	12.0
MTHW9909	135.37	62.27	14.70	177.00	36.47	.67	12.1
ID533	132.03	63.23	15.97	174.33	37.93	.33	12.1
MTHW9603	129.33	61.23	12.57	172.67	37.93	.33	12.2
MTHW9913	127.67	62.17	12.53	172.33	36.20	.00	12.6
MTHW9420	126.73	61.90	11.93	171.67	37.00	.00	12.8
MTHW9907	123.63	62.13	12.50	172.00	36.47	1.00	12.8
MTHW9706	122.97	61.50	13.43	171.67	38.33	.00	13.4
MTHW9901	121.53	63.83	13.60	174.67	41.57	.33	13.2
MTHW9715	121.00	63.83	12.73	171.33	40.07	1.00	13.4
MTHW9902	120.43	62.73	14.40	176.67	43.03	2.00	12.8
MTHW9906	118.53	63.67	12.40	171.67	36.60	.33	13.1
MTHW9905	118.40	62.70	11.63	171.33	38.60	.67	12.8
MTHW9804	116.83	63.40	11.97	170.33	35.67	.67	13.2
MTHW9716	116.83	62.27	12.40	169.67	37.13	.00	13.3
HI-LINE	116.20	62.93	11.97	171.67	36.20	.00	13.3
MTHW9705	115.97	61.67	13.03	172.00	35.67	.00	12.8
MTHW9903	114.50	62.60	12.37	174.00	38.20	1.00	12.8
MTHW9904	114.37	64.30	13.37	173.00	40.43	.00	13.8
MTHW9701	114.30	61.57	12.07	172.33	34.40	.00	12.4
MTHW9709	113.17	60.90	11.60	170.67	37.67	1.33	12.7
ARGENT	112.17	63.40	12.80	174.00	41.20	1.00	14.7
KLASIC	110.33	60.73	11.03	168.33	25.60	1.00	13.0
MTHW9710	108.97	61.60	11.67	169.33	35.03	.33	14.4
Mean	124.16	62.37	12.79	172.50	37.19	0.66	12.9
C.V.	5.66	0.78	5.43	0.45	2.12	81.1	
LSD (.05)	11.49	0.80	1.13	1.28	1.29	0.87	

PROJECT TITLE: Evaluation of spring wheat variety performance in off-station trials near Ronan, MT.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Luther Talbert, Spring Wheat Breeder, Bozeman, MT
Susan Lanning, Research Associate, Bozeman, MT
Jack Stivers, Lake Co. Extension Agent, Ronan, MT
Lake Seed Inc., Ronan, MT

OBJECTIVES:

To evaluate the performance of spring wheat varieties in environments and cropping systems representative of west-central Montana.

RESULTS:

Harsh conditions persisted throughout the 1999 growing season. Emergence, stand, and tillering were adversely affected by dry, cold soils through June. A late frost and cereal leaf beetle infestations also inhibited yield to some extent. Plots were irrigated twice to supplement below average rainfall. Yields ranged from 47 to 73 bu/A with a 22 entry average of 57 bu/A. Test weights were average ranging from 55.5 to 61.0 lbs/bu under light lodging pressure and hot-dry conditions throughout grain-fill. Proteins were high with WestBred 936 and Ernest exceeding 18 percent.

SUMMARY:

Despite multiple adverse growing conditions, yield and test weights were representative of area producer expectations. The cold-dry conditions followed by a hot-dry environment resulted in little to no lodging or disease pressure and high protein levels. A 27 bu/A difference existed between the highest (Express) and poorest (Lew) yielding cultivars.

FUTURE PLANS:

Spring wheat variety evaluations will continue in Lake County.

Table 1. Agronomic data from the Off-station Spring Wheat Nursery at Lake Seed Inc. in Ronan, MT.

Planted: April 16, 1999 Harvested: August 26, 1999

VARIETY	Yield Bu/A	Test Wt Lbs/Bu	Height Inch	Lodge 0-9	Protein %
WESTBRED EXPRESS	72.93	58.87	27.33	.00	16.6
VANNA	68.37	55.47	31.77	1.00	14.6
MTHW9420	64.10	58.63	32.70	.33	15.8
AMIDON	61.60	59.33	32.93	1.33	17.1
SCHOLAR	61.53	61.03	32.30	.00	17.5
PNR 2375	60.33	60.37	31.50	.67	16.1
RAMBO	60.20	59.73	32.57	.00	16.1
WESTBRED 936	58.60	59.33	27.57	.00	18.0
FERGUS	58.23	59.67	30.83	.67	16.6
REEDER	57.07	60.67	32.83	1.00	17.5
WESTBRED 926	56.70	58.70	30.73	.33	17.1
MCNEAL	56.60	57.70	33.07	.00	16.5
MTHW9701	55.80	58.93	30.57	.33	15.4
CONAN	55.40	60.57	29.67	.00	16.4
NEWANA	55.13	59.60	32.70	.67	16.1
HI-LINE	55.07	58.70	30.43	1.00	16.7
GRANDIN	53.43	59.73	34.13	1.00	17.3
PENAWAWA	52.37	57.07	30.60	.00	14.7
ERNEST	52.20	59.20	35.03	.67	18.4
PARSHALL	49.77	60.03	35.03	.67	17.9
FORTUNA	49.53	59.27	38.73	2.00	16.9
LEW	46.53	58.20	38.47	3.33	16.3
Mean	57.34	59.13	32.34	0.68	16.6
C.V.	14.16	1.92	3.88	57.2	
LSD (.05)	13.38	1.87	2.07	0.64	

PROJECT TITLE: Evaluation of intrastate barley nursery cultivars for disease resistance.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Tom Blake, Barley Breeder, Bozeman, MT
Pat Hensleigh, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate experimental barley cultivars for yield, lodging, quality, and disease resistance in northwestern Montana.

RESULTS:

Cool temperatures extending from March through June resulted in slow emergence and seedling growth. Extensive vegetative growth (tillers) resulted from the extended spring-like climate. While dry throughout the growing season, plant stress was not noted as soil available moisture never reached wilting point. Yields exceeded those recorded in previous years ranging from 124 to 186 bu/A with a 64 entry mean of 149 bu/A. All entry test weights topped 50 lbs/bu with a high overall mean of 53.5 lbs/bu. While not severe, some lodging susceptibility differences were detected. Protein percentage across the nursery averaged 12.8 with good kernel plumpness (94%). Climatic conditions resulted in no measurable disease infections.

SUMMARY:

Yield, test weight, and seed plumpness excelled in the absence of disease and lodging pressure combined with good grain-fill temperatures and soil moisture. Eighteen cultivars yielded higher than the check variety 'Baronesse'.

FUTURE PLANS:

Continued barley evaluations for the purpose of identifying varieties best suited for production in Montana.

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

Planted: April 7, 1999 Harvested: August 23, 1999

VARIETY	Yield Bu/A	Test Wt Lbs/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	Plump %	Protein %
MT960100	167.50	53.57	12.03	178.67	37.67	.00	92.00	12.5
MT960225	165.30	53.90	12.93	175.67	43.43	1.00	93.00	11.4
MT970107	165.20	54.53	12.13	175.33	41.33	1.33	97.00	12.5
MT960101	164.63	53.67	12.37	179.67	39.50	1.00	94.00	12.4
MT920073	162.70	53.23	11.87	174.33	39.50	.67	95.00	13.3
MT950186	161.60	54.83	11.27	179.33	43.30	.67	94.00	12.3
MT970231	158.83	53.17	15.27	175.33	42.13	2.33	94.00	12.7
MT970205	158.77	53.10	11.57	178.67	37.00	.00	95.00	12.1
MT970228	156.73	52.77	10.97	176.33	39.13	.67	92.00	13.1
GS 1750	156.63	53.37	13.60	177.67	42.40	.33	95.00	12.6
MT970248	156.23	53.17	13.73	173.67	43.43	1.67	94.00	12.9
MT970207	155.93	54.50	11.93	176.67	40.83	.00	95.00	12.2
MT960228	155.60	53.57	12.10	179.00	37.57	.33	95.00	12.2
AC 96/1114	155.40	51.97	12.63	177.33	38.60	.67	96.00	12.8
MT970229	155.13	54.70	15.20	179.33	40.43	1.00	95.00	12.4
MT960222	155.03	53.67	11.13	178.67	43.83	2.33	96.00	12.1
MT970245	154.90	51.83	11.70	174.67	43.57	1.67	92.00	12.6
MT960099	154.60	52.00	12.27	178.67	36.73	.33	90.00	13.2
BARONESSE	154.57	53.50	11.43	178.00	39.73	.33	95.00	12.8
MT970116	154.23	54.23	13.23	175.00	40.80	.00	94.00	12.6
MT920053	154.23	53.90	11.63	175.00	40.57	3.00	93.00	13.2
HARRINGTON	153.97	53.00	11.80	177.00	41.33	1.67	93.00	12.5
MT960198	153.20	54.13	11.80	175.67	40.17	1.00	92.00	13.0
MORAVIAN 22	153.07	53.20	11.03	183.00	37.67	1.00	97.00	12.6
MT970086	153.00	54.43	13.80	178.00	40.00	.00	95.00	12.9
LEWIS	152.97	53.67	11.50	176.67	41.47	1.33	91.00	13.1
MT970196	152.27	53.47	11.90	178.67	41.97	1.00	91.00	12.1
MT970148	152.07	52.27	11.20	173.33	37.53	1.00	93.00	11.8
MT970019	151.77	53.90	14.00	177.67	40.70	.00	97.00	12.5
MT920059	151.73	54.23	14.47	177.00	41.07	.33	95.00	12.9
MT970125	151.63	52.77	10.97	179.67	43.17	1.33	94.00	13.3
MT970110	151.43	54.13	13.13	180.00	42.90	.67	97.00	12.5
MTLB 5	151.40	53.57	12.40	178.00	40.83	1.00	94.00	13.1
MT970214	150.90	53.40	11.83	176.00	41.83	.33	95.00	12.5
MT970218	149.90	52.93	11.60	175.00	39.87	.00	96.00	13.0
MT940053	148.73	54.03	13.37	180.67	41.07	1.33	93.00	13.1
MT970053	148.00	52.53	13.67	176.00	39.73	1.00	95.00	12.1
MT960226	147.87	53.47	10.57	175.67	42.23	2.00	96.00	12.6
STARK	147.23	53.37	12.30	173.67	42.13	1.00	93.00	12.6
MT970026	147.23	53.73	14.63	176.33	38.33	.33	94.00	13.4
MTLB 6	146.93	52.90	13.73	175.33	36.50	.00	94.00	13.8
WPB XENA	146.47	52.50	11.87	178.00	39.40	.67	93.00	13.5
MT970177	146.47	53.03	11.87	176.00	40.67	.33	93.00	12.6
LOGAN	145.93	52.80	15.60	175.33	38.97	.67	90.00	12.6
MT910189	145.80	54.13	13.53	174.00	39.40	1.00	94.00	12.4
MT940082	145.80	54.17	12.27	178.00	38.43	.33	92.00	13.2
MT970105	145.70	54.23	12.57	173.33	43.83	1.00	93.00	13.0
MTLB 13	145.47	52.67	12.07	177.00	38.07	.67	94.00	12.8

CONTINUED...

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

Planted: April 7, 1999 Harvested: August 23, 1999

VARIETY	Yield Bu/A	Test Wt Lbs/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	Plump %	Protein %
H1851195	144.80	52.27	14.93	177.00	42.00	.67	92.00	13.5
CHINOOK	144.50	53.87	15.57	177.33	40.57	2.00	91.00	13.1
MT960082	142.93	53.70	14.57	178.67	40.93	.33	97.00	13.2
MT940214	142.20	53.57	11.80	177.33	39.40	.33	95.00	12.3
MT970155	140.90	53.80	11.20	181.33	39.80	1.00	96.00	13.2
MERIT	140.83	52.77	10.77	177.33	42.00	1.00	95.00	12.7
BUSCH AGR 1202	140.70	52.10	12.13	177.33	39.27	1.00	94.00	Missing
H3860224	139.77	53.07	13.73	180.67	40.27	.33	93.00	13.5
JERSEY	137.27	53.23	13.53	181.67	40.27	.67	92.00	12.4
COORS C37	137.13	54.67	11.27	182.33	37.80	.00	98.00	12.4
MTLB 30	137.03	53.37	12.33	178.67	41.63	1.00	94.00	13.2
GALLATIN	136.90	53.90	11.87	176.00	42.23	.67	94.00	12.8
MT970129	130.77	54.00	11.10	182.67	36.50	.67	91.00	13.1
MT960045	130.67	53.77	12.97	184.00	36.87	.67	90.00	12.7
MOREX	127.63	50.07	10.60	173.67	44.87	2.67	93.00	13.4
WPB BZ594-35	123.67	60.93	16.33	176.67	35.30	.33	85.00	14.7
Mean	149.35	53.51	12.58	177.42	40.32	0.84	94.00	12.78
C.V.	8.10	1.02	13.07	0.60	4.17	88.8		
LSD (.05)	19.56	0.88	2.66	1.71	2.72	1.20		

PROJECT TITLE: Evaluation of malt barley variety performance in Kalispell, MT.

PROJECT LEADERS: Doug Holen, Research Associate, NWARC
Mal Westcott, Soil Scientist, WARC
Bob Stougaard, Weed Scientist, NWARC

PROJECT PERSONNEL: Tom Blake, Barley Breeder, Bozeman, MT
Pat Hensleigh, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate the agronomic and quality performance of malt barley varieties compared to feed varieties in environments and cropping systems representative of western Montana.

RESULTS:

Cool temperatures resulted in slow germination and plant development through June. Well below normal growing season precipitation did not impact yield as soil available water was adequate at critical plant developmental stages. Scouting identified Cereal Leaf Beetle populations approaching economic thresholds but were not sprayed and little crop damage was noted. Yields ranged from 125 to 154 bu/A with a nursery mean of 141 bu/A. High yields and test weights (mean = 52.8 lbs/bu) occurred in the absence of disease and lodging pressure. Kernel plumpness was very good with an average of 97 percent and proteins ranged from 11.1 to 12.7 percent.

SUMMARY:

This study was initiated to identify those malting cultivars which could hold quality in an environment conducive to high yields, diseases, lodging, and sprouting. Yield and test weights excelled in the absence of disease and lodging pressure. No detrimental conditions existed during the 1999 growing season to differentiate the quality characteristics of the malting varieties grown under typical environmental western Montana conditions.

FUTURE PLANS:

The state malt nursery will be grown at Kalispell in 2000 to document agronomic and quality performance of malt and feed barley varieties in western Montana.

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

Planted: April 7, 1999 Harvested: August 24, 1999

VARIETY	Yield Bu/A	Test Wt Lb/Bu	Moist %	Hd Date Julian	Height Inch	Lodge 0-9	Agro 0-9	Plump %	Protein %
Foster	154.27	50.60	10.77	174.33	41.87	.67	4.33	97.00	11.1
Merit	154.27	52.23	14.80	179.00	42.90	1.00	5.67	95.00	11.2
Moravian 22	151.73	52.83	12.20	182.33	38.07	.33	5.00	98.00	11.3
MTLB 05	149.30	53.50	12.37	175.67	39.63	.67	5.00	96.00	12.5
Chinook	146.63	53.97	14.33	174.67	40.80	.67	4.33	96.00	12.3
MT910189	144.23	54.37	12.80	172.00	38.20	1.00	4.33	98.00	11.6
Baronesse	143.23	52.83	11.60	176.67	37.93	.00	5.67	98.00	11.5
Harrington	143.10	53.50	11.70	177.00	40.30	.33	5.00	96.00	12.0
Coors 37	140.10	54.33	13.07	180.67	36.37	.33	3.67	99.00	11.8
Gallatin	137.40	53.97	14.30	174.00	41.33	.67	5.00	95.00	11.4
Busch Agr 1202	137.37	53.00	12.07	176.67	40.57	1.00	5.00	98.00	12.3
Galena	134.90	53.03	14.07	181.00	35.13	.67	5.33	97.00	11.7
Stander	132.40	51.30	12.43	173.33	38.73	.00	4.00	98.00	11.8
Robust	131.97	51.77	11.77	174.00	44.50	.33	3.67	98.00	12.3
Menuet	128.37	53.90	13.67	177.33	38.57	.67	5.33	97.00	11.9
Morex	124.60	50.27	10.10	173.00	45.97	3.00	2.67	96.00	12.7
Mean	140.87	52.84	12.63	176.35	40.05	0.71	4.63	97.00	11.8
C.V.	4.68	0.64	10.91	0.52	4.54	71.2	11.4		
LSD (.05)	11.00	0.57	2.30	1.52	3.03	0.84	0.88		

PROJECT TITLE: Evaluation of malt barley variety performance in Corvallis, MT.

PROJECT LEADERS: Doug Holen, Research Associate, NWARC
Mal Westcott, Soil Scientist, WARC
Bob Stougaard, Weed Scientist, NWARC

PROJECT PERSONNEL: Tom Blake, Barley Breeder, Bozeman, MT
Pat Hensleigh, Research Associate, Bozeman, MT

OBJECTIVES:

To evaluate the agronomic and quality performance of malt barley varieties compared to feed varieties in environments and cropping systems representative of western Montana.

RESULTS:

The growing season began with good stand establishment and ended with excellent yields. Irrigation at critical plant stages aided development and grain fill as natural precipitation was well below normal. Scouting identified Cereal Leaf Beetle populations approaching economic thresholds and were sprayed on June 22nd with little crop damage noted. Yields ranged from 111 to 170 bu/A with a nursery mean of 144 bu/A. Malting types Stander and Harrington yielded comparable to the feed check varieties Menuet and Gallatin. A late windstorm combined with high yields resulted in moderately heavy lodging which didn't effect overall test weights (mean = 52.0lbs/bu) but did hinder seed plump percentages. Protein percentages ranged from 12.4 to 14.5.

SUMMARY:

This study was initiated to identify those malting cultivars which could hold quality in an environment conducive to high yields, diseases, lodging, and sprouting. Yield and test weights excelled under irrigated conditions in the absence of disease pressure. While significant lodging did inhibit kernel plumpness to some extent, disease and untimely rain events at maturity were absent for good identification of those cultivars able to hold quality under typical western Montana conditions. Only four of the 12 malting types (Stander, Harrington, Foster, and MT910189) were below the malting industry protein ceiling standard of 13 percent.

FUTURE PLANS:

The state malt nursery will be grown in Corvallis in 2000 to document agronomic and quality performance of malt and feed barley varieties in western Montana.

Table 1. Agronomic data from the State Malt Barley Nursery grown at the Western Agricultural Research Center in Corvallis, MT.

Planted: April 26, 1999 Harvested: August 31, 1999

VARIETY	Yield Bu/A	Test Wt Lb/Bu	Height Inch	Lodge 0-9	Plump %	Protein %
Menuet	170.23	53.80	40.33	1.67	89.00	12.9
Stander	168.17	52.47	42.67	5.00	91.00	12.4
Harrington	158.63	52.37	41.83	5.33	81.00	12.9
Gallatin	154.80	52.63	39.00	4.33	78.00	13.2
Galena	153.80	51.43	36.00	3.33	76.00	13.7
Baronesse	152.30	52.00	40.00	5.00	84.00	13.9
Busch Agr 1202	146.77	51.20	40.00	5.00	85.00	13.4
Foster	141.30	51.47	42.67	3.33	96.00	12.6
MT910189	141.07	52.63	38.00	7.33	88.00	12.6
Robust	140.07	52.80	46.83	4.67	91.00	13.5
Chinook	140.03	52.00	40.00	8.00	74.00	14.5
Morex	137.63	50.90	43.83	3.67	91.00	13.9
Coors 37	133.73	52.90	37.67	2.00	85.00	13.0
Merit	130.40	50.90	44.83	5.00	81.00	14.1
MTLB 05	129.93	52.87	41.67	3.33	88.00	14.0
Moravian 22	111.33	50.27	38.83	5.33	82.00	13.5
Mean	144.39	52.04	40.89	4.52	85.00	13.4
C.V.	13.98	1.64	5.07	58.3		
LSD (.05)	33.65	1.42	3.45	4.39		

PROJECT TITLE: Evaluation of spring barley variety performance in off-station trials near Ronan, MT.

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Tom Blake, Barley Breeder, Bozeman, MT
Pat Hensleigh, Research Associate, Bozeman, MT
Jack Stivers, Lake Co. Extension Agent, Ronan, MT
Lake Seed Inc., Ronan, MT

OBJECTIVES:

To evaluate the performance of spring barley varieties in environments and cropping systems representative of west-central Montana.

RESULTS:

Harsh conditions persisted throughout the 1999 growing season. Emergence, stand, and tillering were adversely affected by dry, cold soils through June. A late frost and cereal leaf beetle infestations also inhibited yield to some extent. Plots were irrigated twice to supplement below average rainfall. Yields ranged from 68 to 84 bu/A with an 18 entry average of 76 bu/A. Test weights were excellent ranging from 52.4 to 54.6 lbs/bu under light lodging pressure and hot-dry conditions throughout grain-fill. Protein and seed plump percentages were high, averaging 15.1 and 90.2 respectively.

SUMMARY:

Despite multiple adverse growing conditions, yield met and test weights exceeded area producer expectations. The cold-dry conditions followed by a hot-dry environment resulted in little to no lodging or disease pressure. A 16 bu/A difference existed between the highest (Xena) and poorest (Harrington) yielding cultivars.

FUTURE PLANS:

Spring barley variety evaluations will continue in Lake County.

Table 1. Agronomic data from the Off-station Spring Barley Nursery at Lake Seed Inc. in Ronan, MT.

Planted: April 16, 1999 Harvested: August 26, 1999

VARIETY	Yield Bu/A	Test Wt Lbs/Bu	Height Inch	Lodge 0-9	Plump %	Protein %
XENA	83.90	53.43	30.67	1.00	92.00	14.3
HECTOR	83.43	53.90	31.73	2.00	88.00	15.6
BARONESSE	83.07	52.43	29.03	1.33	91.00	15.1
MT950186	81.93	54.60	29.27	.67	97.00	14.5
MT960228	81.80	53.10	27.30	1.00	89.00	14.2
CHINOOK	81.73	53.97	30.57	1.67	91.00	15.2
GALLATIN	77.17	53.63	29.53	1.33	87.00	15.3
MTLB 13	76.33	52.60	26.80	1.00	85.00	15.1
MT920073	76.20	53.13	28.87	1.00	97.00	15.3
MTLB 5	75.97	53.30	29.77	1.33	92.00	15.3
BOWMAN	74.93	53.43	26.77	1.67	93.00	14.7
GALENA	73.60	53.70	26.53	.67	93.00	15.6
STARK	72.90	53.87	31.33	1.33	92.00	14.8
MTLB 6	72.43	52.80	26.27	1.00	88.00	15.7
LEWIS	71.43	53.67	30.33	1.67	92.00	15.6
VALIER	69.60	53.33	29.40	.67	89.00	15.3
MENUET	68.60	52.93	29.13	1.00	86.00	15.3
HARRINGTON	68.40	53.07	30.83	1.33	82.00	15.7
Mean	76.30	53.38	29.12	1.20	90.22	15.1
C.V.	8.59	1.05	6.61	33.5		
LSD (.05)	10.87	0.93	3.20	0.67		

PROJECT TITLE: Montana Statewide Spring Oat Variety Performance

PROJECT LEADERS: Bob Stougaard, Weed Scientist, NWARC
Doug Holen, Research Associate, NWARC

PROJECT PERSONNEL: Tom Blake, Barley Breeder, Bozeman, MT
Pat Hensleigh, Research Associate, Bozeman, MT

OBJECTIVES:

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

RESULTS:

Cool temperatures resulted in slow germination and plant development through June. Well below average growing season precipitation did not impact yield as soil available water was adequate at critical developmental stages. Yields ranged from 156 to 253 bu/A with a high nursery mean of 217 bu/A. Tests weights were also high in the absence of diseases and lodging. As in past years, Monida yielded best (253 bu/A), Otana had the highest test weight (39.6 lbs/bu), and Ajay displayed good lodging resistance. It should be noted that entries Paul, 86AB1616, and 88AB3073 are hulless cultivars.

SUMMARY:

Yield and test weights excelled in the absence of diseases and minimal lodging.

FUTURE PLANS:

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

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

Planted: April 7, 1999 Harvested: August 24, 1999

VARIETY	Yield Bu/A	Test Wt Lb/Bu	Lodge 0-9	Height Inch	Hd Date Julian
Monida	252.90	36.6	1.00	45.70	181.67
Otana	241.97	39.6	2.00	48.67	178.33
Powell	238.70	35.6	.67	38.20	181.33
Celsia	231.10	35.9	.67	47.37	180.33
ABSP 9-2	230.00	38.2	.67	43.83	177.33
Rio Grande	228.90	38.5	1.00	40.83	174.33
ABSP19-9	227.83	36.3	.00	43.43	183.00
87AB5125	226.77	36.5	.00	39.00	178.00
ND860416	226.73	39.0	1.67	45.53	174.67
90Ab1322	221.27	37.7	.00	37.40	178.00
Whitestone	211.47	37.8	.33	40.53	177.33
Ajay	211.43	36.7	.00	33.90	177.67
Prairie	207.07	35.4	.00	41.63	173.33
Paul	178.73	43.5	1.00	50.53	179.00
86AB1616	176.60	40.4	.33	45.03	183.00
88Ab3073	155.90	44.0	.00	39.67	180.33
Mean	216.71	38.2	0.58	42.58	178.60
C.V.	7.51		142	2.68	0.62
LSD (.05)	27.14		1.39	1.90	1.84

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: 1999/ 755
TITLE: **Intrastate Alfalfa Yield Trials - Irrigated & Dryland**
PROJECT LEADERS: Ray Ditterline / Robert Dunn, MSU-Bozeman
COOPERATORS: Leon Welty / Louise Strang, MSU-NWARC

Alfalfa varieties were established each spring at dryland and irrigated sites from 1996 to 1998. All trials were harvested 3 times in 1999: mid June, late July, and late September to early October (after frost) for the 1997 and 1998 trials, and early September for the 1996 trials. The 1996 trials were plowed down after the last harvest.

Precipitation from April through August was 8.17 inches (19% below average), with April and May much below normal. Because of drier than average weather from September through January, moisture was lacking for the growing season.

The 1996 dryland trial had retained at least 80% of its stands (Table 1a). The most productive cultivars over the 4-year duration of the trial were 'XAL 46', '5454', 'Hyland', 'WL 324', and 'Rainier', and the lowest were 'Ladak 65', '329', 'Legendairy 2.0', 'MT 9309', 'MT 9303', and 'MT 9305' (Table 1b). Mean total yield was 19.51 tons/acre. The 1996 irrigated trial had recovered and retained at least 88% of its stands (Table 2a). Over the 4-year life of the nursery, mean total yield was 13.18 tons/acre, with 'Hyland' the top yielding variety overall (15.05 tons/acre) and 'MT 9309' the lowest yielding (11.57 tons/acre) (Table 2b). Because this was a heavy soil moist site, *Vert* wilt resistance was an important factor in stand persistence. Total production of the irrigated trial was lower than the dryland trial because of stand loss in 1997 due to standing water.

The 1997 dryland trial averaged 4.83 tons/acre in 1999. (Table 3a) Pioneer 5396 was most productive, with 5.48 tons/acre in 1999 and 15.09 tons/acre from 1997-99 (Table 3b). The 1997 irrigated trial had excellent spring stands, with the exception of 'Riley' which established poorly the seeding year. Total 1998 production (3 cuttings) averaged 5.74 tons/acre. 'DK 140' and Pioneer '5396' had the highest yields in 1999 and over the duration of the trial (Table 4a & b).

'Millennia' experienced major winterkill in the 1998 trials. 1999 yields averaged 4.65 tons/acre in the dryland trial (Table 5a) and 6.41 tons/acre in the irrigated trial (Table 6a). 'Enhancer' had the highest yields in the dryland trial with 5.98 tons/acre in 1999 and 8.18 tons/acre for the 2-year total yield (Table 5b). '53V08' had the highest 1999 yield for the irrigated trial with 7.14 tons/acre, and 'Magnum V', Enhancer, and 53V08 produced over 10 tons/acre from 1998 to 1999 (Table 6b).

Table 1a. Total dry matter yields for the 1996 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1999.

					Dry Matter Yield			
					6/15	*7/27*	*9/1*	1999
Cultivar	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	Total
				%	*t/a*	*t/a*	*t/a*	*t/a*
XAL 46	314	-	-	91	3.03	2.02	1.57	6.62
Magnagraze	323	3	R	93	2.91	1.90	1.46	6.27
Hyland	322	3	R	91	2.90	1.88	1.46	6.23
5454	263	4	MR	93	2.85	1.83	1.48	6.17
Wrangler	146	2	LR	93	2.93	1.78	1.30	6.01
WL 324	318	3	R	93	2.87	1.77	1.36	5.99
MT 9316	334	-	-	90	2.96	1.69	1.19	5.84
Magnum III	238	4	MR	91	2.72	1.75	1.37	5.84
Rainier	320	3	R	90	2.79	1.67	1.32	5.78
Ladak 65	2	1	-	91	2.84	1.70	1.13	5.66
Oasis 371	324	-	-	94	2.75	1.67	1.25	5.66
MT 9310	332	-	-	89	2.72	1.67	1.19	5.58
WL 325 HQ	319	3	R	89	2.54	1.68	1.30	5.52
Oneida VR	309	3	HR	90	2.62	1.62	1.22	5.46
MT 9503	335	-	-	85	2.59	1.60	1.21	5.39
Affinity+Z	315	4	HR	90	2.58	1.59	1.19	5.36
Excalibur II	248	-	-	89	2.46	1.61	1.26	5.33
MT 9308	330	-	-	89	2.59	1.52	1.15	5.25
329	317	3	HR	85	2.30	1.69	1.23	5.22
MT 9321	333	-	-	88	2.59	1.50	1.13	5.21
MT 9306	329	-	-	90	2.51	1.53	1.15	5.19
Bighorn	316	4	R	81	2.30	1.57	1.25	5.12
Legendairy 2.0	321	3	R	88	2.36	1.55	1.17	5.08
MT 9309	331	-	-	85	2.49	1.50	1.07	5.05
Riley	122	4	LR	85	2.41	1.43	1.13	4.96
MT 9302	325	-	-	86	2.35	1.46	1.12	4.93
Ultra	229	3	R	85	2.32	1.48	1.12	4.92
MT 9303	326	-	-	90	2.36	1.34	0.99	4.68
MT 9305	328	-	-	88	2.16	1.39	1.07	4.62
MT 9304	327	-	-	81	2.06	1.39	1.08	4.52
mean				89	2.59	1.62	1.23	5.45
LSD(0.05)				5	0.34	0.21	0.15	0.66
CV(s/mean) %				4.1	9.3	9.2	8.8	8.6

[1] Fall Dormancy rating

[2] Vert Wilt resistance

Table 1b. Total dry matter yields for the 1996 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1996 to 1999.

				Dry Matter Yield				
Cultivar	MTNo	FD[1]	VW[2]	1996	1997	1998	1999	1996-1999 Total
				t/a	*t/a*	*t/a*	*t/a*	*t/a*
XAL 46	314	-	-	2.93	5.48	7.45	6.62	22.47
5454	263	4	MR	2.84	5.38	6.93	6.17	21.31
Hyland	322	3	R	2.81	5.41	6.82	6.23	21.26
WL 324	318	3	R	3.05	5.42	6.62	5.99	21.09
Rainier	320	3	R	2.80	5.58	6.83	5.78	20.98
Bighorn	316	4	R	3.04	5.66	6.70	5.12	20.52
Magnagraze	323	3	R	2.72	5.25	6.64	6.27	20.18
Magnum III	238	4	MR	2.46	5.14	6.55	5.84	19.99
WL 325 HQ	319	3	R	2.66	5.28	6.51	5.52	19.97
Affinity+Z	315	4	HR	2.93	5.28	6.15	5.36	19.71
Excalibur II	248	-	-	2.68	5.21	6.47	5.33	19.68
Ultra	229	3	R	2.95	5.69	6.09	4.92	19.65
Wrangler	146	2	LR	2.45	5.12	6.05	6.01	19.64
Oasis 371	324	-	-	2.41	4.99	6.48	5.66	19.53
MT 9321	333	-	-	2.75	5.22	6.26	5.21	19.44
MT 9304	327	-	-	2.81	5.68	6.36	4.52	19.36
Oneida VR	309	3	HR	2.30	5.33	6.25	5.46	19.33
MT 9308	330	-	-	2.94	5.17	5.76	5.25	19.11
MT 9310	332	-	-	2.47	5.20	5.83	5.58	19.07
MT 9503	335	-	-	2.85	5.54	6.14	5.39	19.05
MT 9316	334	-	-	2.41	4.71	6.05	5.84	19.02
Riley	122	4	LR	2.61	5.48	5.85	4.96	18.90
MT 9306	329	-	-	2.80	4.97	5.76	5.19	18.70
MT 9302	325	-	-	2.90	5.16	5.60	4.93	18.58
MT 9305	328	-	-	2.70	5.35	5.85	4.62	18.51
MT 9309	331	-	-	2.52	5.32	5.56	5.05	18.45
329	317	-	-	2.59	4.46	6.13	5.22	18.40
Legendairy 2.0	321	3	R	2.49	4.76	6.07	5.08	18.39
Ladak 65	2	1	-	2.62	4.67	5.23	5.66	18.18
MT 9303	326	-	-	2.53	4.39	5.15	4.68	16.75
mean				2.70	5.21	6.20	5.45	19.51
LSD(0.05)				NS	NS	0.55	0.66	1.83
CV(s/mean) %				12.6	12.5	6.3	8.6	6.7

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Fertilizer: preplant - 25 lbs/a N + 120 lbs/a P_2O_5
4/2/98 - 22 lbs/a N + 104 lbs/a P_2O_5
4/2/99 - 13 lbs N + 62 lbs P_2O_5

Table 2a. Total dry matter yields for the 1996 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1999.

					Dry Matter Yield			
					6/24	*7/29*	*9/3*	1999
Cultivar	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	Total
				%	*t/a*	*t/a*	*t/a*	*t/a*
Hyland	322	3	R	93	2.71	1.30	1.08	5.08
Magnagraze	323	3	R	96	2.62	1.24	1.01	4.86
Wrangler	146	2	LR	95	2.80	1.15	0.91	4.86
WL 325 HQ	319	3	R	96	2.55	1.26	1.04	4.85
5454	263	4	MR	96	2.66	1.20	0.98	4.84
XAL 46	314	-	-	93	2.56	1.24	1.02	4.82
Oneida VR	309	3	HR	95	2.61	1.22	0.97	4.80
Rainier	320	3	R	96	2.61	1.15	1.02	4.78
Oasis 371	324	-	-	96	2.69	1.15	0.90	4.73
Magnum III	238	4	MR	96	2.57	1.15	0.98	4.70
WL 324	318	3	R	94	2.50	1.14	0.95	4.58
329	317	3	HR	96	2.42	1.16	1.01	4.58
Bighorn	316	4	R	94	2.41	1.09	1.02	4.52
Ultra	229	3	R	94	2.54	1.02	0.92	4.47
Excalibur II	248	-	-	95	2.35	1.08	1.00	4.42
Legendairy 2.0	321	3	R	96	2.34	1.08	0.95	4.37
MT 9321	333	-	-	94	2.48	0.99	0.83	4.30
MT 9503	335	-	-	95	2.41	1.04	0.83	4.28
Affinity+Z	315	4	HR	95	2.41	1.00	0.82	4.23
MT 9310	332	-	-	89	2.48	0.96	0.78	4.21
MT 9303	326	-	-	93	2.45	0.95	0.72	4.12
MT 9305	328	-	-	93	2.35	0.93	0.81	4.09
MT 9304	327	-	-	91	2.26	1.00	0.83	4.08
MT 9306	329	-	-	93	2.31	0.97	0.74	4.02
MT 9308	330	-	-	89	2.29	0.90	0.74	3.92
Riley	122	4	LR	90	2.31	0.86	0.74	3.90
MT 9316	334	-	-	91	2.22	0.93	0.74	3.89
Ladak 65	2	1	-	88	2.40	0.76	0.61	3.77
MT 9309	331	-	-	90	2.13	0.84	0.66	3.63
MT 9302	325	-	-	88	1.97	0.83	0.71	3.51
mean				93	2.45	1.05	0.88	4.37
LSD(0.05)				4	0.28	0.12	0.15	0.51
CV(s/mean) %				3.3	8.2	8.2	12.0	8.3

[1] Fall Dormancy rating

[2] Vert Wilt resistance

Seeding date: 5/10/96

Table 2b. Total dry matter yields for the 1996 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1996 to 1999.

		Dry Matter Yield				
						1996-1999
Cultivar	MTNo	1996	1997	1998	1999	Total
		t/a	*t/a*	*t/a*	*t/a*	*t/a*
Hyland	322	1.28	2.86	5.82	5.08	15.05
Ultra	229	1.36	3.08	5.83	4.47	14.72
Rainier	320	1.15	2.88	5.57	4.78	14.38
WL 325 HQ	319	1.18	2.56	5.74	4.85	14.34
Wrangler	146	0.84	2.66	5.91	4.86	14.27
Oasis 371	324	1.14	2.79	5.59	4.73	14.26
Magnum III	238	1.19	2.79	5.46	4.70	14.13
Magnagraze	323	1.30	2.64	5.29	4.86	14.09
Oneida VR	309	0.80	2.38	6.02	4.80	14.01
329	317	1.09	2.70	5.57	4.58	13.94
WL 324	318	1.05	2.51	5.39	4.58	13.53
XAL 46	314	1.00	2.33	5.35	4.82	13.49
Legendairy 2.0	321	0.91	2.80	5.28	4.37	13.37
Excalibur II	248	1.02	2.50	5.33	4.42	13.28
MT 9305	328	1.15	2.91	5.09	4.09	13.24
MT 9321	333	0.93	2.37	5.61	4.30	13.21
MT 9503	335	1.03	2.55	5.34	4.28	13.20
5454	263	1.35	2.57	5.24	4.84	13.20
Bighorn	316	1.25	2.66	5.28	4.52	12.88
MT 9310	332	0.86	2.47	5.22	4.21	12.77
Affinity+Z	315	0.96	2.37	4.92	4.23	12.48
MT 9304	327	0.86	2.32	5.13	4.08	12.39
MT 9308	330	1.15	2.61	4.71	3.92	12.39
MT 9303	326	0.81	2.33	5.02	4.12	12.28
MT 9306	329	1.00	2.23	4.82	4.02	12.06
MT 9316	334	0.71	2.33	4.92	3.89	11.84
MT 9302	325	1.07	2.19	4.88	3.51	11.65
Ladak 65	2	0.74	2.02	5.12	3.77	11.65
Riley	122	0.96	2.36	4.42	3.90	11.63
MT 9309	331	0.91	2.24	4.78	3.63	11.57
mean		1.03	2.53	5.29	4.37	13.18
LSD(0.05)		0.25	0.52	0.54	0.51	1.58
CV(s/mean) %		17.5	14.6	7.30	8.3	8.6

Seeded 5/10/96
Fertilizer: preplant - 44 lbs/a N + 208 lbs/a P_2O_5
4/2/98 - 22 lbs/a N 104 lbs/a P_2O_5
4/2/99 - 13 lbs N/a + 62 lbs P_2O_5/a

Table 3a. Total dry matter yields for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1999.

					Dry Matter Yield			
					6/17	*7/26*	*10/5*	1999
Cultivar	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	TOTAL
				%	*t/a*	*t/a*	*t/a*	*t/a*
5396	345	-	-	98	2.39	1.42	1.67	5.48
Wrangler	146	2	LR	100	2.59	1.47	1.39	5.45
Oneida VR	309	3	HR	98	2.28	1.37	1.58	5.23
Rhino	339	3	R	99	2.41	1.27	1.47	5.15
645	341	3	R	96	2.34	1.33	1.45	5.12
3L 102	336	-	-	98	2.17	1.23	1.61	5.01
DK 140	342	4	R	95	2.11	1.27	1.60	4.98
Ladak 65	2	-	-	99	2.41	1.26	1.25	4.92
Cimmaron 31	338	4	LR	93	2.01	1.21	1.44	4.66
DK 143	344	3	R	95	2.03	1.19	1.31	4.53
Ace	337	4	R	96	1.97	1.23	1.28	4.48
DK 142	343	4	R	95	1.96	1.15	1.30	4.41
Riley	122	4	LR	76	1.85	1.05	1.36	4.26
5301	340	-	-	89	1.80	1.00	1.15	3.95
mean				95	2.17	1.25	1.42	4.83
LSD(0.05)				5	0.37	0.24	0.27	0.79
CV(s/mean) %				3.8	12.0	13.3	13.2	11.4

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

Table 3b. Total dry matter yields for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1997 to 1999.

				Dry Matter Yield			
Cultivar	MTNo	FD[1]	VW[2]	1997	1998	1999	Total
				t/a	*t/a*	*t/a*	*t/a*
5396	345	-	-	2.13	6.57	5.48	15.09
DK 140	342	4	R	2.39	6.30	4.98	14.68
Rhino	339	3	R	2.38	5.95	5.15	14.48
645	341	3	R	2.28	6.01	5.12	14.38
Oneida VR	309	3	HR	2.19	5.79	5.23	14.15
3L 102	336	-	-	2.27	5.93	5.01	14.15
DK 142	343	4	R	2.40	6.27	4.41	14.11
Wrangler	146	2	LR	2.06	5.68	5.45	14.07
DK 143	344	3	R	2.24	5.83	4.53	13.56
Ace	337	4	R	2.02	6.00	4.48	13.35
Cimmaron 31	338	4	LR	2.26	5.29	4.66	13.18
Ladak 65	2	-	-	2.03	5.14	4.92	12.95
5301	340	-	-	2.14	5.33	3.95	12.34
Riley	122	4	LR	1.52	4.15	4.26	10.57
mean				2.17	5.73	4.83	13.65
LSD(0.05)				0.23	0.47	0.79	1.34
CV(s/mean) %				7.4	5.7	11.4	6.9

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Seeding date: 4/26/96

Seeding rate: 8 lbs. PLS/acre

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 4a. Total dry matter yields for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated -1999.

					Dry Matter Yield			
					6/22	*7/30*	*9/29*	
Cultivar	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	Total
				%	*t/a*	*t/a*	*t/a*	*t/a*
5396	345	--	--	95	2.90	1.88	1.79	6.57
DK 140	342	4	R	96	2.74	1.78	1.93	6.45
Ace	337	4	R	96	2.73	1.84	1.59	6.15
Rhino	339	3	R	98	2.73	1.64	1.70	6.07
645	341	3	R	95	2.74	1.67	1.59	5.99
3L 102	336	--	--	96	2.53	1.71	1.65	5.89
DK 142	343	4	R	96	2.45	1.65	1.67	5.77
Oneida VR	309	3	HR	96	2.49	1.63	1.61	5.73
Wrangler	146	2	LR	95	2.72	1.56	1.39	5.67
DK 143	344	3	R	95	2.44	1.63	1.53	5.61
5301	340	--	--	93	2.34	1.60	1.64	5.58
Cimmaron 31	338	4	LR	95	2.22	1.45	1.64	5.31
Ladak 65	2	--	--	96	2.54	1.36	1.19	5.08
Riley	122	4	LR	86	2.05	1.19	1.28	4.52
mean				95	2.54	1.61	1.59	5.74
LSD(0.05)				3	0.22	0.13	0.17	0.37
CV(s/mean) %				2.5	6.1	5.5	7.5	4.5

[1] Fall Dormancy rating

[2] Vert Wilt resistance

Table 4b. Total dry matter yields for the 1997 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1997 to 1999.

				Dry Matter Yield			
Cultivar	MT No	FD[1]	VW[2]	1997	1998	1999	1997-99 Total
				t/a	*t/a*	*t/a*	*t/a*
DK 140	342	4	R	3.13	6.51	6.45	16.10
5396	345	--	--	2.93	6.34	6.57	15.83
DK 142	343	4	R	3.03	6.26	5.77	15.06
Ace	337	4	R	2.91	5.87	6.15	14.92
3L 102	336	--	--	3	5.99	5.89	14.88
5301	340	--	--	3.26	5.88	5.58	14.72
Rhino	339	3	R	2.97	5.53	6.07	14.56
DK 143	344	3	R	2.93	5.94	5.61	14.49
Oneida VR	309	3	HR	2.75	5.80	5.73	14.27
645	341	3	R	2.78	5.49	5.99	14.26
Cimmaron 31	338	4	LR	2.91	5.20	5.31	13.43
Wrangler	146	2	LR	2.56	5.17	5.67	13.39
Ladak 65	2	--	--	2.44	4.58	5.08	12.10
Riley	122	4	LR	2.05	3.95	4.52	10.52
mean				2.83	5.61	5.74	14.18
LSD(0.05)				0.27	0.42	0.37	0.87
CV(s/mean) %				6.6	5.26	4.53	4.26

[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 5a. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1999.

					Dry Matter Yield			
					6/16/99	*7/27/99*	*10/5/99*	1999
Cultivar	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	Total
				%	*t/a*	*t/a*	*t/a*	*t/a*
Enhancer	348	4	R	98	2.57	2.36	1.05	5.98
Imperial	280	3	R	94	2.43	2.23	1.04	5.70
Ripin	349	--	--	94	2.29	2.13	1.00	5.41
Riley	122	4	LR	81	2.07	2.11	1.07	5.26
Innovator+Z	281	3	HR	93	2.22	2.08	0.95	5.25
3L115	355	--	--	95	2.16	1.97	0.97	5.10
Magnum V	347	--	--	98	2.25	2.11	0.73	5.08
Emperor	351	--	--	96	2.07	2.05	0.95	5.07
Reno	357	--	--	90	2.11	1.98	0.98	5.07
Ladak 65	2	--	--	93	2.46	1.87	0.71	5.03
Wrangler	146	2	LR	95	2.13	1.94	0.85	4.92
TMF Multiplier II	359	--	--	90	1.88	1.91	1.02	4.80
Oneida VR	309	3	HR	94	2.01	1.94	0.83	4.78
53V08	346	--	--	94	2.08	1.88	0.78	4.74
Rambo	353	--	--	95	2.21	1.79	0.73	4.73
PS595-106	361	--	--	94	2.12	1.73	0.80	4.65
3L171	358	--	--	96	1.92	1.89	0.81	4.62
631	350	4	R	94	2.07	1.77	0.71	4.55
ZX9852	352	--	--	91	1.76	1.87	0.92	4.54
A-395	362	3	R	94	1.91	1.76	0.80	4.47
NL 91229	363	--	--	91	1.93	1.56	0.70	4.19
Rebound	356	--	--	94	1.65	1.65	0.70	3.99
Enhancer PI	SC981	4	R	95	1.61	1.61	0.55	3.77
Enhancer MiRi	SC982	4	R	95	1.55	1.56	0.61	3.72
NL 90732	360	--	--	95	1.65	1.37	0.53	3.54
Millennia	354	--	--	29	0.64	0.95	0.43	2.02
mean				91	1.99	1.85	0.82	4.65
LSD(0.05)				6	0.59	0.55	0.34	1.36
CV(s/mean) %				4.7	21.1	21.3	29.4	20.8

[1] *Fall Dormancy rating*

[2] *Vert Wilt resistance*

Table 5b. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Dryland - 1998 to 1999.

Cultivar	MTNo	FD[1]	VW[2]	Dry Matter Yield 1998 t/a	1999 t/a	1998-99 Total t/a
Enhancer	348	4	R	2.18	5.98	8.18
Imperial	280	3	R	1.71	5.70	7.48
Ripin	349	--	--	1.93	5.41	7.34
Magnum V	347	--	--	2.10	5.08	7.19
Innovator+Z	281	3	HR	1.71	5.25	6.95
Emperor	351	--	--	1.84	5.07	6.91
3L115	355	--	--	1.61	5.10	6.71
Rambo	353	--	--	1.88	4.73	6.62
Reno	357	--	--	1.50	5.07	6.57
Riley	122	4	LR	1.31	5.26	6.56
Ladak 65	2	--	--	1.43	5.03	6.46
Wrangler	146	2	LR	1.53	4.92	6.44
631	350	4	R	1.76	4.55	6.31
Oneida VR	309	3	HR	1.49	4.78	6.27
53V08	346	--	--	1.53	4.74	6.26
ZX9852	352	--	--	1.59	4.54	6.14
TMF Multiplier II	359	--	--	1.32	4.80	6.13
3L171	358	--	--	1.47	4.62	6.08
PS595-106	361	--	--	1.36	4.65	6.00
A-395	362	3	R	1.50	4.47	5.97
NL 91229	363	--	--	1.40	4.19	5.68
Rebound	356	--	--	1.59	3.99	5.58
NL 90732	360	--	--	1.58	3.54	5.12
Enhancer PI	SC981	4	R	1.34	3.77	5.11
Enhancer MiRi	SC982	4	R	1.20	3.72	4.92
Millennia	354	--	--	1.91	2.02	3.92
mean				1.63	4.65	6.26
LSD(0.05)				0.47	1.36	1.60
CV(s/mean) %				20.50	20.80	18.08

[1] Fall Dormancy rating

[2] Vert Wilt resistance

Seeding date: 4/23/98

Fertilizer: 4/30/98 - 37 lbs/a N + 177lbs/a P_2O_5

Table 6a. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1999.

					Dry Matter Yield			
					6/22	*7/30*	*9/29*	
Cultivar	MTNo	FD[1]	VW[2]	Stand	Harvest-1	Harvest-2	Harvest-3	Total
				%	*t/a*	*t/a*	*t/a*	*t/a*
53V08	346	3	HR	99	3.36	1.99	1.79	7.14
Enhancer	348	4	R	98	3.29	1.93	1.83	7.06
PS595-106	361	--	--	96	3.34	1.91	1.78	7.03
Oneida VR	309	3	HR	96	3.37	1.86	1.78	7.00
Magnum V	347	--	--	100	3.18	1.95	1.83	6.96
Rebound	356	--	--	99	3.11	1.94	1.86	6.91
631	350	4	R	98	3.03	1.91	1.83	6.77
Reno	357	--	--	95	3.05	1.85	1.72	6.62
Imperial	280	3	R	98	3.15	1.79	1.66	6.60
Ripin	349	4	R	98	2.95	1.79	1.81	6.54
Enhancer PI	SC981			96	3.08	1.74	1.69	6.50
3L115	355	--	--	98	2.98	1.68	1.77	6.42
Innovator+Z	281	3	HR	95	3.07	1.73	1.61	6.41
NL 90732	360	--	--	96	2.97	1.68	1.75	6.40
Enhancer MiRi	SC982			95	3.02	1.72	1.65	6.40
Rambo	353	3	HR	99	2.96	1.76	1.64	6.37
3L171	358	--	--	96	2.86	1.73	1.78	6.37
TMF Multiplier II	359	--	--	96	3.02	1.66	1.68	6.36
A-395	362	3	R	96	3.05	1.68	1.62	6.35
Emperor	351	4	HR	99	2.86	1.80	1.59	6.25
NL 91229	363	--	--	95	2.88	1.70	1.65	6.23
Wrangler	146	2	LR	95	3.06	1.59	1.57	6.22
ZX9852	352	--	--	94	2.64	1.74	1.72	6.10
Ladak 65	2	2	--	95	3.06	1.51	1.41	5.98
Riley	122	4	LR	95	2.77	1.48	1.53	5.78
Millennia	354	4	R	40	1.20	1.15	1.57	3.91
mean				94	2.97	1.74	1.70	6.41
LSD(0.05)				5	0.32	0.14	0.15	0.56
CV(s/mean) %				3.5	7.6	5.5	6.3	6.2

[1] Fall Dormancy rating

[2] Vert Wilt resistance

Table 6b. Total dry matter yields for the 1998 Intrastate Alfalfa Yield Trial at Kalispell - Irrigated - 1998 to 1999.

				Dry Matter Yield		
						1998-99
Cultivar	MTNo	FD[1]	VW[2]	1998	1999	Total
				t/a	*t/a*	*t/a*
Magnum V	347	--	--	3.40	6.96	10.36
Enhancer	348	4	R	3.05	7.06	10.11
53V08	346	3	HR	2.92	7.14	10.06
631	350	4	R	3.17	6.77	9.94
PS595-106	361	--	--	2.91	7.03	9.94
Oneida VR	309	3	HR	2.93	7.00	9.93
Rebound	356	--	--	3.00	6.91	9.92
Ripin	349	4	R	3.32	6.54	9.86
Reno	357	--	--	2.93	6.62	9.54
Imperial	280	3	R	2.84	6.60	9.44
NL 90732	360	--	--	2.99	6.40	9.39
Enhancer PI	SC981				6.50	9.27
A-395	362	3	R	2.87	6.35	9.21
3L115	355	--	--	2.76	6.42	9.18
TMF Multiplier II	359	--	--	2.81	6.36	9.17
Emperor	351	4	HR	2.91	6.25	9.16
Innovator+Z	281	3	HR	2.70	6.41	9.10
Rambo	353	3	HR	2.73	6.37	9.10
3L171	358	--	--	2.71	6.37	9.08
ZX9852	352	--	--	2.89	6.10	8.99
NL 91229	363	--	--	2.69	6.23	8.92
Wrangler	146	2	LR	2.64	6.22	8.86
Enhancer MiRi	SC982			2.87	6.40	8.85
Ladak 65	2	2	--	2.35	5.98	8.33
Riley	122	4	LR	2.16	5.78	7.93
Millennia	354	4	R	3.17	3.91	7.08
				0.41		
mean				10.19	6.41	9.26
LSD(0.05)					0.56	0.81
CV(s/mean) %					6.17	6.24

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

Seeding date: 4/27/98
Fertilizer: 4/30/98 - 44 lbs/a N + 208 lbs/a P_2O_5
4/2/99 - 13 lbs./a N + 62 lbs./a P_2O_5

TITLE: **1999 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. Establishment was difficult due to severe weed pressure. Two pints/acre of 2,4-DB amine plus 1 qt/a Poast plus 1 qt/acre Dash were applied June 1. On June 14, 1.08 qt/a Pursuit plus 1.5 pt/a Sun-It were applied.

The study was harvested July 28. Mean yield was 0.77 tons/acre. 'Ladak 65' alfalfa and 'RDWY' sainfoin were most productive. 'Eski' sainfoin, 'Tretana' birdsfoot trefoil, and the cicer milkvetches produced less than 0.20 tons/acre for this cutting. The study was cut again Oct.4. The sainfoins regrew best of the legumes. For total first year yields, RDWY produced significantly more forage than any other entry. The sainfoins, with the exception of Eski, produced more than the trefoils and milkvetches.

Height, maturity stages at harvest and dry matter yields of Perennial Forage Legumes in 1999.

Entry	*7/26/99* Height *inches*	*7/28/99* Stage	*7/28* 1st Harvest *tons/acre*	*10/4* 2nd Harvest *tons/acre*	Total *tons/acre*
RDWY Sainfoin	21.5	mid bloom	1.48	2.29	3.78
97-1 Sainfoin	20.8	early bloom	1.22	2.19	3.42
Alfalfa+Sainfoin 3+16[1/]	20.3	early bloom	1.28	2.00	3.29
WYPX 2-94 Sainfoin	17.0	1st bloom	0.98	2.17	3.15
Ladak 65 alfalfa	22.8	bud	1.55	1.59	3.13
Remont Sainfoin	19.0	early bloom	0.92	2.11	3.03
AC Grazeland alfalfa	23.3	bud	1.36	1.65	3.00
Alfalfa+Sainfoin 3+8[1/]	20.8	early bloom	1.14	1.84	2.97
L-2 Synthetic B.Trefoil	9.5	early bloom	0.39	0.85	1.24
Eski Sainfoin	11.0	bud	0.19	0.56	0.74
Tretana B.Trefoil	6.8	1st bloom	0.09	0.55	0.63
Windsor Cicer Milkvetch	7.8	vegetative	0.08	0.30	0.38
Monarch Cicer Milkvetch	7.5	vegetative	0.12	0.21	0.33
Lutana Cicer Milkvetch	7.8	vegetative	0.05	0.17	0.22
mean	15.4		0.77	1.32	2.09
LSD(0.05)	2.6		0.15	0.23	0.29
CV(s/mean) %	11.7		13.9	12.3	9.6

[1/] *lbs/a planted seed*

TITLE: **1996 Meadow Bromegrass Trial - Kalispell - Irrigated**
PROJECT LEADER: Dennis Cash, MSU-Bozeman
COOPERATORS: Leon Welty / Louise Strang, MSU-NWARC

A trial comparing 6 meadow bromegrass cultivars was seeded on May 10, 1996. Cultivars included 'Regar', 'Fleet', 'Paddock', and 3 experimental lines. In August,1999, all cultivars were harvested for seed yield to determine if a 4th year stand of any cultivar would produce more seed than Regar. 'Mb-1', 'Mb-2', and Fleet produced the most seed. 'Mb-3' and Regar produced significantly less seed.

1996-1999 Forage Yields and 1999 Seed Production of 6 Meadow Bromegrass Cultivars planted at Kalispell in 1996

Cultivar	1996 Forage *t/a*	1997 Forage *t/a*	1998 Forage *t/a*	1996-98 Forage t/a	1999 Seed Yield lbs/a
Mb-1	1.19	6.51	5.44	13.14	336
Mb-2	1.34	6.74	5.33	13.40	270
Mb-3	1.09	6.66	5.30	13.05	177
Regar	0.93	6.73	5.41	13.07	103
Fleet	1.36	6.42	5.42	13.20	289
Paddock	1.44	6.69	5.42	13.55	217
MEAN	1.22	6.62	5.39	13.24	232
LSD(0.05)	0.28	NS	NS	NS	76

Fertilizer: **4/10/96 - 85 lbs/a N + 45 lbs/a P_2O_5 + 50 lbs/a K_2O + 20 lbs/a SO_2**
5/24/97 - 60 lbs N/a
4/2/99 - 113 lbs N/a + 62 lbs P_2O_5/a

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 Orchardgrass cultivars. Establishment was difficult due to severe weed pressure. The study was first harvested July 28. Mean yield was 2 tons/acre, with no significant differences among cultivars. It was cut again Oct.4 with discernable differences in regrowth among entries. All orchardgrass yields were higher than any timothy. Timothy cv 'TM9710-02' yielded more than the other cultivars of the species, and total yearly production of this cultivar was similar to the orchardgrass.

Dry Matter Yields in the Timothy Trial at Kalispell - 1999.

Cultivar	Species	*7/28/99* Harvest-1 *t/a*	*10/4/99* Harvest-2 *t/a*	1999 Total *t/a*
Benchmark	Orchardgrass	1.92	2.14	4.06
OG9202	Orchardgrass	1.93	2.04	3.96
Haymate	Orchardgrass	1.91	1.88	3.79
OG9503	Orchardgrass	1.97	1.74	3.70
TM9710-02	Timothy	2.27	1.42	3.69
Colt	Timothy	2.02	0.59	2.61
TM8903	Timothy	1.98	0.60	2.58
mean		2.00	1.49	3.48
LSD(0.05)		NS	0.54	0.72
CV(s/mean) %		12.4	24.3	13.9

Seeded 5/5/99
Fertilizer: **5/14/99 - 50 lbs/a N + 234 lbs/a P_2O_5**
5/17/99 - 70 lbs/a N

TITLE: **1999 Spring Cereal Forage Trial - Dryland**
PROJECT LEADER: Dave Wichman, MSU-CARC
COOPERATORS: Leon Welty / Louise Strang, MSU-NWARC

Two cultivars of triticale (one awnless), 2 barley, 3 oat, 2 spelt (one awnless, one winter) and a spelt/wheat cross were seeded April 19, 1999, in a randomized complete block design with 4 replicates. Forage was harvested at the soft dough stage and dry matter yield compared.

All entries had vigorous stands. Haybet barley and the awnless spelt were first to reach soft dough, and awnless triticale was last. The winter spelt was harvested August 2, although it never headed.

The awnless triticale,'91002005', produced the most dry matter (6.30 tons/acre). The 'GR 900' winter spelt produced the least (2.71 tons/acre). The spring awnless spelt produced 5.25 tons/acre.

Montana Cereal Forage Trial
Kalispell, 1999

Cultivar	*5/5/99* Stand *%*	Harvest *date*	Yield *t/a*
Awnless triticale 91002005	100	8/2	6.30
Haybet barley	99	7/20	5.45
93-ST-5-93 spelt/wheat	99	7/27	5.30
Westford barley	98	7/22	5.26
Awnless spelt	100	7/20	5.25
Pronghorn triticale	95	7/26	4.79
Celsia oat	99	7/22	4.72
Otana oat	98	7/22	4.66
Stampede oat	99	7/27	4.45
GR 900 spelt	100	8/2	2.71
mean	99		4.89
LSD(0.05)	NS		0.86
CV(s/mean) %	2.7		12.0

Fertilizer: **4/2/99 - 100 lbs/a N**

TITLE: **Spring Pea/Cereal Forage Trial - Dryland**
PROJECT LEADER: Karnes Neill, MSU-CARC
COOPERATORS: Leon Welty, MSU-NWARC
Louise Strang, MSU-NWARC

Four pea cultivars, alone and in combination with 'Haybet' barley were seeded April 19, 1999, in a randomized complete block design with 4 replicates. Forage was harvested when peas were at the fourth flowering node. Dry matter yields of mixtures and pure stands were compared, and samples saved for quality determination.

All entries had vigorous stands. Trapper pea and the Trapper/Haybet mixture established slightly poorer stands than the other entries. Haybet barley and any Haybet/pea mixture had significantly higher dry matter yield than any pure stand of pea. No pea produced significantly higher yields than any other pea. Yields ranged from 1.66 tons/acre to 4.16 tons/acre.

Pea/Cereal Forage Trial - Kalispell, 1999

Cultivar(s)	Stand	Yield
	%	t/a
Haybet barley	97.5	4.07
Trapper pea	91.3	1.67
Trapper/Haybet	93.8	3.50
Arvika pea	98.8	2.13
Arvika/Haybet	97.5	4.16
Melrose pea	95.0	1.66
Melrose/Haybet	95.0	3.72
Granger pea	95.0	1.83
Granger/Haybet	97.5	4.02
mean	95.7	2.97
LSD(0.05)	3.9	0.86
CV(s/mean) %	2.8	15.9

Fertilizer: 4/2/99 - 100 lbs/a N

TITLE: **1999 Winter Annual Forage Trial - Dryland**
PROJECT LEADER: Dave Wichman, MSU-CARC
COOPERATORS: Leon Welty, MSU-NWARC
Louise Strang, MSU-NWARC

Six winter wheat lines, 5 winter spelts, and 5 Austrian winter pea cultivars were planted in 4 separate randomized complete block designs with 4 replicates on 22 & 23 September, 1998. The nursery was fertilized with 32 lbs. N/a, 40 lbs. P_2O_5/a, and 15 lbs. K_2O/a on Sept. 21. An additional 100 lbs. N/a was added to the cereal plots on April 2, 1999. Cereal plots were sprayed with Bronate (1½ pts/a) and pea plots with Basagran (1 qt/a) on Mar.23. Forage was harvested when the grains were at anthesis and the peas were at the eighth flowering node. Since only one lentil cultivar survived the winter, this entry was allowed to mature and harvested for seed. Dry matter yields of all other entries were compared, and samples saved for quality determination.

Spring stands were generally good, except for winter wheat line '97 seg 30' (Table 3). 'Granger' pea had significantly higher dry matter yield than any other pea (2.39 tons/acre) (Table 1). 'PI 348-159' spelt had significantly higher dry matter yield than any other spelt (7.63 tons/acre) (Table 2). Of the wheat lines, '97 seg 316' and SROB 637' produced the most forage (8.25 & 7.95 tons/acre, respectively) (Table 3). Selection 97 seg 30 was the poorest producer due to poor winter survival (1.26 tons/acre).

Table 1. Winter pea forage yields in the Winter Annual Forage Trial at Kalispell, 1998-99.

Cultivar	Spring Stand	First Bloom	Forage Yield
	%	*day/365*	*t/a*
FSAWPPOP	85	168	1.90
Granger	90	169	2.39
Sioux	94	168	2.04
SSAWPPOP	94	166	2.04
Wahlechia	88	150	1.90
mean	90	164	2.05
LSD(0.05)	6	1	0.30
CV(s/mean)%	4.3	0.3	9.5

Table 2. Winter spelt forage yields in the Winter Annual Forage Trial at Kalispell, 1998-99.

	Spring Stand	Heading	Forage Yield
	%	*day/365*	*t/a*
320-6	94	177	6.34
Bangerter	89	172	6.22
Dover	96	175	6.46
PI 348-159	93	175	7.63
Spelta	90	171	5.58
mean	92	174	6.45
LSD(0.05)	5	1	0.89
CV(s/mean)%	3.5	0.5	9.0

Table 3. Winter wheat forage yields in the Winter Annual Forage Trial at Kalispell, 1998-99.

	Spring Stand	Heading	Forage Yield
	%	*day/365*	*t/a*
97 seg 30	11	171	1.26
97 seg 316	95	167	8.25
PI 191303	78	174	5.44
SROB 632	100	166	7.58
SROB 633	100	171	6.51
SROB 637	100	170	7.95
mean	81	170	6.16
LSD(0.05)	8	3	1.21
CV(s/mean)%	6.3	1.1	13.0

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: 1999 / 758
TITLE: **1999 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

Twenty-seven dry pea and sixteen lentil varieties were seeded on April 13, 1999. Good stands were obtained. There were very few disease symptoms, probably due to a drier than average growing season. Both pea (Tables 1&2) and lentil (Tables 3&4) yields were above average.

For the first time the peas were thrashed using the ALMACO plot combine, with excellent results.

Table 1. Results of the Western Regional Dry Pea Yield Trial at Kalispell in 1999.

Cultivar	Type	Stand *plants/ft*	Maturity *days*[1/]	Height *inches*	Seed Size *#/lb*	Yield *lbs/a*
Alaska 81	green	7.5	114	27	2297	3507
Shawnee	yellow	6.5	110	20	1868	3478
PS510691	green	7.5	115	34	2196	3384
PS610168	green	7.9	112	22	2198	3368
PS510737	green	6.4	113	23	2210	3331
PS510718	green	5.6	115	38	2163	3325
PS610169	green	5.4	111	21	2214	3305
Joel	green	5.4	115	53	1950	3217
Fallon	yellow	7.5	111	19	1870	3114
PS610509	marrowfat	9.4	114		1553	2715
PS510947	marrowfat	7.5	115		1730	2445
PS510163	marrowfat	6.8	115	20	1458	1476
mean		7.0	113.3		1976	3055
LSD(0.05)		2.2			57	398
CV(s/mean) %		22.1			2.0	9.1

[1/] *days after seeding (4/13/99)*

Harvest date: 8/24/99
Harvest area = 40 ft^2

Pesticide: Poast (1-qt/a), Dash (1-qt/a), Basagran (1-qt/a) - 5/25/99
Fertilizer: 4/15/99 - 11 lbs/a N, 52 lbs/a P_2O_5

Table 2. Results of the Statewide Dry Pea Yield Trial at Kalispell in 1999.

Cultivar	Stand *pl/ft*	First Bloom *days*	Maturity *days*[1/]	Height *in*	Seed Size *#/lb*
Espace	10.3	69.3	110	28	2080
Adagio	8.8	67.3	111	29	1879
Victoria	6.0	67.8	111	43	2611
Profi	8.0	67.5	109	34	1871
Carrera	3.6	67.3	109	27	1772
Majoret	7.4	68.8	110	27	1961
Atomic	6.4	68.8	110	26	1696
Toledo	8.8	66.8	109	30	1764
Scuba	8.5	67.8	109	29	2010
Karita	7.3	67.3	110	28	1775
Explorer	8.0	71.3	112	24	2018
Grande	7.6	71.0	110	35	1976
Integra	7.6	67.5	109	31	1748
Columba	7.0	69.0	110	29	1727
TSG 982	9.5	67.8	110	27	1770
mean	7.6	68.3			1911
LSD(0.05)	2.6	1.3			92
CV(s/mean) %	11.8	1.3			3.4

[1/] days after seeding (4/13/99)

Harvest date: 8/17/99
Harvest area = 40 ft^2

Pesticide: 5/25/99 - Poast (1-qt/a), Dash (1-qt/a), Basagran (1-qt/a)
Fertilizer: 4/15/99 - 11 lbs/a N, 52 lbs/a P_2O_5

Table 3. Results of the Western Regional Lentil Yield Trial at Kalispell in 1999.

Cultivar	Stand *pl/ft*	First Flower *days*[1/]	Plant Height *inches*	Maturity *days*[1/]	Seed Size *#/lb*	Yield *lbs/a*
LC660609T	4.2	62.5	18.0	109.0	14105	2046
LC660527P	6.4	62.3	14.0	109.7	11347	1904
Brewer	8.0	62.0	16.0	109.7	6914	1677
LC460266L	7.4	62.3	17.0	110.5	6682	1667
LC560340L	8.3	62.0	16.5	110.6	6874	1485
LC560071E	6.1	64.3	15.3	109.2	10996	1380
Mason	6.1	62.3	15.0	110.0	5543	1356
Palouse	6.1	62.0	16.8	110.2	5575	1312
LC460212L	7.7	67.3	16.0	110.0	6971	1209
LC460199L	7.8	66.3	16.5	110.5	7140	1102
LC460197L	8.3	64.5	17.0	110.7	7158	1101
LC460200L	8.1	68.8	16.0	110.5	7120	1032
mean	7.0	63.9	16.2	110.1	8035	1439
LSD(0.05)	1.9	1.2	1.9	NS	380	296
CV(s/mean) %	18.7	1.3	8.3	0.8	3.3	14.3

[1/] days after seeding (4/13/99)

Seeding date: 4/13/98
Harvest date: 8/6/99
Harvest area = 40 ft^2

Pesticide: Poast (1-qt/a) + Dash (1-qt/a) - 5/25/99
Fertilizer: 11 lbs/a N, 52 lbs/a P_2O_5

Table 4. Results of the Statewide Lentil Yield Trial at Kalispell in 1999.

Cultivar	Stand *pl/ft*	First Flower *day*[1]	Maturity *day*[1]	Height *inches*	Seed Size *#/lb*	Yield *lbs/a*
Milestone	6.3	67.5	109.3	16.3	12184	1883
Brewer	5.4	62.3	110.0	17.5	7383	1696
Vantage	6.6	66.5	110.8	18.3	9284	1455
Glamis	7.4	69.5	110.8	17.8	8329	1030
mean	6.4	66.4	110.2	17.4	9295	1516
LSD(0.05)	NS	1.1	0.9	NS	632	294
CV(s/mean) %	29.6	1.1	0.5	6.1	4.3	12.1

[1/] days after planting (4/13/99)

Seeding date: 4/13/98
Harvest date: 8/6/99
Harvest area = 40 ft^2

Pesticide: Poast (1-qt/a) + Dash (1-qt/a) - 5/25/99
Fertilizer: 11 lbs/a N, 52 lbs/a P_2O_5

TITLE: **1999 Spring Spelt and Emmer Trial – Dryland**
PROJECT LEADER: Gil Stallknecht, MSU-CARC
COOPERATORS: Leon Welty, MSU-NWARC
Louise Strang, MSU-NWARC

Four emmer cultivars and 2 spring spelt lines were compared to 'Otana' oat, 'Lewis' barley, and 'McNeal' spring wheat for grain yield and test weight. The grains were seeded 4/28/99 in a randomized complete block design with 4 replicates. The nursery was fertilized with 96 lbs. N and 52 lbs. P_2O_5/a. Weeds were controlled by hand. Excellent stands were established. The tallest entries, 'PI 535' emmer, 'Bowman' emmer, and 'Jeff' emmer lodged severely.

Otana had the highest grain yield, with 6481 lbs./acre. 'McNeal' wheat (5046 lbs./acre) and 'Lewis' barley (4693 lbs./acre) followed. Of the 4 emmers, PI 535 produced the most grain (4357 lbs./acre) and 'Bread #3' the least (3388 lbs./acre). The spelts produced the least grain, with less than 2600 lbs./acre.

Stand Establishment, Plant Height, Grain Yield and Test Weight of Entries in the Spring Emmer Trial at Kalispell in 1999.

	Stand *%*	Height *inches*	Test Weight *lbs/bu*	Yield *lbs/a*
Otana oat	95	44	38.2	6481
McNeal wheat	96	36	60.6	5046
Lewis barley	94	33	50.8	4693
PI 535 emmer	95	46	38.6	4357
Jeff emmer	89	47	40.1	4124
Bowman emmer	98	45	38.9	3893
Bread #3 emmer	95	37	34.2	3388
1094 spelt-Konzak	91	38	37.3	2588
1088 spelt-Konzak	90	35	41.4	2557
mean	94	40	42.2	4125
LSD(0.05)	NS	2	2.5	505
CV(s/mean) %	6.3	3.9	4.0	8.4

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

Two cultivars of German chamomile, 'Bodegold' and 'Bona', were direct seeded on May 3, 1999 at 0.29 g/60 ft^2 plot. This first seeding was not successful, and the nursery was reseeded closer to the surface at 0.58 g/plot (49.6 seeds/linear ft.) on May 27. This seeding resulted in visible germination on June 10. Three plots of each variety were planted in each replicate to allow 3 different harvest/distillation treatments to be tested: 1) hand raking the blossoms from the plants, and distilling the dry flowers; 2) clipping the tops of the plants with a swather, drying, and distilling the dry clippings; 3) clipping the tops and distilling the fresh clippings.

Bona was harvested 4 times in 1999, and Bodegold, which grew slower, was harvested 3 times. The last harvest for both varieties was a total dry matter clipping on Sept. 10, which was dried and distilled. Bona clipped and dried produced the most oil (6.7 lbs./acre), and Bona clipped and distilled fresh produced the least (2.1 lbs./acre). These yields are only rough estimates. The small amount of material distilled and the viscosity of the oil made accurate measurement very difficult.

ChamomileTrial

Cultivar	Stand	Harv/Distill	Date	Dm Yld	Oil Concen	Oil Yield
	pl/ft			*lbs/a*	*% of dm*	*lbs/a*
Bodegold	8.6	clip-green	8/12	1591	0.04	0.6
			8/26	843	0.05	0.4
			9/10	3801	0.05	2.0
			Total	**6235**		**3.0**
Bodegold		clip-dry	8/12	996	0.02	0.2
			8/26	1120	0.09	1.0
			9/10	3862	0.05	1.8
			Total	**5978**		**3.0**
Bodegold		rake	8/12	431	0.12	0.5
			8/26	627	0.08	0.5
			9/10	7440	0.03	2.5
			Total	**8498**		**3.5**
Bona	8.0	clip-green	8/3	764	0.05	0.4
			8/19	893	0.04	0.4
			9/3	1607	0.02	0.4
			9/10	1533	0.06	0.9
			Total	**4797**		**2.1**
Bona		clip-dry	8/3	1000	0.21	2.1
			8/19	1007	0.14	1.4
			9/3	1886	0.10	1.8
			9/10	1282	0.11	1.4
			Total	**5175**		**6.7**
Bona		rake	8/3	451	0.11	0.5
			8/19	647	0.08	0.5
			9/3	373	0.13	0.5
			9/10	5909	0.04	2.2
			Total	**7380**		**3.7**

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

Three species of *Echinacea*, *E. purpurea, E. angustifolia,* and *E. pallida* were direct seeded at 9-seeds/linear ft. on May 4, 1999. *E. angustifolia* and *E. pallida* emerged May 27, and *E. purpurea* emerged June 10. On July 9, *E. purpurea* averaged 2.2-plants/linear foot, *E. pallida* had 1.3, and *E. angustifolia* had 0.8.

No material was harvested in 1999. Tops will be harvested in 2000, and tops and roots will be harvested in 2001.

Echinacea Trial at Kalispell, 1999.

Species	Stand *pl/linear ft*
E.purpurea	2.2
E.angustifolia	0.8
E.pallida	1.3
mean	1.4
LSD(0.05)	0.4
CV(s/mean)%	17.1

Seeding rate: 9 seeds/linear ft

TITLE: **1996 Black Mitcham Peppermint Propagation Trial**
PROJECT LEADER: Leon Welty, MSU-NWARC
RESEARCH ASSISTANT: Louise Strang, MSU-NWARC

Nuclear plants representing stem-cut, *in vitro* nodal and meristem culture were propagated from a single plant or from a randomly selected group of plants from the Black Mitcham mother block by Summit Labs. These seven entries, plus plants from a contaminated culture of Lake's, were planted on June 4 and 5, 1996. Seven lines from various sources were stem-cut propagated at the NWARC and planted on June 17, 1996.

All propagation lines were successfully established in the field in a randomized block design. Appropriate management practices (irrigation, fertility, weed and pest control) were employed to insure maximum mint growth and oil production.

Entries were evaluated for stand vigor indicators June 1, 1999. All plots were harvested August 18, 1999. Hay yield was measured, and approximately 20 pounds green material from each plot was dried and the oil separated by steam distillation to determine oil yield. Oil samples from each plot were sent to RCB International, Ltd. for quality component analysis.

The seven MIRC entries allow us to compare different propagation methods carried out in the same laboratory, eliminating variance due to the propagation environment (equipment, personnel, source material, etc.). As in 1997 and 1998, plants propagated from meristem culture produced significantly more dry matter than non-meristem plants (Fig.1). This supports previous observations that meristem derived Black Mitcham exhibits more vigorous growth than non-meristem peppermint. There was no difference in hay yield between single parent derivation and propagation from a randomly selected group.

In 1999, oil yield was not affected by propagation method directly. Parental selection, however, was significant (Fig.2). Plants derived from a randomly selected parental group produced more oil than plants propagated from a single parent plant. The advantage of using a random selection of parental plants reinforces the previous indication that there is some variation within the Black Mitcham mother block for some trait influencing oil yield. Unlike 1998, this relationship was observed in the entries that had been propagated by meristem culture as well as non-meristem derived plants.

The objective of propagating at NWARC was to determine if the high vigor/lower oil yield characteristic attributed to *in vitro* nodal or meristem culture could be transferred through the stem-cut process. Plants derived from the Lake-94 (source: Lake-92) nodal material were more vigorous and produced more dry matter than those derived from the Plant Tech-94 stem cut material. Unlike previous years, however, the nodal-derived material produced slightly more oil than the stem cut (Table 2). These results no longer support the theory of persistence of the high oil yield trait associated with the Plant Tech material. There was no significant oil yield difference between the R-5 and R-7 field material, but material propagated from the R-7 field still showed more vigorous vegetative growth, as originally observed.

In 1997, correlation between response variables revealed a strong negative relationship between dry matter production and oil yield. This relationship was no longer significant in 1998 or 1999. In fact, there was a significant positive correlation between hay and oil yield in 1999 (Table 3). This year, available heat units, as measured by growing degree-days, were 19% below average for June and July. Since this period is crucial for oil synthesis, the lack of heat may have inhibited oil production thereby increasing the dependence of oil yield on the amount of vegetative production.

The two MIRC meristem selections produced the most hay during all 3 years of the study (Table 4b, Figure 3). This is consistent with the observed "meristem trait" of vigorous dry matter production. Total oil produced during the three years following establishment is presented in Table 5. The MIRC entries derived from a randomly selected group of plants from the mother block yielded significantly more oil than those plants derived from a single individual (Fig.4). This is consistent with the assumption of variation in oil yield potential among plants within the foundation base of Black Mitcham. Propagating from several parent plants increases the probability of obtaining the high yield trait within the population selected. Propagating from a single plant limits the resultant population to the traits of that single parent. Over the 3-year harvest duration of this study, total oil yield differences among propagation types were significant, with the mean yield of meristem derived Black Mitcham lower than that of non-meristem derived mint (Table 5b). In 1999 the Plant Tech material stem-cut propagated at NWARC did not support the theory of persistence of the high oil yield trait associated with this material, but the total oil yield from this source was still significantly higher than that of the Lake-94 material (Table 5a). Cool early summer weather in 1999 may account for this. There was no significant oil yield difference between the R-5 and R-7 field material, but material propagated from the R-7 field still showed more vigorous vegetative growth, as originally observed.

Oil quality data for 1999 is presented in Table 6. All entries were at the pre-bloom maturity stage.

Table 1. Descriptions of entries in the Black Mitcham peppermint propagation evaluation planted at NWARC in 1996.

Source	Propagator	Method	Origin
MIRC-1	Summit Labs	stem cut (sc)	single plant (sp)
MIRC-2	Summit Labs	nodal tissue culture (nc)	single plant (sp)
MIRC-3	Summit Labs	meristem tissue culture (ms)	random selection (rs)
MIRC-4	Summit Labs	nodal tissue culture (nc)	random selection (rs)
MIRC-5	Summit Labs	meristem tissue culture (ms)	single plant (sp)
MIRC-6	Summit Labs	stem cut (sc)	random selection (rs)
MIRC-7	Summit Labs	stem cut (sc)	reestablished tissue culture from single plant (nc/sp)
Lake-96	Lake's	nodal tissue culture	bacteria infected culture
Lake-94	NWARC	stem cut	1994 trial - nodal
PlantTech-94	NWARC	stem cut	1994 trial - stem-cut
R-5 field	NWARC	stem cut	meristem low vigor field
R-7 field	NWARC	stem cut	meristem high vigor field
Montana-1	NWARC	stem cut	stem-cut high yield field
Montana-2	NWARC	stem cut	stem-cut high yield field
Idaho	NWARC	stem cut	McClelland stolons

Table 2. Stand observations, hay and oil yields of Black Mitcham propagation lines in 1999.

Source	Evaluated 6/1/99		Harvested 8/18/99		
	Row Cover	Vigor	Oil Yield	Hay Yield	Oil Content
Summit Labs	%	(0-5)[1/]	*lbs/acre*	*tons/acre*	*% dm*
MIRC-1 sc/sp	53	2.8	54.5	2.50	1.1
MIRC-2 nc/sp	55	2.5	56.1	2.48	1.2
MIRC-3 ms/rs	76	3.8	64.6	3.47	1.0
MIRC-4 nc/rs	64	2.5	61.3	2.58	1.2
MIRC-5 ms/sp	74	3.5	54.3	3.46	0.8
MIRC-6 sc/rs	51	2.5	67.0	2.60	1.4
MIRC-7 sc/nc/sp	60	2.3	67.0	2.72	1.3
Lake-96	58	2.3	66.5	2.70	1.3
NWARC					
Lake-94	56	2.8	65.7	2.77	1.2
Plant Tech-94	44	1.8	61.3	2.28	1.5
R-5 field	30	1.3	55.7	2.05	1.4
R-7 field	44	2.0	57.0	2.62	1.1
Montana-1	36	1.8	57.1	2.16	1.4
Montana-2	34	2.0	63.4	2.18	1.6
Idaho	26	1.3	55.7	1.92	1.6
LSD(0.10)	16	0.8	7.9	0.38	0.2
CV(s/mean)%	26.7	28.1	11.0	12.6	12.9

[1] *0=no growth; 5=plants exhibiting healthy, vigorous growth*

Table 3. Pearson correlations (r^2) with P-values for vigor, yield, and oil content levels of Black Mitcham propagation lines at Kalispell in 1999.

		Hay Yield	Oil Yield	Oil Content
Vigor	r^2	0.6736	0.1212	-0.6037
	P	0.0000	0.3561	0.0000
Hay Yield	r^2		0.3049	-0.8985
	P		0.0179	0.0000
Oil Yield	r^2			-0.0173
	P			0.8937

Table 4a. Total hay yields for 1997-1999 for the Black Mitcham propagation lines planted in 1996.

Source		1997 Hay Yield *tons/acre*	1998 Hay Yield *tons/acre*	1999 Hay Yield *tons/acre*	TOTAL HAY *tons/acre*
MIRC-1:	sc/sp	4.68	2.52	2.50	9.69
MIRC-2:	nc/sp	4.83	2.36	2.48	9.67
MIRC-3:	ms/rs	5.36	2.66	3.43	11.45
MIRC-4:	nc/rs	4.63	2.48	2.58	9.70
MIRC-5:	ms/sp	5.41	2.72	3.46	11.58
MIRC-6:	sc/rs	4.61	2.31	2.60	9.52
MIRC-7:	sc/nc/sp	4.93	2.52	2.72	10.17
Lake-96		4.30	2.70	2.83	9.83
Lake-94		4.57	2.42	2.77	9.76
Plant Tech-94		3.89	2.34	2.28	8.51
R-5 field		4.08	2.23	2.05	8.36
R-7 field		4.27	2.37	2.53	9.17
Montana-1		4.26	2.38	2.16	8.79
Montana-2		3.69	2.16	2.18	8.03
Idaho		4.05	2.21	1.95	8.21
mean		4.50	2.42	2.57	9.49
LSD(0.10)		0.60	0.24	0.39	0.95
CV(s/mean) %		11.3	8.3	12.7	8.35

Table 4b. Total hay yields for 1997-1999 for the MIRC propagated lines planted in 1996.

Propagation Method	Parent Plant(s) Single	Random selection	mean	
stem-cut	9.69	9.52	9.60	
nodal culture	9.67	9.70	9.68	
meristem	11.58	11.25	11.42	
mean	10.31	10.15		LSD(0.10): Prop = 0.71 Parent - NS Interact - NS

Table 5a. Total oil yields for 1997-1999 for the Black Mitcham propagation lines planted in 1996.

Source		1997 Oil Yield *lbs/acre*	1998 Oil Yield *lbs/acre*	1999 Oil Yield *lbs/acre*	TOTAL OIL *lbs/a*
MIRC-1:	sc/sp	67.8	58.4	54.5	180.8
MIRC-2:	nc/sp	73.2	62.5	56.1	191.7
MIRC-3:	ms/rs	59.7	61.3	64.6	185.6
MIRC-4:	nc/rs	77.4	69.8	61.3	208.4
MIRC-5:	ms/sp	62.2	64.8	54.3	181.3
MIRC-6:	sc/rs	81.2	69.7	67.0	217.8
MIRC-7:	sc/nc/sp	71.2	58.7	67.0	196.8
Lake-96		77.0	73.8	66.5	217.2
Lake-94		70.7	63.2	65.7	199.6
Plant Tech-94		83.1	73.5	61.3	217.8
R-5 field		70.9	64.4	55.7	191.0
R-7 field		68.2	66.9	57.0	192.0
Montana-1		72.9	70.1	57.1	200.0
Montana-2		77.1	65.9	63.4	206.4
Idaho		75.5	77.7	55.7	208.8
mean		72.5	66.7	60.5	199.7
LSD(0.10)		9.3	6.8	7.9	17.3
CV(s/mean x100)		10.8	8.6	11.0	7.3

Table 5b. Total oil yields for 1997-1999 for the MIRC propagated lines planted in 1996.

Propagation Method	Parent Plant(s) Single	Random selection	mean	
stem-cut	180.8	217.8	199.3	
nodal culture	191.7	208.4	200.1	
meristem	181.3	178.6	180.0	
mean	184.6	201.6	LSD(0.10):	Prop = 10.6 Parent = 8.6 Interact = 21.2

Table 6. Quality components of Black Mitcham propagation lines at Kalispell, MT in 1999 (GC%).

Propagation Source		Menthol	Neo-Menthol	D-iso Menthone	Menthone	Mentho-furan	Menthyl acetate	Pulegone
		%	%	%	%	%	%	%
MIRC-1:	sc/sp	39.1	2.9	23.0	2.8	4.3	2.8	0.83
MIRC-2:	nc/sp	38.2	2.8	24.2	2.8	4.2	2.4	0.93
MIRC-3:	ms/rs	40.7	2.8	22.3	2.6	2.0	2.7	0.71
MIRC-4:	nc/rs	40.4	3.1	20.9	2.5	3.9	2.5	0.81
MIRC-5:	ms/sp	39.3	2.9	23.7	2.7	3.3	2.6	0.74
MIRC-6:	sc/rs	38.1	2.7	24.4	2.8	3.0	2.3	0.70
MIRC-7:	sc/nc/sp	38.5	2.8	23.4	2.7	4.0	2.7	0.81
Lake-96		38.7	2.8	23.9	2.8	2.5	2.5	0.69
Lake-94		39.6	2.9	22.2	2.7	4.1	2.8	0.84
PlantTech-94		39.0	2.8	23.0	2.7	3.6	2.4	0.73
R-5 field		40.1	2.9	22.4	2.7	3.5	2.4	0.71
R-7 field		39.6	2.9	23.3	2.7	3.4	2.4	0.71
Montana-1		38.6	2.8	22.6	2.7	3.9	2.4	0.77
Montana-2		38.7	2.7	23.0	2.7	3.9	2.4	0.73
Idaho		38.5	2.7	22.9	2.7	4.2	2.3	0.83
mean		39.1	2.8	23.0	2.7	3.6	2.5	0.77
LSD(0.10)		0.8	0.1	1.1	0.1	0.4	0.2	0.08
CV(s/mean)%		1.8	2.4	4.1	2.3	10.2	7.3	8.5

Figure 1. Comparisons among MIRC propagated entries by propagation method and parent plant source for 1999 dry matter yield.

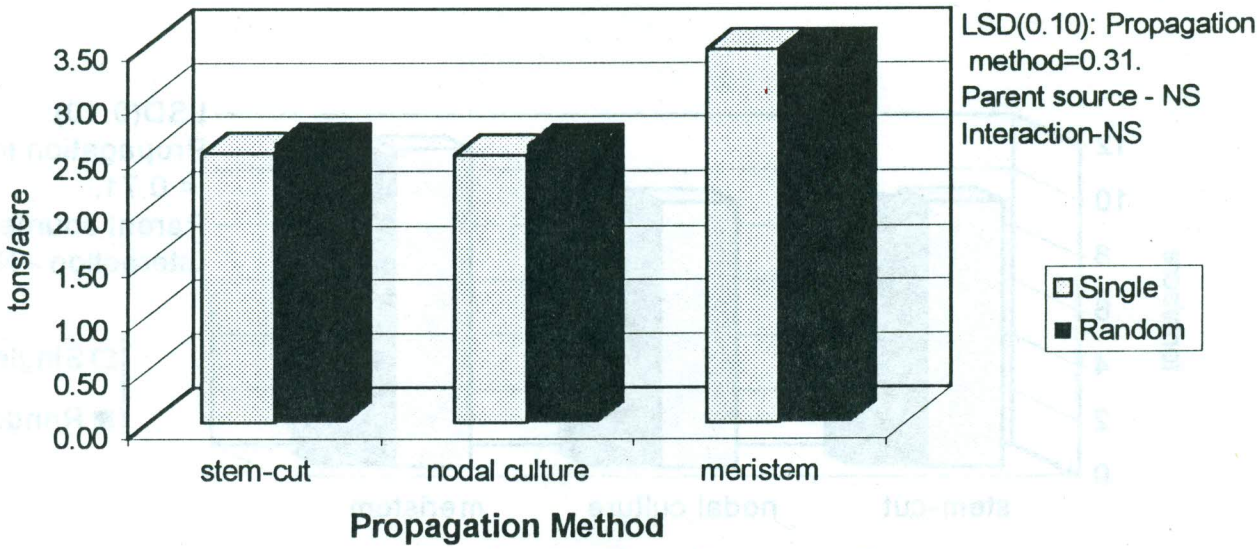


Figure 2. Comparisons among MIRC propagated entries by propagation method and parent plant source for 1999 oil yield.

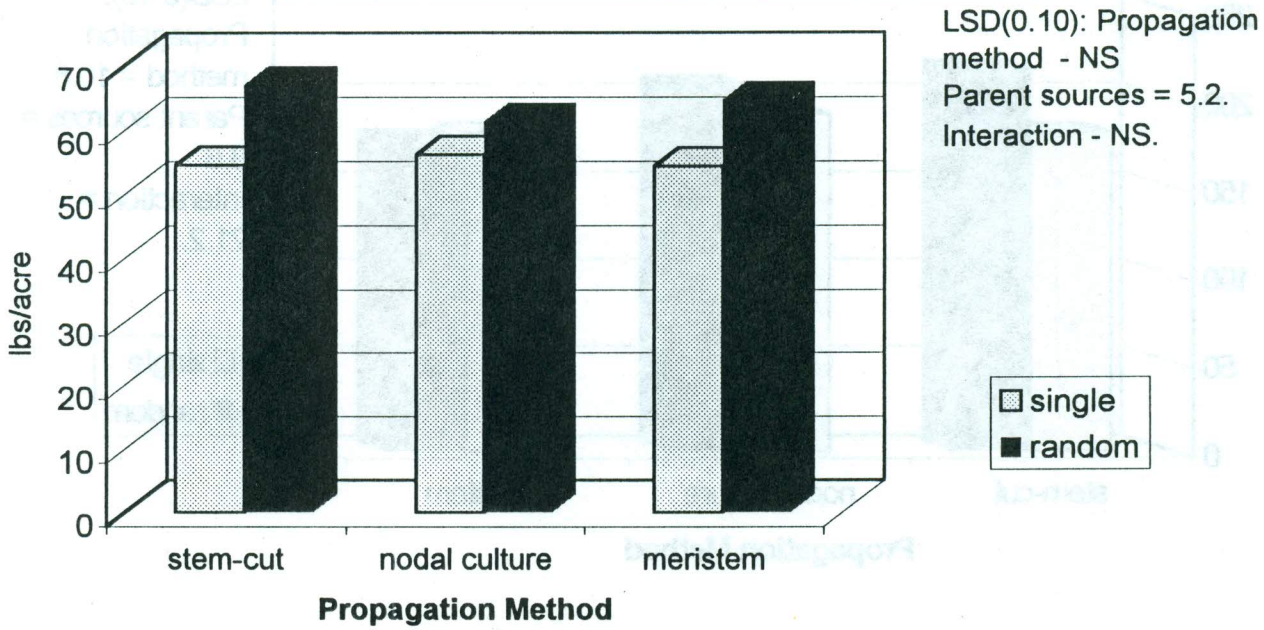


Figure 3. Comparisons among MIRC propagated entries by propagation method and parent plant source for total dry matter yield.

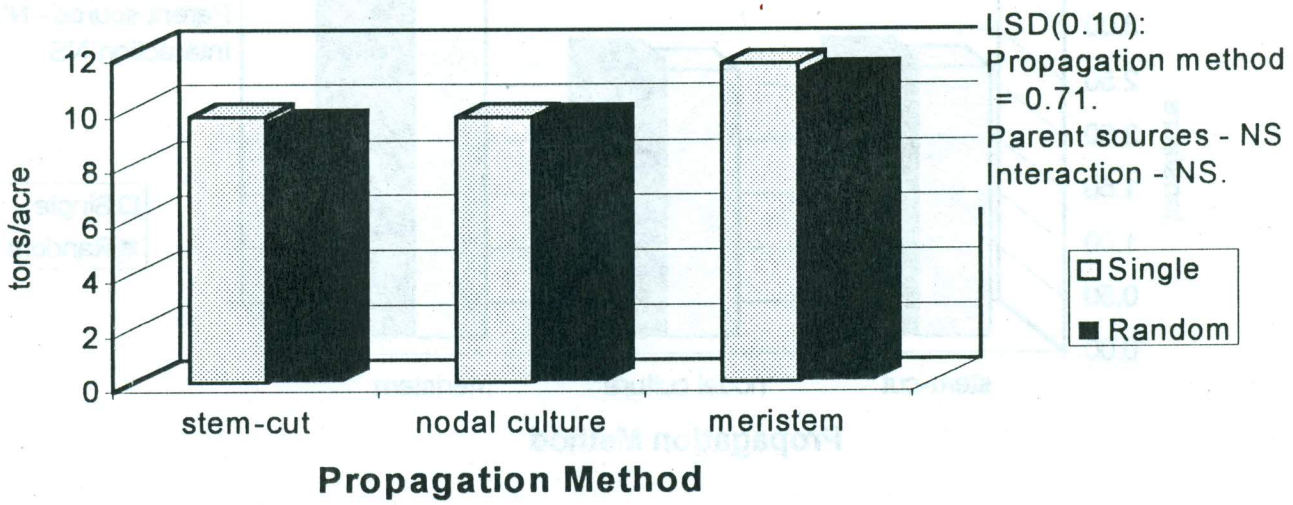
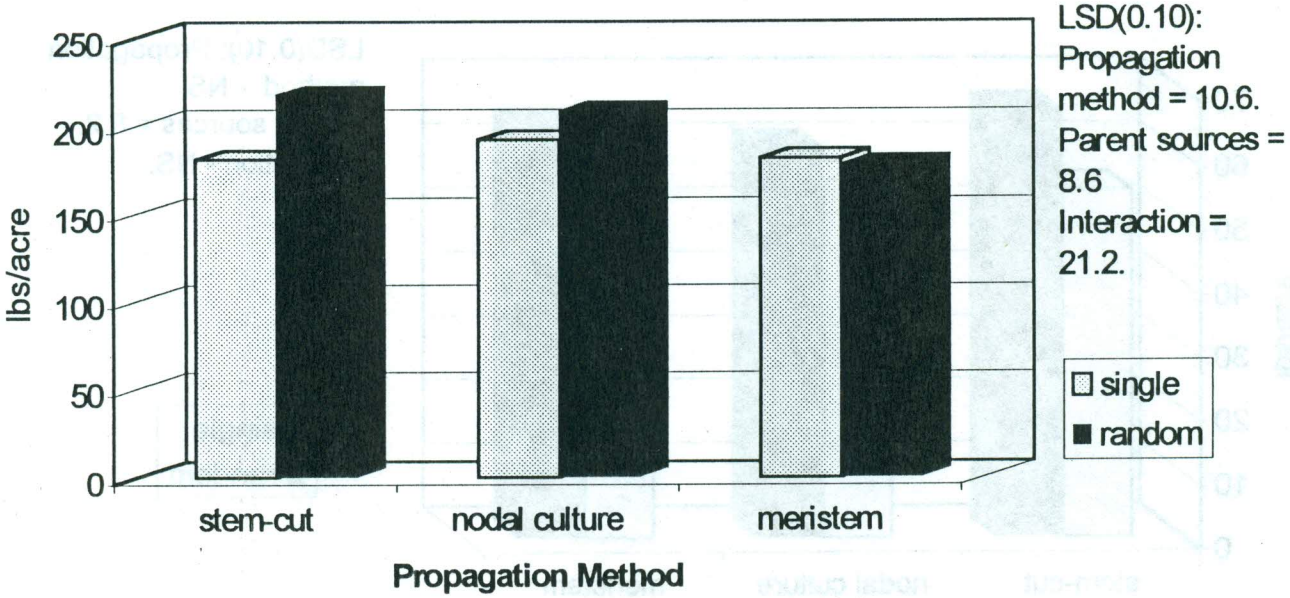


Figure 4. Comparisons among MIRC propagated entries by propagation method and parent plant source for total oil yield.



TITLE: PEPPERMINT FALL HARVEST MANAGEMENT TRIAL

PERSONNEL: Leon E. Welty, Professor of Agronomy, MSU, Kalispell, MT
Louise Strang, Research Specialist, MSU, Kalispell, MT

OBJECTIVE: Determine the effect of harvest timing on peppermint hay yield, oil yield, oil quality, and spring vigor.

DURATION: 1996-1999

PROCEDURES: The study was initiated in 1996. Plots (10' x 30') were laid out in an established stand of Black Mitcham, meristem derived (stolon source – Sonstelie Farms), and treatments assigned in a randomized complete block design with 4 replicates. From 1996-1998, treatments were 7 harvest dates at 10-day intervals (Aug.1-Sept.30) and an uncut check. In 1999, 220 lbs/a N, 52 lbs/a P_2O_5, 60 lbs/a K_2O and 24 lbs/a S were applied. To terminate the study, all plots, including the check, were harvested Aug.19. Approximately 20 pounds of herbage from each plot was air-dried and the oil removed by steam distillation. Morphological stage, height, dry matter yield, oil yield, and oil quality were determined. Oil samples were sent to A.M. Todd Co. for chemical analyses.

RESULTS AND DISCUSSION: The mint was harvested 8/19/99 at the late bud to early bloom stage. There were 1111 growing degree-days (GDD) before harvest for this study in 1999.

Plots previously harvested (1996-1998) between 8/1 and 8/20 and the uncut check plots resulted in more extensive ground cover and more vigorous growth in 1999 than those harvested later in the fall (Table 1). Plots harvested the end of August were intermediate in stand persistence, while peppermint harvested from September 10 through the end of the month had incurred significant stand losses. In fact, plots harvested on 9/20 did not contain enough mint to sample.

Harvesting 9/10 or later resulted in significantly lower hay yields than harvesting in August (Table 2, Figure 1). Dry matter yields from the September harvest schedules decreased 88% from the yields from the early August schedule. The mint usually reached the full bloom stage around the first of September and had at least two weeks to recover before the first frost. Note that the mint from the check plots, which had never been cut, had significantly lower hay and oil yields in 1999 than mint that had been cut between 8/1 and 8/20.

Levels of major quality components for all years are presented in Table3. In 1999, total ketones and menthone were highest in the plots, which were harvested on 9/10, and lowest in the plots harvested 8/1. Menthol was highest in the plots with the latest harvest. Menthofuran exceeded 4% in the mint, which had received the August harvests. Menthofuran levels for prime quality Montana peppermint usually range from 1-4%. Desirable oil contains 45% menthol. Menthol levels in 1999 were below 40%.

Table 1. Spring 1999 stand evaluation of the Mint Harvest Management trial at Kalispell.

1996-98 HARVEST DATE (approx.)	6/10/99* COVER [1/] %	VIGOR [2/] 0-5
8/1	29	3.5
8/10	24	3.0
8/20	21	3.0
8/30	14	1.8
9/10	2	1.3
9/20	1	0.8
9/30	1	1.5
not harvested	15	3.0
	13	2.2
	14	0.8
	85.5	31.0

* Date of observation

[1/] % of plot containing live green material.

[2/] 0=dead; 5=vigorous, healthy growth.

Table 2a. Hay and oil yields for peppermint harvested in **1996**.

Date	Accum. GDD	Growth Stage	Hay Yield *tons/ac*	Oil Content *% DM*	Oil Yield *lbs/ac*
8/1	926	20% bud	1.89	1.3	48.1
8/12	1061	full bud	2.33	1.3	59.8
8/22	1211	10% bloom	2.98	1.3	74.5
8/30	1336	20% bloom	3.01	1.3	77.9
9/10	1442	mid bloom	3.61	0.9	62.4
9/19	1526	90% bloom	2.98	1.1	62.9
9/27	1526	frozen	2.67	1.0	56.1
mean			2.78	1.2	63.1
LSD(0.10)			0.27	0.1	6.5

Table 2b. Hay and oil yields for peppermint harvested in **1997**.

Date	Accum. GDD	Growth Stage	Hay Yield *tons/ac*	Oil Content *% DM*	Oil Yield *lbs/ac*
8/1	948	mid bud	5.66	0.6	71.3
8/12	1141	full bud	4.30	0.7	60.4
8/22	1283	mid bloom	4.23	0.8	65.6
8/30	1395	late bloom	4.35	0.9	59.9
9/10	1539	late bloom	4.02	0.8	63.8
9/19	1597	late bloom	2.99	0.7	40.8
9/29	1597	mature	2.74	0.4	22.1
mean			4.04	0.7	54.8
LSD(0.10)			0.83	0.1	13.0

Table 2c. Hay and oil yields for peppermint harvested in **1998**.

Date	Accum. GDD	Growth Stage	Hay Yield *tons/ac*	Oil Content *% DM*	Oil Yield *lbs/ac*
7/31	1064	full bud	2.32	1.4	63.0
8/10	1258	mid bloom	2.23	1.5	65.8
8/20	1434	85% bloom	2.73	1.1	61.5
8/31	1602	full bloom	3.30	1.4	92.7
9/10	1796	full bloom	3.20	1.5	95.3
9/23	1873	seed set	3.07	1.3	79.5
9/30	1873	leaf drop	2.79	1.2	65.1
mean			2.80	1.3	74.7
LSD(0.10)			0.25	0.2	8.3

Table 2d. Hay and oil yields for peppermint harvested on **8/19/99.**

HARVEST DATE *(1996-98)*	HAY YIELD *t/a*	OIL CONTENT *%dm*	OIL YIELD *lbs/a*
8/1	1.88	1.8	68.1
8/10	1.84	1.7	62.9
8/20	1.78	2.0	70.6
8/30	1.42	1.8	50.0
9/10	0.59	1.5	18.1
9/20	0.23	0.7	3.6
9/30	0.43	1.6	11.7
check	1.16	1.8	39.6
mean	1.17	1.6	40.6
LSD(0.10)	0.37	NS	12.9
CV(s/mean)%	26.0	36.9	26.1

Table 3a. Quality components of peppermint harvested on different dates in **1996** [1/].

DATE	Menthol	Neo-menthol	Menthone	D-iso-menthone	Esters	MF	Pulegone
			GC%				
8/1	38.9	3.2	24.8	2.9	3.7	1.9	0.15
8/12	43.1	3.6	20.1	2.6	3.7	2.3	0.19
8/22	42.9	3.5	19.1	2.3	3.6	3.3	0.47
8/30	42.2	3.5	18.9	2.2	3.9	4.2	0.57
9/10	43.7	3.6	16.8	1.9	5.2	4.6	0.38
9/19	45.4	3.7	14.4	1.7	6.3	4.9	0.21
9/27	47.2	3.7	13.4	1.7	6.2	4.4	0.17
MEAN	43.3	3.5	18.2	2.2	4.6	3.7	0.30
LSD(0.10)	1.3	0.1	1.7	0.1	0.5	0.3	0.05

Table 3b. Quality components of peppermint harvested on different dates in **1997** [1/].

DATE	Menthol	Total Alcohol	Menthone	Total Ketones	Esters	MF	Pulegone
8/1	37.2	47.3	28.3	30.8	4.1	2.1	0.3
8/12	36.8	46.7	25.5	27.9	4.0	4.7	1.1
8/22	39.3	49.7	20.7	22.7	4.5	7.4	1.2
8/30	43.2	55.2	15.1	16.9	5.8	7.7	1.1
9/10	44.0	56.9	12.9	14.4	7.0	10.3	0.8
9/19	44.5	57.8	13.2	14.5	7.9	10.9	0.4
9/29	46.6	60.7	12.3	13.5	8.7	10.3	0.3
MEAN	41.7	53.5	18.3	20.1	6.0	7.6	0.7
LSD(0.10)	1.1	1.3	1.2	1.2	0.4	0.6	0.1

Table 3c. Quality components of peppermint harvested on different dates in **1998**[1/]..

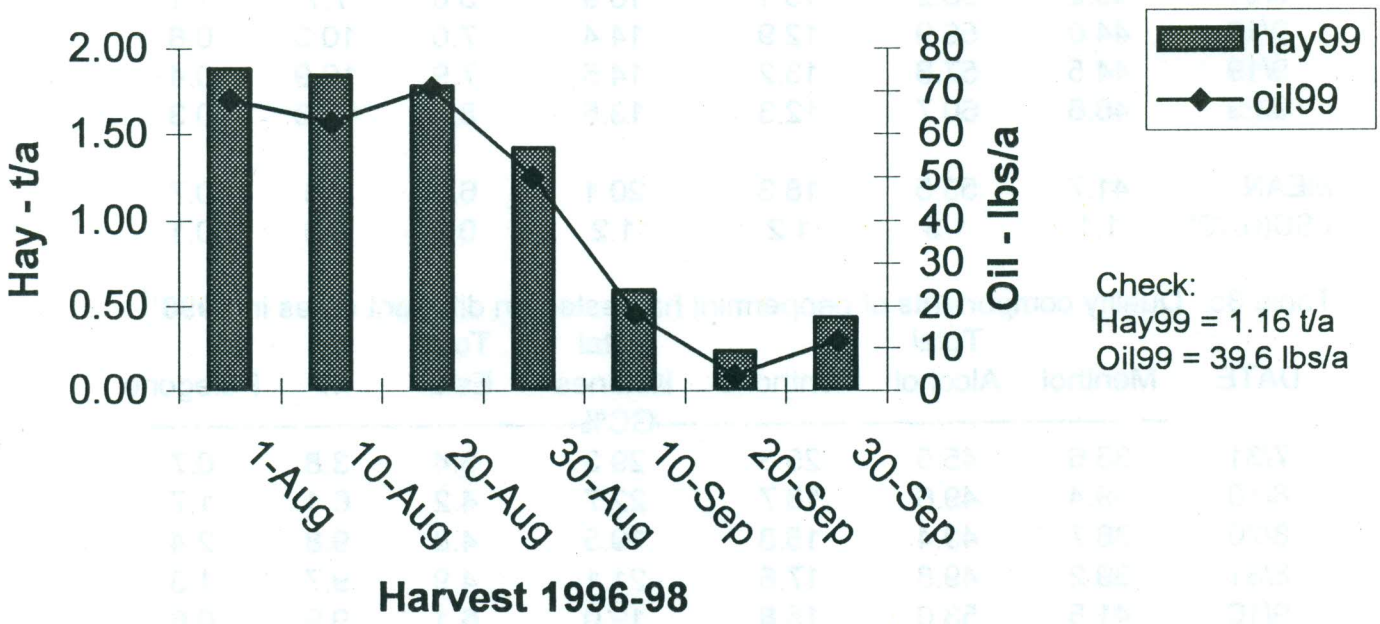
DATE	Menthol	Total Alcohol	Menthone	Total Ketones	Total Ester	MF	Pulegone
				GC%			
7/31	36.6	45.5	25.3	29.3	3.4	3.8	0.7
8/10	39.4	49.6	18.7	22.7	4.2	6.1	1.7
8/20	38.7	49.4	15.8	19.5	4.8	9.8	2.4
8/31	39.2	49.8	17.6	21.1	4.9	9.7	1.3
9/10	41.5	53.0	15.8	19.0	6.1	9.9	0.6
9/23	44.6	57.5	12.7	15.7	7.7	9.9	0.4
9/30	46.3	59.6	10.7	13.5	8.1	10.1	0.3
MEAN	40.9	52.0	16.7	20.1	5.6	8.5	1.1
LSD(0.10)	1.3	1.6	1.1	1.2	0.3	0.6	0.1

[1/] For growth stage at harvest, see Tables 2a, 2b, and 2c.

Table 3d. Quality components of peppermint harvested on 8/19/99.

1996-98 DATE	Total Alcohol	Total Ketones	Total Ester	Menthol	Menthone	MF	Pulegone
				GC%			
8/1	45.4	29.5	4.2	38.0	24.7	4.9	0.49
8/10	45.0	30.9	4.2	37.6	26.0	5.0	0.56
8/20	46.0	30.6	4.3	38.5	25.7	4.9	0.55
8/30	45.8	31.8	4.1	38.5	26.9	4.4	0.56
9/10	44.1	34.0	4.0	36.8	29.0	3.6	0.49
9/20				insufficient material			
9/30	47.0	29.6	4.7	39.1	24.9	3.8	0.60
check	45.4	31.7	4.2	37.9	26.7	4.0	0.49
mean	45.5	31.1	4.2	38.1	26.3	4.4	0.53
LSD(0.10)	NS	2.2	NS	1.2	2.1	0.8	NS
CV(s/mean)%	2.8	5.8	7.6	2.7	6.5	14.7	16.4

Figure 1. Previous harvest management effects on 1999 hay and oil yields.



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 vigor and row cover on 5/25/99. All plots were harvested 7/9/99 and 9/9/99 at the bud stage. Harvest method and hay and oil yield calculations were the same as the other mint trials. A.M. Todd Company conducted oil quality analyses.

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

At both cuttings, Scotch 770 had much higher oil content (%oil/lb dry matter) than Native and its derivative N-83-5 (Table 2). The nodal propagated Scotch 770 had the highest concentration of oil followed by the meristem followed by the stem-cut propagated. Native and N-83-5 showed no differences among propagation types. Native and N-83-5 produced significantly more dry matter than Scotch 770. Meristem Scotch 770 produced significantly more hay than nodal, which produced more than stem-cut. Meristem and nodal Scotch 770 produced more oil than the other cultivars and more than the stem-cut Scotch 770. Scotch 770 produced 34% more oil than Native and N-83-5, and the nodal propagated entries produced more than meristem which produced more than stem-cut.

Rust was just beginning to invade the plots by the second cutting. N-83-5 produced more hay than Native. As in the first harvest, Scotch 770 produced the least hay (Table 3). Scotch 770 had 50% higher oil content than the other cultivars. Because of the higher concentration, Scotch 770 also had the highest oil yield of the three cultivars. The interaction between cultivar and propagation type was not significant in the second cutting.

Total oil yields for 1999 are displayed graphically in Figure 1. Scotch 770 nodal and meristem-propagated material produced significantly more oil than any other line. Scotch 770 produced at least 24% more oil than Native or N-83-5. Total oil yields from 1997-1999 show significant differences among cultivars, propagation sources, and the interaction of the two factors (Table 4, 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 were mainly due to species differences, but there was an interaction effect in some components (Table 5). All the entries had reached the early budding stage. Scotch 770 had higher carvone and limonene levels than Native or N-83-5.

Table 1. Stand ratings for spearmint cultivars/propagation sources on 5/25/99.

VIGOR (1-5)

	Stem cut	Meristem	Nodal	means
Native	4.3	3.8	3.8	3.9
N-83-5	4.3	4.3	4.5	4.3
Scotch 770	2.5	3.0	2.8	2.8
means	3.7	3.7	3.7	
			LSD(0.10):	cultivar: 0.4
				propagation: NS
				interaction: NS

ROW COVER (1-5)

	Stem cut	Meristem	Nodal	means
Native	3.8	3.5	3.8	3.7
N-83-5	3.3	3.5	3.8	3.5
Scotch 770	1.8	2.5	2.5	2.3
means	2.9	3.2	3.3	
			LSD(0.10)	cultivar: 0.4
				propagation: NS
				interaction: NS

Table 2. Hay yield, oil content, and oil yield of cultivars at first harvest – 7/9/99.

HAY YIELD (tons/acre)[1/]

	Stem cut	Meristem	Nodal	means
Native	2.55	2.37	2.54	2.49
N-83-5	2.45	2.55	2.71	2.57
Scotch 770	1.87	2.43	2.14	2.14
means	2.29	2.45	2.46	

LSD(0.10) cultivar: 0.18
propagation: NS
interaction: 0.24

OIL CONTENT (%dm)

	Stem cut	Meristem	Nodal	means
Native	0.8	0.7	0.8	0.8
N-83-5	0.8	0.8	0.8	0.8
Scotch 770	1.0	1.2	1.5	1.2
means	0.9	0.9	1.0	

LSD(0.10)
cultivar: 0.1
propagation: 0.1
interaction: 0.5

OIL YIELD (lbs/acre)[1/]

	Stem cut	Meristem	Nodal	means
Native	42.0	34.4	40.2	38.9
N-83-5	38.8	39.5	41.6	40.0
Scotch 770	38.0	57.8	63.0	52.9
means	39.6	43.9	48.3	

LSD(0.10) cultivar: 4.4
propagation: 4.4
interaction: 5.9

[1/] *All spearmints were in the early bud stage on 7/9/99.*

Table 3. Hay yield, oil content, and oil yield of cultivars at second harvest – 9/9/99.

HAY YIELD (tons/acre) [1/]

	Stem cut	Meristem	Nodal	means	
Native	1.98	2.01	2.08	2.02	
N-83-5	2.13	2.17	2.11	2.14	
Scotch 770	1.76	1.67	1.55	1.66	
means	1.96	1.95	1.91		
			LSD(0.10)	cultivar:	0.10
				propagation:	NS
				interaction:	NS

OIL CONTENT (%dm)

	Stem cut	Meristem	Nodal	means	
Native	5.6	5.3	5.8	5.6	
N-83-5	5.4	6.2	5.9	5.9	
Scotch 770	8.2	8.7	9.7	8.9	
means	6.4	6.7	7.2		
			LSD(0.10)	cultivar:	0.8
				propagation:	NS
				interaction:	NS

OIL YIELD (lbs/acre) [1/]

	Stem cut	Meristem	Nodal	means	
Native	41.9	40.0	45.1	42.3	
N-83-5	44.0	50.8	46.0	46.9	
Scotch 770	54.5	55.1	57.6	55.7	
means	46.8	48.6	49.6		
			LSD(0.10)	cultivar:	5.5
				propagation:	NS
				interaction:	NS

[1/] *Growth stage - early to late bud.*

Table 4. Total oil yields 1997-99 (lbs/acre).

	Stem cut	Meristem	Nodal	means	
Native	206.6	208.0	232.7	215.8	
N-83-5	220.3	224.7	240.7	228.6	
Scotch 770	269.1	292.3	331.8	297.7	
means	232.0	241.7	268.4		
			LSD(0.10)	cultivar:	9.2
				propagation:	9.2
				interaction:	15.9

Table 5a. Quality components of 3 spearmint cultivars and 3 propagation types for the first harvest, 1999.

	a-Pinene	b-Pinene	Limonene	Cineole	Dihydro-carvone	Carvone
			GC %			
Stem cut Native	0.97	1.41	11.6	1.62	1.68	56.5
Stem cut N-83-5	0.98	1.34	10.9	1.72	1.10	55.7
Stem cut Scotch 770	0.89	1.36	17.6	1.29	0.90	61.2
Meristem Native	1.08	1.52	13.1	1.79	1.60	52.6
Meristem N-83-5	1.01	1.37	12.2	1.59	1.00	54.7
Meristem Scotch 770	0.92	1.38	15.9	1.14	1.10	63.0
Nodal Native	1.04	1.44	12.7	1.36	1.15	54.6
Nodal N-83-5	0.98	1.35	11.6	1.68	1.13	53.7
Nodal Scotch 770	0.90	1.38	16.7	1.08	0.93	64.0
mean	0.97	1.39	13.6	1.47	1.18	57.3
LSD(0.10)	0.08	NS	0.9	0.11	0.24	3.0
CV(s/mean)	7.2	6.5	5.8	5.9	16.8	4.3

Table 5b. Quality components of 3 spearmint cultivars and 3 propagation types for the second harvest, 1999.

	a-Pinene	b-Pinene	Limonene	Cineole	Dihydro-carvone	Carvone
			GC %			
Stem cut Native	1.07	1.59	10.3	2.32	1.28	58.6
Stem cut N-83-5	1.40	1.79	11.1	2.41	0.88	57.4
Stem cut Scotch 770	1.08	1.67	16.9	1.77	0.55	65.1
Meristem Native	1.17	1.68	10.7	2.32	1.18	61.5
Meristem N-83-5	1.14	1.59	11.1	2.28	0.68	61.7
Meristem Scotch 770	1.04	1.57	14.8	1.53	0.80	66.7
Nodal Native	1.19	1.67	11.2	2.16	0.81	58.7
Nodal N-83-5	1.21	1.67	10.4	2.36	0.83	61.7
Nodal Scotch 770	1.03	1.56	15.8	1.55	0.83	67.2
mean	1.15	1.64	12.5	2.08	0.87	62.1
LSD(0.10)	0.10	NS	1.9	0.25	0.14	4.7
CV(s/mean)	4.8	4.6	12.6	9.9	13.5	6.3

Analysis by A.M.Todd Co.

Figure 1. Total 1999 oil yields in the Spearmint Cultivar/Propagation Trial.

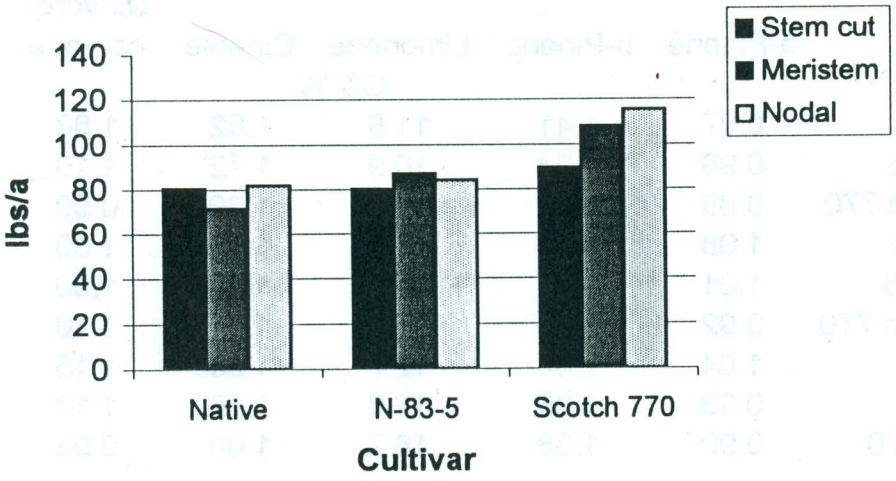
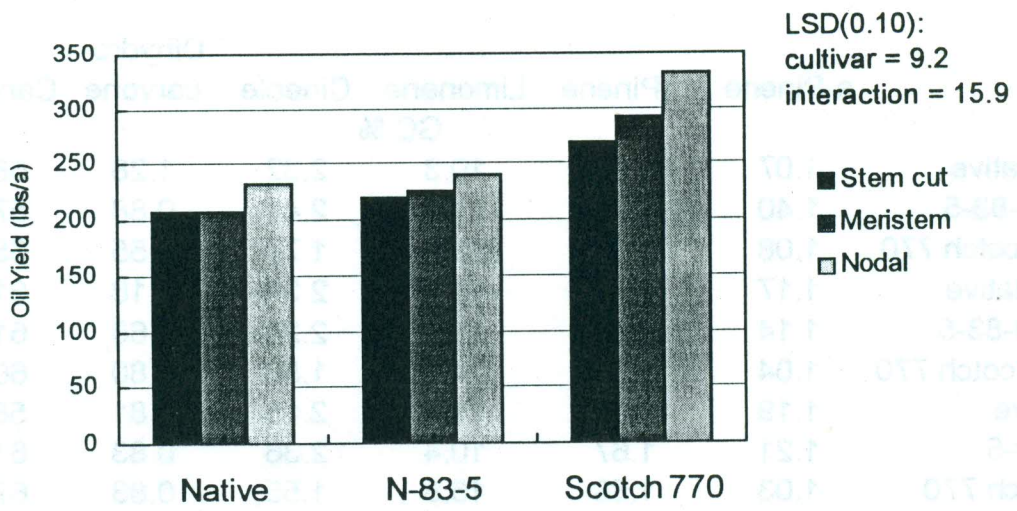


Figure 2. Total oil yields in the Spearmint Cultivar/Propagation Trial from 1997 to 1999.



TITLE: **Effect Of Freezing On Survival Of Peppermint And Spearmint Rhizomes/Stolons.**

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).

There was considerable variation in winter stand survival and vigor as observed on 5/24/99 (Table 2). The *M.longifolia* cv.polyadenia (origin South Africa) winterkilled completely. The meristem propagated Black Mitcham, the stem-cut propagated Native spearmint, N-83-5, and stem-cut Scotch 770 had the weakest early stands. The two *surviving M. longifolia* entries had the most robust stands.

The mint was harvested 8/4/99 (Table 2). Plant heights ranged from 17 inches (stem-cut Native and Scotch 770) to 38 inches (the hymaliensis *longifolia*). The hymaliensis *longifolia* and Arctic mint produced the most dry matter. Oil content was highest in Scotch, Scotch 213, Scotch 770 and Black Mitcham-stem cut propagated by Clarke. The *longifolia*s and *suaveolens* contained very little oil. Of the peppermint entries, the Black Mitcham stem-cut propagated line from Summit, the MIRC92 line, the McClelland Mc96-7 and Mc96-9 lines, the two English lines, and Murray Mitcham produced the most oil. Of the spearmints, Scotch, Scotch 213, and Scotch 770 - stem-cut propagated were the top producers. The *M.canadensis* "Arctic" entry produced the most oil of any entry in the trial (86.3 lbs/acre).

Fall regrowth was removed and the stolons/rhizomes dug from a 1.5-ft^2 area in each plot on 11/1/99. The stolons/rhizomes were cleaned and weighed, and eight, two-inch stolon pieces for each of five cold treatments were selected, weighed, wrapped in moist cheesecloth and aluminum foil, and stored at 34°F until testing. On 11/4 one set of stolons (the non-frozen check samples), were planted in plugs in the lab. On 11/5 the remaining stolons were placed in a biofreezer at 20^0 and held there for two hours. Stolons for the 20^0 treatment were removed and the freezer cooled to 15^0. The 15^0 stolons were removed after 2 hours, and then the temperature reduced to 10^0 for 2 hours. These stolons were removed and the remaining stolons cooled to 5^0 for 2 hours. The stolons were planted in the lab at 65°F following their removal from the freezer. Emergence of live shoots was recorded for each cold treatment from each plot for the following 3 weeks.

Survival data for fall 1999 stolons are summarized in Table 3 and for fall 1998 stolons in Table 4. There was variation among cultivar/propagation lines for all treatments, but data from the two years were not closely related. Because of the small number of replicates, these results should be viewed as a suggestion of which mint lines may have special cold temperature tolerance. Based on the fall 1999 stolons, Black Mitcham, Todd's Mitcham, Native, N-83-5, and Scotch might be considered. This year, the Arctic mint (*M. canadensis*) did demonstrate more cold tolerance than many other entries.

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	stemcut	MIRC	Summit
piperita	Black Mitcham	stemcut	McClelland	Clarke
piperita	M-83-7	stemcut	MIRC	Summit
piperita	Murray Mitcham	stemcut	MIRC	Summit
piperita	Roberts Mitcham	stemcut	MIRC	Summit
piperita	Todd's Mitcham	stemcut	MIRC	Summit
cardiaca	Scotch	stemcut	MIRC	Summit
cardiaca	Scotch 213	stemcut	MIRC	Summit
cardiaca	Scotch 227	stemcut	MIRC	Summit
cardiaca	Scotch 770	meristem	MIRC	Starkel
cardiaca	Scotch 770	stemcut	MIRC	Summit
spicata	N-83-5	stemcut	MIRC	Summit
spicata	Native	meristem	MIRC	Starkel
spicata	Native	stemcut	MIRC	Summit
canadensis	Arctic	nodal	I.P.Callison	Lake
longifolia	*hymaliensis*	stemcut	Davis	Grey
longifolia	*polyadenia*	stemcut	Davis	Lake (S.Africa)
longifolia		nodal	NCGR	Lake (Netherlands)
suaveolens	rotundifolia	nodal	NCGR	Lake (Minnesota)

Table 2. Height, growth stage, and yield components of entries in the cold tolerance trial at Kalispell in 1999.

Cultivar	Method	Source	Prop.	Cover[1] (0-5)	Vigor[2] (0-5)	Height inches	Stage *	Hay Yield t/a	Oil Content %dm	Oil Yield lbs/a
Black M.	stem	MIRC	Summit	2.0	2.0	22	mb	1.75	1.3	45.9
Black M.	meris.	MIRC	Summit	1.0	2.5	20	eb	1.75	1.2	43.1
Black M.	meris.	MIRC	Starkel	1.5	1.0	23	eb	1.80	1.0	34.0
Black M.	nodal	MIRC92	Lake	2.0	2.5	25	fb	2.55	1.1	55.9
Murray M.	stem	MIRC	Summit	2.0	2.5	23	eb	2.45	1.2	57.4
Todd's M.	stem	MIRC	Summit	2.0	1.5	22	eb	1.40	1.0	28.1
Roberts M	stem	MIRC	Summit	2.0	2.0	26	eb	2.60	0.9	50.1
M-83-7	stem	MIRC	Summit	2.5	2.0	23	eb	2.00	1.1	47.4
Black M.	nodal	Mc96-9	Lake	2.5	2.5	25	fb	2.15	1.3	57.1
Black M.	nodal	English 1	Lake	2.5	2.0	24	eb	2.15	1.2	51.7
Black M.	nodal	English 2	Lake	2.0	2.0	24	eb	2.25	1.2	53.7
Native	stem	MIRC	Summit	1.0	1.5	17	fb	0.70	0.8	10.9
N-83-5	stem	MIRC	Summit	1.0	2.5	22	mblm	1.50	0.8	24.9
Native	meris.	MIRC	Starkel	2.0	3.0	25	eblm	2.70	0.8	43.4
Scotch	stem	MIRC	Summit	1.5	2.5	19	fblm	1.45	1.4	45.0
S. 213	stem	MIRC	Summit	2.5	3.0	23	fblm	2.65	1.5	67.7
S. 227	stem	MIRC	Summit	1.5	1.5	19	fblm	1.55	1.2	34.5
S. 770	stem	MIRC	Summit	1.0	2.1	17	fblm	1.35	1.7	41.6
S. 770	meris.	MIRC	Starkel	2.5	3.0	25	fblm	2.65	1.3	70.3
hymal.	stem	Davis	Grey	4.0	5.0	38	fblm	5.90	0.1	12.5
longifolia	nodal	NCGR	Lake	3.0	4.5	32	eblm	4.55	0.2	12.3
suaveolens	nodal	NCGR	Lake	2.0	2.5	22	mblm	1.25	0.1	2.5
Black M.	meris.	Mc96-7	Starkel/ Clarke	2.5	1.5	25	fb	2.35	1.2	57.0
Black M.	stem		Clarke	1.5	2.0	19	fb	0.55	1.5	15.8
Black M.	nodal	Mc96-19	Lake	2.5	2.5	25	b	2.05	0.4	19.6
Arctic	nodal	Callison	Lake	3.5	3.5	30	eblm	6.00	0.7	86.3
		mean		2.1	2.4	23		2.31	1.0	41.6
		LSD(0.10)		1.0	1.0	5		0.87	0.4	20.7
		CV(s/mean) %		28.3	24.7	13.6		22.0	21.4	29.0

[1] 0=none; 5=entire plot covered

[2] 0=dead; 5=very vigorous growth

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

Table 3. Survivorship of fall 1999 stolon segments at four freezing treatments and a 36° F control.

	36°check	20°	15°	10°	5°
BM-sc-MIRC-Summit	75.5	87.5	50.5	75.0	50.0
BM-ms-MIRC-Summit	100.0	94.0	75.0	100.0	44.0
BM-ms-MIRC-Starkel	62.5	56.5	69.0	38.0	56.5
BM-n-MIRC92-Lake	69.0	50.0	31.5	38.0	37.5
MM-sc-MIRC-Summit	87.5	75.0	50.5	31.5	50.0
TM-sc-MIRC-Summit	87.5	87.5	94.0	75.0	31.5
RM-sc-MIRC-Summit	81.5	87.5	75.0	25.0	0.0
M83-7-sc-MIRC-Sum	100.0	75.0	56.5	50.5	62.5
BM-n-McC96-9-Lake	75.0	69.0	31.5	44.0	31.5
BM-n-UK1-Lake	75.0	69.0	75.0	12.5	19.0
BM-n-UK2-Lake	81.5	69.0	25.0	31.5	12.5
NS-sc-MIRC-Summit	88.0	87.5	100.0	94.0	50.0
N83-5-MIRC-Summit	94.0	100.0	94.0	75.5	37.5
NS-ms-MIRC-Starkel	100.0	100.0	94.0	50.0	50.0
SS-sc-MIRC-Summit	81.5	75.5	75.0	81.5	0.0
S213-sc-MIRC-Sum	94.0	75.5	31.5	56.5	0.0
S227-sc-MIRC-Sum	94.0	50.0	87.5	38.0	81.5
S770-ms-MIRC-Starkel	81.5	69.0	28.0	56.5	0.0
S770-sc-MIRC-Sum	75.5	81.5	25.0	56.5	25.0
Hymal-sc-Davis-Grey	69.0	63.0	44.0	12.5	6.5
Long-n-NCGR-Lake	94.0	94.0	69.0	44.0	0.0
Rotund-n-NCGR-Lake	81.5	31.5	31.5	25.0	50.0
BM-n-McC96-7-Lake	69.0	81.5	56.5	12.5	6.5
BM-sc-Clarke	94.0	6.5	0.0	0.0	0.0
BM-n-McC96-19-Lake	87.5	56.5	56.5	87.5	25.0
Arctic-n-Callison-Lake	75.5	75.0	81.5	44.0	50.0
mean	83.6	71.8	58.0	48.3	29.9
LSD(0.10)	NS	NS	42.3	45.4	NS
CV(s/mean)%	20.4	36.4	42.7	55.1	123.5

Table 4. Survivorship of fall 1998 stolon segments at four freezing treatments and a 36° F control.

	36°check	20°	15°	10°	5°
BM-sc-MIRC-Summit	100	95	85	5	0
BM-ms-MIRC-Summit	85	85	70	0	0
BM-ms-MIRC-Starkel	95	80	95	25	0
BM-n-MIRC92-Lake	95	95	100	85	0
MM-sc-MIRC-Summit	95	95	95	10	0
TM-sc-MIRC-Summit	95	85	100	75	0
RM-sc-MIRC-Summit	100	90	90	0	0
M83-7-sc-MIRC-Sum	95	75	80	0	0
BM-n-McC96-9-Lake	85	95	95	30	5
BM-n-UK1-Lake	95	90	85	0	0
BM-n-UK2-Lake	95	80	75	0	0
NS-sc-MIRC-Summit	100	60	65	35	0
N83-5-MIRC-Summit	100	95	80	0	0
NS-ms-MIRC-Starkel	95	75	85	0	0
SS-sc-MIRC-Summit	60	75	70	35	20
S213-sc-MIRC-Sum	95	80	80	0	0
S227-sc-MIRC-Sum	96	35	80	0	0
S770-ms-MIRC-Starkel	95	95	80	20	0
S770-sc-MIRC-Sum	40	94	82	50	0
Hymal-sc-Davis-Grey	100	95	85	0	0
Long-n-NCGR-Lake	100	100	100	30	0
Rotund-n-NCGR-Lake	95	65	95	15	0
BM-n-McC96-7-Lake	95	75	80	35	0
BM-McClelland/Clarke	100	90	80	30	0
BM-n-McC96-19-Lake	79	70	55	15	0
Poly-sc-Davis-Lake	85	50	75	15	0
Arctic-n-Callison-Lake	95	90	50	15	0
mean	91	80	80	18	1
LSD(0.10)	NS	NS	NS	42	8
CV(s/mean)%	15	17	24	141	473

Table 5. Quality components of mint oil from the *Mentha* Cold Tolerance Study.

Peppermint

Species	Cultivar	Method	Source	Propagator	Menthol	Neo-menthol	Menthone	D-iso-menthone	Mentho-furan	Menthyl acetate	Pulegone
piperita	Black Mitcham	stem-cut	MIRC	Summit	36.8	2.8	27.9	3.2	2.2	2.3	0.6
piperita	Black Mitcham	meristem	MIRC	Summit	37.7	2.7	27.9	3.7	2.1	2.4	0.5
piperita	Black Mitcham	meristem	MIRC	Starkel	37.7	2.6	26.9	3.0	1.9	2.1	0.6
piperita	Black Mitcham	nodal	MIRC-92	Lake	36.3	2.6	26.7	2.9	1.9	2.4	0.6
piperita	Murray Mitcham	stem-cut	MIRC	Summit	37.2	2.6	28.2	3.1	1.3	2.2	0.6
piperita	Todd's Mitcham	stem-cut	MIRC	Summit	37.4	3.0	27.2	3.0	1.3	3.0	0.5
piperita	Roberts Mitcham	stem-cut	MIRC	Summit	34.8	2.4	29.2	3.3	1.4	2.1	0.5
piperita	M-83-7	stem-cut	MIRC	Summit	35.1	2.5	29.1	3.5	1.5	2.1	0.4
piperita	Black Mitcham	nodal	McClelland	Lake	36.1	2.3	27.8	3.2	2.2	1.8	0.5
piperita	Black Mitcham	nodal	English 1	Lake	32.3	2.3	26.1	2.9	1.9	1.7	0.6
piperita	Black Mitcham	nodal	English 2	Lake	36.9	2.5	29.3	3.0	1.9	2.1	0.6
piperita	Black Mitcham	meristem	Mc96-7	Starkel/Clarke	39.4	2.7	24.3	3.1	2.4	2.2	0.5
piperita	Black Mitcham	stem-cut		Clarke	25.8	1.7	22.8	2.2	4.0	1.6	0.7
piperita	Black Mitcham	nodal	Mc96-19	Lake	39.9	2.7	25.6	2.9	2.0	2.4	0.7
				mean	35.9	2.5	27.1	3.1	2.0	2.2	0.6
				LSD(0.10)	NS	NS	NS	NS	NS	NS	NS
				CV(s/mean)%	14.5	15.3	9.3	17.0	36.1	19.0	14.9

Spearmint

Species	Cultivar	Method	Source	Propagator	A:Pinene	B:Pinene	Limonene	Cineole	Octanol	carvone
spicata	Native spearmint	stem-cut	MIRC	Summit	1.1	1.7	16.5	2.9	0.9	55.7
spicata	N-83-5	stem-cut	MIRC	Summit	1.2	1.7	12.1	2.8	0.8	51.8
spicata	Native spearmint	meristem	MIRC	Starkel	0.9	1.4	15.7	2.1	1.3	53.7
cardiaca	Scotch	stem-cut	MIRC	Summit	1.0	1.6	21.6	1.9	1.8	53.7
cardiaca	Scotch 213	stem-cut	MIRC	Summit	0.9	1.4	17.0	1.7	2.0	61.1
cardiaca	Scotch 227	stem-cut	MIRC	Summit	0.7	1.2	18.8	1.2	1.6	60.0
cardiaca	Scotch 770	stem-cut	MIRC	Summit	0.7	1.1	9.5	1.9	0.8	60.7
cardiaca	Scotch 770	meristem	MIRC	Starkel	0.9	1.4	17.0	1.5	1.6	58.7
longifolia	hymaliensis	stem-cut	Davis	Grey	0.8	1.7	12.8	1.4	0.9	23.8
longifolia		nodal	NCGR	Lake	0.9	1.5	14.2	4.0	1.4	46.4
canadensis	Arctic	nodal	Callison	Lake	1.1	1.5	22.6	1.1	0.9	53.3
				mean	0.9	1.5	16.2	2.0	1.3	52.6
				LSD(0.10)	NS	NS	4.5	NS	NS	NS
				CV(s/mean)%	26.0	23.0	13.0	53.8	39.5	16.2

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. Stand vigor was rated May 25. Spearmint plots were harvested July 9 at the vegetative to early bud stage, and September 9, 1999 at the late bud to early bloom stage. Peppermint entries were harvested August 10, 1999 at the full bud to prebloom stage. There were some indications of rust in the second spearmint harvest. Plant height and growth stage was determined immediately before harvest. Yields were determined by swathing a 94 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. Data were analyzed using MSUSTAT, Version 5.22 (R.E. Lund, Montana State University), Procedure ANOVA for a randomized block with 4 replicates. Means of treatments were separated by the method of Least Significant Differences (Student's t) at the P=0.90 confidence level.

On 11/2/99 fall regrowth was removed and stolons/rhizomes dug from a 1.5-ft^2 area in each plot. The stolons/rhizomes were cleaned and weighed, and eight, two-inch stolon pieces for each of five cold treatments were selected, weighed, wrapped in moist cheesecloth and aluminum foil, and stored at 34°F until testing. On 11/4 one set of stolons (the non-frozen check samples), were planted in plugs in the lab. On 11/5 the

remaining stolons were placed in a biofreezer at 20° F and held there for two hours. Stolons for the 20° treatment were removed and the freezer cooled to 15°F. The 15° stolons were removed after 2 hours, and then the temperature reduced to 10° F for 2 hours. These stolons were removed and the remaining stolons cooled to 5° F for 2 hours. The stolons were planted in the lab at 65°F following their removal from the freezer. Emergence of live shoots was recorded for each cold treatment from each plot for the following 3 weeks.

Spring stand evaluation indicated B-90-9 and the McKellip selection peppermints and Native spearmint were most vigorous, while the 92(B-37xM0110) cross, Scotch 770 and S-90-9 were least vigorous (Table 1). In 1998 we were able to observe the performance of the various cultivars in the presence of a severe infestation of mint rust. Brownish-red spots typical of the rust uredial stage were seen in a few plots at the second spearmint harvest of 1999. Symptoms were minimal compared to 1998.

In this first post-establishment year of the study, there was variation in yield parameters among peppermint cultivars and selection groups (Table 2). No peppermint entry produced significantly more dry matter than Black Mitcham, and Murray Mitcham and 92(B-37xM0110) produced significantly less. B-90-9 and Plant Tech-94 had a higher amount of oil as percent of dry matter than the other entries. B-90-9, McKellip selection, Plant Tech-94 selection, and Black Mitcham produced significantly more oil than the other entries, and 92(B-37xM0110) produced significantly less. No new introduction or selection line was superior to the Black Mitcham from the MIRC mother block.

Of the spearmint entries, the parent Native produced the most dry matter. Scotch 770 and S-90-9 produced less hay than the parent Scotch did (Table 3). Scotch 770 had the highest concentration of oil on a dry matter basis, and N-83-22 had the lowest. Scotch and Scotch 770 produced more oil for both harvests than S-90-9 or the Native lines. Scotch and Scotch 770 both produced over 110 lbs./acre of spearmint oil, 43% more than Native. N-83-22 produced only half the oil of the parent Native. None of the new peppermint or spearmint cultivars or selections showed improvement in oil yield over the parental lines (Table 4).

The peppermint was harvested in the late bud stage. The spearmints were at early bud for the first cutting and mid-bud to early bloom for the second. The Black Mitcham check entry, B-90-9, B-37XM0110, the McClelland and the PlantTech-94 selections had the highest menthol levels of the peppermints (Table 5a). Scotch 770 had the highest carvone levels of the spearmints (Table 5b).

Stolon viability after freezing treatments is summarized in Table 6. The lowest temperature for which cultivar/line differences are significant is 10°F. Stolon segments from the Black Mitcham mother block, the Lewis McKellip line, the Plant Tech-94 line, the McClelland line meristem-propagated by Starkel, and the UK-2 line propagated by Lake had the highest number of live stolons. The lowest peppermint survivorship at this temperature was in Murray Mitcham and the 92-(B-37xM0110) cross. Of the spearmint lines, Native, N-83-22, and S-90-9 were most vulnerable to this freezing treatment. Correlation with winter hardiness will be determined by spring 2000 observations.

Table 1. Stand establishment evaluation of peppermint and spearmint in the 1998 Mint Cultivar Trial at Kalispell, MT on May 25, 1999.

Selection/Cultivar	Source	Cover (0-5)[1/]	Vigor (0-5)[2]	Stolon Spread (0-5)[3]
PEPPERMINT				
Black Mitcham	stem-cut/MIRC	4.0	3.3	4.0
B-90-9	stem-cut/MIRC	3.8	3.5	4.0
Murray Mitcham	stem-cut/MIRC	2.5	1.8	3.0
M-83-14	stem-cut/MIRC	2.5	2.8	4.8
92 (B-37 x M0110)	stem-cut/MIRC	1.8	1.8	1.8
Lewis McKellip	nodal/MIRC	4.3	4.0	3.8
UK-1	nodal/Lake	3.3	3.3	3.8
UK-2	nodal/Lake	3.0	2.8	4.0
McClelland	meristem/Starkel	3.5	3.0	3.8
Plant Tech 94	stem-cut/Grey	3.3	2.5	3.8
SPEARMINT				
Native	stem-cut/MIRC	4.5	5.0	4.8
N-83-22	stem-cut/MIRC	4.0	4.0	4.3
Scotch	stem-cut/MIRC	4.0	3.5	3.3
Scotch 770	stem-cut/MIRC	2.3	2.5	3.5
S-90-9	stem-cut/MIRC	2.3	2.8	4.0
LSD(0.10)		0.8	0.7	1.1

[1/] 0=empty; 5=total plot covered

[2/] 0=dead; 5=very healthy, vigorous growth

[3/] 0=no visible spread from crowns; 5=extensive spreading

Table 2. Heights, total dry matter, oil concentration, and oil yields for peppermint entries in the Mint Cultivar Trial established at Kalispell, MT in 1998.

Selection/Cultivar	Source	Height	Hay Yield	Oil Content	Oil Yield
		inches	*t/a*	*%dm*	*lbs/a*
B-90-9	stem-cut/MIRC	29	3.45	1.3	91.9
Lewis McKellip	nodal/MIRC	31	3.89	1.1	89.2
Plant Tech-94	stem-cut/Grey	30	3.49	1.3	87.7
Black Mitcham	stem-cut/MIRC	30	3.54	1.2	87.1
UK-1	nodal/Lake	28	3.21	1.1	70.6
McClelland	meristem-Starkel	33	3.66	1.0	70.4
UK-2	nodal/Lake	28	3.09	1.1	66.9
M-83-14	stem-cut/MIRC	30	3.37	1.0	66.6
Murray Mitcham	stem-cut/MIRC	29	2.87	1.1	61.7
92 (B-37 x M0110)	stem-cut/MIRC	23	1.61	1.1	36.8
	LSD(0.10)	3	0.54	0.2	15.0
	CV(s/mean)%	7.7	14.0	14.7	17.1

Table 3. Heights, total dry matter and oil concentration, and oil yields for spearmint entries in the Mint Cultivar Trial established at Kalispell, MT in 1998.

First Harvest 7/9/99			Hay	Oil	Oil
Selection/Cultivar	Source	Height	Yield	Content	Yield
		inches	*t/a*	*%dm*	*lbs/a*
Scotch 770	stem-cut/MIRC	19	1.69	1.5	49.5
Scotch	stem-cut/MIRC	23	2.18	1.1	46.4
Native	stem-cut/MIRC	29	3.16	0.6	39.8
S-90-9	stem-cut/MIRC	20	1.73	0.9	30.5
N-83-22	stem-cut/MIRC	27	2.34	0.3	16.5
	LSD(0.10)	2	0.34	0.1	6.3
	CV(s/mean x100)	7.7	12.2	10.4	13.8
Second Harvest 9/9/99			Hay	Oil	Oil
Selection/Cultivar	Source		Yield	Content	Yield
			t/a	*%dm*	*lbs/a*
Scotch 770	stem-cut/MIRC		1.89	1.8	67.0
Scotch	stem-cut/MIRC		1.96	1.6	63.3
Native	stem-cut/MIRC		2.18	0.9	37.2
S-90-9	stem-cut/MIRC		1.60	1.4	43.9
N-83-22	stem-cut/MIRC		2.20	0.5	22.3
LSD(0.10)			0.38	0.3	9.7
CV(s/mean)%			15.1	19.6	16.4

Table 4. Total dry matter and oil yields for peppermint and spearmint entries in the Mint Cultivar Trial at Kalispell, MT from 1998 to1999.

Peppermint		1998	1998	1999	1999	1998+99	1998+99
Selection/Cultivar	Source	Hay Yield	Oil Yield	Hay Yield	Oil Yield	Hay	Oil
		t/a	*lbs/a*	*t/a*	*lbs/a*	*t/a*	*lbs/a*
Black Mitcham	sc/MIRC	2.09	59.3	3.54	87.1	5.63	146.4
B-90-9	sc/MIRC	1.98	59.8	3.45	91.9	5.42	151.7
Murray Mitcham	sc/MIRC	1.87	48.0	2.87	61.7	4.74	109.7
M-83-14	sc/MIRC	2.05	56.7	3.37	66.6	5.42	123.3
92 (B-37 x M0110)	sc/MIRC	1.67	38.4	1.61	36.8	3.28	75.1
Lewis McKellip	nodal	2.15	55.3	3.89	89.2	6.04	144.5
UK-1	n-Lake	1.83	49.5	3.21	70.6	5.04	120.1
UK-2	n-Lake	1.60	46.5	3.09	66.9	4.68	113.4
McClelland	ms-Starkel	1.98	51.0	3.66	70.4	5.64	121.3
Plant Tech 94	sc-MSU	1.73	49.5	3.49	87.7	5.22	137.2
mean		1.89	51.4	3.22	72.9	5.11	124.3
LSD(0.10)		0.23	8.0	0.54	15.0	0.61	18.9
CV(s/mean)%		10.29	12.8	14.0	17.1	9.9	12.7
Spearmint							
Native	sc/MIRC	1.84	34.6	5.34	77.0	7.18	111.6
N-83-22	sc/MIRC	1.57	17.7	4.54	38.8	6.11	56.5
Scotch	sc/MIRC	1.76	44.5	4.14	110.6	5.90	155.1
Scotch 770	sc/MIRC	1.39	38.0	3.58	116.6	4.97	154.6
S-90-9	sc/MIRC	1.41	26.3	3.33	74.4	4.74	100.8
mean		1.59	32.24	4.19	83.5	5.78	115.7
LSD(0.10)		0.27	7.4	0.34	14.1	0.73	16.4
CV(s/mean)%		12.5	13.7	12.2	13.3	9.9	11.2

Table 5a. Oil quality components (GC%) of peppermint entries in the Mint Germplasm Trial at Kalispell, MT in 1999.

Selection/Cultivar	Menthol	Neo-menthol	Menthone	D-iso-menthone	Mentho-furan	Menthyl acetate	Pulegone
	%	%	%	%	%	%	%
Black Mitcham	40.6	3.0	21.2	2.9	2.6	3.3	0.64
B-90-9	41.8	3.3	20.7	2.8	2.9	2.9	0.72
Murray Mitcham	39.2	3.1	25.7	3.1	1.4	2.9	0.51
M-83-14	39.0	3.7	25.8	3.0	1.9	2.8	0.55
92 (B-37 x M0110)	40.7	3.5	26.4	2.6	1.8	2.8	0.55
Lewis McKellip	39.3	2.9	22.3	2.9	2.9	3.0	0.70
UK-1	38.7	3.0	24.6	3.0	2.1	3.1	0.67
UK-2	39.5	3.1	23.1	2.9	2.1	3.3	0.65
McClelland	41.9	3.0	20.6	2.9	2.1	3.3	0.68
Plant Tech 94	41.0	3.1	21.0	2.9	2.7	3.3	0.69
LSD(0.10)	1.5	0.1	2.0	0.1	0.2	0.3	0.05
CV(s/mean) %	3.2	3.6	7.2	3.8	8.6	8.2	5.9

Table 5b. Oil quality components (GC%) of spearmint entries in the Mint Cultivar Trial at Kalispell, MT in 1999.

First Harvest Selection/Cultivar	A:Pinene	B:Pinene	Limonene	Cineole	Octanol	Dihydro-carvone	Carvone
	%	%	%	%	%	%	%
Native	0.98	0.88	12.2	1.2	0.9	1.8	55.1
N-83-22	0.97	0.82	13.9	1.3	0.8	0.9	47.3
Scotch	0.89	0.82	18.8	1.0	1.9	0.8	62.0
Scotch 770	0.87	0.86	16.1	0.8	1.9	1.1	65.9
S-90-9	0.89	0.86	16.5	1.1	1.4	1.4	60.4
LSD(0.10)	NS	NS	1.4	0.1	0.1	0.2	2.6
CV(s/mean)%	8.2	13.9	7.4	9.0	6.5	14.3	3.5

Second Harvest Selection/Cultivar	A:Pinene	B:Pinene	Limonene	Cineole	Octanol	Dihydro-carvone	Carvone
	%	%	%	%	%	%	%
Native	1.06	0.90	10.7	1.8	1.1	1.8	61.2
N-83-22	1.08	0.88	13.3	2.0	0.9	0.8	56.0
Scotch	0.92	0.86	18.8	1.3	2.3	0.8	63.9
Scotch 770	0.94	0.87	18.4	1.2	2.3	1.0	65.0
S-90-9	0.94	0.92	18.9	1.4	1.9	1.6	62.2
LSD(0.10)	0.11	NS	0.8	0.2	0.1	0.2	2.6
CV(s/mean)%	8.4	6.6	3.7	9.6	4.8	14.1	3.3

Table 6. Survivorship of stolon segments at four freezing treatments and a 36° F control.

Selection/Cultivar	Source	Total Stolon DWT	8-2" Pieces DWT	VIABILITY 36°F	20°F	15°F	10°F	5°F
		gms	*gms*	*%*	*%*	*%*	*%*	*%*
Peppermint								
Black Mitcham	sc	143.2	17.2	90.6	68.8	56.3	84.4	31.3
B-90-9	sc	144.5	23.2	84.4	78.1	90.6	34.4	28.1
Murray Mitcham	sc	132.8	19.7	78.1	62.5	59.4	6.3	3.1
M-83-14	sc	154.9	16.0	84.4	84.4	59.4	50.0	37.5
92 (B-37 x M0110)	sc	95.9	23.7	40.6	15.6	34.4	0.0	0.0
Lewis McKellip	nodal	161.5	19.6	84.4	90.6	84.4	68.8	25.0
UK-1	nodal-Lake	132.0	16.4	84.4	84.4	78.1	34.4	0.0
UK-2	nodal-Lake	138.9	15.1	65.6	62.5	59.4	62.5	6.3
McClelland	ms-Starkel	135.6	13.1	68.8	78.1	81.3	65.6	15.6
Plant Tech 94	stem-MSU	141.6	15.7	62.5	77.7	78.1	87.5	34.4
Spearmint								
Native	stem/MIRC	113.6	20.7	43.8	43.8	30.3	25.0	0.0
N-83-22	stem/MIRC	103.3	25.2	34.4	6.3	18.8	6.3	15.6
Scotch	stem/MIRC	118.7	20.4	59.4	75.0	43.8	34.4	18.8
Scotch 770	stem/MIRC	88.8	16.4	46.9	34.4	40.6	43.8	3.1
S-90-9	stem/MIRC	103.9	13.6	68.8	57.6	39.7	9.4	0.0
mean		127.3	18.4	66.5	61.3	57.0	40.8	14.6
LSD(0.10)		23.1	5.4	21.9	22.6	25.5	29.4	NS
CV(s/mean) %		10.3	16.7	27.8	31.0	37.6	60.5	158.1

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. Stand vigor was rated July 28, 1999. Plots were harvested September 3, 1999, when all cultivars had started to bloom. Plant height and growth stage was determined the day of harvest. Yields were determined by swathing a 94 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.

Data were analyzed using MSUSTAT, Version 5.22 (R.E. Lund, Montana State University), Procedure ANOVA for a randomized block with 4 replicates. Means of treatments were separated by the method of Least Significant Differences (Student's t) at the P=0.90 confidence level.

All entries established well with excellent transplant survival. Mid-summer stand evaluation indicated '84-M0107-7' and '87-M0109-1' had the most vigorous initial growth while 'M90-11' was least vigorous (Table 1). There were no signs of disease.

In this establishment year of the study, there was variation in yield parameters among cultivars and selection groups (Table 2). Selection 87-M0109-1 produced significantly more dry matter than any other entry, and 'Murray Mitcham', which was visibly the least vigorous, produced significantly less.

'Black Mitcham' had the highest ratio of oil to dry matter and 84-M0107-7 had the lowest (Table 2). Black Mitcham and 87-M0109-1 had the highest oil yield, while the Murray Mitcham was the least productive. Murray Mitcham's lack of vigor at establishment and the absence of any disease pressure on the stands make its performance inconclusive at this point.

84M0107-7 and M90-11 were harvested at the full bloom stage, while the other entries were just beginning to bloom. Black Mitcham had the highest menthol and methyl acetate levels. M90-11 had very high menthofuran and pulegone levels (Table 3).

Table 1. Stand establishment evaluation of peppermint entries in the 1999 MIRC Peppermint Trial at Kalispell, MT on July 28, 1999.

Selection/Cultivar	Cover	Vigor	Stolon Spread
	(0-5)[1/]	*(0-5)[2]*	*(0-5)[3]*
Black Mitcham	4.0	3.5	3.3
84-M0107-7	4.3	4.8	2.5
M-90-11	3.3	3.0	2.0
87-M0109-1	4.5	4.0	3.5
Murray Mitcham	2.8	2.8	3.0
LSD(0.10)	0.6	0.5	0.7

[1/] 0=empty; 5=total plot coverage

[2/] 0=dead; 5=very healthy, vigorous growth

[3/] 0=no visible spread from crowns; 5=extensive spreading

Table 2. Growth stages, heights, total dry matter and oil yields for entries in the MIRC Peppermint Trial established at Kalispell, MT in 1999.

Selection/Cultivar	Growth Stage	Height	Hay Yield	Oil Content	Oil Yield
		inches	*t/a*	*%dm*	*lbs/a*
Black Mitcham	early bloom	20	1.29	1.5	36.6
87-M0109-1	mid bloom	24	1.76	1.1	32.0
M-90-11	full bloom	22	1.31	1.1	28.0
84-M0107-7	full bloom	21	1.24	0.9	26.1
Murray Mitcham	pre bloom	15	0.69	1.2	17.7
LSD(0.10)		3	0.31	0.2	8.1
CV(s/mean x100)		12.4	19.7	13.6	22.8

Table 3. Oil quality components (GC%) of MIRC peppermint lines planted at Kalispell, MT in 1999.

Line/Cultivar	Menthone	D Iso-menthone	Menthol	Neo-menthol	Menthyl acetate	Mentho-furan	Pulegone
Black Mitcham	25.7	3.0	38.5	2.77	3.89	3.2	0.56
84M0107-7	35.3	14.3	25.3	1.92	1.69	1.3	0.53
M90-11	19.9	8.8	23.4	1.41	2.49	11.0	7.72
87M0109-1	34.9	17.7	21.5	1.90	2.09	1.4	1.05
Murray Mitcham	29.6	3.8	35.5	2.69	3.61	2.3	0.42
mean	29.1	9.5	28.8	2.14	2.75	3.8	2.06
LSD(0.10)	1.6	1.3	2.1	0.12	0.39	0.6	0.54