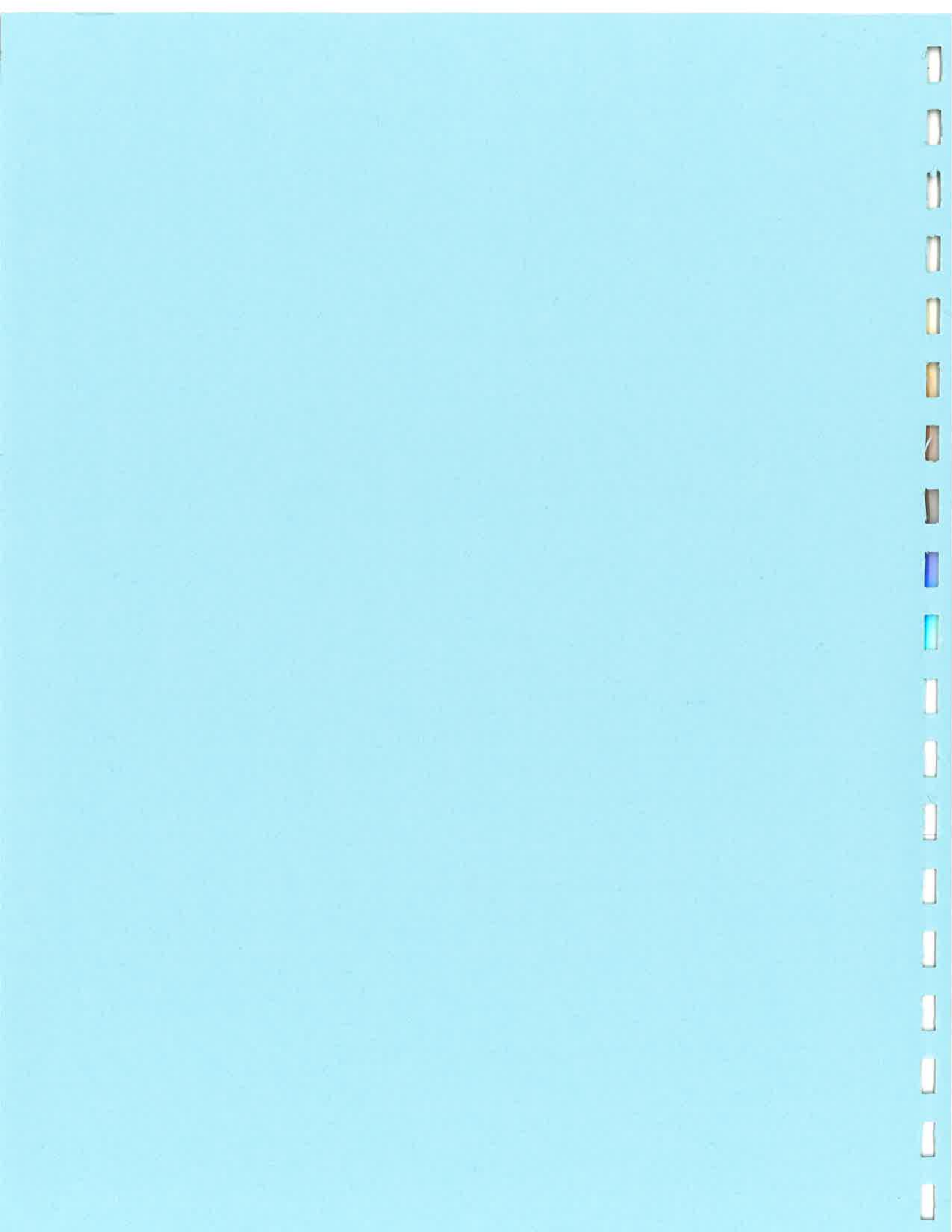


**The 16th**  
**ANNUAL REPORT**  
**of the**  
**WESTERN TRIANGLE AGRICULTURAL RESEARCH CENTER**  
**Montana Agricultural Experiment Station**  
**Conrad, Montana**  
**1993**

**Submitted by**  
**Dr. Gregory D. Kushnak, Superintendent & Crop Scientist**  
**and**  
**Dr. Grant D. Jackson, Soil Scientist**

**MSU-MAES Research Report**



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Climatic summary for the 1993 calendar year at the Western Triangle Research Center,  
Conrad, MT.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total or average
<b>Precipitation (inches)</b>													
Current Year	0.20	0.32	0.81	0.96	1.89	3.80	3.85	3.05	1.09	0.25	0.46	0.24	16.92
Average	0.24	0.23	0.62	0.89	1.89	2.47	1.72	1.89	1.67	0.51	0.32	0.18	12.63
<b>Mean Temperature (°F)</b>													
Current Year	12.5	17.0	34.0	43.5	56.5	55.5	57.5	60.5	55.0	46.5	27.0	30.0	41.3
Average	24.2	22.6	35.1	44.7	53.9	61.1	64.9	64.7	57.1	46.0	31.8	17.8	43.6
<b>Growing Degree days</b>													
1993					320	251	300	423	281	198			1773
Average					297	385	477	475	313	200			2148

**Last killing frost in Spring**

1993----- May 3 (22°)  
Average----- May 16

**First killing frost in Fall**

1993----- Sept 17 (32°)  
Average----- Sept 19

**Frost free period (days)**

1993----- 138  
Average----- 126

Maximum summer temperature----- 88° (Aug 10)

Minimum winter temperature----- -16° (Jan 6)

Summary of climatic data by month for the 1992-93 crop year (September thru August) at the Western Triangle Agricultural Research Center, Conrad, MT.

	Sep 1992	Oct 1992	Nov 1992	Dec 1992	Jan 1993	Feb 1993	Mar 1993	Apr 1993	May 1993	June 1993	July 1993	Aug 1993	Total or Average
<b>Precipitation (inches)</b>													
Current year	0.39	1.75	0.26	0.32	0.20	0.32	0.81	0.96	1.89	3.80	3.85	3.05	17.06
Average	1.74	0.54	0.30	0.17	0.24	0.23	0.62	0.89	1.89	2.47	1.72	1.89	12.70
<b>Mean Temperature (°F)</b>													
Current year	55.5	47.0	32.9	16.5	12.5	17.0	34.0	43.5	56.5	55.5	57.5	60.5	40.7
Average	57.4	45.9	32.5	24.1	24.2	22.6	35.1	44.7	53.9	61.1	64.9	64.7	44.3
<b>Growing Degree days</b>													
1993	307	202											1803
Average	317	200											2151
<b>Last killing frost in Spring</b>													
1993													
Average													
<b>First killing frost in Fall</b>													
1993													
Average													
<b>Frost free period (days)</b>													
1993													
Average													
<b>Maximum summer temperature</b>													
1993													
Average													
<b>Minimum winter temperature</b>													
1993													
Average													



Title: Winter Wheat Variety Investigations.

Year: 1993

Personnel: Gregory D. Kushnak, Ron Thaut, and Larry Christiaens - Research Center; and Dr. Phil Bruckner, MSU, Bozeman.

Winter wheat variety trials were grown near Conrad, Chester, Knees area west of Brady, Dutton, Sun River, and Eden during 1993. Above average rainfall resulted in high yields at Conrad, Chester and Dutton, but yields at the Knees and Eden were reduced substantially by wheat streak mosaic virus and Septoria, respectively. None of the test plots were affected by sawfly or Russian wheat aphid this year.

Data for the 1993 trials are presented in Tables 1,3,5,7,9, and 11; with five-year averages for the respective sites in Tables 2,4,6,8,10, and 12. Recently developed varieties do not have enough test-years to be included in the five-year summaries, and caution should be used when considering these for production. These include Meridian (grown only at Conrad), Readymade, and Kestrel. Meridian was several days later to ripen than Neeley and Tiber in 1993, and appears to be adapted to high moisture environments. Meridian was developed in Idaho. Readymade is a Canadian variety, and was selected at Lethbridge from Redwin. Kestrel was developed in Saskatchewan, and has shown a high level of winterhardiness.

These trials were conducted by the Western Triangle Research Center, Conrad in Cooperation with Dr. Phil Bruckner, Montana State University Plant and Soil Science Department. The background and detailed descriptions for many of the varieties tested are included in Extension Bulletin 1098, "Performance Summary of Winter Wheat Varieties in Montana," available at all county agent offices. Other comments about the varieties, based on observations in Triangle Area trials, are presented in the following pages.

VARIETY NOTESWINTER WHEAT

Abilene (AqriPro NA 362-5) - Ranked low, Conrad 1988, low winter-hardiness(2). Adapted north of Ks/Okla borders and Texas panhandle. Short semidwarf. Susceptible to Hessian fly.

Agassiz(ND) - Recommended for District 6 only to replace Froid (Eastern Montana). High winterhardiness (4-5). Tall very weak straw, lodges bad. Low yield; shatter resistance and protein fairly good, better than Norstar. Medium late maturity.

Arapaho (Nebr)-Medium height with long coleptile and moderate straw strength. Winterhardiness fairly good?? Heterozygous (mixed) resistance to Great Plains strain of Hessian fly, moderate tolerance to Cephalosporium stripe. Medium yield, low test weight, early heading. Medium winter survival.

Archer(NAPB) - Winterhardiness less than Centurk, but greater than Vona (probably should classify as a 2). Low protein. Sometimes can have test weight problems due to its massive tillering. Short straw. Good lodging and shatter resistance. Early maturity. Not widely adapted for Montana.

Blizzard (ID 0297) - Idaho/Oregon/USDA joint: Snow mold resistance - for high elevation areas under snow. Probably similar to Weston for winterhardiness which is not very high. Better dwarf bunt resistance than Weston or Manning. Tough to thresh; lots of spikelets in grain sample.

Bighorn(Rohm & Haas, Inc. Hybritech Intl, Inc.) - Winterhardiness less than Cheyenne, and may be risky. (might be considered a 2). Short straw. Medium early maturity. Protein is fairly high.

Centurk-(Nebraska). High yield, low protein. Medium winterhardiness, less than Redwin and Tiber. Very susceptible to yellow berry expression under low Nitrogen conditions. Early maturity, which sometimes allows escape from sawfly. Medium stiff straw.

Cheyenne - High protein. Tall straw, medium winterhardiness, medium to high yield, shatters bad -(see 'Cree' for an improvement). Medium maturity.

Chisolm -(Oklahoma). Winterhardiness equal or less than Cimmaron.

Cimmaron -(Oklahoma). Winterhardiness adequate for Kansas, Nebraska, and Colorado. Semidwarf, red head, awnless (awnletted). Hard to thresh due to very stiff straw.

Cree(MSU)-Shatter resistant version of Cheyenne. Identical to Cheyenne in other respects except has red head and brown chaff. Medium to high yield. Winterhardiness medium (3). Tall straw. High protein. Medium maturity and highly vulnerable to sawfly.

Dawn (S.Dak.)-Medium short height, good lodging resistance. Early maturity. Fair winterhardiness, greater than Hawk. Quality is fair.

Eklund (private var.- eastern Mta grower)-Beardless. Medium short height and maturity. High winterhardiness (4 or 5). Medium shatter resistance.

Froid - Drop from recommended list. Low yield and tall weak straw. High winterhardiness (5).

Hawk -(AgriPro) Winterhardiness moderate to poor, probably less than Centurk; sometimes yields high, but not consistently. Early maturity & good lodging resistance. Adapted to Southern Great Plains.

Hill-81 (Oregon)- Soft White. Compared to other soft-white wheats, winterhardness is good, but still may be risky for Triangle area. Good straw strength.

Judith (MT 8039)(MSU)- Yields fair to good - sometimes equal to Rocky, and Tiber. Low vernalization requirement. Stripe and stem rust resistant. Protein is equal to Tiber, greater than Centurk, and less than Redwin. Heading slightly later than Rocky, but earlier than Tiber. However, it had more sawfly damage than Rocky & Tiber at the Knees plot in 1991. Medium short straw; winterhardiness higher than Rocky and Cheyenne, and equal to Redwin. Medium shatter resistance.

Three problems:

- 1) Test weight is sometimes low, and may be a problem.
- 2) Broken stems at crown and white heads at Conrad in 1986.
- 3) Straw less stiff than Neeley, Tiber and Redwin; but stiffer than Rocky and Centurk. Has some red heads and tall and beardless heads.

Kestrel (Sask., Can)- Winterhardy and high yielding in Canada (hardiness similar to Norstar with higher yield). Shorter straw, better lodging resistance, and three days earlier than Norstar. Test weight and protein less than for Norstar. Probably will not tolerate drought stress very well. Leaf spots at Conrad 1992.

Lamar(Colorado)-Medium height with long coleoptile. Adapted to severe low moisture conditions of Colorado. Heterogeneous reaction to Great Plains biotype of Hessian fly. Very early heading, medium yield, high test weight, weak straw, poor winterhardiness.

Manning(Utah)-Medium short. Adapted to deep snow areas, resistant to dwarf bunt and moderately tolerant to snow mold. Good straw strength, poor winterhardiness.

Meridian(Idaho)- Developed for irrigated conditions in Idaho. Very high yield, medium test weight, late maturity (several days later than Neeley). Good straw strength, poor winterhardiness.

MT 7811 - Hard white winter wheat for specialty markets (Market still under development). Medium high yield. Currently (1992) has a small percentage of red kernels, and attempts are underway to purify it for possible release.

Minter-Medium height and maturity. High winterhardiness (4-5). Good shatter resistance. Low yield.

Mounty - (Wally Johnson's) Stiffer straw than Neeley, and yield claimed to be equal to or better than Neeley, according to Johnson?? Not tested by MSU.

Neeley(Idaho) - Very high yielder in good years, but does poor if stressed for moisture. Winterhardiness medium to high; greater than Cheyenne, but less than Winalta. Medium short straw slightly less stiff than Redwin and Tiber. Medium maturity. Good shatter resistance. Protein & quality are erratic, ranging from low to high; apparently more sensitive to Nitrogen deficiency. Highly vulnerable to sawfly due to medium-late maturity.

Norstar(Canada) - Maximum Winterhardiness (5). Lower protein than Roughrider (medium). Very tall straw, poor lodging resistance. Low yield. Late maturity. Medium shatter resistance? (head shattering occurred at Conrad in 1980).

Norwin(MSU)-Winalta winterhardiness (4-5 high). Protein medium to low. Pseudomonas bacterial leaf blight bad. Licensed in Canada. Short semidwarf straw, but not a tripledwarf. Too short for dryland. Medium yield. Good shatter resistance. Medium maturity.

Promontory (Utah)- Excellent dwarf smut resistance. Yield and test weight higher than Manning. Medium height, strong straw, good lodging resistance. Winterhardiness probably poor.

Quantum 542 (Hybritech- Seed Intl. Inc.) - An F<sub>1</sub> hybrid; needs new seed each year. Planting F<sub>2</sub> (second generation) seed may result in yield reduction and development of ergot due to sterility in a small percentage of florets (ms ratio less than 3:1). F<sub>1</sub> vs F<sub>2</sub> tests in 1992 indicated a 12% yield reduction from planting 2nd generation seed. High yield; protein as good as Rocky; early maturity like Rocky. Recommended in 1991 for districts 2,3,4, & 5 (but not for dwarf smut areas). Medium short height, lodging resistance equal to Rocky. Winterhardiness is fairly good but less than Winalta. Bearded.

Quantum 555 - An F<sub>1</sub> hybrid (see Q 542). According to Hybritech, adapted to Montana, 2 days later than Centurk. Semidwarf. Excellent straw strength. Good winterhardiness. Dryland and irrigated. Awnletted.

Ram(NAPB) - Winterhardiness less than Centurk. Tall semidwarf with good straw strength. Early maturity (similar to the Centurk-type wheats). Adapted to Southern Great Plains. Susceptible to Hessian fly. Low winterhardiness, medium-low test weight.

Rawhide(Nebraska)-not tested. For Southern Plains.

Redwin(MSU) -Among the highest protein winter wheats. Yields similar to Winalta. Winterhardiness greater than Cheyenne but slightly less than Winalta. Medium short height. Very stiff straw, (along with Tiber, is among the stiffest available among Mta wheats). Medium-late maturity, medium yield. Red head. Very susceptible to leaf spot fungi and bacterial leaf blight. Good shatter resistance. Tiber and Readymade were selected from Redwin.

Readymade (W188)(Lethbr. Canada) - Selection out of Redwin by Agr Canada at Lethbridge. Slightly lower protein, and larger kernels than Redwin. Winterhardiness and yield similar to Redwin. Head color same as Redwin; but stems are yellow, whereas Redwin stems are mixture of red and yellow. Redwin has a mix of small spring wheat-like seeds with large seeds. Readymade is all large seed that grade properly under the Canadian system. Had similar leaf spot problems as Redwin at Conrad 1992.

Rio Blanco (NAPB)-not tested. For Southern Plains.

Rocky (NAPB) -A selection from Centurk for soil borne mosaic resistance. High yield, low protein. Medium winterhardiness, less than Redwin and Tiber. Very susceptible to yellow berry expression under low Nitrogen conditions. Rocky is lower quality than Centurk. Early maturity, which sometimes allows escape from sawfly. Medium stiff straw, medium height.

Roughrider(ND) - Tall, but more lodging resistant than Winalta. Good winterhardiness (5). Low yield. Medium-late maturity. For Eastern Montana; protein slightly greater than Winalta (high). Has a shatter problem in the Triangle area. Susceptible to leaf spot diseases.

Seward (ND 8002) - (Centurk/Froid/Norstar). Winterhardness of Winalta (4), outyields Winalta by 20% at Sidney, but not at Conrad. Medium height and is shorter and stiffer than Winalta (about like Rocky). Protein 3/4% less than Norstar. Good lodging resistance. Low protein & poor quality. Medium shatter resistance. Low yield.

Siouxland (S.Dak) - Sticky dough problems, and could damage our market image. Winterhardness not adequate for Triangle area of Montana.

Tam 107 (Texas) - Early maturing, short straw. Moderate resistance to wheat curl mite infestation, and thus may be able to escape wheat streak mosaic virus. However, wheat streak symptoms were observed on Tam 107 at Conrad in 1993 (average level). Winterhardness medium to low???

Thunderbird (AgriPro) - Winterhardness may be low, less than Centurk. Short straw with good lodging resistance, long coleoptile. Early maturity.

Tiber (MSU) - Winterhardness comparable to Redwin, greater than Cheyenne, and slightly lower than Winalta. Equal, or sometimes 1 bushel less than Neeley. Among highest yielders. Medium short height with good lodging resistance. Stiff straw - stiffer than Judith, but not quite as stiff as Redwin (This may cause it to thresh a little harder than weaker-strawed varieties). It seems to persist longer after tillage, thus good for conservation compliance. Higher yielding and more tillers than Redwin, but 1/2% less protein. Protein is higher than Rocky, and similar to Neeley. Medium maturity. Slightly earlier than Redwin, but still late enough to be sawfly vulnerable. Much greater tolerance to leaf spot diseases than Redwin. Good shatter resistance. Good milling and baking quality. Dark Red head, (darker than redwin); blackish red in years of favorable moisture. This trait makes Tiber popular for wheat weaving and other crafts.

Vona (Colorado) - Winterkilled fairly often in Triangle area tests, but yields high if it survives without injury. Very early maturity if not winter-injured. Short stiff straw. Poor milling and baking quality.

Warrior (NEBR) - Tall straw and medium maturity. Medium shatter resistance. Yields lower than Cree. May be resistant to the Great Plains strain of Hessian fly.

Weston (Idaho) Dwarf smut resistant, but less than Blizzard. Tall straw, lodges. Winter killed at Moccasin in 1989, winterhardness poor. Moderate snowmold tolerance. Low to medium yield.

Winalta - High protein, tall weak straw, high winterhardness (4). Medium yields. Good shatter resistance. Redwin and Tiber offer improvements.

Winoka - Similar to Winalta, but slightly earlier to mature.

Wings - (Private variety) Winterhardness less than Centurk. Sister to Vona, but a little more winterhardness. Early maturity.

Winridge (MSU) - Medium to high yield. Medium height with stiff straw. Medium late maturity, and therefore highly vulnerable to sawfly. Low test weight and protein. Winterhardness (2) medium, better than Centurk but less than Cheyenne. Good shatter resistance. For dwarf smut areas.

Yuma (Colorado) - Early maturing semidwarf, long coleoptile. Winterhardness probably poor.

Table 1. Dryland Winter Wheat variety trial grown north of Conrad at the Western Triangle Ag. Research Center. Mont. Ag. Expt. Station, Conrad, MT.

Variety	Yield bu/ac	Test wt lbs/bu	Plant hgt. inches	Head date	Spring survival class 1/	% Prot.
MERIDIAN	71.8	60.0	34	179		9.1
HYBRITECH 1486	63.8	61.5	30	169		9.3
S86-736	61.6	60.1	35	172		8.2
BLIZZARD	60.1	60.0	32	175	2-3	10.4
JUDITH	60.0	60.2	34	171	3	8.8
ID 355	59.5	60.2	33	171		9.3
KESTREL	59.2	60.0	38	172	4-5	7.8
NEELEY	59.1	60.3	31	176	3	8.4
TIBER	59.0	60.7	34	171	3	8.6
YUMA	58.1	61.0	30	169		8.9
IDHW0355	57.4	60.3	35	176		9.7
W235	57.2	60.2	36	173		9.5
VONA	56.7	61.4	30	168		8.0
WINRIDGE	56.1	59.8	34	176	2	8.5
ROCKY	55.7	60.9	33	171	2	9.0
PROMONTORY	55.0	60.7	31	172		9.2
MT 8949	54.9	60.3	37	172		9.7
ARAPAHO	54.7	60.8	32	169		10.6
AC READYMADE	54.3	60.5	38	175	3	10.4
CREE	54.0	60.7	36	175	3	9.6
MT 7811	54.0	60.5	34	172		9.7
LAMAR	54.0	62.1	30	169		9.6
MTSF1142	54.0	60.7	32	172		9.8
MT 8957	53.5	60.4	30	175		9.6
RAM	53.4	60.5	33	170		9.3
REDWIN	53.4	60.1	33	172	3	9.7
MT 8909	53.3	60.0	32	175		9.8
WESTON	52.8	60.3	36	171		10.3
MT 8713	52.3	61.4	27	170		9.8
MTSF2238	51.8	61.7	33	171		10.0

(continued on next page)

(Conrad Winter Wheat, *continued.*)

Variety	Yield bu/ac	Test wt lbs/bu.	Plant hgt. inches	Head date	Spring survival class 1/	% Prot.
PI499375	51.3	60.0	33	169		10.1
MANNING	50.4	60.0	30	171		9.7
MT 8719	49.8	60.7	30	172		10.9
PI499376	49.8	60.3	30	171		9.0
PI499377	49.6	60.0	32	171		9.8
SEWARD	49.2	60.7	35	172	4	9.0
CENTURK	48.6	60.7	34	171	2	9.0
NORSTAR	47.8	64.0	41	179	5	10.0
MT 88030	47.3	60.7	29	171		11.1
TAM 107	46.7	60.7	28	168		10.2
MT 8918	46.7	60.5	31	175		9.1
AGASSIZ	45.7	60.7	39	178	4	9.6
WINALTA	45.3	60.7	36	172	4	10.1
NORWIN	43.0	60.5	29	177		9.1
MT 88005	42.5	60.3	42	172		11.3
ROUGH RIDER	42.3	61.2	35	171		10.3
MT 88046	39.4	60.5	29	170		10.7

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-52-0 with the seed, + 35# N broadcast.  
 Previous crop: Fallow.  
 Date seeded: Sept. 23, 1992.  
 Date harvested: Aug. 27, 1993.  
 Rainfall: From May 1 to harvest was 11.58 inches.  
 1/ = Spring survival class: 5=best; 1=very low; based on  
 several location-years of observation.  
 Yield experimental mean: 53.01  
 Error degrees of freedom: 96  
 F test for var. = 6.66, C.V. 2 = 4.42, LSD (0.05) = 6.58

Table 1a. Dryland Winter Wheat variety trial grown north of Conrad at the Western Triangle Ag. Research Center. Mont. Ag. Expt. Station, Conrad, MT. (*abbreviated*)

Variety	Yield bu/ac	Test wt lbs/bu	Plant hgt. inches	Head date	Spring survival class 1/	% Prot.
MERIDIAN	71.8	60.0	34	179		9.1
HYBRITECH 1486	63.8	61.5	30	169		9.3
BLIZZARD	60.1	60.0	32	175	2-3	10.4
JUDITH	60.0	60.2	34	171	3	8.8
KESTREL	59.2	60.0	38	172	4-5	7.8
NEELEY	59.1	60.3	31	176	3	8.4
TIBER	59.0	60.7	34	171	3	8.6
YUMA	58.1	61.0	30	169		8.9
VONA	56.7	61.4	30	168		8.0
WINRIDGE	56.1	59.8	34	176	2	8.5
ROCKY	55.7	60.9	33	171	2	9.0
PROMONTORY	55.0	60.7	31	172		9.2
ARAPAHO	54.7	60.8	32	169		10.6
AC READYMADE	54.3	60.5	38	175	3	10.4
CREE	54.0	60.7	36	175	3	9.6
LAMAR	54.0	62.1	30	169		9.6
RAM	53.4	60.5	33	170		9.3
REDWIN	53.4	60.1	33	172	3	9.7
WESTON	52.8	60.3	36	171		10.3
MANNING	50.4	60.0	30	171		9.7
SEWARD	49.2	60.7	35	172	4	9.0
CENTURK	48.6	60.7	34	171	2	9.0
NORSTAR	47.8	64.0	41	179	5	10.0
TAM 107	46.7	60.7	28	168		10.2
AGASSIZ	45.7	60.7	39	178	4	9.6
WINALTA	45.3	60.7	36	172	4	10.1
NORWIN	43.0	60.5	29	177		9.1
ROUGH RIDER	42.3	61.2	35	171		10.3

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-52-0 with the seed, + 35# N broadcast.  
 Previous crop: Fallow.  
 Date seeded: Sept. 23, 1992.  
 Date harvested: Aug. 27, 1993.  
 Rainfall: From May 1 to harvest was 11.58 inches.  
 1/ = Spring survival class: 5=best; 1=very low; based on  
 several location-years of observation.  
 Yield experimental mean: 53.01  
 F test for var. = 6.66, C.V. 2 = 4.42, LSD (0.05) = 6.58



Table 2. **Five-year summary for Winter Wheat varieties** grown north of **Conrad** at the Western Triangle Ag. Research Center, 1987 - 1988 - 1989 - 1990 - 1993. Mont. Agr. Expt. Station, Conrad, MT.

-----					
5 - year comparable average					
Variety	Yield bu\ac	Test wt. lbs\bu.	Plant hgt. inches	Head date 1/	% Protein
-----					
QUANTUM 542	65.3	62.2	35.7	165	11.8
NEELEY	64.8	61.5	31.4	171	11.8
ROCKY	63.3	63.3	32.4	166	11.5
TIBER	63.2	62.6	34.2	169	11.3
JUDITH	63.0	61.4	32.2	167	10.9
BLIZZARD	61.2	62.1	40.1	177	11.7
WINRIDGE	61.1	60.6	33.8	170	10.5
BIGHORN	61.0	62.2	28.0	168	11.4
CENTURK	60.2	62.8	33.2	166	11.8
CREE	59.4	62.5	36.6	170	12.2
AGASSIZ	56.9	62.5	38.0	170	12.0
REDWIN	56.7	61.6	33.2	168	12.1
NORSTAR	56.5	61.8	40.4	174	11.8
WINALTA	56.1	63.4	36.2	168	13.0
SEWARD	56.0	62.0	33.8	169	10.8
ROUGH RIDER	51.7	62.3	35.2	167	12.7
-----					

Cooperator: Conrad Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 1/ = Head dates based on four years only, 1988-1989-1990-1993.

Table 3. Dryland Winter Wheat variety trial grown near Chester, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	Spring survival class 1/	% protein
KESTREL	71.7	62.1	33	4-5	7.7
BLIZZARD	71.3	62.3	35	2-3	11.9
NEELEY	69.6	62.4	32	3	10.3
TIBER	68.7	62.2	34	3	10.8
WINRIDGE	64.5	61.1	33	2	9.4
AC READYMADE	64.0	62.0	33	3	11.5
SEWARD	63.4	60.6	34	4	9.2
QUANTUM 542	63.3	61.5	35	3	10.0
JUDITH	63.3	61.0	33	3	10.7
NORSTAR	63.3	62.7	38	5	9.9
REDWIN	62.5	62.6	33	3	10.8
ROCKY	62.2	61.8	33	2	10.8
BIGHORN	62.1	62.4	30	3	11.2
ARCHER	61.1	60.5	31		10.5
ARAPAHO	60.2	60.2	32		11.7
AGASSIZ	60.1	61.7	38	4	12.4
CREE	60.0	62.4	34	3	11.0
WESTON	59.7	63.0	35		12.0
WARRIOR	59.5	61.8	37		11.4
HAWK	59.2	61.9	28	2-3	10.2
WINALTA	57.3	63.1	36	4	11.2
CENTURK	57.1	61.9	32	2	10.1
MANNING	54.9	61.0	30		10.8

Cooperator: Mike Violet

Location: Ten miles southwest of Chester, Liberty County.

Fertilizer: 100# 11-52-0 with the seed, + 50# AA-N.

Previous crop: Fallow.

Date seeded: Sept. 22, 1992.

Date harvested: Aug. 19, 1993.

Rainfall: From May 14 to Aug. 19, 7.4 inches.

1/ = Spring survival class: 5=best; 1=very low; based on several location-years of observation.

Yield experimental mean: 62.54

Error degrees of freedom: 44.00

F test for var. = 4.08, C.V. 2 = 3.45, LSD (0.05) = 6.16

Table 4. **Five-year summary for Winter Wheat varieties grown southwest of Chester, MT. 1987 - 1988 - 1989 - 1990 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

-----				
5 - year comparable average				
Variety	Yield bu\ac	Test wt. lbs\bu.	Plant hgt. inches	% Protein
-----				
NEELEY	52.3	58.1	28.2	13.9
QUANTUM 542	51.6	57.8	30.4	13.1
TIBER	49.3	59.0	29.2	13.8
BLIZZARD	48.8	59.2	29.0	15.5
JUDITH	48.6	59.1	29.2	14.0
SEWARD	48.2	57.9	29.8	13.1
ROCKY	47.8	59.5	27.6	13.8
CENTURK	47.5	58.7	28.2	13.5
WINRIDGE	47.2	57.3	28.6	13.2
REDWIN	47.0	60.0	28.4	15.0
CREE	46.7	60.6	29.6	14.3
NORSTAR	45.1	60.2	32.0	13.6
HAWK	44.5	59.7	25.0	13.8
WARRIOR	43.9	59.0	30.6	14.5
WINALTA	43.9	62.0	30.6	14.6
AGASSIZ	42.2	59.1	32.6	15.3

Cooperator: Mike Violet.

Location: Ten miles southeast of Chester, MT. (Liberty Co.)

Table 5. Dryland Winter Wheat variety trial grown near the Knees, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac *	Test wt. lbs/bu *	Plant hgt. inches	Spring survival class 1/	% Protein
ROCKY	43.2	52.4	31	2	13.4
BLIZZARD	42.8	53.8	31	2-3	13.7
QUANTUM 542	38.7	51.9	30	3	12.6
HAWK	38.5	53.1	26	2-3	13.7
TIBER	34.8	53.2	29	3	12.8
SEWARD	33.8	50.0	28	4	12.1
CENTURK	33.2	50.9	30	2	13.5
ARCHER	33.1	48.8	23		14.1
BIGHORN	32.9	51.6	25	3	12.6
REDWIN	30.5	51.7	29	3	14.0
AC READYMADE	29.2	52.4	30	3	13.8
CREE	28.6	52.6	30	3	12.5
ARAPAHO	28.6	49.0	26		14.3
WARRIOR	28.4	51.4	30		13.1
NEELEY	28.2	49.2	27	3	13.0
MANNING	26.9	47.6	26		12.7
JUDITH	25.5	49.2	30	3	14.0
WINALTA	24.3	50.9	26	4	13.3
KESTREL	24.2	48.3	33	4-5	12.8
WESTON	23.7	49.2	30		13.0
NORSTAR	20.1	50.3	31	5	13.3
AGASSIZ	18.1	48.1	29	4	13.3
WINRIDGE	16.5	47.0	26	2	11.8

Cooperator: Dan Picard.

Location: Thirty miles east of Brady, Chouteau County.

Fertilizer: 100# 11-52-0 with the seed, + 65# AA-N.

Previous crop: Fallow.

Date seeded: Sept. 22, 1992.

Date harvested: Aug. 13, 1993.

Rainfall: From May 13 to Aug. 13, = 8.06 inches.

1/ = Spring survival class: 5=best; 1=very low; based on several location-years of observation.

\* = Yield and test weight were reduced by wheat streak virus.

Yield experimental mean: 29.72

F test for var. = 10.57, C.V. 2 = 7.39, LSD(0.05) = 6.26.

Table 6. **Five-year summary for Winter Wheat varieties grown east of Brady, MT. near the Knees, 1987 - 1988 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average			
	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Protein
QUANTUM 542	48.0	56.5	32.9	13.2
BLIZZARD	46.8	57.8	31.3	14.1
ROCKY	45.4	56.8	30.8	14.0
CENTURK	42.9	57.0	30.6	13.7
TIBER	42.5	59.1	31.2	14.2
CREE	40.2	59.6	32.8	14.3
JUDITH	40.2	56.4	31.4	14.7
NEELEY	39.6	56.5	29.6	13.9
SEWARD	39.5	55.3	30.0	13.5
WARRIOR	39.2	59.3	33.0	14.8
REDWIN	38.4	58.8	30.8	14.8
WINRIDGE	34.1	54.5	30.0	13.3
WINALTA	33.6	57.8	33.2	14.4
NORSTAR	31.4	56.8	35.6	14.9
AGASSIZ	31.3	54.7	33.8	14.5

Cooperator: Dan Picard.

Location: Thirty miles east of Brady, MT. (Chouteau County)

Table 7. Dryland Winter Wheat variety trial grown near Dutton, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu	Plant hgt. inches	Spring survival class 1/	% protein
NEELEY	71.7	61.7	34	3	11.1
BLIZZARD	71.2	61.5	35	2-3	9.4
REDWIN	67.2	61.8	37	3	12.4
BIGHORN	65.6	61.6	31	3	11.1
ARAPAHO	64.8	60.2	29		12.1
ARCHER	64.7	60.4	34		10.8
WARRIOR	64.6	61.2	37		11.5
MANNING	62.4	60.3	34		9.4
ROCKY	60.8	61.2	35	2	11.6
QUANTUM 542	59.5	61.0	36	3	9.5
AC READYMADE	58.0	61.4	39	3	11.3
CENTURK	57.9	61.2	29	2	11.8
NORSTAR	57.6	61.7	41	5	11.7
WINRIDGE	57.3	60.5	37	2	9.6
JUDITH	56.9	60.9	37	3	11.8
KESTREL	54.3	61.4	37	4-5	8.8
WINALTA	53.4	62.4	41	4	12.5
HAWK	52.4	61.2	26	2-3	9.8
TIBER	52.0	61.5	36	3	10.6
CREE	51.0	61.6	37	3	11.4
AGASSIZ	49.8	61.1	40	4	12.4
SEWARD	48.9	60.0	38	4	10.2
WESTON	48.3	62.1	37		12.4

Cooperator: Darrell Goodmundson.

Location: Three miles east of Dutton, Teton County.

Fertilizer: 100# 11-52-0 with the seed, + 100# AA-N.

Previous crop: Fallow.

Date seeded: Sept. 22, 1992.

Date harvested: Aug. 13, 1993.

Rainfall: From May 13 to Aug. 13, 7.1 inches.

1/ = Spring survival class: 5=best; 1=very low; based on several location-years of observation.

Yield experimental mean: 58.70

Error degrees of freedom: 44.0

F test for var. = 2.01, C.V. 2 = 8.32, LSD(0.05) = 13.91

Table 8. **Five-year summary for Winter Wheat varieties grown near Dutton, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Agr. Research Center, Conrad, MT.**

Variety	5 - year comparable average			
	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Protein
NEELEY	60.0	61.1	31.6	11.6
JUDITH	57.5	60.3	32.0	11.5
REDWIN	57.3	60.5	33.6	12.1
QUANTUM 542	57.2	60.0	33.3	10.7
ROCKY	56.7	61.7	31.6	11.2
TIBER	54.0	60.8	33.6	11.2
CREE	53.6	61.3	35.0	11.6
WARRIOR	53.6	60.9	34.2	12.9
NORSTAR	52.2	61.3	38.2	11.8
CENTURK	52.0	61.2	30.8	10.8
WINRIDGE	51.2	60.0	33.6	10.3
WINALTA	48.8	62.3	36.0	12.5

Cooperator: Darrell Goodmundson.

Location: Three miles east of Dutton, MT. (Teton County)

Table 9. Dryland Winter Wheat variety trial grown near Sun River, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu	Plant hgt. inches	Spring survival class 1/	% Protein
KESTREL	46.6	62.1	33	4-5	11.5
NEELEY	46.3	61.0	31	3	12.6
WESTON	45.0	63.0	33		12.5
WARRIOR	44.7	61.7	32		13.7
QUANTUM 542	44.4	62.4	30	3	11.7
ROCKY	44.2	62.8	34	2	11.8
JUDITH	42.5	60.8	35	3	13.1
REDWIN	42.5	58.6	33	3	13.8
TIBER	42.3	61.5	32	3	13.9
BIGHORN	41.7	62.4	28	2	12.8
ARCHER	41.4	61.1	27		12.3
CREE	40.6	62.3	30	3	13.7
CENTURK	40.1	62.6	31	2	13.0
ARAPAHO	39.3	61.2	31		14.4
SEWARD	38.9	61.3	33	4	12.1
AC READYMADE	38.8	61.7	35	3	14.7
WINRIDGE	38.7	62.1	33	2	12.0
WINALTA	37.1	62.8	35	4	13.8
NORSTAR	36.6	62.0	34	5	13.8
HAWK	35.5	61.9	29	2-3	12.7
AGASSIZ	35.5	59.3	33	4	13.6
MANNING	34.0	61.5	31		11.8
BLIZZARD	33.1	62.2	30	2-3	12.5

Cooperator: Chuck Merja.

Location: Two miles southeast of Sun River, Cascade county.

Fertilizer: 100# 11-52-0 with the seed + 50# AA-N.

Previous crop: Fallow.

Date seeded: Sept. 24, 1992.

Date harvested: Aug. 13, 1993.

Rainfall: From May 13 to Aug. 13, 8.03 inches.

1/ = Spring survival class: 5=best; 1=very low; based on several location-years of observation.

Yield experimental mean: 40.43

Error degrees of freedom: 44.00

F test for var. = 0.80, C.V. 2 = 10.79, LSD(0.05) = 12.44.



Table 10. **Five-year summary for Winter Wheat varieties grown near Sun River, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

-----				
5 - year comparable average				
Variety	Yield bu\ac	Test wt. lbs\bu.	Plant hgt. inches	% Protein
-----				
QUANTUM 542	42.8	59.5	30.4	15.1
ROCKY	40.4	61.3	30.8	15.3
JUDITH	39.7	58.9	31.2	16.0
NEELEY	39.7	58.8	29.0	15.7
CENTURK	39.3	61.0	30.2	15.9
TIBER	38.9	60.8	30.6	15.6
CREE	38.2	61.4	31.4	15.9
REDWIN	38.1	60.4	29.8	16.2
WARRIOR	37.2	60.2	31.3	16.2
SEWARD	37.1	59.9	30.7	14.6
WINRIDGE	35.9	59.4	30.8	15.4
BLIZZARD	35.0	60.6	29.8	15.4
WINALTA	34.0	61.5	33.8	15.5
AGASSIZ	33.0	59.1	35.1	16.4
NORSTAR	31.6	60.5	35.4	15.8
-----				

Cooperator: Chuck Merja.

Location: Two miles southeast of Sun River, MT. (Cascade County)

Table 11. Dryland Winter Wheat variety trial grown near Eden, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac *	Test wt. lbs/bu *	Plant hgt. inches	Spring survival class 1/	% Protein
HAWK	31.2	56.2	33	2-3	10.9
QUANTUM 542	27.9	56.9	36	3	11.5
ARAPAHO	27.0	55.7	33		11.6
NEELEY	26.7	55.2	31	3	10.1
AC READYMADE	26.3	52.5	37	3	11.8
KESTREL	26.2	55.0	36	4-5	10.0
ARCHER	26.1	55.0	31		10.2
WESTON	25.9	57.2	38		11.6
MANNING	25.9	54.7	32		10.2
BIGHORN	25.7	55.5	30	3	11.0
ROCKY	24.6	55.7	35	2	11.0
WINRIDGE	23.5	54.2	36	2	9.54
BLIZZARD	23.5	53.9	36	2-3	10.7
WARRIOR	23.3	55.3	35		11.6
CENTURK	23.0	54.8	32	2	10.5
SEWARD	22.8	55.7	37	4	10.8
REDWIN	22.6	53.4	35	3	11.7
TIBER	22.2	55.3	35	3	10.5
JUDITH	21.5	54.8	34	3	10.1
NORSTAR	20.5	54.7	38	5	10.7
CREE	18.8	54.6	34	3	11.6
WINALTA	17.7	56.0	37	4	12.0
AGASSIZ	15.9	54.3	37	4	12.2

Cooperator: Tom Lorang.

Location: Three miles east of Eden, MT.

Fertilizer: 100# 11-52-0 with the seed, + 30# N. topdressed.

Previous crop: Fallow.

Date seeded: Sept. 23, 1992.

Date harvested: Aug. 25, 1993.

Rainfall: From May 13 to Aug. 25, = 8+ inches.

1/ = Spring survival classs: 5=best; 1=very low; based on several location-years of observation.

\* = Yield and test weight were reduced by Septoria disease.

Yield experimental mean: 23.86

F test for var. = 3.39, C.V. 2 = 8.21, LSD(0.05) = 5.58

Table 12. **Five-year summary for Winter Wheat varieties grown near Eden, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average			
	Yield bu\ac	Test wt. lbs\bu.	Plant hgt. inches	% Protein
QUANTUM 542	49.8	61.7	36.7	10.2
NEELEY	47.0	60.9	33.8	10.0
WINRIDGE	45.4	59.2	37.8	9.3
HAWK	43.7	61.0	33.7	10.2
JUDITH	43.2	59.3	33.6	10.4
TIBER	41.1	60.5	36.0	10.6
ROCKY	40.7	61.2	35.8	10.6
CENTURK	40.6	60.7	34.2	10.0
BLIZZARD	40.5	60.2	36.7	10.6
REDWIN	40.2	60.1	35.8	11.1
CREE	39.0	61.3	37.6	10.9
WARRIOR	39.8	61.1	36.8	11.1
SEWARD	39.7	60.7	39.8	10.8
NORSTAR	38.6	61.1	42.4	10.5
WINALTA	35.0	61.7	38.8	11.3
AGASSIZ	33.9	60.5	39.9	11.0

Cooperator: Tom Lorang.

Location: Three miles east of Eden, MT.

(Cascade Co.)

TITLE: Spring Wheat and Durum variety investigations.

YEAR: 1993

LOCATION: Western Triangle Research Center, Conrad, MT.

PERSONNEL: Gregory D. Kushnak, Ron Thaut, and Larry Christiaens, Research Center, Conrad; and Dr. Luther Talbert, MSU Dept. of Plant & Soil Science.

Dryland spring wheat variety trials were grown near Cut Bank, Oilmont, Choteau, Sun River and the Research Center at Conrad. The "irrigated" trial at Conrad did not receive irrigation due to the persistent rainfall and wet soil conditions of 1993. Durum varieties were included at Conrad. In addition, a no-till recrop variety trial was grown at Conrad, and is reported in the no-till section of this report.

Data for the 1993 spring wheat and durum tests at the various locations are presented in Tables 13-29. Five-year averages are included among the data tables. (Emphasis should be placed more on the five-year averages when predicting which varieties are best suited for a given area. The 1993 tables reflect performance under the conditions of only one year, and therefore should not be relied on too heavily).

Exceptionally high rainfall produced dryland yields comparable to that of irrigated conditions at most locations. Delayed planting and below normal growing season temperatures extended ripening and harvest by approximately one month, resulting in moderate frost damage at the Conrad and Cut Bank sites. Sawfly infestations were lower than normal, and no stem cutting was observed at any of the sites. Although not severe, wheat streak mosaic virus occurred at the Conrad site. Expression of the disease varied among varieties, with Amidon and Westbred Express showing the least amount of symptoms. It is not known if these two varieties have resistance or if they simply did not express the symptoms in the usual detectable form.

These trials were conducted by the MSU Western Triangle Research Center, Conrad; in cooperation with Dr. Luther Talbert, MSU Plant and Soil Science Department. The background and detailed descriptions for many of the varieties tested are included in MSU Extension Bulletin 1093 available at all County Agent offices. Other comments about the varieties, based on observations in Triangle Area trials, are presented in the following pages.

SPRING WHEAT

Far-Go herbicide tolerance:

Spring wheat varieties reported to have the highest tolerance to Far-Go are Fortuna, Bronze Chief, Kodiak, NK 751, Len, Oslo, Butte, Marshall, Success and Rambo. Lew, Newana, Alex, Erik, Pondera, Fremont and Amidon are the least tolerant, while Westbred 906R, McKay and Glenman are somewhere in between. How to plant is just as important as what to plant. For best results plant with a hoe drill rather than a double-disc drill. A hoe drill moves the Far-Go treated soil out and away from the seed row so at normal planting depths the seed will go under the treated layer, where it's less susceptible to injury. Weather and soil type are also important. Cold, wet weather can delay the wheat's emergence and increase its chance of damage from the Far-Go in the soil. If the soil is light and has little organic matter, injury to the spring wheat is more likely.

1) Semidwarf Sawfly resistant varieties:

Cutless (ND)-Bearded semidwarf. Poor lodging resistance. Among lowest yielders. Protein high like Fortuna. Moderately susceptible to septoria. Medium test weight. Very good sawfly resistance (slightly more so than Fortuna).

Glenman (MSU)-Beardless semidwarf, poor lodging resistance, (weak straw for a semidwarf). Medium-low (1% < Lew, 2% < Fortuna) protein, low test weight, hard to thresh. High yield. Higher yield than Lew most years, and about equal to Rambo. Quality poor. Sawfly resistance has been very good in Triangle area tests (better than Amidon & Rambo), but the variety tends to produce some hollow stems under certain conditions, especially at Bozeman. Thus, it is rated "moderately" resistant (27% less solid than Fortuna).

Rambo, Westbred (WPB)-Sawfly resistance-partial (36% less solid than Fortuna). Short stiff straw, but medium lodging resistance. Bearded semidwarf. Threshes easily, high yield, similar to Glenman. Medium-low protein similar to Glenman, but 1% lower than Lew and 2% lower than Fortuna. May have more tolerance to septoria than Fortuna, but is still susceptible. Test weight high.

2) Standard Height Sawfly resistant Varieties:

Amidon (ND 606)-Standard height, bearded. Partial solid stem (30% less solid than Fortuna), lodges worse than Fortuna. Weak broken stems. Same maturity as Lew, but slightly higher yield. Slightly later to mature than Pondera. Yield and test weight is medium to high. High protein like Fortuna. Does well in dry areas. Moderately susceptible to septoria. Sawfly resistance not sufficient for severely infested areas.

Fortuna (ND)-Beardless, high protein and test weight, early maturing; medium to low yield. Apparently tolerant to Fargo. Very susceptible to septoria. Somewhat susceptible to shattering. Very good sawfly resistance.

Lancer (Sask. Canada)-Awnless. Among lowest yielders and seldom a protein advantage over Lew and Fortuna. Tangled lodging mess due to weak straw. Test weight medium-low.

Leader-(Canada) Among lowest yielders. Seldom a protein advantage

over Lew and Fortuna.

Lew(MSU)-Beardless. Septoria tolerance moderate. 3 days later, and slightly lower protein than Fortuna, and susceptible to Fargo. Average yield similar to Fortuna. Avenge herbicide cannot be used. Medium to high test weight. Better shatter resistance than Fortuna. Medium-high protein, but less than Fortuna. Good sawfly resistance (10 to 15% less than Fortuna, but 22% more resistant than Amidon).

Tioqa (ND)-Beardless, standard height. Medium test weight, high protein, low yield. Good shatter resistance. Susceptible to lodging. Septoria tolerant.

### 3) Hollow Stem varieties:

Alex-(ND) beardless. Standard height, semidwarf, medium lodging, high protein. Good shatter resistance and test weight.

Bergen -(Agripro), 1991. For Minnesota. Medium test weight, low protein, semi-dwarf, good lodging resistance, medium-late maturity.

Bronze Chief(Seed Research Inc.)-Very low yield and tough threshability. Very high protein. Used in specialty milling market at Three Forks, MT.

Butte (ND) - Standard height. Early maturity (one day earlier than Fortuna). Low yield. Sawfly susceptible.

Butte 86(ND) - Stronger straw than Butte. Low yield. Medium height. Bearded. Early maturity. Medium test weight, high protein. Septoria susceptible.

Copper(Idaho) - Intended to replace McKay (higher quality) in Idaho, but acreage less than expected. Protein and test weight is 1% less than Pondera. Awned semidwarf. Late maturity. Straw weaker than Pondera and 906R.

Fjeld-(Agripro)-Medium yield, short stiff straw, medium maturity, low test weight and protein.

Grandin (ND)-To replace Stoa in North Dakota. Semidwarf, good lodging resistance, bearded, medium high protein. Maturity similar to Pondera. Yields less than Pondera and Hi-Line.

Gus(ND)-For high yield areas of Eastern Montana. Semidwarf; good lodging resistance, bearded. Very high protein and medium-late maturity (like Newana). Lower yield than Pondera and Hi-Line.

Hi-Line(MT8402) - Semidwarf. Higher protein and 3 days earlier than Newana. Hi-Line yields greater than Newana on dryland, but similar to Newana on irrigated. Test weight slightly higher than Newana. Hi-Line yields similar to Pondera on dryland, but is 3 bu/a better than Pondera on irrigated. Protein and maturity of Hi-Line is similar to Pondera; but height is one inch shorter and test weight is slightly less than Pondera. Hi-Line contains a small percentage of tall plants, giving the variety a ragged appearance. This trait is probably due to an unstable chromosome carrying the semidwarf gene, and it may not be possible to purify the variety for uniform height.

Kamut (T. polonicum 4x)-Polish wheat: about like durum; seeds bigger than durum. Non-allergenic gluten. 1% more protein than Pondera. Pasta & cereal products. 4 to 6" taller than Fortuna. Four days later to mature than Pondera. Too tall for irrigation.

Kodiak -Triple Dwarf-10" lower than Newana; 18" lower than Fortuna. Very low yield.

Len, (ND)-Bearded semidwarf. High protein. Straw not as stiff as Newana. Good quality, shatter resistance, and test weight. Tolerant to septoria. Yields similar to Pondera and Hi-Line, but Len has slightly lower protein.

Marshall (Minn)-Bearded, semidwarf, high yield and test weight on irrigated; good lodging resistance, low protein. Irrigation only.

McKay-(Idaho) Very late maturing. High yield if water lasts, otherwise low yield. Lower quality than Copper.

Minnproe (MINN)-Bearded, semidwarf. short stiff straw, medium maturity, low test weight, medium protein.

Newana(MSU)-Very Good yield on irrigation; medium on dryland. Protein medium. Very susceptible to sawfly. Medium-late maturity, 3 days later than Pondera and Hi-Line. Good lodging and shatter resistance. Tolerant to septoria. Yields similar to Hi-Line on irrigation, but has less protein than Hi-Line. Yields lower than Hi-Line on dryland.

Nomad (WPB)-Semidwarf, good lodging resistance, medium-early maturity, beardless medium test weight (but higher than Glenman), medium protein.

Norak-NAPB.

Nordic-Tall semidwarf; straw and protein are marginal for high yield, irrigation areas.

Olaf(ND)-Bearded semidwarf, medium test weight and lodging. Medium to low shatter resistance. Medium high protein, but most of it is concentrated in the bran, resulting in low flour prtein. Medium-low yield. Septoria leaf blotch tolerant.

Pioneer 2369-Bearded semidwarf, good lodging resistance. High yield and test weight on irrigated. Protein medium. (All pioneer materials turned over to NDSU).

Pondera(MSU)-Semidwarf with good lodging resistance. A higher protein, earlier maturity (3 days) version of Newana. Sawfly susceptible. Good on irrigation or dryland. High yield and test weight. Tolerant to septoria.

Prospect (SD)-Bearded, semidwarf, low yield, medium maturity, medium lodging, high protein and test weight.

Probrand 751(NK)-High yield on irrigated, short stiff straw, low test weight and protein. For irrigation only. Good shatter resistance.

Stoa(ND)-Poor yield in triangle area, but popular in North Dakota because of protein. Bearded standard height. Lew and Pondera compete with it quite well in triangle area. To be replaced in ND by Grandin. Later to mature than Pondera and Grandin.

Success-(Cenex)Medium high yield with irrigation. Semidwarf, late maturity, low test weight and protein. Medium lodging resistance.

Telemark-(Agripro) medium early, good protein, short excellent stiff straw, semidwarf; good yield with irrigation.

Thatcher-Tall beardless. Very low yield.

Vance(MINN)-Bearded semidwarf, medium test weight, low protein.

Vandal(Idaho)-For irrigated only.

Wampum(Mn) - Semidwarf. Very high yield on irrigated. Low protein. Very susceptible to rust.

Westbred Express (WPB) - Among highest yielders when tested at Conrad 1993.

Westbred 926R (WPB) - Bearded semidwarf. Among highest yielders. Earlier maturity than Newana.

Westbred 936 (WPB) - Possible replacement for 906 and 926. Superior to 906 and 926 as an irrigated variety. (Tested as ph986-61 in 1992).

Wheaton-(MN) Bearded semidwarf, low protein and test weight. High yield with irrigation. Short stiff straw, good lodging and good shatter resistance, medium to low test weight.

#### 4) Soft White Spring Wheat

AC Reed(Alberta, Can.) - Resistant to prevalent races of stripe rust. Higher yield, two days earlier maturity, and higher milling & baking quality than Fielder. Good lodging resistance and moderate shatter resistance. Adapted to irrigated regions of southern Alberta.

Fielder- Semidwarf. Highly susceptible to stripe rust and can lose 40% yield.

Owens(Idaho/Oregon)-Semidwarf. Earlier than Waverly and Treasure, but still may be too late for dryland in most years. Stripe rust resistant. Short straw, medium maturity and test weight.

Penawawa-(Wash/Oregon)Semidwarf. Replacement for Owens? Bearded. shorter and stiffer straw than Owens, later to mature than Owens, and lower test weight.

Sprite-WPB

SWS-52-(Canadian) - Much better lodging resistance than Owens, but 5-6 days later than Owens and Fielder. Resistant to stripe rust (like Owens).

Treasure-Late maturing. Yields higher than Owens on irrigated; and also on dryland in years of favorable moisture.

Waverly-Late maturing.

5) Hard White Spring-For specialty market. Protein of hard white will probably need to be at least 13% to meet market standards. In order to be officially classified as Hard White by U.S. Grain Standards, the developer/owner of the variety must petition for classification. Hard whites sprout more readily than hard reds, especially those developed from Australian germ plasm. The pure white trait is difficult to maintain, as pollen from red wheats may pollinate a white variety, causing a mixture of red kernels.

Genesis(Canada) - not tested in Montana.

Golden 86 (Private Variety)-Owned by a commercial milling and baking firm north of Three Forks, Montana. A high quality hard white for specialty markets. Yielded more than Klasic, but less than Tanager (1 year), and 1.5 to 2% higher protein than Tanager and Klasic.

Klasic-(NK) Hard white. Adapted to California. Not well adapted to Triangle area. Officially classified as a hard white by U.S. Grain Stds.



MT 8182-Fairly high protein and yield on irrigation or dryland.  
Bearded, hard white.

Tanager "S" (CIMMYT)-Very high yield (steep BYX) hard white.

#### DURUM

(Durum quality scale: 1 - 4; 1 = low, 4 = high).

Cando(ND) - Very short semidwarf. Very high lodging resistance. For irrigation or favorable moisture. Not suited for dry conditions. Good shatter resistance and high yield. Test weight medium. Septoria susceptible. Quality = 2.

Coulter (Canada)- Blackbearded, but blackness disappears upon ripening.

Crosby(ND) - Standard height. Fair lodging resistance on dryland, and good shatter resistance. Test weight medium to high. Quality = 2.

Fjord - (Agripro, NAPB developed) - Standard height, medium yield durum.

Golden Ball - Black bearded Canadian - old variety, seed may be hard to find - for wheat weaving.

Laker, Westbred - (WPB) - Semidwarf. High yield, stiff straw, medium lodging resistance, midway between standard height and semidwarf, better height choice for all around production, not as short as Lloyd and Cando. Diseased in irrigated in 1989, while other entries were not. Recommended for Dist 2-6. Protein medium. High test weight. Quality = 3.

Lloyd(ND) - Very short. For irrigation or favorable moisture. Not suited for dry conditions. Very high lodging resistance. Good quality. High yield and good shatter resistance. Test weight is medium.

Medora - (Manitoba, Canada) - Standard height, with fair lodging resistance. Dryland only, medium to early maturity. Good yield on dryland, better than Monroe. Test weight is medium to high. Quality = 4.

Monroe(ND) - Standard height, fair lodging resistance for dryland. Early maturity, dryland only. Test weight is medium. Quality = 4.

Pelissier - Black bearded Canadian. Wheat weaving.

Pendur(WPB) -Does not do well in Triangle area.

Plenty (Canada) - High yield, but very tall weak straw. Lodges easily. Late maturing. Quality = 4.

Regal, Westbred (WPB)-Standard height durum for dryland areas of Montana and North Dakota. Excellent semolina color and strong gluten. Medium yield, high test weight, medium-low protein.

Renville(ND) - (Rollette/Vic) -Standard height. 1 day later and greater yield than Vic. Tall, lodges bad; thus, even though it yields good on irrigation, its weak straw renders it unsuitable for irrigation. Has a niche in the low yield/low rainfall areas. Test weight is medium. Quality = 4.

Rolette(ND)-Standard height. Good shatter resistance and test weight. Good quality. Susceptible to leaf spot diseases.

Rugby(ND)-Standard height. Good shatter resistance. Medium test weight. Good quality. Moderately susceptible to septoria.

Sceptre(Sask. Can.) - Standard to medium height, but fairly stiff straw. Taller than Laker, but shorter than Medora and other standard height varieties. High yield. Quality = 4.

Stockholm - (Agripro, NAPB developed) - Semidwarf (short like Lloyd and Cando), medium early durum. High yield (Similar to Lloyd, and higher than Fjord). Very stiff straw. Protein medium to low. Quality = 3.

Vic(ND) - Tall weak straw. Good shatter resistance and high test weight. Quality = 4.

Ward(ND) - Standard height with fair lodging resistance for dryland, and good shatter resistance. Test weight medium. Tolerant to septoria. Quality = 2.

TRITICALE

1) Spring Triticale: Assume all triticales have a potential ergot problem!

Carman (Canada) - early maturing (similar to Newana wheat in maturity) by triticale standards; generally the best for dryland; and generally higher protein. Shorter straw than Welsh triticale, but still tall.

Juan(Calif.)- Too late to mature, resulting in low yield & T.W. some yrs.

Karl(N. Dakota)-Early maturing (similar to Newana wheat in maturity) by triticale standards; generally the best for dryland; and generally higher yield & protein. A semidwarf; thus, easier to manage than taller & later varieties. Similar height as Newana wheat.

Kramer - (N. Dakota) - Very early maturity by triticale standards. Good yield. A semidwarf, but slightly taller than Newana wheat and Karl triticale. Kramer is medium height, while Karl and Newana are short.

Marval(S. Dak.) - Medium maturity. Low yield on dryland in some years.

T-54, T-59, T-61 - (Saskatchewan) Very late maturity. Look like wheat, and have test weights nearly equal to wheat.

Wapiti - (Canada) - To replace Carman and Welsh. High yield but tall weak straw and late maturity.

Welsh - (Canada) - Late maturing, may be discontinued.

Whitman(Wash.) - Too late to mature, resulting in low yield & test weight in some years.

Test weight of triticale = approximately 50 lbs/bu. Proteins were less than Newana wheat, but slightly higher than barley. Triticale seed rate 20% higher than wheat. Relative maturities and heights for triticale:

Newana wheat	very early	short
Kramer	very early	med short
Carman	early	med. tall
Karl	early	short
Marval	medium	very tall
Welsh	medium late	tall
Beagle	late	tall
Wapiti	late	med. tall
Sunland	very late	med. tall

T-54	very late	tall
T-61	very late	tall
Juan	extreme late	tall
Whitman	extreme late	tall

2) Winter Triticale

Decade - (Canada) - Shorter than most other winter triticales, but still as tall as some of the taller winter wheats; earlier and higher yield and shorter strawed than Winteri. Thus Decade may be the better choice. May have a head snap problem.

Flora - Short strawed (like Rocky w.wht.) and good yield, but had very low test weight. Survived winter of 1989 OK, but winterhardiness is questionable. Straw breakage observed in 1988.

Grace - Poor winterhardiness (May be a spring type). Stembreakage and crinkle-joint.

Winteri - (Canada) - Very tall and late maturing.

VTO numbers from 1988: winter types according to Peterson (WSU).

Table 13.

**Advanced Yield Spring Wheat variety trial**  
 grown north of **Conrad, 1993.** Mont. Agr.  
 Expt. Station, Western Triangle Ag. Research  
 Center, Conrad, MT.

Variety		Yield bu/ac	Test weight lbs/bu	Plant hgt. inches	Head date	% protein
PENAWAWA	(S. white)	89.8	58.7	36	190	8.2
RAMBO	*	79.6	56.0	37	193	13.2
OWENS	(s. white)	77.2	55.3	38	187	8.3
BZ684-23		77.0	57.9	37	191	8.9
GLENMAN	*	73.8	59.5	39	190	12.5
HI-LINE		73.2	59.8	35	187	14.1
WESTBRED EXPRESS		72.9	57.5	32	191	12.5
TR 983-239		71.1	59.0	38	186	13.3
AMIDON	*	70.5	60.0	44	188	11.0
MT 8849		70.2	60.4	38	188	10.9
MT 9229		70.2	57.9	37	187	12.9
MT 9153		70.0	59.5	37	187	10.2
MT 9266		69.8	58.3	37	191	10.8
MT 9254		69.0	58.1	39	191	11.4
MT 9242		68.8	60.7	37	189	11.8
FA 982-220		68.4	56.9	39	191	11.3
PONDERA		68.0	61.2	38	187	14.4
WESTBRED 936		67.9	57.2	33	185	15.1
NEWANA		67.8	57.6	37	190	13.0
LEW	*	67.4	61.1	44	192	12.8
WPB BZ 984-326		66.6	60.2	38	186	13.9
MT 9260		65.3	62.2	35	189	12.5
MT 9232		64.5	59.3	35	186	14.5
MT 9233		63.8	56.5	38	190	14.2
MT 9262		63.3	59.0	37	187	14.1
WESTBRED 926		63.1	59.5	35	185	13.8
MT 9217		62.9	60.9	34	188	11.9
MT 9209		62.4	57.9	41	189	13.2
MT 9222		62.2	60.7	40	185	11.7
MT 9158		62.1	57.3	36	189	12.1

(continued on the next page)

(Advanced Yield Spring Wheat *continued*)

Variety	Yield bu\ac	Test weight lbs\bu	Plant hgt. inches	Head date	% protein
MT 9248	61.7	57.3	45	192	10.6
MT 9206	61.6	58.6	44	190	12.2
MT 9212	61.2	60.3	37	185	12.5
MT 9265	61.0	58.9	41	190	11.1
LEN	61.0	57.7	37	189	14.0
MT 9221	60.5	60.7	43	188	13.1
MT 9154	60.4	60.9	42	189	11.5
STOA	60.2	59.3	44	189	11.8
THATCHER	59.8	58.1	50	190	11.5
MT 9157	59.7	59.1	47	191	10.3
FORTUNA *	59.0	61.1	44	189	12.3
MT 9203	58.8	58.9	44	186	12.6
MT 9257	58.5	60.7	37	187	12.3
KLASIC (h. white)	57.1	59.4	28	184	10.7
MT 9234	56.3	60.3	38	187	11.8
MT 9215	56.2	56.7	47	186	13.6
CUTLESS *	55.9	59.0	40	189	13.6
MT 9253	53.1	59.8	36	186	14.3
OLAF	51.4	58.8	43	189	12.7

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-52-0 with the seed, + 30# N topdressed.  
 Previous crop: Fallow.  
 Date seeded: May 3, 1993.  
 Date harvested: Sept. 23, 1993.  
 Rainfall: From May 13 to harvest was 12.87 inches.  
 \* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Yield experimental mean: 65.14  
 Error degrees of freedom: 96.00  
 F test for var: 5.54  
 C.V. 2: 4.74  
 LSD (0.05): 8.67

Table 13a.

**Advanced Yield Spring Wheat variety trial**  
 grown north of Conrad, 1993. Mont. Agr.  
 Expt. Station, Western Triangle Ag. Research  
 Center, Conrad, MT.  
*(Abbreviated list)*

Variety		Yield bu/ac	Test weight lbs/bu	Plant hgt. inches	Head date	% protein
PENAWAWA	(S. white)	89.8	58.7	36	190	8.2
RAMBO	*	79.6	56.0	37	193	13.2
OWENS	(s. white)	77.2	55.3	38	187	8.3
GLENMAN	*	73.8	59.5	39	190	12.5
HI-LINE		73.2	59.8	35	187	14.1
WESTBRED EXPRESS		72.9	57.5	32	191	12.5
AMIDON	*	70.5	60.0	44	188	11.0
MT 8849		70.2	60.4	38	188	10.9
PONDERA		68.0	61.2	38	187	14.4
WESTBRED 936		67.9	57.2	33	185	15.1
NEWANA		67.8	57.6	37	190	13.0
LEW	*	67.4	61.1	44	192	12.8
WESTBRED 926		63.1	59.5	35	185	13.8
LEN		61.0	57.7	37	189	14.0
STOA		60.2	59.3	44	189	11.8
THATCHER		59.8	58.1	50	190	11.5
FORTUNA	*	59.0	61.1	44	189	12.3
KLASIC	(h. white)	57.1	59.4	28	184	10.7
CUTLESS	*	55.9	59.0	40	189	13.6
OLAF		51.4	58.8	43	189	12.7

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-52-0 with the seed, + 30# N topdressed.  
 Previous crop: Fallow.  
 Date seeded: May 3, 1993.  
 Date harvested: Sept. 23, 1993.  
 Rainfall: From May 13 to harvest was 12.87 inches.  
 \* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Yield experimental mean: 65.14  
 Error degrees of freedom: 96.00  
 F test for var: 5.54  
 C.V. 2: 4.74  
 LSD (0.05): 8.67

Table 14. **Five-year summary for dryland Spring Wheat varieties grown near Conrad, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

-----						
5 - year comparable average						
Variety		Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	Head date	% Protein
-----						
PENAWAWA	(s. white)	66.6	60.2	30.3	184	10.9
RAMBO	*	63.9	59.7	30.8	185	13.6
AMIDON	*	62.9	61.1	37.8	183	13.5
HI-LINE		62.4	61.4	30.8	181	13.5
OWENS	(s. white)	62.3	59.2	32.2	182	10.3
GLENMAN	*	61.8	59.9	33.2	184	13.1
PONDERA		60.5	62.0	32.2	181	13.8
NEWANA		60.2	59.1	31.2	185	13.2
LEN		56.8	60.1	31.0	180	14.5
LEW	*	56.4	62.0	38.0	185	13.7
FORTUNA	*	56.0	61.9	38.2	183	14.0
OLAF		55.5	60.3	33.7	182	13.6
KLASIC	(h. white)	55.2	60.9	23.5	178	12.3
WESTBRED	926	54.5	61.2	29.9	179	14.8
CUTLESS	*	53.1	61.4	36.0	183	14.6
STOA		52.9	61.1	37.8	183	13.2
THATCHER		51.0	59.7	40.8	183	13.4
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Cooperator: Western Triangle Agricultural Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 \* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Table 15. Irrigated Spring Wheat variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Station. Western Triangle Ag. Research Center, Conrad, MT.

Variety		Yield bu/ac	Test weight lbs/bu	Plant hgt. inches	Head date	% protein
PENAWAWA	(s. white)	75.3	59.6	36	188	6.2
AMIDON	*	68.8	59.8	42	189	10.6
OWENS	(s. white)	68.7	57.6	37	188	6.9
RAMBO	*	67.0	59.5	39	193	8.6
WESTBRED	926	62.9	60.3	35	184	12.0
GLENMAN	*	61.2	60.7	39	189	8.8
FORTUNA	*	59.2	61.7	43	188	10.4
NEWANA		57.2	60.5	36	190	9.6
MT 8849		56.9	61.7	36	189	9.8
CUTLESS	*	55.5	60.3	40	190	11.3
LEW	*	54.8	61.6	44	191	9.3
HI-LINE		54.5	60.3	36	186	11.0
PONDERA		54.0	61.8	36	188	11.7
KLASIC	(h. white)	52.7	60.7	27	183	8.9
LEN		51.4	60.1	35	188	12.0
GRANDIN		51.2	61.7	38	186	10.9
GUS		49.9	61.2	38	188	11.5
OLAF		49.2	59.8	37	188	11.6
STOA		47.4	60.7	41	188	9.9
LANCER	*	46.9	61.8	44	190	10.6

Cooperator: Western Triangle Ag. Research Center.

Location: Ten miles north of Conrad, MT. (Pondera County)

Fertilizer: 100# 11-52-0 with the seed, + 30# N topdressed.

Previous crop: Fallow.

Date seeded: May 3, 1993.

Date harvested: Sept. 23, 1993.

Rainfall: From May 13 to harvest was 12.87 inches.

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Irrigation was not applied due to persistent rain and wet soil conditions.

Yield experimental mean: 57.23

F test for var: 5.65, C.V. 2: 5.79, LSD (0.05): 9.48



Table 16. **Five-year summary for Irrigated Spring Wheat varieties grown near Conrad, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

-----						
5 - year comparable average						
Variety		Yield bu/ac	Test wt lbs/bu	Plant hgt. inches	Head date	% Protein
-----						
PENAWAWA	(s. white)	83.3	61.2	33.1	183	9.7
OWENS	(s. white)	73.9	60.1	33.0	183	9.9
RAMBO	*	69.1	61.5	32.8	184	11.7
AMIDON	*	67.1	61.4	39.6	183	12.6
GLENMAN	*	67.0	61.8	35.0	183	12.1
HI-LINE		66.9	62.7	32.6	181	12.8
WESTBRED	926	66.8	61.8	31.7	178	13.8
NEWANA		66.6	61.5	33.2	182	12.2
PONDERA		66.3	62.7	33.8	182	13.0
LEN		64.0	61.8	31.4	179	12.8
LEW	*	62.7	63.2	40.0	184	12.6
CUTLESS	*	62.3	62.2	35.3	183	13.3
KLASIC	(h. white)	61.8	61.5	24.0	178	11.6
OLAF		60.1	61.2	34.6	182	13.4
FORTUNA	*	59.5	63.2	38.8	181	12.9
GUS		59.3	62.3	35.0	182	14.3
GRANDIN		58.5	62.6	35.0	182	13.7
STOA		58.3	61.9	38.0	182	12.5
LANCER	*	48.5	63.0	40.3	184	14.0
-----						

Cooperator: Western Triangle Agricultural Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 \* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Table 17. Dryland Spring Wheat variety trial grown near Cut Bank, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety		Yield bu/ac	Test wt. lbs/bu. 1/	Plant hgt. inches
PENAWAWA	(s. white)	58.5	52.6	35
OWENS	(s. white)	58.5	51.4	37
AMIDON	*	54.3	52.1	42
GLENMAN	*	49.8	53.3	36
LEN		49.3	52.0	36
STOA		49.0	52.8	42
MT 8849		48.7	53.8	37
PONDERA		48.6	54.1	36
GRANDIN		48.2	54.5	40
OLAF		48.1	53.2	38
GUS		48.0	52.9	40
NEWANA		48.0	52.6	36
RAMBO	*	48.0	52.5	38
WESTBRED 926		47.7	51.9	35
HI-LINE		47.2	54.9	35
LEW	*	46.2	54.0	43
FORTUNA	*	46.0	55.6	42
CUTLESS	*	45.9	53.8	41
KLASIC	(h. white)	45.5	53.6	28
LANCER	*	41.0	55.3	48

Cooperator: Don Bradley.

Location: Fifteen miles north of Cut Bank, MT. (Glacier Co.)

Fertilizer: 100# 11-52-0 with the seed.

Previous crop: Fallow.

Date seeded: May 11, 1993.

Date harvested: Oct. 12, 1993.

Rainfall: From seeding to harvest was 11 + inches.

Soil probe depth at seeding: 30 inches.

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

1/ = Test weights reduced by frost.

Yield experimental mean: 48.81

F test for var: 3.57

C.V. 2: 4.46

LSD (0.05): 6.23

Table 18. **Five-year summary for dryland Spring Wheat varieties grown near Cut Bank, MT. 1989 - 1990 - 1991 - 1992 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average			
	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Protein @
PENAWAWA (s. white)	46.4	58.4	28.8	10.2
OWENS (s. white)	45.3	56.5	30.6	10.5
AMIDON *	41.7	57.2	37.0	12.1
HI-LINE	40.0	59.7	29.0	12.3
GLENMAN *	40.0	57.3	30.2	11.6
PONDERA	39.5	59.9	30.0	12.6
RAMBO *	39.2	57.3	29.4	11.2
WESTBRED 926	38.7	57.6	29.5	12.1
STOA	38.1	58.0	34.2	12.0
LEN	38.0	57.7	29.2	12.4
LEW *	37.8	58.2	35.6	12.2
GRANDIN	37.7	59.4	32.2	12.9
OLAF	37.1	57.9	29.8	12.5
FORTUNA *	36.9	59.9	35.8	12.6
GUS	36.2	58.5	31.5	12.5
CUTLESS *	35.4	59.2	33.4	12.6
NEWANA	35.2	57.4	28.8	12.0
LANCER *	34.9	59.2	37.4	12.3
KLASIC (h. white)	34.3	60.0	23.3	13.3

Cooperator: Don Bradley.

Location: Fifteen miles north of Cut Bank, MT. (Glacier Co.)

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

@ = Protein averages based on four years only. (89-90-91-92)

Table 19. Dryland Spring Wheat variety trial grown near Oilmont, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety		Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% protein
PENAWAWA	(s. white)	77.4	61.8	37	5.7
GLENMAN	*	76.9	61.5	38	9.5
OWENS	(s. white)	76.4	61.1	40	8.6
HI-LINE		72.7	63.3	38	11.2
AMIDON	*	70.2	61.9	40	12.0
WESTBRED 926		69.1	61.5	36	9.6
NEWANA		68.8	62.4	36	8.9
GRANDIN		67.1	62.6	39	14.3
LEN		66.7	61.7	38	12.8
LEW	*	66.0	64.1	45	11.0
MT 8849		65.8	61.9	39	11.3
PONDERA		64.1	63.3	36	12.0
OLAF		63.6	61.9	38	13.9
FORTUNA	*	62.2	63.1	42	10.6
GUS		62.1	63.2	38	11.4
STOA		62.0	62.4	45	10.4
KLASIC	(h. white)	61.9	61.7	27	12.5
LANCER	*	62.4	62.6	46	12.0
RAMBO	*	61.3	62.5	37	10.4
CUTLESS	*	56.9	62.7	39	11.9

Cooperator: Terry Alme.  
 Location: Eight miles east of Oilmont. (Toole County)  
 Fertilizer: 100# 11-52-0 with the seed.  
 Previous crop: Fallow.  
 Date seeded: April 26, 1993.  
 Date harvested: Sept 9, 1993.  
 Rainfall: From May 24 to harvest was 8.5 + inches.  
 Soil probe depth at seeding: 32 inches.  
 \* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Yield experimental mean: 66.64  
 Error degrees of freedom: 38.00  
 F test for var. = 3.44, C.V. 2 = 4.68, LSD (0.05) = 8.93

Table 20. **Five-year summary for dryland Spring Wheat varieties grown near Oilmont, MT. 1989 - 1990 - 1991 - 1992 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average			
	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Protein
PENAWAWA (s. white)	43.2	56.1	28.0	13.6
GLENMAN *	42.7	57.0	30.4	14.6
HI-LINE	39.1	57.1	29.6	16.4
AMIDON *	38.9	58.1	34.2	15.9
WESTBRED 926	38.9	57.0	28.1	16.4
OWENS (s. white)	38.7	55.1	29.0	14.7
GRANDIN	38.1	56.3	31.1	17.4
LEW *	37.4	58.4	35.4	15.4
NEWANA	37.4	56.2	28.6	15.2
LEN	37.3	55.9	31.2	16.0
OLAF	37.1	56.9	30.4	16.2
FORTUNA *	36.7	58.4	34.8	15.6
PONDERA	36.4	57.9	29.8	16.3
RAMBO *	35.6	58.3	28.0	15.6
STOA	35.4	56.4	35.0	16.6
LANCER *	34.7	57.9	35.4	16.1
KLASIC (h. white)	34.5	56.5	21.5	16.5
GUS	34.2	56.7	29.9	17.4
CUTLESS *	31.9	58.0	30.0	16.7

Cooperator: Terry Alme.

Location: Eight miles east of Oilmont, MT. (Toole County)

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Table 21. Dryland Spring Wheat variety trial grown near Choteau, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety		Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% protein
GLENMAN	*	72.1	59.1	38	14.2
PENAWAWA	(s. white)	67.8	57.9	35	12.5
MT 8849		66.6	58.3	38	15.6
NEWANA		65.4	59.1	36	14.3
PONDERA		64.0	59.8	35	16.2
RAMBO	*	62.4	59.6	37	14.5
HI-LINE		61.9	59.0	34	15.6
LEW	*	60.7	60.5	40	16.2
AMIDON	*	57.0	57.1	39	16.3
GRANDIN		56.2	59.3	39	16.1
OWENS	(s. white)	56.1	57.4	35	12.1
FORTUNA	*	54.6	58.8	40	15.7
WESTBRED 926		51.8	57.8	32	15.9
STOA		49.1	57.6	38	15.6
LEN		48.1	57.1	34	16.3
CUTLESS	*	46.7	57.4	36	16.4
GUS		46.6	57.3	36	17.9
LANCER	*	43.8	58.3	41	17.3
KLASIC	(h. white)	42.4	56.6	22	15.9
OLAF		41.6	57.0	35	16.3

Cooperator: Rick Corey.

Location: Eighteen miles northeast of Choteau. (Teton County)

Fertilizer: 100# 11-52-0 with the seed, + 80# AA-N.

Previous crop: Fallow.

Date seeded: April 29, 1993.

Date harvested: Sept 23, 1993.

Rainfall: From May 13 to harvest was 9.25 inches.

Soil probe depth at seeding: 27 inches.

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Yield experimental mean: 55.74

Error degrees of freedom: 38.00

F test for var. = 20.23, C.V. 2 = 3.67, LSD (0.05) = 5.86

Table 22. **Five-year summary for dryland Spring Wheat varieties grown near Choteau, MT. 1989 - 1990 - 1991 - 1992 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

		5 - year comparable average			
Variety		Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Protein
GLENMAN	*	43.7	57.9	31.6	14.6
PENAWAWA	(s. white)	40.4	59.3	29.4	13.0
HI-LINE		40.2	59.9	29.2	15.1
RAMBO	*	38.8	57.6	29.4	14.3
FORTUNA	*	38.8	59.8	36.6	15.4
PONDERA		38.0	60.0	30.2	15.1
LEW	*	38.0	58.6	36.2	15.3
OWENS	(s. white)	37.2	57.7	31.0	12.9
AMIDON	*	36.7	57.3	35.8	15.8
LEN		36.1	58.3	29.8	14.8
WESTBRED 926		35.9	58.9	29.1	14.8
LANCER	*	35.9	59.7	37.2	16.2
NEWANA		35.3	58.0	29.0	14.6
GRANDIN		34.4	59.2	31.9	15.9
CUTLESS	*	34.0	59.7	32.8	15.9
STOA		33.6	57.7	35.0	15.2
GUS		30.9	58.5	30.4	16.1
OLAF		28.9	57.8	30.4	15.2
KLASIC	(h. white)	28.2	59.8	19.9	15.5

Cooperator: Rick Corey.

Location: Fifteen miles northeast of Choteau, MT. (Teton Co.)

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Table 23. Dryland Spring Wheat variety trial grown near Sun River, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety		Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% protein
PENAWAWA	(s. white)	56.9	59.5	30	12.1
MT 8894		54.6	60.0	34	15.9
HI-LINE		50.8	61.0	30	15.6
LEW	*	50.6	59.3	39	15.3
NEWANA		49.4	60.3	32	14.5
GLENMAN	*	49.1	56.8	35	14.0
PONDERA		49.0	59.3	33	16.0
LEN		48.6	60.5	35	16.0
AMIDON	*	47.6	58.6	35	16.2
OWENS	(s. white)	47.4	60.2	30	11.6
STOA		45.7	58.9	37	16.9
GRANDIN		45.3	61.9	35	16.9
RAMBO	*	45.2	56.2	33	15.2
FORTUNA	*	44.6	61.4	38	15.7
WESTBRED 926		43.7	60.0	31	16.6
GUS		42.8	60.3	33	17.6
KLASIC	(h. white)	42.1	60.1	21	15.9
CUTLESS	*	40.4	60.8	34	16.9
LANCER	*	40.3	60.7	38	17.5
OLAF		39.2	59.8	36	16.3

Cooperator: Chuck Merja.

Location: Two miles southeast of Sun River, MT. (Cascade Co.)

Fertilizer: 100# 11-52-0 with the seed, + 40# AA-N.

Previous crop: Fallow.

Date seeded: May 11, 1993.

Date harvested: Sept 9, 1993.

Rainfall: From May 13 to harvest was 9.25 inches.

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Yield experimental mean: 46.66

Error degrees of freedom: 38.00

F test for var. = 3.23, C.V. 2 = 5.56, LSD (0.05) = 7.43



Table 24. **Five-year summary for dryland Spring Wheat varieties grown near Sun River, MT. 1989 - 1990 - 1991 - 1992 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

		5 - year comparable average			
Variety		Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Protein
PENAWAWA	(s. white)	38.5	58.8	26.4	14.1
HI-LINE		37.6	58.4	27.0	17.2
OWENS	(s. white)	36.0	57.3	28.0	14.3
WESTBRED		35.8	59.0	26.7	17.1
PONDERA		35.6	58.7	29.4	16.9
GRANDIN		35.5	59.1	31.6	17.8
NEWANA		35.3	56.8	28.0	16.0
AMIDON	*	34.5	58.2	33.2	16.3
LEN		34.0	58.2	29.6	16.8
STOA		34.0	58.0	34.0	17.4
GUS		33.8	57.9	28.9	18.0
KLASIC	(h. white)	33.0	60.2	19.7	17.5
FORTUNA	*	32.0	60.2	34.4	16.1
GLENMAN	*	31.8	55.2	29.8	15.5
LEW	*	31.4	58.3	34.4	16.5
RAMBO	*	30.6	57.0	29.0	16.3
OLAF		30.5	57.7	29.8	17.1
CUTLESS	*	30.2	59.3	29.4	17.7
LANCER	*	29.6	58.4	34.2	17.4

Cooperator: Chuck Merja.

Location: Two miles southeast of Sun River, MT. (Cascade Co.)

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Table 25. **Dryland Durum** variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	Head date	% Protein
STOCKHOLM	77.9	59.1	33	189	11.3
RENVILLE	76.8	60.3	41	189	12.0
SCEPTRE	70.5	59.9	38	189	12.7
LLOYD	70.3	56.7	30	190	10.4
PLENTY	70.0	60.3	46	192	10.6
CANDO	69.5	60.2	32	190	9.8
LAKER	69.0	58.5	37	190	11.3
CROSBY	61.4	60.6	41	187	11.3
MONROE	59.8	59.9	41	186	13.0
WARD	58.1	61.0	45	188	11.3
VIC	57.4	60.5	41	189	11.2
MEDORA	55.0	60.3	40	188	12.6

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-51-0 with the seed, + 30# N topdressed.  
 Previous crop: Fallow  
 Date seeded: May 3, 1993.  
 Date harvested: September 23, 1993.  
 Rainfall: From seeding to harvest, 12.87 inches.  
 Yield experimental mean: 66.31  
 Error degrees of freedom: 22.00  
 F test for var.: 9.78  
 C.V. 2: 3.71  
 LSD (0.05): 7.21

Table 26. **Five-year** summary for **Dryland Durum** varieties grown north of **Conrad, MT.** 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.

-----					
5 - year comparable average					
Variety	Yield Bu\ac	Test weight lbs\bu	Plant hgt. inches	head date	% Protein
-----					
STOCKHOLM	68.8	62.1	29.3	184	12.3
LLOYD	65.7	59.9	27.0	185	12.3
CANDO	64.9	62.0	27.2	184	12.7
RENVILLE	62.1	62.1	38.8	184	13.2
LAKER	60.8	61.7	31.6	185	12.8
SCEPTRE	59.5	61.7	35.4	184	13.2
MEDORA	57.7	62.5	37.8	183	13.9
MONROE	55.9	62.0	37.0	180	13.8
CROSBY	55.8	62.3	37.6	181	14.3
WARD	53.5	62.1	38.2	182	13.8
VIC	53.3	62.2	37.8	183	13.7
-----					

Cooperator: Western Triangle Ag. Research Center.  
 Location : Ten miles north of Conrad, MT. (Pondera County)

Table 27. **Irrigated Durum variety trial grown north of Conrad, 1993.** Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	Head date	% Protein
CANDO	65.8	61.8	33	189	9.0
PLENTY	61.9	60.7	46	191	8.7
LAKER	61.1	60.6	33	189	10.0
STOCKHOLM	57.2	61.2	33	187	8.6
LLOYD	56.0	60.0	32	189	8.7
SCEPTRE	55.1	60.0	36	187	9.3
RENVILLE	53.7	60.0	43	188	8.6
CROSBY	52.9	61.2	41	187	10.0
VIC	51.5	61.5	41	187	10.3
MONROE	50.8	60.3	41	185	10.2
WARD	50.8	61.2	44	186	10.2
MEDORA	46.7	61.2	40	189	10.6

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-51-0 with the seed, + 30# N topdressed.  
 Previous crop: Fallow  
 Date seeded: May 3, 1993.  
 Date harvested: September 23, 1993.  
 Rainfall: From seeding to harvest, 12.87 inches.  
 Irrigation was not applied due to persistent rain and wet soil conditions.  
 Yield experimental mean: 55.28  
 Error degrees of freedom: 22.00  
 F test for var.: 4.44  
 C.V. 2: 4.70  
 LSD (0.05): 7.62

Table 28. **Five-year summary for Irrigated Durum varieties grown north of Conrad, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

-----					
5 - year comparable average					
Variety	Yield Bu\ac	Test weight lbs\bu	Plant hgt. inches	head date	% Protein
-----					
STOCKHOLM	75.8	62.9	29.8	183	10.9
CANDO	74.2	63.1	29.2	184	10.7
LLOYD	70.5	61.6	29.0	184	10.6
RENVILLE	68.7	62.2	39.0	183	11.4
LAKER	68.5	62.7	30.4	184	11.8
SCEPTRE	66.6	62.6	34.4	183	11.7
MEDORA	64.4	62.8	38.4	182	12.3
WARD	62.8	62.6	37.2	181	12.6
CROSBY	62.7	62.8	37.6	181	12.9
MONROE	62.0	62.4	37.6	179	12.2
VIC	60.8	62.6	38.4	182	12.5
-----					

Cooperator: Western Triangle Ag. Research Center.  
 Location : Ten miles north of Conrad, MT. (Pondera County)

Table 29.

**Dryland Uniform Regional Durum variety trial  
grown north of Conrad, 1993. Mont. Agr.  
Expt. Station, Western Triangle Ag. Research  
Center, Conrad, MT.**

Variety	Yield bu/ac	Test * weight lbs/bu	Plant hgt. inches	Head date	Kernal weight in mg.
D89424	80.0	41.2	42	188	52
D88303	77.0	42.3	34	188	51
D87450	74.1	40.4	45	188	54
D87436	73.0	40.4	38	189	54
LLOYD	72.8	39.3	34	191	53
D87240	72.6	42.0	39	191	51
D8460	72.4	42.0	39	187	48
D89538	71.1	40.8	34	188	56
D89-346	71.1	40.7	56	188	57
D89-476	70.9	43.0	34	187	49
RENVILLE	70.8	42.3	40	189	49
D89111	68.8	41.8	42	190	51
D88450	67.6	41.7	37	189	47
D89008	66.8	42.2	42	188	47
D89331	64.4	43.0	35	189	53
D89263	64.3	42.1	37	188	46
D88273	63.8	41.6	38	188	49
D88289	63.4	42.4	34	188	50
D89235	63.0	41.7	38	190	44
MONROE	61.5	42.2	35	186	52
SCEPTRE	61.2	41.8	37	195	42
D89172	60.9	40.9	40	189	48
D88793	60.9	41.8	42	187	50
WARD	60.8	42.8	33	188	44
VIC	60.5	42.8	38	189	49
RUGBY	59.5	42.9	40	188	41
D87122	59.0	42.8	35	189	51

(Continued on next page)

(Uniform Regional Durum variety trial *continued*)

Variety	Yield bu/ac	Test * weight lbs/bu	Plant hgt. inches	Head date	Kernal weight in mg.
D87130	58.6	43.2	34	189	49
D89135	58.5	43.0	42	189	49
MEDORA	57.6	42.1	36	188	48
MINDUM	55.4	43.4	43	193	45
STOA (wheat)	50.1	38.5	35	193	37

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-52-0 with the seed, + 30# N topdressed.  
 Previous crop: Fallow.  
 Date seeded: May 3, 1993.  
 Date harvested: Sept. 23, 1993.  
 Rainfall: From May 13 to harvest was 12.87 inches.  
 Yield experimental mean: 65.37  
 \* = Low test weights due to frost damage.  
 Error degrees of freedom: 62.00  
 F test for var: 5.29  
 C.V. 2: 4.60  
 LSD (0.05): 8.49

TITLE: Barley Variety Investigations

YEAR: 1993

LOCATION: Western Triangle Research Center, Conrad.

PERSONNEL: Gregory D. Kushnak, Ron Thaut, & Larry Christiaens, Research Center, Conrad, MT; Dr. Tom Blake MSU, Bozeman.

Dryland barley variety trials were grown near Cut Bank, Oilmont, Choteau, Sun River, and the Research Center at Conrad. The "irrigated" trial at Conrad did not receive irrigation due to the persistant rainfall and wet soil conditions of 1993. All trials were grown on fallow. A seperate no-till recrop trial was grown at Conrad, and is reported in the no-till section of this report.

Data for 1993, as well as 5-year averages, are presented in Tables 30-41. Moisture levels were unusually high in 1993, resulting in very high dryland yields. Baronesse was among the top yielders at all locations. This variety has not yet encountered dry conditions in Triangle area tests, and it is therefore uncertain if it will maintain high yield rankings in drier years. Baronesse was fairly late to mature (similar to Harrington), and therefore may be more vulnerable to moisture stress than earlier maturing varieties. Baronesse is a stiff-strawed 2-row private variety (Ackermann) from Europe. It is not known at this time if Baronesse will be used for malting in the U.S.A.

Recently developed varieties do not have enough test-years to be included in the five-year summaries, and caution should be used when considering these for production. These were grown at Conrad, and include Medallion, Galena, and IdaGold. Medallion is a stiff-strawed, 6-row feed barley designed for high moisture conditions. In drier conditions, Medallion would likely have low test weights. IdaGold and Galena are 2-row malt types from Coors Brewing Co. Galena was among the latest to mature at Conrad in 1993.

These trials were conducted by the MSU Western Triangle Research Center, Conrad and the Cooperative Extension Service, in cooperation with Dr. Tom Blake, Montana State University Plant and Soil Science Department. The background and detailed descriptions of the varieties tested are included in MSU Extension Bulletin 1094, "Performance Summary of Barley Varieties in Montana," available at all County Agent offices. Other comments about the varieties, based on observation in Triangle Area trials, are presented in the following pages.



BARLEY

Andre 2-row from WSU- never made it.

BA 1202 (Busch Ag) 2-Row. Very good yield. Stiffer strawed & higher yield than Klages. Requires good rainfall or irrigation.

BA 1215 (Busch Ag) 2-row malt. Very high irrigated yields, and very good lodging resistance. Maturity approx same as 1202. Tested as BA8529 prior to 1990.

BA 5133 (Busch Ag) - experimental 2-row type. Earlier maturity than 1202.

BA 5648 (Busch Ag) - experimental 2-row type. Similar maturity as 1202.

BA 2601 (Busch Ag) 6-row for parts of the triangle area. Very high irrigated yield. Erect head.

BA 1614 (Busch Ag) 6-row experimental. Taller than 2601, shorter than Morex. Stronger strawed & higher yield than Morex. Nodding head.

Baronesse (Ackermann-Germany) - Seed produced in USA by Western Plant Breeders. 2-row feed. Short straw and good lodging resistance. Among highest yielders when tested in favorable moisture conditions (not tested in dry years yet). Four days later maturity than Pirolina and Gallatin; equal or slightly later maturity than Harrington; thus, may possibly rank lower for yield in dry years without irrigation. Recommended list for irrigated.

Bearpaw (MT 81616)(MSU) 2-row feed. Medium yield, but better than Clark and Harrington in most cases (Harrington will usually outyield Bearpaw in extremely high fertility conditions). One day later than Clark and Hector, but slightly earlier than Harrington. May sprout and skin easily. Malt tolerance is 7% skinning, thus may be difficult to manage. Has exceeded the limits in morphology of malt quality. Can "go out of condition" (germ dropped 60% in 2 years), probably due to high DP (Harrington also does this). Probably worse than Harrington for sprouting at low moisture content (ie. Bin sweat). In spite of very high malt extract, Bearpaw was dropped for consideration as a malt variety. Test weight is sometimes low on dryland, possibly due to its medium-late maturity.

Bellona Dropped from recommended list, due to nonavailability of seed. High yield on irrigation, and excellent lodging resistance.

Bowman(ND) 2-row. Strictly for drought conditions. Early maturing, large seeded, feed type. Highest yielder on dryland in drought years; but in wet years, only medium to low yield. Weak straw. Stark is a possible alternative.

Bridge (Lethbridge, Alberta) 2-row feed; higher yield than Adee and Harrington. Similar to Harrington for height and lodging resistance. Good test weight and plump seed. Reportedly does well under drought conditions in Alberta. (Hector/Pirolina/Zephyr parentage).

Clark(MSU) 2-row feed. Better yield and earlier maturity than Klages. Does not have the malt quality of Harrington. Dryland primarily.

Colter (Id/Ore/Wash) 6-row feed. Very low yield and test weight in Triangle area tests in 1993. Tested as ID 71966 in Western Regional (79Ab10719-66). Stiffer straw than Steptoe.

Columbia 6-row. Comparable to Steptoe yield (very high). Short, stiff straw, and is among the best for lodging resistance.

Crystal (78AB6871)(ID) 2-row malt (AMBA for Idaho & Montana). (Klages cross). 5% greater yield than Klages but 2% less than Clark; same height and head date as Klages, but better lodging resistance. Good tolerance to Pseudomonas Kernel Blight. Did not "store" well in Idaho (lost germination in six months), and thus was dropped from production by Coors.

Eight-Twelve (Id/Oregon) 6-row winter barley. Feed. Not adapted to winter conditions of the Triangle area.

Excel (Minn.) 6-row malt. Supposed to combine the superior agronomics of Robust and the malt quality of Morex. Stiff straw. Higher yield and later maturity than Morex. On Minnesota AMBA list; will be on ND AMBA soon. Probably will not be used in Montana.

Galena (Coors) - 2-row malt. Among latest to mature at Conrad 1993. High irrigated yield.

Gallatin (MSU) 2-row feed. A stiff strawed variety with good lodging resistance (more than Hector, Klages, Lewis, and Clark); yields high in both dry and wet conditions; thus a broadly adapted feed barley. Good drought tolerance. Slightly earlier than Hector, and earlier than Bearpaw.

Harrington (Sask. Canada) 2-row malt. Sensitive to hot dry areas; yields good in moist areas. Matures later than Clark and Bearpaw, but earlier than Klages. Lodging resistance better than Klages. Can sprout or germinate (internal falling number) at a lower moisture content than any other barley except perhaps Bearpaw. Sweating in the bin has been suspected of being sufficient enough to ruin the germination. Susceptible to skinning unless carefully threshed. Montana AMBA. See notes on Bearpaw.

Haybet (MSU) 2-row hooded hay barley. Later to mature than Horsford, and higher forage yield. Similar to Horsford for grain yield (which is low). Caution: any cereal grain grown for hay should be tested for nitrate level prior to cutting.

Hector (Lethbridge, Alberta) 2-row feed type. High yield on dryland (similar to Gallatin); slightly later to mature and weaker strawed than Gallatin. Yields less than Gallatin on irrigated.

Idagold (Coors) - 2-row malt. Lower irrigated yield than Galena at Conrad 1993. Late maturing.

Karla (Idaho) 6-row. Medium high yield. Low test weight on dryland. Tall, but fairly good lodging resistance. Rejected for malt.

Kimberly (Idaho) 2-row. Slightly lower yield than Harrington in dry conditions, but slightly higher in moist conditions. Later to mature than Harrington. Poor lodging resistance.

Klages (ID) 2-row malt type. Late maturity; for irrigation or high rainfall only. Being replaced on contracted acres by Harrington, BA-1215, etc.

Lamont (ID) 2-row feed. Rejected by AMBA. (74Ab10167).

Lewis (MSU) 2-row feed. Higher yield than Clark and Klages. Similar to Gallatin but not as stiff strawed. Rejected by AMBA due to flavor. Gallatin and Lewis are good for both dry and wet conditions.

Manley (TR 409) 2-row. A little stiffer strawed and three days later than Harrington, (approx. Klages maturity); longer shelf life than

Harrington - does not lose its germination as bad. May replace Harrington in Canada; but only in high rainfall, stripe rust areas.

Medallion (Western Pl. Breeders) 6-row feed. Very high yield at Conrad 1993 under high rainfall conditions. Very stiff straw. Not intended for dryland as test weight may drop unless high rainfall.

Meltan (Wash) 2-row. Short stiff straw; very good lodging resistance. Late maturing irrigated type.

Menuet (Netherlands)-Marketed by Cenex. 2-row. Short stiff straw. Feed.

Morex (Minn.) 6-row malt type. Shatters readily - swathing advised.

Nancy (Wash) 2-row. Short stiff straw; very good lodging resistance. Late maturing irrigated type.

Piroline 2-row. Medium yield, except during drought years it yielded high relative to most varieties.

Prowashonupana (line 3) (MSU) 2-row hulless. Does not have soluble B-glucan unless they can find a way to steam process it out. Potential specialty market.

Robust 6-row malt type-ND AMBA list; but not Montana's, in order to keep Montana clear for Morex. The 1992 Robust crop in Minnesota did not malt due to dormancy for unknown reasons. Growers therefore switched to 'Stander' in 1993.

Russell (Idaho) 6-row (tested in 83-85 as ID 789009). Greater yield and plump, but less protein than Morex and Robust. Shatters; swathing advised. Was planned for possible replacement for Karla on dryland as a malt, but did not pass AMBA tests. However, Russell may be contracted for malt in some areas.

Shonkin (MSU)- 2-row hulless. Name for Wanubet LR 247. Stands up better than Wanubet, but has weak straw and low yield. (A separate variety from Wanubet) A "clean seed" source of Wanubet to allow a more pure line. Heads a little later than Hector. Special use, with no recommendation. Up to 10% or more of the grain may not thresh free from the hulls.

Stander (Minn, M-64) - May replace Excel and Robust as a 6-row malt variety in the mid-west. Stiffer straw than other 6-row malt types. Better yield stability than Excel.

Stark (N. Dakota, ND 9866) 2-row feed. Medium to high yield. Related to Bowman; but yields higher than Bowman except in extremely dry conditions. Probably not as drought tolerant as Bowman. Weak straw.

Steptoe (Wash.) 6-row. Among the highest yielders on irrigation or dryland. Feed type. Low test weight dryland.

Targhee (Id/Wash/Ore) 2-row feed. Lower test weight and yield than Hector, and two inches shorter. Straw too weak for irrigated. (78-Ab10099).

Triumph 2-row. Malt in Europe, but may not fit USA malt requirements (germinates too slow). Very high yields on irrigation, but very late to mature, and thus not recommended except for "lower Yellowstone valley type" of growing season, feed barley only.

Wanubet (MSU) 2-row hulless. 'The' B-glucan line that will most likely be industrialized. Up to 10% or more of the seed may not thresh free from the hulls. Weak straw and low yield (70% of Hector or Gallatin).

Westford, Westbred (WPB) 6-row hooded hay barley. Seed yield low (similar to Horsford). Hay yields considerably higher than Horsford. Maturity considerably later than Horsford and Whitford, allowing for greater forage production. Hooded barleys are sometimes vulnerable to ergot, but the amount is slight. Caution should be taken to avoid high nitrate levels when using any small grain as a forage. Testing of the forage for nitrate should be done before the crop is harvested.

Westbred 501 (WPB) - 6-row feed. Marketed mainly in Idaho. Very stiff straw (supposedly doesn't lodge).

Table 30. **Dryland Intrastate Barley** variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test weight lbs\bu	Plant hgt. inches	% Plump	% Thin	Head date	% Protein
MT890008	106.6	51.4	36	95	2	190	8.7
Medallion	106.3	49.4	31	86	3	193	8.0
Baronesse	102.6	53.4	32	96	1	189	8.1
MT851195	99.5	53.2	36	96	1	190	8.4
MT860756	97.9	53.2	36	96	1	188	8.6
H3860224	97.3	53.5	39	97	1	188	9.0
MT140523	97.1	53.7	40	95	1	189	8.6
863829H7	97.1	50.0	26	87	4	196	8.4
H1851195	96.9	53.0	40	98	1	188	9.4
H881161	96.1	51.7	35	94	2	187	8.1
MT 83435	95.7	51.2	37	92	3	186	9.8
Lewis	95.5	53.9	41	98	1	188	8.5
MT910032	95.5	53.5	37	93	2	186	8.6
MT890128	94.9	47.1	36	90	3	184	8.5
BA 1202	94.2	52.8	38	98	1	187	9.0
MT910173	94.1	52.3	37	90	3	192	8.6
Harrington	93.7	52.5	42	95	2	191	8.3
BA 1215	93.7	53.3	36	96	1	190	8.0
H5860219	93.5	53.4	38	95	1	190	8.3
Gallatin	93.5	53.1	33	96	1	189	8.2
H5870120	92.4	45.7	35	89	4	181	9.3
MT886610	92.4	53.6	38	95	2	187	8.2
H5860224	92.4	53.7	37	97	1	189	8.2
H2860224	92.1	53.6	39	98	1	190	8.0
MT890070	91.2	51.7	35	96	2	185	9.1
MT900071	91.2	53.6	40	97	1	187	9.6
H1381161	91.1	52.3	34	97	2	186	8.9
H6860756	90.6	54.0	40	95	2	189	9.0
BA 2B88-5133	90.3	52.4	38	96	1	187	9.0
H6851032	89.8	53.7	39	85	1	189	8.3
MT900145	89.7	52.7	38	95	2	189	8.3
MT910150	89.3	53.6	38	97	1	188	9.0
MT900002	89.3	53.9	36	97	1	186	8.6

(continued on next page)

(Dryland Intrastate Barley continued)

MT900176	89.1	46.8	35	96	1	186	8.9
2B885648	89.0	53.4	45	96	2	191	8.6
MT910170	88.6	50.7	27	82	7	194	9.0
Steptoe	88.2	45.2	35	90	4	183	9.2
MT910187	87.9	52.7	36	97	1	188	8.0
MT861596	87.6	53.9	38	96	1	188	8.4
MT910033	87.6	53.2	35	98	1	185	9.4
MT910189	87.4	52.0	35	96	1	186	9.0
MT890018	87.4	54.0	35	96	2	189	9.2
Bowman	87.1	52.4	39	95	1	186	9.2
H1281161	86.6	52.7	35	96	1	186	9.1
H3851032	86.1	51.9	39	97	1	194	8.3
BA 1614	85.6	49.5	38	93	2	187	9.1
MT910024	85.1	52.0	39	96	1	187	9.2
12140523	84.8	52.0	37	91	3	188	9.2
MT910160	84.7	53.8	39	98	1	190	8.8
MT 81161	84.1	52.5	35	93	2	189	8.4
Hector	84.0	52.6	40	94	2	188	8.8
MT910176	83.4	53.1	36	95	1	189	8.6
MT900111	83.2	52.4	40	98	1	186	8.9
MT851032	83.1	53.1	38	95	1	193	8.2
MT900132	83.0	53.4	36	97	1	189	8.8
20140523	82.9	52.3	36	93	2	189	8.3
Russell	81.8	47.8	34	91	3	185	9.0
Stark	81.3	52.8	38	95	2	186	8.9
MT889106	81.0	52.2	35	96	1	184	9.8
21140523	80.3	52.4	35	94	2	191	8.9
MT910046	79.4	51.6	39	97	1	183	9.8
MT910183	77.5	51.7	38	92	3	188	9.3
Shonkin	76.5	58.0	42	72	5	193	9.6

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-51-0 with the seed, + 30# N actual  
 topdressed before planting.  
 Previous crop: Fallow.  
 Date seeded: May 3, 1993.  
 Date harvested: Sept. 2, 1993.  
 Rainfall: From seeding to harvest was 12.59 inches.  
 Yield experimental mean: 88.40  
 Error degrees of freedom: 126  
 F test for var. = 13.89, C.V. 2 = 3.92, LSD (0.05) = 9.70

Table 30a. **Dryland Intrastate Barley** variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.  
(*Abbreviated list*)

Variety	Yield bu/ac	Test weight lbs\bu	Plant hgt. inches	% Plump	% Thin	Head date	% Protein
Medallion	106.3	49.4	31	86	3	193	8.0
Baronesse	102.6	53.4	32	96	1	189	8.1
MT860756	97.9	53.2	36	96	1	188	8.6
MT140523	97.1	53.7	40	95	1	189	8.6
Lewis	95.5	53.9	41	98	1	188	8.5
BA 1202	94.2	52.8	38	98	1	187	9.0
Harrington	93.7	52.5	42	95	2	191	8.3
BA 1215	93.7	53.3	36	96	1	190	8.0
Gallatin	93.5	53.1	33	96	1	189	8.2
Steptoe	88.2	45.2	35	90	4	183	9.2
Bowman	87.1	52.4	39	95	1	186	9.2
BA 1614	85.6	49.5	38	93	2	187	9.1
MT 81161	84.1	52.5	35	93	2	189	8.4
Hector	84.0	52.6	40	94	2	188	8.8
Russell	81.8	47.8	34	91	3	185	9.0
Stark	81.3	52.8	38	95	2	186	8.9
Shonkin	76.5	58.0	42	72	5	193	9.6

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-51-0 with the seed, + 30# N actual  
 topdressed before planting.  
 Previous crop: Fallow.  
 Date seeded: May 3, 1993.  
 Date harvested: Sept. 2, 1993.  
 Rainfall: From seeding to harvest was 12.59 inches.  
 Yield experimental mean: 88.40  
 Error degrees of freedom: 126  
 F test for var. = 13.89, C.V. 2 = 3.92, LSD (0.05) = 9.70

Table 31.

**Five-year summary for Dryland Barley varieties grown north of Conrad, MT. 1988 - 1989 - 1990 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average						
	Yield bu\ac	Test weight lbs\bu	Plant hgt. inches	% Plump	% thin	Head date	% Protein
BARONESSE	99.5	52.9	28.9	88.2	4.4	186	10.9
GALLATIN	92.0	53.4	32.2	90.8	3.2	184	11.2
MT 860756	91.2	53.2	30.6	93.6	2.0	185	11.7
STARK	90.5	53.4	34.2	95.5	1.6	181	11.4
LEWIS	90.1	54.0	33.4	93.2	2.2	186	11.6
MT 140523	89.2	52.6	32.0	90.0	5.0	185	11.6
MT 81161	87.3	51.7	31.9	91.4	3.4	184	11.4
STEPTOE	87.3	48.1	33.0	90.2	3.4	178	10.8
HECTOR	87.2	52.3	33.8	90.8	3.4	185	11.3
HARRINGTON	85.3	51.1	32.8	88.0	4.0	186	11.3
BOWMAN	84.6	52.5	31.6	94.0	2.0	179	11.8
RUSSELL	80.6	49.5	31.8	86.0	5.2	179	11.3
SHONKIN	74.3	55.6	33.8	59.4	12.2	187	13.1

Cooperator: Western Triangle Ag. Research Center.

Location: Ten miles north of Conrad, MT. (Pondera County)



Table 32. Irrigated Intrastate Barley variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test weight lbs\bu	Plant hgt. inches	% Plump	% Thin	Head date	% Protein
Baronesse	105.5	52.4	33	98	1	187	7.8
H5860219	102.9	51.4	35	97	1	187	8.2
DA587170	101.4	46.9	27	97	1	189	8.6
Galena	100.1	49.5	32	95	2	195	8.2
MT890008	98.4	49.9	34	97	1	190	8.2
MT910173	96.5	50.2	39	96	1	190	8.8
MT851195	96.4	51.3	36	97	2	186	8.8
MT910167	96.2	51.2	33	79	6	193	8.0
H1851195	96.1	51.6	37	99	1	185	9.0
863829H7	95.9	46.9	23	90	3	196	7.9
Medallion	95.9	48.5	30	94	1	189	7.7
BA 1215	94.3	51.2	37	98	1	188	8.7
MT910187	94.0	51.2	35	96	1	186	8.3
H1281161	93.5	51.3	36	97	1	185	8.8
Excel	93.1	47.6	37	96	1	184	8.9
MT860756	93.1	52.1	35	98	1	186	8.0
H6860756	93.0	53.1	33	97	1	187	7.5
H3860224	92.9	51.9	37	97	1	188	8.4
H2860224	92.7	51.7	36	99	1	189	8.1
MT910160	91.9	52.4	34	99	1	189	9.3
H5851161	91.2	51.3	36	97	1	188	8.6
Steptoe	91.2	45.0	31	90	4	180	9.6
Gallatin	90.7	51.6	37	97	2	186	7.8
BU585-82	90.6	47.4	24	98	1	188	8.2
MT910024	89.3	50.7	37	99	1	186	9.1
Lewis	88.0	52.7	36	97	1	187	8.8
BA 1202	88.0	50.7	36	98	1	188	9.0
H6851032	87.4	51.8	37	96	1	189	8.0
MT861596	87.4	52.6	39	95	2	187	8.5
Klages	87.2	48.3	40	87	5	194	8.7
MT910032	87.1	52.6	31	95	2	184	8.6
MT900176	86.5	46.0	34	97	1	181	9.1
MT886610	86.3	48.1	36	97	1	186	8.0

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(Irrigated Intrastate Barley continued)

BZ588335	86.1	46.9	20	98	1	188	8.0
H1381161	86.1	51.1	33	97	1	185	8.3
H881161	85.6	51.0	32	96	2	185	9.0
Stark	85.2	51.6	36	95	2	185	9.1
MT910170	83.1	49.8	32	93	3	187	8.6
20140523	82.8	50.7	34	95	2	189	8.5
H3851032	82.7	50.6	39	95	1	191	9.0
MT140523	82.6	51.9	36	97	1	188	8.1
MT890128	82.4	45.8	28	91	4	181	8.8
MT910176	82.4	52.0	34	97	1	187	9.1
IdaGold	81.8	51.9	25	89	3	196	7.6
MT890070	81.5	50.8	34	96	2	181	8.9
MT 83435	81.0	50.8	34	96	2	183	8.7
MT900071	80.6	51.2	39	98	1	186	8.7
H5870120	80.4	45.2	31	92	4	181	9.4
Hector	79.4	51.3	40	97	1	188	8.5
21140523	79.3	50.5	33	95	2	189	9.4
MT851032	79.1	51.9	34	97	1	190	8.3
MT890018	78.8	52.2	32	97	2	187	8.3
MT 81161	78.8	50.2	33	93	3	188	8.8
MT910150	78.8	53.1	34	97	1	186	9.2
12140523	78.5	50.8	34	95	2	187	9.1
Coors C14	78.1	51.7	28	94	2	184	8.3
SK 76333	76.6	50.7	35	96	1	188	7.9
2B885133	76.4	51.2	35	99	1	185	8.6
Coors C16	74.6	51.5	33	97	1	188	7.8
MT900111	71.4	50.7	30	98	1	185	8.8
MT910046	70.6	50.2	33	96	1	181	9.9
MT889106	67.1	50.8	36	95	2	181	9.7
Russell	60.6	45.9	29	91	3	181	9.2

Cooperator: Western Triangle Ag. Research Center.

Location: Ten miles north of Conrad, MT. (Pondera County)

Fertilizer: 100# 11-51-0 with the seed, + 30# N actual  
topdressed before planting.

Previous crop: Fallow.

Date seeded: May 3, 1993. Date harvested: Aug. 26, 1993.

Rainfall: From seeding to harvest was 12.1 inches.

Yield experimental mean = 85.10, Error degrees of freedom = 126.

F test for var. = 7.00, C.V. 2 = 6.17, LSD (0.05) = 14.70

Table 32a. **Irrigated Intrastate Barley** variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT. (*Abbreviated list*)

Variety	Yield bu/ac	Test weight lbs\bu	Plant hgt. inches	% Plump	% Thin	Head date	% Protein
Baronesse	105.5	52.4	33	98	1	187	7.8
Galena	100.1	49.5	32	95	2	195	8.2
Medallion	95.9	48.5	30	94	1	189	7.7
BA 1215	94.3	51.2	37	98	1	188	8.7
Excel	93.1	47.6	37	96	1	184	8.9
MT860756	93.1	52.1	35	98	1	186	8.0
Steptoe	91.2	45.0	31	90	4	180	9.6
Gallatin	90.7	51.6	37	97	2	186	7.8
Lewis	88.0	52.7	36	97	1	187	8.8
BA 1202	88.0	50.7	36	98	1	188	9.0
Klages	87.2	48.3	40	87	5	194	8.7
Stark	85.2	51.6	36	95	2	185	9.1
MT140523	82.6	51.9	36	97	1	188	8.1
IdaGold	81.8	51.9	25	89	3	196	7.6
Hector	79.4	51.3	40	97	1	188	8.5
MT 81161	78.8	50.2	33	93	3	188	8.8
Russell	60.6	45.9	29	91	3	181	9.2

Cooperator: Western Triangle Ag. Research Center.

Location: Ten miles north of Conrad, MT. (Pondera County)

Fertilizer: 100# 11-51-0 with the seed, + 30# N actual  
topdressed before planting.

Previous crop: Fallow.

Date seeded: May 3, 1993. Date harvested: Aug. 26, 1993.

Rainfall: From seeding to harvest was 12.1 inches.

Note: Irrigation was not applied due to persistent rainfall and wet soil conditions.

Yield experimental mean = 85.10.

F test for var. = 7.00, C.V. 2 = 6.17, LSD (0.05) = 14.70

Table 33. **Five-year summary for Irrigated Barley varieties grown north of Conrad, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average						
	Yield bu\ac	Test weight lbs\bu	Plant hgt. inches	% Plump	% thin	Head date	% Protein
BARONESSE	108.9	53.6	29.8	95.8	0.9	185	10.1
BA 1215	101.7	53.3	33.3	96.5	1.4	183	10.1
EXCEL	100.2	49.7	34.2	94.2	2.2	179	10.6
GALLATIN	100.2	54.1	33.4	93.4	2.4	181	10.7
MT 860756	99.1	54.0	31.3	94.1	1.9	183	10.6
STEPTOE	98.7	47.9	30.4	92.6	2.4	177	10.0
STARK	98.4	54.0	33.9	96.5	1.7	180	10.9
LEWIS	97.9	54.5	33.0	96.0	1.7	183	11.3
MT 81161	95.8	52.2	32.7	93.5	2.1	181	10.9
BA 1202	94.5	52.3	30.6	95.7	1.2	184	11.3
HECTOR	90.7	52.6	35.2	92.0	2.4	181	11.1
MT 140523	90.3	51.7	32.6	92.2	2.4	181	11.1
HARRINGTON	85.7	51.5	33.8	89.8	3.2	184	9.8
RUSSELL	83.9	50.0	31.8	90.8	2.6	177	10.5

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)

Table 34. Dryland Barley variety trial grown north of Cut Bank, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu.	% Plump	% Thin	% Protein
Baronesse	65.4	51.6	92	2	8.0
Steptoe	56.1	43.4	84	6	8.7
MT 851195	53.0	51.9	93	2	8.0
Harrington	52.9	52.6	94	2	7.9
Hector	50.7	52.6	92	3	8.3
Lewis	48.4	52.8	95	2	8.0
MT 890008	46.8	50.3	89	4	7.6
MT 81161	46.7	51.2	91	2	8.2
MT 140523	44.3	53.0	95	2	7.9
Clark	43.8	51.4	88	3	7.8
MT 851032	43.5	52.1	93	2	7.5
Bearpaw	42.5	51.4	88	3	7.8
Piroline	42.2	52.4	91	2	8.2
Stark	38.5	52.6	95	2	8.8
MT 860756	38.4	52.7	93	2	8.1
Gallatin	36.7	52.7	89	3	8.2
Bowman	35.9	52.4	96	2	9.6
Colter	30.9	44.0	68	13	8.5

Cooperator: Don Bradley.  
 Location: Fifteen miles north of Cut Bank, MT. (Glacier Co.)  
 Fertilizer: 100# 11-51-0 with the seed.  
 Previous crop: Fallow.  
 Date seeded: May 11, 1993.  
 Date harvested: Sept. 9, 1993.  
 Soil probe depth at seeding: 30 inches.  
 Rainfall: From seeding to harvest was 11 + inches.  
 Yield experimental mean: 45.37  
 Error degrees of freedom: 34  
 F test for var. = 3.87, C.V. 2 = 9.29, LSD (0.05) = 12.12

Table 37. **Five-year summary for Barley varieties grown near Oilmont, MT. 1989 - 1990 - 1991 - 1992 - 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average					
	Yield bu\ac	Test wt. lbs\bu.	Plant hgt. inches	% Plump	% thin	% Protein
BARONESSE	66.3	46.4	27.6	46.0	51.1	12.9
MT 140523	66.0	47.1	29.4	53.2	39.2	13.6
LEWIS	65.8	48.1	30.6	56.4	27.4	13.1
BOWMAN	65.0	47.9	29.8	62.4	20.2	12.9
PIROLINE	62.8	47.7	31.4	50.6	43.0	13.1
HECTOR	62.2	47.9	32.2	48.2	40.0	13.0
STARK	61.8	47.8	31.7	56.8	23.9	12.8
GALLATIN	61.5	47.8	30.6	50.8	31.6	12.7
MT 860756	60.2	46.9	28.8	55.2	23.1	12.4
STEPTOE	59.4	41.7	28.6	56.0	28.4	11.3
CLARK	58.7	47.2	30.2	56.4	27.4	13.1
HARRINGTON	54.6	47.7	29.8	56.2	27.0	13.2
BEARPAW	54.6	46.5	29.0	46.2	32.0	14.0

Cooperator: Terry Alme.

Location: Eight miles east of Oilmont, MT. (Toole County)

Table 38. Dryland **Barley** variety trial grown northeast of **Choteau**, 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Plump	% Thin	% Protein
MT 890008	118.2	49.9	32	94	4	10.4
Baronesse	103.8	52.3	29	95	3	11.4
Steptoe	101.6	45.3	30	92	4	10.9
Stark	99.9	52.1	31	94	4	11.1
MT 851195	99.4	50.9	29	94	3	11.4
Lewis	98.0	51.2	29	92	4	11.1
MT 860756	96.4	52.3	28	97	2	10.2
MT 140523	93.8	50.4	27	91	6	11.0
Hector	93.0	51.4	35	94	4	11.7
Gallatin	92.0	52.2	32	94	4	10.8
Bowman	91.0	50.3	31	92	4	11.5
Piroline	89.7	51.4	31	90	7	11.4
MT 851032	88.5	52.1	31	97	2	10.7
MT 81161	86.3	50.4	28	94	2	11.1
Clark	84.5	51.3	30	92	4	11.2
Colter	84.2	44.6	27	83	7	9.7
Harrington	82.7	49.8	33	92	5	10.9
Bearpaw	79.1	50.0	32	90	5	11.0

Cooperator: Rick Corey.  
 Location: Northeast of Choteau, MT. (Teton County)  
 Fertilizer: 100# 11-51-0 with the seed, + 80# AA-N.  
 Previous crop: Fallow.  
 Date seeded: April 29, 1993.  
 Date harvested: Aug. 24, 1993.  
 Soil probe depth at seeding: 27 inches.  
 Rainfall: From May 13 to harvest was 9.25 inches.  
 Yield experimental mean: 93.41  
 Error degrees of freedom: 34  
 F test for var. = 10.46, C.V. 2 = 3.08, LSD (0.05) = 8.28

Table 39.

**Five-year summary for Barley varieties grown near Choteau, MT. 1988 - 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Sta., Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average					
	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Plump	% thin	% Protein
BARONESSE	79.8	51.7	29.1	80.1	6.4	11.8
STEPTOE	78.7	45.9	30.6	78.4	7.0	10.4
MT 860756	74.1	52.6	27.3	84.6	2.8	10.7
STARK	73.0	53.0	31.7	90.5	3.0	11.9
MT 140523	72.2	51.6	29.8	74.8	8.0	11.7
GALLATIN	70.9	52.0	31.0	78.0	7.0	11.8
HECTOR	70.9	51.6	31.6	81.0	5.2	12.0
LEWIS	70.7	52.3	30.2	81.6	5.2	11.6
PIROLINE	67.5	52.0	30.2	66.2	12.0	12.4
BOWMAN	66.9	52.1	31.0	92.8	2.0	12.2
MT 81161	66.2	49.7	30.8	79.1	6.0	11.7
CLARK	66.0	50.4	29.6	75.0	8.4	11.9
HARRINGTON	66.0	49.7	31.0	87.2	4.8	11.9
BEARPAW	66.0	49.5	30.2	81.8	5.0	11.7

Cooperator: Rick Corey.

Location: Fifteen miles northeast of Choteau. (Teton County)



Table 40. Dryland **Barley** variety trial grown southeast of **Sun River, 1993**. Mont. Agr. Expt. Station. Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt. lbs/bu.	Plant hgt. inches	% Plump	% Thin	% Protein
Stark	93.7	47.9	38	80	13	12.1
Baronesse	88.0	50.0	26	84	8	11.7
Bearpaw	87.3	49.8	37	91	3	11.5
Steptoe	86.5	43.5	30	85	10	11.3
Clark	86.0	48.8	35	89	8	11.8
MT 140523	85.8	50.0	31	89	7	12.2
Lewis	85.1	50.7	31	89	8	12.1
Pirolina	85.1	48.7	34	80	13	11.8
MT 890008	83.5	45.7	30	74	12	12.0
MT 851195	82.7	47.5	25	81	13	12.5
MT 851032	82.7	49.0	31	89	7	12.1
Gallatin	82.4	49.0	29	82	9	12.0
Hector	81.9	49.1	40	86	9	12.2
Colter	81.7	44.5	31	80	9	10.9
MT 860756	81.3	51.4	31	92	4	11.7
MT 81161	80.5	48.9	29	90	8	12.3
Harrington	79.2	50.2	30	92	4	11.5
Bowman	67.7	47.4	29	81	12	11.9

Cooperator: Chuck Merja.  
 Location: Two miles southeast of Sun River, MT. (Cascade Co.)  
 Fertilizer: 100# 11-51-0 with the seed, + 40# AA-N.  
 Previous crop: Fallow.  
 Date seeded: May 11, 1993.  
 Date harvested: Aug. 24, 1993.  
 Rainfall: From May 13 to harvest was 7.1 inches.  
 Yield experimental mean: 83.39  
 Error degrees of freedom: 34  
 F test for var. = 0.82, C.V. 2 = 6.85, LSD (0.05) = 16.42

Table 41.

**Five-year summary for Barley varieties grown near Sun River, MT. 1989 - 1990 - 1991 - 1992 - 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.**

Variety	5 - year comparable average					
	Yield bu\ac	Test wt. lbs\bu.	Plant hgt. inches	% Plump	% thin	% Protein
STARK	75.2	50.2	32.5	74.2	12.1	14.2
STEPTOE	66.6	44.2	30.4	67.2	14.2	12.3
BARONESSE	65.6	48.5	25.9	65.2	13.4	14.3
GALLATIN	63.8	49.8	30.4	69.4	14.4	14.2
MT 140523	63.6	49.3	30.2	67.2	18.6	15.1
LEWIS	62.9	49.8	30.6	67.4	15.0	14.8
HECTOR	62.9	48.8	34.2	66.0	15.8	14.8
PIROLINE	62.4	50.0	31.8	53.0	22.0	14.6
MT 860756	62.0	50.4	29.9	71.5	7.6	13.3
BOWMAN	61.5	49.3	31.6	78.0	8.4	14.5
CLARK	60.2	48.2	32.2	66.2	14.8	14.6
BEARPAW	59.7	47.8	30.6	63.4	14.6	15.1
MT 81161	59.0	47.1	29.5	61.3	16.6	14.4
HARRINGTON	55.7	48.0	29.2	68.8	11.4	14.4

Cooperator: Chuck Merja.

Location: Two miles southeast of Sun River. (Cascade County)

Project Title: Small grain variety performance under no-till cropping conditions.

Year: 1993

Location: Western Triangle Agricultural Research Center, Conrad.

Personnel:

Project Leader: Gregory D. Kushnak

Cooperators: Luther Talbert & Sue Lanning (Spring Wheat)  
Tom Blake & Pat Hensleigh (Barley).

Objectives: Identify small grain varieties most adapted to no-till conditions.

Methods: Spring wheat and barley varieties were no-till planted into barley stubble at right angles to the previous crop. Crop history for the site was barley in 1992, fallow in 1991, and barley in 1990. Planting was accomplished with a double-disc no-till plot planter constructed by our Research Center Staff. The double disc openers were supplied by Acra-Plant, Inc., Garden City, KS. Row space was 12 inches. MAP was applied with the seed to provide 51 lbs P<sub>2</sub>O<sub>5</sub>/a. Ammonium nitrate (34-0-0) was topdressed to provide 60 lbs N/a. Herbicides included Roundup for pre-seeding vegetation control; Hoelon for wild oat control; and Bronate for broadleaf control. Planting date was May 12, 1993.

Results: Growing season rainfall was approximately 2 inches higher than average and the soil moisture depth at planting time was 39 inches. Recrop yields for 1993, however, were similar to the four-year average (Tables 42-45). The amount of applied nitrogen was based on projected yields, which was less than needed for the moisture conditions of 1993. This is reflected in the low proteins for both wheat and barley in 1993 (Tables 42 & 44). Delayed maturity due to the cool, rainy growing season resulted in slight frost damage (and subsequently low test weight) in spring wheat.

The four-year average yield ranking of wheat and barley varieties on no-till (Tables 43 & 45) is very similar to that found on fallow. However, moisture was favorable during the four years included in the Tables, allowing late maturing varieties to reach potential yields. Baronesse barley had the highest yield, but was fairly late to mature (similar to Harrington) (Tables 44 & 45). Thus Baronesse may not rank as high under the drier conditions normally encountered on recrop. Similarly, the late maturing soft white wheats ranked high in these high moisture recrop trials (Tables 42 & 43), but have yielded poorly in other trials under drier conditions.

Table 42. **Dryland Recrop No-till Spring Wheat variety trial** grown north of Conrad, 1993. Mont. Agr. Expt. Station. Western Triangle Ag. Research Center, Conrad, Montana.

Variety	Yield bu/ac	Test wt. lbs/bu.	Head date	% protein
PENAWAWA (s. white)	54.4	57.3	197	5.8
WESTBRED 926	46.9	56.8	190	9.5
MT 8849	44.7	58.1	196	9.7
OWENS (s. white)	43.7	51.9	195	8.5
AMIDON *	43.2	57.2	197	10.7
RAMBO *	41.8	50.9	201	9.4
GLENMAN *	40.4	56.2	198	9.0
PONDERA	38.8	59.7	194	11.0
STOA	38.4	58.1	199	9.9
GUS	38.0	58.0	197	10.0
HI-LINE	37.7	60.7	195	9.4
FORTUNA *	37.5	60.2	194	9.7
KLASIC (h. white)	36.3	59.3	188	9.4
LEW *	36.1	59.4	201	9.4
NEWANA	36.1	57.7	199	9.6
GRANDIN	36.1	58.6	195	10.2
LEN	35.3	56.9	195	12.6
OLAF	35.2	56.5	198	12.8
CUTLESS *	33.1	58.8	197	11.5
LANCER *	32.1	59.6	197	10.8

Cooperator: Western Triangle Ag. Research Center.

Location: Ten miles north of Conrad, MT. (Pondera County)

Fertilizer: 100# 11-52-0 with the seed, + 60# N topdressed.

Previous crop: Barley.

Date seeded: May 12, 1993.

Date harvested: Sept. 22, 1993.

Rainfall: From May 13 to harvest was 12.87 inches.

Soil probe depth at seeding: 39 inches.

\* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)

Yield experimental mean: 39.29

Error degrees of freedom: 38.00

F test for var: 2.92

C.V. 2: 7.87

LSD (0.05): 8.85

Table 43. **Four-year summary for Recrop Spring Wheat varieties** grown near **Conrad, MT.** 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Agr. Research Center, Conrad, MT.

-----						
4 - year comparable average						
-----						
Variety		Yield bu/ac	Test wt lbs/bu	Plant hgt. @ inches	Head date	% Protein
-----						
PENAWAWA	(s. white)	50.8	60.7	28.7	190	8.5
WESTBRED	926	46.4	60.7	29.6	186	10.5
OWENS	(s. white)	45.7	58.3	30.0	189	9.5
RAMBO	*	43.8	59.3	30.4	193	11.3
GLENMAN	*	43.7	60.0	30.9	190	10.5
HI-LINE		42.7	62.8	30.1	189	11.0
STOA		42.3	61.1	36.3	189	11.9
AMIDON	*	42.3	61.1	35.7	189	11.4
PONDERA		41.8	62.3	30.0	188	11.8
FORTUNA	*	41.8	62.1	36.3	189	11.7
GUS		41.5	61.6	30.9	190	12.0
NEWANA		41.4	61.0	28.6	192	10.8
LEN		41.2	60.6	29.7	187	11.6
LEW	*	41.0	62.3	36.0	192	11.1
KLASIC		40.4	63.2	22.1	181	10.5
GRANDIN	(h. white)	40.2	61.8	31.7	187	10.9
OLAF		40.2	60.4	31.3	190	12.2
CUTLESS	*	38.5	61.0	33.5	190	12.2
LANCER	*	38.4	62.2	37.4	191	11.8
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Cooperator: Western Triangle Agricultural Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 \* = Sawfly resistant varieties. (Amidon and Rambo have partial resistance.)  
 @ = Plant height averages based on three years only. (89-90-91)

Table 44. **Dryland Recrop No-till Barley** variety trial grown north of Conrad, 1993. Mont. Agr. Expt. Station, Western Triangle Ag. Research Center, Conrad, MT.

Variety	Yield bu/ac	Test wt lbs/bu	% Plump	% Thin	Head date	% Protein
Baronesse	72.4	51.6	90	3	198	7.7
MT 890008	62.7	50.5	90	3	199	7.5
MT 860756	60.6	51.4	91	3	197	7.6
MT 851195	59.9	51.2	88	3	197	7.7
Piroline	58.1	53.5	91	2	195	7.7
Gallatin	56.8	52.3	92	3	196	8.0
Hector	55.9	51.3	73	5	198	8.3
MT 851032	55.2	50.8	88	3	200	7.6
Harrington	54.0	49.7	91	2	200	7.7
MT 81161	53.9	50.2	93	2	194	8.4
Lewis	53.6	52.2	90	3	196	7.6
Clark	53.1	49.4	64	12	198	7.9
Steptoe	52.8	44.1	77	9	188	8.3
Bearpaw	49.9	50.0	86	3	198	7.6
Bowman	49.2	51.8	95	2	190	8.8
MT 140523	48.5	50.4	82	5	195	7.8
Colter	41.5	45.6	71	10	191	8.2
Stark	35.8	52.3	95	2	191	8.3

Cooperator: Western Triangle Ag. Research Center.  
 Location: Ten miles north of Conrad, MT. (Pondera County)  
 Fertilizer: 100# 11-51-0 with the seed, + 60# N actual  
 topdressed before planting.  
 Previous crop: Barley.  
 Method of seeding: Double-disc drill.  
 Date seeded: May 12, 1993.  
 Date harvested: Sept. 2, 1993.  
 Soil probe depth at seeding: 3 feet 3 inches.  
 Rainfall: From seeding to harvest was 9.1 inches.  
 Yield experimental mean: 54.10  
 Error degrees of freedom: 34  
 F test for var. = 5.53, C.V. 2 = 6.27, LSD (0.05) = 9.75

Table 45. **Four-year summary for Recrop Dryland No-Till Barley varieties grown north of Conrad, MT. 1989 - 1990 - 1991 - 1993. Mont. Agr. Expt. Station, Western Triangle Agr. Research Center, Conrad, MT.**

Variety	4 - year comparable average						
	Yield bu\ac	Test weight lbs\bu	Plant hgt.* inches	% Plump	% thin	Head date	% Protein
BARONESSE	78.1	52.7	28.5	85.9	3.2	193	7.9
GALLATIN	66.8	53.2	30.3	86.0	4.3	190	8.8
HECTOR	66.6	52.4	30.0	81.0	5.8	191	8.9
MT 140523	65.9	52.2	29.3	86.5	3.8	191	9.0
LEWIS	65.2	53.4	29.3	86.0	4.3	192	9.1
STEPTOE	64.9	46.7	28.7	85.8	5.8	185	8.3
PIROLINE	64.3	54.5	31.7	92.0	2.5	189	8.8
MT 81161	64.0	51.5	29.5	92.3	1.7	189	9.2
HARRINGTON	62.3	51.3	30.0	88.5	3.3	193	8.6
CLARK	61.3	50.6	31.7	70.3	9.8	192	9.2
BEARPAW	60.7	50.6	29.3	83.5	4.0	194	8.6
BOWMAN	60.2	52.7	29.6	95.5	2.0	186	10.1
STARK	56.0	53.8	30.2	94.8	2.2	187	9.2

Cooperator: Western Triangle Ag. Research Center.

Location: Ten miles north of Conrad, MT. (Pondera County)

\* = Plant height averages based on three years only. (89-90-91)

Table 46. Vitavax, Imazalil, and Tilt treatments on malt barley varieties, 1993.  
Western Triangle Agr. Research Center, Conrad, MT.

Variety	Seed treat	Foliar treat	Yield bu/a	Test wt bu/a	% plump	% thin
1202	No Treat	0	89	52.6	98	0.5
	Vitavax	0	99	52.6	98	0.5
	Vit + IMZ	0	89	52.6	98	0.5
1202	No Treat	Tilt	97	53.0	98	0.5
	Vitavax	Tilt	100	52.8	98	0.5
	Vit + IMZ	Tilt	101	52.6	98	0.5
1215	Vitavax	0	94	53.2	97	1.0
	Vit + IMZ	0	108	52.9	97	1.0
1215	Vitavax	Tilt	102	52.8	96	1.5
	Vit + IMZ	Tilt	92	52.7	96	1.0
5133	Vitavax	0	86	53.0	97	1.0
	Vit + IMZ	0	87	52.9	97	1.0
5133	Vitavax	Tilt	90	52.0	97	1.0
	Vit + IMZ	Tilt	82	51.9	96	1.0
5648	Vitavax	0	94	53.3	96	1.0
	Vit + IMZ	0	89	52.7	95	1.0
5648	Vitavax	Tilt	106	53.3	97	1.0
	Vit + IMZ	Tilt	97	52.9	97	1.0
Harrington	Vitavax	0	95	52.7	96	1.5
	Vit + IMZ	0	93	52.6	96	1.0
Harrington	Vitavax	Tilt	89	52.5	96	1.0
	Vit + IMZ	Tilt	90	52.9	97	1.0

(continued)



Variety	Seed treat	Foliar treat	Yield bu/a	Test wt #bu/a	% plump	% thin
1614	Vitavax	0	81	48.8	94	2.0
	Vit + IMZ	0	83	48.8	94	2.0
1614	Vitavax	Tilt	86	48.6	94	2.0
	Vit + IMZ	Tilt	86	48.9	93	2.5
2601	Vitavax	0	95	50.2	95	1.0
	Vit + IMZ	0	96	50.3	94	1.5
2601	Vitavax	Tilt	99	50.5	96	1.0
	Vit + IMZ	Tilt	96	50.5	96	1.0

Date planted: May 3, 1993 (Harvested Sept. 2, 1993).

Rainfall, April through August, = 13.55 inches (average for this period = 8.27 inches).

Growing degree days, May through August = 1294 (average for this period = 1634).

Tilt fungicide applied July 1, 1993 during flag leaf emergence, at 4 oz/acre. Volume 10 gpa.

Net blotch was found on the majority of flag leaves for all varieties and treatments, but lesions were 30% smaller and fewer on Tilt treatments. Net blotch was very slow to move up the plant as the growing season progressed, and coverage of the flag leaves was only moderate.

Scald did not occur in significant amounts at this location in 1993.

Treatment mean comparisons are presented in Tables 47-49.

Table 47. Comparison of Vitavax vs Vitavax + IMZ across all varieties and spray treatments on barley, 1993. Western Triangle Agr. Res. Center, Conrad, MT.

Treatment	Means			
	Yield bu/a	Test weight	% plump	% thin
Vitavax	94.0	51.9	96.2	1.14
Vitavax + IMZ	92.1	51.8	96.0	1.14
Difference	1.9	0.1	0.2	0
0.95 CI	±3.7	±0.13	±0.33	±0.16
T (13df)	1.125	1.141	1.385	.1608E-05
P-value	.281	.274	.189	1.0

Table 48. Comparison of Tilt fungicide treatments across all varieties and seed treatments on barley, 1993. Western Triangle Agr. Res. Center, Conrad, MT.

Treatment	Means			
	Yield bu/a	Test weight	% plump	% thin
Untreated	92.1	51.9	96.0	1.14
Tilt	94.0	51.8	96.2	1.14
Difference	1.9	0.1	0.2	0
0.95 CI	±4.4	±0.25	±0.61	±0.16
T (13df)	.946	1.061	.763	0
P-value	.362	.308	.459	1.0

Table 49. Comparison of Tilt + IMZ vs zero tilt/zero IMZ on barley, 1993.  
Western Triangle Agr. Res. Center, Conrad, MT.

Treatment*	Means			
	Yield bu/a	Test weight	% plump	% thin
zero Tilt, zero IMZ	92.0	52.0	96.1	1.14
Tilt + IMZ	92.0	51.8	96.1	1.14
difference	0	0.2	0	0
0.95 CI	$\pm 3.5$	$\pm 0.43$	$\pm 0.92$	$\pm .27$
T (6 df)	0	1.128	0	0
P-value	1.0	.302	1.0	1.0

\* All treatments included Vitavax.

Table 50. Effect of crop residue management and Tilt fungicide on net blotch levels in recrop barley, 1993.  
Western Triangle Agr. Research Center, Conrad, MT.

Tillage/ Variety	Fungicide treatment	Yield bu/a	Test wt.	% plump	% thin	% protein	Net blotch 1/
<b>No-Till</b>							
Harrington	Tilt	78.0	49.3	93.5	2	8.7	2.5
Harrington	untreated	69.1	48.7	89.3	3	8.4	4.3
Baronesse	Tilt	84.1	51.1	92.8	2.5	7.9	1.5
Baronesse	untreated	73.3	50.9	89.3	3.5	8.0	2.8
<b>Cultivated</b>							
Harrington	Tilt	61.2	49.4	94.0	2	7.9	2.5
Harrington	untreated	61.2	48.6	90.3	3	8.1	4.0
Baronesse	Tilt	71.9	50.9	92.5	2.3	7.6	1.8
Baronesse	untreated	71.2	50.6	88.5	3.3	7.8	3.0
<b>Burn</b>							
Harrington	Tilt	59.1	50.0	93.3	2	7.7	2.8
Harrington	untreated	55.3	49.6	89.3	2.8	7.5	4.0
Baronesse	Tilt	70.4	51.5	93.5	1.8	7.8	1.8
Baronesse	untreated	67.1	50.5	90.8	2.3	7.6	3.3

1/ Net blotch readings taken July 22 (full heading stage). 0 = no symptoms, 3 = symptoms on leaves halfway to head, 4 = symptoms on leaf below flag leaf, 5 = symptoms on majority of flag leaves. (By August 4, kernels filled but green, net blotch was on flag leaves of all treatments; but symptoms were less severe in Tilt treatments and in Burn treatments).  
Planting date: May 12, 1993. Cultivated treatment was tilled with 2 passes, leaving most of the stubble on the surface.  
Burn treatment was not tilled prior to planting.

Harvest date: September 2, 1993.

Previous crop: Harrington barley.

Fertilizer: 71 lbs/a N + 51 lbs/a P<sub>2</sub>O<sub>5</sub>.

Soil moisture depth at planting = 39 inches + 13.55 inches seasonal rainfall April through August.

Growing degree days, May through August, = 1294 (9 year average = 1634).

Tilt applied: June 9, 4 leaf stage & June 30, flag leaf stage.

Table 51. Evaluation of Gaucho 480 insecticide seed treatment for sawfly control in Newana spring wheat.

Treatment/ location	Yield bu/a	Test wt.	Height	Head date	% sawfly infestation	% cutting
Choteau non-treated	65.4	59.1	36	-	17	10%
Gaucho	62.4	59.3	36	-	18	10%
Conrad non-treated	67.8	57.6	37	190	10	0
Gaucho	63.0	60.4	36	191	10	0

Newana seed treated with Vitavax at 4 Fl. oz./cwt and Gaucho at 1 oz. ai/cwt. Slurry rate = 16 Fl.oz./cwt.

Planting dates: Choteau April 29, 1993; Conrad May 3, 1993.  
Rainfall approximately 125% of normal and growing degree days approximately 80% of normal.

Peak sawfly wasp activity at Conrad occurred June 25 0.1 wasps collected per sweep, which was much below normal.

TITLE: Canola, rapeseed, and peas as enhancers of soil nutrient availability and crop productivity in cereal rotations

YEAR: 1993

LOCATION: Western Triangle Ag. Research Center, Conrad, MT

PERSONNEL: Grant Jackson, Larry Christiaens, and Mal Wescott-  
Western Ag. Research Center, Corvallis

OBJECTIVES: To develop a low-input system of enhancing nutrient availability through the use of canola and rapeseed grown with legumes in rotation with cereal crops, and to integrate biological disease control into a rotational system. 1. Study nutrient accumulation by rapeseed, cereal hay, and cereal grain crops; and legume, rapeseed, and legume-rapeseed green manure combinations. 2. Determine the effects of the above rotations on nutrient availability to a subsequent barley crop. 3. Identify the influence of rotations Brassica spp. differing in glucosinolate levels on populations and activities of soilborne plant pathogens and integrate rotational sequencing with biological control of seedling diseases.

PROCEDURES: Fourteen crop and green manure crops were seeded no-till in 1992 in a RCB design with 4 replications. Treatments were:

1. High glucosinolate 'R 500' spring rapeseed as a crop
2. Low glucosinolate 'Westar' spring canola as a crop
3. 'Latah' spring pea as a crop
4. High glucosinolate 'Humus' winter rapeseed as a green manure
5. Low glucosinolate 'Imerald' winter canola as a green manure
6. 'Latah' spring pea as a green manure
7. 25% no. 4 and 75% no. 6 as a green manure
8. 50% no. 4 and 50% no. 6 as a green manure
9. 75% no. 4 and 25% no. 6 as a green manure
10. 25% no. 5 and 75% no. 6 as a green manure
11. 50% no. 5 and 50% no. 6 as a green manure
12. 75% no. 5 and 25% no. 6 as a green manure
13. 'Haybet' barley as hay crop (low residue level)
14. 'Gallatin' barley as grain crop (high residue level)

Plot size was 10 x 20'; plots were arranged for irrigation. Preplant weed control was accomplished with glyphosate. Thirty lbs P<sub>2</sub>O<sub>5</sub>/a as 0-45-0 were applied on all plots; small grain plots received 50 lb N/a as 46-0-0. Seeding rates were or based on 150 lbs/a for the spring peas, 6 lbs/a for canola and rapeseed, and 70 lbs/a for the small grains. Seeding depth was 1.5" for peas and small grains and 0.75" for the canola and rapeseed. Plots were seeded twice to accomplish the desired seeding depths. This resulted in poor stands in some canola and rapeseed plots. Plots were sampled for total yield and N, P, K, and S content and harvested or green manured. Dicamba and glyphosate were used kill the vegetation so the plot area would remain untilled. Addition

information including soil tests and soil pathogen assays are located in Table 25. In 1993 the plot area was seeded no-till, to 'Harrington' barley and no fertilizer was applied. Weeds were controlled with Bronate and Hoelon. Treatments were sampled for nutrients, grain yield, and grain quality.

**RESULTS:** Results for the 1992 green manure and crop yields and nutrient accumulation are shown in Table 52. Note the nutrients in the hay crop were removed. Essentially all the other crop or green manure nutrients were added back to the soil because of the two hail storms. As expected, the pea and pea combinations had the highest yields and N accumulations. The pea green manure did not yield as well as the pea crop because of poor stands in some of the green manure plots. Note the canola and rapeseed had the highest S accumulation.

The grain yield and quality results are presented in Table 53. Subsequent barley grain yields and quality reflect the amount of N accumulated in the previous crops or green manures. The highest N accumulation in the previous crop or green manure produced the highest grain yield.

Total yield, net blotch infection, Pythium, and Cochliobolus estimates are tabulated in Table 54. The plant total yields also reflect the N accumulation of the previous crop or green manure. The net blotch infection estimates are significantly different but are inconsistent with the previous crops or green manures. This is probably due to the small plot size and the amount of inoculant present on the seed. Soil Pythium ultimum levels were the lowest in the spring small grain and canola and rapeseed plots. Cochliobolus sativus levels were unaffected by crop or green manure.

The 1993 barley nutrient levels are shown in Table 55 and total nutrient accumulation in Table 56. These data will be useful for interpreting next years results.

TABLE 52. TOTAL YIELD AND NUTRIENT UPTAKE OF VARIOUS GREEN MANURE CROPS UNDER NO-TILL CONDITIONS. Western Triangle Ag. Research Center, Conrad, MT. 1992.

TREATMENT	TOTAL YIELD	N UPTAKE	P UPTAKE	K UPTAKE	S UPTAKE
crop/mix/system	cwt/a	-----lb/ac-----			
SPRING PEA-CROP	106.52	239.11	27.00	168.30	13.55
75% WINTER CANOLA, 25% PEA-GM	95.08	227.73	29.54	188.75	22.84
GALLATIN BARLEY-CROP	83.95	118.69	18.32	77.30	13.85
25% WINTER CANOLA, 75% PEA-GM	82.60	180.70	23.87	176.82	15.49
50% WINTER CANOLA, 50% PEA-GM	75.78	189.45	22.29	175.03	14.64
75% PEA, 25% WINTER RAPESEED-GM	71.05	156.79	20.42	134.57	12.41
50% PEA, 50% WINTER RAPESEED-GM	67.08	166.33	19.94	133.61	13.31
SPRING PEA-GM	63.33	118.06	14.28	102.33	9.88
HAYBET BARLEY-HAY CROP	62.33	76.99	14.47	70.15	8.83
25% PEA, 75% WINTER RAPESEED-GM	60.95	122.60	16.03	131.10	14.72
SPRING RAPESEED-CROP	50.38	87.35	18.51	50.24	33.09
SPRING CANOLA-CROP	45.23	63.30	13.68	67.51	24.92
WINTER CANOLA-GM	37.25	89.81	15.31	116.14	28.49
WINTER RAPESEED-GM	31.75	74.28	11.97	95.39	22.69
***** STATISTICAL TABLE *****					
EXPERIMENTAL MEANS	66.66	136.51	18.97	120.52	17.76
TOTAL OBSERVATIONS	56.00	56.00	56.00	56.00	56.00
NO. OF REPLICATIONS	4.00	4.00	4.00	4.00	4.00
NO. OF TREATMENTS	14.00	14.00	14.00	14.00	14.00
REP. MEAN SQUARE	356.76	65.96	8.99	2160	207.64
TREATMENT MEAN SQUARE	1822.47	13270	109.54	8214	215.06
ERROR MEAN SQUARE	528.02	3771	54.58	2352	73.53
ERROR DEGREES OF FREEDOM	39.00	39.00	39.00	39.00	39.00
F TEST FOR REPS.	.68	.02	.16	.92	2.82
F TEST FOR TREATMENTS	3.45	3.52	2.01	3.49	2.92
P-VALUE	0.00	0.00	0.04	0.00	0.00
STANDARD ERROR	22.98	61.41	7.39	48.50	8.57
STANDARD ERROR OF THE MEAN	11.49	30.70	3.69	24.25	4.29
C.V. 1: (S/MEAN)*100	34.47	44.98	38.94	40.24	48.28
C.V. 2: (S OF MEAN/MEAN)*100	17.24	22.49	19.47	20.12	24.14
LSD (0.05)	32.87	87.83	10.57	69.37	12.26

All data is on a dry weight basis. Seeding date: 4-24-92  
 Previous crop: Chemical fallow-1991, Barley-1990; plot area has been no-tilled since 1982.

Growing season precip: 5.7" Irrigated on 5-15-1992: 2.5"  
 Sampled for total yield on 7-16, and all green manure plots sprayed with glyphosate and dicamba. Haybet barley was harvested for hay at the soft dough stage on July 17. Plots were hauled out on 8-1 and 8-3. "Crop" plots were harvested and stover spread on 8-26.  
 Soil Test Results: 0-6" samples-pH=7.3, O.M.=1.6%, P=35 ppm, K=351 ppm, SO<sub>4</sub>-S=51 ppm; NO<sub>3</sub>-N (0-4' samples)=103 lb/a.  
 Pythium ultimum assay=4 propagules/g of dry soil.  
 Cochliobolus sativus assay=10 propagules/g of dry soil.



TABLE 53. EFFECT OF NO-TILL GREEN MANURE CROPS ON NO-TILL BARLEY YIELD AND QUALITY. Western Triangle Ag. Research Center, Conrad, MT 1993.

TREATMENT	GRAIN GRAIN TEST				
	YIELD	PROTEIN	WT.	PLUMP	THINS
crop/mix/system	bu/a	%	lb/bu	%	%
SPRING PEA-GM	87.65	8.43	50.18	91.00	2.75
75% PEA, 25% WINTER RAPESEED-GM	82.40	8.10	49.45	91.25	2.25
50% WINTER CANOLA, 50% PEA-GM	77.70	7.85	49.65	91.25	2.50
25% WINTER CANOLA, 75% PEA-GM	75.83	7.73	49.55	88.50	3.25
50% PEA, 50% WINTER RAPESEED-GM	71.57	7.63	49.25	88.25	3.75
25% PEA, 75% WINTER RAPESEED-GM	67.65	7.55	49.98	90.50	3.00
WINTER RAPESEED-GM	66.08	7.35	49.80	89.50	2.75
75% WINTER CANOLA, 25% PEA-GM	65.90	7.33	50.13	92.00	1.75
SPRING PEA-CROP	62.90	7.70	48.95	94.00	2.25
WINTER CANOLA-GM	60.48	7.55	49.98	92.75	2.50
SPRING RAPESEED-CROP	53.00	7.65	48.40	93.25	1.75
SPRING CANOLA-CROP	42.55	8.23	47.08	95.75	1.25
HAYBET BARLEY-HAY CROP	37.48	7.78	49.30	93.75	1.50
GALLATIN BARLEY-CROP	28.50	8.63	44.20	91.75	3.75
***** STATISTICAL TABLE *****					
EXPERIMENTAL MEANS	62.83	7.82	48.99	91.68	2.50
TOTAL OBSERVATIONS	56.00	56.00	56.00	56.00	56.00
NO. OF REPLICATIONS	4.00	4.00	4.00	4.00	4.00
NO. OF TREATMENTS	14.00	14.00	14.00	14.00	14.00
REP. MEAN SQUARE	31.45	.17	3.28	15.69	1.33
TREATMENT MEAN SQUARE	1182.63	.60	10.27	18.09	2.42
ERROR MEAN SQUARE	64.67	.19	.85	6.31	.88
ERROR DEGREES OF FREEDOM	39.00	39.00	39.00	39.00	39.00
F TEST FOR REPS.	.49	.88	3.85	2.49	1.51
F TEST FOR TREATMENTS	18.29	3.20	12.04	2.87	2.74
P-VALUE	0.00	0.00	0.00	0.01	0.01
STANDARD ERROR	8.04	.43	.92	2.51	.94
STANDARD ERROR OF THE MEAN	4.02	.22	.46	1.26	.47
C.V. 1: (S/MEAN)*100	12.80	5.56	1.88	2.74	37.62
C.V. 2: (S OF MEAN/MEAN)*100	6.40	2.78	.94	1.37	18.81
LSD (0.05)	11.50	.62	1.32	3.59	1.35

Grain yields reported with 48 lb/bu as standard test weight.  
 Seeded on 5-11-93. Harvested on 9-7-93.  
 Growing season precip: 11.78"

TABLE 54. EFFECT OF NO-TILL GREEN MANURES ON NO-TILL BARLEY TOTAL YIELD, NET BLOTCH, PYTHIUM ULTIMUM, AND COCHLIOBOLUS SATIVUS. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	PLANT YIELD	NET BLOTCH	PYTHIUM ultimum	COCH. sativus
crop/system	cwt/a	+	#	#
SPRING PEA-GM	76.49	2.48	9.50	9.75
75% PEA, 25% WINTER RAPESEED-GM	84.87	2.46	116.30	9.75
50% WINTER CANOLA, 50% PEA-GM	81.53	2.23	9.50	9.50
25% WINTER CANOLA, 75% PEA-GM	83.16	2.38	9.50	19.25
50% PEA, 50% WINTER RAPESEED-GM	73.98	2.08	58.50	38.25
25% PEA, 75% WINTER RAPESEED-GM	73.20	1.96	106.50	48.50
WINTER RAPESEED-GM	61.68	2.20	9.50	65.75
75% WINTER CANOLA, 25% PEA-GM	77.49	2.45	19.75	9.75
SPRING PEA-CROP	55.54	2.13	87.50	9.75
WINTER CANOLA-GM	63.73	2.13	19.25	38.00
SPRING RAPESEED-CROP	48.83	2.35	0.00	29.00
SPRING CANOLA-CROP	34.94	2.48	0.00	9.50
HAYBET BARLEY-HAY CROP	32.98	2.23	0.00	19.25
GALLATIN BARLEY-CROP	30.48	2.08	0.00	50.50
***** STATISTICAL TABLE *****				
EXPERIMENTAL MEANS	62.78	2.26	31.84	26.18
TOTAL OBSERVATIONS	56.00	56.00	56.00	56.00
NO. OF REPLICATIONS	4.00	4.00	4.00	4.00
NO. OF TREATMENTS	14.00	14.00	14.00	14.00
REP. MEAN SQUARE	601.22	.67	1507.00	926.80
TREATMENT MEAN SQUARE	1491.77	.12	7035.00	1440.00
ERROR MEAN SQUARE	271.35	.06	2958.00	974.70
ERROR DEGREES OF FREEDOM	39.00	39.00	39.00	39.00
F TEST FOR REPS.	2.22	11.51	.51	0.95
F TEST FOR TREATMENTS	5.50	2.04	2.37	1.48
P-VALUE	0.00	0.04	0.02	0.17
STANDARD ERROR	16.47	.24	54.39	31.22
STANDARD ERROR OF THE MEAN	8.24	.12	27.20	15.61
C.V. 1: (S/MEAN)*100	26.24	10.70	170.80	119.30
C.V. 2: (S OF MEAN/MEAN)*100	13.12	5.35	85.42	59.63
LSD (0.05)	23.56	.35	77.80	NS

+ 0 = no disease, 1 = symptoms on lower 1/3 of canopy, 2 = symptoms at mid portion of canopy, 3 = symptoms on upper portion of canopy. Readings taken on 7-22-93.

# propagules/g of soil, assays determined from soil taken in May, 1993. Assays from soil taken prior to experiment establishment were: Pythium = 4 propagules/g and Cochliobolus = 10 propagules/g.

Samples for total yield were taken on 8-19-93.

TABLE 55. EFFECT OF NO-TILL GREEN MANURE CROPS ON NO-TILL BARLEY TISSUE COMPOSITION. Western Triangle Ag. Research Center, Conrad, MT 1993.

TREATMENT	-----NUTRIENT-----			
	N	P	K	S
crop/mix/system	-----%			
SPRING PEA-GM	0.85	0.17	0.65	0.09
75% PEA, 25% WINTER RAPESEED-GM	0.81	0.18	0.61	0.09
50% WINTER CANOLA, 50% PEA-GM	0.72	0.16	0.69	0.08
25% WINTER CANOLA, 75% PEA-GM	0.79	0.17	0.58	0.08
50% PEA, 50% WINTER RAPESEED-GM	0.75	0.18	0.55	0.09
25% PEA, 75% WINTER RAPESEED-GM	0.75	0.17	0.55	0.08
WINTER RAPESEED-GM	0.78	0.17	0.55	0.09
75% WINTER CANOLA, 25% PEA-GM	0.78	0.17	0.56	0.08
SPRING PEA-CROP	0.76	0.18	0.52	0.09
WINTER CANOLA-GM	0.69	0.17	0.54	0.09
SPRING RAPESEED-CROP	0.78	0.20	0.53	0.09
SPRING CANOLA-CROP	0.95	0.22	0.55	0.12
HAYBET BARLEY-HAY	0.81	0.20	0.52	0.10
GALLATIN BARLEY-CROP	0.95	0.26	0.73	0.12
***** STATISTICAL TABLE *****				
EXPERIMENTAL MEANS	0.80	0.18	0.58	0.09
TOTAL OBSERVATIONS	56.00	56.00	56.00	56.00
NO. OF REPLICATIONS	4.00	4.00	4.00	4.00
NO. OF TREATMENTS	14.00	14.00	14.00	14.00
REP. MEAN SQUARE	0.01	0.00	0.02	0.00
TREATMENT MEAN SQUARE	0.02	0.00	0.02	0.00
ERROR MEAN SQUARE	0.01	0.00	0.01	0.00
ERROR DEGREES OF FREEDOM	39.00	39.00	39.00	39.00
F TEST FOR REPS.	1.49	0.54	2.06	0.22
F TEST FOR TREATMENTS	2.66	5.96	1.57	3.21
P-VALUE	0.01	0.00	0.13	0.00
STANDARD ERROR	0.09	0.02	0.10	0.02
STANDARD ERROR OF THE MEAN	0.05	0.01	0.05	0.01
C.V. 1: (S/MEAN)*100	11.67	12.14	17.88	16.96
C.V. 2: (S OF MEAN/MEAN)*100	5.84	6.07	8.94	8.48
LSD (0.05)	0.13	0.03	0.15	0.02

Samples taken on 8-19-93.

TABLE 56. EFFECT OF NO-TILL GREEN MANURE CROPS ON NO-TILL BARLEY NUTRIENT UPTAKE. Western Triangle Ag. Research Center, Conrad, MT 1993.

TREATMENT	N	P	K	S
	UPTAKE UPTAKE UPTAKE UPTAKE			
crop/mix/system	-----lb/a-----			
SPRING PEA-GM	64.32	13.02	52.21	6.58
75% PEA, 25% WINTER RAPESEED-GM	69.95	15.02	51.16	7.35
50% WINTER CANOLA, 50% PEA-GM	59.12	13.27	57.61	6.68
25% WINTER CANOLA, 75% PEA-GM	66.27	14.06	48.82	6.58
50% PEA, 50% WINTER RAPESEED-GM	54.17	12.61	40.37	6.08
25% PEA, 75% WINTER RAPESEED-GM	54.21	12.48	40.53	6.19
WINTER RAPESEED-GM	48.04	10.31	34.38	5.50
75% WINTER CANOLA, 25% PEA-GM	60.66	12.87	42.73	6.23
SPRING PEA-CROP	42.34	9.84	29.53	5.34
WINTER CANOLA-GM	43.67	10.64	33.95	5.83
SPRING RAPESEED-CROP	38.21	9.43	26.54	4.51
SPRING CANOLA-CROP	32.93	7.69	19.40	4.20
HAYBET BARLEY-HAY CROP	26.82	6.39	16.94	3.35
GALLATIN BARLEY-CROP	28.84	7.78	21.65	3.74
***** STATISTICAL TABLE *****				
EXPERIMENTAL MEANS	49.25	11.10	36.84	5.58
TOTAL OBSERVATIONS	56.00	56.00	56.00	56.00
NO. OF REPLICATIONS	4.00	4.00	4.00	4.00
NO. OF TREATMENTS	14.00	14.00	14.00	14.00
REP. MEAN SQUARE	717.92	17.33	107.65	5.97
TREATMENT MEAN SQUARE	803.15	27.65	671.28	5.82
ERROR MEAN SQUARE	174.58	10.08	234.02	2.51
ERROR DEGREES OF FREEDOM	39.00	39.00	39.00	39.00
F TEST FOR REPS.	4.11	1.72	.46	2.37
F TEST FOR TREATMENT	14.60	2.74	2.87	2.31
P-VALUE	0.00	0.01	0.01	0.02
STANDARD ERROR	13.21	3.18	15.30	1.59
STANDARD ERROR OF THE MEAN	6.61	1.59	7.65	.79
C.V. 1: (S/MEAN)*100	26.83	28.61	41.52	28.40
C.V. 2: (S OF MEAN/MEAN)*100	13.41	14.30	20.76	14.20
LSD (0.05)	18.90	4.54	21.88	2.27

Samples were taken on 8-19-93.

**TITLE:** Effect of nitrogen, phosphorus, potassium, and chloride on grain yield and quality of spring wheat.

**YEAR:** 1993

**LOCATIONS:**

1. Patricia Hellinger Farm, east of Ethridge;
2. Ron Long Farm, north of Shonkin;
3. Bruce Bradley Farm, northwest of Cut Bank;
4. Don Bradley Farm, northeast of Cut Bank;
5. Bob Inabnit Farm, east of Ledger;
6. Allan Skari Farm, north of Lothair;
7. Moog Farms, north of Joplin;
8. Lyle McKeever Farm, north east of Loma;
9. Gene Billmayer Farm, south of Hogeland;
10. Ryle Simons Farm, west of Turner;
11. Howard Smith Farm, south of Dodson;
12. John Flansas Farm, near Loring;
13. Kathy Blessette Farm, north of Havre;
14. Ray Ramberg Farm, north of Inverness;

**PERSONNEL:** Grant Jackson, Larry Christiaens, Robert Kirby-Glacier County Agent, Joe Broesder-Toole County Agent, John Maatta-Liberty County Agent, Judy Wargo-Chouteau County Agent, Robert Brastrup-Hill County Agent, Steve Williams-Blaine County Agent, and Kent Williams-Phillips County Agent.

**OBJECTIVES:** Determine the response of spring wheat to N fertilizer, and calibrate nitrate-N soil test to spring wheat response.

**PROCEDURES:** Six to eight fertilizer treatments, described in each data table, were applied broadcast prior to seeding. Plot size was 10 x 20 feet with four replications. Location characteristics such as variety, fertilizer applied with the seed, soil test results, etc. are shown in each table also.

**RESULTS:** Data are summarized in Tables 57 through 70. Comments about individual locations are shown at the bottom of each table. Eight of the 14 sites had a yield and protein response to N. Nitrogen significantly lowered test weight at four locations and increased test weight at two no-till, recrop locations. Phosphorus significantly lowered grain protein at five locations.

TABLE 57. EFFECT OF N, K, AND Cl ON SPRING WHEAT. Experiment located east of Ethridge. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb/a N-P <sub>2</sub> O <sub>5</sub> -K-Cl			
(3) 60-50-20-18	34.60	12.45	55.03
(7) 60-50-0-0	33.38	12.23	54.59
(4) 90-50-20-18	32.45	12.92	54.69
(4) 60-50-20-0	31.53	12.30	54.41
(2) 30-50-20-18	31.45	11.93	55.05
(5) 60-0-20-18	31.40	12.62	54.85
(1) 0-50-20-18	31.30	11.52	55.89
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	32.30	12.28	54.93
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	630.34	4.61	4.87
TREATMENT MEAN SQUARE	6.40	.84	.93
ERROR MEAN SQUARE	20.27	.20	.19
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	31.09	23.11	26.23
F TEST FOR TREATMENTS	.32	4.22	5.02
STANDARD ERROR	4.50	.45	.43
STANDARD ERROR OF THE MEAN	2.25	.22	.22
C.V. 1: (S/MEAN)*100	13.94	3.64	.78
C.V. 2: (S OF MEAN/MEAN)*100	6.97	1.82	.39
LSD (0.05)	NS	.66	.64

Grain yields based on 60 lb/bu.

Variety: Rambo

Growing Season ppt. = 13.05" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: May 13, 1993 Harvest Date: October 12, 1993

Sixty lbs of 27-27-0 with the seed, all others broadcast before planting on April 27, 1993.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 8.0, O.M. = 2.0%, P = 13 ppm, K = 455 ppm  
Zn = 0.4 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	12	27.9	19.6	192
0-2	23	60.4	33.8	532
0-3	33	87.0	48.0	1012
0-4	41	133.4	62.2	1812

Comments: Wheat stand was highly variable, thus the yield results were non-significant. Protein was increased by N (compare treatments 1-4). Wheat samples had about 50% frost damage.

TABLE 58. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located north of Shonkin. Western Triangle Ag. Research Center, Conrad, MT 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
1b N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(7) 100-50-0-0	40.90	13.60	58.10
(6) 100-50-30-0	39.35	13.70	57.92
(4) 150-50-30-27	38.97	14.20	57.69
(3) 100-50-30-27	38.53	13.25	57.59
(5) 100-0-30-27	36.75	13.88	57.07
(2) 50-50-30-27	35.82	12.00	58.66
(1) 0-50-30-27	29.33	11.67	58.43
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	37.09	13.19	57.92
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	67.89	.13	3.49
TREAT. MEAN SQUARE	58.16	3.75	1.15
ERROR MEAN SQUARE	12.55	.08	.63
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	5.41	1.70	5.54
F TEST FOR TREAT.	4.63	47.53	1.82
STANDARD ERROR	3.54	.28	.79
STANDARD ERROR OF THE MEAN	1.77	.14	.40
C.V. 1: (S/MEAN)*100	9.55	2.13	1.37
C.V. 2: (S OF MEAN/MEAN)*100	4.78	1.07	.69
LSD (0.05)	5.25	0.42	NS

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 8.35" Depth of Moist Soil = > 3'

Previous crop: wheat

Seeding Date: April 28, 1993 Harvest Date:

P fertilizer placed with the seed, all others broadcast in front of the openers while seeding.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 7.7, O.M. = 2.1%, P = 17 ppm, K = 350 ppm  
Zn = 0.9 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	23	27.9	23.1	132
0-2	55	55.2	44.5	208
0-3	64	83.9	56.4	579
0-4	68	108.6	73.0	1158
0-5	72	133.0	90.8	1958

**Comments:** This trial experienced early drought conditions. Data shows classical yield and protein response to N (compare treats. 1-4). The P treatment (compare treats. 3 and 5) caused about 0.5% reduction in protein.

TABLE 59. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located northwest of Cut Bank. Western Triangle Ag. Research Center, Conrad, MT. 1993

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(4) 150-50-30-28	75.40	12.23	51.78
(6) 100-50-30-0	69.00	11.60	53.74
(3) 100-50-30-28	68.22	10.98	53.19
(7) 100-50-0-0	67.40	11.65	53.69
(5) 100-0-30-28	65.83	11.40	53.48
(2) 50-50-30-28	59.95	9.65	53.58
(1) 0-50-30-28	43.20	9.13	53.37
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	64.14	10.95	53.26
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	46.50	1.17	8.52
TREATMENT MEAN SQUARE	424.40	5.17	1.84
ERROR MEAN SQUARE	26.67	.08	.70
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	1.74	14.65	12.19
F TEST FOR TREATMENTS	15.91	64.87	2.63
STANDARD ERROR	5.16	.28	.84
STANDARD ERROR OF THE MEAN	2.58	.14	.42
C.V. 1: (S/MEAN)*100	8.05	2.58	1.57
C.V. 2: (S OF MEAN/MEAN)*100	4.03	1.29	.78
LSD (0.05)	7.67	.42	1.24

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 11.35" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date:

Harvest Date: October 12, 1993

Fertilizers were applied on May 20, 1993 when wheat was in the two leaf growth stage. Forty lbs/a of 11-53-0 was applied with the seed.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 7.1, O.M. = 1.8%, P = 23 ppm, K = 354 ppm  
Zn = 0.9

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	31	47.2	14.2	39
0-2	56	88.0	32.0	81
0-3	73	120.8	48.6	154

Comments: Classical yield and protein response to N (compare treats. 1-4). Note high N (treat. 4) rate reduced test weight, and the P treat. (compare treats. 3 and 5) reduced protein.



TABLE 60. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located northeast of Cut Bank. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
1b N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(3) 100-50-30-28	37.13	11.35	38.43
(7) 100-50-0-0	36.30	11.75	36.67
(2) 50-50-30-28	35.90	10.30	43.46
(5) 100-0-30-28	32.65	11.38	40.05
(4) 150-50-30-28	31.80	12.17	35.12
(6) 100-50-30-0	31.75	11.88	37.53
(1) 0-50-30-28	29.65	9.50	44.31
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	33.60	11.19	39.37
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	89.18	.83	23.65
TREATMENT MEAN SQUARE	32.12	3.64	47.46
ERROR MEAN SQUARE	21.69	.15	3.55
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	4.11	5.47	6.65
F TEST FOR TREATMENTS	1.48	23.98	13.36
STANDARD ERROR	4.66	.39	1.89
STANDARD ERROR OF THE MEAN	2.33	.19	.94
C.V. 1: (S/MEAN)*100	13.86	3.48	4.79
C.V. 2: (S OF MEAN/MEAN)*100	6.93	1.74	2.39
LSD (0.05)	NS	.58	2.80

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 14.70" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date:

Harvest Date: October 12, 1993

Fertilizers were broadcast on May 20, 1993 when the wheat was emerging.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 7.9, O.M. = 1.6%, P = 12 ppm, K = 284 ppm  
Zn = 0.4 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	37	33.4	16.0	46
0-2	58	68.8	30.2	86
0-3	70	95.4	40.9	172

**Comments:** This site was late and had considerable frost damage. Due to high variability, the yield data was non-significant, however, N did increase protein and decrease test weight.

TABLE 61. EFFECT OF N, P, K, and Cl ON NO-TILL SPRING WHEAT.  
 Experiment located east of Ledger. Western Triangle Ag.  
 Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD	GRAIN PROTEIN	TEST WT.
lb N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a	bu/a	%	lb/bu
(4) 150-30-30-28	46.75	12.23	60.62
(3) 100-30-30-28	46.53	9.78	60.57
(6) 100-30-0-0	45.53	9.93	60.00
(5) 100-0-30-28	43.70	11.35	60.73
(2) 50-30-30-28	37.08	8.90	59.81
(1) 0-30-30-28	20.55	9.90	59.76
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	40.02	10.35	60.25
TOTAL OBSERVATIONS	24.00	24.00	24.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	5.92	1.12	.02
TREATMENT MEAN SQUARE	415.37	5.87	.77
ERROR MEAN SQUARE	10.87	.97	.11
ERROR DEGREES OF FREEDOM	15.00	15.00	15.00
F TEST FOR REPS.	.55	1.16	.16
F TEST FOR TREATMENTS	38.22	6.05	6.77
STANDARD ERROR	3.30	.98	.34
STANDARD ERROR OF THE MEAN	1.65	.49	.17
C.V. 1: (S/MEAN)*100	8.24	9.52	.56
C.V. 2: (S OF MEAN/MEAN)*100	4.12	4.76	.28
LSD (0.05)	4.97	1.48	.51

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 10.79" Depth of Moist Soil = > 3'

Previous crop: barley

Seeding Date: April 30, 1993 Harvest Date: Sept. 14, 1993

P fertilizer placed with the seed, all others broadcast in front of the openers while seeding.

Fertilizer sources: Urea, treble superphosphate, and potassium chloride.

Soil Tests: pH = 8.1, O.M. = 1.6%, P = 18 ppm, K = 276 ppm

Zn = 0.5 ppm

Depth	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
ft.	-----lb/a-----			

0-1	11	34.8	24.9	389
0-2	17	75.3	51.6	1111
0-3	43	116.1	94.3	1911
0-4	59	156.9	144.1	2711

Comments: The N treats. (1-4) increased yield, protein, and test weight. Note that P decreased protein (compare treats. 3 and 5).

TABLE 62. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located north of Lothair. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P2O5-K-Cl/a			
(6) 60-50-20-0	69.97	12.43	59.12
(4) 90-50-20-18	69.03	13.63	58.63
(5) 60-0-20-18	68.57	13.43	59.94
(7) 60-50-0-0	65.63	12.77	58.84
(3) 60-50-20-18	64.50	13.57	60.16
(2) 30-50-20-18	61.17	13.50	59.97
(1) 0-50-20-18	54.13	13.33	59.83
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	64.71	13.24	59.50
TOTAL OBSERVATIONS	21.00	21.00	21.00
NO. OF REPLICATIONS	3.00	3.00	3.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	112.30	1.09	35.34
TREATMENT MEAN SQUARE	93.26	.62	1.15
ERROR MEAN SQUARE	6.04	.19	.66
ERROR DEGREES OF FREEDOM	12.00	12.00	12.00
F TEST FOR REPS.	18.60	5.71	53.89
F TEST FOR TREATMENTS	15.44	3.28	1.75
STANDARD ERROR	2.46	.44	.81
STANDARD ERROR OF THE MEAN	1.42	.25	.47
C.V. 1: (S/MEAN)*100	3.80	3.30	1.36
C.V. 2: (S OF MEAN/MEAN)*100	2.19	1.90	.79
LSD (0.05)	4.37	.78	NS

Grain yields based on 60 lb/bu.

Variety: Rambo

Growing Season ppt. = 12.65" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: Harvest Date: Sept. 27, 1993

Fertilizers applied broadcast before seeding on April 15, 1993.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 6.9, O.M. = 1.5%, P = 17 ppm, K = 603 ppm

Zn = 0.7 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			

0-1	18	29.5	19.5	287
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0-2	38	58.2	71.0	584
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0-3	84	120.5	193.7	1367
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0-4	158	171.5	474.7	1367
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Comments: This location had a traditional yield and protein response to N (compare treats. 1-4). The Cl addition increased protein ( compare treats. 3 and 6).

TABLE 63. EFFECT OF N, P, K, AND Cl ON NO-TILL SPRING WHEAT.  
 Experiment located northeast of Loma. Western Triangle  
 Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD	GRAIN PROTEIN	TEST WT.
	bu/a	%	lb/bu
1b N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(3) 100-50-30-28	48.43	13.27	59.33
(4) 150-50-30-28	47.78	14.87	59.44
(6) 100-50-30-0	46.90	13.40	58.49
(5) 100-0-30-28	45.73	13.05	58.64
(7) 100-50-0-0	44.20	12.82	58.70
(2) 50-50-30-28	34.75	12.97	59.12
(1) 0-50-30-28	20.98	13.62	56.70
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	41.25	13.43	58.63
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	85.09	9.54	2.78
TREATMENT MEAN SQUARE	405.35	1.91	3.41
ERROR MEAN SQUARE	38.42	1.11	1.94
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	2.21	8.57	1.43
F TEST FOR TREATMENTS	10.55	1.72	1.76
STANDARD ERROR	6.20	1.06	1.39
STANDARD ERROR OF THE MEAN	3.10	.53	.70
C.V. 1: (S/MEAN)*100	15.03	7.85	2.38
C.V. 2: (S OF MEAN/MEAN)*100	7.51	3.93	1.19
LSD (0.05)	9.21	1.57	2.07

Grain yields based on 60 lb/bu.

Variety: Newana

Growing Season ppt. = 11.40" Depth of Moist Soil = > 3'

Previous crop: barley

Seeding Date:

Harvest Date: August 24, 1993

Fertilizers broadcast prior to seeding on April 28, 1993

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 8.1, O.M. = 1.3%, P = 21 ppm, K = 407 ppm

Zn = 0.5 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	6	36.4	17.8	225
0-2	10	66.6	33.8	585
0-3	14	99.6	48.0	1385
0-4	23	136.6	65.8	2185
0-5	46	176.9	90.7	2985

Comments: Excellent yield response to N (compare treats. 1-4), however, protein response was highly variable and increases were non-significant. Note the increase test weight due to N.

TABLE 64. EFFECT ON N, P, K, S, AND Cl ON NO-TILL SPRING WHEAT. Experiment located north of Joplin. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-S-Cl/a			
(6) 100-50-30-0-0	66.90	10.80	58.89
(4) 150-50-30-0-28	66.30	11.57	58.98
(8) 100-50-30-30-28	65.88	11.20	60.00
(7) 100-50-0-0-0	65.30	10.90	59.33
(5) 100-0-30-0-28	63.05	12.13	59.67
(3) 100-50-30-0-28	60.57	10.90	59.19
(2) 50-50-30-0-28	45.48	9.65	60.62
(1) 0-50-30-0-28	25.15	10.45	60.87
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	57.33	10.95	59.69
TOTAL OBSERVATIONS	32.00	32.00	32.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	8.00	8.00	8.00
REP. MEAN SQUARE	41.50	2.19	5.54
TREATMENT MEAN SQUARE	873.10	2.17	2.21
ERROR MEAN SQUARE	26.17	.56	1.31
ERROR DEGREES OF FREEDOM	21.00	21.00	21.00
F TEST FOR REPS.	1.59	3.88	4.22
F TEST FOR TREATMENTS	33.36	3.86	1.68
STANDARD ERROR	5.12	.75	1.15
STANDARD ERROR OF THE MEAN	2.56	.38	.57
C.V. 1: (S/MEAN)*100	8.92	6.85	1.92
C.V. 2: (S OF MEAN/MEAN)*100	4.46	3.43	.96
LSD (0.05)	7.52	1.10	NS

Grain yields based on 60 lb/bu.

Variety: Rambo

Growing Season ppt. = 9.45" Depth of Moist Soil = > 3'

Previous crop: chemical fallow

Seeding Date:

Harvest Date: Sept. 27, 1993

Fertilizers applied broadcast before seeding on April 15, 1993.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 7.4, O.M. = 1.4%, P = 22 ppm, K = 409 ppm  
Zn = 0.5 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	12	24.1	30.3	96
0-2	29	46.0	58.8	234
0-3	43	63.2	76.6	274
0-4	47	81.6	98.0	410

**Comments:** The S treatment was added at the request of the cooperator and did not significantly increase yield or protein (compare treats. 8 and 3). The N treats. (compare treats. 1-4) significantly increased yield and protein, and the P treat. (compare treats. 3 and 5). significantly reduced protein.

TABLE 65. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located south of Hogeland. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. bu/a
1b N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(6) 60-50-20-0	51.40	11.40	58.77
(4) 90-50-20-18	50.53	11.57	58.32
(3) 60-50-20-18	50.33	11.93	58.56
(5) 60-0-20-18	48.77	11.47	58.82
(7) 60-50-0-0	47.70	10.97	58.89
(1) 0-50-20-18	43.27	10.33	58.20
(2) 30-50-20-18	42.80	10.87	58.23
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	47.83	11.22	58.54
TOTAL OBSERVATIONS	21.00	21.00	21.00
NO. OF REPLICATIONS	3.00	3.00	3.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	19.31	25.09	.01
TREATMENT MEAN SQUARE	36.67	.85	.25
ERROR MEAN SQUARE	31.57	.47	.10
ERROR DEGREES OF FREEDOM	12.00	12.00	12.00
F TEST FOR REPS.	.61	52.96	.11
F TEST FOR TREATMENTS	1.16	1.79	2.48
STANDARD ERROR	5.62	.69	.32
STANDARD ERROR OF THE MEAN	3.24	.40	.18
C.V. 1: (S/MEAN)*100	11.75	6.13	.55
C.V. 2: (S OF MEAN/MEAN)*100	6.78	3.54	.32
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Newana

Growing Season ppt. = 13.35" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date:

Harvest Date: Sept. 30, 1993

Fertilizers applied broadcast before seeding on April 12, 1993.

Eighty lbs of 11-53-0 was applied with the seed on all plots.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 7.2, O.M. = 1.3%, P = 19 ppm, K = 372 ppm

Zn = 0.4 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	16	31.7	23.2	352
0-2	26	72.9	46.3	788
0-3	41	117.8	66.4	1127
0-4	57	147.0	80.8	1927

Comments: Data was all non-significant probably due to the high variability.

TABLE 66. EFFECT OF N, P, K, AND Cl ON IRRIGATED SPRING WHEAT.  
 Experiment located west of Turner. Western Triangle Ag.  
 Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(8) 150-50-0-0	80.12	13.63	57.15
(3) 150-50-40-37	79.95	12.97	58.05
(6) 150-0-40-37	77.38	13.25	57.64
(1) 0-50-40-37	76.58	13.88	56.69
(7) 150-50-40-0	76.37	13.62	57.25
(5) 300-50-40-37	75.43	13.52	56.74
(4) 225-50-40-37	74.95	13.58	56.88
(2) 75-50-40-37	70.12	13.90	56.07
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	76.36	13.54	57.06
TOTAL OBSERVATIONS	32.00	32.00	32.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	8.00	8.00	8.00
REP. MEAN SQUARE	3.40	.29	1.49
TREATMENT MEAN SQUARE	39.93	.38	1.49
ERROR MEAN SQUARE	49.31	.26	1.28
ERROR DEGREES OF FREEDOM	21.00	21.00	21.00
F TEST FOR REPS.	.07	1.11	1.16
F TEST FOR TREATMENTS	.81	1.44	1.16
STANDARD ERROR	7.02	.51	1.13
STANDARD ERROR OF THE MEAN	3.51	.26	.57
C.V. 1: (S/MEAN)*100	9.20	3.78	1.98
C.V. 2: (S OF MEAN/MEAN)*100	4.60	1.89	.99
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: NK 751

Growing Season ppt. = Depth of Moist Soil = > 3'

Previous crop: dry beans

Seeding Date: Harvest Date: Sept. 30, 1993

Fertilizer applied broadcast before seeding on April 13, 1993.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 7.4, O.M. = 1.5%, P = 32 ppm, K = 481 ppm  
 Zn = 1.3 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	26	29.4	65.8	302
0-2	53	50.5	113.9	622
0-3	82	72.8	170.5	991
0-4	108	101.2	241.7	1431

Comments: Data was all non-significant probably due to the high variability.

TABLE 67. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located south of Dodson. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(7) 60-50-0-0	29.83	17.42	54.87
(6) 60-50-20-0	29.28	17.58	55.88
(3) 60-50-20-18	27.70	17.72	55.15
(4) 90-50-20-18	27.23	17.80	55.38
(2) 30-50-20-18	26.93	17.30	55.13
(1) 0-50-20-18	25.42	17.15	55.35
(5) 60-0-20-18	24.20	17.68	55.93
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	27.23	17.52	55.38
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	31.59	.12	2.03
TREATMENT MEAN SQUARE	15.78	.23	.61
ERROR MEAN SQUARE	4.99	.11	.57
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	6.33	1.08	3.59
F TEST FOR TREATMENTS	3.16	2.02	1.08
STANDARD ERROR	2.23	.34	.75
STANDARD ERROR OF THE MEAN	1.12	.17	.38
C.V. 1: (S/MEAN)*100	8.20	1.92	1.36
C.V. 2: (S OF MEAN/MEAN)*100	4.10	.96	.68
LSD (0.05)	3.32	NS	1.12

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 11.13" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date:

Harvest Date: Sept. 9, 1993

Fertilizer applied broadcast before seeding on April 13, 1993.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 5.4, O.M. = 1.7%, P = 23 ppm, K = 462 ppm  
Zn = 2.0 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	21	22.5	19.0	159
0-2	36	48.2	38.0	507
0-3	47	72.6	61.7	953
0-4	58	103.9	97.3	1418
0-5	64	135.9	118.7	1953

Comments: This site had a small but significant response to P. Data are too variable for a significant N response.



TABLE 68. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located southwest of Loring. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(3) 60-50-20-18	54.03	15.40	57.09
(6) 60-50-20-0	52.60	15.63	57.15
(4) 90-50-20-18	52.43	15.52	57.57
(1) 0-50-20-18	51.35	15.05	57.85
(5) 60-0-20-18	51.28	15.40	57.30
(2) 30-50-20-18	47.78	15.30	57.23
(7) 60-50-0-0	47.53	15.43	57.16
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	51.00	15.39	57.34
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	29.94	.66	.59
TREATMENT MEAN SQUARE	24.28	.13	.30
ERROR MEAN SQUARE	19.30	.23	.34
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	1.55	2.81	1.73
F TEST FOR TREATMENTS	1.26	.57	.89
STANDARD ERROR	4.39	.48	.58
STANDARD ERROR OF THE MEAN	2.20	.24	.29
C.V. 1: (S/MEAN)*100	8.62	3.14	1.02
C.V. 2: (S OF MEAN/MEAN)*100	4.31	1.57	.51
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Newana

Growing Season ppt. = 10.57" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date:

Harvest Date: October 1, 1993

Fertilizers applied broadcast before seeding on April 13, 1993.

Fifty lbs of 27-27-0 was applied with the seed on all plots.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Soil Tests: pH = 5.7, O.M. = 1.7%, P = 26 ppm, K = 481 ppm

Zn = 1.3 ppm

Depth	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
ft.	-----lb/a-----			

0-1	24	19.9	10.7	182
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0-2	48	35.9	28.5	326
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**Comments:** Data was highly variable due to drought conditions early in the growing season and extensive "sucker" heads. The first significant rain fell on June 16.

TABLE 69. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Experiment located north of Havre. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
1b N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(3) 60-50-20-18	31.53	13.13	60.00
(4) 90-50-20-18	31.25	12.55	59.97
(6) 60-50-20-0	30.10	11.87	59.61
(2) 30-50-20-18	29.13	11.70	59.91
(5) 60-0-20-18	28.58	11.80	59.88
(7) 60-50-0-0	28.53	11.78	60.27
(1) 0-50-20-18	22.95	11.95	59.74
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	28.86	12.11	59.91
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	57.75	2.17	.05
TREATMENT MEAN SQUARE	33.03	1.12	.17
ERROR MEAN SQUARE	19.76	1.84	.21
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	2.92	1.17	.26
F TEST FOR TREATMENTS	1.67	.61	.84
STANDARD ERROR	4.45	1.36	.45
STANDARD ERROR OF THE MEAN	2.22	.68	.23
C.V. 1: (S/MEAN)*100	15.40	11.21	.76
C.V. 2: (S OF MEAN/MEAN)*100	7.70	5.61	.38
LSD (0.05)	NS	NS	NS

**Note:** Data should be interpreted with caution because the surrounding field had an estimated hail loss of 35%.

Grain yields based on 60 lb/bu.

Variety: Newana

Growing Season ppt. = 14.16" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: April 21, 1993 Harvest Date: Sept. 9, 1993

Fertilizers applied broadcast before seeding on April 14, 1993.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Weed Control: 4 oz of Banvel SGF, 8 oz 2,4-D LV6 on May 15.

Soil Tests: pH = 8.3, O.M. = 1.2%, P = 11 ppm, K = 417 ppm  
Zn = 0.5 ppm

Depth ft.	NO <sub>3</sub> -N lb/a	NH <sub>4</sub> -N lb/a	Cl lb/a	SO <sub>4</sub> -S lb/a
0-1	18	29.7	44.5	388
0-2	26	59.6	138.8	1075
0-3	34	105.8	266.9	1875
0-4	38	161.4	316.7	2675

TABLE 70. EFFECT OF N, P, K, AND Cl ON SPRING WHEAT. Ramberg location north of Inverness. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-Cl/a			
(4) 150-50-30-28	60.20	13.90	60.80
(6) 100-50-30-0	58.38	13.58	60.73
(3) 100-50-30-28	56.03	12.85	60.69
(7) 100-50-0-0	55.33	13.75	60.62
(5) 100-0-30-28	51.02	14.13	60.62
(2) 50-50-30-28	50.60	11.80	60.71
(1) 0-50-30-28	36.28	10.35	60.46
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	52.55	12.91	60.66
TOTAL OBSERVATIONS	28.00	28.00	28.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	7.00	7.00	7.00
REP. MEAN SQUARE	30.49	.12	.12
TREATMENT MEAN SQUARE	255.49	7.60	.05
ERROR MEAN SQUARE	6.58	.61	.06
ERROR DEGREES OF FREEDOM	18.00	18.00	18.00
F TEST FOR REPS.	4.63	.19	1.87
F TEST FOR TREATMENTS	38.82	12.46	.73
STANDARD ERROR	2.57	.78	.25
STANDARD ERROR OF THE MEAN	1.28	.39	.13
C.V. 1: (S/MEAN)*100	4.88	6.05	.41
C.V. 2: (S OF MEAN/MEAN)*100	2.44	3.02	.21
LSD (0.05)	3.81	1.16	NS

Grain yields based on 60 lb/bu.

Variety: Rambo

Growing Season ppt. = 14.93" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: May 2, 1993 Harvest Date: Sept. 27, 1993

Fertilizers applied broadcast before seeding on April 14, 1993.

Seventy seven lbs 11-53-0 applied with the seed on all plots.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and potassium nitrate.

Weed Control: 4 oz Banvel SGF, 8 oz 2,4-D LV6 on May 2.

Soil Tests: pH = 7.7, O.M. = 0.7%, P = 9 ppm, K = 295 ppm

Zn = 0.4 ppm

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	14	25.2	16.0	44
0-2	27	47.6	33.8	83
0-3	38	71.4	48.0	144
0-4	46	98.8	67.6	313
0-5	72	133.0	90.8	1958

Comments: Classical yield and protein response to N (see treats. 1-4). Also a increase in yield but a decrease in protein due to P (compare treats. 3 and 5).

TITLE: Effect of nitrogen applied at flowering on spring wheat.

YEAR: 1993

LOCATIONS: 1. Don Bradley Farm, northeast of Cut Bank;  
2. Moog Farms, north of Joplin;  
3. Ray Ramberg Farm, north of Inverness;  
4. Lyle McKeever Farm, northwest of Loma.

PERSONNEL: Grant Jackson, Larry Christiaens, Robert Kirby-Glacier County Agent, John Maatta-Liberty County Agent, Robert Brastrup-Hill County Agent, and Judy Wargo-Chouteau County Agent.

OBJECTIVES: To determine the grain protein response of spring wheat to N applied after flowering.

PROCEDURES: Five N fertilizer treatments, 0, 30, and 60 lbs N/a as urea and ammonium nitrate, were applied broadcast after flowering. Plot size was 10 x 20 feet with four replications. Location characteristics such as variety, fertilizer applied, etc. are shown in each table.

RESULTS: Data are tabulated in Tables 71 through 74. Results were probably affected by the wet and cool growing season. Grain protein was increased significantly at two of the four locations.

TABLE 71. EFFECT OF N APPLIED AT FLOWERING ON SPRING WHEAT.  
 Experiment located northeast of Cut Bank. Western  
 Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
1b N/a, N source			
60 N UREA	26.03	13.77	44.22
check	25.95	9.93	45.52
30 N UREA	23.68	12.00	45.20
60 N AMMONIUM NITRATE	23.03	13.15	45.36
30 N AMMONIUM NITRATE	19.10	12.23	43.21
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	23.56	12.22	44.70
TOTAL OBSERVATIONS	20.00	20.00	20.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	5.00	5.00	5.00
REP. MEAN SQUARE	71.61	.27	3.88
TREATMENT MEAN SQUARE	31.98	8.60	3.82
ERROR MEAN SQUARE	35.20	.28	1.82
ERROR DEGREES OF FREEDOM	12.00	12.00	12.00
F TEST FOR REPS.	2.03	.95	2.13
F TEST FOR TREATMENTS	.91	30.28	2.10
STANDARD ERROR	5.93	.53	1.35
STANDARD ERROR OF THE MEAN	2.97	.27	.67
C.V. 1: (S/MEAN)*100	25.19	4.36	3.02
C.V. 2: (S OF MEAN/MEAN)*100	12.59	2.18	1.51
LSD (0.05)	NS	.82	NS

Grain yields based on 60 lb/bu.

Variety: Amidon Harvest Date: October 12, 1993

Growing Season ppt. = 14.70" Depth of Moist Soil = > 3'

Previous crop: fallow

Fertilizers applied broadcast on August 4, 1993. Plants had just finished flowering.

**Comments:** Excellent protein response to N when applied after flowering, however, results are difficult to interpret due frost damage and low test weights.

TABLE 72. EFFECT OF N APPLIED AFTER FLOWERING ON SPRING WHEAT.  
 Experiment located north of Joplin. Western Triangle  
 Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD	GRAIN PROTEIN	TEST WT.
lb N/a, N source	bu/a	%	lb/bu
60 N AMMONIUM NITRATE	50.67	13.38	57.89
30 N AMMONIUM NITRATE	50.50	12.92	58.12
check	50.13	11.60	58.80
60 N UREA	49.15	13.98	57.37
30 N UREA	48.55	12.45	58.87
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	49.80	12.87	58.21
TOTAL OBSERVATIONS	20.00	20.00	20.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	5.00	5.00	5.00
REP. MEAN SQUARE	107.13	3.34	8.32
TREATMENT MEAN SQUARE	3.35	3.27	1.60
ERROR MEAN SQUARE	15.57	2.05	1.30
ERROR DEGREES OF FREEDOM	12.00	12.00	12.00
F TEST FOR REPS.	6.88	1.63	6.41
F TEST FOR TREATMENTS	.21	1.59	1.24
STANDARD ERROR	3.95	1.43	1.14
STANDARD ERROR OF THE MEAN	1.97	.72	.57
C.V. 1: (S/MEAN)*100	7.92	11.14	1.96
C.V. 2: (S OF MEAN/MEAN)*100	3.96	5.57	.98
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Rambo Harvest Date: Sept. 27, 1993

Growing Season ppt. = 9.45" Depth of Moist Soil = > 3'

Previous crop: chemical fallow

Fertilizer applied on August 4, 1993. Kernels had just started to form.

Comments: The protein data was too variable for the differences to be significant.

TABLE 73. EFFECT OF N APPLIED AT FLOWERING ON SPRING WHEAT.  
 Experiment located north of Inverness. Western Triangle  
 Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD	GRAIN PROTEIN	TEST WT.
lb N/a, N source	bu/a	%	lb/bu
check	39.83	10.38	60.51
60 N AMMONIUM NITRATE	38.90	13.50	60.85
60 N UREA	38.80	13.38	60.46
30 N UREA	38.38	12.33	60.69
30 N AMMONIUM NITRATE	38.05	13.12	60.67
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	38.79	12.54	60.64
TOTAL OBSERVATIONS	20.00	20.00	20.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	5.00	5.00	5.00
REP. MEAN SQUARE	40.59	1.04	.15
TREATMENT MEAN SQUARE	1.80	6.69	.10
ERROR MEAN SQUARE	24.09	1.03	.08
ERROR DEGREES OF FREEDOM	12.00	12.00	12.00
F TEST FOR REPS.	1.68	1.01	1.77
F TEST FOR TREATMENTS	.07	6.53	1.14
STANDARD ERROR	4.91	1.01	.29
STANDARD ERROR OF THE MEAN	2.45	.51	.14
C.V. 1: (S/MEAN)*100	12.65	8.07	.48
C.V. 2: (S OF MEAN/MEAN)*100	6.33	4.04	.24
LSD (0.05)	NS	1.56	NS

Grain yields based on 60 lb/bu.

Variety: Rambo Harvest Date: Sept. 27, 1993

Growing Season ppt. = 14.96" Depth of Moist Soil = > 3'

Previous crop: fallow

Fertilizers applied on July 27, 1993.

**Comments:** Grain protein levels were significantly increased by N with both fertilizer materials. The data was too variable for significant rate and material differences.

TABLE 74. EFFECT ON N APPLIED AT FLOWERING ON SPRING WHEAT.  
 Experiment located northwest of Loma. Western Triangle  
 Ag. Research Center, Conrad, MT 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N/a, N source check	35.15	13.88	57.15
60 N UREA	33.32	14.33	55.43
30 N UREA	32.48	14.40	57.18
60 N AMMONIUM NITRATE	31.40	13.90	56.12
30 N AMMONIUM NITRATE	31.20	14.27	57.41
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	32.71	14.16	56.66
TOTAL OBSERVATIONS	20.00	20.00	20.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	5.00	5.00	5.00
REP. MEAN SQUARE	8.44	.06	4.93
TREAT. MEAN SQUARE	10.38	.25	2.86
ERROR MEAN SQUARE	19.44	.22	2.06
ERROR DEGREES OF FREEDOM	12.00	12.00	12.00
F TEST FOR REPS.	.43	.26	2.39
F TEST FOR TREAT.	.53	1.11	1.39
STANDARD ERROR	4.41	.47	1.44
STANDARD ERROR OF THE MEAN	2.20	.24	.72
C.V. 1: (S/MEAN)*100	13.48	3.33	2.54
C.V. 2: (S OF MEAN/MEAN)*100	6.74	1.67	1.27
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Newana

Growing Season ppt. = 11.40" Depth of Moist Soil = > 3'

Previous crop: barley

Fertilizer applied: 7-16 Harvest Date: 8-26-93

Growth stage when fertilized: flowering

Comments: Protein data was non-significant.



TITLE: Effect phosphorus (P) fertilizers on spring wheat production.

YEAR: 1992

LOCATIONS:

1. Patricia Hellinger Farm, northeast of Ethridge;
2. Bob Inabnit Farm, east of Ledger;
3. Don Bradley Farm, northeast of Cut Bank;
4. Terry Alme Farm, east of Oilmont;
5. Rick Corey Farm, northeast of Choteau;
6. Western Triangle Ag. Research Center, north of Conrad;
7. Western Triangle Ag. Research Center, north of Conrad.

PERSONNEL: Grant Jackson, Greg Kushnak, Ron Thaut, and Larry Christiaens.

OBJECTIVES: To calibrate the Olsen P soil test for spring wheat in northcentral Montana.

PROCEDURES: Phosphorus rates of 0 to 60 lbs  $P_2O_5/a$  were applied with the seed at seven locations. Plot size was 5 x 20' with four replications at locations 1 and 2, and 4 x 10' with three replications at locations 3 through 7. Two of the sites were no-till in barley stubble and the remaining locations were on fallow. Other location information is included in each table.

RESULTS: Data are summarized in Tables 75 through 81. Comments on results of the individual locations are included with each table. Two of the seven had significant yield increases due P fertilizer. Grain protein was significantly reduced at one location. Locations 3 through 7 need more replication to show significant results.

TABLE 75. EFFECT OF PHOSPHORUS ON SPRING WHEAT. Experiment located east of Ethridge. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
50 lb P <sub>2</sub> O <sub>5</sub> /a	67.93	10.98	60.41
30	66.38	11.03	60.13
40	64.85	10.95	60.16
10	64.33	11.00	58.72
20	63.87	11.15	60.14
0	63.20	11.13	58.52
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	65.09	11.04	59.68
TOTAL OBSERVATIONS	24.00	24.00	24.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	184.22	.23	10.51
TREATMENT MEAN SQUARE	12.30	.03	2.76
ERROR MEAN SQUARE	3.84	.28	.32
ERROR DEGREES OF FREEDOM	15.00	15.00	15.00
F TEST FOR REPS.	47.93	.81	32.83
F TEST FOR TREATMENTS	3.20	.09	8.62
STANDARD ERROR	1.96	.53	.57
STANDARD ERROR OF THE MEAN	.98	.27	.28
C.V. 1: (S/MEAN)*100	3.01	4.82	.95
C.V. 2: (S OF MEAN/MEAN)*100	1.51	2.41	.47
LSD (0.05)	2.95	NS	.85

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 13.05" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: May 13, 1993 Harvest Date: Sept. 28, 1993

P fertilizer placed with the seed, N fertilizer (60 lb N/a) was applied in front of the openers while seeding.

Fertilizer sources: Urea, treble superphosphate.

Soil Tests: pH = 8.0, O.M. = 2.0%, P = 13 ppm, K = 455 ppm  
Zn = 0.4

Depth ft.	NO <sub>3</sub> -N	NH <sub>4</sub> -N	Cl	SO <sub>4</sub> -S
	-----lb/a-----			
0-1	12	27.9	19.6	193
0-2	23	60.4	33.8	532
0-3	33	87.0	48.0	1012
0-4	41	133.4	62.2	1812

**Comments:** Phosphorus significantly increased yield and test weight. Optimum P<sub>2</sub>O<sub>5</sub> rate appears to be 30. Grain protein was not affected by increasing P.

TABLE 76. EFFECT OF P AND S ON NO-TILL SPRING WHEAT. Experiment located east of Ledger. Western Triangle Ag. Research Center. Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	GRAIN PROTEIN %	TEST WT. lb/bu
lb N-P <sub>2</sub> O <sub>5</sub> -K-S/a			
(5) 100-60-30-0	51.63	10.15	60.20
(6) 100-30-30-10	49.53	10.15	60.30
(3) 100-30-30-0	49.18	10.27	60.16
(2) 100-15-30-0	47.60	9.98	60.14
(4) 100-45-30-0	46.63	10.18	59.88
(1) 100-0-30-0	43.85	11.13	60.30
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	48.07	10.31	60.16
TOTAL OBSERVATIONS	24.00	24.00	24.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	5.33	.92	.15
TREATMENT MEAN SQUARE	28.87	.68	.10
ERROR MEAN SQUARE	11.28	.15	.08
ERROR DEGREES OF FREEDOM	15.00	15.00	15.00
F TEST FOR REPS.	.47	6.15	1.82
F TEST FOR TREATMENT	2.56	4.54	1.15
STANDARD ERROR	3.36	.39	.29
STANDARD ERROR OF THE MEAN	1.68	.19	.15
C.V. 1: (S/MEAN)*100	6.99	3.75	.48
C.V. 2: (S OF MEAN/MEAN)*100	3.49	1.87	.24
LSD (0.05)	5.06	.58	.44

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 10.79" Depth of Moist Soil = > 3'

Previous crop: barley

Seeding Date: April 30, 1993 Harvest Date: Sept. 14, 1993

P fertilizer placed with the seed, all others broadcast in front of the openers while seeding.

Fertilizer sources: Urea, treble superphosphate, potassium chloride, and ammonium sulfate.

Soil Tests: pH = 8.1, O.M. = 1.6%, P = 18 ppm, K = 276 ppm

Zn = 0.5 ppm

Depth ft.	NO <sub>3</sub> -N lb/a	NH <sub>4</sub> -N lb/a	Cl lb/a	SO <sub>4</sub> -S lb/a
0-1	11	34.8	24.9	389
0-2	17	75.3	51.6	1111
0-3	43	116.1	94.3	1911
0-4	59	156.9	144.1	2711

**Comments:** The S treatment was added at the cooperators request; S did not increase yield or protein (compare treats 5 and 6). P increased yields about 5 bu/a but consistently decreased protein. Optimum P level appears to be about 30 lbs P<sub>2</sub>O<sub>5</sub>/a. Test weight was not affected by P.

TABLE 77. EFFECT OF PHOSPHORUS ON SPRING WHEAT. Experiment Located northeast of Cut Bank. Western Triangle Ag. Research Center. Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	TEST WT. lb/bu	GRAIN PROTEIN %
40 lb P <sub>2</sub> O <sub>5</sub> /a	54.81	52.28	10.00
30	51.02	52.94	9.42
0	49.79	55.97	9.71
50	46.18	54.23	9.08
10	44.47	54.25	9.24
20	43.31	53.38	8.80
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	48.26	53.84	9.38
TOTAL OBSERVATIONS	18.00	18.00	18.00
NO. OF REPLICATIONS	3.00	3.00	3.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	222.09	15.75	1.09
TREATMEANT MEAN SQUARE	57.62	5.00	.56
ERROR MEAN SQUARE	29.00	13.85	.26
ERROR DEGREES OF FREEDOM	10.00	10.00	10.00
F TEST FOR REPS.	7.66	1.14	4.20
F TEST FOR TREATMENT	1.99	.36	2.18
STANDARD ERROR	5.38	3.72	.51
STANDARD ERROR OF THE MEAN	3.11	2.15	.29
C.V. 1: (S/MEAN)*100	11.16	6.91	5.43
C.V. 2: (S OF MEAN/MEAN)*100	6.44	3.99	3.13
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. > 11"      Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: May 11, 1993      Harvest Date: October 12, 1993

P fertilizer placed with the seed, 67 lbs N/a broadcast at two leaf stage.

Fertilizer sources: treble superphosphate, ammonium nitrate.

Soil Tests: pH = 8.1, O.M. = 1.5%, P = 15 ppm, K = 303 ppm  
Zn = 0.2

Comments: No significant P response.

TABLE 78. EFFECT OF PHOSPHORUS ON SPRING WHEAT. Experiment located east of Oilmont. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	TEST WT. lb/bu	GRAIN PROTEIN %
lb P <sub>2</sub> O <sub>5</sub> /a			
50	69.66	61.90	12.01
30	67.29	62.39	12.83
20	60.98	61.87	10.85
40	60.79	61.87	11.32
0	59.72	60.93	12.62
10	56.16	61.97	10.30
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	62.43	61.82	11.65
TOTAL OBSERVATIONS	18.00	18.00	18.00
NO. OF REPLICATIONS	3.00	3.00	3.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	322.97	.34	6.34
TREATMENT MEAN SQUARE	76.34	.69	3.01
ERROR MEAN SQUARE	41.66	.11	1.82
ERROR DEGREES OF FREEDOM	10.00	10.00	10.00
F TEST FOR REPS.	7.75	3.11	3.49
F TEST FOR TREATMENTS	1.83	6.25	1.66
STANDARD ERROR	6.45	.33	1.35
STANDARD ERROR OF THE MEAN	3.73	.19	.78
C.V. 1: (S/MEAN)*100	10.34	.54	11.58
C.V. 2: (S OF MEAN/MEAN)*100	5.97	.31	6.68
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 8.5" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: April 26, 1993 Harvest Date: Sept. 9, 1993

P fertilizer placed with the seed.

Fertilizer sources: treble superphosphate.

Soil Tests: pH = 6.6, O.M. = 1.8%, P = 13 ppm, K = 488 ppm  
Zn = 1.4

**Comments:** Data is too variable to show a significant response to P.

TABLE 79. EFFECT OF PHOSPHORUS ON SPRING WHEAT. Experiment located northeast of Choteau. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	TEST WT. lb/bu	GRAIN PROTEIN %
1b P <sub>2</sub> O <sub>5</sub> /a			
30	60.64	57.64	15.87
0	60.27	57.85	15.97
20	59.90	57.24	15.13
50	59.72	57.59	15.51
40	57.61	57.15	16.04
10	56.27	57.71	15.38
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	59.07	57.53	15.65
TOTAL OBSERVATIONS	18.00	18.00	18.00
NO. OF REPLICATIONS	3.00	3.00	3.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	14.16	.13	.52
TREATMENT MEAN SQUARE	8.99	.23	.39
ERROR MEAN SQUARE	20.10	.15	.23
ERROR DEGREES OF FREEDOM	10.00	10.00	10.00
F TEST FOR REPS.	.70	.87	2.22
F TEST FOR TREATMENTS	.45	1.51	1.69
STANDARD ERROR	4.48	.39	.48
STANDARD ERROR OF THE MEAN	2.59	.23	.28
C.V. 1: (S/MEAN)*100	7.59	.68	3.09
C.V. 2: (S OF MEAN/MEAN)*100	4.38	.39	1.78
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 9.25" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: April 29, 1993 Harvest Date: Sept. 23, 1993

P fertilizer placed with the seed, 80 lbs N/a broadcast at two leaf stage.

Fertilizer sources: treble superphosphate, ammonium nitrate.

Soil Tests: pH = 8.1, O.M. = 1.4%, P = 26 ppm, K = 500 ppm  
Zn = 0.3

Comments: P soil test was probably too high for a P response.

TABLE 80. EFFECT OF PHOSPHORUS ON NO-TILL SPRING WHEAT.  
 Experiment located north of Conrad. Western  
 Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	TEST WT. lb/bu	GRAIN PROTEIN %
lb P <sub>2</sub> O <sub>5</sub> /a			
40	38.28	59.10	10.88
30	35.45	59.45	10.62
50	35.42	60.01	10.91
20	34.47	59.26	10.75
0	32.93	58.65	10.54
10	31.40	59.54	9.98
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	34.66	59.34	10.61
TOTAL OBSERVATIONS	18.00	18.00	18.00
NO. OF REPLICATIONS	3.00	3.00	3.00
NO. OF TREATMENTS	6.00	6.00	6.00
REP. MEAN SQUARE	34.45	3.25	7.32
TREATMENT MEAN SQUARE	16.78	.63	.35
ERROR MEAN SQUARE	9.76	.41	.73
ERROR DEGREES OF FREEDOM	10.00	10.00	10.00
F TEST FOR REPS.	3.53	8.01	9.99
F TEST FOR TREATMENTS	1.72	1.55	.48
STANDARD ERROR	3.12	.64	.86
STANDARD ERROR OF THE MEAN	1.80	.37	.49
C.V. 1: (S/MEAN)*100	9.01	1.07	8.07
C.V. 2: (S OF MEAN/MEAN)*100	5.20	.62	4.66
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 12.87" Depth of Moist Soil = > 3'

Previous crop: barley

Seeding Date: May 12, 1993 Harvest Date: Sept. 22, 1993

P fertilizer placed with the seed, 60 lbs N broadcast.

Fertilizer sources: treble superphosphate, ammonium nitrate.

Soil Tests: pH = 8.1, O.M. = 1.8%, P = 12 ppm, K = 263 ppm

Zn = 0.3

Comments: Data was too variable.

TABLE 81. EFFECT OF PHOSPHORUS ON SPRING WHEAT. Experiment located north of Conrad. Western Triangle Ag. Research Center, Conrad, MT. 1993.

TREATMENT	GRAIN YIELD bu/a	TEST WT. lb/bu	GRAIN PROTEIN %
lb P <sub>2</sub> O <sub>5</sub> /a			
25	73.52	59.10	13.01
0	72.14	59.31	12.77
50	72.04	59.16	12.90
***** STATISTICAL TABLE *****			
EXPERIMENTAL MEANS	72.57	59.19	12.89
TOTAL OBSERVATIONS	12.00	12.00	12.00
NO. OF REPLICATIONS	4.00	4.00	4.00
NO. OF TREATMENTS	3.00	3.00	3.00
REP. MEAN SQUARE	119.68	.40	.60
TREATMENT MEAN SQUARE	2.74	.05	.06
ERROR MEAN SQUARE	25.16	.13	1.02
ERROR DEGREES OF FREEDOM	6.00	6.00	6.00
F TEST FOR REPS.	4.76	3.17	.59
F TEST FOR TREATMENTS	.11	.38	.06
STANDARD ERROR	5.02	.36	1.01
STANDARD ERROR OF THE MEAN	2.51	.18	.50
C.V. 1: (S/MEAN)*100	6.91	.60	7.83
C.V. 2: (S OF MEAN/MEAN)*100	3.46	.30	3.91
LSD (0.05)	NS	NS	NS

Grain yields based on 60 lb/bu.

Variety: Amidon

Growing Season ppt. = 12.87" Depth of Moist Soil = > 3'

Previous crop: fallow

Seeding Date: May 3, 1993 Harvest Date: Sept. 23, 1993

P fertilizer placed with the seed, 30 lbs N/a broadcast.

Fertilizer sources: treble superphosphate, ammonium nitrate.

Soil Tests: pH = 6.8, O.M. = 2.1%, P = 37 ppm, K = 624 ppm

Zn = 0.5 ppm

**Comments:** P soil test level is probably too high for a significant yield increase.



TITLE: Nitrogen (N), phosphorus (P), and irrigation water effects on no-till spring barley.

YEAR: 1993

LOCATION: Western Triangle Ag. Research Center, 10 miles north of Conrad, Pondera Co.

PERSONNEL: Grant Jackson, Ron Thaut, and Larry Christiaens

OBJECTIVES: (1) To determine the response of spring barley to differential irrigation water applications; (2) to evaluate spring barley response to three soil series, and N and P fertilizers; and (3) to measure N effects on spring barley water use and nitrate-N movement below the root zone.

PROCEDURES: Line source irrigation experiments were conducted on spring barley with three irrigation treatments (W-1=less than optimum, W-2=optimum, and W-3=greater than optimum) plus dryland, three soil series: Scobey clay loam (cl), Kevin cl, and Hillon cl, four N rates (0, 50, 100, and 150 lbs N/a, and four P<sub>2</sub>O<sub>5</sub> rates (0, 30, 45, and 60 lbs P<sub>2</sub>O<sub>5</sub>/a). The N treatments had 45 lb P<sub>2</sub>O<sub>5</sub>/ as a constant P rate while the P treatments had a standard application of 100 lbs N/a. Soils (each 12' x 12' plot) in the experimental area were classified into Scobey, Kevin, or Hillon series. Fertilizer treatments were randomized in each soil series and water treatment. Soil water use and nitrate-N data were collected on the Kevin cl. Data analysis was accomplished by completely random, ANOVA and multiple regression. Plots were seeded with a custom built no-till drill, and fertilizer sources were urea and treble super phosphate. A total plant sample from one feet of row was collected at crop maturity for total N and P analysis. This is the third year this plot area has been maintained. The initial plots were barley in 1991, then seeded to canola in 1992 and barley in 1993. The canola plots were hailed out last year. Plots were seeded May 11, 1993 to 'Harrington' barley and harvested Sept. 9, 1993. Roundup was used for preplant weed control. Weeds were controlled during the growing season with Hoelon and Bronate. Rainfall was 11.78", and W-3 irrigation treatment received 1.5" of water and the W-2 treatment received 0.5" of water on July 1, 1993. Soil water and nitrate-N in the 0, 50, 100, and 150 lb N/a plots are still being analyzed and will be reported next year.

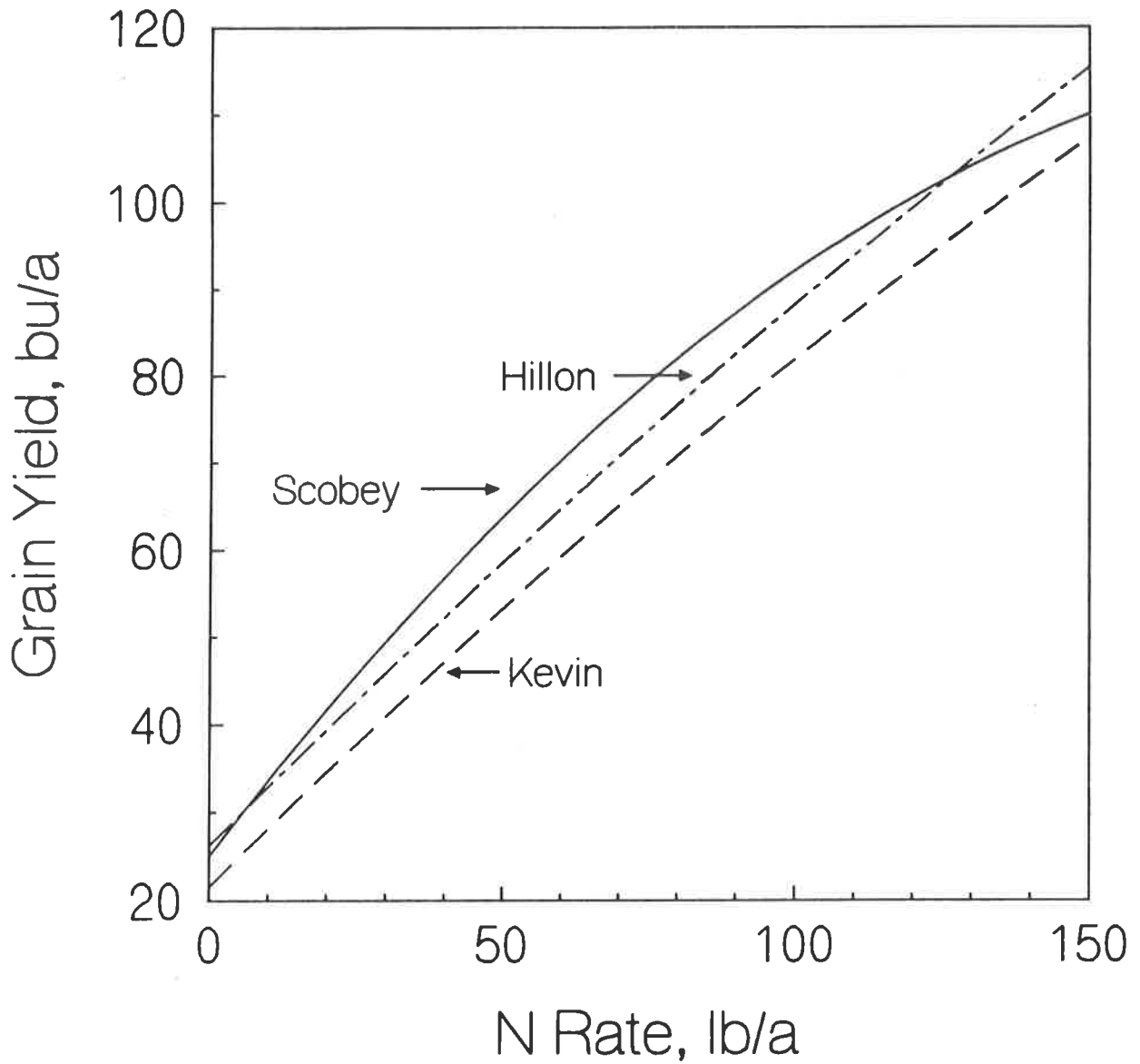
RESULTS AND DISCUSSION: Differences due to the irrigation were very small and non-significant, therefore, all irrigation treatments were combined, and the data analyzed by regression.

Grain yield equations for the three soil types and fertilizer N rate are shown and plotted on Figure 1. Yields were 15 to 20 bu/a higher than in 1991, and excellent relationships between applied N and grain yield were calculated. The plants had less disease stress in 1993 than 1991 (see 1992 report). The response to water and soil was about the same for both years ie. very little

difference between soil type and water regime. Excellent relationships between N rate and grain protein were calculated for Kevin and Hillon soils (see Figure 2.), but the same relationship was very weak for the Scobey soil. The effect of N on barley kernel characteristics of test weight, plump kernels, and thin kernels are shown in Figures 3 through 5. These curves show the positive effect as well as the negative effect that N can have on kernel size. Figure 6 shows the above ground plant N accumulation relationships of the three soils and applied fertilizer N. These curves account for about 66% of the fertilizer N applied. The remaining 34% of the fertilizer N could be in the soil, in the plant roots or lost via denitrification or leaching. The effect of fertilizer N and soil type on P uptake are shown in Figure 7. About 50% of the total plant P is in the grain, therefore, these equations are useful in estimating maintenance levels of fertilizer P.

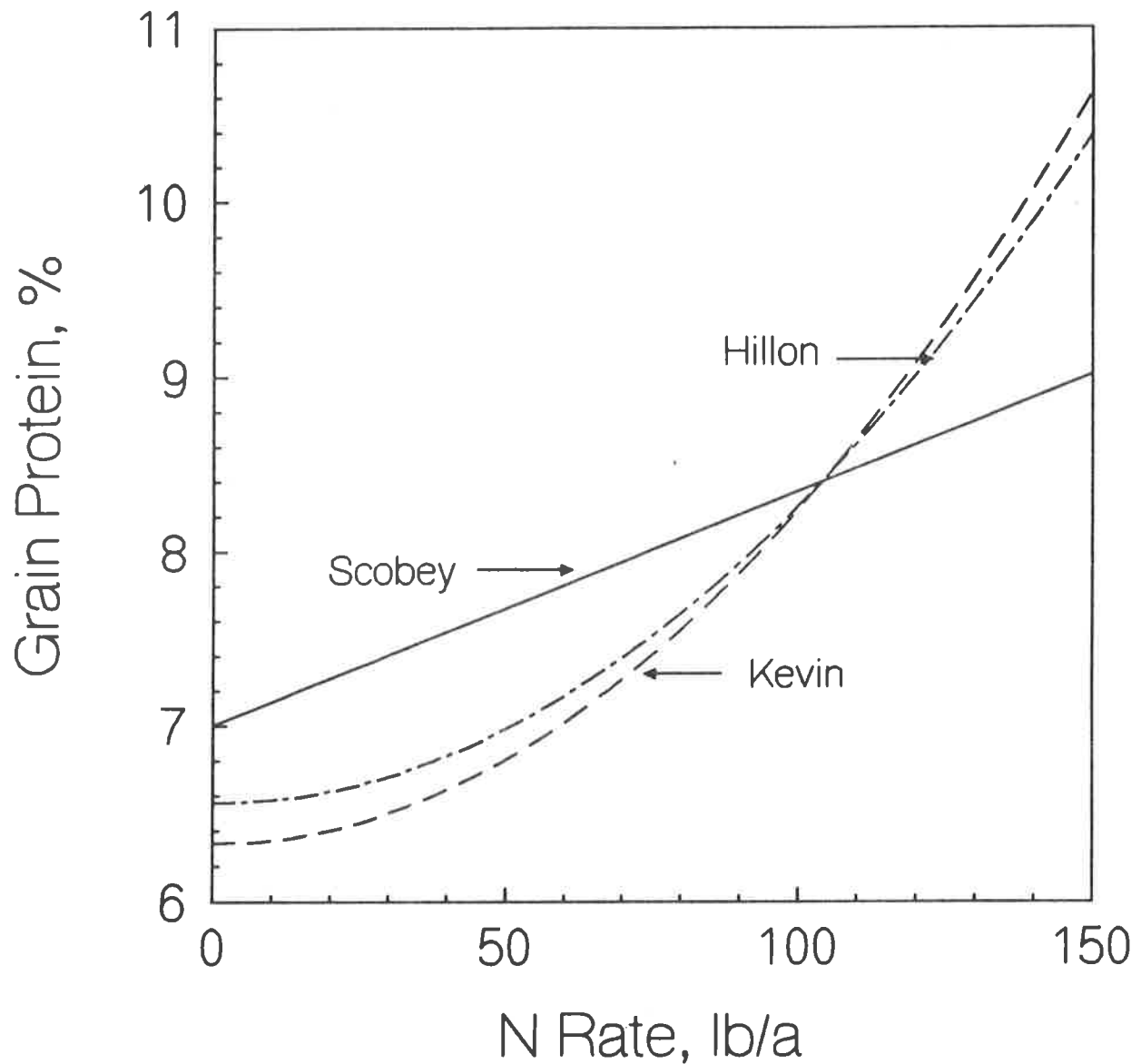
The effect of P fertilizer on grain protein (Figure 8) was the only significant P fertilizer relationship of the data set. The Kevin and Scobey soils had similar protein prediction curves probably reflecting the initial P soil test level of 20 ppm for both soils. The Hillon soil, as expected, had the lowest P soil test of 15 ppm. These equations show that increasing P fertilizer reduces grain protein which is probably the reason many malting barley growers use high rates of P fertilizer in spite of the P soil test level.

Fig. 1. Effect of N and Soil on Barley Grain Yield.



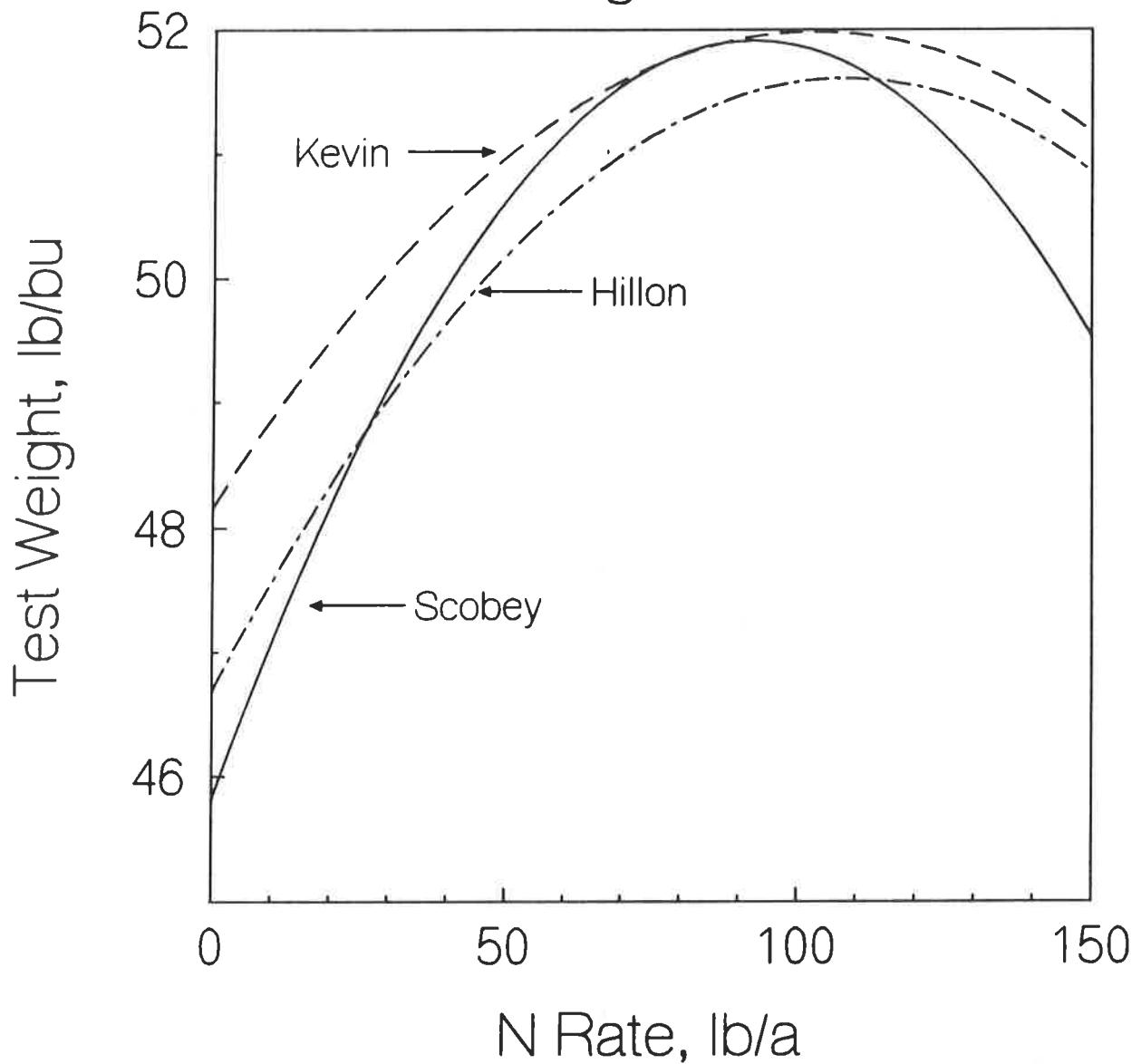
— Yield =  $25.01 + 0.879 N - 0.00208 N^2$ ,  $R^2 = 0.95$   
-- Yield =  $24.41 + 0.663 N - 0.000620 N^2$ ,  $R^2 = 0.935$   
-·- Yield =  $26.21 + 0.672 N - 0.000518 N^2$ ,  $R^2 = 0.941$

Fig. 2. Effect of N and Soil on Barley Grain Protein.



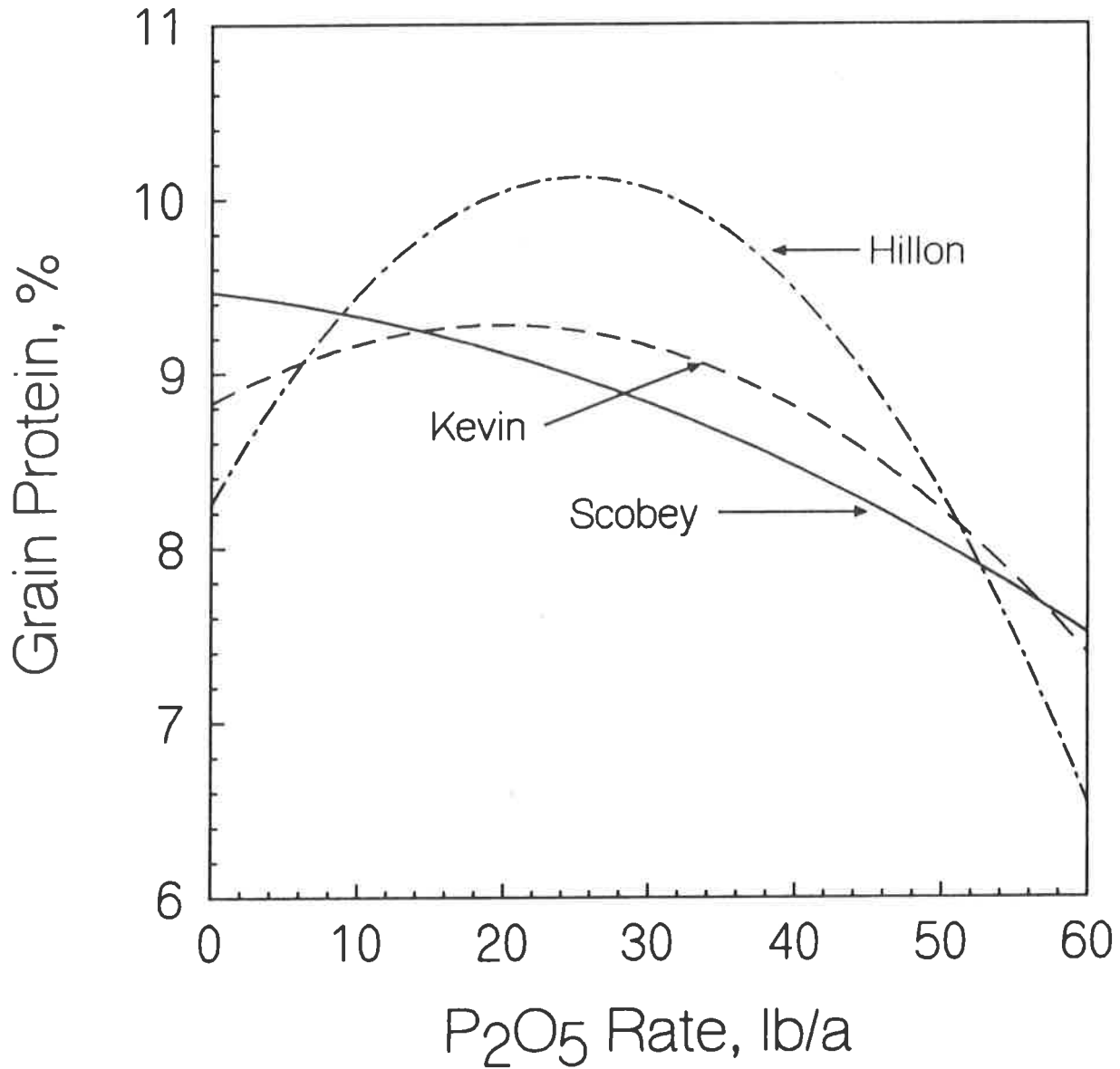
— Protein = 7.005 + 0.0134 N, R<sup>2</sup> = 0.214  
-- Protein = 6.331 + 0.000191 N<sup>2</sup>, R<sup>2</sup> = 0.783  
-·- Protein = 6.56 + 0.000170 N<sup>2</sup>, R<sup>2</sup> = 0.625

Fig. 3. Effect of N and Soil on Barley Test Weight.



- Test Weight =  $45.82 + 0.132 N - 0.000715 N^2$ ,  $R^2 = 0.770$
- - Test Weight =  $48.16 + 0.0744 N - 0.000362 N^2$ ,  $R^2 = 0.745$
- · - Test Weight =  $46.69 + 0.0911 N - 0.000422 N^2$ ,  $R^2 = 0.863$

Fig. 8. Effect of P and Soil on Barley Grain Protein.



— Protein = 9.465 - 0.0101 P<sub>2</sub>O<sub>5</sub> - 0.000375 P<sub>2</sub>O<sub>5</sub><sup>2</sup>, R<sup>2</sup> = 0.301

- - Protein = 8.824 + 0.0458 P<sub>2</sub>O<sub>5</sub> - 0.00116 P<sub>2</sub>O<sub>5</sub><sup>2</sup>, R<sup>2</sup> = 0.213

- · - Protein = 8.25 + 0.149 P<sub>2</sub>O<sub>5</sub> - 0.00296 P<sub>2</sub>O<sub>5</sub><sup>2</sup>, R<sup>2</sup> = 0.670