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The 6th

ANNUAL REPORT

of the

WESTERN TRIANGLE AGRICULTURAL RESEARCH CENTER

Montana Agricultural Experiment Station

1983

Submitted by

Dr. Gregory D. Kushnak, Superintendent & Crop Scientist

and

Dr. Alice Jones, Soil Scientist

MAES Research Report

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STATION ACTIVITIES AND DEVELOPMENTS

1983

Several new staff members were hired in 1983: Dr. Alice Jones, soil scientist and cropping systems agronomist; Walt Adams, ag. research specialist and assistant to Alice's program; Larry Christiaens, farm/ranch hand; and Linda Cardinal, secretary (half-time basis). This brings the permanent staff to a total of 6 individuals, including Greg Kushnak (Supt.) and Ron Thaut (ag. res. specialist). In addition, one temporary employee (Larry Jones) was hired for 2 months during the summer.

Electrical wiring and hookup were completed for the shop, drying room, pressure pump, and herbicide storage building. Special funds were made available for this work. A drain field was installed south of the building and driveway for the shop restroom. Construction of shelves, painting, and installation of phone service brought the shop/drying room complex to completion; and will greatly enhance work capabilities.

Other development activities included establishment of lawn and caragana shelter belts around the yard. The shelter belt planting was assisted by Jerry Johnson and Mark Stannard of the SCS.

The highlight of development was passage of HB-878 by the 1983 Montana Legislature, which appropriated $121,000 for the construction of an office/laboratory building at the Western Triangle Research Center. Funding will come from the bonding portion of the Long Range Building Program, which is backed by the tax on cigarettes. The building will approximate 2400 sq. feet in size; and will consist of 3 office cubicles, a secretary/reception area, library/conference room, soils lab, and grain lab. Location of the facility will be west of the large steel building, and north of the driveway entrance to the Research Center. Cal Hoiland of Great Falls is providing the architectural services, and construction is scheduled to begin April 1984.

A soil monolith (a 4 foot profile featuring the vertical succession of soil horizons) was prepared by Walt Adams. The profile sample was obtained at the Research Center, and represents the "Scobey" soil series common to much of Northern Montana's crop land.

A field day was held at the station on July 13, with 70 attendees. On July 19, the Research Center held a tour for 65 individuals from the Alberta Dryland Salinity Control Association. This tour was sponsored by Triangle Conservation District, and was assisted by staff from the Northern Research Center at Havre. Tours featuring off-station plots were held in Teton and Toole counties on July 12 and 13; each having approximately 30 individuals in attendance.

On July 25, disaster struck the Research Center in the form of hail. Nearly all experiments on the station were destroyed. Most off-station trials came through the season successfully.

Several items of capital equipment were purchased or obtained during 1983, and are listed below:

		Cost	Source
1.	Pickup, standard cab ½ Ton, 1983 Ford	$6697	Stn
2.	Pickup, supercab ½ Ton, 1983 Ford	7549	Stn
3.	ATV, Honda Odessy	1596	G&C
4.	Copier, EP 300RE Minolta	2349	Stn
5.	Lawn/Garden Tractor, mower & tiller, JD-214	3848	G&C
6.	Neutron Soil moisture/density probe	5760	special
7.	Drilling rig/soil sampler, 1957 Dodge 4x4	loaned from P&S	

Three Advisory Board members completed their terms at the end of 1983, and will need to be re-appointed or replaced. Following is a list of Board members:

Past Members

Richard Page, Bynum, Teton Co.	1977-1979
Dave Shane, Floweree, Cascade Co.	1977-1982
Vade Hamma, Brady, Choteau Co.	1977-1982

Re-appointed through 1983

Wilson Hodgskiss, Choteau, Teton Co.
Don Buffington, Ledger, Liberty Co.
Jerry Swenson, Cut Bank, Glacier Co.

Re-appointed through 1984

Karl Ratzburg, Ledger, Toole Co.
Paul Kronebusch, Conrad, Pondera Co.
Joe DeStaffany, Conrad, Pondera Co.
Dale Vermullan, Cut Bank, Glacier Co.
Jack Baringer, Conrad, CES Representative (ex-officio)

Re-appointed through 1985

Arnold Gettal, Power, Teton Co.
Gary Iverson, Sunburst, Toole Co.

New appointment through 1984

Bob Longcake, Shelby, Toole Co.
Randy Weaver, Cut Bank, Glacier Co.

New appointment through 1985

Ted Neuman, Vaughn, Cascade Co.
Bill Mclean, Brady, Choteau Co.

1983 RESEARCH ACTIVITIES - Part I: Crops & Varieties

by

Greg Kushnak

Acknowledgements: Research trials during 1983 were conducted in cooperation with the USDA-SEA and Plant and Soil Science Department at MSU; and the Cooperative Extension Service. County Agents were very helpful in arranging cooperators for test plot sites. Special thanks is extended to the landowners who provided land for the test plots; and to Ron Thaut, Research Technician, for his assistance in conducting research and compiling data for the contents of this report.

1983 Trials: A hail storm occurred at the Research Center on July 25, causing severe damage to all crops except annual legumes. Therefore, most data reported in the following sections are from off-station trials. Rainfall in the Western Triangle area during 1983 was 70% of average, or less; and essentially was regarded as a drought. Plot yields, however, were very good; due to fairly abundant soil moisture in the spring, early seeding, and cool growing season temperatures.

Precipitation Summary - Conrad Airport 1981-1983 (inches):

	1981	1982	1983
Jan	.33	.89	.07
Feb	.10	.57	.14
Mar	2.67	1.30	.49
Apr	0	.31	.30
May	3.82	3.21	2.72
June	.97	2.53	1.46
July	1.06	.73	1.59
Aug	1.58	.63	.46
Sept	.12	2.31	.95
Oct	.93	.10	.09
Nov	.07	.16	.44
Dec	.28	.11	.35 (To Dec. 20)
Total	11.93	12.85	9.06
Frost-free:	6/18-9/20	6/8-9/11	6/20-9/29

TITLE: Winter Wheat Investigations

YEAR: 1983

LOCATION: Western Triangle Research Center, Conrad, Montana

PERSONNEL: Gregory D. Kushnak, Ron Thaut, and Larry Christiaens - Research Center, Conrad; Dr. Allan Taylor, MSU, Bozeman.

Winter wheat variety trials were located near Dutton, and on Station near Conrad. The trials on Station were destroyed by hail, and consequently not harvested.

The Dutton location produced high yields, in spite of below average rain fall during 1983 (Table 1). Nearly all varieties were beginning to kernel-shatter at approximately 15% moisture (time of harvest), a condition which was probably aggravated by exceptionally large kernel sizes this year. The shatter-susceptible variety 'Cheyenne' had already lost a considerable amount of kernels by harvest time, and consequently yielded 14 bu/acre less than 'Hill' (Table 1). Hill (MT 77063) is a shatter-resistant Cheyenne line recently developed by the Montana Agricultural Experiment Station. It was developed by crossing shatter resistance into Cheyenne, and is essentially the same as Cheyenne in all respects except shatter resistance and chaff color (Hill is brown chaffed).

Several of the numbered, experimental lines showed superior performance in this trial. These lines have undergone only limited testing, and are not commercially available.

This winter wheat trial was conducted by the Western Triangle Research Center in cooperation with Dr. Allan Taylor, MSU Dept. of Plant & Soil Science.

Table 1 . Winter wheat variety trial east of Dutton, 1983. Montana Agricultural Experiment Station, Western Triangle Research Center, Conrad, MT.

Variety	Height (in)	Yield bu/a	Test wt. lb/bu	% Protein	Shatter
MT 8003 (Redwin Sel.)	34	72.6	61.9	11.3	slight
MT 7823	38	70.8	61.5	11.9	moderate
MT 7811	36	69.9	60.0	14.1	slight
Centurk	35	68.4	63.5	9.7	slight
MT 77063 (CNN Shat Res) ~~Hill~~ Cree	41	68.3	62.9	10.3	slight
Rocky	35	68.1	63.3	11.0	slight
MT 7877 Norwin	24	66.6	60.8	12.5	none
MT 7961	33	65.2	63.0	15.3	slight
Citation	25	65.2	62.3	14.1	none
Redwin	34	64.3	59.5	10.3	slight
Winalta	41	57.2	63.6	11.1	slight
Cheyenne	39	54.6	62.2	11.6	severe
Brawny	28	54.0	62.6	13.9	none
Norstar	44	53.5	61.7	10.2	slight
Froid	42	46.3	60.5	13.1	moderate
Experimental Means:	35.2	63.0	62.0	12.0	

Cooperator: Darryl Goodmanson, east of Dutton
Fertilizer: 82 lbs N/a as A.A. + 100 lbs/a 11-51-0
Date Seeded: 20 September, 1982
Date Harvested: 5 August, 1983

Rosebud 7431 not in test

Table 2 . Winter wheat varieties grown on No-till, recrop near Power, 1983.

Variety	Yield bu/a	Test Wt.	% Protein
Centurk	59.9	61.3	15.4
Cheyenne	53.0	60.0	16.9
Norstar	52.4	58.5	15.7
Citation	52.3	60.6	16.4
Redwin	51.0	59.3	17.3
Winalta	47.0	61.0	17.0

Cooperator: Dave Gettel, east of Power
Date Seeded: 21 September, 1982
Date Harvested: 5 August, 1983
Previous Crop: Spring wheat
Fertilizer: 75 lbs/A 11-55-0 + 230 lbs/A actual N + 14 lbs/a residual N.

Table 3 . Insecticide seed treatments on Redwin winter wheat.

Treatment	Yield bu/a	Test Wt.	% Protein
Check	60.0	58.0	14.7
Lindane	65.7	58.3	13.7
Adv-2	68.7	58.0	14.5
Adv-4	65.0	58.6	13.8
Adv-8	64.2	58.0	13.6

See footnotes to Table above.

TITLE: Spring Wheat Investigations

YEAR: 1983

LOCATION: Western Triangle Research Center, Conrad

PERSONNEL: Gregory D. Kushnak, Ron Thaut, and Larry Christiaens, Research Center, Conrad; Larry Alexander, USDA-SEA, MSU, Bozeman

Dryland spring wheat variety trials were located near Cut Bank, Sunburst, Choteau; and on station near Conrad. Irrigated trials were located north of Choteau, and on station. Both irrigated and dryland trials on station were destroyed by hail, and consequently not harvested.

Cut Bank was the driest of the locations, which was reflected by low test weights and high protein levels. Yields, however, remained quite high (Table 5). A two-year summary for this location is presented in Table 6, with Newana, Wampum, McKay, and Pondera among the top yielders. It should be noted that McKay was very late to mature, and may not perform consistently well in short growing season areas.

Yields from Sunburst and Choteau dryland were influenced by sawfly damage; and the solid stemmed, sawfly resistant varieties tended to rank higher at these locations (Tables 7 & 8). A 4-year summary for the Choteau location is presented in Table 7. Each of the four years at this location was under sawfly condtions.

Data from the Choteau irrigated trial are presented in Table 10. At this location, sawflys were absent; and, unlike the dryland location, yields of the solid stemmed varieties were surpassed by most other varieties.

Table 4. Dryland recrop spring wheat variety trial near Highwood, 1983. Mont. Agr. Expt. Sta.; Central & Western Triangle Research Center, Moccasin & Conrad, Mont.

Variety	Yield bu/a	Plant Height	Test Wt.	% Protein	% Vitreous
Marshall	57.7	29	60.0	12.1	-
McKay	57.2	31	57.0	11.5	-
Crosby durum	56.4	34	61.9	12.3	95
MT 7926 *	56.1	37	62.0	12.7	-
Wampum	54.1	-	58.0	12.1	-
MT 8043	54.0	31	58.3	13.1	-
Alex	53.8	37	61.0	13.3	-
Probrand-711	53.0	33	60.1	12.5	-
Probrand-715	52.0	33	58.0	13.2	
Lloyd durum	51.6	26	58.9	12.9	94
Lew *	51.2	37	61.6	13.4	-
Vic durum	50.9	34	61.5	13.1	97
MT 7836	50.4	32	59.5	12.8	-
MT 7819 *	50.3	32	58.6	12.3	-
Oslo	49.3	28	59.3	13.0	-
Newana	48.6	31	58.2	12.1	-
Pondera	47.8	31	60.0	14.4	-
Thatcher	46.9	37	59.9	13.8	-
Ward	46.2	35	61.3	12.7	86
Olaf	46.1	31	59.8	13.8	-
Marberg	45.9	31	58.8	12.9	-
Cando durum	45.8	26	60.1	14.5	95
Fortuna *	41.8	37	60.0	13.1	-
Experimental means:	50.7	32	59.7	12.9	
LSD (.05)					

Cooperator & location: Barry Wharram, north of Highwood
Harvest Date: 24 August 1983
Previous Crop: Spring wheat

* Sawfly resistant

Table 5 . Dryland spring wheat variety trial north of Cut Bank, 1983. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mont.

Variety	Yield bu/a	Plant Height	Test Wt.	% Protein
MT 7819 *	42.1	28	55.7	15.7
Newana	40.1	28	56.8	15.0
MT 8043	39.8	30	56.0	14.9
Probrand 711	38.9	28	56.9	14.7
Lloyd durum	38.3	24	56.8	16.2
MT 7836	38.1	26	55.7	16.4
McKay	38.0	29	56.7	16.2
Cando durum	37.8	21	60.2	15.6
Marshall	37.8	24	55.5	15.9
MT 7926 *	37.7	32	57.2	15.1
Probrand 715	37.3	28	55.9	15.1
Pondera	37.2	28	58.8	15.3
Oslo	36.0	27	55.3	14.6
Marberg	35.5	28	56.6	15.8
Wampum	34.6	26	53.4	14.9
Vic durum	34.5	31	59.5	16.2
Fortuna *	34.0	31	58.0	14.4
Olaf	34.0	28	56.3	16.0
Alex	33.7	33	58.0	17.5
Crosby durum	33.9	33	58.7	17.7
Lew *	33.5	31	58.8	16.3
Ward durum	31.4	32	56.9	17.8
Thatcher	31.1	32	57.0	17.4
Experimental Means:	36.3	28.6	57	15.8
LSD (.05)	5.0			
C.V.	8.4			

Cooperator & location: Don Bradley, north of Cut Bank.
Seed Date: 23 May 1983
Harvest Date: 31 August 1983
Previous Crop: Fallow

* Sawfly resistant

Table 6 . Two-year summary for Spring wheat varieties grown on dryland north of Cut Bank, 1982-83. Montana Agricultural Experiment Station, Western Triangle Research Center, Conrad, MT.

Variety	2-year average Yield bu/a	Test wt.	Plant height in.	% protein
MT7819 *	46.1	58.0	28	13.5
Newana	45.2	58.6	27	13.1
Wampum	44.8	56.6	28	12.8
McKay	44.2	58.1	28	13.4
Pondera	43.0	54.6	27	13.7
MT7836	42.1	57.9	27	14.2
Olaf	41.9	58.3	28	13.7
Marberg	41.6	58.3	26	13.6
Lew *	38.8	59.8	33	14.0
Fortuna *	38.8	58.8	33	13.0
Cando durum	38.6	59.6	22	13.5
Alex	37.4	59.1	34	14.8
Ward durum	35.3	58.6	32	15.0
Thatcher	34.3	58.5	33	14.8

Cooperator & location: Don Bradley, north of Cut Bank
Seed dates: 5 May 82; 23 May 83
Fertilizer: 11-51-0 (100 #)
Previous crop: Fallow
Harvest dates: 8 Sept 82; 31 Aug 83

*Sawfly resistant

Table 7 . Dryland spring wheat variety trial near Sunburst, 1983. Mont. Agr. Expt. Sta.; Western Triangle Recearch Center, Conrad, Mont.

Variety	Yield bu/a	Plant Height	Test Wt.	% Protein	% Vitreous	% Sawfly Damage
Lew *	31.1	24	60.0	13.0	-	0
MT 7819 *	29.3	19	58.9	13.1	-	0
Fortuna *	29.3	25	61.4	12.3	-	0
Cando durum	28.7	21	62.4	12.7	98	0
Lloyd durum	25.9	20	61.0	12.2	94	10
Probrand-711	25.6	21	60.2	12.4	-	10
MT 7926 *	24.4	25	61.7	11.6	-	5
Newana	24.4	22	61.2	12.3	-	50
Oslo	24.3	22	59.4	12.5	-	10
Ward durum	24.1	24	61.5	13.4	96	10
MT 8043	23.7	24	60.7	12.5	-	50
Pondera	23.5	23	61.0	13.2	-	10
Marberg	22.6	22	61.1	13.0	-	10
McKay	21.9	23	59.7	12.2	-	10
Probrand-715	21.1	19	58.2	12.7	-	20
MT 7836	20.3	25	60.7	13.0	-	30
Olaf	19.9	25	60.5	13.1	-	60
Crosby durum	19.9	25	61.2	13.2	95	15
Vic durum	18.7	26	61.6	13.3	98	15
Alex	17.8	20	60.2	14.3	-	75
Marshall	17.8	18	58.9	12.3	-	20
Thatcher	16.8	25	60.5	12.9	-	30
Wampum	15.7	23	54.9	12.9	-	30
Experimental Means:	22.9	22.6	60.3	12.8		20.4
LSD (.05)	3.4					
C.V.	9.1					

Cooperator & location: Dave Sandon, Sunburst
Seed Date: May 3, 1983
Harvest Date: 22 August 1983
Previous Crop: Fallow
Fertilizer: 11-51-0

* Sawfly resistant

Table 8 . Dryland spring wheat variety trial near Choteau, 1983. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mont.

Variety	Yield bu/a	Plant Height	Test Wt.	% Protein	% Vitreous	% Sawfly Damage
MT 7926 *	60.5	36	63.0	11.8	-	30
Lloyd durum	60.0	25	61.2	11.7	88	0
MT 7819 *	58.5	30	60.3	13.5	-	10
Cando durum	56.7	26	63.0	11.7	88	0
Probrand 715	54.6	28	60.1	12.3	-	40
MT 8043	54.0	31	60.3	11.5	-	60
Fortuna *	53.1	31	62.6	13.3	-	0
Oslo	51.5	25	60.7	12.5	-	10
Olaf	51.2	27	60.6	14.3	-	35
Marberg	50.6	27	60.8	12.6	-	25
Pondera	50.0	28	61.0	13.3	-	40
Lew *	49.9	33	62.3	13.9	-	10
Ward durum	49.6	33	61.9	14.0	92	10
McKay	49.0	28	60.9	13.3	-	40
Thatcher	49.0	35	61.0	13.6	-	15
Wampum	48.7	32	58.1	12.1	-	45
Crosby durum	48.1	32	61.5	13.4	88	25
Vic durum	47.6	35	62.0	12.9	92	25
Probrand 711	46.7	29	61.9	12.1	-	40
MT 7836	44.0	29	61.3	13.8	-	20
Newana	43.8	27	60.6	13.8	-	50
Alex	43.6	33	61.5	13.5	-	60
Marshall	43.3	28	60.0	12.3	-	50
Experimental Means:	50.6	29.8	61.1	12.9		27.8
LSD (.05)	6.1					
C.V.	7.4					

Cooperator & location: Bert Corey, NE of Choteau
Seed Date: 19 April 1983
Harvest Date: 23 August 1983
Previous Crop: Fallow

* Sawfly resistant

Table 9 . Four-year summary for spring wheat varieties grown on dryland near Choteau, 1979-83. Montana Agricultural Experiment Station, Western Triangle Research Center, Conrad, MT.

Variety	4-year average *			
	Yield bu/a	Test wt.	Plant height	% protein
McKay	51.6	61.5	30	12.3
Cando durum	50.4	62.4	26	12.4
Lew	50.0	61.5	34	13.9
Marberg	49.5	59.7	29	13.0
Pondera	48.6	61.0	29	13.3
Fortuna	47.0	60.8	34	14.1
Newana	46.9	59.7	28	13.4
Ward durum	45.5	60.8	35	14.1
Wampum	45.3	57.2	31	12.0
Prodax	45.2	56.8	28	13.1
Olaf	44.7	59.8	30	13.8
Thatcher	43.9	59.5	36	14.3

Cooperator & location: Bert Corey, N.E. of Choteau

* for years 1979, 80, 81, 83

Table 10. Irrigated spring wheat variety trial near Choteau, 1983. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mont.

Variety	Yield bu/a	Plant Height	% Protein
MT 8043	67.3	33	13.4
Lloyd durum	65.6	28	15.1
McKay	65.5	32	13.6
Marshall	65.1	30	13.9
Alex	64.6	39	14.9
Wampum	62.4	35	13.7
Newana	62.3	32	14.7
Probrand-711	62.1	32	14.3
Pondera	60.9	31	15.8
Cando durum	60.1	30	15.7
Ward durum	59.2	40	16.1
Probrand-715	59.1	35	14.6
MT 7819 Glenman	58.2	31	13.9
Olaf	58.1	33	16.3
Lew	56.1	35	14.6
Oslo	55.6	28	13.6
Crosby durum	55.3	33	17.0
Vic durum	55.2	35	17.1
MT 7836	54.3	31	15.1
Marberg	53.6	28	13.9
Fortuna	52.7	33	13.8
Thatcher	52.1	38	15.9
MT 7926	51.2	36	13.4
Experimental Means:	59	32.9	14.8
LSD (.05)	8.2		
C.V.	6.7		

Cooperator & Location: Lyle Weist, N.E. of Choteau
Seed Date: 2 May, 1983
Harvest Date: 31 August 1983
Previous Crop: Spr. wheat
Fertilizer: 110-50-30

Table 11. Wireworm seed treatments on Lew spring wheat grown on dryland fallow near Cut Bank, 1983. Western Triangle Agricultural Research Center, Conrad.

Treatment	Yield bu/a	Test wt.	Plant hgt.
Untreated check	39.1	59.0	33
Vivavax	36.2	59.3	33
Pseudomonas	30.9	58.6	33
Lindane	35.4	57.9	33
Amaze, low	33.4	58.6	33
Amaze, med	35.8	58.8	33
Amaze, high	33.2	57.5	33
Advantage 1 oz.	36.5	58.7	33
Advantage 4 oz.	34.6	59.5	33
Advantage 16 oz.	35.5	58.7	33

Cooperator & location: Don Bradley, North of Cut Bank
Seeded: May 23, 1983
Harvested: Sept. 1, 1983

<u>TITLE:</u> Barley Investigations

<u>YEAR:</u> 1983

<u>LOCATION:</u> Western Triangle Research Center, Conrad

<u>PERSONNEL:</u> Gregory D. Kushnak, Ron Thaut, & Larry Christiaens - Research Center, Conrad; Dr. E.A. Hockett, USDA - SEA, MSU, Bozeman

Dryland barley variety trials were located near Cut Bank, Sunburst, Choteau, and on Station near Conrad. Irrigated trials were located north of Choteau, and on Station. Both irrigated and dryland trials on station were destroyed by hail, and consequently not harvested.

Drought conditions at Cut Bank reduced test weight and percent plump considerably, but yields remained fairly high (Table 13). On a two-year average, Hector was the highest yielding 2-row feed barley; and Karla (a 6-row) the highest yielding malt type (Table 14). However, Karla is prone to low test weight on dryland; and may seldom meet minimum standards unless moisture is abundant. Clark, a 2-row malt barley, averaged 8 bu/a higher than Klages during the last two years at this location.

The nursery at Sunburst experienced slight hail damage near the time of anthesis, and the data may not be reliable (Table 15).

Yields at the dryland Choteau location were very high, possibly due to movement of subsurface moisture into the plot area from an adjacent hill (Table 16). The highest yielding feed types were Bridger-82, Hector, Summit, and Lewis. Clark and Karla were the top yielding malt types. A four-year summary for the dryland Choteau trials is presented in Table 17.

Data for the Choteau irrigated trial are presented in Table 18.

Table 12. Dryland recrop barley variety trial near Highwood, 1983. Mont. Agr. Expt. Sta.; Central & Western Triangle Research Center, Moccasin & Conrad, Mont.

Variety	Yield bu/a	Plant Height	Test Wt.	% Plump	% Thin	% Protein
MT 547123 (Lewis)	73.9	29	51.2	77	12	10.9
Bridger-82	72.3	26	50.8	74	11	10.6
Hector	69.7	27	50.4	68	17	10.8
Harrington	66.6	28	50.4	82	9	9.0
Summit	65.7	27	50.2	59	19	10.8
Clark	65.1	29	50.5	75	11	11.1
Piroline	62.5	29	52.3	80	9	10.4
Glenn	60.2	25	49.5	82	6	10.8
Karla	60.1	29	48.8	72	12	9.1
Robust	56.5	28	52.0	87	6	10.9
Morex	51.8	25	50.6	78	9	11.7
Klages	50.1	27	49.1	64	16	10.0
Experimental Means:	62.9	27.4	50.5	74.8	11.4	10.5
LSD (.05)						

Cooperator & location: Barry Wharram, North of Highwood
Harvest Date: 24 August 1983
Previous Crop: Spring Wheat

Table 13. Dryland barley variety trial north of Cut Bank, 1983. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mont.

Variety	Yield bu/a	Plant Height in.	Test Wt.	% Plump	% Thin	% Protein
Piroline	66.0	28	48.0	20	28	13.6
Morex	64.9	31	42.5	15	45	12.8
Hector	64.4	27	46.6	43	19	12.7
Summit	64.0	27	45.6	18	39	12.1
MT 547123 (Lewis)	63.4	27	46.6	51	15	12.2
Bridger-82	62.6	25	45.4	33	21	12.4
Glenn	60.8	33	43.8	22	31	12.7
Harrington	59.3	27	43.1	47	18	12.2
Robust	59.1	28	43.0	28	32	13.3
Karla	59.1	29	42.0	19	40	11.5
Clark	56.7	25	44.4	31	24	12.6
Klages	49.8	27	38.5	5	70	14.5
Experimental Means:	60.8	27.8	44.1	27.6	31.8	12.7
LSD (.05)						

Cooperator & location: Don Bradley, north of Cut Bank.
Seed Date: 23 May 1983
Harvest Date: 22 August 1983
Previous Crop: Fallow

Table 14. Two-year summary for Barley varieties grown on dryland north of Cut Bank, 1982-83. Montana Agricultural Experiment Station, Western Triangle Research Center, Conrad, MT.

Variety	2-year average					
	Yield bu/a	Test wt.	Plant height in.	% plump	% thin	% protein
Hector	67.1	48.7	28	65	12	12.0
Karla	65.5	45.8	29	47	24	10.9
Piroline	65.3	50.9	29	55	16	12.2
Harrington	64.1	46.9	27	69	11	11.5
Summit	64.0	49.6	27	54	21	10.8
Morex	62.5	46.4	30	50	25	12.5
Clark	61.5	47.5	27	60	14	12.1
Glenn	60.8	46.4	30	51	19	12.1
Klages	53.1	43.7	29	42	39	12.7

Cooperator & location: Don Bradley, North of Cut Bank
Seed dates: 5 May 82; 23 May 83
Fertilizer: 11-51-0 (100 #)
Previous crop: Fallow
Harvest dates: 8 Sept 82; 22 Aug 83

Table 15. Barley variety trial on dryland near Sunburst, 1983. Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad.

Variety	Yield bu/a	Plant Height In.	Test Wt.	% Plump	% Thin	% Protein
Bridger-82	47.0	20	48.9	74	9	10.0
Harrington	45.5	20	48.9	62	11	10.5
Summit	45.3	21	49.7	61	15	9.5
Karla	43.7	23	47.9	75	9	8.6
Klages	40.2	22	46.5	49	22	10.6
Clark	38.4	20	48.5	67	15	9.5
Piroline	38.2	22	51.2	60	19	12.3
Hector	35.7	22	49.1	69	15	10.1
MT 547123 (Lewis)	34.7	20	49.5	71	15	8.7
Glenn	33.6	23	43.9	66	12	10.3
Robust	30.4	22	47.8	74	8	8.6
Morex	30.3	24	46.6	71	9	9.4
Experimental Means	38.6	21.6	48.2	66.6	13.2	9.8
LSD (.05)						

Cooperator & location: Dave Sandon, Sunburst
Seed Date: 3 May 1983
Harvest Date: 8 August 1983
Previous Crop: Fallow
Fertilizer: 11-51-0

Table 16. Dryland barley variety trial near Choteau, 1983.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mont.

Variety	Yield bu/a	Plant Height In.	Test Wt.	% Plump	% Thin	% Protein
Bridger-82	103.1	28	52.1	91	1	9.7
Hector	102.8	30	53.1	92	1	10.8
Clark	101.0	29	52.5	95	1	10.4
Summit	99.1	30	53.1	83	3	10.0
MT 547123 (Lewis)	98.0	29	53.6	95	1	8.8
Karla	96.5	31	48.7	87	3	9.1
Harrington	96.0	29	52.2	95	1	10.8
Klages	94.3	28	50.6	85	3	9.9
Piroline	93.5	30	54.6	92	2	12.1
Glenn	92.6	34	49.5	91	2	10.3
Morex	91.4	34	51.1	87	3	10.8
Robust	86.1	30	52.3	92	2	9.1
Experimental Means:	96.2	30.2	51.9	90.4	1.9	10.2

Cooperator & location: Bert Corey, NE of Choteau
Seed Date: 19 April 1983
Harvest Date: 8 August 1983
Previous Crop: Fallow

Table 17. Four-year summary for Barley varieties grown on dryland near Choteau, 1979-83. Montana Agricultural Experiment Station, Western Triangle Research Center, Conrad, MT.

	4-year average *					
Variety	Yield bu/a	Test wt.	Plant height	% plump	% thin	% protein
Hector	85.7	51.5	31	91	3	11.4
Summit	83.7	51.4	29	83	5	11.1
Clark	81.1	51.4	29	92	3	10.9
Piroline	80.9	52.5	30	90	3	11.9
Klages	79.2	49.8	30	84	5	11.7
Morex	73.7	49.5	32	84	3	11.3

Cooperator & location: Bert Corey, N.E. of Choteau

* for years 1979, 80, 81, 83

Table 18. Irrigated barley variety trial near Choteau, 1983. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mont.

Variety	Plant Height	Yield bu/a	% Plump	% Thin	% Protein
Klages	33	98.6	86	4	12.2
Summit	29	92.5	84	4	13.5
Bridger-82	27	90.3	85	3	12.9
Purcell	29	89.9	87	4	13.9
Karla	33	87.1	76	8	10.1
Harrington	27	86.4	94	3	11.2
Morex	33	86.2	88	4	13.3
MT 547123 (Lewis)	26	84.9	93	2	12.3
Robust	33	83.3	84	3	13.2
Clark	29	82.8	88	5	13.8
Piston	31	82.7	88	3	13.8
Menuet	27	81.4	92	2	12.7
Hector	28	80.7	91	3	12.3
Piroline	31	79.8	91	3	12.9
Ingrid	31	77.8	92	2	13.6
Glenn	29	75.3	85	4	12.6
Experimental Means:	29.7	85.0	87.7	3.6	12.8
LSD (.05)					

Cooperator & location: Lyle Weist, N.E. of Choteau
Seed Date: 2 May, 1983
Harvest Date: 31 August 1983
Previous Crop: Spring wheat
Fertilizer: 110-50-30

TITLE: Oilseed and pulse crop investigations

YEAR: 1983

LOCATION: Western Triangle Research Center, Conrad; and off-station locations.

PERSONNEL: Gregory D. Kushnak, Ron Thaut, and Larry Christiaens

Oilseed variety trials were grown on fallow near Sunburst and Dutton during 1983; and included safflower, sunflower, and rapeseed (canola). Sunflower and rapeseed were completely destroyed by hail and grasshoppers at Sunburst; with safflower sustaining approximately 60% loss. The safflower was harvested for oil testing purposes.

All three crops produced excellent yields at Dutton (Table 19). The top yielding safflower entries included S-541, S-208, Sidwill, and Oker (80B2793-2). Although Oker bloomed late at this location, its filling and ripening period were more rapid than most other entries. Oker combines early maturity with high oil content; and is a new release from the Montana Agricultural Experiment Station Safflower breeding program at Sidney. It is intended for situations where early maturity is desired; such as short growing season areas, or late seeding. Under longer growing seasons, it is not expected to compete with Sidwill, Hartman, or Rehbein. Oker will be made available to Foundation seed growers in 1984.

Westar was the highest yielding rapeseed variety. Both Westar and Regent yielded higher when P_2O_5 (as MAP) was not placed in contact with the seed. Other research has indicated that rapeseed is susceptible to seed injury and stand reduction when greater than 25 lbs/acre of P_2O_5 are banded with the seed.

Pulse crop trials were grown on fallow at Sunburst, and on barley stubble at Conrad. Each location received below normal rainfall during 1983. Hail storms occurred at both locations during July, but only the lentils appeared to suffer any shatter loss. Fababeans suffered seed set reductions due to blister beetles at Conrad; and were completely destroyed by grasshoppers at Sunburst.

Garbanzo bean was the highest producing crop at Sunburst (Table 21). Of the three types of peas grown, 'Melrose' Austrian winter was the highest yielder.

At Conrad, Garfield pea was the highest producing crop; followed by Garbanzo bean (Table 22). Yields of all crops were below average in 1983 due to the combination of dry growing conditions, hail, and insects (fababean). Presented in Table 23 is a 2-year summary for these crops, with 1982 showing above average yields for all but garbanzo bean. The low garbanzo bean yield in 1982 was due to lack of fungicide seed treatment and subsequent poor germination. This was corrected in 1983, and garbanzo beans appear to have potential for dryland production in the Triangle Area. However, it is unknown whether garbanzo beans produced under these conditions would have sufficient quality (seed size) to meet "salad-bar" market standards; and therefore may be limited to feed status.

The stubble of the 1982 pulse crop trial was tilled under, and seeded to barley in 1983. Drastic visual responses in growth were noted for the barley grown on pulse crop stubble vs. barley grown on barley stubble. Loss of the barley to hail precluded any yield determinations, but the visual response indicated that the pulse crops were contributing a considerable amount of nitrogen to the soil.

Table 19. Oilseed crops grown on dryland east of Dutton, 1983. Western Triangle Research Center, Montana Agr. Expt. Station, Conrad, MT

Crop/Bariety	Yield lbs/acre	Test weight	% Oil 1/	Plant height (inches)	Bloom date
Safflower					
S-541	2200	39.2	42.1	30	Aug 8
S-208	1969	41.3	41.2	30	Aug 8
Sidwill	1952	42.5	34.1	31	Aug 6
(80B2793-2)Oker *	1792	39.9	44.2	28	Aug 8
80B2793-1	1791	40.0	44.4	30	Aug 4
80B2793-5	1741	39.7	44.2	28	Aug 6
Hartman	1690	39.3	37.2	31	Aug 7
Rehbein	1674	42.5	34.1	30	Aug 5
80B2795-5	1647	39.2	43.3	26	Aut 6
34 C, Y-0	1454	44.0	33.8	25	Aug 2
34 C, 0-0	1110	43.9	34.2	24	Aug 2
34 A, YO-0	965	43.9	34.5	24	Aug 1
Sunflower					
DO-705 (oil)	1677	25.9		57	
DO-704XL (oil)	1505	25.1		58	
D-131 (confection)	1430	22.5		63	
Rapeseed					
Westar (-)	1206	51.6		29	
Westar (+)	1179	51.1		33	
Activ	990	52.6		45	
Hanna	966	51.9		37	
Regent (-)	936	50.4		37	
Regent (+)	708	49.9		32	
Olga	912	51.9		44	

continued

Table 19. (continued). Oilseed crop varieties.

Cooperator & location: Frank Loch, Dutton; Teton Co. T24N, R2E, Sec 12
Fertilizer: 80-51-0
Westar & Regent (-): 11-51-0 Brdct on surface (100#)
Westar & Regent (+): 11-51-0 applied with seed (100#)
Seed date: April 19, on fallow
Seed rates: Safflower 20 lbs/a; Sunflower 18,000 plts/a; Rapeseed 8 lbs/a
Row space: Sunflower 24"; other crops 12"
Harvest dates: Rapeseed Aug 8; Sunflower Sept 15; Safflower Oct 6

* New MAES release for areas where early maturity is desired.
1/oil content reported on a dry weight basis

Table 20. Safflower variety trial grown on dryland east of Sunburst, 1983. Western Triangle Research Center, Montana Agricultural Research Center, Conrad, MT

Variety	Yield lbs/a	Test wt.	% oil 1/	Plant hgt. in.
Cal West A-24	600	39.9	36.5	21
34C, Y-0	511	44.4	31.2	20
34C, 0-0	517	46.1	32.5	21
80B2793-1	474	35.5	41.3	22
80B2793-2 (Oker)	473	39.1	41.9	21
Hartman	472	40.4	29.9	18
Sidwill	457	40.9	30.9	22
80B2793-5	450	42.5	40.6	20
Rehbein	442	45.4	31.5	18
34A, Y0-00	420	42.3	32.2	20
80B2795-5	417	39.5	41.8	22
S-208	417	38.0	36.1	18
S-541	354	34.3	38.6	18
Means:	450	40.7	35.8	20

Cooperator & location: Gary Iverson, east of Sunburst
Fertilizer: 11-51-0, on fallow
Seed Date: May 3
Harvest Date: Oct 6
Crop damaged by hail
1/ dry wt. basis

Table 21. Pulse crop trial grown on dryland east of Sunburst, 1983

Crop	Yield lbs/a
Austrian Winter Pea - 'Melrose'	1014
'Trapper' Pea	714
'Garfield' Pea	666
Lentil - 'Chilean'	624
Garbanzo bean 'UC-5'	1260
Fababean	Lost to grasshoppers

Footnotes same as for Table 20.
Harvest dates: Peas & lentils Aug 8; Garbanzo Aug 22.

Table 22. Comparison of several annual legumes grown on dryland recrop, 1983. Western Triangle Research Center, Montana Agricultural Experiment Station, Conrad, MT

Crop/variety	Grain yield lbs/a	Straw yield lbs/a	Bloom date	Swathing date
Fababean Ackerperle	637	739	June 25	Aug 10
Garbanzo Bean UC-5	1002	621	June 30	Aug 25
Lentil Chilean	780	857	June 27	Aug 2
Grain Pea Garfield	1152	964	June 27	Aug 2
Aust. W. Pea (Hay) Melrose	---	2176 *	July 4	July 12

Location: Station
Seed Date: Apr 22; soil temp at 2.5" = 61 F
Previous crop: Barley; stubble burned
Fertilizer: 11-51-0 with seed
Seed inoculated with rhizobia
Herbicide: Hoelon

* Hay yield

Table 23 . Two-year summary for annual legumes grown on dryland recrop, 1982-83. Western Triangle Research Center, Montana Agricultural Experiment Station, Conrad, MT.

	Grain, yield, lbs/a			Straw yield, lbs/a		
Crop/Variety	1982	1983	average	1982	1983	average
Fababean Ackerperle	1632	637	1135	1911	739	1325
Garbanzo bean UC-5	743	1002	873	897	621	759
Lentil Chilean	1692	780	1236	1869	857	1363
Grain Pea Garfield	2323	1152	1738	2097	964	1531
Aust. W. Pea Melrose	---	---	---	2282 *	2176 *	2229 *

Location: Station
Previous crop, both years: Barley
Fertilizer: 100# 11-51-0

* hay yield

TITLE: Forage Crop Investigations

YEAR: 1983

LOCATION: Western Triangle Research Center, Conrad

PERSONNEL: Gregory D. Kushnak, Ron Thaut, and Larry Christiaens

Several alfalfa varieties with moderate resistance to verticillium wilt resistance were established near Fairfield, during the spring of 1983, on a field contaminated with the pathogen. Observations for disease resistance, stand logevity, and yield will be initiated in 1984.

Data from the irrigated alfalfa trial near Bynum (established 1980) was collected from the first cutting only during 1983 (Table 24). Regrowth after the first cutting was minimal due to shortage of irrigation water and lack of rainfall. The 3-year average yields presented in Table 24 do not show the full potential yield of this location, since two of the 3 years lost one cutting to unusual circumstances. Under the conditions of this trial, WL 220, Vernal, and Ladak-65 produced the highest 3-year average yields. These varieties were consistent, in that they were also among the top yielders in each of the 3 years.

1983 data from the range renovation (chiseling) plot at Wally Bradley's is presented in Table 25. Drought conditions prevailed at this location during 1983, and yields are below average. The renovation treatments, however, continued to show beneficial responses in yield and species composition. This trial was established in 1975, and data from previous years are summarized in the 1982 Western Triangle Research Center annual report.

Table 24. Alfalfa variety trial grown under irrigation near Bynum, 1981-1983. Western Triangle Agricultural Research Center, Montana Agricultural Experiment Station, Conrad, MT

Variety	Tons/acre, dry wt. 1981 2-cuttings	1982 1 cutting 1/	1983 1 cutting 2/	3-year average
WL 220	2.42	1.15	1.67	1.75
Vernal	2.52	1.19	1.49	1.73
Ladak-65	2.50	0.92	1.62	1.68
NAPB 89-1	2.16	0.87	1.49	1.51
Perry	2.30	0.72	1.47	1.50
C11-25	2.14	0.83	1.44	1.47
Raider	2.33	0.72	1.32	1.46
Vancor	2.29	0.75	1.31	1.45
Thor	2.25	0.76	1.32	1.44
Spreador II	1.95	0.70	1.67	1.44
Baker	2.05	0.65	1.60	1.43
Marathon	2.17	0.76	1.30	1.41
Classic	2.26	0.67	1.30	1.41
Cascade	2.11	0.66	1.41	1.39
Anchor	2.12	0.63	1.38	1.38
Ranger	2.03	0.74	1.25	1.34
Experimental Means:	2.23	0.80	1.44	1.49

Cooperator & Location: Bill Jones, Bynum, MT
Date Seeded: 5 May 1980, on fallow
Fertilizer: 0-45-0 with seed 1980; 0-100-0 injected spring 1981
Irrigation: sprinkler
1981 cutting dates: July 8 & August 28

1/ 1982: 1st cutting lost to hail; 2nd cut August 26.

2/ 1983: 1st cutting July 7; 2nd cut lost to drought and lack of irrigation water.

Water use for the legumes ranged from 1.6 to 2.2 inches from June 14-July 8 (Fig. 3). Average water use among legumes was 1.86 inches while the water evaporated from the fallow plot was 1.5 inches. Rooting depths ranged from 2.5 to 4.5 ft. Garbanzo beans were the most shallow rooted and grain peas were the most deeply rooted legume. Faba beans, australian peas and lentils had similar rooting depths.

The loss of 1.5 inches of water on fallow to a depth of 2.5 ft. is 80 percent of the average water use by the crops. This nonuseful loss of water on fallow makes this practice a questionable one for water conservation purposes.

Figure 1. Barley water use and rooting depth. June 16-July 11, 1983.

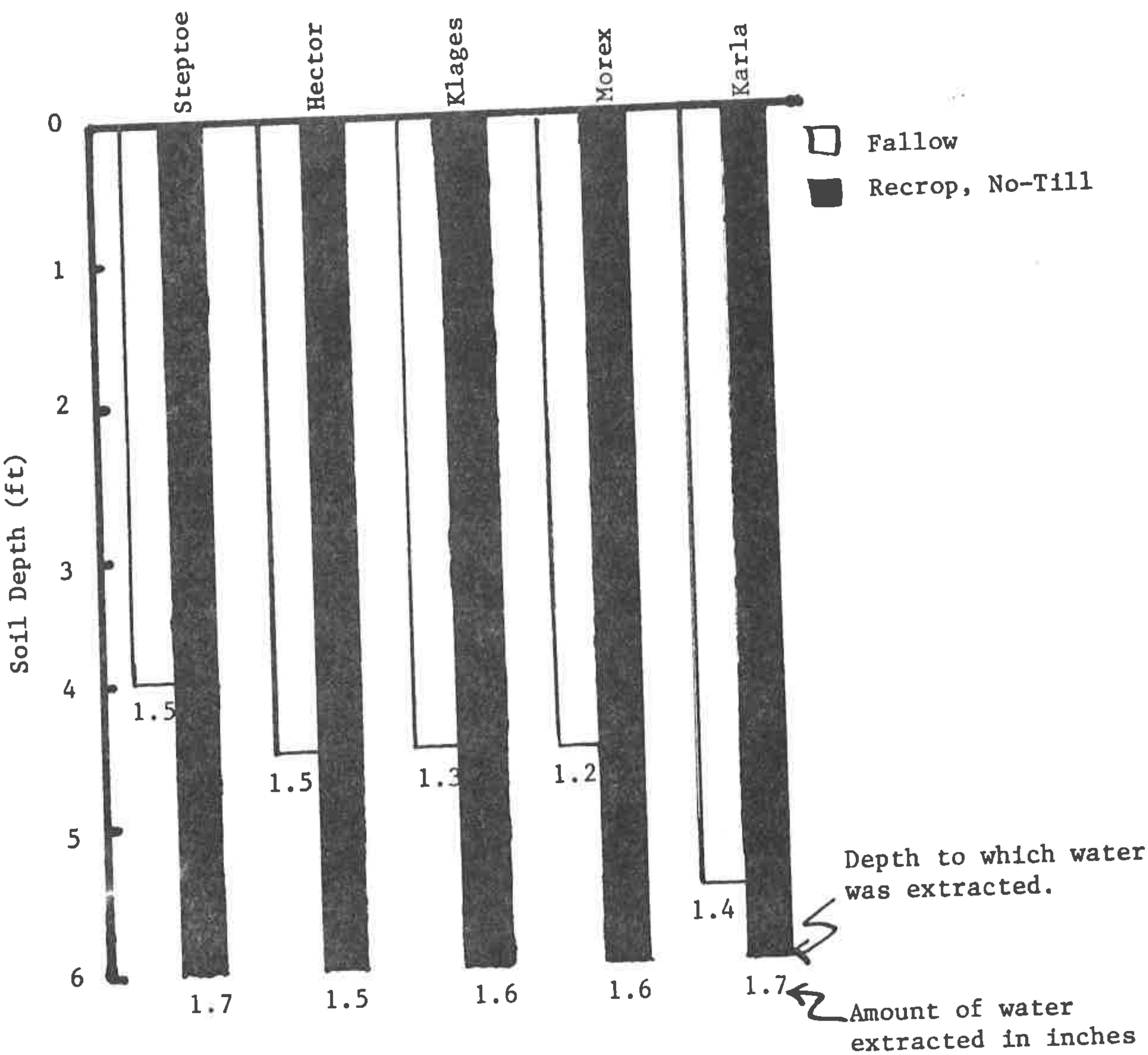


Figure 2. Spring wheat water use and rooting depth. June 16-July 11, 1983.

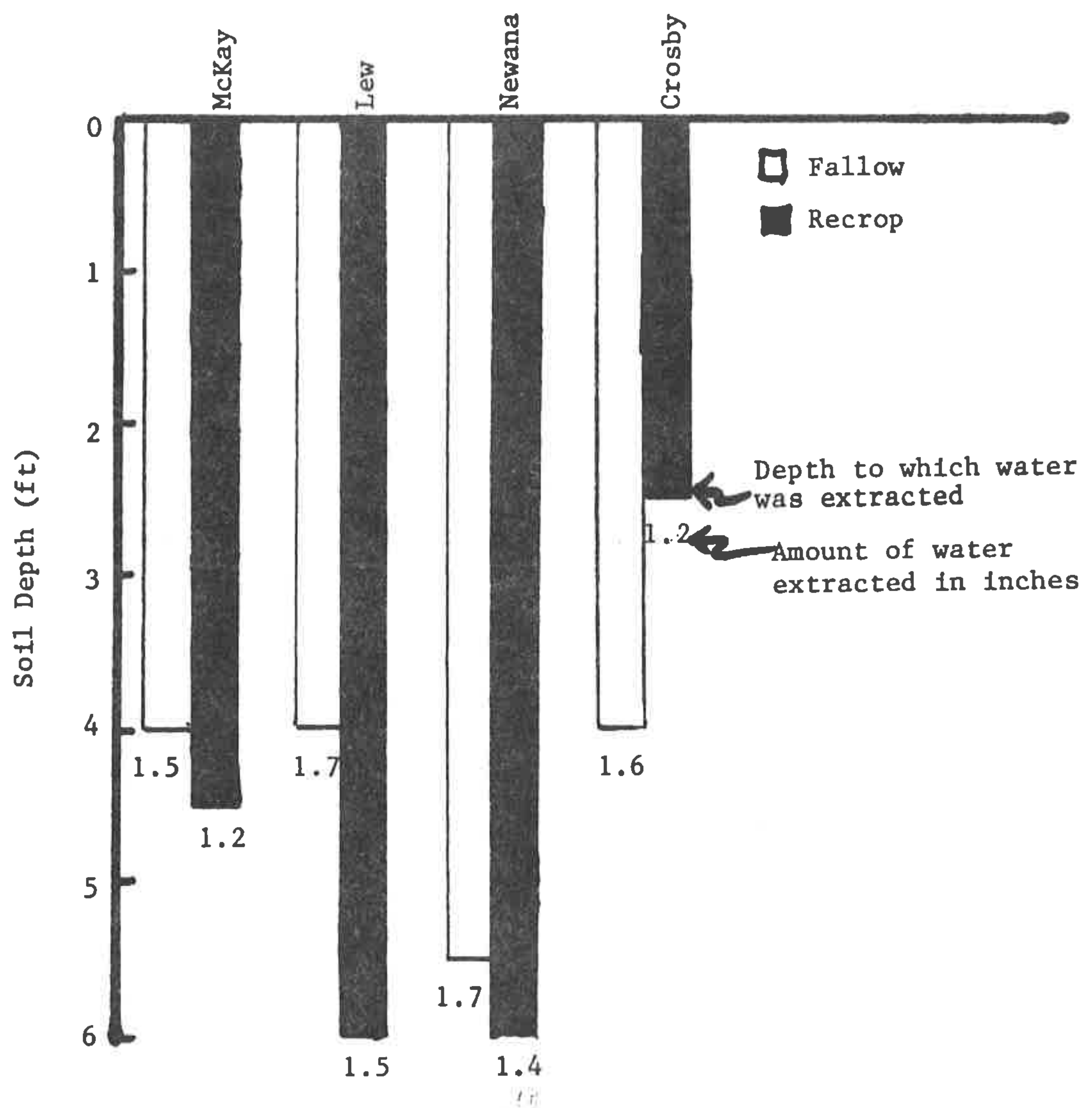
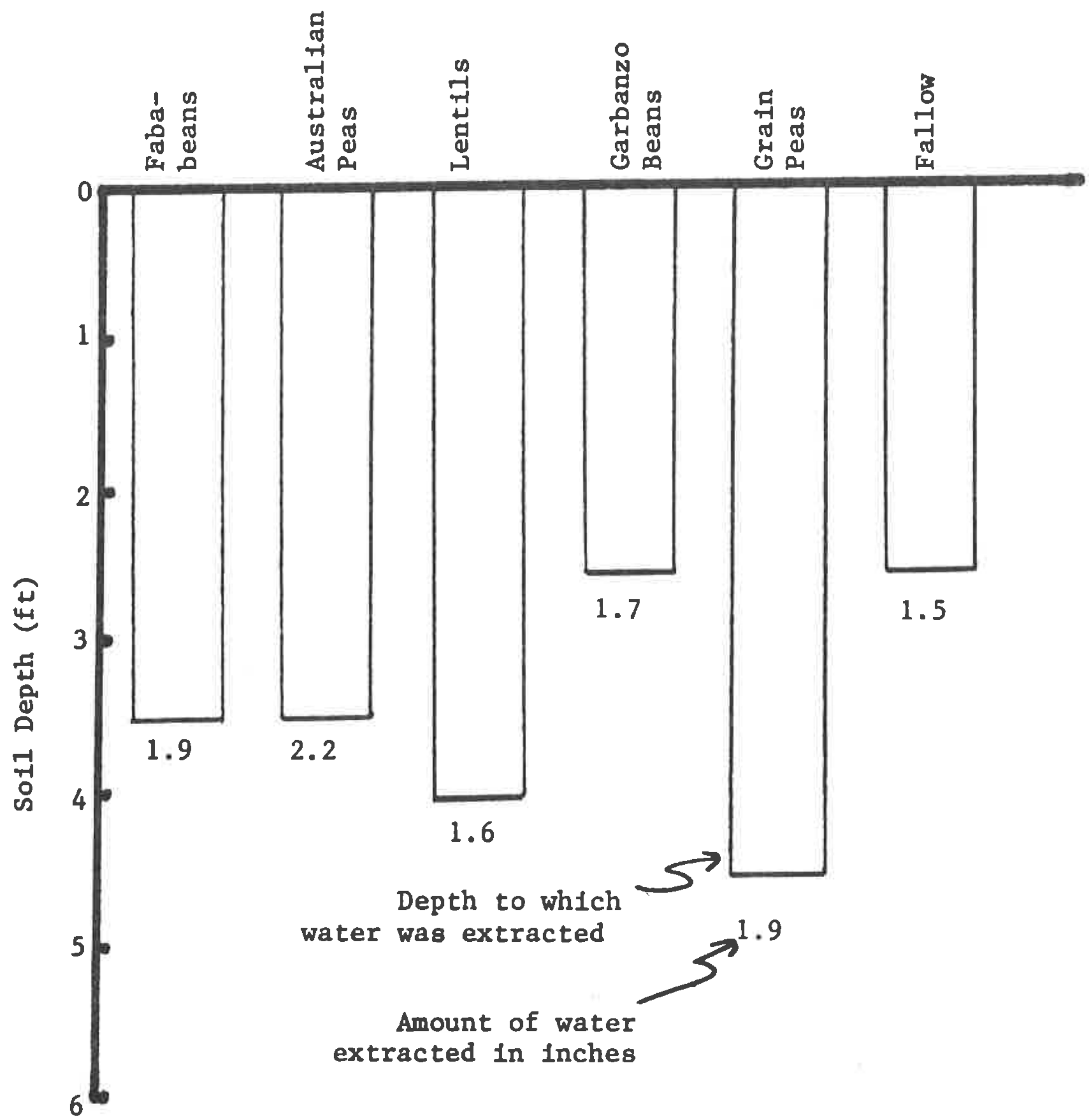


Figure 3. Annual legume (and fallow) water use and rooting depth. June 14-July 8, 1983.



TITLE: Wheel Traffic Compaction

PERSONNEL: Alice J. Jones, Asst. Professor of Agronomy
Hayden Ferguson, Professor of Soil Science
Walt Adams, Agricultural Research Specialist

COOPERATORS: Paul Bley, Big Sandy, MT
Gordon Dyrud, E. of Conrad, MT

OBJECTIVES:

1) to evaluate grain yield patterns across a cropping strip

2) to relate wheel traffic compaction to substantial differences in grain yields

PROCEDURES:

Strips of winter wheat or barley, grown in a crop-fallow rotation, were harvested in two-row or four-row plots across the strip. Each plot was analyzed for grain yield. Test weights and protein analyses are pending final evaluation of yield results.

RESULTS:

Substantial scatter was observed in yields of winter wheat and barley across the width of the field (Fig. 1-3). Yields ranged from 13.7 to 48.5 bu/a (WW-Dyrud), 13.3 to 45.7 bu/a (WW-Bley) and 15.6 to 38.4 bu/a (Bly-Bley). Average values for these three fields were 41.8, 32.5 and 24.8 bu/a, respectively. The majority of fluctuation in yield can be attributed to variation in soil texture, soil fertility, soil moisture, straw and chaff distribution, fertilizer application, weed growth (in some cases), and plant competition.

Each field also contained numerous harvest samples that had substantially lower yields than the adjacent harvest samples. The lower samples yields were below 30, 25 and 20 bu/a for winter wheat at Dyrud's and Bley's and for barley at Bley's, respectively. The drill width of each cooperator is indicated on each figure. Indications are that the lowest yields are associated with the tire tracks of the the tractor being used to pull the seeder.

The low yields assumed to be associated with compaction from tractor tires represent a yield reduction of 9.5 to 67% when compared to adjacent harvest samples. Yield reductions where 23 to 62% when compared to the field averages. The area affected by compaction is approximately 13.5%, thus, yield losses due to wheel traffic compaction is considerable.

Fig. 1. Winter Wheat yields harvested across a cropping strip.
Dyrud Farm. 1983.

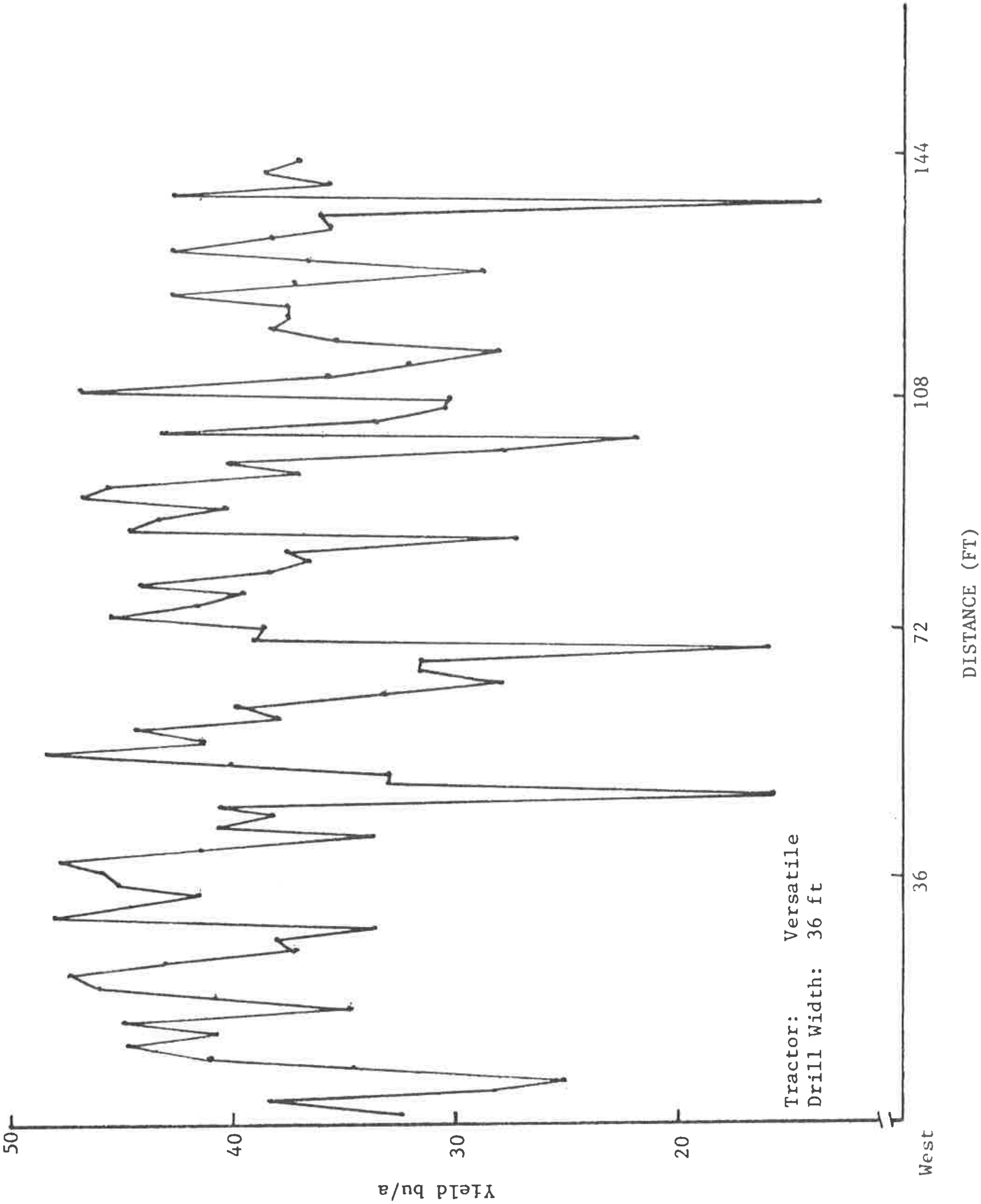


Fig 2. Winter Wheat yields across a cropping strip. Bley Farm, Big Sandy 1983.

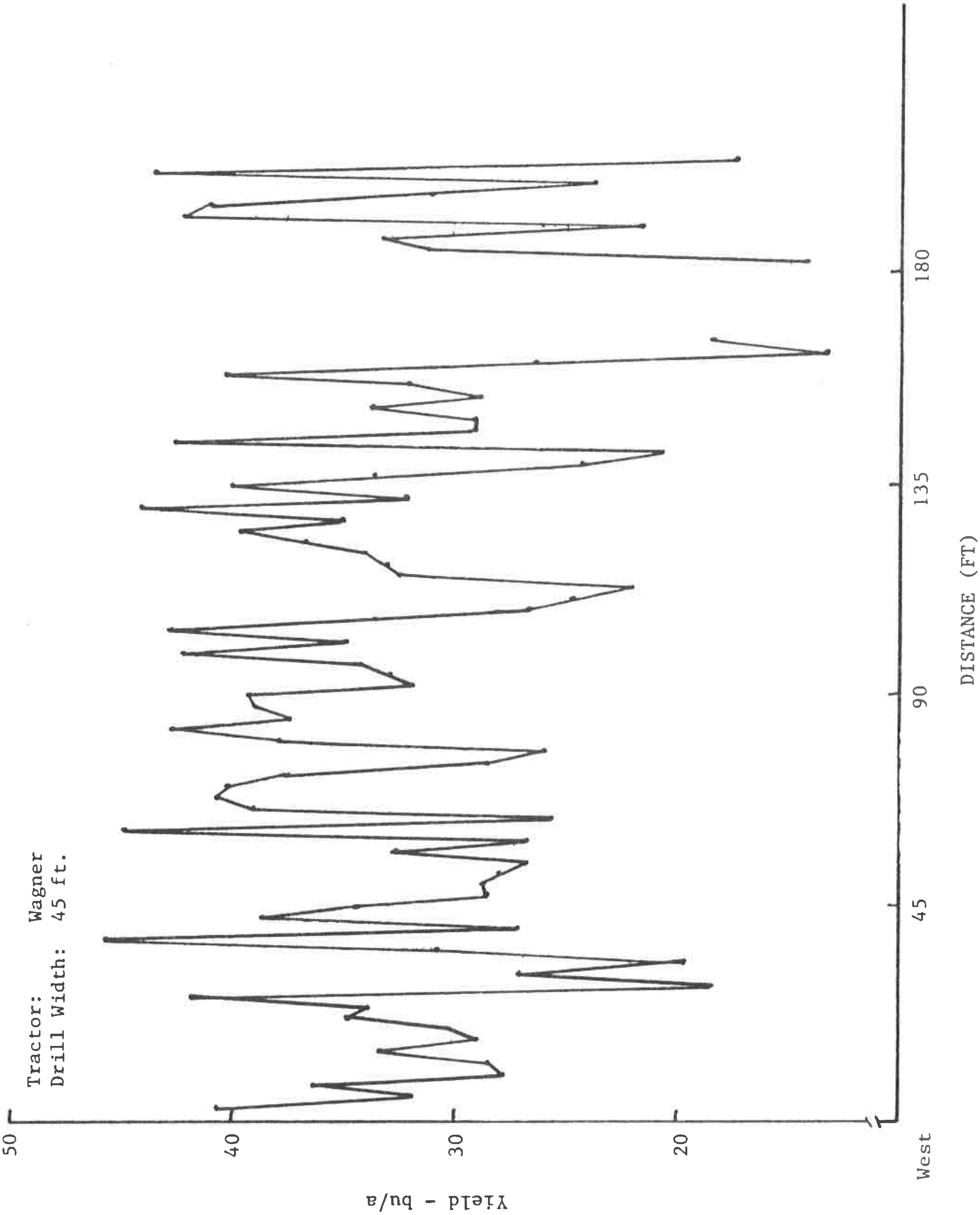
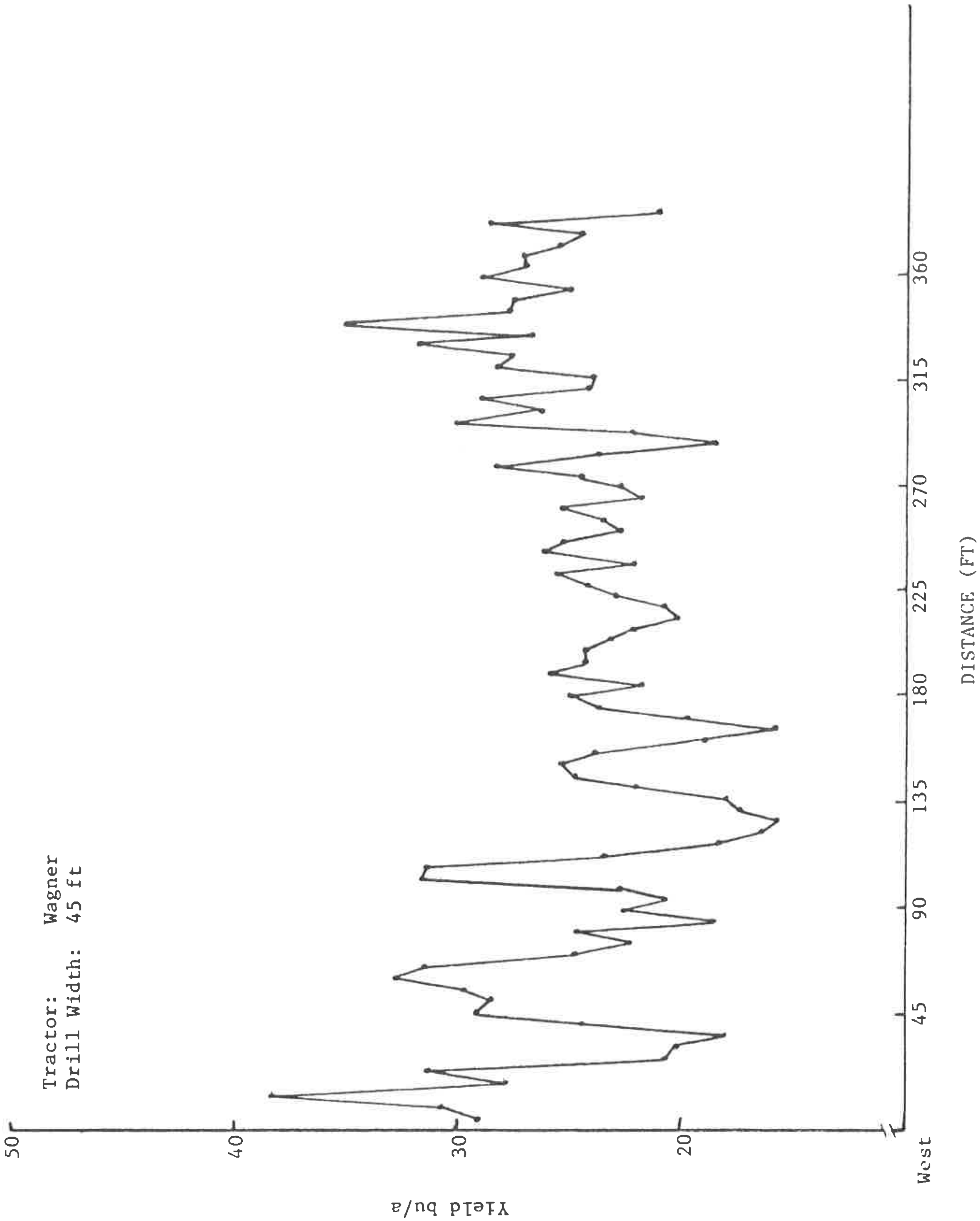


Fig. 3. Barley yields across a cropping strip. Bley Farm, Big Sandy. 1983.



TITLE: Tillage Power Requirements

LOCATION: Western Triangle Research Center, Conrad, MT

PERSONNEL: Alice J. Jones, Asst. Professor of Agronomy
Hayden Ferguson, Professor of Soil Science

COOPERATORS: Paul Bley, Big Sandy, MT.
Bud Myers, Big Sandy, MT.
Robin Hurd, Big Sandy, MT.
Merwin Works, Big Sandy, MT.
Jim Bjelland, Conrad, MT.

OBJECTIVES:

1) to determine the magnitude of the tillage power requirement of different soils
2) to relate tillage power requirements to cropping systems
3) to evaluate the relationship between tillage power requirements and soil physical properties

PROCEDURES:

The power rig used to determine tillage power requirements was designed and constructed by Jim Krall and Stan Bruce. It consists of a toolbar with two shanks that is pulled behind a specially modified pickup. Each shank is outfitted with a chisel point. The rig was pulled across a field perpendicular to the stubble, at 2.5 mph. Chisels tilled the soil to a depth of 8 inches. Power measurements were obtained using a millivolt integrator. The integrator was connected to a hydraulic pressure sensor that attached to the rig via a level arm. Data recorded in the field were distance, time and millivolts. All treatments were replicated six times. Horsepower - hour was calculated as follows:

$$PSI = 48.708 \text{ mV} - 10.609$$

$$\text{hp-hr} = \frac{\text{Vel (ft s}^{-1}\text{) x PSI (lb in}^{-2}\text{) x Cylinder Area (in}^{2}\text{)}}{550 \text{ (ft-lb s}^{-1}\text{ hp-hr}^{-1}\text{) x } 2.667}$$

Additional measurements taken in the field were bulk density and water content. These data were obtained using a neutron surface density/moisture probe. Soils were also sampled at the 0-8 inch depth and returned to the laboratory for further analysis.

RESULTS:

Tillage power requirements (TPR) for barley and winter wheat stubble were about 1 hp-hr less on the sandy loam soil than on the clay loam soil. This difference is mainly attributed to soil texture. Smaller sized soil particles like clay pack more closely together than larger sized soil particles such as sand. Although clayey soils have a greater tendency to aggregate than do sands, aggregation did not seem to influence the TPR. This may be due to the decomposition of stubble during fallow or to the low quantity of stubble on these fields as compared to higher rainfall areas.

Power requirements were similar for barley and winter wheat stubble on the sandy loam soil; however, TPR for fallow was about 0.37 hp-hr less than for stubble. Fallow was also less than for sunflower stubble but was equivalent to the safflower stubble. Where stubble was present, the higher TPR are due to the great quantity of roots near the soil surface that must be broken up. Also, these soils are likely to be more compacted by wheel traffic and raindrop impact than are the fallowed fields. Greater compaction is indicated by the higher bulk density values. Currently, there are no scientific reasons for the TPR of the safflower to be similar to the fallow but many farmers and state researchers have observed that safflower fields are quite mellow.

The chemical fallow plot on the Works farm was similar to the barley stubble. This means that the surface soil of both soils had the same degree of hardness - barley stubble due to roots and chemical fallow due to natural and wheel traffic compaction.

The barley stubble fields that were no-tilled or burned also had similar TPR. There is no indication that stubble management or the number of years in no-till has affected the power requirement or bulk density yet. Based on experience, as the surface mulch of the no-till increases and the organic contribution from stubble decreases on the burned areas, the TPR of no-till would be expected to increase while the burn plots would decrease. The timetable for these changes to occur may be upwards of 10 years.

Table 1. Tillage power requirements and associated soil physical properties. All values are the mean of six replications.

Soil	Field	hp-hr	bulk density g cm^{-3}	water content % (cm^3 cm^{-3})
Sandy Loam	Barley Stubble 1	1.41 ± .13	1.45 ± .07	5.3 ± .24
	Barley Stubble 2	1.36 ± .10	1.50 ± .06	5.9 ± .60
	Fallow 1	0.92 ± .16	1.38 ± .09	6.3 ± .60
	Fallow 2	1.12 ± .25	1.44 ± .09	7.5 ± .55
	W. Wheat Stubble 1	1.25 ± .05	1.46 ± .03	5.4 ± .45
	W. Wheat Stubble 2	1.53 ± .15	1.46 ± .08	6.6 ±1.27
	Fallow 1	0.99 ± .09	1.39 ± .04	8.9 ± .65
	Fallow 2	1.05 ± .08	1.38 ± .06	8.8 ± .44
	W. Wheat Stubble	1.10 ± .14	1.42 ± .07	9.2 ± .34
	Safflower Stubble	1.03 ± .11	1.39 ± .06	8.2 ± .72
	Sunflower Stubble	1.27 ± .17	1.42 ± .12	5.3 ± .55
Clay Loam	Barley Stubble	2.11 ± .22	1.41 ± .06	10.5 ± 1.4
	Chemical Fallow	1.92 ± .18	1.40 ± .06	12.5 ± 1.32
	Barley Stubble; No-Till, 2 yr 1	2.47 ± .16	1.26 ± .10	19.5 ± 2.5
	Barley Stubble; No-Till, 2 yr 2	2.70 ± .23	1.34 ± .13	19.6 ± 3.4
	Barley Stubble; No-Till, 3 yr	2.55 ± .17	1.36 ± .06	18.9 ± 2.3
	Barley Stubble; Burn, 3 yr	2.32 ± .16	1.33 ± .04	15.5 ± 1.7
	Barley Stubble; Burn, 2 yr	2.51 ± .07	1.36 ± .09	17.2 ± 2.2
	W. Wheat Stubble	2.48 ± .22	1.32 ± .08	19.2 ± 2.0

TITLE: Soil Compaction and Subsoiling

LOCATION: Western Triangle Research Center, Conrad, MT

PERSONNEL: Alice J. Jones, Asst. Professor of Agronomy
Hayden Ferguson, Professor of Soil Science
Walt Adams, Agricultural Research Specialist

COOPERATORS: Prairie Nest Ranch, Great Falls, MT
Lee Knedler, Geraldine, MT

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OBJECTIVES: (1) to measure seasonal water use of spring grains on adjacent fields that have or have not been subsoiled.

(2) to measure crop response to subsoiling.

PROCEDURES:

Winter wheat plots were seeded on fallow and fertilized by the cooperators in the fall. Neutron access tubes were then installed and soil moisture was monitored throughout the winter and summer. Subsoiling was performed at some time during previous years by the cooperators. Plots were harvested in August and analyzed for yield, protein and test weight.

RESULTS:

Yield results, protein and test weights are presented in Table 1. A 10 bu/a yield increase was observed at Prairie Nest due to subsoiling, however a 10 bu/a yield decrease was observed at Knedler's. The yield difference at Knedler's is questionable because of the lack of replication. The no-till, chemical fallow plot at Prairie Nest that was subsoiled was very poor and is attributed to very dense infestations of cheatgrass and goat-grass.

Protein content was similar at Knedler's however, there was about a 2% protein increase at Prairie Nest on the subsoiled plots above that obtained on the nonsubsoiled fallow plots. Test weights were similar at each location. A higher test weight was observed on the no-till chemical fallow plots in response to the low yields.

The responses in yield, protein and test weight reflect differences due to subsoiling as well as the fertilizer management program. Crop water use data is pending.

Table 1. Grain yield, test weight and protein for adjacent fields that were undisturbed or subsoiled.

Cooperator	Nonsubsoiled	Subsoiled
	---- Yield (bu/a) ----	
Prairie Nest	54.7	64.1 (36.7)[a/]
Knedler	56.8	46.1[b/]
	---- Protein (%) ----	
Prairie Nest	10.9	13.2 (11.3)
Knedler	14.6	14.1[b/]
	---- Test Weight (lb/bu) ----	
Prairie Nest	60.4	62.2 (68.5)
Knedler	62.9	61.3[b/]

a/ numbers in parentheses are for plots that were seeded on a no-till chemical fallow field.

b/ number represents only one replication

TITLE: Long Term Phosphorous Fertility Response

LOCATION: Western Triangle Research Center, Conrad, MT

PERSONNEL: Alice J. Jones, Assistant Professor of Soil Science
Jim W. Bauder, Extension Soil Scientist
Walt Adams, Agricultural Research Specialist

COOPERATOR: Kelvin Kanning, Devon, MT

OBJECTIVES:
1) to evaluate the response of small grains to P fertilizer
2) to evaluate the production differences for single vs multiple year applications of P

PROCEDURE:

The experimental plots were located north of Devon on summer fallowed land in the spring of 1983. The area was seeded to barley following the application of phosphorous fertilizer. Nitrogen was applied at the time of seeding. Plot size was 12 x 50 ft. All treatments were replicated four times in a completely randomized block design.

Phosphorous was broadcast on the plots at the rate of 40, 80, or 160 lb P/ac as triple superphosphate (0-45-0). The application of P by year to evaluate multiple year applications is as follows:

Year:	1983	1984	1985	1986
	lb P/ac			
Treatment				
1	0	0	0	0
2	40	40	40	40
3	80	0	80	0
4	160	0	0	0

Plots were harvested on August 17. Samples were analyzed for yield, test weight and protein.

Table 1. Yield, grain protein, test weight, plumps and thins of barley as influenced by fertilizer rates. Kanning Farm. Devon. Toole County. 1983.

Trt. No.	P kg/ha	Grain Yield kg/ha	Grain Yield bu/a	Protein %	Test Wt. lb/bu
1	0	2962	55.3	11.6	41.2
2	40 x 4 yr.	3048	56.9	12.3	41.2
3	80 x every 2nd yr.	3645	68.1	11.5	41.1
4	160 x every 4th yr.	3430	64.0	11.3	41.0
	LSD	423	7.9		

Table 2. Analysis of variance for treatment comparisons in Table 1. Kanning Farm. Toole County. 1983.

Sources	df	Level of Significance 1/ Yield	Protein	Test Wt.
Treatment	3	*	ns	ns
Residual	9			

1/ ns, *, ** not significantly different p <0.05, significantly different at p = 0.05 and 0.01, respectively.

TITLE: Phosphorous Fertility - Seed Treatment Interaction

LOCATION: Western Triangle Research Center, Conrad, MT

PERSONNEL: Alice J. Jones, Asst. Professor of Agronomy
Don Mathre, Professor of Plant Pathology
Walt Adams, Agricultural Research Specialist
Bernard Schaff, Soils Research Associate

COOPERATOR: Bill McInerney, Fairfield, MT

DISCLAIMER:

PROCEDURE:

Experimental plots were established at one irrigated location in the spring of 1983 and soil samples were taken. The site was seeded with Pondera spring wheat on April 26. Plot size was 2 x 7 m. All treatments were replicated 3 times in a randomized complete block design.

Nitrogen was withheld or applied at the recommended rate, based on the soil test, as anhydrous ammonia or ammonium nitrate. Phosphorous was applied at the rate of 0 or 17 kg P/ha as liquid phosphoric acid. The phosphorous was banded with the seed or knifed 4-6" below the soil surface and 6" to the side of the seed row. Potassium was applied as KCl at the rate of 0 or 50 kg K/ha; sulfur was applied as $CaSO_4$ at the rate of 0 or 40 kg S/ha. Ammonium nitrate, KCl and $CaSO_4$ were broadcast on the soil surface prior to seeding.

The seed treatment consisted of Baytan for takeall rootrot. Plots were harvested on August 12. Samples were analyzed for yield, test weight and protein.

RESULTS:

Growing season precipitation at this site was 12.4 cm (4.9"). Soil samples taken early in the spring indicated the following:

Soil Depth (cm)	P(Olsen)	N
0- 15	20 ppm (high)	-
0-120	-	89 kg/ha

The phosphorous test indicated a "high" level of available phosphorous in the soil suggesting that no P_2O_5 would be needed to produce an adequate spring wheat crop. Nitrogen at the site was relatively high for an irrigated field but would indicate that all of the nitrogen was not used by the previous crop. It is also known that unusually high nitrate values are common for this area. The N rate selected for this field was 120 kg N/ha for a yield goal of 6730 kg/ha (100 bu/a).

Wheat yields, grain protein and test weight values for each treatment are presented in Table 1. Analysis of variance for the comparisons in Tables 1 and 2 are presented in Table 3. Results in Table 1 allow for the comparison of any two treatments. Yields ranged from 2684 kg/ha (39.9 bu/a) to 3840 kg/ha (57.1 bu/a). This 143 percent increase can not be attributed to any given nutrient rate or placement or to the seed treatment. Main effects of N,P,K, and S can be determined by making comparisons of two or more treatments. The yield goal of 6730 kg/ha (100 bu/a) was not realized on any treatment. Large infestations of timothy were noted in this field which may in part account for the reduced yields. Also contributing to the low yields were low rainfall and poor timing of rainfall in conjunction with irrigation events. Soil nitrogen seemed adequate for the yields obtained based on consumption of 2 lb N/bu grain produced.

Table 2 presents results averaged over various treatments to illustrate comparisons among fertilizer management. Significant differences in yield were observed for phosphorous placement and the nitrogen source by phosphorous placement interaction. Yields for plots on which phosphorous was knifed into the soil averaged 9 bu/ac higher than for plots where phosphorous was banded. This response is likely due to the better moisture conditions and longer period of phosphorous availability when knifed below the seed. Among the N-source, P-placement interactions, the surface application of ammonium nitrate in combination with knifed phosphorous was 11.5 to 16 bu/ac higher than the other combinations.

Yields for the Baytan treated seed was 6.5 bu/a lower than for the nontreated seed, however, this difference was not statistically significant. Results of a larger seed treatment study also indicated that treated seed yields were lower than for nontreated seed treatments. There were no real differences between treated seed yields due to phosphorous placement.

Table 1. Yield, grain protein and test weight of spring wheat as influenced by fertilizer rate, combinations, placements, and seed treatment. McInerney Farm. Fairfield. Teton County. 1983. (Values are the average of three replications). Treatments designated with a 'T' received Baytan seed treatment for takeall root rot.

Trt. No.	N Rate	Kg/ha N	Kg/ha P	Kg/ha K	Kg/ha S	Grain Yield kg/ha	Grain Yield bu/a	Grain Protein %	Test Wt. lb/bu
1		0	0	0	0	2993	44.5	13.4	60.0
16 T		0	0	0	0	3047	45.3	15.0	60.6
4		0	17	50	40	3129	46.5	13.3	60.0
5		180	0	50	40	3043	45.2	14.7	55.9
6		180	17	0	40	3840	57.1	14.5	57.2
7		180	17	50	0	3555	52.9	14.3	58.2
3	180	AN	P-Band	K	S	2684	39.9	13.9	56.2
9	135					2934	43.6	14.1	59.0
11	225					3055	45.4	14.6	56.5
13	270					3039	45.2	14.7	55.5
2	180	AN	P-Knif	K	S	3772	56.1	14.0	58.4
8	135					3344	56.1	14.4	58.7
10	225					3079	45.8	13.8	57.0
12	270					3480	51.7	13.8	56.5
15 T	180	AN	P-Band	K	S	2705	40.2	12.5	58.4
14 T	180	AN	P-Knif	K	S	2857	42.5	13.6	58.0
17	180	NH_3	P-Band	K	S	2998	44.6	13.9	59.8
18	180		P-Knif	K	S	2933	43.6	14.0	58.6

Table 2. Main effects of fertilizer variables and seed treatment averaged over other treatment variables. Irrigated spring wheat. McInerney Farm. Teton Co. 1983.

Main Effect Comparisons		Yield bu/a	Protein %	Test Weight lb/bu
Nitrogen Rate (AN)				
135		49.8	14.2	58.8
180		49.0	14.0	57.3
225		45.6	14.2	56.8
270		48.5	14.3	56.0
P-Banded		43.5	14.3	56.8
vs	W/AN, all rates			
P-Knifed		52.4	14.0	57.7
Anhydrous Ammonia	P-Knif	43.6	14.0	59.2
	P-Band	44.6	14.0	57.3
vs				
Ammonium Nitrate	P-Knif	56.1	13.9	59.8
	P-Band	39.9	14.0	58.6
Treated Seed		41.4	13.1	58.2
vs				
Non-treated Seed		48.0	14.0	57.3
Fertilizer Rate Response (no statistics)				
K	0	57.1	14.5	57.2
	50	56.1	14.0	58.4
S	0	52.9	14.3	58.2
	40	56.1	14.0	58.4

Table 3. Analysis of variance for treatment comparisons in Tables and . McInerney Farm. Teton County. 1983.

Sources	df	Level of Significance 1/		
		Yield	Protein	Test Weight
Overall Trt. 1-18				
Treatment	2	ns	ns	**
Residual	17			
N-Rate, P-Placement Trt. 2,3,8-13				
N-Rate	3	ns	ns	*
P-Place	1	*	ns	ns
N x P	3	ns	ns	ns
Residual	14			
N-Source, P-Placement Trt. 2,3,17,18				
N-Source	1	ns	ns	*
P-Place	1	*	ns	ns
N x P	1	*	ns	*
Residual	6			
Seed Trt, P-Place Trt. 2,3,14,15				
Seed Trt.	1	ns	ns	ns
P-Place	1	ns	ns	ns
S x P	1	ns	ns	ns
Residual	6			

1/ ns, *, ** not significantly different at $P<0.05$, significantly different at $p=0.05$ and $p=0.01$, respectively.

TITLE: Phosphorous Soil Test and P Fertilizer Response

LOCATION: Western Triangle Research Center, Conrad, MT.

PERSONNEL: Alice J. Jones, Assistant Professor of Agronomy
Earl O. Skogley, Professor of Soils
Murray Klages, Professor of Soils
Bernard Schaaf, Soils Research Associate
Walt Adams, Agricultural Research Specialist

COOPERATORS: Adam Dahlman, East of Dutton. Teton County.
Leif Larson, East of Choteau. Teton County.
Erling Grubb, North of Ledger. Pondera County.

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OBJECTIVES:
1) to evaluate crop response to P fertilizer rates and placement.
2) to relate soil physical and chemical properties to phosphorous soil test.
3) to relate crop response and soil phosphorous test to phosphorous isotherms.

PROCEDURE:

Experimental plots were established at three locations in the spring of 1983 and soil samples were taken. The sites were seeded to Hector barley on recrop, Clark barley on fallow, and Pondera spring wheat on fallow at Dutton, Ledger, and Choteau, respectively. The Ledger site was hailed out in July so no research results are presented for that location. The Dutton and Choteau sites were seeded on May 4 and April 27, respectively. Plot size was 2 x 7m. All treatments were replicated four times in a randomized complete block design.

Nitrogen was withheld or applied at the recommended rate, based on the soil test, as anhydrous ammonia or ammonium nitrate. Phosphorous was applied at the rate of 0, 13, 17, 26, or 34 kg P/ha as liquid phosphoric acid. The phosphorous was banded with the seed or knifed 10-15 cm (4-6") below the soil surface and 6" to the side of the seed row. Potassium was applied as KCl at the rate of 0 or 25 kg K/ha; sulfur was applied as $CaSO_4$ at the rate of 0 or 20 kg S/ha. Ammonium nitrate, KCl, and $CaSO_4$ were broadcast on the soil surface prior to seeding. Phosphorous was either knifed 10-15 cm below the soil surface alone or in combination with anhydrous ammonia prior to seeding or it was banded with the seed. Plots were harvested on August 18 and 29 at Dutton and Choteau, respectively. Samples were analyzed for yield, test weight, protein, and percent plumps and thins (barley only).

RESULTS: Teton County - Dutton Site

At the Dutton site barley (var. Hector) was grown on recrop. Growing season precipitation was 22 cm (8.6 in.). Soil samples taken early in the spring indicated the following:

soil depth (cm)	P(Olsen)	N
0- 15	19 ppm (high)	-
0-120	-	11 kg/ha

The nitrogen soil test result is the summation of test results for the 0-15, 15-30, 30-60, and 60-120 cm depth samples. Additional soil tests (e.g. K, O.M., pH, and EC) were not run due to the lack of personnel and equipment during the initial field season of my research. Soil samples will be completely analyzed during the winter of 1983-84.

The phosphorous test indicated a "high" level of available phosphorous in the soil suggesting that no P_2O_5 would be needed to produce an adequate barley crop. Nitrogen at the site was low as expected for a recrop field. The rate of N selected for this site was 90 kg N/ha due to its soil and growing season moisture status and to a yield goal of 3226 kg/ha (60 bu/a).

Barley yield, grain protein, and test weight values for each treatment are presented in Table 1. Analysis of variance for the comparisons in Tables 1 and 2, are presented in Table 3. Results in Table 1 allow for the comparison of any two treatments. Yields ranged from 1439 kg/ha (26.8 bu/a) to 3859 kg/ha (71.8 bu/a). This 267 percent increase is due primarily to the application of nitrogen.

Main effects of N, P, K, and S can be determined by making comparisons of two or more treatments. There was a substantial increase in yield due to the application of N. Yields, when no N was applied, averaged 1594 kg/ha (29.7 bu/a) but increased to 3109 kg/ha (57.8 bu/a) with the addition of N and no P. The presence of P, K, and S, in combination with nitrogen (anhydrous ammonia) was ineffective in increasing yields. In fact yields were decreased by the presence of these nutrients when compared with the check (zero rate) plots. The yield goal of 3226 kg/ha (60 bu/a) was approximated by fertilizer combinations of anhydrous ammonia or ammonium nitrate and phosphorous that was knifed in or ammonium nitrate with 26 kg P/ha (80 lb P_2O_5/a).

Table 2 presents results averaged over various treatments to illustrate comparisons among fertilizer management. None of the comparisons showed significant differences in yield however, substantial yield differences did occur. Average yield for anhydrous ammonia as compared to the average yield for ammonium nitrate revealed an advantage of 323 kg/ha (6 bu/a) for ammonium nitrate. This difference may be explained by the N form (ammonia vs nitrate) or the placement of the N (knifed vs surface). Soil moisture, the long dry period during the early portion of the growing season, and the precipitation patterns throughout the growing season may also explain, in part these results.

Comparison between banding P with the seed and knifing it in a deeper band below and to the side of the seed indicated that a 323 kg/ha (6 bu/a) increase in yield occurred from knifing over banding. This difference is not significant; however, a benefit from the P seems to be due to the deeper placement of P and not necessarily the dual placement of N and P together. This is indicated because the average yield for NH_3 plus knifed P, is 3243 kg/ha (60 bu/a) and the average yield for AN plus knifed P is 3393 kg/ha (63 bu/a).

Comparison among rates of P in combination with N also revealed a 323 kg/ha (6 bu/a) advantage of 26 kg/ha of P (60 lb P_2O_5/a) over 13 kg P/ha (30 lb P_2O_5/a). This difference was not significant but clearly showed a consistent increase in yield with a higher rate of P whether it was banded or knifed.

Grain protein ranged from 8.6 to 12.2 percent among all treatments (Table 1). This protein increase was substantial however, most treatments that included N had protein contents between 10.0 and 11.0 percent. No differences were observed in protein due to the main effects except for the N source. The ammonium nitrate treatments averaged 11.4 percent while the anhydrous ammonia treatments averaged 9.7 percent. In general protein and yield were indirectly related.

Test weights, plumps and thins varied substantially among treatments but no main effect differences were indicated.

Teton County - Choteau Site

At the Choteau site spring wheat (var. Pondera) was grown on fallow. Growing season precipitation was 9.4 cm (3.7 in.). Soil samples taken early in the spring indicated the following:

soil depth (cm)	P(Olsen)	N
0- 15	21 (high)	-
0-120	-	42 kg/ha

The nitrogen soil test result is the summation of test results for the 0-15, 15-30, 30-60, and 60-120 cm depth samples. Additional soil tests (e.g. K, O.M., pH and EC) were not run due to the lack of personnel and equipment during the initial field season of research. Soil samples will be completely analyzed during the winter of 1983-84.

The phosphorous test indicated a "high" level of available phosphorous in the soil, thus, it can be concluded that no P_2O_5 would be needed to grow an adequate crop of spring wheat. Nitrogen at the site was high. The N rate selected for this site was 60 kg N/ha. This application, in conjunction with the 42 kg N/ha in the soil provided for a 3355 kg/ha (50 bu/a) yield goal based on 0.09 kg (2 lb) of N required to grow 66 kg (1 bu) of wheat.

Spring wheat yield, grain protein, and test weight values for each treatment are presented in Table 4. Analysis of variance for the comparisons in Tables 4 and 5 are presented in Table 6. Results in Table 4 allow for the comparison of any two treatments. Yields ranged from 1713 kg/ha (25.5 bu/a to 2683 kg/ha (40 bu/a). This 57 percent increase is due primarily to the application of nitrogen.

Main effects of N, P, K, and S can be determined by making comparisons of two or more treatments. There was a substantial increase in yield due to the application of N. Yields, when no N was added, averaged 1914 kg/ha (28.5 bu/a) but increased to 2511 kg/ha (37 bu/a) with the addition of N and no P. The presence of P, in combination with N (anhydrous ammonia) was ineffective in increasing yields. The absence of potassium from the soil, however caused a 470 kg/ha (7 bu/a) drop in yield. Also, the presence of sulfur decreased the yield by 403 kg/ha (6 bu/a). It may be beneficial to begin the use of potassium test strips on this site. The yield goal of 3356 kg/ha (50 bu/a) was not reached. The treatments having the highest yields (approx. 2650 kg/ha; 40 bu/a) were fertilizer combinations of N, P, and K without S and all fertilizers with anhydrous ammonia and 34 kg P/ha knifed below the seed.

Table 5 presents results averaged over various treatments to illustrate comparisons among fertilizer management. None of the comparisons showed significant differences in yield. The long dry period during the growing season and the rainfall patterns may, in part, explain the lack of response to any fertilizer source, placement or rate except for nitrogen rate.

Grain protein ranged from 13.7 to 14.8 percent among all treatments (Table 4). Indications are that nitrogen fertilizer was influential in increasing protein above 14 percent. No other fertilizer management schemes influenced protein including sulfur. Test weights also were not strongly influenced by fertilizer management.

Table 2. Main effects of fertilizer variables, averaged over other treatment variables. Barley. Dahlman Farm. Teton County. 1983.

Main effect	Grain yield bu/a	Grain protein %	Test wt. lb/bu	Plumps %	Thins %
Anhydrous Ammonia	55.5	9.7	49.2	80.3	7.9
vs					
Ammonium Nitrate	61.5	11.4	49.7	72.1	9.2
P-Banded	55.4	11.0	48.7	75.6	10.1
vs					
P-Knifed	61.6	10.1	50.2	76.8	7.1
P-Rate					
13	55.6	10.6	49.4	78.0	9.1
26	61.4	10.5	49.5	74.4	8.1

Table 3. Analysis of variance for treatment comparisons in Tables Dahlman Farm. Teton County.

Sources	df	Level of Significance [1/]				
		Yield	Protein	Test Wt	Plumps	Thins
Overall Trt. 1-16						
Treatment	15	**	**	*	**	*
Residual	45					
N-Source, P-Placement, P-Rate Trt. 7-10, 13-16						
N-Source (N)	1	ns	**	ns	ns	ns
P-Place (P)	1	ns	**	ns	ns	ns
P-Rate (R)	1	ns	ns	ns	ns	ns
N x P	1	ns	ns	ns	ns	ns
N x R	1	ns	ns	ns	ns	ns
P x R	1	ns	ns	ns	ns	ns
N x P x R	1	ns	ns	ns	ns	ns
Residual	21	ns	ns	ns	ns	ns

1/ ns, *, ** not significantly different at $p < 0.05$, significantly different at $p = 0.05$, 0.01, respectively.

Table 4. Yield, grain protein, and test weight of spring wheat as influenced by fertilizer rates, combinations and placement. Larson Farm. Choteau. Teton County. 1983. (Values are the averages of four replications).

Trt. No.	P Rate	kg/ha N	kg/ha P	kg/ha K	kg/ha S	Grain Yield kg/ha	Grain Yield bu/a	Grain Protein %	Test Wt. lb/bu
1		0	0	0	0	2114	31.5	13.8	60.7
2		0	17	25	20	1713	25.5	13.7	58.0
3		60 NH_3	0	25	20	2511	37.4	14.7	60.5
4		60	17 K	0	20	2032	30.2	14.2	57.9
5		60	17	25	0	2636	39.2	14.0	59.6
6		60	17 B	25	20	2501	37.3	14.2	60.3
8	13	60 NH_3	P-Band	25 K	20 S	2378	35.4	14.8	59.9
10	26					2234	33.2	14.3	59.5
12	34					2148	32.0	14.4	58.2
7	13	60 NH_3	P-Knif	25 K	20 S	2318	34.5	14.8	58.2
9	26					2288	34.0	14.1	59.5
11	34					2683	40.0	14.1	59.7
16	13	60 AN	P-Band	25 K	20 S	2384	35.5	14.5	58.7
14	26					2215	33.0	14.7	57.5
15	13	60 AN	P-Knif	25 K	20 S	2214	32.9	13.9	59.4
13	26					2105	31.3	14.3	58.8

Table 5. Main effects of fertilizer variables, averaged over other treatment variables. Spring wheat. Larson Farm. Teton County. 1983.

Main effect	Yield bu/a	Protein %	Test Weight lb/bu
Anhydrous Ammonia	43.0	14.5	59.2
vs			
Ammonium Nitrate	44.4	14.3	58.6
P-Banded	43.0	14.6	58.8
vs			
P-Knifed	44.5	14.3	59.0
P-Rate			
13	43.4	14.5	59.0
26	44.1	14.4	58.7

Table 6. Analysis of variance for treatment comparisons in Tables
Larson Farm. Teton County.

Sources	df	Level of Significance 1/ Yield	Protein	Test Weight
Overall Trt. 1-16				
Treatment	15	ns	ns	ns
Residual	45			
N-Source, P-Placement, P-Rate Trt. 7-10, 13-16				
N-Source (N)	1	ns	ns	ns
P-Place (P)	1	ns	ns	ns
P-Rate (R)	1	ns	ns	ns
N x P	1	ns	ns	ns
N x R	1	ns	ns	ns
P x R	1	ns	ns	ns
N x P x R	1	ns	ns	ns
Residual	21			

1/ ns, *, ** not significantly different at $p < 0.05$, significantly different at $p = 0.05$, 0.01, respectively.

Toole County - Galata Site

Lew spring was grown on fallow with a growing season precipitation of 6.9 cm (2.7 in). Soil test results in the spring indicated the following:

soil depth (cm)	P(Olsen)	N
0- 15	16 ppm (high)	-
0-120	-	117 kg/ha

The phosphorous test indicated a "high" level of available phosphorous in the soil suggesting that no P_2O_5 would be needed to produce an adequate spring wheat crop. This P level is the break point between medium and high soil P so it would be possible crops grown on this soil to respond to P fertilizer. Nitrogen was very high at the site and over half of the nutrient was found at the 60-120 cm (2-4 ft) depth. Assuming that the crop could not readily use this deeper N an additional 20 kg N/ha was added for a yield goal of 3363 kg/ha (50 bu/a).

Yield, protein and test weight information for each treatment are presented in Table 7. Statistical analysis for Tables 7 and 8 are provided in Table 9. Yields ranged from 1995 kg/ha (29.7 bu/a) to 2709 kg/ha (40.3 bu/a). This 36 percent increase is due primarily to the addition of phosphorous.

Main effects of N,P,K,S and micronutrients can be determined by making comparisons of two or more treatments in Table 1. No yield increase was observed due to the application of N. Yields for treatments where no N was applied averaged 2233 kg/ha (33.2 bu/a) whereas the N treatment with no phosphorous averaged 1995 kg/ha (29.7 bu/a). The presence of P,K and S, in combination with nitrogen (anhydrous ammonia) increased yields 6.5, 2 and 0.5 bu/a, respectively when compared to treatments in which each nutrient was withheld. The yield goal of 3363 kg/ha (50 bu/a) was not reached by any fertilizer combination. Micronutrients did not increase grain yields.

Table 8 presents average results for various fertilizer management schemes. None of the comparisons indicated substantial differences in yield. Yields for anhydrous ammonia and ammonium nitrate plots were comparable but urea plots were lower. Also, the deep knifing of phosphorous provided a slight yield advantage as compared to phosphorous banding with the seed.

Protein ranged from 14.0 to 15.7 percent among all treatments (Table 1) but was not affected by any fertilizer management program. Test weights were similar for all treatments and not affected by fertilizer management program.

Table 3 . Analysis of variance for treatment comparisons in Tables 1 and 2. Iverson Farm. Pondera Co. 1983.

Sources	df	Level of Significance 1/				
		Yield	Protein	Test Weight	Plumps	Thins
Overall Trt. 1-16						
Treatment	15	**	**	**	**	ns
Residual	45					
N-Source, P-Placement Trt. 2, 7-11						
N-Source	2	ns	**	*	**	**
P-Place	1	ns	ns	ns	ns	ns
N x P	2	ns	ns	ns	ns	ns
Residual	15					
N-Source, N-Rate Trt. 2, 8, 10, 12, 14, 15						
N-Source (N)	2	ns	**	ns	ns	ns
N-Rate (R)	1	ns	**	*	**	ns
N x R	2	ns	ns	ns	ns	ns
Residual	15					
Micronutrients Trt. 12, 16						
Micro.	1	ns	ns	ns	ns	ns
Residual	3					

1/ ns, *, ** not significantly different at $p<0.05$, significantly different at $p=0.05$, 0.01, respectively

Table 4 . Yield, grain protein and test weight of spring wheat as influenced by fertilizer rate, combinations and placement. Fauque Farm. Sunburst. Toole County. 1983. (Values are the averages of four replications).

Trt. No.	N Rate	kg/ha N	kg/ha P	kg/ha K	kg/ha S		Grain Yield kg/ha	Grain Yield bu/a	Grain Protein %	Test Wt. lb/bu
1		0	0	0	0		1285	19.1	14.2	59.8
3		0	17	25	20		1527	22.7	13.8	59.1
4		60	0	25	20		1557	23.1	17.1	57.6
5		60	17	0	20		1619	24.1	16.2	58.5
6		60	17	25	0		1616	24.0	16.5	58.8
7	60	NH_3	P-Band	K	S		1360	20.2	17.0	57.7
13	120						1451	21.6	16.9	57.6
2	60	NH_3	P-Knif	K	S		1831	27.2	16.1	58.5
12	120						1696	25.2	17.3	56.6
16	120	NH_3	P-Knif	K	S	+ 20 Fe, 10 Zn, 1 B	1668	24.8	17.3	57.2
9	60	AN	P-Band	K	S		1441	21.4	16.2	58.5
8	60		P-Knif	K	S		1802	26.8	16.9	57.0
14	120						1656	24.6	16.6	56.4
11	60	UR	P-Band	K	S		1737	25.8	16.6	58.7
10	60		P-Knif	K	S		1548	23.0	16.5	58.4
15	120						1495	22.2	18.0	56.9

Table 5. Main effects of fertilizer variables, averaged over other treatment variables. Spring wheat. Fauque Farm. Toole Co. 1983.

Main effect comparisons	Yield bu/a	Protein %	Test Weight lb/bu
Anhydrous Ammonia	23.7	16.5	58.1
vs			
Ammonium Nitrate	24.1	16.5	57.8
vs			
Urea	24.4	16.6	58.5
P-Banded	22.5	16.6	58.3
vs			
P-Knifed	25.7	16.5	57.9
N Rate			
60	25.7	16.5	57.9
120	24.0	17.3	56.6
20 Iron + 10 Zinc + 1 Boron	24.8	17.3	57.2
vs + N + P + K + S			
0 Iron + 0 Zinc + 0 Boron	25.2	17.3	56.6
Fertilizer Rate Response (no statistics)			
K 0	24.1	16.2	58.5
25	27.2	16.1	58.5
S 0	24.0	16.5	58.5
20	27.2	16.1	58.5

Table 6 . Analysis of variance for treatment comparisons in Tables 4 and 5 . Zelenka Farm. Toole Co. 1983.

Sources	df	Level of Significance 1/ Yield	Protein	Test Weight
Overall Trt. 1-16				
Treatment	15	ns	*	*
Residual	45			
N-Source, P-Placement Trt. 2, 7-11				
N-Source	2	ns	ns	ns
P-Place	1	ns	ns	ns
N x P	2	ns	ns	*
Residual	15			
N-Source, N-Rate Trt. 2, 8, 10, 12, 14, 15				
N-Source (N)	2	ns	*	ns
N-Rate (R)	1	ns	ns	ns
N x R	2	ns	ns	ns
Residual	15			
Micronutrients Trt. 12, 16				
Micro.	1	ns	ns	*
Residual	3			

1/ ns, *, ** not significantly different at p<0.05, significantly different at p=0.05, 0.01, respectively.

Table 7 . Yield, grain protein and test weight of spring wheat as influenced by fertilizer rate, combinations, and placement. Zelenka Farm. Galata. Toole County. 1983. (Values are the averages of four replications).

Trt. No.	N Rate	kg/ha N	kg/ha P	kg/ha K	kg/ha S		Grain Yield kg/ha	Grain Yield bu/a	Grain Protein %	Test Wt. lb/bu
1		0	0	0	0		2335	34.7	15.2	58.9
3		0	17	25	20		2131	31.7	14.0	59.2
4		20	0	25	20		1995	29.7	15.4	58.4
5		20	17	0	20		2308	34.3	15.2	58.7
6		20	17	25	0		2405	35.8	15.7	58.3
7	20	NH_3	P-Band	K	S		2660	39.5	15.7	58.4
13	40						2313	34.4	15.7	58.5
2	20	NH_3	P-Knif	K	S		2432	36.2	15.6	58.8
12	40						2709	40.3	15.3	58.7
16	40	NH_3	P-Knif	K	S	+ 20 Fe 10 Zn 1 B	2492	37.1	15.7	58.4
9	20	AN	P-Band	K	S		2393	35.6	15.2	58.4
8	20		P-Knif	K	S		2605	38.7	14.6	59.1
14	40						2355	35.0	14.9	58.4
11	20	UR	P-Band	K	S		2011	29.9	15.7	58.8
10	20		P-Knif	K	S		2398	35.6	15.0	58.4
15	40						2352	35.0	15.1	58.8