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# The 7th ANNUAL REPORT

of the

## WESTERN TRIANGLE AGRICULTURAL RESEARCH CENTER

Montana Agricultural Experiment Station

1984

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

## 1984

Bids and construction of the office/lab building were opened on February 22, and were well under the $121,000 budget. The low set of bids totaled approximately $105,630 and included 3 contractors; Swank Enterprises of Valier - general construction; Egan Metal Products of Conrad - heating & plumbing; and Kronebusch Electric of Conrad - electrical. In addition, architectural and engineering fees were approximately $8700. The remainder of the budget was used to install the sewage disposal system, floor carpeting, telephone system, and additional electrical services. Construction began early April; and although essentially completed by July 10, moving into the new facility was delayed until November 1, when carpet and telephone installations were completed. The building is located on station, 10 miles north of Conrad.

A landscape design for the Research Center buildings was prepared by MSU student Wanda Jenkins as a special project for her landscape design class. The design was supervised by Dr. Richard Pohl, MSU Department of Plant & Soil Science. The Center is indebted to Wanda and Richard for the excellent design, which includes many native species of shrubs and trees. It will take several years to establish all of the plants, but some progress has been made. Green ash trees were planted around the steel building and some additional Caragana were planted near the pesticide building. Additional tree plantings are scheduled for 1985.

1984 was the second dry year in a row, with rainfall less than 50% of normal during the growing season. Seeding was earlier than normal, starting on April 9. At the station, barley and spring wheat on fallow yielded 51 and 29 bu/a, respectively. On first-year recrop, the yields were reduced to 26 and 17 bu/a for barley and spring wheat, respectively. With three or more years of continuous cropping, yields were almost zero. Drought was not the only peril. Winter wheat suffered winterkill, and sawflys damaged both winter and spring wheats. There were approximately 18 off-station experiments for the crops project, and 19 for the soils.

A short field day was held at the station on June 23, as part of the Weed Fair. On July 13, an off-station plot tour was conducted in Teton County.

A special grant of $13,000 from the Montana Wheat Research and Marketing Committee was given to the Reaearch Center for the purchase of an additional plot combine. Variety testing has been expanded to include no-till or minimum till conditions; and a soils/cropping systems project has been added to the Research Center. The extra harvest load was too much for one combine to accomplish without losing some plots to shatter; so the extra combine will be a great help.

Research Center staff during 1984 included Greg Kushnak, Superintendent and crops project; Dr. Alice Jones, soils/cropping systems project; Research Technicians Ron Thaut, Walt Adams, and Larry Christiaens; and Gladys Dunahoo secretary (half-time). Walt Adams resigned in September to become Teton County Extension Agent. We wish Walt the best in his new career.

The Advisory Committee had their annual meeting on December 18. With facility development fairly well completed, the Committee will now be able to focus more on providing suggestions for research programs. I wish to thank all the members, past and present, for their valuable assistance in getting the Research Center established.

Following is a list of Advisory Committee members:

Past Members

| | |
|---|---|
| Richard Page, Bynum, Teton Co. | 1977-79 |
| Dave Shane, Floweree, Cascade Co. | 1977-82 |
| Vade Hamma, Brady, Chouteau Co. | 1977-82 |
| Wilson Hodgskiss, Choteau, Teton Co. | 1977-83 |
| Don Buffington, Ledger, Liberty Co. | 1977-83 |
| Jerry Swenson, Cut Bank, Glacier Co. | 1977-83 |
| Karl Ratzburg, Ledger, Toole Co. | 1977-84 |
| Joe DeStaffany, Conrad, Pondera Co. | 1977-84 |
| Dale Vermulm, Cut Bank, Glacier Co. | 1977-84 |
| Jack Baringer, Conrad, Pondera Co. | 1977-84 |
| Bob LongCake, Shelby, Toole Co. | 1982-84 |
| Randy Weaver, Cut Bank, Glacier Co. | 1982-84 |

Re-appointed through 1985

Arnold Gettal, Power, Teton Co.
Gary Iverson, Sunburst, Toole Co.
Paul Kronebusch, Conrad, Pondera Co.

New appointment through 1985

Ted Neuman, Vaughn, Cascade Co.
Bill McLean, Brady, Chouteau Co.

New appointment through 1986

Leif Larson, Choteau, Teton Co.

New appointment through 1987

Miles Lewis, Cut Bank, Glacier Co.
Bruce Bradley, Cut Bank, Glacier Co.
Joe Larsen, Glata, Toole Co.
Bob Layne, Valier, Pondera Co.
Richard Thieltges, Chester, Liberty Co.
Bill Richter, Choteau, CES Representative (ex-officio)

Precipitation summary for the 1983-84 crop year (September through August) at Conrad, MT.

| | Sept 1983 | Oct 1983 | Nov 1983 | Dec 1983 | Jan 1984 | Feb 1984 | Mar 1984 | Apr 1984 | May 1984 | June 1984 | July 1984 | Aug 1984 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Precipitation (inches) | 0.95 | 0.09 | 0.44 | 0.35 | 0.27 | 0.18 | 0.27 | 0.77 | 0.95 | 1.14 | 0.53 | 0.58 | 6.52 |

Last killing frost in spring (32°) June 2

First killing frost in fall (32°) September 8

TITLE: Winter Wheat Investigations

YEAR: 1984

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, Galata, and on Station near Conrad. The trial on Station suffered winter injury and sawfly damage; both of which influenced yield ranking (Table 1). Varieties that were earlier to head appeared to escape sawfly damage more than the later types.

Data for the Dutton location are presented in Tables 2 and 3. Cheyenne was the highest yielder in 1984, but was among the lowest in 1983 due to shatter. Over a 2-year average, Centurk was the top yielding variety; and MT 8003, a selection from Redwin, showed potential to produce higher yield and protein than Centurk.

At Galata, yield differences were small among most varieties; probably due to the dry growing conditions (Table 4). The seed bed at this location was below optimum moisture conditions, but a good stand was obtained in two of the three replications. Consequently, the data in Table 4 is an average of only 2 replications.

A three location summary is presented in Table 5, and data from a variety trial grown near the "Knees" in Chouteau county are presented in Table 5a. The trial at the Knees location was conducted by the Northern Research Center, Havre.

Table 1. Intrastate winter wheat variety trial, 1984.
Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in . | Yield bu/a | Test wt. | % protein | % Spring survival |
|---|---|---|---|---|---|
| MT 8030 | 21 | 30.0 | 62.6 | 12.4 | 100 |
| Rosebud | 23 | 28.3 | 61.2 | 13.4 | 90 |
| MT 80168 | 21 | 27.7 | 60.6 | 14.2 | 67 |
| Cree* | 24 | 27.5 | 61.9 | 12.8 | 96 |
| Warrior | 25 | 27.3 | 62.0 | 14.8 | 96 |
| MT 7829 | 24 | 27.1 | 59.9 | 14.4 | 94 |
| MT 80194 | 23 | 27.0 | 60.5 | 13.0 | 100 |
| MT 80124 | 24 | 26.3 | 61.6 | 12.8 | 75 |
| MT 80132 | 22 | 25.9 | 62.6 | 12.8 | 83 |
| Roughrider | 24 | 25.6 | 61.9 | 15.1 | 95 |
| MT 80279 | 22 | 25.4 | 62.6 | 12.4 | 96 |
| MT 8039 | 22 | 25.3 | 58.7 | 14.4 | 83 |
| Rocky | 23 | 25.0 | 62.3 | 13.8 | 78 |
| Teton | 25 | 24.9 | 58.7 | 12.9 | 93 |
| Norstar | 27 | 24.6 | 60.6 | 13.5 | 100 |
| ND 7687 | 26 | 24.5 | 59.9 | 14.2 | 100 |
| Cheyenne | 25 | 24.2 | 60.7 | 13.4 | 84 |
| MT 8003 (Redw.Sel.) | 23 | 24.1 | 59.6 | 14.1 | 87 |
| MT 7934 | 25 | 23.7 | 59.8 | 13.7 | 80 |
| Froid | 26 | 23.5 | 60.1 | 14.1 | 93 |
| Winridge | 23 | 23.5 | 60.1 | 12.9 | 83 |
| MT 80280 | 23 | 22.5 | 60.6 | 14.7 | 82 |
| MT 8002 | 23 | 22.4 | 60.8 | 13.8 | 90 |
| Winalta | 23 | 21.9 | 62.3 | 14.2 | 93 |
| Redwin | 24 | 21.5 | 60.6 | 15.5 | 84 |
| MT 80119 | 22 | 20.9 | 60.1 | 13.5 | 78 |
| Centurk | 21 | 20.6 | 60.3 | 13.1 | 65 |
| Norwin (7877) | 19 | 20.7 | 62.3 | 14.7 | 94 |
| HT 841 | 22 | 20.6 | 60.6 | 13.9 | 63 |
| MT 80179 | 22 | 20.5 | 59.1 | 15.5 | 69 |
| MT 80121 | 23 | 20.1 | 59.9 | 15.1 | 63 |
| MT 80277 | 22 | 20.1 | 59.5 | 14.2 | 100 |
| MT 7930 | 21 | 19.7 | 60.3 | 14.2 | 69 |

(continued)

Table 1. continued Intrastate winter wheat.

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % protein | % Spring survival |
|---|---|---|---|---|---|
| Neeley | 23 | 19.5 | 61.2 | 13.0 | 81 |
| MT 80122 | 22 | 19.5 | 59.5 | 13.7 | 66 |
| MT 7811 | 22 | 19.2 | 60.9 | 14.8 | 88 |
| Archer | 19 | 19.2 | 59.4 | 12.8 | 62 |
| Bennett | 20 | 18.9 | 59.8 | 14.9 | 81 |
| MT 80273 | 22 | 18.8 | 60.8 | 12.9 | 69 |
| Brule | 21 | 18.6 | 60.3 | 12.4 | 75 |
| Citation | 19 | 16.6 | 59.5 | 15.9 | 44 |
| WS 775201 | 22 | 15.0 | -- | 13.7 | 40 |
| Crest | 20 | 14.5 | 60.5 | 13.9 | 44 |
| Hawk | 19 | 14.4 | 60.9 | 13.4 | 38 |
| MT 7951 | 22 | 13.4 | 59.4 | 13.6 | 61 |
| BH 201 | 19 | 13.1 | -- | 14.2 | 31 |
| Nugaines | 20 | 12.4 | 56.4 | 12.4 | 31 |
| HT 842 | 22 | 11.9 | 59.9 | 15.1 | 47 |
| SR 5677 | 20 | 10.7 | 61.1 | 14.1 | 40 |
| Brawny | 18 | 10.4 | 58.9 | 16.9 | 49 |
| SR 5221 | 22 | 10.1 | 60.1 | 12.9 | 53 |
| BH 310 | 20 | 9.6 | 60.1 | 14.2 | 38 |
| BH 202 | 20 | 8.5 | 57.5 | 13.0 | 19 |
| BH 203 | 20 | 5.2 | -- | 14.2 | 25 |
| BH 100 | 20 | 3.6 | -- | 13.1 | 16 |
| BH 301 | 20 | -- | -- | -- | 25 |

Location Research Center, N. of Conrad.
Fertilizer: 100# 11-51-0 with seed + 40 actual N shanked in.
Date seeded: September 22, 1983
Date harvested: August 7, 1984

Winter injury was measured as % spring survival. Additionally, lack of soil moisture and root development suppressed tillering.

Sawfly damage was moderate.
*Cree is a shatter resistant cheyenne.

Table 2. Winter wheat variety trial east of Dutton, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % protein |
|---|---|---|---|---|
| Cheyenne | 26 | 34.7 | 62.0 | 15.4 |
| Redwin | 25 | 33.3 | 61.7 | 15.6 |
| Centurk | 25 | 32.4 | 62.2 | 14.1 |
| Winridge | 26 | 30.5 | 60.3 | 12.9 |
| MT 8003 (Redw.Sel) | 25 | 29.9 | 60.2 | 14.9 |
| Rocky | 25 | 29.8 | 60.7 | 14.1 |
| Cree (77063)* | 26 | 29.8 | 60.7 | 15.3 |
| Norstar | 29 | 28.9 | 60.2 | 13.9 |
| Rosebud | 26 | 27.9 | 60.2 | 15.6 |
| Norwin (7877) | 19 | 27.4 | 61.0 | 15.8 |
| Winalta | 26 | 26.1 | 61.2 | 15.4 |
| Roughrider | 26 | 21.5 | 60.3 | 15.6 |
| Brawny | 22 | 20.2 | 61.0 | 16.0 |
| Citation | 20 | 19.3 | 59.5 | 15.0 |

F-test sig .01; L.S.D. = 4.4 bu; C.V. = 9.5%
Cooperator: Darryl Goodmundson, east of Dutton.
Fertilizer: 11-51-0 actual with seed + 80 AA actual
Previous crop: Fallow
Date seeded: September 20, 1983
Date harvested: July 31, 1984
Shattering & sawfly damage: none
*Cree is a shatter resistant cheyenne.

Table 3. Two-year summary for winter wheat varieties grown near Dutton, 1983-84. Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Two - year average Height inches | Yield bu/a | Test wt. | % protein |
|---|---|---|---|---|
| MT 8003 | 30 | 51.3 | 61.1 | 13.1 |
| Centurk | 30 | 50.4 | 62.9 | 11.9 |
| Cree | 34 | 49.1 | 61.8 | 12.8 |
| Rocky | 30 | 49.0 | 62.0 | 12.6 |
| Redwin | 30 | 48.8 | 60.6 | 13.0 |
| Norwin | 22 | 47.0 | 60.9 | 14.2 |
| Cheyenne* | 33 | 44.7 | 62.1 | 13.5 |
| Citation | 23 | 42.3 | 60.9 | 16.6 |
| Winalta | 34 | 41.7 | 62.4 | 13.3 |
| Norstar | 37 | 41.2 | 61.0 | 12.1 |
| Brawny | 25 | 37.1 | 61.8 | 15.0 |

Cooperator and location: Darryl Goodmundson, east of Dutton
Previous crop: Fallow
Fertilizer (each year): 82#N as A.A. + 100# 11-51-0.
Seed date (each year): September 20
*Cheyenne shattered severly in 1983.

Table 4. Winter wheat variety trial, east of Galata, 1984.
Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT

| Variety | Yield bu/a | Test wt | % protein |
|---|---|---|---|
| Cheyenne | 25.9 | 59.4 | 15.4 |
| Centurk | 25.4 | 56.5 | 15.8 |
| Rocky | 24.7 | 57.6 | 15.8 |
| Redwin | 24.6 | 57.4 | 16.1 |
| Winalta | 24.4 | 59.1 | 15.8 |
| MT 8003 (Redw.Sel) | 24.2 | 57.4 | 14.8 |
| Rosebud | 24.0 | 57.0 | 15.0 |
| Winridge | 24.0 | 54.9 | 15.5 |
| Norwin (7877) | 23.3 | 59.5 | 15.3 |
| Roughrider | 23.3 | 56.2 | 16.8 |
| Cree (77063)* | 21.8 | 59.5 | 15.3 |
| Citation | 20.5 | 56.5 | 14.6 |
| Norstar | 19.4 | 56.7 | 15.5 |
| Brawny | 19.2 | 59.5 | 16.0 |

F- test n.s.; L.S.D. = 4.6 bu; C.V. = 9.1%
Cooperator: Joe Larsen, NE of Galata, Toole Co.
Fertilizer: 11-51-0 actual with seed.
Previous crop: Fallow
Date seeded: September 12, 1983; 3" deep
Date harvested: July 30, 1984
Shattering or sawfly damage: none

Table 5. Three-location summary of winter wheat varieties grown in the Western Triangle Area, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Yield, bu/a Dutton | Galata | Conrad * | 3-location average |
|---|---|---|---|---|
| Cheyenne | 34.7 | 25.9 | 24.2 | 28.3 |
| Rosebud | 27.9 | 24.0 | 28.3 | 26.7 |
| Redwin | 33.3 | 24.6 | 21.5 | 26.5 |
| Rocky | 29.8 | 24.7 | 25.0 | 26.5 |
| Cree | 29.8 | 21.8 | 27.5 | 26.4 |
| Centurk | 32.4 | 25.4 | 20.6 | 26.1 |
| MT 8003 | 29.9 | 24.2 | 24.1 | 26.1 |
| Winridge | 30.5 | 24.0 | 23.5 | 26.0 |
| Norstar | 28.9 | 19.4 | 24.6 | 24.3 |
| Winalta | 26.1 | 24.4 | 21.9 | 24.1 |
| Norwin | 27.4 | 23.3 | 20.7 | 23.8 |
| Roughrider | 21.5 | 23.3 | 25.6 | 23.5 |
| Citation | 19.3 | 20.5 | 16.6 | 18.8 |
| Brawny | 20.2 | 19.2 | 10.4 | 16.6 |

* Conrad data influenced by winterkill and sawflys.

Table 5a. Winter wheat variety trial grown near the "Knees" in western Chouteau county. Mont. Agr. Expt. Sta., Northern Agricultural Research Center, Havre, MT.

| Variety | Height inches | Yield bu/a | Test wt. |
|---|---|---|---|
| CI 17902 Winridge | 27.33 | 45.23 | 57.93 |
| CI 15075 Centurk | 26.67 | 45.20 | 62.20 |
| CI 8885 Cheyenne | 28.67 | 44.20 | 62.47 |
| CI 17439 Roughrider | 28.25 | 43.47 | 60.40 |
| NA 1316 Rocky | 27.58 | 42.60 | 62.33 |
| MT 8003 Redwin Sel. | 25.17 | 41.17 | 61.00 |
| MT 77063 Cree | 26.33 | 41.00 | 61.47 |
| CI 13670 Winalta | 29.33 | 40.47 | 62.67 |
| CI 17844 Redwin | 28.00 | 39.80 | 61.27 |
| PI473570 Rosebud | 26.67 | 39.70 | 60.70 |
| MT 7877 Norwin | 20.33 | 36.70 | 59.60 |
| SR 4714 Brawny | 23.75 | 36.67 | 61.40 |
| CI 17735 Norstar | 32.33 | 34.70 | 60.20 |
| SR 4685 Citation | 23.92 | 29.47 | 60.47 |
| C.V. % | 7.34 | 12.7 | 1.6 |
| LSD .05 | 3.29 | 8.53 | 1.62 |

Cooperator : Dan Picard

TITLE: Spring Wheat Investigations

YEAR: 1984

LOCATION: Western Triangle Research Center, Conrad, MT

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

Spring wheat variety trials were grown near Conrad, Cut Bank, Sunburst, and Choteau. Data for 1984 are presented in Tables 6, 9, 11, 13, and 15; with multiple year averages in Tables 10, 12, 14, and 16. Data for variety evaluations on no-till are presented in Tables 7 and 8.

Except for the Cut Bank location, yields were influenced by sawfly damage and resistant varieties yielded the highest. Of the sawfly resistant varieties, Glenman tended to be the highest yielder, but had low test weight. Glenman is a new semidwarf variety from Montana Agricultural Experiment Station and USDA/ARS and should be available in limited quantities by 1985 or 1986.

Durum yields ranked fairly high at some of the sawfly infested locations. Although not resistant, the durums appeared to be less preferred by sawflys when grown amidst susceptible spring wheats in small plots. However, on a larger field scale, durums are vulnerable to sawflys.

The no-till trial was damaged by sawflys, and subsequently the resistant varieties performed the best.

Table 6. Advanced yield spring wheat variety trial, north of Conrad, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| Fortuna * | 24 | 29.1 | 60.5 | 14.1 |
| Glenman (7819 Aytsor) * | 23 | 26.9 | 57.8 | 14.6 |
| Glenman (7819 Brdr) * | 23 | 26.7 | 57.9 | 14.4 |
| MT 8320 | 24 | 26.3 | 59.9 | 15.3 |
| MT 7926 * | 25 | 25.1 | 59.9 | 14.5 |
| Lew * | 24 | 24.6 | 59.8 | 14.7 |
| MT 8306 | 23 | 23.7 | 58.7 | 15.7 |
| Waverly (white) | 19 | 23.4 | 56.4 | 13.7 |
| MT 8336 | 23 | 22.8 | 61.3 | 15.9 |
| Neepawa | 24 | 22.6 | 57.9 | 14.9 |
| MT 8177 * | 21 | 22.5 | 59.9 | 14.3 |
| Thatcher | 24 | 22.5 | 57.2 | 15.3 |
| MT 8333 | 22 | 22.4 | 58.2 | 15.6 |
| MT 8043 | 22 | 22.3 | 59.9 | 13.5 |
| NK 4342 | 22 | 22.2 | 59.9 | 15.0 |
| Stoa | 23 | 22.2 | 59.3 | 15.6 |
| MT 8282 | 21 | 21.7 | 57.1 | 14.1 |
| MT 8352 | 23 | 21.5 | 58.3 | 15.2 |
| Pondera | 23 | 21.2 | 60.2 | 15.3 |
| MT 8328 | 24 | 21.1 | 59.9 | 15.4 |
| MT 808 | 19 | 21.1 | 58.3 | 14.2 |
| Cando durum | 19 | 20.6 | 61.3 | 15.2 |
| Newana | 21 | 20.1 | 60.6 | 15.0 |
| MT 8218 | 20 | 19.9 | 57.8 | 14.0 |
| MT 8321 | 22 | 19.9 | 56.6 | 15.7 |
| Len | 22 | 19.8 | 59.9 | 14.9 |
| MT 8316 | 22 | 19.8 | 59.8 | 15.9 |
| Vic durum | 22 | 19.6 | 60.7 | 15.1 |
| Centa | 25 | 19.4 | 61.3 | 15.5 |
| MT 8365 | 23 | 19.3 | 59.8 | 16.4 |
| MT 8313 | 22 | 19.0 | 59.5 | 15.4 |
| Crosby durum | 23 | 18.6 | 60.1 | 16.8 |
| Challenger | 22 | 18.4 | 60.3 | 15.1 |

(continued)

Table 6. (continued).

| Variety | Plant hgt. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| Ward durum | 23 | 18.2 | 59.8 | 16.3 |
| MT 8184 | 20 | 18.1 | 60.9 | 14.3 |
| MT 8330 | 23 | 18.1 | 59.6 | 15.0 |
| H 78113 | 20 | 18.0 | 58.7 | 14.5 |
| Butte | 23 | 17.8 | 61.3 | 15.1 |
| Alex | 24 | 17.7 | 59.8 | 15.7 |
| MT 8344 | 20 | 17.3 | 59.5 | 15.9 |
| Lloyd durum | 19 | 17.0 | 59.5 | 13.2 |
| Guard | 21 | 16.7 | 60.3 | 14.6 |
| Owens (white) | 20 | 16.2 | 58.3 | 13.4 |
| McKay | 22 | 16.2 | 57.4 | 13.2 |
| Marshall | 20 | 15.9 | 58.3 | 14.9 |
| MT 8277 | 22 | 15.6 | 58.3 | 14.9 |
| Oslo | 20 | 15.6 | 57.7 | 14.9 |
| NK 8002 | 21 | 14.7 | 59.9 | 14.9 |
| MT 8017 | 21 | 14.4 | 58.8 | 15.6 |
| Olaf | 20 | 12.1 | 58.8 | 14.4 |

Location: Station, N. of Conrad
Previous crop: Fallow
Seed date: April 13, 1984
Harvest date: August 6, 1984
Fertilizer: 51-51-0 actual.
Sawfly damage: moderate, except none on resistant lines.
* Sawfly resistant.

Table 7. Comparison of spring wheat varieties under recrop and summerfallow conditions, 1984. Montana Agr. Exp. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Height | | Test Wt. | | % Protein | | Yield-bu/a | |
|---|---|---|---|---|---|---|---|---|
| | fallow | recrop | fallow | recrop | fallow | recrop | fallow | recrop |
| Fortuna* | 24 | 20 | 60.5 | 60.2 | 14.1 | 15.1 | 29.1 | 15.0 |
| Glenman* | 23 | 19 | 57.8 | 57.1 | 14.5 | 13.9 | 26.9 | 16.9 |
| Lew* | 24 | 20 | 59.8 | 58.8 | 14.7 | 14.4 | 24.6 | 15.2 |
| Waverly (white) | 19 | 16 | 56.4 | 56.0 | 13.7 | 12.6 | 23.4 | 15.6 |
| MT 8043 | 22 | 20 | 59.9 | 58.8 | 13.5 | 13.4 | 22.3 | 14.1 |
| Stoa | 23 | 20 | 59.3 | 58.9 | 15.6 | 14.3 | 22.2 | 13.2 |
| Pondera | 23 | 20 | 60.2 | 59.6 | 15.3 | 16.0 | 21.2 | 11.1 |
| Cando durum | 19 | 17 | 61.3 | 60.1 | 15.2 | 15.4 | 20.6 | 13.2 |
| Newana | 21 | 18 | 60.6 | 58.8 | 15.0 | 14.6 | 20.1 | 11.5 |
| Vic durum | 22 | 20 | 60.7 | 57.0 | 15.1 | 15.2 | 19.6 | 11.5 |
| Ward durum | 23 | 19 | 59.8 | 58.2 | 16.3 | 14.7 | 18.2 | 12.6 |
| Lloyd durum | 19 | 16 | 59.5 | 57.7 | 13.2 | 14.7 | 17.0 | 13.9 |
| Owens (white) | 20 | 19 | 58.3 | 57.8 | 13.4 | 12.9 | 16.2 | 13.0 |
| McKay | 22 | 19 | 57.4 | 56.3 | 13.2 | 13.6 | 16.2 | 12.1 |
| Marshall | 20 | 16 | 58.3 | 56.7 | 14.9 | 15.7 | 15.9 | 11.9 |
| MT 8017 | 21 | 18 | 58.8 | 59.4 | 15.6 | 15.5 | 14.4 | 13.8 |
| Olaf | 20 | 17 | 58.8 | 59.1 | 14.4 | 14.3 | 12.1 | 13.7 |
| Wampum | -- | 18 | -- | 56.3 | -- | 14.1 | -- | 11.9 |
| F-test | | | | | | | | sig.05 |
| L.S.D. | | | | | | | | 2.9 |
| C.V. % | | | | | | | | 13.2 |

Location: Research Center, N. of Conrad.
Seed Date: April 13, 1984.
Harvest Date: August 2, 1984.
Fertilizer: 51-51=0 fallow; 61-51-0 recrop.
Recrop no-till seeded into spring wheat stubble.
Sawfly damage: moderate, except none for resistent varieties.
*Sawfly resistant.
1984 rainfall (January to harvest) = 4.1"

Table 8. Spring wheat variety trial on no-till recrop near Conrad, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| Glenman (7819)* | 19 | 16.9 | 57.1 | 13.9 |
| Waverly (white) | 16 | 15.6 | 56.0 | 12.6 |
| Lew * | 20 | 15.2 | 58.8 | 14.4 |
| Fortuna * | 20 | 15.0 | 60.2 | 15.1 |
| MT 8043 | 20 | 14.1 | 58.8 | 13.4 |
| Lloyd durum | 16 | 13.9 | 57.7 | 14.7 |
| MT 8017 | 18 | 13.8 | 59.4 | 15.5 |
| Olaf | 17 | 13.7 | 59.1 | 14.3 |
| Cando durum | 17 | 13.2 | 60.1 | 15.4 |
| Stoa | 20 | 13.2 | 58.9 | 14.3 |
| Owens (white) | 19 | 13.0 | 57.8 | 12.9 |
| Ward durum | 19 | 12.6 | 58.2 | 14.7 |
| McKay | 19 | 12.1 | 56.3 | 13.6 |
| Marshall | 16 | 11.9 | 56.7 | 15.4 |
| Wampum | 18 | 11.9 | 56.3 | 14.1 |
| Newana | 18 | 11.5 | 58.8 | 14.6 |
| Vic durum | 20 | 11.5 | 57.0 | 15.2 |
| Pondera | 20 | 11.1 | 59.6 | 16.0 |

F-test sig .05; L.S.D. = 2.9 bu; C.V = 13.2%
Location: Research Center, north of Conrad.
Seed date: April 13, 1984
Harvest date: August 2, 1984
Previous crop: Lew spring wheat
Fertilizer: 61-51-0 actual
Sawfly damage: moderate, except none for resistant varieties.
* Sawfly resistant.
1984 rainfall (Jan 1 to harvest): 4.1"

Table 9. Spring wheat variety trial grown north of Cut Bank, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| Waverly (white) | 21 | 21.3 | 55.8 | 14.0 |
| MT 8017 | 21 | 19.0 | 57.1 | 16.9 |
| Newana | 22 | 18.9 | 59.5 | 15.3 |
| Glenman (7819) * | 23 | 18.9 | 56.7 | 14.1 |
| Owens (white) | 19 | 18.4 | 55.3 | 15.7 |
| Fortuna * | 21 | 17.3 | 59.1 | 15.7 |
| Pondera | 21 | 17.2 | 58.1 | 17.1 |
| McKay | 20 | 16.8 | 56.3 | 15.3 |
| Lew * | 23 | 16.7 | 58.1 | 15.7 |
| Ward durum | 26 | 16.4 | 58.1 | 17.0 |
| Olaf | 22 | 16.1 | 56.8 | 16.8 |
| Cando durum | 19 | 16.0 | 59.8 | 15.0 |
| Marshall | 18 | 15.6 | 56.7 | 15.7 |
| Vic durum | 25 | 15.5 | 59.4 | 17.2 |
| Stoa | 22 | 15.3 | 57.4 | 16.9 |
| Wampum | 19 | 15.0 | 55.7 | 15.9 |
| Lloyd durum | 18 | 14.4 | 57.2 | 17.6 |
| MT 8043 | 18 | 14.0 | 57.2 | 14.7 |

F-test sig .05; L.S.D. = 3.8 bu; C.V. = 13.6%
Cooperator & Location: Don Bradley, N. of Cut Bank
Previous crop: fallow
Seed date: May 4, 1984.
Harvest date: August 21, 1984
Fertilizer: 11-51-0 actual with seed.
* Sawfly resistant.

Table 10. Three-year summary for spring wheat varieties grown north of Cut Bank, 1982-1984. Mont. Agr. Expt. Sta.; Western Triangle Research Center. Conrad, MT.

| Variety | 3 - year average Height in. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| Glenman * | 26 | 37.0 | 57.5 | 13.7 |
| Newana | 25 | 36.4 | 58.9 | 13.8 |
| McKay | 25 | 35.0 | 57.5 | 14.0 |
| Wampum | 25 | 34.8 | 56.3 | 13.8 |
| Pondera | 25 | 34.4 | 59.1 | 14.8 |
| Olaf | 26 | 33.3 | 57.8 | 14.7 |
| Marshall | 22 | 32.8 | 55.8 | 14.5 |
| Lloyd durum | 21 | 32.4 | 57.0 | 15.6 |
| Fortuna * | 29 | 31.6 | 58.9 | 13.9 |
| Lew * | 29 | 31.4 | 59.2 | 14.6 |
| Cando durum | 21 | 31.1 | 59.7 | 14.0 |
| Vic durum | 29 | 30.7 | 59.2 | 15.4 |
| Ward durum | 30 | 29.0 | 58.4 | 15.7 |

* Sawfly resistant

note: Sawflys have not been present at this site during the test period.

Table 11. Spring wheat variety trial near Sunburst, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| Glenman (7819) * | 17 | 18.6 | 57.8 | 13.3 |
| Fortuna * | 21 | 18.1 | 59.1 | 13.7 |
| MT 8043 | 18 | 17.7 | 58.2 | 11.3 |
| Lloyd durum | 19 | 17.6 | 57.9 | 12.7 |
| Newana | 18 | 16.7 | 59.4 | 12.4 |
| Waverly (white) | 19 | 16.0 | 55.4 | 12.9 |
| Lew * | 20 | 15.9 | 58.4 | 14.0 |
| Olaf | 19 | 15.5 | 60.2 | 13.8 |
| Stoa | 20 | 15.4 | 59.4 | 14.4 |
| Cando durum | 18 | 15.3 | 60.3 | 14.8 |
| Ward durum | 20 | 15.1 | 61.2 | 14.8 |
| Wampum | 20 | 15.0 | 56.7 | 13.5 |
| Owens (white) | 16 | 14.5 | 55.6 | 11.5 |
| Vic durum | 21 | 14.2 | 59.4 | 13.3 |
| MT 8017 | 17 | 12.6 | 57.9 | 14.4 |
| Pondera | 18 | 12.4 | 59.9 | 15.1 |
| McKay | 18 | 10.0 | 55.7 | 13.3 |
| Marshall | 15 | 8.7 | 59.4 | 15.5 |

F- test sig .01 ; L.S.D. = 3.4 bu ; C.V. = 13.7%
Cooperator & location: Dave Sandon, SE of Sunburst, Toole Co.
Seed date: April 11, 1984
Harvest date: August 3, 1984
Previous crop: Fallow
Fertilizer: 11-51-0 actual with seed.
Sawfly damage: moderate, except none for resistant varities. (severe loss to sawfly was likely if harvest had been delayed a few days).
* Sawfly resistant variety.

Table 12. Two-year summary for spring wheat varieties grown near Sunburst, 1983-1984. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT.

| Variety | 2 - year average | | | |
|---|---|---|---|---|
| | Height in. | Yield bu/a | Test wt. | % Protein |
| Glenman * | 18 | 24.0 | 58.4 | 13.2 |
| Fortuna * | 23 | 23.7 | 60.3 | 13.0 |
| Lew * | 22 | 23.5 | 59.2 | 13.5 |
| Cando durum | 20 | 22.0 | 61.4 | 13.8 |
| Lloyd durum | 20 | 21.8 | 59.5 | 12.5 |
| Newana | 20 | 20.6 | 60.3 | 12.4 |
| Ward durum | 22 | 19.6 | 61.4 | 14.1 |
| Pondera | 21 | 18.0 | 60.5 | 14.2 |
| Olaf | 22 | 17.7 | 60.4 | 13.5 |
| Vic durum | 24 | 16.5 | 60.5 | 13.3 |
| McKay | 21 | 16.0 | 57.7 | 12.8 |
| Wampum | 22 | 15.4 | 55.8 | 13.2 |
| Marshall | 17 | 13.3 | 59.2 | 13.9 |

* Sawfly resistant

note: Yields in these trials have been affected by sawflys.

Table 13. Spring wheat variety trial near Choteau, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| MT 8043 | 25 | 28.1 | 59.3 | 13.3 |
| Fortuna * | 28 | 27.8 | 61.2 | 13.7 |
| Glenman (7819)* | 24 | 27.8 | 58.8 | 12.2 |
| Lloyd durum | 23 | 27.6 | 60.3 | 12.8 |
| Lew * | 27 | 26.9 | 60.0 | 13.2 |
| Waverly (white) | 22 | 25.2 | 58.1 | 12.2 |
| Pondera | 25 | 25.0 | 61.3 | 13.0 |
| Owens (white) | 24 | 24.8 | 60.5 | 11.7 |
| Ward durum | 30 | 24.6 | 61.8 | 13.1 |
| Newana | 23 | 24.2 | 61.8 | 12.1 |
| Vic durum | 30 | 24.0 | 62.0 | 13.5 |
| Cando durum | 21 | 23.9 | 62.0 | 13.9 |
| Stoa | 29 | 23.2 | 60.9 | 13.1 |
| MT 8017 | 22 | 20.6 | 59.1 | 13.8 |
| Olaf | 26 | 19.3 | 60.5 | 13.0 |
| McKay | 25 | 19.3 | 59.1 | 12.2 |
| Wampum | 26 | 19.3 | 58.5 | 12.5 |
| Marshall | 21 | 17.0 | 59.1 | 13.6 |

F- test sig .05 ; L.S.D. = 3.4 bu ; C.V. = 8.5%
Cooperator & location: Herb Corey, NE of Choteau, Teton Co.
Seed date: April 9, 1984
Harvest date: August 9, 1984
Previous crop: Fallow
Fertilizer: 56-51-0
Sawfly damage: none for resistant varieties; slight for durums; and moderate for the remaining varieties. Note: durums are not resistant, but are less desireable to sawflys when grown amidst other susceptible spring wheats.
*Sawfly resistant.

Table 14. Four-year summary of spring wheat varieties grown near Choteau, 1981-1984. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT.

| Variety | 4 year average | | | |
|---|---|---|---|---|
| | Height in. | Yield bu/a | Test wt. | % Protein |
| Lloyd durum | 24 | 51.4 | 60.8 | 12.3 |
| Glenman* | 27 | 50.6 | 59.6 | 12.9 |
| Lew* | 30 | 49.5 | 61.2 | 13.6 |
| Cando durum | 24 | 48.4 | 62.5 | 12.8 |
| Pondera | 27 | 48.3 | 61.2 | 13.2 |
| Fortuna* | 30 | 47.5 | 61.9 | 13.5 |
| McKay | 27 | 46.0 | 60.0 | 12.8 |
| Newana | 25 | 45.5 | 61.2 | 13.0 |
| Ward durum | 32 | 44.3 | 61.8 | 13.6 |
| Wampum | 29 | 43.3 | 58.3 | 12.3 |
| Olaf | 27 | 42.6 | 60.6 | 13.7 |
| Vic durum | 33 | 42.0 | 62.0 | 13.2 |
| Marshall | 25 | 35.4 | 59.6 | 13.0 |

* Sawfly resistant

note: Yields in these trials have been affected by sawflys.

Table 15. Irrigated spring wheat variety trial north of Choteau, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % Protein |
|---|---|---|---|---|
| MT 8043 | 26 | 47.1 | 60.4 | |
| Newana | 27 | 46.8 | 61.5 | |
| Glenman (7819)* | 27 | 44.5 | 59.5 | |
| McKay | 25 | 43.7 | 58.5 | |
| Owens (white) | 25 | 43.6 | 60.9 | |
| Solar | 25 | 42.6 | 59.8 | |
| Cando (durum) | 24 | 42.1 | 60.3 | |
| Lloyd (durum) | 23 | 41.7 | 59.4 | |
| Wampum | 26 | 41.5 | 58.8 | |
| Waverly (white) | 26 | 40.0 | 59.1 | |
| Pondera | 26 | 39.5 | 60.7 | |
| Vic (durum) | 27 | 38.7 | 61.0 | |
| MT 8017 | 26 | 38.4 | 59.8 | |
| Marshall | 25 | 36.9 | 59.3 | |
| Stoa | 26 | 36.0 | 60.2 | |
| Olaf | 25 | 35.1 | 60.0 | |
| Lew* | 28 | 35.1 | 59.2 | |
| Ward durum | 29 | 34.8 | 59.5 | |
| Fortuna * | 30 | 32.4 | 60.5 | |

F-test sig .01 ; L.S.D. = 7.6 bu ; C.V. = 11.6%
Cooperator & location: Lyle Weist, NE of Choteau, Teton Co.
Previous crop: spring wheat.
Fetilizer: 11-51-0 actual with seed + 100 AA actual + 20-20-20.
Seed date: April 9, 1984
Harvest date: August 29, 1984
Sawfly damage: none
* Sawfly resistant

Table 16. Two-year summary for irrigated spring wheat varieties grown north of Choteau, 1983-84. Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Two - year average | |
|---|---|---|
| | Height inches | Yield bu/a |
| Newana | 30 | 54.6 |
| McKay | 29 | 54.6 |
| Lloyd durum | 31 | 52.0 |
| Wampum | 31 | 52.0 |
| Glenman | 29 | 51.4 |
| Cando durum | 27 | 51.1 |
| Marshall | 28 | 51.0 |
| Pondera | 29 | 50.2 |
| Ward durum | 35 | 47.0 |
| Vic durum | 31 | 47.0 |
| Olaf | 29 | 46.6 |
| Lew | 32 | 45.6 |
| Fortuna | 32 | 42.6 |

Cooperator and location: Lyle Weist, N E of Choteau.
Previous crop (each year): spring wheat.
Fertilizer (each year): 100# N as A.A. + 100# 11-51-0 + 20-20-20
Seed dates: May 2, 1983; April 9, 1984.
Irrigation method: center pivot.

Table 17. Uniform Regional Durum Nursery, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Accession number | Variety or Cross | Plant hgt. in. | Yield bu/a | Test wt. | % Sawfly cutting |
|---|---|---|---|---|---|
| C8814 | --- | 23 | 20.3 | 60.8 | 30 |
| P47829 | 77204/7618 | 19 | 19.6 | 59.5 | 10 |
| PI7438 | Cando | 20 | 19.3 | 59.5 | 80 |
| D79209 | D74111/CD | 19 | 17.3 | 60.2 | 30 |
| D80162 | 774/7224 | 20 | 16.4 | 60.1 | 30 |
| P17282 | Crosby | 23 | 16.3 | 59.7 | 20 |
| P17789 | Vic | 22 | 16.2 | 60.1 | 20 |
| D80152 | 773/Cal | 19 | 16.0 | 60.3 | 80 |
| P5296 | Mindum | 24 | 15.6 | 61.0 | 10 |
| D7925 | 7456/Vic | 21 | 15.3 | 59.3 | 40 |
| D79104 | --- | 20 | 15.1 | 60.1 | 40 |
| P47829 | --- | 17 | 15.1 | 60.4 | 60 |
| P17284 | Rugby | 20 | 15.0 | 59.3 | 20 |
| DT375 | --- | 22 | 14.4 | 59.3 | 60 |
| D8012 | --- | 20 | 14.2 | 59.0 | 20 |
| D79103 | --- | 20 | 14.1 | 60.4 | 40 |
| DT371 | WSC/HC | 22 | 13.5 | 57.6 | 50 |
| DT411 | Coulter | 20 | 13.4 | 59.1 | 90 |
| DT433 | Medora | 21 | 13.3 | 60.0 | 10 |
| H81466 | Cal/Ed | 19 | 13.2 | 60.5 | 60 |
| D79168 | 7224/Vic | 19 | 12.7 | 61.0 | 20 |
| H81485 | Ed/Ward | 21 | 12.7 | 60.3 | 80 |
| P47621 | Lloyd | 18 | 12.6 | 59.0 | 20 |
| D8082 | --- | 19 | 12.5 | 60.1 | 20 |
| D793 | 7456/Vic | 19 | 12.3 | 59.5 | 20 |
| D8034 | --- | 18 | 12.2 | 58.1 | 10 |
| D8019 | --- | 17 | 12.0 | 58.1 | 20 |
| P15892 | Ward | 20 | 11.7 | 59.4 | 20 |
| D8016 | --- | 19 | 11.6 | 58.7 | 60 |
| P15326 | Rolette | 19 | 10.5 | 59.7 | 10 |

F- test sig .01 ; L.S.D. = 3.4 bu ; C.V. = 14.4%
Location: Research Center, N. of Conrad
Previous crop: Fallow
Fertilizer: 11-51-0 actual with seed + 40 AN actual shanked in.
Seed date: April 13, 1984
Harvest date: August 15, 1984
1984 precipitation (Jan 1 to harvest): 4.1"

TITLE: Barley Investigations

YEAR: 1984

LOCATION: Western Triangle Research Center, Conrad

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

Dryland Barley variety trials were grown near Conrad, Cut Bank, Sunburst, and Choteau. Data are presented in Tables 18-27.

Among the 2-row malt types, yields of Lewis and Clark were similar at all locations; and were higher than Klages. Clark has malt status in Montana; but the designation of Lewis as a malt variety is pending further tests.

Among the 2-row feed varieties, Hector, Summit, and Bridger-82 were among the top yielders at all locations. The 6-row malt types generally yielded low, and were apparently less tolerant to drought.

On irrigated, the feed varieties Piston and Bridger-82 yielded 10-15 bu/a higher than the malt varieties (Table 26).

At Conrad, varieties were tested on both fallow and no-till/recrop conditions (Tables 19 & 20). Recrop yields were approximately half of fallow yields, which was a reflection of the drought conditions of 1984. Hector and Clark ranked high under both cropping systems, indicating a dual purpose adaptation of these varieties. However, diseases were not present in this test; which is a factor that will likely affect no-till variety performance during wet years.

Table 18. Barley variety trial (Intrastate & West Dryland) N. of Conrad, 1984. Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| MT81619 | 21 | 55.3 | 47.3 | 50 | 21 | |
| Gallatin | 21 | 53.8 | 48.3 | 38 | 24 | |
| MT41279 | 20 | 53.3 | 49.1 | 48 | 22 | |
| Lindy | 22 | 53.2 | 44.2 | 66 | 9 | |
| Munsing | 19 | 52.9 | 50.1 | 71 | 6 | |
| Steptoe | 22 | 52.3 | 45.0 | 68 | 8 | |
| MT4126 | 20 | 52.2 | 48.8 | 40 | 20 | |
| Teton | 21 | 51.9 | 44.4 | 72 | 8 | |
| Summit | 21 | 51.4 | 47.4 | 23 | 43 | |
| Hector | 22 | 50.9 | 49.0 | 35 | 27 | |
| MT 312526 | 22 | 50.9 | 47.9 | 35 | 28 | |
| Cornel | 20 | 49.3 | 49.2 | 82 | 5 | |
| BA296 | 20 | 49.3 | 47.2 | 65 | 11 | |
| Bridger-82 | 20 | 49.0 | 48.6 | 50 | 16 | |
| MT 81192 | 22 | 49.0 | 48.3 | 55 | 18 | |
| Clark | 21 | 49.0 | 46.9 | 39 | 24 | |
| Bowman | 21 | 48.8 | 51.5 | 91 | 3 | |
| Piroline | 21 | 48.7 | 50.8 | 55 | 12 | |
| ID810264 | 21 | 48.2 | 46.4 | 53 | 17 | |
| ID789009 | 20 | 47.9 | 47.6 | 66 | 9 | |
| MT 312613 | 21 | 47.6 | 48.9 | 64 | 11 | |
| Lewis | 20 | 46.9 | 49.4 | 62 | 14 | |
| MT7312 | 21 | 46 7 | 49 9 | 40 | 21 | |
| Apex | 20 | 46.7 | 49.3 | 51 | 13 | |
| MT81502 | 20 | 46.6 | 47.5 | 42 | 25 | |
| Harrington | 20 | 46.5 | 47.4 | 51 | 20 | |
| Robust | 22 | 46.5 | 47.0 | 54 | 16 | |
| MT41918 | 20 | 46.5 | 46.2 | 34 | 29 | |
| Morex | 24 | 46.1 | 46.2 | 45 | 15 | |
| Bellona | 19 | 46.0 | 46.6 | 44 | 21 | |
| BA26 | 20 | 45.6 | 45.0 | 58 | 16 | |
| VDH31578 | 20 | 45.4 | 47.9 | 34 | 23 | |
| TR451 | 21 | 45.3 | 47.6 | 31 | 35 | |

(continued)

Table 18. (Intrastate Barley cont.)

| Variety | Plant hgt. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| MT311885 | 20 | 45.4 | 46.9 | 43 | 21 | |
| UT1733 | 23 | 45.4 | 44.9 | 44 | 20 | |
| VDH43278A | 20 | 45.3 | 46.9 | 58 | 12 | |
| MT81615 | 20 | 45.1 | 48.6 | 71 | 10 | |
| Piston | 19 | 44.8 | 47.2 | 40 | 23 | |
| Menuet | 19 | 44.7 | 48.5 | 47 | 19 | |
| MT81143 | 21 | 44.1 | 51.1 | 77 | 8 | |
| Hazen | 22 | 43.8 | 45.3 | 45 | 18 | |
| Abee | 19 | 43.7 | 46.7 | 24 | 39 | |
| Sunbar-560 | 18 | 43.6 | 46.1 | 46 | 24 | |
| Triumph | 19 | 43.5 | 48.0 | 21 | 39 | |
| Karla | 20 | 43.3 | 45.2 | 28 | 32 | |
| ID810099 | 21 | 43.1 | 46.7 | 58 | 15 | |
| Premier | 20 | 43.1 | 46.5 | 31 | 33 | |
| MT81535 | 19 | 43.0 | 48.1 | 67 | 11 | |
| UT1731 | 24 | 42.7 | 44.0 | 63 | 13 | |
| Andante | 19 | 42.6 | 47.1 | 32 | 30 | |
| WP787 | 20 | 42.4 | 43.5 | 17 | 41 | |
| WA889278 | 20 | 41.3 | 47.6 | 32 | 30 | |
| UT1423 | 19 | 41.2 | 42.4 | 27 | 34 | |
| BA7937 | 20 | 40.9 | 47.1 | 22 | 40 | |
| UDH22476C | 19 | 40.9 | 43.1 | 20 | 51 | |
| UT1422 | 19 | 39.8 | 40.7 | 17 | 50 | |
| AZ-28 | 16 | 36.9 | 43.9 | 55 | 19 | |
| UDH13078 | 19 | 36.8 | 50.1 | 64 | 12 | |
| WA145837 | 18 | 36.4 | 41.7 | 7 | 73 | |
| UT1734 | 21 | 35.9 | 43.5 | 64 | 12 | |
| Klages | 22 | 31.5 | 45.2 | 50 | 19 | |
| AZ-5 | 17 | 31.2 | 43.6 | 76 | 8 | |

Location: Research Center, N. of Conrad.
Previous crop: Fallow
Fertilizer: 11-51-0 actual with seed + 40 AN actual shanked in.
Seed date: April 13, 1984
Harvest date: August 2, 1984
1984 rainfall (Jan 1 to harvest): 4.1"

Table 19. Comparison of barley varieties under recrop and summerfallow conditions, 1984. Montana Agr. Exp. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Height | | Test wt. | | % Plump | | Yield-bu/a | |
|---|---|---|---|---|---|---|---|---|
| | fallow | recrop | fallow | recrop | fallow | recrop | fallow | recrop |
| Gallatin | 21 | 17 | 48.3 | 47.4 | 38 | 51 | 53.8 | 22.0 |
| Summit | 21 | 16 | 47.4 | 48.9 | 23 | 33 | 51.4 | 20.3 |
| Hector | 22 | 18 | 49.0 | 48.4 | 35 | 49 | 50.9 | 25.9 |
| Bridger-82 | 20 | 16 | 48.6 | 48.7 | 50 | 55 | 49.0 | 21.9 |
| Clark | 21 | 17 | 46.9 | 48.8 | 39 | 54 | 49.0 | 24.8 |
| Piroline | 21 | 17 | 50.8 | 48.9 | 55 | 53 | 48.7 | 24.1 |
| Lewis | 20 | 17 | 49.4 | 49.4 | 62 | 47 | 46.9 | 19.7 |
| Harrington | 20 | 16 | 47.4 | 47.7 | 51 | 53 | 46.5 | 25.0 |
| Robust | 22 | 16 | 47.0 | 48.6 | 54 | 51 | 46.5 | 20.0 |
| Hazen | 22 | 16 | 45.3 | 45.1 | 45 | 48 | 43.8 | 21.2 |
| Karla | 20 | 17 | 45.2 | 48.9 | 28 | 57 | 43.3 | 23.5 |
| F-test | | | | | | | sig.01 | n.s. |
| L.S.D. | | | | | | | 7.6 | 7.3 |
| C.V. % | | | | | | | 6.0 | 19.1 |

Location: Research Center, N. of Conrad.
Seed Date: April 13, 1984
Harvest Date: August 2, 1984
Fertilizer: 51-51-0 fallow; 61-51-0 recrop.
Recrop no-till seeded into spring wheat stubble.
1984 rainfall (January to harvest) = 4.1"

Table 20. Barley variety trial on no-till recrop, Conrad 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| Hector | 18 | 25.9 | 48.4 | 49 | 22 | |
| Harrington | 16 | 25.0 | 47.7 | 53 | 18 | |
| Clark | 17 | 24.8 | 48.8 | 54 | 18 | |
| Piroline | 17 | 24.1 | 48.9 | 53 | 18 | |
| Karla | 17 | 23.5 | 48.9 | 57 | 14 | |
| Gallatin | 17 | 22.0 | 47.4 | 51 | 20 | |
| Bridger - 82 | 16 | 21.9 | 48.7 | 55 | 16 | |
| Hazen | 16 | 21.2 | 45.1 | 48 | 18 | |
| Summit | 16 | 20.3 | 48.9 | 33 | 31 | |
| Robust | 16 | 20.0 | 48.6 | 51 | 21 | |
| Lewis | 17 | 19.7 | 49.4 | 47 | 19 | |

F- test n.s. ; L.S.D. = 7.3 bu ; C.V. = 19.1%
Location: Research Center, N. of Conrad.
Previous crop: Lew spring wheat.
Seed date: April 13, 1984
Harvest date: August 2, 1984
Fertilizer: 61-51-0 actual
1984 rainfall (Jan 1 to harvest) : 4.1"

Table 21. Barley variety trial grown north of Cut Bank, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| Hector | 18 | 26.7 | 46.0 | 26 | 43 | |
| Piroline | 17 | 24.9 | 45.5 | 21 | 50 | |
| Robust | 20 | 24.2 | 42.5 | 11 | 64 | |
| Clark | 17 | 23.3 | 46.7 | 38 | 35 | |
| Bridger - 82 | 17 | 22.9 | 44.8 | 22 | 40 | |
| Karla | 19 | 22.8 | 42.9 | 19 | 47 | |
| Gallatin | 21 | 21.4 | 45.3 | 30 | 38 | |
| Summit | 18 | 21.2 | 46.5 | 30 | 37 | |
| Harrington | 17 | 18.2 | 43.1 | 27 | 40 | |
| Hazen | 15 | 16.8 | 46.2 | 36 | 30 | |
| Lewis | 18 | 16.2 | 48.8 | 58 | 16 | |

F-test n.s. ; L.S.D. = 10.3 bu ; C.V. = 28.7%
Cooperator & location: Don Bradley, N. of Cut Bank
Previous crop: Fallow
Seed date: May 4, 1984
Harvest date: August 21, 1984
Fertilizer: 11-51-0 with seed.

Table 22. Three year summary for barley varieties grown north of Cut Bank, 1982-84. Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Rows per head | Three - year average | | | | |
|---|---|---|---|---|---|---|
| | | Yield bu/a | Height inches | Test wt. | % plump | % thin |
| Hector | 2 | 53.6 | 25 | 47.8 | 52 | 22 |
| Piroline | 2 | 51.8 | 25 | 49.1 | 44 | 27 |
| Karla | 6 | 51.2 | 26 | 44.8 | 38 | 31 |
| Bridger - 82 | 2 | 50.3 | 23 | 46.6 | 41 | 22 |
| Morex | 6 | 49.9 | 27 | 45.5 | 51 | 22 |
| Summit | 2 | 49.7 | 24 | 48.5 | 46 | 26 |
| Robust | 6 | 49.0 | 26 | 44.1 | 29 | 34 |
| Harrington | 2 | 48.8 | 24 | 45.6 | 55 | 20 |
| Clark | 2 | 48.7 | 23 | 47.2 | 52 | 21 |
| Lewis | 2 | 46.8 | 25 | 49.2 | 82 | 11 |
| Gallatin | 2 | 43.0 | 26 | 47.1 | 60 | 19 |
| Klages | 2 | 42.4 | 25 | 43.9 | 41 | 37 |
| Hazen | 6 | 33.7 | 23 | 47.5 | 50 | 20 |

Cooperator and location, all years: Don Bradley, N. of Cut Bank.

Previous crop: Fallow

Seed dates: May 5, 1982; May 23, 1983; May 4, 1984.

Fertilizer: 11-51-0 Actual with seed.

Table 23. Barley variety trial, Sunburst 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| Summit | 19 | 36.3 | 47.9 | 18 | 43 | |
| Gallatin | 19 | 35.9 | 47.7 | 35 | 27 | |
| Bridger - 82 | 18 | 33.6 | 48.5 | 27 | 27 | |
| Piroline | 16 | 33.4 | 48.6 | 29 | 33 | |
| Lewis | 17 | 33.0 | 46.4 | 21 | 45 | |
| Hector | 18 | 30.7 | 47.2 | 32 | 31 | |
| Clark | 16 | 30.7 | 45.1 | 13 | 44 | |
| Harrington | 18 | 29.6 | 45.8 | 27 | 35 | |
| Hazen | 22 | 29.2 | 43.3 | 39 | 19 | |
| Robust | 19 | 28.1 | 44.6 | 36 | 26 | |
| Karla | 17 | 24.3 | 43.6 | 40 | 26 | |

F-test sig .05 ; L.S.D. = 7.6 bu ; C.V. = 14.7 %
Cooperator & location: Dave Sandon, SE of Sunburst, Toole Co.
Previous crop: Fallow
Seed date: April 11, 1984
Harvest date: August 3, 1984
Fertilizer: 11-51-0 actual.

Table 24. Barley Variety trial, north of Choteau, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| Piroline | 25 | 51.4 | 51.1 | 59 | 9 | |
| Hector | 21 | 50.4 | 50.1 | 67 | 7 | |
| Summit | 23 | 49.2 | 49.8 | 38 | 19 | |
| Lewis | 22 | 48.8 | 49.9 | 77 | 5 | |
| Harrington | 21 | 47.2 | 48.4 | 87 | 3 | |
| Gallatin | 23 | 45.1 | 50.2 | 72 | 6 | |
| Bridger - 82 | 22 | 44.8 | 49.8 | 43 | 12 | |
| Karla | 26 | 44.1 | 47.9 | 63 | 11 | |
| Hazen | 27 | 42.2 | 47.5 | 71 | 4 | |
| Clark | 19 | 41.2 | 48.0 | 46 | 13 | |
| Robust | 26 | 40.8 | 49.3 | 71 | 6 | |

F-test sig .01 ; L.S.D. = 6.3 bu ; C.V. 8.3%
Cooperator & location: Herb Corey, NE of Choteau, Teton Co.
Previous crop: Fallow
Seed date: April 9, 1984
Harvest date: July 31, 1984
Fertilizer: 56-51-0 actual

Table 25. Two - year summary for barley varieties grown near Choteau, 1983-84. Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Rows per head | Two - year average | | | | |
|---|---|---|---|---|---|---|
| | | Yield bu/a | Height inches | Test wt. | % plump | % thin |
| Hector | 2 | 76.6 | 26 | 51.5 | 80 | 4 |
| Summit | 2 | 74.2 | 27 | 51.4 | 61 | 11 |
| Bridger - 82 | 2 | 74.0 | 25 | 50.9 | 67 | 7 |
| Lewis | 2 | 73.4 | 26 | 51.8 | 86 | 3 |
| Piroline | 2 | 72.5 | 28 | 52.9 | 76 | 6 |
| Harrington | 2 | 71.6 | 25 | 50.3 | 91 | 2 |
| Clark | 2 | 71.1 | 24 | 50.3 | 71 | 7 |
| Gallatin | 2 | 70.3 | 27 | 51.6 | 86 | 3 |
| Karla | 6 | 70.3 | 29 | 48.3 | 75 | 7 |
| Klages | 2 | 70.3 | 24 | 48.8 | 74 | 8 |
| Hazen | 6 | 64.1 | 29 | 48.8 | 82 | 2 |
| Robust | 6 | 63.5 | 28 | 50.8 | 82 | 4 |

Cooperator and location: Herb Corey, N.E. of Choteau.

Previous crop: Fallow

Seed Dates: April 19, 1983; April 9, 1984.

Fertilizer: 56-51-0 actual

Table 26. Irrigated barley variety trial north of Choteau, 1984.
Mont. Agri. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|
| Piston | 28 | 91.7 | 53.7 | 91 | 3 | |
| Bridger - 82 | 22 | 85.6 | 53.0 | 87 | 4 | |
| Clark | 24 | 74.1 | 53.6 | 94 | 2 | |
| Piroline | 23 | 71.5 | 54.6 | 90 | 3 | |
| Morex | 27 | 68.7 | 53.0 | 89 | 3 | |
| Summit | 22 | 67.6 | 53.9 | 95 | 1 | |
| Karla | 23 | 65.1 | 52.3 | 79 | 6 | |
| Lewis | 22 | 63.2 | 53.9 | 93 | 2 | |
| Hector | 23 | 57.9 | 54.0 | 91 | 3 | |
| Gallatin | 23 | 55.8 | 54.2 | 92 | 3 | |
| Ingrid | 23 | 55.7 | 54.5 | 94 | 2 | |
| Robust | 29 | 54.4 | 53.2 | 92 | 2 | |
| Menuet | 22 | 54.3 | 54.6 | 94 | 2 | |
| Harrington | 21 | 52.6 | 53.4 | 93 | 2 | |
| Hazen | 28 | 52.1 | 53.2 | 91 | 3 | |

F-test sig .01 ; L.S.D = 14.3 bu ; C.V. = 13.2%
Cooperator & location: Lyle Weist, NE of Choteau, Teton Co.
Previous crop: spring wheat
Fertilizer: 11-51-0 actual with seed + 100 AA actual + 20-20-20.
Seed date: April 9, 1984
Harvest date: August 29, 1984

Table 27. Two - year summary for irrigated barley varieties grown north of Choteau, 1983-84. Mont. Agr. Expt. Sta., Western Triangle Research Center, Conrad, MT.

| Variety | Two - year average | | | |
|---|---|---|---|---|
| | Height inches | Yield bu/a | Test wt. | % protein |
| Bridger-82 | 25 | 88.0 | 86 | 4 |
| Piston | 30 | 87.2 | 90 | 3 |
| Summit | 26 | 80.1 | 90 | 3 |
| Clark | 27 | 78.5 | 91 | 4 |
| Morex | 30 | 77.5 | 89 | 4 |
| Karla | 28 | 76.1 | 78 | 7 |
| Piroline | 27 | 75.7 | 91 | 3 |
| Lewis | 24 | 74.1 | 93 | 2 |
| Harrington | 24 | 69.5 | 94 | 3 |
| Hector | 26 | 69.3 | 91 | 3 |
| Robust | 31 | 68.9 | 88 | 3 |
| Menuet | 25 | 67.9 | 93 | 2 |
| Ingrid | 27 | 66.8 | 93 | 2 |

Cooperator and location: Lyle Weist, N E of Choteau.
Previous crop: spring wheat.
Fertilizer: 100# N as A.A. + 100# 11-51-0 + 20-20-20
Seed dates: May 2, 1983; April 9, 1984.
Irrigation method: center pivot.

PROJECT TITLE:

Spring grain rates of seeding under no-till conditions.

PROJECT LEADER:

Gregory D. Kushnak, Western Triangle Research Center, Conrad, MT.

INTRODUCTION/OBJECTIVES:

Preliminary studies at Conrad indicated that seeding rates had a considerable influence on yield of spring grains. The purpose of this study was to determine if the preliminary findings were consistent, and to estimate optimum seed rates for no-till conditions.

RESULTS:

Five rates of seeding for barley (Clark) and spring wheat (Newana) were compared under fallow and no-till conditions in 1984. Precipitation was 70% and 30% of normal during 1983 and 1984, respectively; leaving a dry soil profile.

Seeding rates did not significantly affect the yield of barley, whether grown on fallow or no-till recrop (Tables 30 & 31). The results on fallow did not concur with the previous studies on fallow, where increased seed rates increased yield. This indicates that seed rates may not cause a yield response unless moisture is more available than it was in 1984.

Data for the spring wheat seeding rates were influenced by sawflys, and cannot be used to measure the treatment effects.

No-till seeding rate studies on spring grains will be repeated in 1985.

Seeding rate studies were also conducted for spring wheat (Table 32) and barley (Table 33) under irrigation. There was only a slight advantage for rates above 20 seeds/sq foot.

Table 28. Seeding rate trial on two varieties of winter wheat grown on dryland near Dutton, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Seed Rate seed / sq.ft. * | Seed Rate lbs. seed/ acre | plant hgt in. | Yield bu/a | Test wt. | % protein |
|---|---|---|---|---|---|---|
| Centurk | 10 | 34 | 23 | 29.5 | 60.9 | 13.1 |
| | 15 | 51 | 23 | 29.9 | 61.0 | 12.7 |
| | 20 | 69 | 24 | 31.8 | 61.6 | 13.2 |
| | 25 | 86 | 24 | 33.7 | 61.6 | 11.9 |
| | 30 | 103 | 24 | 32.9 | 62.2 | 10.9 |
| Redwin | 10 | 33 | 25 | 29.6 | 61.1 | 13.3 |
| | 15 | 50 | 25 | 27.2 | 61.0 | 14.4 |
| | 20 | 67 | 25 | 30.3 | 61.1 | 14.6 |
| | 25 | 83 | 24 | 32.2 | 61.7 | 12.4 |
| | 30 | 100 | 23 | 32.6 | 61.8 | 11.4 |
| Seed rate means (over both varieties): | | | | | | |
| | 10 | | 24 | 29.6 | 61.0 | |
| | 15 | | 24 | 28.6 | 61.0 | |
| | 20 | | 25 | 31.1 | 61.4 | |
| | 25 | | 24 | 33.0 | 61.7 | |
| | 30 | | 24 | 32.8 | 62.0 | |
| Variety means (over all rates): | | | | | | |
| Centurk | | | 24 | 31.6 | 61.5 | |
| Redwin | | | 24 | 30.4 | 61.3 | |

F-test n.s. ; L.S.D. = 4.4 bu ; C.V. = 7.6%
Cooperator & location: Darryl Goodmundson, East of Dutton.
Fertilizer: 11-51-0 actual with seed + 80 AA actual.
Date seeded: September 20, 1983
Date harvested: July 31, 1984
Previous crop: Fallow
* Pure live seed per square foot.
1984 precipitation (Jan 1 to harvest): approximately 2".

Table 29. Seeding rate trial on two varieties of winter wheat grown on dryland near Conrad, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Variety | Seed Rate seed / sq. ft. | Seed Rate lbs. seed/ acre | Plant hgt in. | Yield bu/a | Test wt. | % protein |
|---|---|---|---|---|---|---|
| Centurk | 10 | 34 | 20 | 16.7 | 60.5 | |
| | 15 | 51 | 21 | 26.5 | 60.5 | |
| | 20 | 69 | 20 | 25.9 | 60.5 | |
| | 25 | 86 | 21 | 23.3 | 60.5 | |
| | 30 | 103 | 20 | 15.8 | 60.5 | |
| Redwin | 10 | 33 | 22 | 14.2 | 59.6 | |
| | 15 | 50 | 22 | 14.5 | 59.6 | |
| | 20 | 67 | 23 | 23.7 | 59.6 | |
| | 25 | 83 | 23 | 19.7 | 59.6 | |
| | 30 | 100 | 22 | 18.0 | 59.6 | |
| Seed rate means (over both varieties): | | | | | | |
| | 10 | | 21 | 15.5 | 60.1 | |
| | 15 | | 22 | 20.5 | 60.1 | |
| | 20 | | 22 | 24.8 | 60.1 | |
| | 25 | | 22 | 21.5 | 60.1 | |
| | 30 | | 21 | 16.9 | 60.1 | |
| Variety means (over all rates): | | | | | | |
| Centurk | | | 20 | 21.6 | 60.5 | |
| Redwin | | | 22 | 18.0 | 59.6 | |

Location Research Center, N. of Conrad
Previous crop: Fallow
Fertilizer: 51-51-0 actual.
Date seeded: September 22, 1983
Date harvested: August 7, 1984
Sawfly damage moderate
1984 precipitation (Jan 1 to harvest): 4.1"

Table 30. Barley seeding rate trial grown on summerfallow, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Seed rate seed/ sq.ft. | lbs. seed/ acre | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|---|
| 10 | 54 | 17 | 28.0 | 49.5 | 57 | 15 | |
| 15 | 81 | 17 | 26.0 | 47.8 | 68 | 13 | |
| 20 | 108 | 16 | 27.6 | 48.6 | 63 | 16 | |
| 25 | 134 | 16 | 22.3 | 48.2 | 65 | 13 | |
| 30 | 162 | 16 | 25.4 | 48.3 | 52 | 19 | |

F-test n.s. ; L.S.D. = 14.3 bu ; C.V. = 29.3 %

Location: Station
Previous crop: Fallow
Fertilizer: 51-51-0 actual
Date seeded: April 13, 1984
Date harvested: August 2, 1984
1984 precipitation (Jan 1 to harvest): 4.1"

Table 31. Barley seeding rate trial grown under no-till stubble conditions, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Seed rate seed/ sq.ft. | lbs. seed/ acre | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|---|
| 10 | 54 | 15 | 20.6 | 47.5 | 39 | 26 | |
| 15 | 81 | 15 | 17.0 | 46.4 | 21 | 38 | |
| 20 | 108 | 15 | 20.5 | 46.3 | 30 | 34 | |
| 25 | 134 | 16 | 22.7 | 46.9 | 37 | 27 | |
| 30 | 162 | 15 | 21.1 | 46.8 | 40 | 31 | |

F-test n.s. ; L.S.D. = 5.6 bu ; C.V. = 14.6 %
Location : Station
Previous crop: spring wheat
Fertilizer: 61-51-0 actual
Date seeded: April 13, 1984
Date Harvested: August 2 , 1984
1984 precipitation (Jan 1 to harvest) : 4.1"

Table 32. Spring wheat seeding rate trial, irrigated, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Seed Rate seed/ sq.ft. | lbs. seed/acre | Yield bu/a | Test wt. | % protein |
|---|---|---|---|---|
| 10 | 34 | 31.7 | 60.1 | |
| 15 | 51 | 39.8 | 60.1 | |
| 20 | 68 | 38.7 | 60.9 | |
| 25 | 90 | 41.6 | 60.7 | |
| 30 | 102 | 41.8 | 60.9 | |

F-test sig .05 ; L.S.D = 5.7 bu ; C.V. = 7.8 %
Cooperator & location: Lyle Weist, NE of Choteau
Previous crop: spring wheat
Fertilizer: 11-51-0 actual with seed + 100 AA actual + 20-20-20
Seed date: April 9, 1984.
Harvest date: August 29, 1984
Variety: Newana

Table 33. Barley seeding rate trial, irrigated, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| Seed Rate seed/ sq.ft. | lbs. seed/acre | Plant hgt. in. | Yield bu/a | Test wt. | % plump | % thin | % protein |
|---|---|---|---|---|---|---|---|
| 10 | 54 | 23 | 50.3 | 52.6 | 95 | 2 | |
| 15 | 81 | 23 | 59.2 | 53.9 | 94 | 2 | |
| 20 | 108 | 24 | 67.9 | 52.8 | 93 | 3 | |
| 25 | 134 | 24 | 68.3 | 53.3 | 93 | 3 | |
| 30 | 162 | 23 | 71.2 | 53.3 | 91 | 3 | |

F-test sig .01 ; L.S.D. = 6.3 bu; C.V. = 5.3%
(Footnotes same as Table 32)
Variety: Clark

PROJECT TITLE:

Testing oilseed and pulse crops under no-till conditions.

PROJECT LEADER:

Gregory D. Kushnak, Western Triangle Research Center, Conrad,MT.

INTRODUCTION/OBJECTIVES:

Oilseed and pulse crops in rotation can benefit grain production (soil amelioration, pest cycle disruption, etc.). The production potential of various oilseed and pulse crops has been determined for fallow systems, under average management levels, in the Western Triangle area. This study sought to determine production potential of these crops on recrop conditions, where they will most likely be grown in rotation with grain.

RESULTS:

Various oilseed and pulse crops, listed in Tables 34-38, were grown on recrop and summerfallow conditions. Precipitation during the year was approximately 20% of normal, and therefore moisture stress on the recrop treatments was substantial.

Safflower on recrop yielded 67% of safflower on fallow. Some of this reduction may have been attributed to cutworms; which were active in the recrop nursery, but not in the fallow. Within cropping systems, varieties did not yield significantly different.

Oil contents of S-541 and S-208 were among the highest; but these varieties are susceptible to Alternaria and Pseudomonas, which imposes a risk of severe yield loss. Oil contents of Hartman and Rehbein were lower, indicating a higher quality risk factor when grown in the cool growing conditions of the Western Triangle area. The oil content of Oker was high, and this variety has greater disease resistance than S-541 and S-208. Therefore, Oker may be more reliable in the Western Triangle area.

Sunflower and oriental mustard on recrop yielded approximately 64% of fallow yields when using standard plant populations. At higher than normal plant populations, sunflowers on recrop were severely stressed; yielding less than 50% of fallow yields. Therefore, the practice of "solid stand sunflower" (seeded in 12" rows with a grain drill) may provide too heavy a population for recrop conditions, unless soil moisture is abundant.

Among the pulse crops, garbanzo bean was the top yielder on recrop; while faba bean suffered a considerable yield reduction. Yields of pea, lentil, and pinto bean were intermediate.

FUTURE PLANS:

Recrop yields for all crops tested were poor. However, the drought conditions imposed unusually severe stress; and the recrop potential of these crops under average recrop conditions may not be realized. Therefore, testing of these species under recrop conditions should continue.

Table 34 . Safflower variety trial on fallow east of Dutton, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mt.

| Variety | Plant height (inches) | Yield lbs/acre | Test Weight | % Oil* | Seed Color |
|---|---|---|---|---|---|
| S-208 | 17 | 1342 | 40.9 | 40.1 | mostly white |
| 81B3635 | 17 | 1252 | 38.6 | 37.3 | mostly striped |
| S-541 | 18 | 1211 | 40.7 | 41.9 | ½ striped |
| 81B3697 | 16 | 1165 | 41.9 | 39.3 | mostly white |
| Hartman | 17 | 1161 | 39.6 | 36.2 | mostly striped |
| Rehbein | 17 | 1117 | 41.3 | 35.0 | mostly striped |
| 81B3546 | 16 | 1065 | 39.6 | 38.1 | mostly striped |
| Oker | 17 | 1036 | 39.2 | 41.5 | mostly striped |
| 81B1607 | 18 | 1013 | 41.8 | 38.4 | some striped |
| 81B3565 | 16 | 1010 | 43.5 | 38.2 | mostly white |
| 81B6078 | 19 | 991 | 40.4 | 38.7 | mostly striped |
| 81B5243 | 17 | 968 | 38.2 | 38.7 | mostly striped |

F-test n.s. ; L.S.D. = 233 lbs ; C.V. = 12.4%
Location & Cooperator: 5 mi. east of Dutton, Teton Co., Frank Loch.
Seed Date: May 8. 1984
Harvest Date: October 1, 1984
Fertilizer: 11-51-0 actual with seed + 60 AA injected.
Previous crop: Fallow
Herbicide: Fargo wild oat.
Precipitation (Jan - Aug 31) = Approx. 2" (20% of normal).
* % Oil on 8% moisture basis.

Table 35 . Safflower variety trial on recrop east of Dutton, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, Mt.

| Variety | Plant height (inches) | Yield lbs/acre | Test Weight | % Oil* | Seed Color |
|---|---|---|---|---|---|
| S-541 | 17 | 888 | 41.8 | 43.5 | ½ striped |
| Hartman | 20 | 846 | 41.3 | 37.1 | mostly striped |
| Rehbein | 19 | 823 | 42.3 | 35.9 | mostly striped |
| Oker | 17 | 710 | 39.7 | 40.9 | mostly striped |
| S-208 | 18 | 664 | 41.6 | 41.0 | mostly white |

F-test n.s. ; L.S.D. = 446 lbs. ; C.V. = 30.1%
Location & Cooperator: 5 mi. east of Dutton, Teton Co. Frank Loch.
Seed Date: May 8. 1984
Harvest Date: October 1, 1984
Fertilizer: 11-51-0 actual with seed + 60 AA injected.
Previous crop: winter wheat, stubble disc. incorporated.
Herbicide: Fargo wild oat.
Pest problems: cutworms thinned this recrop nursery, but not the fallow nursery.
Precipitation (Jan-Aug 31) = approx. 2" (20% of normal).
* % Oil on 8% moisture bases.

Table 36. Two-year summary for Safflower varieties grown on fallow east of Dutton, 1983-84.
Mont. Agr. Expt. Sta; Western Triangle Research Center, Conrad, Mt.

| | Two-Year Average | | | |
|---|---|---|---|---|
| Variety | Plant Height (inches) | Yield lbs/acre | Test Weight | % Oil |
| S-541 | 24 | 1706 | 40.0 | 42.0 |
| S-208 | 24 | 1656 | 41.1 | 40.7 |
| Hartman | 24 | 1426 | 39.5 | 36.7 |
| Oker | 23 | 1414 | 39.6 | 42.9 |
| Rehbein | 24 | 1386 | 41.9 | 34.6 |

Cooperator & location both years: Frank Loch, east of Dutton

Table 37. Sunflower, mustard and rapeseed, trials on recrop and fallow, east of Dutton, 1984.
Mont. Agr. Expt. Sta; Western Triangle Research Center, Conrad, Mt.

| | Fallow | | | Recrop | | |
|---|---|---|---|---|---|---|
| Crop/Variety/Treatment | Plant Height | Yield lbs/acre | Test Weight | Plant Height | Yield lbs/acre | Test Weight |
| Sunflower (18,000 plts/a rate) (24" row space) | | | | | | |
| D O- 855 " | 41 | 1376 | 24.8 | -- | -- | -- |
| C - 207 " | 43 | 1277 | 21.9 | 34 | 800 | 25.3 |
| D O- 730 " | 47 | 1229 | 23.1 | -- | -- | -- |
| D O- 704 XL " | 42 | 1196 | 23.1 | -- | -- | -- |
| Sunflower (30,000 plts/a rate) | | | | | | |
| C 208 24" row space | 30 | 897 | 22.1 | 22 | 428 | 25.7 |
| C 208 12" row space | 26 | 954 | 24.3 | 17 | 312 | 25.7 |
| Oriental Mustard | | | | | | |
| Domo | 50 | 300 | 52.9 | 32 | 192 | 49.5 |
| Rapeseed | | | | | | |
| several varieties | | Poor emergence/ dry seedbed 2/ | | | | |

Cooperator & location: Frank Loch, east of Dutton
Seed Date: May 8, 1984
Harvest Date Sunflower, Aug. 30, 1984 (physiol. mature, oven dried); mustard July 31.
Fertilizer: 11-51-0 actual with seed + 60 AA injected.
Previous crop for recrop: winter wheat, stubble disc. incorporated .
Herbicide: Fargo wild oat.
Precipitation (Jan - Aug 31) approx. 2" (20% of normal).
Pest problems: cutworms thinned the recrop nursery.
1/ Variety sources: DO + Dahlgren ; C = Cargill. (all flowers oil type).
2/ Shallow seeding (½") of rapeseed was not into moisture.

Fallow Stat: F-test sig .05 ; L.S.D. = 287 lbs ; C.V. = 13.7%
Recrop Stat: F-test n.s. ; L.S.D. = 810 lbs ; C.V. = 35.6%

Table 38. Pulse crops grown on fallow and recrop east of Dutton, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| | Fallow | | | Recrop | | | |
|---|---|---|---|---|---|---|---|
| Crop/variety | Plt. hgt./ low pod hgt inches | Yield lbs/a | Test wt. | Plt. hgt./ low pod hgt inches | Yield lbs/a | Test wt. | Cutting date |
| Garbanzo Bean | | | | | | | |
| UC-5 | 13/5 | 1336 | 59.3 | 14/7 | 904 | 59.3 | 8/30 |
| Fababean | | | | | | | |
| Ackerperle | 17/5 | 1004 | 64.1 | 15/6 | 388 | 62.4 | 8/9 |
| Aust. W. Pea | | | | | | | |
| Trapper | -- | 1096 | 64.1 | -- | 522 | 63.3 | 7/31 |
| Melrose | -- | 984 | 64.5 | -- | 556 | 62.4 | 7/31 |
| Lentil | | | | | | | |
| Red Chief | 8/3 | 840 | 57.8 | 8/2 | 540 | 57.8 | 7/31 |
| Pinto Bean | | | | | | | |
| UI-111 | 12/4 | 546 | 53.2 | | 472 | 53.2 | |
| UI-114 | 12/4 | 598 | 56.9 | | 438 | 51.4 | |
| NW-590 | 12/3 | 512 | 55.0 | | 470 | 55.0 | |
| Nodak | 15/3 | 560 | 54.1 | | 552 | 55.9 | |

Cooperator & location: Frank Loch, east of Dutton.
Seed date: May 8, 1984
Fertilizer: 11-51-0 actual with seed + 60 AA.
Previous crop for recrop: winter wheat, stubble disc incorporated.
Herbicide: Fargo wild oat.
Precipitation (Jan - Aug 31) approx 2" (20% of normal).

| | Fallow | Recrop |
|---|---|---|
| Pinto F-test | n.s. | n.s. |
| Pinto L.S.D. | 184 | 134 |
| Pinto C.V. | 16.6 | 13.8 |
| Other crop F-test | n.s. | sig .05 |
| Other crop L.S.D. | 330 | 282 |
| Other crop C.V. | 16.9 | 25.1 |

Table 39. Irrigated alfalfa variety trial near Fairfield, 1984.
Mont. Agr. Expt. Sta.; Western Triangle Research Center, Conrad, MT

| | Tons/acre, 12% moisture | | |
|---|---|---|---|
| Variety | 1st cut | 2nd cut | Total |
| Vernema | 1.56 | 1.79 | 3.35 |
| Peak | 1.54 | 1.80 | 3.34 |
| Ladak-65 | 1.49 | 1.81 | 3.30 |
| Apollo II | 1.50 | 1.75 | 3.25 |
| Vernal | 1.56 | 1.68 | 3.24 |
| WL-316 | 1.54 | 1.70 | 3.24 |
| Trumpetor | 1.50 | 1.66 | 3.16 |
| Ranger | 1.47 | 1.64 | 3.11 |

Cooperator & location: Ross Peace, N. of Fairfield.
Seed date: June 13, 1983
Harvest dates: 1st cut July 3 ; 2nd cut August 23, 1984
Fertilizer: 11-51-0 actual with seed
Previous crop: Alfalfa torn out 1982 (Verticillium wilt infected).

| | | |
|---|---|---|
| F-test | n.s. | n.s. |
| L.S.D. (.05) | 0.13 | 0.19 |
| C.V. % | 5.7 | 7.4 |

# 1984 RESEARCH ACTIVITIES - Part II: Soils & Cropping Systems

by

Alice J. Jones

Acknowledgements: Soil and cropping system research was conducted in cooperation with the Plant and Soil Science Department at MSU and the Montana Cooperative Extension Service. County Agents were invaluable in helping to locate potential cooperators for off station plot work. Many thanks are extended to the landowners who provided land, time and equipment for the experimental work. Walt Adams and Ron Thaut, Agricultural Research Specialists, and Larry Christians, farm foreman made great contributions that were essential for a successful field season. A special thanks to Gladys Dunahoo for data entry and report typing.

1984 Trials: Research work was conducted on-and off-station to provide the greatest diversity of climatic conditions and soils among the experiments. Variability among research results were greatly affected by droughty conditions. Additional studies conducted but not included here include some water use, sawfly, and winter wheat information. These data are not shown due to poor yields resulting from drought, severe sawfly infestations, or weed growth.

TITLE: Winter Wheat Survival and Production Under Alternate Cropping Systems

LOCATION: Western Triangle Research Center, Conrad, MT

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

COOPERATORS: Arnold Gettel, Power, MT.
Don Bradley, Cut Bank, MT.
Ross Fitzgerald, Power, MT.
Jim Seewald, Cut Bank, MT.
Hayden Ferguson, MSU
Greg Kushnak, WTRC
Montana Wheat Research and Marketing Committee

DISCLAIMER:



OBJECTIVES: (1) Develop barley row spacing, seeding rates, and residue management that will optimize survival of selected winter wheat varieties.

(2) Determine winter wheat row spacing and seeding rates required for maximum production of non-winterhardy, high yielding winter wheat varieties for each barley management options.

(3) Evaluate crop water use as affected by residue management and row spacing.

PROCEDURES:

Barley was planted in the spring of 1983 at Dutton, Cut Bank, and Conrad in row spacings of 10, 11, or 12 inches and 20, 22, 24 inches. Harvest samples were obtained from the fields in August.

Residue treatments were superimposed on the barley row spacings at the following levels: no-till, stubble mulch (1 pass of cultivator), and clean till (4 passes of cultivator). Ten varieties of winter wheat were seeded into the barley row spacing-residue main treatments in 12 and 24 inch rows. Each plot measured 8 x 10 ft. and was replicated three times.

All winter wheat plots received 130 lb N/a as ammonium nitrate, plus 10 lb N/a as ammonium phosphate and 50 lb $P_2O_5$/a as ammonium phosphate. Weed and volunteer control was accomplished through chemical applications and roguing the field.

Harvest data was collected and analyzed for yield, test weight, and protein and plant height (Dutton only). Also barley harvest data was collected in preparation for 1984 winter wheat planting.

RESULTS:

Barley - No significant differences were identified for yield, test weight and protein at any of the three test sites (Table 1). The greatest yields were obtained from narrow row spacing at two of the three sites. Higher protein content generally reflected lower yields. Percent plumps and thins reflected dry growing condition.

Winter Wheat - Harvest data for Dutton are presented in (Tables 2-6). Yields were greatest for no-till, Centurk and Cheyenne, narrow barley spacing and wide winter wheat spacing. Test weight and protein for tillage treatments were similar while plant height ranged from 40 to 54 cm (15.7 - 21.2 in). Test weights for varieties ranged from 54.7 to 58.8 lb/bu; protein ranged from 13.4 to 14.4 %; plant height ranged from 39.8 to 51.8 cm (15.7 to 20.4 in). Yields were similar for varieties grown on N x N (barley x winter wheat) and W x W row spacings under no-till conditions. The highest yields were obtained by Cheyenne and Centurk grown on N x W with no-till.

Harvest data for Conrad are presented in (Tables 7-9). Yields were greatest for no-till, Centurk, Cheyenne, and Winalta, wide barley spacing and wide winter wheat spacing. Summary data for other test variables is not summarized due to poor stands and lack of grain from the test plots. Yields were generally greatest for varieties grown on W x W row spacings.

Table 1. Harvest data for barley row spacing variables.

| Location | Yield | Test Wt. | Protein | Plumps | Thins |
|---|---|---|---|---|---|
| | bu/a | lb/bu | - - - - - - - - | % - - - - - - - - | |
| Conrad | | | | | |
| 11" spacing | 27.1 | 44.9 | 13.4 | 25.0 | 37.3 |
| 22" spacing | 30.3 | 47.1 | 13.0 | 42.3 | 22.7 |
| Dutton | | | | | |
| 10" spacing | 21.4 | 46.7 | 16.5 | 61.0a 2/ | 13.0a |
| 20" spacing | 17.0 | 48.0 | 16.7 | 70.0b | 8.7b |
| 20" spacing 1/ | 17.6 | 42.3 | 14.5 | 91.3c | 2.7c |
| Cut Bank | | | | | |
| 10" spacing | 27.0 | 45.1 | 13.6 | 2.7 | 67.3 |
| 20" spacing | 21.0 | 45.3 | 15.7 | 4.7 | 71.0 |

1/ Treatment received one-half the seeding rate of the other two treatments.

2/ Numbers within a column followed by the same letter are not significantly different at p=.01.

Table 2. Yield, test weight, protein, and plant height comparisons for winter wheat main treatment effects. Dutton. 1984.

| Main Effect | Yield | Test Wt. | Protein | Plant Ht. |
|---|---|---|---|---|
| | bu/a | lb/bu | % | cm |
| Tillage | | | | |
| No-till | 21.3 | 56.6 | 14.9 | 53.5 |
| Stubble Mulch | 13.4 | 56.9 | 14.0 | 45.0 |
| Clean Till | 10.6 | 58.3 | 14.0 | 40.6 |
| Variety | | | | |
| Archer | 16.7 | 57.8 | 14.0 | 42.9 |
| Brawny | 11.8 | 57.5 | 13.7 | 39.8 |
| Centurk | 17.7 | 58.5 | 13.8 | 47.1 |
| Cheyenne | 17.5 | 58.8 | 13.6 | 51.8 |
| Daws | 15.8 | 54.7 | 13.4 | 44.6 |
| Norstar | 14.1 | 57.6 | 14.0 | 48.9 |
| Redwin | 16.2 | 57.7 | 14.4 | 48.8 |
| Rocky | 13.4 | 56.8 | 13.7 | 42.0 |
| Winalta | 15.1 | 58.4 | 13.8 | 49.6 |
| Winridge | 12.8 | 54.7 | 13.9 | 48.0 |
| Barley Stubble Spacing | | | | |
| Narrow | 16.2 | 56.8 | 13.8 | 47.7 |
| Wide | 14.0 | 57.7 | 14.5 | 44.9 |
| W. Wheat Spacing | | | | |
| Narrow | 13.2 | 57.1 | 14.4 | 48.5 |
| Wide | 17.0 | 57.4 | 14.2 | 44.2 |

Table 3. Yield comparisons for winter wheat grown on no-till, stubble mulch, and simulated fallow in combination with narrow and wide barley stubble and winter wheat row spacings. Dutton. 1984.

| Barley Stubble Spacing[1/] | W. Wheat Spacing [1/] | Variety | Residue Management No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - -Yield (bu/a)- - - - - - - - | | |
| N | N | Archer | 21.5 | 17.0 | 9.5 |
| N | N | Brawny | 18.5 | 9.6 | 7.0 |
| N | N | Centurk | 20.4 | 15.1 | 10.2 |
| N | N | Cheyenne | 20.0 | 19.0 | 7.2 |
| N | N | Daws | 21.0 | 18.8 | 8.9 |
| N | N | Norstar | 21.8 | 13.8 | 7.2 |
| N | N | Redwin | 24.4 | 15.3 | 8.9 |
| N | N | Rocky | 18.7 | 10.0 | 8.2 |
| N | N | Winalta | 21.4 | 13.7 | 8.7 |
| N | N | Winridge | 17.9 | 12.2 | 7.3 |
| W | N | Archer | 18.6 | 11.4 | 10.3 |
| W | N | Brawny | 10.0 | 9.5 | 5.9 |
| W | N | Centurk | 19.0 | 13.4 | 10.4 |
| W | N | Cheyenne | 20.9 | 11.9 | 11.7 |
| W | N | Daws | 16.7 | 11.2 | 9.9 |
| W | N | Norstar | 17.3 | 6.7 | 5.7 |
| W | N | Redwin | 18.2 | 7.4 | 12.6 |
| W | N | Rocky | 14.1 | 10.6 | 6.3 |
| W | N | Winalta | 15.1 | 11.6 | 11.7 |
| W | N | Winridge | 14.5 | 8.9 | 6.8 |

Table continued

Table 3. Continued

| Barley Stubble Spacing 1/ | W. Wheat Spacing 1/ | Variety | Residue Management No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - Yield (bu/a) | - - - - - - - - | |
| N | W | Archer | 27.9 | 19.3 | 10.5 |
| N | W | Brawny | 25.6 | 11.1 | 8.3 |
| N | W | Centurk | 29.8 | 18.0 | 12.7 |
| N | W | Cheyenne | 30.2 | 19.7 | 12.0 |
| N | W | Daws | 24.6 | 18.0 | 11.5 |
| N | W | Norstar | 23.9 | 17.7 | 9.2 |
| N | W | Redwin | 29.0 | 18.6 | 12.3 |
| N | W | Rocky | 25.0 | 17.1 | 9.1 |
| N | W | Winalta | 25.4 | 17.1 | 9.9 |
| N | W | Winridge | 24.7 | 13.2 | 10.6 |
| W | W | Archer | 23.4 | 12.8 | 18.2 |
| W | W | Brawny | 15.7 | 10.3 | 9.9 |
| W | W | Centurk | 32.2 | 13.3 | 17.7 |
| W | W | Cheyenne | 25.1 | 19.0 | 12.9 |
| W | W | Daws | 23.0 | 14.7 | 10.8 |
| W | W | Norstar | 18.9 | 8.6 | 19.0 |
| W | W | Redwin | 20.7 | 17.2 | 10.2 |
| W | W | Rocky | 20.2 | 14.0 | 12.3 |
| W | W | Winalta | 22.0 | 9.9 | 14.2 |
| W | W | Winridge | 15.8 | 9.4 | 12.4 |

1/ N=narrow row spacing; W=wide row spacing

Table 4. Test weight comparisons for winter wheat grown on no-till, stubble mulch, and simulated fallow in combination with narrow and wide barley stubble and winter wheat row spacings. Dutton. 1984.

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Residue Management No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - Test Wt. (lb/bu) | - - - - - - | |
| N | N | Archer | 58.9 | 57.4 | 58.0 |
| N | N | Brawny | 58.7 | 55.9 | 58.3 |
| N | N | Centurk | 57.8 | 56.8 | 59.0 |
| N | N | Cheyenne | 57.1 | 58.6 | 59.0 |
| N | N | Daws | 51.0 | 52.7 | 54.7 |
| N | N | Norstar | 57.6 | 57.1 | 56.2 |
| N | N | Redwin | 53.5 | 56.8 | 59.0 |
| N | N | Rocky | 58.2 | 55.9 | 57.4 |
| N | N | Winalta | 56.8 | 58.2 | 58.3 |
| N | N | Winridge | 52.6 | 53.8 | 54.1 |
| W | N | Archer | 57.5 | 57.1 | 58.6 |
| W | N | Brawny | 57.4 | 56.2 | 59.0 |
| W | N | Centurk | 57.8 | 58.3 | 60.8 |
| W | N | Cheyenne | 59.0 | 60.2 | 59.0 |
| W | N | Daws | 52.0 | 54.7 | 59.6 |
| W | N | Norstar | 55.2 | 57.4 | 61.7 |
| W | N | Redwin | 57.0 | 59.0 | 60.5 |
| W | N | Rocky | 56.3 | 55.6 | 57.7 |
| W | N | Winalta | 56.2 | 60.0 | 60.0 |
| W | N | Winridge | 52.8 | 56.2 | 58.0 |

Table continued

Table 4. continued

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Residue Management No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - Test wt. (lb/bu) | - - - - - - | |
| N | W | Archer | 57.9 | 57.1 | 57.7 |
| N | W | Brawny | 58.9 | 57.7 | 57.7 |
| N | W | Centurk | 58.2 | 57.5 | 58.3 |
| N | W | Cheyenne | 59.3 | 59.2 | 58.3 |
| N | W | Daws | 52.1 | 53.8 | 55.0 |
| N | W | Norstar | 57.4 | 57.2 | 58.3 |
| N | W | Redwin | 57.7 | 57.8 | 57.7 |
| N | W | Rocky | 58.4 | 54.1 | 54.4 |
| N | W | Winalta | 58.1 | 58.8 | 59.3 |
| N | W | Winridge | 55.1 | 53.7 | 55.6 |
| W | W | Archer | 59.0 | 56.8 | 58.0 |
| W | W | Brawny | 55.0 | 57.4 | 58.3 |
| W | W | Centurk | 58.6 | 58.6 | 59.8 |
| W | W | Cheyenne | 56.8 | 58.4 | 61.4 |
| W | W | Daws | 55.1 | 56.1 | 59.0 |
| W | W | Norstar | 56.9 | 56.5 | 59.5 |
| W | W | Redwin | 57.6 | 57.1 | 59.2 |
| W | W | Rocky | 57.2 | 57.1 | 59.3 |
| W | W | Winalta | 59.6 | 58.0 | 57.4 |
| W | W | Winridge | 52.6 | 54.7 | 57.7 |

1/ N=narrow row spacing; W=wide row spacing

**Table 5.** Protein comparisons for winter wheat grown on no-till, stubble mulch and simulated fallow in combination with narrow and wide barley stubble and winter wheat row spacings. Dutton. 1984.

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Residue Management: No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - - - - | Protein % | - - - - - - - - - |
| N | N | Archer | 13.1 | 13.4 | 13.6 |
| N | N | Brawny | 14.0 | 14.5 | 14.2 |
| N | N | Centurk | 13.1 | 13.2 | 13.4 |
| N | N | Cheyenne | 12.6 | 12.5 | 13.9 |
| N | N | Daws | 12.8 | 12.9 | 14.0 |
| N | N | Norstar | 12.1 | 13.6 | 14.0 |
| N | N | Redwin | 12.9 | 13.8 | 14.3 |
| N | N | Rocky | 12.9 | 14.0 | 13.6 |
| N | N | Winalta | 12.7 | 13.4 | 13.8 |
| N | N | Winridge | 13.2 | 13.3 | 13.7 |
| W | N | Archer | 14.2 | 14.6 | 13.9 |
| W | N | Brawny | 14.5 | 15.0 | 14.8 |
| W | N | Centurk | 13.5 | 14.2 | 12.8 |
| W | N | Cheyenne | 13.9 | 13.8 | 12.9 |
| W | N | Daws | 13.1 | 13.4 | 12.0 |
| W | N | Norstar | 14.2 | 14.3 | 14.3 |
| W | N | Redwin | 14.7 | 14.7 | 14.0 |
| W | N | Rocky | 9.6 | 14.1 | 15.0 |
| W | N | Winalta | 13.9 | 13.6 | 13.6 |
| W | N | Winridge | 14.0 | 14.0 | 14.3 |

Table continued

Table 5. continued

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Residue Management: No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - - Protein % | - - - - - - - | - - - - - - - |
| N | W | Archer | 13.8 | 14.1 | 14.7 |
| N | W | Brawny | 14.3 | 15.1 | 15.2 |
| N | W | Centurk | 13.4 | 13.8 | 14.3 |
| N | W | Cheyenne | 13.5 | 13.6 | 14.7 |
| N | W | Daws | 13.6 | 13.8 | 14.1 |
| N | W | Norstar | 14;0 | 14.0 | 15.1 |
| N | W | Redwin | 14.3 | 14.1 | 14.3 |
| N | W | Rocky | 13.5 | 14.2 | 14.6 |
| N | W | Winalta | 13.7 | 14.3 | 14.5 |
| N | W | Winridge | 13.8 | 13.7 | 14.4 |
| W | W | Archer | 14.5 | 14.7 | 14.0 |
| W | W | Brawny | 15.1 | 15.6 | 14.2 |
| W | W | Centurk | 14.9 | 14.8 | 13.9 |
| W | W | Cheyenne | 14.3 | 13.5 | 13.7 |
| W | W | Daws | 14.1 | 13.9 | 13.5 |
| W | W | Norstar | 14.7 | 14.9 | 12.7 |
| W | W | Redwin | 14.9 | 14.9 | 15.3 |
| W | W | Rocky | 14.3 | 14.5 | 14.3 |
| W | W | Winalta | 14.5 | 14.5 | 13.4 |
| W | W | Winridge | 14.8 | 13.9 | 14.0 |

1/ N=narrow row spacing; W =wide row spacing

Table 6. Plant height comparisons for winter wheat grown on no-till, stubble mulch, and simulated fallow in combination with narrow and wide barley stubble and winter wheat row spacings. Dutton. 1984.

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Residue Management: No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - - - Plant Ht. (cm) | - - - - - - - - | |
| N | N | Archer | 55 | 47 | 39 |
| N | N | Brawny | 50 | 42 | 38 |
| N | N | Centurk | 59 | 51 | 41 |
| N | N | Cheyenne | 65 | 62 | 43 |
| N | N | Daws | 51 | 48 | 43 |
| N | N | Norstar | 63 | 51 | 44 |
| N | N | Redwin | 66 | 58 | 44 |
| N | N | Rocky | 50 | 46 | 40 |
| N | N | Winalta | 65 | 56 | 45 |
| N | N | Winridge | 61 | 43 | 52 |
| W | N | Archer | 45 | 40 | 40 |
| W | N | Brawny | 43 | 44 | 36 |
| W | N | Centurk | 56 | 51 | 41 |
| W | N | Cheyenne | 65 | 49 | 42 |
| W | N | Daws | 48 | 44 | 42 |
| W | N | Norstar | 58 | 45 | 45 |
| W | N | Redwin | 56 | 40 | 46 |
| W | N | Rocky | 48 | 42 | 35 |
| W | N | Winalta | 56 | 43 | 47 |
| W | N | Winridge | 56 | 46 | 43 |

Table continued

Table 6. continued

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Residue Management: No-till | Stubble Mulch | Clean Till |
|---|---|---|---|---|---|
| | | | - - - - - - - -Plant Ht. (cm) | | - - - - - - |
| N | W | Archer | 49 | 40 | 31 |
| N | W | Brawny | 46 | 35 | 32 |
| N | W | Centurk | 56 | 42 | 37 |
| N | W | Cheyenne | 60 | 51 | 41 |
| N | W | Daws | 49 | 46 | 39 |
| N | W | Norstar | 61 | 48 | 39 |
| N | W | Redwin | 56 | 38 | 45 |
| N | W | Rocky | 44 | 40 | 34 |
| N | W | Winalta | 60 | 50 | 37 |
| N | W | Winridge | 56 | 39 | 44 |
| W | W | Archer | 48 | 40 | 41 |
| W | W | Brawny | 39 | 35 | 36 |
| W | W | Centurk | 52 | 40 | 39 |
| W | W | Cheyenne | 54 | 49 | 41 |
| W | W | Daws | 49 | 40 | 36 |
| W | W | Norstar | 50 | 34 | 49 |
| W | W | Redwin | 50 | 38 | 48 |
| W | W | Rocky | 45 | 40 | 41 |
| W | W | Winalta | 51 | 39 | 46 |
| W | W | Winridge | 49 | 46 | 42 |

1/ N=narrow row spacing; W=wide row spacing

Table 7. Yield, comparisons for winter wheat main treatment effects. Conrad. 1984.

| Main Effect | Yield |
|---|---|
| | bu/a |
| **Tillage** | |
| No-till | 9.5 |
| Stubble Mulch | 3.8 |
| Clean Till | -- |
| **Variety** | |
| Archer | 6.5 |
| Brawny | 5.3 |
| Centurk | 7.7 |
| Cheyenne | 7.7 |
| Daws | 6.9 |
| Norstar | 7.3 |
| Redwin | 5.8 |
| Rocky | 4.9 |
| Winalta | 7.8 |
| Winridge | 6.2 |
| **Barley Stubble Spacing** | |
| Narrow | 5.5 |
| Wide | 7.8 |
| **W. Wheat Spacing** | |
| Narrow | 5.6 |
| Wide | 7.7 |

Table 8. Yield comparisons for winter wheat grown on no-till and stubble mulch, in combination with narrow and wide barley stubble and winter wheat row spacings. Conrad. 1984.

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | No-till | Stubble Mulch |
|---|---|---|---|---|
| | | | - - - - Yield (bu/a) | - - - - |
| N | N | Archer | 10.8 | 5.4 |
| N | N | Brawny | 4.5 | 1.3 |
| N | N | Centurk | 10.1 | 0.7 |
| N | N | Cheyenne | 8.2 | 1.4 |
| N | N | Daws | 5.7 | 1.2 |
| N | N | Norstar | 7.4 | 3.1 |
| N | N | Redwin | 6.1 | 5.2 |
| N | N | Rocky | 7.6 | 0.8 |
| N | N | Winalta | 9.0 | 1.5 |
| N | N | Winridge | 8.0 | 2.0 |
| W | N | Archer | 8.5 | 2.4 |
| W | N | Brawny | 9.9 | 5.4 |
| W | N | Centurk | 12.0 | 4.4 |
| W | N | Cheyenne | 8.2 | 3.0 |
| W | N | Daws | 6.6 | 4.2 |
| W | N | Norstar | 8.3 | 4.1 |
| W | N | Redwin | 5.9 | 4.9 |
| W | N | Rocky | 7.6 | 3.5 |
| W | N | Winalta | 7.4 | 3.4 |
| W | N | Winridge | 7.0 | 6.4 |

Table continued

Table 8. continued

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | No-till | Stubble Mulch |
|---|---|---|---|---|
| | | | - - - - Yield (bu/a) | - - - - |
| N | W | Archer | 11.9 | 1.0 |
| N | W | Brawny | 6.8 | 1.2 |
| N | W | Centurk | 7.1 | 2.8 |
| N | W | Cheyenne | 16.0 | 2.8 |
| N | W | Daws | 9.0 | 2.5 |
| N | W | Norstar | 11.8 | 2.9 |
| N | W | Redwin | 10.5 | 1.4 |
| N | W | Rocky | 5.1 | 2.4 |
| N | W | Winalta | 11.5 | 5.3 |
| N | W | Winridge | 6.7 | 0.5 |
| W | W | Archer | 9.0 | 3.3 |
| W | W | Brawny | 10.7 | 2.9 |
| W | W | Centurk | 15.9 | 8.4 |
| W | W | Cheyenne | 14.0 | 7.7 |
| W | W | Daws | 14.2 | 12.0 |
| W | W | Norstar | 13.1 | 7.8 |
| W | W | Redwin | 8.0 | 4.7 |
| W | W | Rocky | 7.8 | 4.4 |
| W | W | Winalta | 17.0 | 7.4 |
| W | W | Winridge | 13.3 | 5.8 |

1/ N=narrow row spacing; W=wide row spacing

Table 9. Test weight comparisons for winter wheat grown on no-till in combination with narrow and wide barley stubble and winter wheat row spacings. Conrad. 1984.

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Test Wt. lb/bu |
|---|---|---|---|
| N | N | Archer | 58.0 |
| N | N | Brawny | 56.5 |
| N | N | Centurk | 58.3 |
| N | N | Cheyenne | 56.5 |
| N | N | Daws | 55.9 |
| N | N | Norstar | 57.7 |
| N | N | Redwin | 58.3 |
| N | N | Rocky | 58.0 |
| N | N | Winalta | 55.9 |
| N | N | Winridge | 57.4 |
| W | N | Archer | 56.8 |
| W | N | Brawny | 56.8 |
| W | N | Centurk | 59.3 |
| W | N | Cheyenne | -- |
| W | N | Daws | -- |
| W | N | Norstar | 53.8 |
| W | N | Redwin | 58.0 |
| W | N | Rocky | 56.2 |
| W | N | Winalta | 58.0 |
| W | N | Winridge | -- |

Table continued

Table 9. continued

| Barley Stubble Spacing[1/] | W. Wheat Spacing[1/] | Variety | Test Wt. |
|---|---|---|---|
| | | | lb/bu |
| N | W | Archer | 59.4 |
| N | W | Brawny | -- |
| N | W | Centurk | 58.6 |
| N | W | Cheyenne | 59.8 |
| N | W | Daws | 58.0 |
| N | W | Norstar | 58.0 |
| N | W | Redwin | 58.6 |
| N | W | Rocky | 57.4 |
| N | W | Winalta | 57.4 |
| N | W | Winridge | 57.7 |
| W | W | Archer | -- |
| W | W | Brawny | -- |
| W | W | Centurk | 60.8 |
| W | W | Cheyenne | 60.0 |
| W | W | Daws | 58.8 |
| W | W | Norstar | 58.0 |
| W | W | Redwin | 59.3 |
| W | W | Rocky | -- |
| W | W | Winalta | 61.3 |
| W | W | Winridge | 59.0 |

1/ N=narrow row spacing; W=wide row spacing

**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.
Merwin Works, Big Sandy, MT.
Jim Bjelland, Conrad, MT.
Marvin Works, Big Sandy, MT.
Gordon Dyrud, 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 6 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 lever arm. Data recorded in the field were distance, time and millivolts. All treatments were replicated six times. Horsepower - hour was calculated as follows:

$$\text{PSI} = 48.708\ (\text{mvs}^{-1}) - 10.609$$

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

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 0-6 inch depth and returned to the laboratory for further analysis.

RESULTS:

Tillage power requirements (TPR) for barley and winter wheat stubble were similar on sandy and clayey soils (Table 1). This lack of difference is attributed to dry soil conditions. Summer fallow fields exhibited lower TPR than other cropping systems due to previous manipulation of the soil surface.

The TPR of barley and winter wheat stubble on clay loam were generally .5 to 1.0 hp-hr lower than for other clay loam soils because of the higher water content (14-16%). Bulk density had no real influence on TPR.

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 %($cm^3 cm^{-3}$) |
|---|---|---|---|---|
| Clay Loam | Chemical Fallow | 2.70 ± .08 | 1.31 ± .06 | 3.5 ± .84 |
| | Barley Stubble | 2.90 ± .14 | 1.42 ± .07 | 4.5 ± .75 |
| | Summer Fallow | 2.49 ± .58 | 1.38 ± .02 | 6.3 ± .72 |
| | W. Wheat Stubble | 1.87 ± .37 | 1.38 ± .05 | 5.1 ± .41 |
| | Summer Fallow | 1.92 ± .46 | 1.31 ± .05 | 14.8 ± 2.0 |
| | Barley Stubble | 1.78 ± .37 | 1.30 ± .05 | 16.1 ± 1.2 |
| | W. Wheat Stubble | 1.91 ± .46 | 1.31 ± .08 | 14.9 ± 1.3 |
| | Chemical Fallow | 3.47 ± .16 | 1.45 ± .03 | 15.0 ± 2.3 |
| | W.Wheat Stubble | 3.00 ± .16 | 1.31 ± .13 | 12.5 ± 0.8 |
| Sandy Loam | Chemical Fallow | 2.96 ± .45 | 1.56 ± .08 | 3.7 ± .63 |
| | W. Wheat Stubble | 2.19 ± .33 | 1.54 ± .07 | 1.7 ± .36 |
| | W. Wheat Stubble | 2.74 ± .30 | 1.52 ± .03 | 0.9 ± .43 |
| | Summer Fallow | 1.72 ± .21 | 1.47 ± .03 | 3.7 ± .68 |
| | Summer Fallow | 1.61 ± .08 | 1.56 ± .04 | 5.6 ± .93 |
| | Barley Stubble | 3.10 ± .29 | 1.55 ± .04 | 2.4 ± .33 |
| | Safflower Stubble | 2.31 ± .15 | 1.45 ± .06 | 6.7 ± 1.03 |
| | W. Wheat Stubble | 2.38 ± .08 | 1.47 ± .06 | 6.7 ± 1.30 |

TITLE: Conservation Tillage

LOCATION: Western Triangle Research Center

PERSONNEL: Alice J. Jones, Asst. Professor of Agronomy
Walt Adams, Agricultural Research Specialist
Dick Matthys, Brady, MT



OBJECTIVES:

1) to evaluate the effect of traditional, minimum, and no-till tillage practices on crop production under flexcrop management.

2) to determine the potential of conservation tillage as a tool for water conservation under Montana conditions.

PROCEDURES:

Three tillage treatments were imposed on a field having clay loam soils in the spring of 1983. No-till plots received applications of glyphosate only; minimum tillage received one application of glyphosate followed by mechanical tillage; traditional tillage received mechanical tillage only. Neutron access tubes were installed in each of the four replications of each treatments. Water use and precipitation were monitored during the fallow season.

In the spring of 1984 all treatments were seeded to Fortuna spring wheat. Fertilizer was applied at the rate of 50 lb $P_2O_5$/a, 25 lb $K_2O$/a and 125 lb N/a. Water use and precipitation were monitored during the growing season. Harvest data on yield, test weight, protein, and water use efficiency was determined.

RESULTS:

Water loss for the tillage treatments during the summer fallow period ranged from 3.5 to 4.2 inches (Table 1). Soil water loss alone was 1.0, 0.7, and 0.3 inches for the stubble mulch, minimum till and no-till treatments, respectively.

Water use by spring wheat on the tillage treatments ranged from 4.4 to 6.7 inches (Table 2). Soil water use alone was 2.2, 4.5, and 4.1 inches for stubble mulch, minimum tillage and no-till treatments, respectively.

Yields ranged from 15.4 to 21.9 bu/a with minimum till having the highest yield and no-till the lowest yield. Water use efficiency decreased with a decrease in tillage. Test weight was not affected by tillage. Protein content was similar for minimum till and no-till but was higher for stubble mulch where water use efficiency was highest.

Table 1. Water loss and growing season precipitation for summer fallow treatments, 1984.

| | Tillage | | |
|---|---|---|---|
| Depth (in) | Stubble Mulch | Minimum Till | No-Till |
| | - - - - - - -1983 Water Loss (in)[1] - - - - - - - | | |
| 0-12 | -.35 | -.214 | -.067 |
| 12-18 | -.16 | -.128 | -.035 |
| 18-24 | -.11 | -.127 | -.047 |
| 24-30 | -.03 | -.021 | +.035 |
| 30-36 | -.07 | +.017 | -.012 |
| 36-42 | -.05 | -.024 | -.047 |
| 42-48 | -.01 | +.049 | -.063 |
| 48-54 | .0 | .0 | -.024 |
| 54-60 | -.05 | -.152 | -.024 |
| 60-66 | -.08 | -.057 | -.012 |
| 66-72 | -.07 | +.011 | -.008 |
| Subtotal | -0.98 | -0.65 | -0.30 |
| Ppt. | -3.2 | -3.2 | -3.2 |
| Total Water Loss | -4.18 | -3.85 | -3.50 |

1/ Negative values indicate a loss of water from the system; positive values indicate a gain of water to the system.

Table 2. Water use and growing season precipitation for spring wheat tillage treatments. 1984.

| Depth (in) | Stubble Mulch | Minimum Till | No-till |
|---|---|---|---|
| | ------ -1984 Water Use (in)1/ ------ | | |
| 0-6 | -0.53 | -0.78 | -0.77 |
| 6-12 | -0.52 | -0.77 | -0.77 |
| 12-18 | -0.33 | -0.78 | -0.76 |
| 18-24 | -0.23 | -0.77 | -0.66 |
| 24-30 | -0.09 | -0.60 | -0.46 |
| 30-36 | +0.04 | -0.30 | -0.34 |
| 36-42 | +0.02 | -0.11 | -0.15 |
| 42-48 | -0.13 | -0.22 | -0.07 |
| 48-54 | -0.26 | +0.03 | -0.01 |
| 54-60 | -0.14 | -0.17 | -0.09 |
| Subtotal | -2.17 | -4.47 | -4.08 |
| Ppt. | -2.2 | -2.2 | -2.2 |
| Total Water Use | -4.37 | -6.67 | -6.28 |

1/ Negative values indicate a loss of water from the system; positive values indicate a gain of water to the system.

Table 3. Yield, test weight, and protein values for spring wheat grown under three tillage management options.

| Parameter | Tillage<br>Stubble Mulch | <br>Minimum Till | <br>No-till |
|---|---|---|---|
| Yield (bu/a) | 18.6 | 21.9 | 15.4 |
| Water Use Efficiency (bu/a in water used) | 4.2 | 3.3 | 2.4 |
| Test Weight (lb/bu) | 59.4 | 59.9 | 59.5 |
| Protein (%) | 15.7 | 14.5 | 14.4 |

TITLE: Rhizosphere Competition Among Cheatgrass and Winter Wheat for Water

LOCATION: Western Triangle Research Center

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



OBJECTIVES:

1) characterize water extraction patterns and root growth of winter wheat and cheatgrass grown in pure culture and in combination

2) determine the effect of cheatgrass on winter wheat yield components and water use efficiency

PROCEDURES:

Experimental plots were established on a Bozeman silt loam soil. Each experimental unit was 8 x 4 ft in area and received one of 5 winter wheat - cheatgrass treatments;

| Cheatgrass | | Winter Wheat |
|---|---|---|
| - - - - - -Seeds $m^{-2}$ - - - - - - - | | |
| 0 | | 20 |
| 4 | (L) | 20 |
| 8 | (M) | 20 |
| 12 | (H) | 20 |
| 12 | | 0 |

Neutron access tubes were inserted into the center of each experimental unit for soil moisture determination throughout the growing season. Rooting depth was inferred by the depth to which soil moisture was extracted. Harvest data was obtained for yield, water use, 1000 kernel weight, protein, and yellowberry.

RESULTS AND DISCUSSION:

Rooting depth of the winter wheat was not affected by the presence of low and medium cheatgrass densities at the end of the growing season but the rate of root growth was reduced earlier in the year (Table 1). Secondary root growth may also have been altered. The high density cheatgrass plot reduced winter wheat root growth approximately 50% early in the season and 20% by the end of the growing season.

Reduced root growth markedly affected water extraction patterns throughout the growing season (Fig 1). Water extraction by the high cheatgrass-winter wheat treatment was markedly reduced throughout the growing season. Rainfall from April 15 through July 31 was 22.4 cm. Soil water extraction by depth for the five treatments indicates rather uniform water use throughout the soil profile for winter wheat, low, and medium cheatgrass density treatments (Fig 2). Water extraction was also fairly uniform for the other two treatments but total depth for extraction was less due to restricted rooting.

Winter wheat grain yields were reduced 20% by the presence of a high cheatgrass density while water use was reduced only 2 cm (Table 2). This also markedly decreased water use efficiency. 1000 kernel weight, protein, and yellowberry were not affected by the presence of cheatgrass (Table 3).

Table 1. Effective rooting depth of winter wheat-cheatgrass treatments.

| Treatment | Date | | |
|---|---|---|---|
| | 5/4 | 6/2 | 7/1 |
| | - - - - Depth (cm) - - - - | | |
| W. Wheat | 90 | 135 | 150 |
| W. Wheat-L. Cheatgrass | 60 | 120 | 150 |
| W. Wheat-M. Cheatgrass | 75 | 120 | 150 |
| W. Wheat-H. Cheatgrass | 52 | 98 | 117 |
| Cheatgrass | 35 | 90 | 110 |

Table 2. Yield, water use, and water use efficiency for winter wheat-cheatgrass treatments.

| Treatment | Yield | Water Use | WUE |
|---|---|---|---|
| | kg ha$^{-1}$ | cm | kg ha$^{-1}$ cm$^{-1}$ |
| W. Wheat | 4984 A | 29.9A | 167A |
| W. Wheat-L. Cht | 4648 AB | 29.9A | 158AB |
| W. Wheat-M. Cht | 4480 B | 29.7A | 151BC |
| W. Wheat-H. Cht | 4002 C | 28.1B | 142C |

Table 3. Protein, 1000 kernel weight, and yellowberry for winter wheat-cheatgrass treatments.

| Treatment | 1000 Kernel Wt | Protein | Yellow Berry |
|---|---|---|---|
| | g | % | % |
| W. Wheat | 33.4 | 13.3 | 7.7 |
| W. Wheat-L. Cht | 34.2 | 13.2 | 9.4 |
| W. Wheat-M. Cht | 34.8 | 13.1 | 10.0 |
| W. Wheat-H. Cht | 34.6 | 13.1 | 6.7 |

Figure 1. Cumulative soil water extraction for winter wheat-cheatgrass treatments.

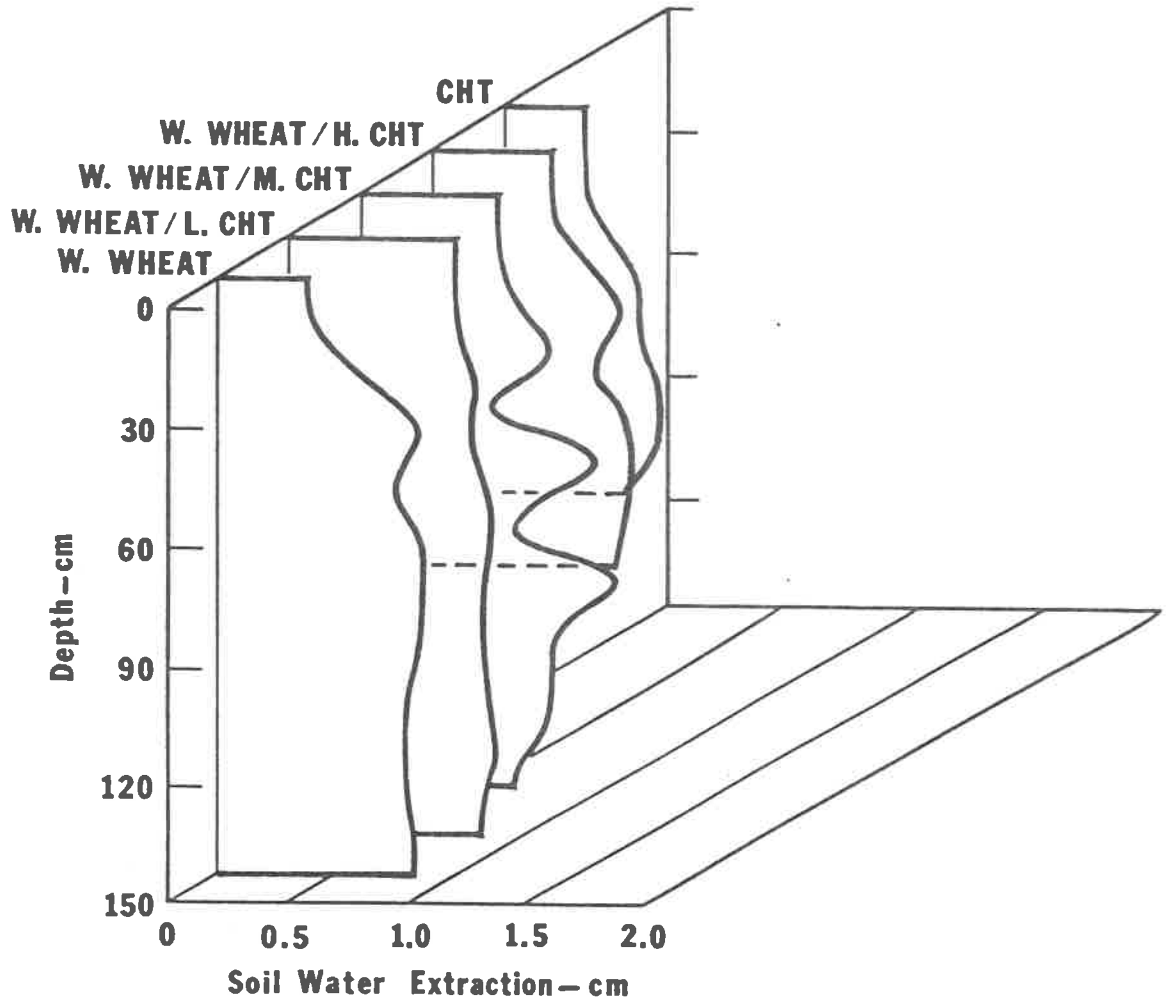
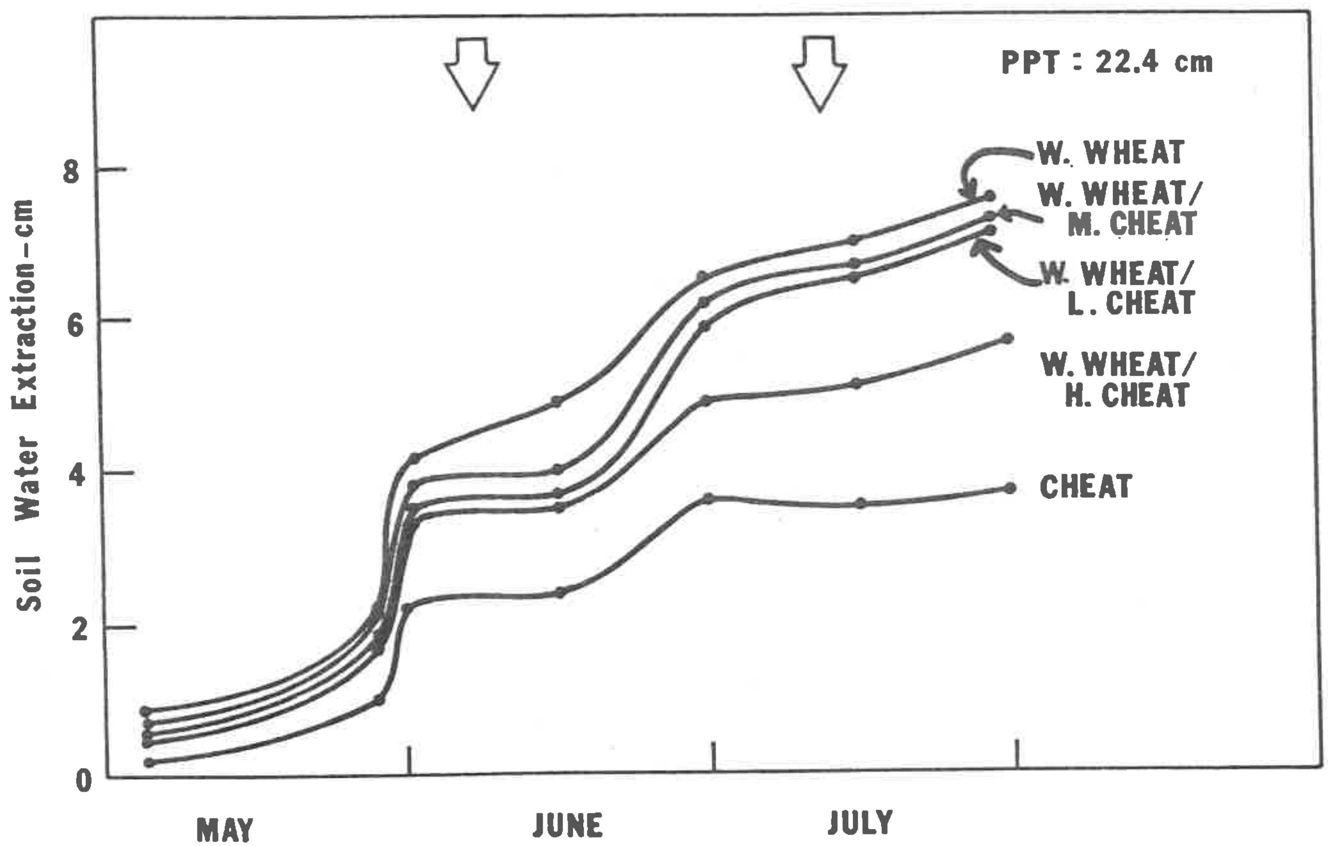


Figure 2. Soil water extraction by depth for the winter wheat-cheatgrass treatments.



TITLE: Variety Response to Fertilizer N

LOCATION: Western Triangle Research Center, Conrad.

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

COOPERATORS: Jim Bjelland, E. of Conrad
Tom Lorang, S. of Great Falls
Don Mason, N. of Cut Bank
Lyle Wiest, Choteau



OBJECTIVES:

1) evaluate crop production under varying levels of moisture, residue, temperature, and nitrogen

2) determine variety response to nitrogen fertilizer

3) develop a model to predict variety yield goals based on concurrent moisture and nitrogen information

PROCEDURE:

The experiment was established using a split-plot design. Varieties were used as main plots. Within each variety five levels of nitrogen were applied and replicated four times. All treatments received uniform applications of 25 lb $K_2O$/a and 50 lb $P_2O_5$/a. Additionally, three treatments were added to one variety to determine crop response to K, P, and S. Liquid phosphoric acid was banded with the seed; all other fertilizers were broadcast and incorporated. Data on yield, test weight, and protein was obtained at harvest.

RESULTS:

Soil nitrate and soil moisture at spring seeding and growing season precipitation are presented in Table 1. With the exception of Wiest's all plots contained over half of their soil nitrate in the 24-48 inch soil depth.

Mason Farm. Spring wheat was grown north of Cut Bank (Table 2). No significant differences were observed for yield or test weight. Yields ranged from 7.3 bu/a for Lew at 56 lb N/a to 9.6 bu/a for Lew at 124 lb N/a. Yields for Newana and Pondera were intermediate. Test weights ranged from 53.6 lb/bu for Lew at 56 lb N/a to 57.5 lb/bu for Lew at 0 lb N/a. Newana and Pondera test weights were intermediate. Variety protein levels were significantly higher for Pondera than for Lew or Newana. Protein level also increased with increasing N level.

Lew spring wheat showed no significant yield or protein differences due to P, K, or S fertilizers (Table 5). Test weight dropped significantly when N, P, and K were applied when compared to N alone or P & K alone.

Lorang Farm. Barley was grown south of Great Falls on summer fallow. Yield response due to varieties was significantly different while N fertilizer had no effect (Table 3). Test weights were significantly different for varieties and N rate. Test weight dropped with increased N level. Protein, % plump, and % thin were also significantly different for varieties and N rates. Protein increased, % plump decreased, and % thins increased with increasing N rate.

Clark spring wheat test weight, yields and %plumps responded positively to the application of potash. Protein reflected N partitioning associated with yield.

Wiest Farm. Spring wheat was grown on irrigated land north of Choteau. Variety yield differences were observed but no response was noted due to N rate. Test weights due to N rates were also significantly different but inconsistent. No protein data were available at the time of publication.

Yields and test weights due to P, K, and S were not significantly different.

Bjelland Farm. Recrop barley was devastated by grasshoppers.

Table 1. Soil nitrate and soil moisture at spring planting and growing season precipitation at all experimental sites.

| Parameter | Depth (in) | Mason | Bjelland | Wiest | Lorang |
|---|---|---|---|---|---|
| | | | lb/a | | |
| Soil Nitrate | | | | | |
| | 0-6 | 39 | 9 | 85 | 18 |
| | 6-12 | 4 | 3 | 13 | 11 |
| | 12-24 | 15 | 16 | 40 | 20 |
| | 24-48 | 103 | 109 | 60 | 34 |
| Plant Avail. Water | | | in | | |
| | 0-48 | 4.0 | 3.5 | Irr. | 2.6 |
| Grow Season Ppt. | | | in | | |
| | | 1.3 | 1.7 | 3.7 | 4.7 |

Table 2. Nitrogen fertilizer and variety influence on spring wheat production on summer fallow. Mason Farm. N. of Cut Bank.

| N Rate (lb/a) | Newana | Variety Pondera | Lew | |
|---|---|---|---|---|
| | | - - - - - - Yield (bu/a)- - - - - - | | Avg. |
| 0 | 9.0 | 8.9 | 8.3 | 8.7 |
| 16 | 7.9 | 8.7 | 8.1 | 8.2 |
| 56 | 8.6 | 7.5 | 7.3 | 7.8 |
| 90 | 8.9 | 9.1 | 8.4 | 8.8 |
| 124 | 8.8 | 9.4 | 9.6 | 9.2 |
| Avg. | 8.6 | 8.7 | 8.3 | 8.6 |
| LSD Variety Averages | | | NS | |
| N Rate Averages | | | NS | |
| Variety x N Rate Averages | | | NS | |
| | | - - - - - Test Weight (lb/bu) - - - - | | Avg. |
| 0 | 56.6 | 57.3 | 57.5 | 57.1 |
| 16 | 57.9 | 57.4 | 56.5 | 57.3 |
| 56 | 55.9 | 56.0 | 53.6 | 55.2 |
| 90 | 54.8 | 56.3 | 56.0 | 55.7 |
| 124 | 57.4 | 54.9 | 57.2 | 56.5 |
| Avg. | 56.6 | 56.4 | 56.2 | 56.4 |
| LSD Variety Averages | | | NS | |
| N Rate Averages | | | NS | |
| Variety x N Rate Interaction | | | NS | |
| | | - - - - - - - - - Protein (%)- - - - - | | Avg. |
| 0 | 15.4 | 16.9 | 16.0 | 16.1 |
| 16 | 15.8 | 17.3 | 16.2 | 16.4 |
| 56 | 16.2 | 17.7 | 16.6 | 16.8 |
| 90 | 16.1 | 18.0 | 16.5 | 16.8 |
| 124 | 16.3 | 17.0 | 16.5 | 16 8 |
| Avg. | 16.0 | 17.5 | 16.3 | 16.6 |
| LSD Variety Averages | | | 1.2 | (p=0.05) |
| N Rate Averages | | | 0.6 | (p=0.01) |
| Variety x N Rate Interaction | | | NS | |

Table 3. Nitrogen fertilizer and variety influence on barley production on summer fallow.
Lorang Farm. S. of Great Falls.

| N Rate (lb/a) | Variety Klages | Piroline | Clark | |
|---|---|---|---|---|
| | - - - - - - - - -Yield (bu/a)- - - - - | | | Avg. |
| 0 | 26.6 | 28.1 | 34.1 | 29.6 |
| 16 | 32.1 | 28.3 | 34.3 | 31.6 |
| 48 | 31.6 | 31.2 | 34.8 | 32.5 |
| 94 | 35.6 | 33.6 | 33.1 | 30.8 |
| 120 | 27.5 | 35.1 | 30.0 | 30.8 |
| Avg. | 28.7 | 31.3 | 33.3 | 31.1 |
| LSD | Variety Averages | | 2.0 | (p=0.01) |
| | N Rate Averages | | NS | |
| | Variety x N Rate Interaction | | 4.6 | (p=0.05) |
| | - - - - - - - - - Test Weight (lb/bu) - - - | | | Avg. |
| 0 | 46.7 | 50.5 | 50.0 | 49.1 |
| 16 | 44.8 | 51.0 | 49.2 | 48.3 |
| 48 | 46.6 | 50.5 | 48.9 | 48.7 |
| 94 | 44.4 | 48.7 | 47.9 | 47.0 |
| 120 | 43.8 | 49.1 | 47.9 | 46.9 |
| Avg. | 45.3 | 50.0 | 48.8 | 48.0 |
| LSD | Variety Averages | | 1.2 | (p=0.01) |
| | N Rate Averages | | 0.8 | (p=0.01) |
| | Variety x N Rate Interaction | | NS | |
| | - - - - - - - - - Protein (%)- - - - - - | | | Avg. |
| 0 | 12.5 | 12.7 | 12.0 | 12.4 |
| 16 | 13.1 | 11.7 | 13.0 | 12.6 |
| 48 | 14.0 | 13.5 | 12.6 | 13.3 |
| 94 | 15.7 | 14.8 | 14.1 | 14.8 |
| 120 | 15.9 | 14.5 | 14.2 | 14.9 |
| Avg. | 14.2 | 13.4 | 13.2 | 13.6 |
| LSD | Variety Averages | | 0.9 | (p=0.05) |
| | N Rate Averages | | 1.1 | (p=0.01) |
| | Variety x N Rate Interaction | | NS | |

Table continued.

Table 3. continued

| N Rate (lb/a) | Klages | Variety Piroline | Clark | |
|---|---|---|---|---|
| | - - - - - - - | Plump (%) | - - - - - - - - | Avg. |
| 0 | 14.5 | 56.0 | 60.2 | 43.6 |
| 16 | 13.5 | 59.5 | 42.8 | 38.6 |
| 48 | 12.0 | 47.5 | 49.0 | 36.2 |
| 94 | 6.0 | 24.8 | 37.8 | 22.8 |
| 120 | 5.5 | 30.8 | 35.0 | 23.8 |
| Avg. | 10.3 | 43.7 | 45.0 | 33.0 |
| LSD | Variety Averages | | 21.3 | (p=0.01) |
| | N Rate Averages | | 18.1 | (p=0.01) |
| | Variety x N Rate Interaction | | NS | |
| | - - - - - - - | Thins (%) | - - - - - - - - | |
| 0 | 55.8 | 14.0 | 12.0 | 27.3 |
| 16 | 53.3 | 11.0 | 19.3 | 27.8 |
| 48 | 50.0 | 20.3 | 17.8 | 29.3 |
| 94 | 75.5 | 33.8 | 25.8 | 45.0 |
| 120 | 76.0 | 27.0 | 28.8 | 43.9 |
| Avg. | 62.1 | 21.2 | 20.7 | 34.7 |
| LSD | Variety Averages | | 14.8 | (p=0.01) |
| | N Rate Averages | | 18.0 | (p=0.01) |
| | Variety x N Rate Interaction | | NS | |

Table 4. Nitrogen fertilizer and variety influence on irrigated spring wheat production.
Wiest Farm. Teton Co.

| N Rate (lb/a) | Variety Newana | Pondera | Lew | |
|---|---|---|---|---|
| | - - - - - - - - - Yield (bu/a) | - - - - - - - | | Avg. |
| 0 | 40.5 | 31.4 | 37.5 | 36.5 |
| 50 | 37.3 | 28.1 | 47.8 | 37.7 |
| 110 | 40.0 | 32.3 | 42.5 | 38.3 |
| 170 | 37.1 | 30.9 | 38.1 | 35.4 |
| 200 | 34.5 | 26.0 | 43.6 | 34.7 |
| Avg. | 37.9 | 29.7 | 41.9 | 36.5 |
| LSD | Variety Averages | | 6.9 | (p=0.01) |
| | N Rate Averages | | NS | |
| | Variety x N Rate Interaction | | NS | |
| | - - - - - Test Weight (lb/bu) | - - - - - - | | Avg. |
| 0 | 58.0 | 56.3 | 56.3 | 56.9 |
| 50 | 57.2 | 57.3 | 57.4 | 57.3 |
| 110 | 56.0 | 57.8 | 53.7 | 55.8 |
| 170 | 50.7 | 56.0 | 53.1 | 53.2 |
| 200 | 55.5 | 56.3 | 53.2 | 55.0 |
| Avg. | 55.5 | 56.7 | 54.7 | 55.6 |
| LSD | Variety Averages | | NS | |
| | N Rate Averages | | 2.5 | (p=0.05) |
| | Variety x N Rate Interaction | | NS | |

Table 5. Lew Spring wheat response to the addition of N,P,K, and S Fertilizers. Mason Farm. N. of Cut Bank.

| N | $P_2O_5$ | $K_2O$ | S | Yield | Test Wt. | Protein |
|---|---|---|---|---|---|---|
| - - - - - - - - | lb/a- | - - - - - - - - | | bu/a | lb/bu | % |
| 0 | 50 | 25 | 0 | 8.3 | 57.5 | 16.0 |
| 56 | 0 | 0 | 0 | 8.4 | 58.1 | 16.4 |
| 56 | 50 | 0 | 0 | 8.1 | 56.1 | 16.1 |
| 56 | 50 | 25 | 0 | 7.3 | 53.6 | 16.6 |
| 56 | 50 | 25 | 20 | 8.3 | 56.3 | 16.3 |
| Avg. | | | | 8.1 | 56.3 | 16.3 |
| LSD | | | | NS | 3.5 | NS |
| p= | | | | -- | 0.05 | -- |

Table 6. **Clark barley production response to fertilizer on summer fallow. Lorang Farm. S. of Great Falls.**

| N | Fertilizer $P_2O_5$ | $K_2O$ | S | Yield | Test Wt. | Protein | Plump | Thin |
|---|---|---|---|---|---|---|---|---|
| - - - - | - - - - | -lb/ac- - - | - - - - | bu/a | lb/bu | - - - - | %- - - | - - - - |
| 0 | 50 | 25 | 0 | 34.1 | 50.0 | 12.0 | 60.3 | 12.0 |
| 48 | 0 | 0 | 0 | 25.1 | 47.9 | 14.0 | 37.3 | 26.5 |
| 48 | 50 | 0 | 0 | 20.9 | 47.7 | 13.4 | 41.0 | 26.8 |
| 48 | 50 | 25 | 0 | 34.8 | 48.9 | 12.6 | 49.0 | 17.8 |
| 48 | 50 | 25 | 20 | 22.8 | 48.5 | 14.2 | 29.8 | 27.8 |
| Avg. | | | | 27.5 | 48.6 | 13.2 | 43.5 | 22.2 |
| LSD | | | | 9.5 | 1.6 | 1.7 | 17.0 | 11.8 |
| P= | | | | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 |

Table 7. Irrigated spring wheat response to fertilizer.
Wiest Farm. Teton Co.

| N | Fertilizer $P_2O_5$ | $K_2O$ | S | Yield | Test Wt. |
|---|---|---|---|---|---|
| - - - - - - - - - - | lb/a | - - - - - - - - | | (bu/a) | lb/bu |
| 0 | 50 | 25 | 0 | 37.5 | 56.3 |
| 110 | 0 | 0 | 0 | 37.9 | 52.5 |
| 110 | 50 | 0 | 0 | 40/8 | 51.4 |
| 110 | 50 | 25 | 0 | 42.5 | 53.7 |
| 110 | 50 | 25 | 40 | 40.4 | 54.3 |
| Avg. | | | | 39.8 | 53.6 |
| LSD | | | | NS | NS |

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

DISCLAIMER:



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 plots across the strip. Each plot was analyzed for grain yield. Test weights and protein analyses are pending final evaluation of yield results.

RESULTS AND DISCUSSION:

Substantial scatter was observed in yields of winter wheat and barley across the width of the field (Fig. 1-3). Yields ranged from 19.4 to 40.6 bu/a ( WW- Dyrud), 25.9 to 43.7 bu/a (WW - Bley), and 17.8 to 51.9 bu/a (Barley - Bley). Average values for these three fields were 32.0, 36.7 and 35.1 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 contained numerous harvest samples that had substantially lower yields than the adjacent harvest samples. Indications are that the lowest yields are associated with the tire tracks of the tractor being used to pull the seeder. Dry seeding conditions likely prevented extremely large yield losses from wheel compaction.

Figure 3. Barley yields harvested across a cropping strip.
Bley Farm. 1984.

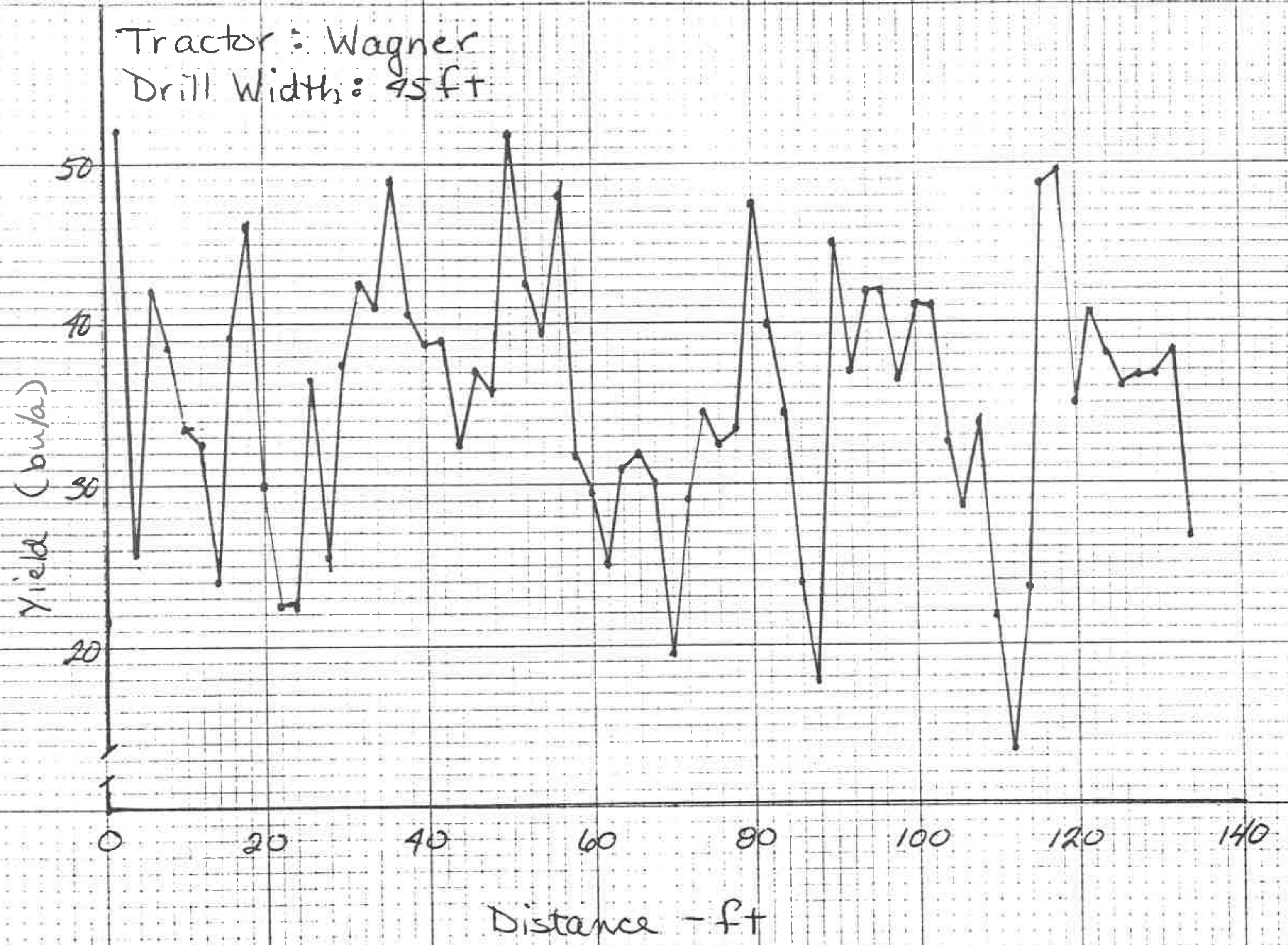


Table 1. Grain yields harvested across a cropping strip.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dyrud - - - - - - | - - - - - - | - - - - - - | - - Winter Wheat Yield (bu/a) | | - - - - - - | - - - - - - | - - - |
| 34.1 | 40.6 | 39.1 | 35.5 | 36.6 | 34.6 | 35.5 | 27.8 |
| 37.3 | 31.6 | 30.0 | 26.3 | 34.5 | 31.9 | 35.5 | 23.6 |
| 36.8 | 36.3 | 32.2 | 35.3 | 36.5 | 34.7 | 34.5 | 35.9 |
| 34.7 | 32.6 | 33.1 | 36.3 | 33.3 | 38.1 | 31.2 | 30.1 |
| 32.0 | 31.7 | 28.5 | 32.0 | 34.7 | 37.8 | 37.9 | 30.0 |
| 37.3 | 37.3 | 36.6 | 33.1 | 37.5 | 33.5 | 29.2 | 31.5 |
| 35.1 | 35.1 | 30.2 | 29.9 | 29.6 | 31.1 | 32.0 | 30.0 |
| 37.7 | 32.3 | 29.7 | 27.7 | 31.4 | 38.4 | 38.4 | 38.5 |
| 39.9 | 38.9 | 34.2 | 26.9 | 38.4 | 27.2 | 42.0 | 34.1 |
| 29.8 | 28.1 | 28.9 | 27.3 | 28.8 | 35.6 | 28.9 | 24.3 |
| 19.4 | 23.7 | 27.6 | 28.2 | 31.0 | 30.4 | 24.0 | 23.4 |
| 24.8 | 27.5 | 29.1 | 24.6 | 28.5 | 20.8 | 24.5 | 24.5 |
| 28.8 | 30.7 | | | | | | |
| Bley - - - - - - | - - - - - - | - - - - - - | Winter Wheat Yield (bu/a) | | - - - - - - | - - - - - - | - - - |
| 28.1 | 32.2 | 40.0 | 42.3 | 43.7 | 39.6 | 37.4 | 42.4 |
| 42.6 | 40.8 | 40.2 | 40.4 | 40.1 | 34.6 | 38.0 | 38.2 |
| 35.9 | 38.2 | 33.5 | 38.8 | 39.8 | 39.7 | 40.3 | 41.1 |
| 40.6 | 40.5 | 37.0 | 39.2 | 38.2 | 36.6 | 33.5 | 32.1 |
| 35.8 | 33.5 | 38.2 | 39.1 | 36.9 | 40.3 | 38.5 | 28.9 |
| 35.5 | 37.2 | 35.9 | 36.0 | 35.3 | 29.9 | 34.2 | 32.1 |
| 35.0 | 35.1 | 32.2 | 30.8 | 35.2 | 34.1 | 32.6 | 34.1 |
| 38.2 | 38.3 | 35.4 | 31.8 | 38.9 | 38.1 | 25.9 | 36.8 |
| 40.2 | 41.3 | 36.9 | 33.4 | | | | |
| Bley - - - - - - | - - - - - - | - - - - - - | Barley Yield (bu/a) | | - - - - - - | - - - - - - | - - - |
| 51.9 | 25.7 | 42.0 | 38.5 | 33.5 | 32.3 | 23.9 | 39.3 |
| 46.1 | 29.8 | 22.4 | 22.3 | 36.4 | 25.5 | 37.6 | 42.3 |
| 40.9 | 48.9 | 40.5 | 38.8 | 39.0 | 32.4 | 36.9 | 35.9 |
| 51.7 | 42.6 | 39.4 | 48.1 | 31.8 | 29.4 | 24.9 | 31.1 |
| 31.9 | 30.0 | 19.3 | 29.0 | 34.7 | 32.5 | 33.5 | 47.3 |
| 39.8 | 34.8 | 23.8 | 17.8 | 45.1 | 37.1 | 41.9 | 41.7 |
| 36.5 | 41.0 | 40.8 | 32.6 | 28.9 | 33.7 | 21.9 | 13.5 |
| 23.3 | 48.7 | 49.3 | 34.9 | 40.4 | 37.9 | 36.2 | 36.8 |
| 36.7 | 38.2 | 26.8 | | | | | |

TITLE: Soil Compaction

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

COOPERATORS: Ron Gernaat, W. of Conrad, MT
Phil Broesder, W. of Conrad, MT
Steve Keil, Conrad, MT

DISCLAIMER:

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OBJECTIVES:

1) to evaluate several soil properties that may be used to identify soil compaction

2) to determine the extent to which soil compaction may occur in glacial till soils

3) to relate crop yield reductions and soil water conditions to soil compaction

4) assess subsoiling influence on soil compaction and crop production

PROCEDURES:

Study 1. The study area had received substantial wheel traffic compaction during seismographic activity in January 1984. Soil monitoring was conducted on specific sites on clay loam and sandy loam soils. Bulk density, water content, and penetrometer resistance measurements were obtained in May and September of 1984 as identified in figures 1 and 8.

Study 2. Subsoiling was accomplished on an irrigated field north of Conrad in the fall of 1984. Neutron access tubes were installed and initial bulk density and water content measurements were obtained. No data are presented for this study.

RESULTS AND DISCUSSION:

Figure 1 depicts the area observed on the clay loam and the sandy loam soil. The crosshatched area denoted the compacted zone on the clay loam. The compacted zone on the sandy loam only near the southeast corner. Figures 2-7 are for spring measurements.

Bulk densities of the clay loam soil are illustrated in figures 2 and 3. The bulk densities at the extreme right and left were obtained on soil that had not been trafficked. These may be considered indicative of the field as it would be without the wheel traffic. As we move from one side of the test area to the other, bulk density increases for both the 0-4 and 0-12 inch depth. The increase is a maximum of about 50% in the top 12 inches is a result of wheel traffic only indicated a change in the relationship between soil and air partitioning in the soil, not the change in soil size distribution which has a substantial impact on plant-water relations and crop growth.

Penetrometer readings for the surface 3 inches of the clay loam soil for the four transects indicated on Figure 1 are illustrated in Figures 4 and 5. Again the penetrometer readings at the extreme right and left of the graph are indicative of the undisturbed field. As you progress toward the center of the graph penetrometer resistance increases as much as 500% for transects 1 and 2. This resistance may be similar to what the plant sees as its roots are growing downward into the soil to obtain water and nutrients. Figure 5 shows the penetrometer readings adjacent to the test area. All readings are higher for the undisturbed area where the only wheel traffic was the tractor and drill at seeding time. Nevertheless, penetrometer readings were still elevated in the compacted area indicating that tillage and seeding alone does not ameliorate these changes at least in the surface 3 inches of soil.

Similar results are presented for the sandy loam soil in Figures 6 and 7. On this soil we only monitored transects 1 and 2. One pass wheel traffic also occurred on this plot and is illustrated by the increased bulk densities and penetrometer readings at approximately 10-20 ft and 45 ft. The heavily trafficked area is illustrated at about 60-75 ft. The differences in bulk density are less than for the clay loam soil while the penetrometer differences are similar.

Figure 8 depicts the sample locations for fall testing on the clay loam soil. The crosshatched area denotes the trafficked zone. Figure 9 denotes the locations for data collection.

No abrupt increases in bulk density with depth were noted at any test location on the clay loam soil at Broesder's (Tables 1-3). Densities less than 1 g $cm^{-3}$ (i.e. location 1) is associated with intermittent coal deposits. Locations 3, 9, 11, and 12 were located on or very near the starline. Increases with depth in the soil is common in glacial till soils and results in part from overburden pressure.

Penetrometer readings were collected at 3 in. intervals at several locations along the two designated transects as well (Tables 4-6). Most holes had a cone index that slowly increased with depth. As one moves along transect 1 from hole 1 to hole 15, the cone index trends to increase then decrease to at least a depth of 15 in. This same trend is observed for transect 2. Increases in cone indices extends to at least 24 in. depth. Also the magnitude of the increase is much greater due to more intense sampling. The starline is rather well defined by holes 17-21 (Table 5). Lighter trafficking appears to have occured from hole 9-17 and 21-27. This observation coincides with visual observation of trafficking on the soil surface. More intensive penetrometer, bulk density and water content data are presented in Tables 6 and 7.

Similar results are presented for two starlines in Tables 8 and 9. Each starline was monitored perpendicular to the line itself. Cone indices above 2 at the 6-12 in. depth above 3 at the lower depths are likely to be associated with traffic compaction.

The sandy loam soil was monitored at several locations (Tables 10-11). Cone index was drastically increased on holes 2-4 which traversed the starline. Where 'MAX' is indicated the penetrometer could not be pushed into the ground without damaging the instrument.

Each of these study sites illustrated that compaction could be measured by use of the penetrometer but not by bulk density measurements. Additionally, penetrometer resistance in the high trafficked areas may have continued to increase beyond the depth of measurement. Penetrometer resistance, as indicated by cone index, generally reflects the ease with which plant roots can grow. The greater the cone index the greater the degree of difficulty for plant root growth.

Figure 1. Field plot diagram of compaction plot. Hashed area is trafficked zone. Transects 3 and 4 were tilled prior to study.

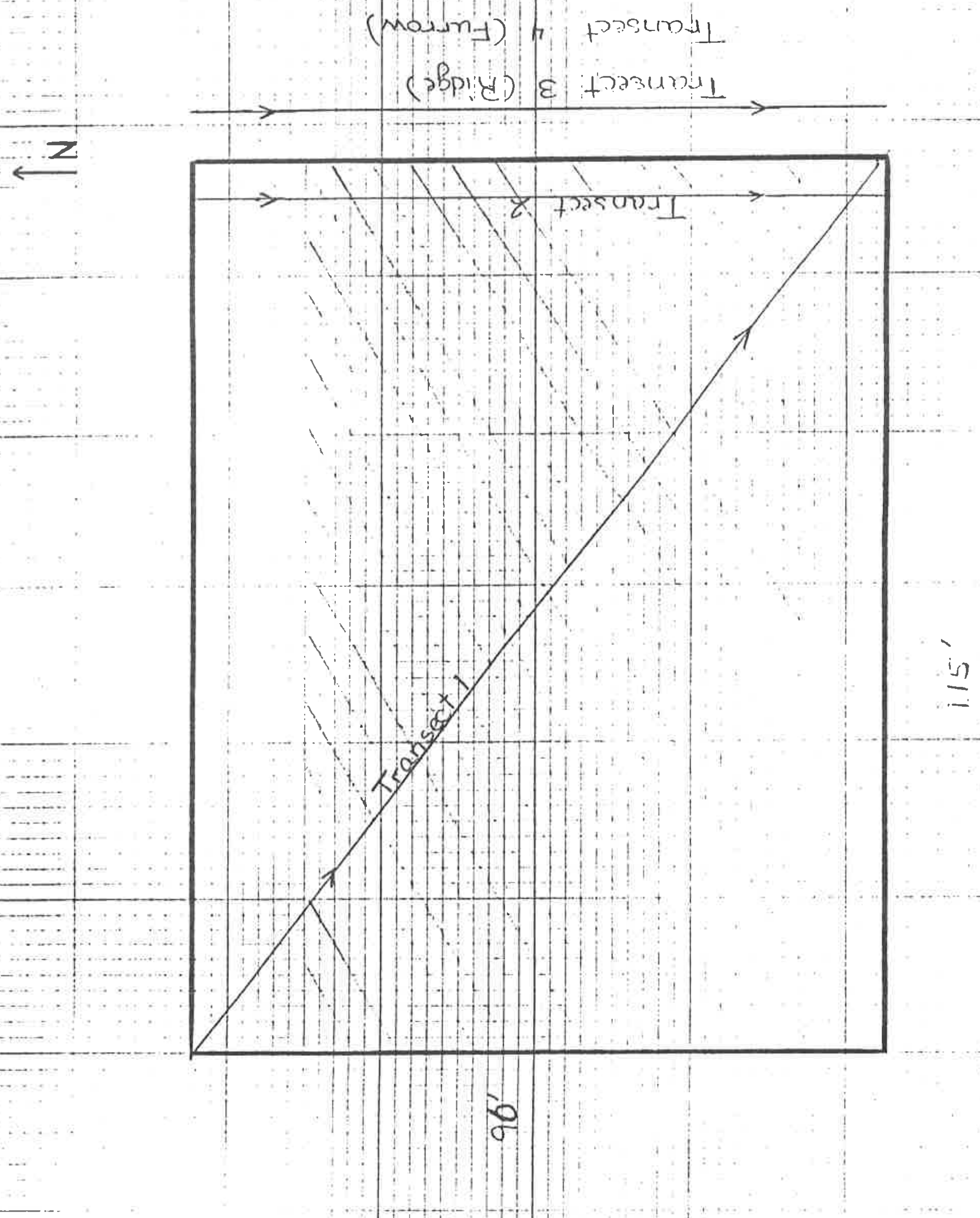

Figure 2. Bulk density of clay loam soil along Transect 1.

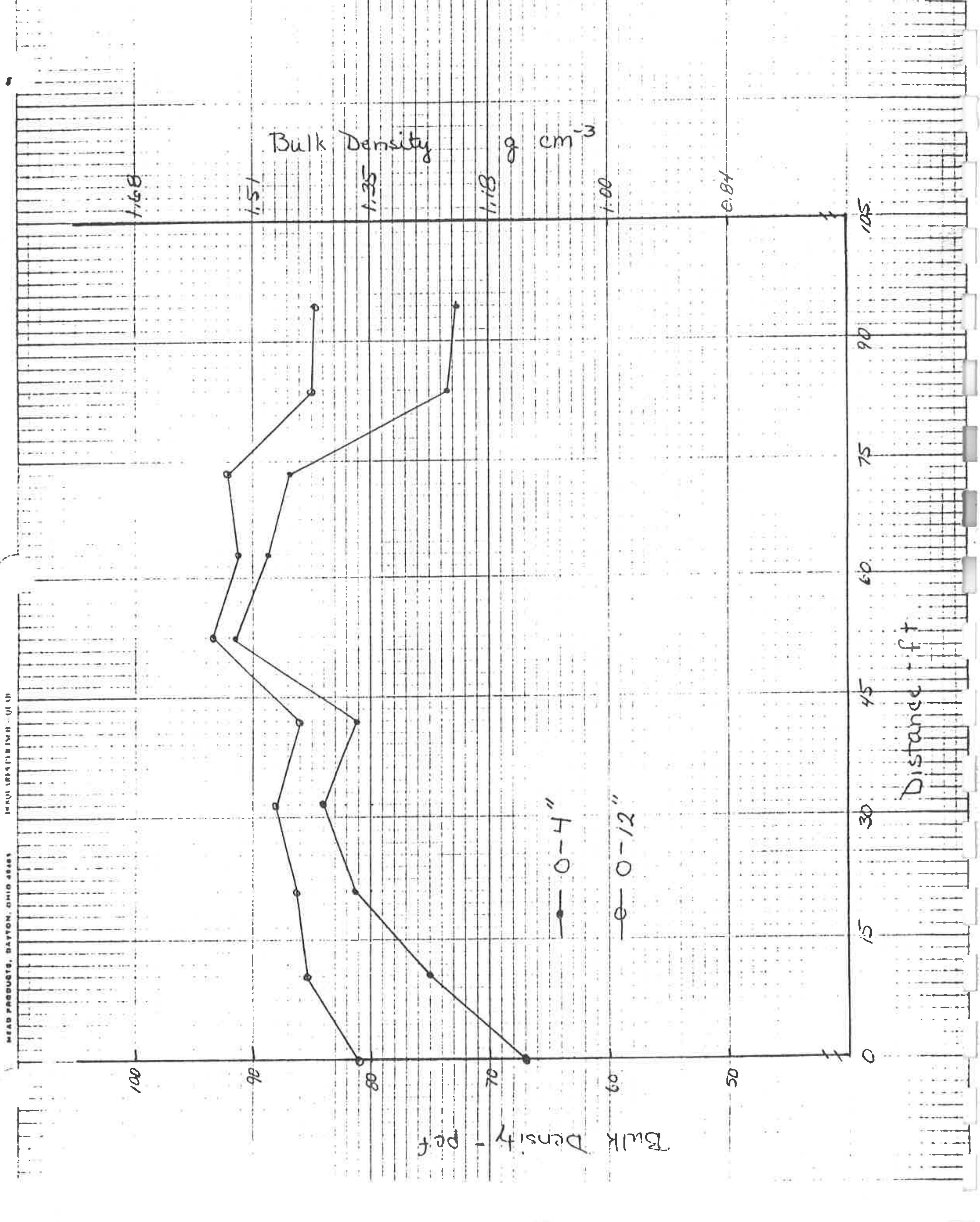

Figure 3. Bulk density of clay loam soil along Transect 2

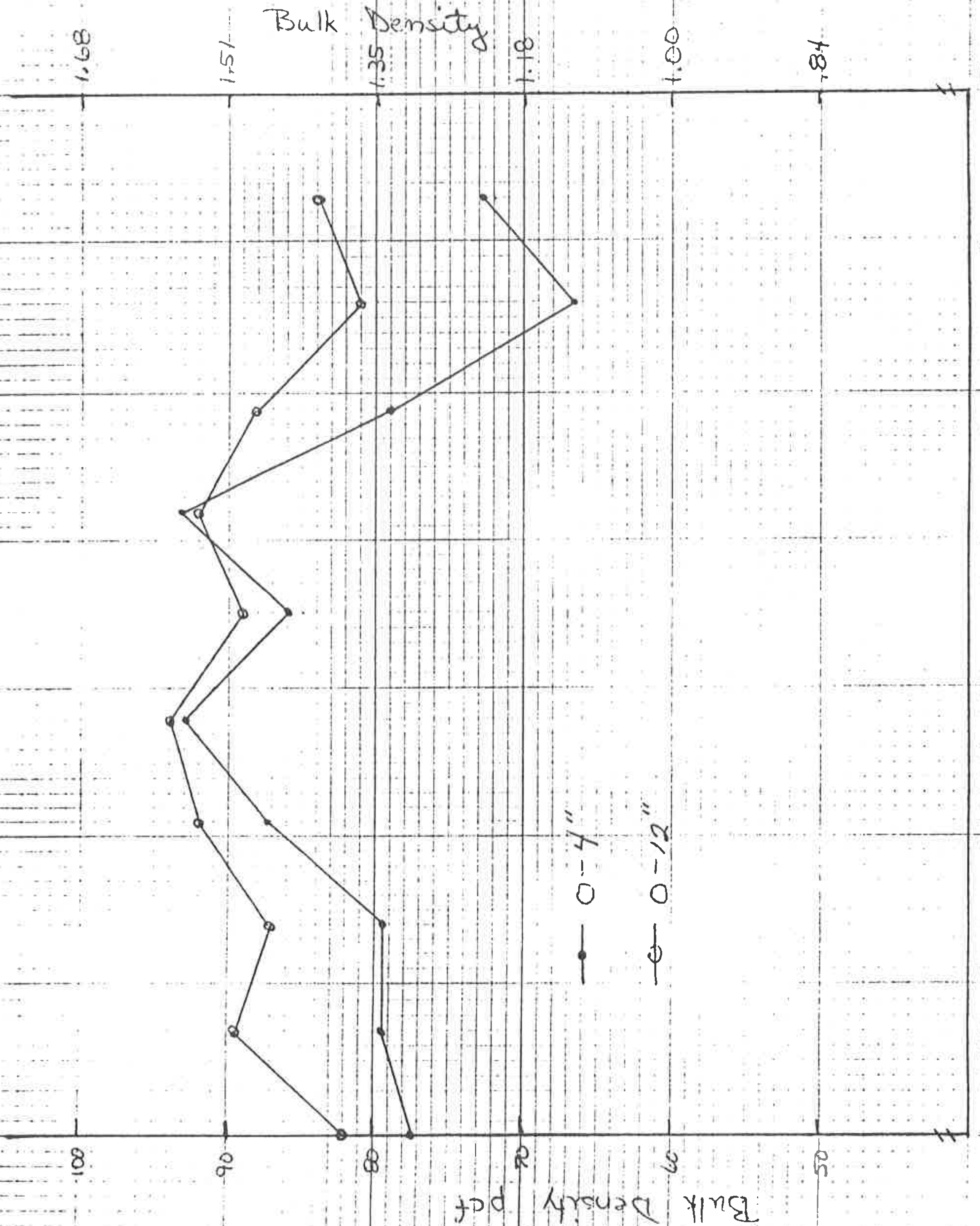

Figure 4. Penetrometer readings of the surface 3" of compaction study on a clay loam.

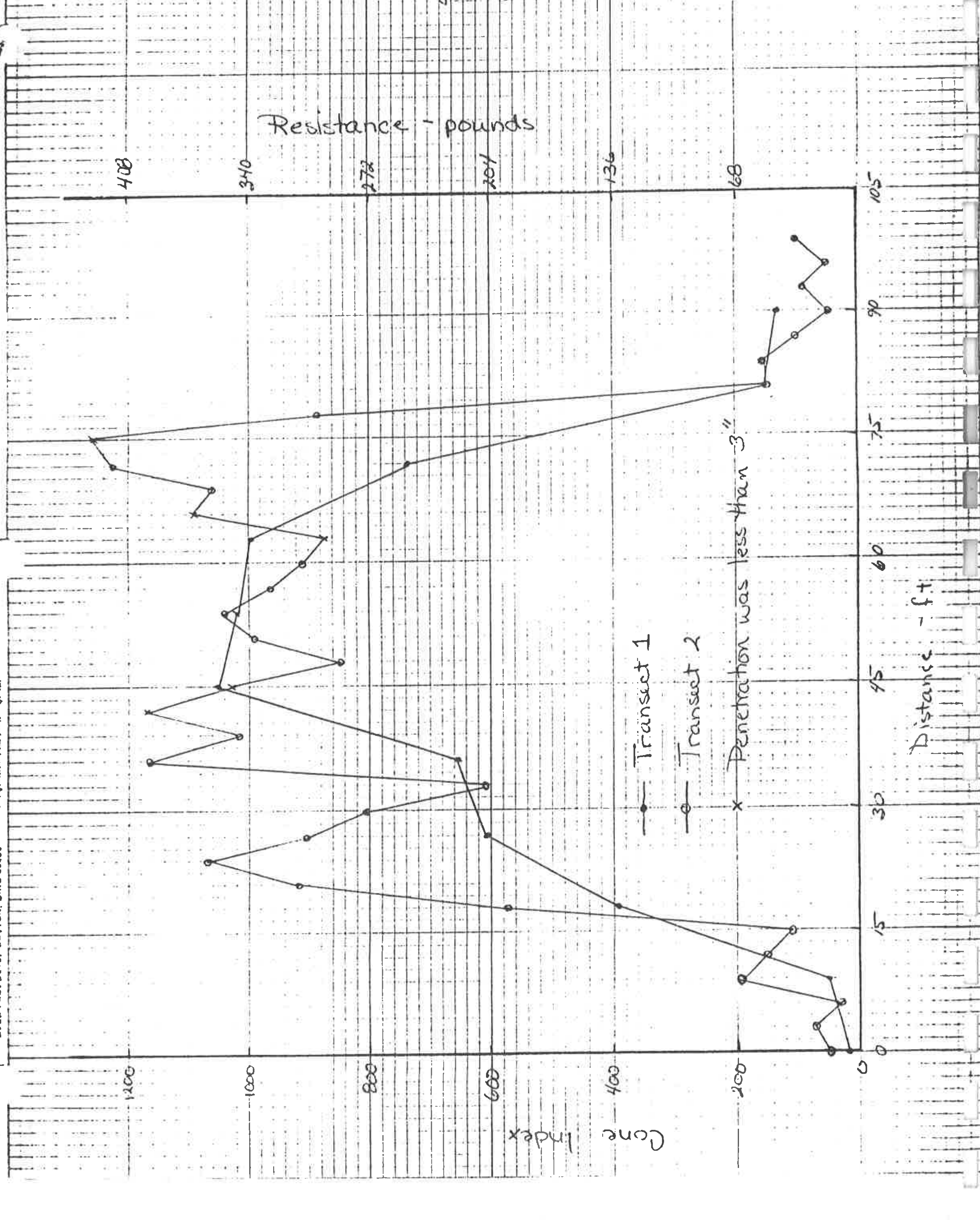

Figure 5. Penetrometer readings of the surface 3" of compaction study on a clay loam.

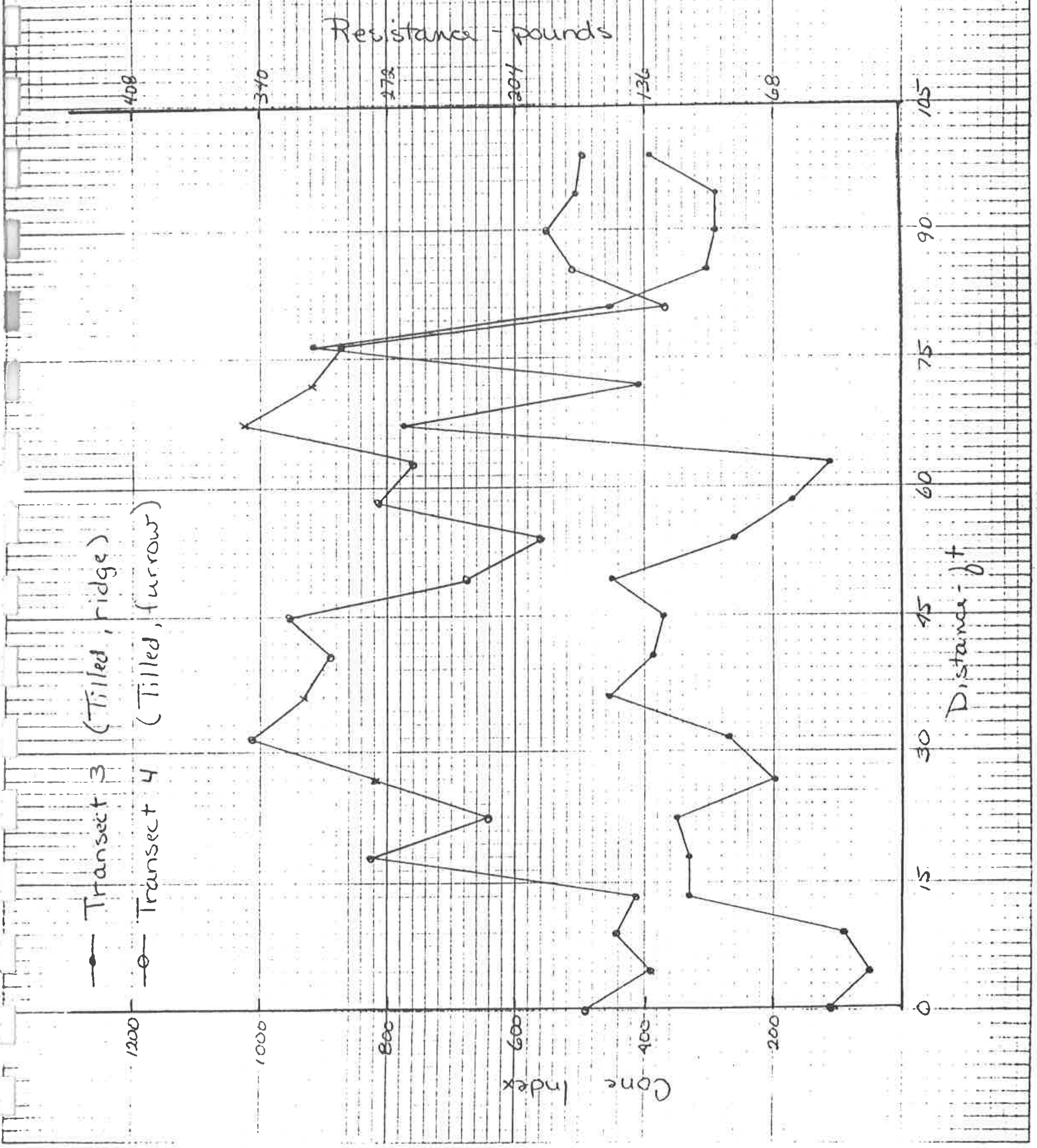

Figure 6. Bulk density of sandy loam soil along Transect 1.

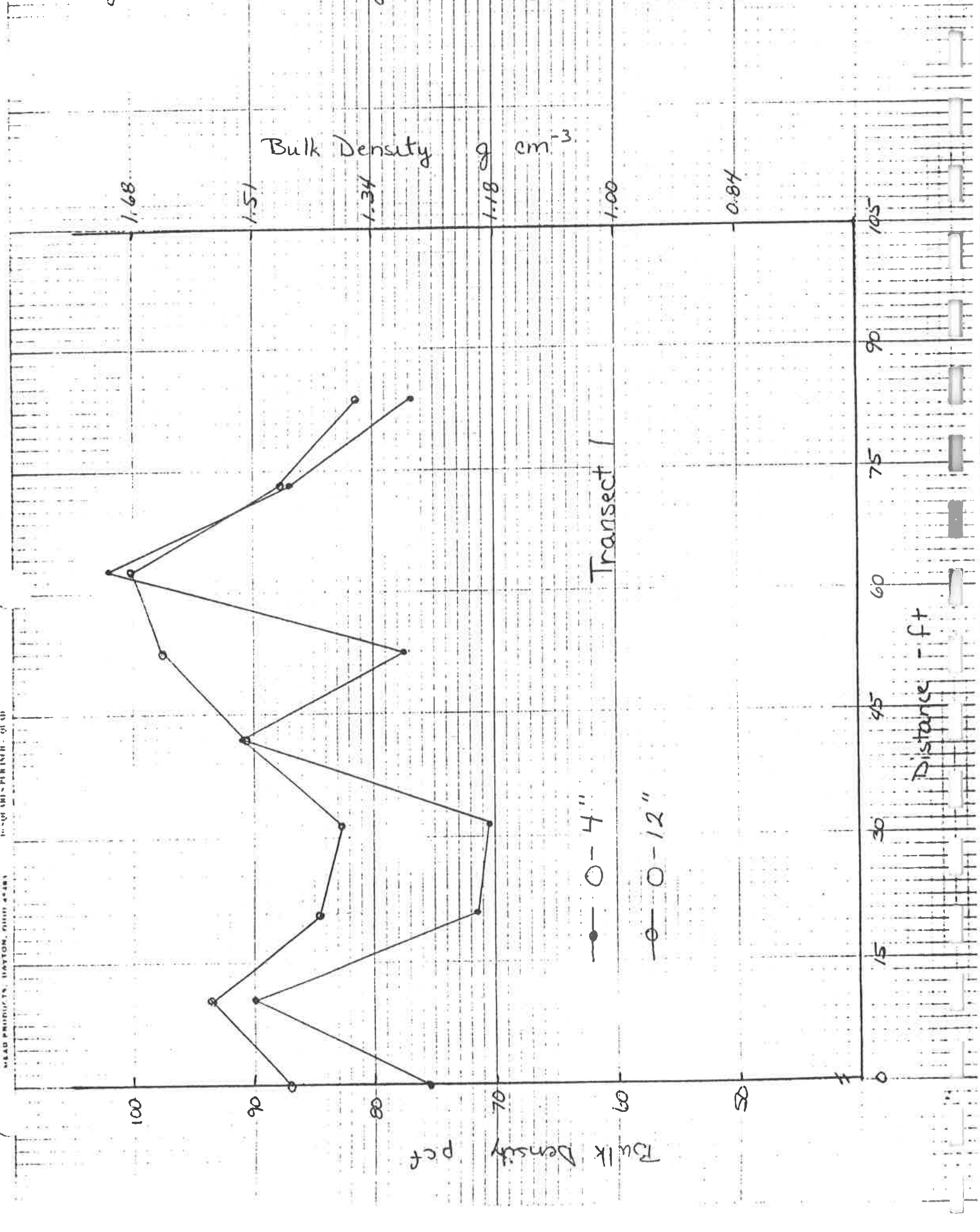

Figure 7. Penetrometer readings of the surface 3" of compaction study on a sandy loam.

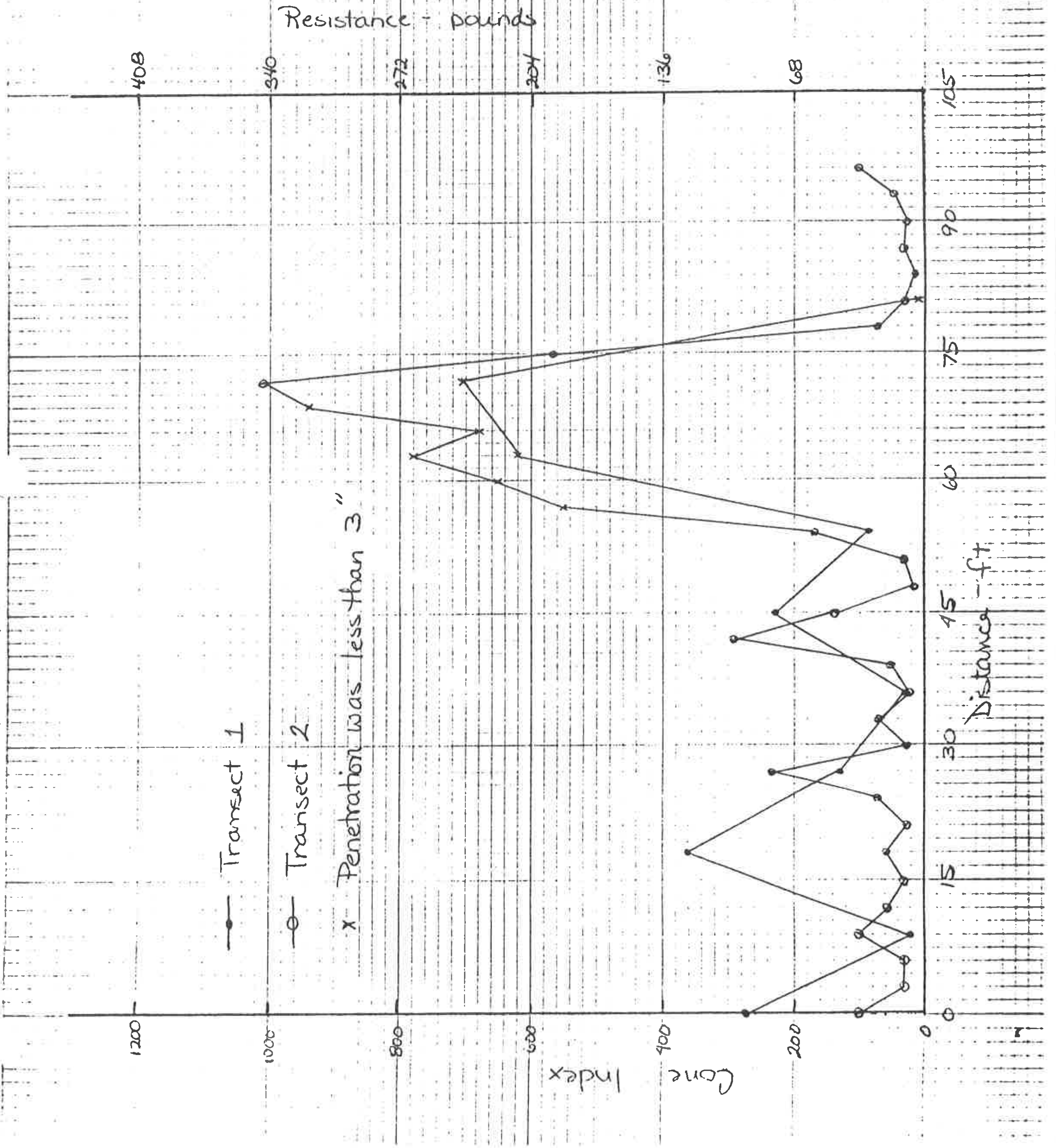

Figure 8. Field plot diagram of compaction plot. Hashed area is trafficked zone.

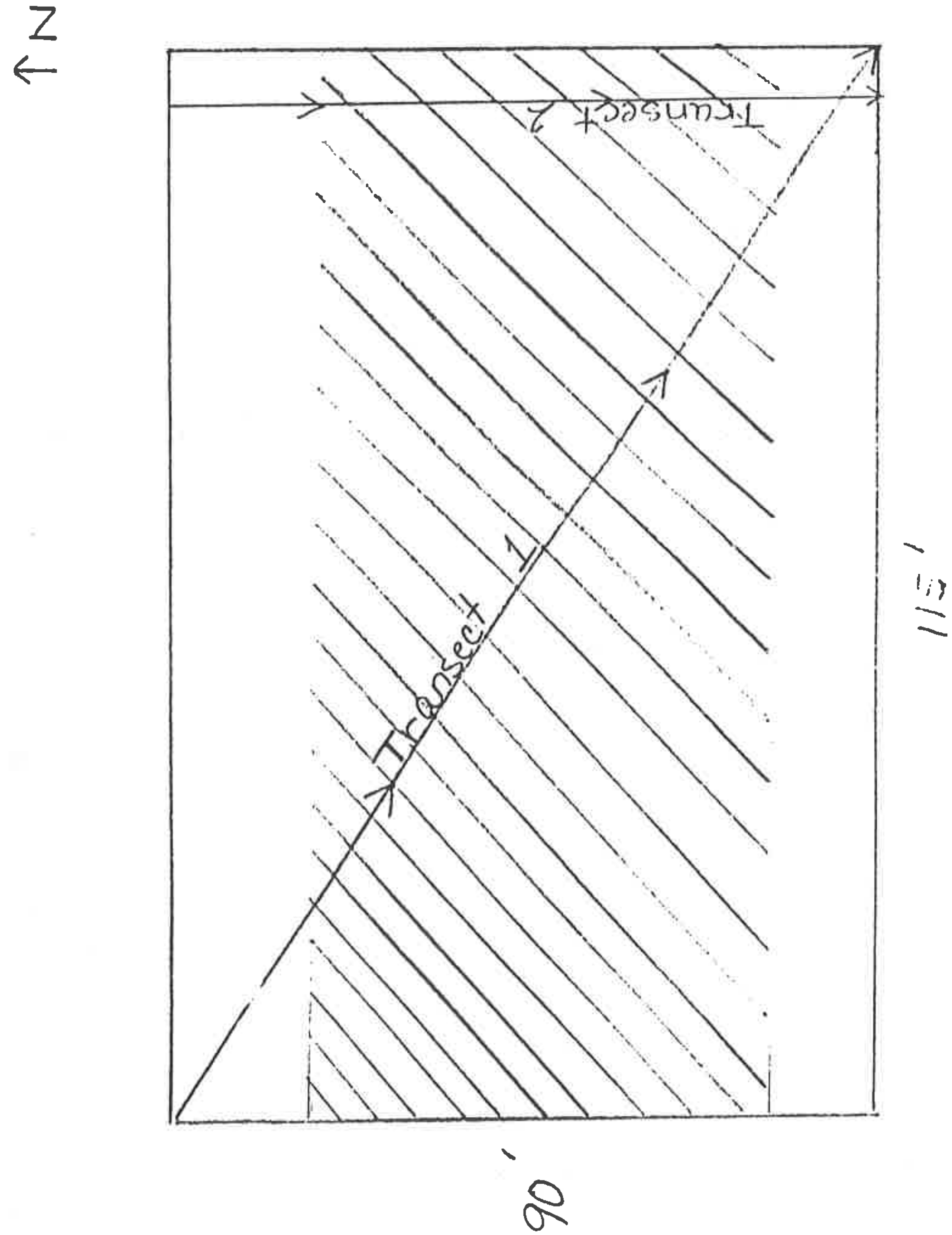

Table 2. Bulk density of clay loam soil along Transect 2.

| Depth (in) | Location | | | |
|---|---|---|---|---|
| | 7 | 8 | 9 | 10 |
| | - - - - - - - - g $cm^{-3}$ - - - - - - - - - - | | | |
| 0-2 | 1.58 | 1.53 | 1.48 | 1.60 |
| 2-4 | 1.61 | 1.55 | 1.52 | 1.59 |
| 4-6 | 1.63 | 1.64 | 1.54 | 1.60 |
| 6-8 | 1.59 | 1.66 | 1.56 | 1.60 |
| 8-10 | 1.66 | 1.65 | 1.61 | 1.62 |
| 10-12 | 1.67 | 1.69 | 1.68 | 1.57 |
| 12-14 | 1.71 | 1.74 | 1.70 | 1.63 |
| 14-16 | 1.71 | 1.73 | 1.72 | 1.63 |
| 16-18 | 1.74 | 1.74 | 1.76 | 1.64 |
| 18-20 | 1.78 | 1.79 | 1.76 | 1.68 |
| 20-22 | 1.84 | 1.80 | 1.80 | 1.71 |
| 22-24 | 1.83 | 1.83 | 1.78 | 1.75 |
| 24-26 | 1.86 | 1.77 | 1.83 | 1.80 |
| 26-28 | -- | 1.85 | 1.78 | 1.82 |

Table 3. Bulk density of clay loam soil off the transects.

| Depth (in) | Location 11 | Location 12 |
| --- | --- | --- |
| | - - - - - g $cm^{-3}$ | - - - - - - |
| 0-2 | 1.52 | 1.55 |
| 2-4 | 1.59 | 1.53 |
| 4-6 | 1.58 | 1.61 |
| 6-8 | 1.57 | 1.58 |
| 8-10 | 1.63 | 1.56 |
| 10-12 | 1.73 | 1.54 |
| 12-14 | 1.81 | 1.61 |
| 14-16 | 1.78 | 1.64 |
| 16-18 | 1.82 | 1.69 |
| 18-20 | 1.81 | 1.69 |
| 20-22 | 1.82 | 1.72 |
| 22-24 | 1.81 | 1.76 |
| 24-26 | 1.86 | 1.75 |
| 26-28 | 1.85 | 1.79 |

Table 4. Cone index of clay loam soil along Transect 1 at 10 ft. intervals beginning at the northwest corner.

| Hole No. | Depth (in) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0-3 | 3-6 | 6-9 | 9-12 | 12-15 | 15-18 | 18-21 | 21-24 |
| | Cone Index | | | | | | | |
| 1 | .009 | 1.31 | 1.94 | 1.40 | 4.56 | -- | -- | -- |
| 2 | .60 | .92 | .98 | 1.31 | 1.31 | 1.60 | 2.31 | 3.69 |
| 3 | .68 | .92 | 1.02 | 1.51 | 2.35 | 2.17 | 2.77 | 2.39 |
| 4 | .81 | .88 | 1.08 | 1.42 | 1.47 | 1.54 | 1.45 | 2.16 |
| 5 | .69 | 1.12 | 1.24 | 1.50 | 1.76 | 1.74 | 1.88 | 2.03 |
| 6 | .52 | .89 | 1.32 | 1.50 | 1.55 | 1.50 | 1.75 | 1.95 |
| 7 | .21 | 1.80 | 2.46 | 2.15 | 1.75 | 1.93 | 1.98 | 2.22 |
| 8 | .50 | 2.22 | 2.71 | 1.93 | 2.80 | 1.48 | 1.74 | 1.65 |
| 9 | 1.01 | 1.90 | 1.81 | 1.48 | 1.70 | 1.68 | 1.92 | 1.82 |
| 10 | 1.55 | 2.50 | 2.11 | 1.43 | 1.42 | 1.60 | 1.72 | 1.80 |
| 11 | 1.93 | 2.74 | 1.95 | 1.66 | 1.53 | 1.71 | 1.85 | 1.90 |
| 12 | 1.42 | 1.98 | 1.64 | 1.42 | 1.48 | 1.50 | 1.56 | 1.93 |
| 13 | .61 | 2.00 | 2.04 | 1.81 | 1.70 | 2.10 | 2.05 | 1.79 |
| 14 | .30 | .92 | 1.19 | 1.23 | 1.30 | 1.41 | 1.36 | 1.48 |

Table 5. Cone index of clay loam soil along Transect 2 at 3 ft. intervals beginning at the northeast corner.

| Hole No. | Depth (in) 0-3 | 3-6 | 6-9 | 9-12 | 12-15 | 15-18 | 18-21 | 21-24 |
|---|---|---|---|---|---|---|---|---|
| | Cone Index | | | | | | | |
| 1 | .28 | .82 | 1.48 | 1.50 | 1.37 | 1.28 | 1.53 | 1.43 |
| 2 | .07 | .01 | 1.68 | 1.67 | 1.65 | 1.49 | 2.19 | 1.64 |
| 3 | .52 | 1.46 | 2.11 | 1.83 | 1.67 | 1.52 | 1.53 | 1.63 |
| 4 | ,87 | 2.18 | 2.61 | 2.02 | 1.88 | 1.68 | 1.96 | 2.35 |
| 5 | .19 | 1.67 | 1.93 | 1.59 | 1.60 | 1.42 | 1.24 | 1.60 |
| 6 | .64 | 2.10 | 2.10 | 1.94 | 1.75 | 1.41 | 1.37 | 1.50 |
| 7 | .79 | 2.08 | 2.34 | 1.69 | 1.43 | 1.28 | 1.34 | 1.39 |
| 8 | .67 | 2.38 | 2.52 | 1.40 | 1.47 | 1.50 | 1.19 | 1.28 |
| 9 | 1.12 | 1.97 | 3.03 | 2.36 | 1.95 | 1.58 | 1.29 | 1.32 |
| 10 | .78 | 1.74 | 3.56 | 2.86 | 2.75 | 2.59 | 2.42 | 2.42 |
| 11 | 2.22 | 3.29 | 3.52 | 2.67 | 2.43 | 2.39 | 2.41 | 2.92 |
| 12 | 2.64 | 2.97 | 3.32 | 2.59 | 2.58 | 2.53 | 2.44 | 2.64 |
| 13 | 1.98 | 2.66 | 2.86 | 2.75 | 2.45 | 2.59 | 2.69 | 2.67 |
| 14 | 2.08 | 2.43 | 2.83 | 2.53 | 2.67 | 2.91 | 2.83 | 2.52 |
| 15 | 2.25 | 3.22 | 2.52 | 2.52 | 2.52 | 2.48 | 2.69 | 2.59 |
| 16 | 2.00 | 2.61 | 3.05 | 2.43 | 2.48 | 2.59 | 2.74 | 3.19 |
| 17 | 2.34 | 3.35 | 3.12 | 2.43 | 2.62 | 2.62 | 2.47 | 2.76 |
| 18 | 2.35 | 3.45 | 3.08 | 2.82 | 2.68 | 2.63 | 2.78 | 2.82 |
| 19 | 2.64 | 4.16 | 4.31 | 3.50 | 3.51 | 3.63 | 4.43 | 4.46 |
| 20 | 2.32 | 4.74 | 6.35 | 4.62 | 4.54 | 4.16 | 4.75 | 5.70 |
| 21 | 2.45 | 2.86 | 2.80 | 2.75 | 3.01 | 3.23 | 3.67 | 3.52 |
| 22 | 2.21 | 3.40 | 3.36 | 2.82 | 2.67 | 2.58 | 2.74 | 2.92 |
| 23 | 2.66 | 2.72 | 2.47 | 2.52 | 2.41 | 2.79 | 3.03 | 3.11 |
| 24 | 2.49 | 2.12 | 2.18 | 2.09 | 2.40 | 2.46 | 2.70 | 2.91 |
| 25 | 2.06 | 2.50 | 2.64 | 2.31 | 2.75 | 2.64 | 3.09 | 3.06 |
| 26 | 2.08 | 2.80 | 3.20 | 2.50 | 2.71 | 2.60 | 2.70 | 3.07 |
| 27 | 2.87 | 2.81 | 2.88 | 2.32 | 2.35 | 2.47 | 2.92 | 2.93 |

Table 6. Cone index for holes 18A, 19A, 20A, and 21A along Transect 2 at 3 ft. intervals and located 3 ft. to the west of holes 18, 19, 20, and 21.

| | Depth (in.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hole No. | 0-3 | 3-6 | 6-9 | 9-12 | 12-15 | 15-18 | 18-21 | 21-24 |
| | Cone Index | | | | | | | |
| 18A | 2.24 | 4.19 | 4.00 | 3.00 | 2.93 | 3.00 | 2.93 | 3.28 |
| 19A | 2.09 | 3.66 | 7.08 | 7.58 | 6.02 | 5.71 | 7.34 | 7.45 |
| 20A | 2.07 | 2.51 | 4.92 | 5.72 | 5.10 | 8.87 | 9.36 | 9.61 |
| 21A | 4.45 | 2.96 | 3.76 | 4.27 | 4.43 | 4.44 | 4.82 | 4.79 |

Table 7. Bulk density and water content for holes 20 and 21 along Transect 2.

| | Depth (in.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hole No. | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-12 | 12-14 | 14-16 | 16-18 | 18-20 |
| | Bulk Density g $cm^{-3}$ | | | | | | | | | |
| 20 | 1.56 | 1.54 | 1.61 | 1.54 | 1.61 | 1.64 | 1.66 | 1.66 | 1.69 | 1.69 |
| 21 | 1.55 | 1.54 | 1.55 | 1.55 | 1.63 | 1.65 | 1.66 | 1.74 | 1.71 | 1.77 |
| | Water Content $cm^3$ $cm^{-3}$ | | | | | | | | | |
| 20 | 23.2 | 23.5 | 21.5 | 20.8 | 19.4 | 18.9 | 19.5 | 19.0 | 19.6 | 20.4 |
| 21 | 27.3 | 26.3 | 23.9 | 23.9 | 23.4 | 23.4 | 23.6 | 23.7 | 24.4 | 24.4 |

Table 8. Cone index of clay loam soil on starlines between Gernaat's and Broesder's.

| | ----- Depth (in) ----- | | | |
|---|---|---|---|---|
| Hole No. | 0.6 | 6-12 | 12-18 | 18-24 |
| | ----- Cone Index ----- | | | |
| 1[1] | .59 | 3.54 | 4.00 | 6.14 |
| 2 | .88 | 2.39 | 3.52 | 4.57 |
| 3 | .40 | 2.08 | 4.37 | 7.40 |
| 4 | .70 | .96 | 2.74 | 4.75 |
| 5 | .86 | 1.28 | 4.66 | 5.88 |
| 6 | .93 | 1.35 | 3.31 | 4.49 |
| 7 | 1.18 | 1.54 | 2.83 | 5.34 |
| 8 | 1.34 | 1.30 | 2.32 | 4.18 |
| 9 | 1.39 | 1.27 | 2.83 | 4.62 |
| 10 | .10 | 1.91 | 3.57 | 3.91 |
| 11 | .38 | 1.35 | 3.05 | 4.14 |
| 12 | .20 | 2.31 | 3.60 | 4.31 |
| 13 | .40 | 1.74 | 3.05 | 3.43 |
| 14 | .82 | 2.12 | 4.01 | 6.72 |
| 15 | 2.35 | 2.91 | 3.60 | 3.13 |
| 16 | .51 | 4.20 | 3.41 | 3.50 |
| 17 | .61 | 3.44 | 3.96 | 4.42 |
| 18 | .62 | 2.81 | 3.62 | 4.43 |

1/ Holes 1-9 are for a starline running E-W. Holes 10-18 are for a starline running NE-SW.

Table 9. Bulk density of clay loam soil on NE-SW starline between Gernaat's and Broesder's.

| | Depth (in) | | | | | |
|---|---|---|---|---|---|---|
| Hole No. | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-12 |
| | Bulk Density g $cm^{-3}$ | | | | | |
| 10 | 1.50 | 1.58 | 1.57 | 1.54 | 1.51 | 1.49 |
| 18 | 1.49 | 1.57 | 1.54 | 1.60 | 1.61 | 1.62 |
| | 12-14 | 14-16 | 16-18 | 18-20 | 20-22 | 22-24 |
| 10 | 1.53 | 1.50 | 1.54 | 1.59 | 1.58 | 1.67 |
| 18 | 1.60 | 1.60 | 1.56 | 1.61 | 1.67 | -- |

Table 10. Cone index of starline on sandy soil.

| Hole No. | 0-6 | 6-12 | 12-18 | 18-24 |
|---|---|---|---|---|
| | Depth (in) | | | |
| | Cone Index | | | |
| 1 (N) | 1.82 | 2.09 | 1.51 | 1.57 |
| 2 | .09 | 7.43 | 7.64 | MAX |
| 3 | 3.56 | 4.09 | 5.36 | 9.57 (MAX) |
| 4 | 3.74 | MAX | -- | -- |
| 5(S) | 1.31 | 1.79 | 1.94 | 2.68 |

Table 11. Bulk density of holes 3 and 5 of starline on sandy soil.

| Hole No. | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-12 |
|---|---|---|---|---|---|---|
| | Depth (in) | | | | | |
| | Bulk Density g $cm^{-3}$ | | | | | |
| 3 | 1.61 | 1.64 | 1.67 | 1.74 | 1.76 | 1.79 |
| 5 | 1.50 | 1.55 | 1.56 | 1.65 | 1.61 | 1.58 |
| | 12-14 | 14-16 | 16-18 | 18-20 | 20-22 | 22-24 |
| 3 | 179 | 1.81 | 1.87 | 1.94 | 1.94 | 1.96 |
| 5 | 1.59 | 1.65 | 1.76 | 1.74 | 1.79 | 1.92 |

Figure 9. Sample locations for experimental data collection on clay [illegible].

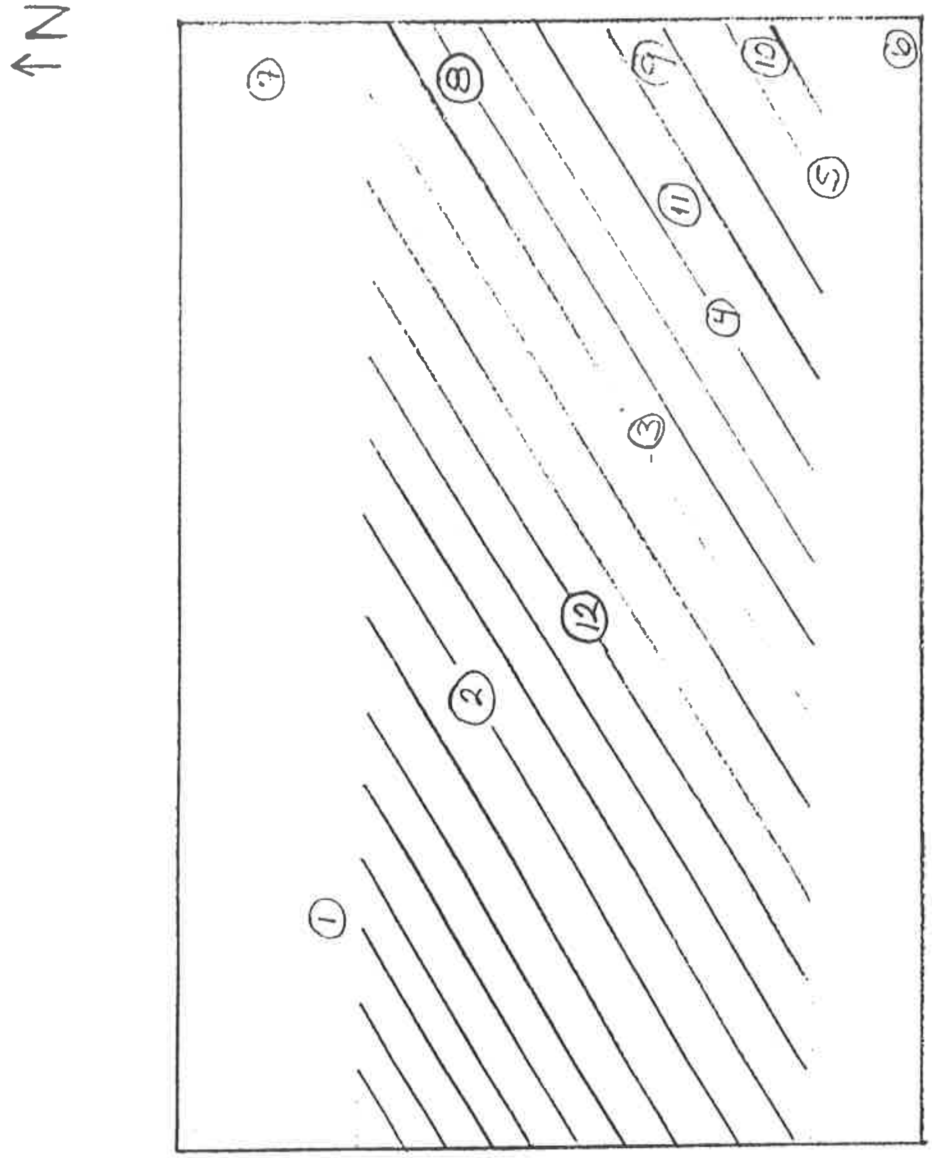

Table 1. Bulk density of clay loam soil along Transect 1.

| Depth (in) | Location 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | ------------- | ------- | g $cm^{-3}$ | ------- | ------- | ------- |
| 0-2 | 1.29 | 1.57 | 1.52 | 1.50 | 1.52 | 1.54 |
| 2-4 | 1.07 | 1.60 | 1.53 | 1.51 | 1.55 | 1.56 |
| 4-6 | 0.98 | 1.56 | 1.58 | 1.55 | 1.52 | 1.56 |
| 6-8 | 1.02 | 1.59 | 1.59 | 1.50 | 2.58 | 1.57 |
| 8-10 | 1.32 | 1.60 | 1.63 | 1.55 | 1.61 | 1.60 |
| 10-12 | 1.30 | 1.60 | 1.61 | 1.52 | 1.67 | 1.64 |
| 12-14 | 1.00 | 1.68 | 1.68 | 1.58 | 1.70 | 1.63 |
| 14-16 | 0.62 | 1.67 | 1.70 | 1.63 | 1.68 | 1.66 |
| 16-18 | 0.62 | 1.76 | 1.73 | 1.65 | 1.72 | 1.74 |
| 18-20 | 0.63 | 1.77 | 1.74 | 1.69 | 1.74 | 1.82 |
| 20-22 | 0.65 | 1.83 | 1.74 | 1.74 | 1.80 | 1.82 |
| 22-24 | 0.72 | 1.83 | 1.73 | 1.69 | 1.80 | -- |
| 24-26 | 0.73 | 1.81 | -- | 1.71 | 1.76 | -- |
| 26-28 | 0.68 | 1.86 | -- | -- | 1.79 | -- |