1991 Research and Cropping Results

Eighth Annual Progress Report

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Contents Relate to Cooperative Agreement between USDA-ARS and Area IV Soil Conservation Districts represented by the Area IV SCD Research Advisory Committee.

NOTICE

Acknowledgment

USDA-ARS and Area IV SCD recognize the contributions made to this research program by the following cooperators: Dow-Elanco Products Co.; Monsanto Agr. Products Co.; Dahlgren and Co.; AgriPro, Inc., Sigco Research Inc.; Hoechst-Roussel Agri. Vet Co.; NDSU-Agricultural Experiment Station, and NDSU-Cooperative Extension Service.

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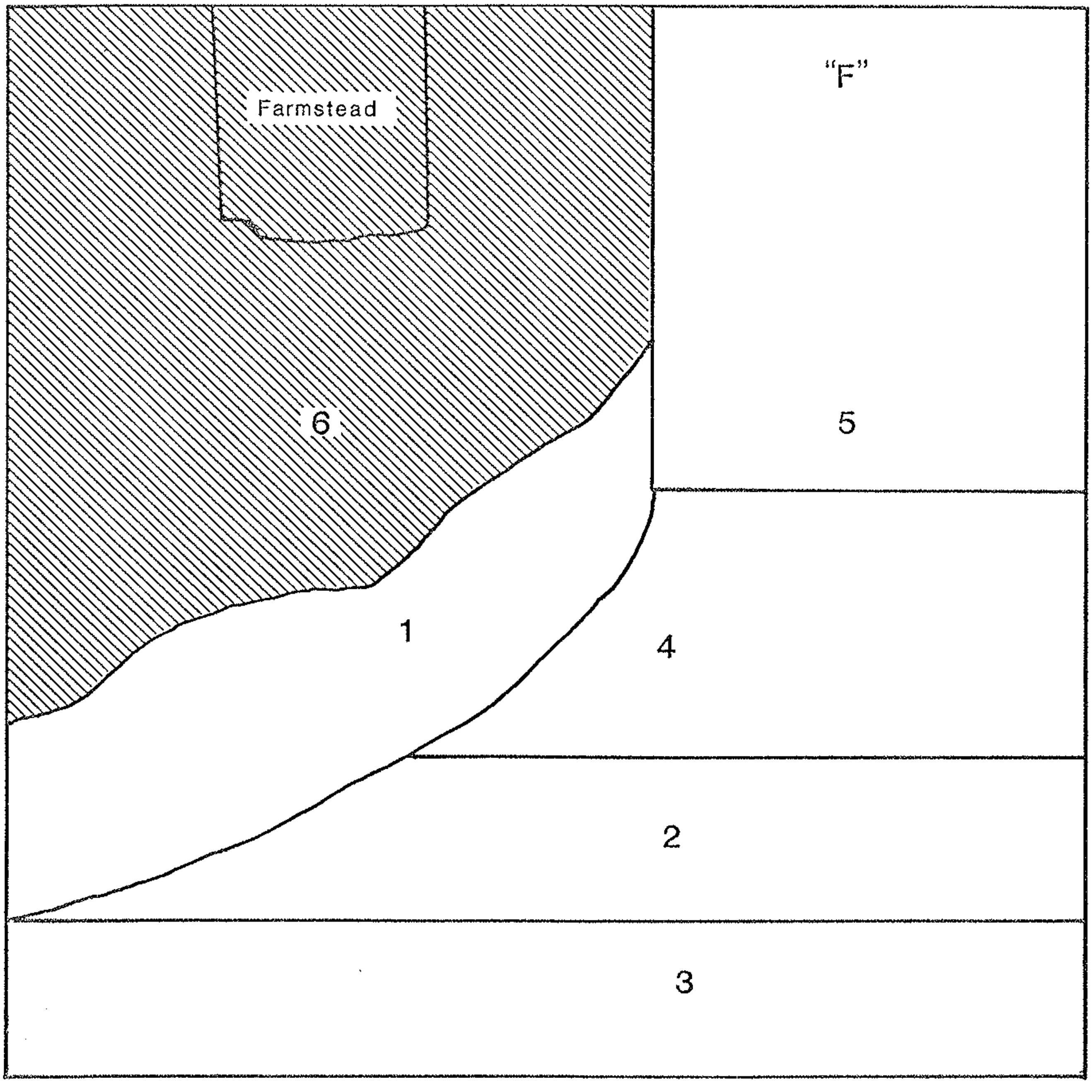

F. NW 1/4 Section 17 - Research Activities

F1. Conservation Bench Terrace Area - This area was excluded from the total acreage leased by AREA IV SCD beginning in 1987. Total cropland area leased is 382 acres.

F2. The previous crop in 1990 was winter wheat. The winter wheat stubble was undercut April 24, 1991 as Sonolan 10G granules were simultaneously applied. The field was undercut again May 21, 1991 for the second incorporation of the Sonolan. Two sunflower varieties were seeded May 24, 1991 (Sigco 452 north half and Sigco 458 on the south half) with the IH800 cyclo unit row planter. No fertilizer -N was applied or banded beside the row. The east end on this field (about 4 to 6 acres) received aerial spray damage from herbicide drift from the adjoining neighbor. We received about $200 compensation for this damage on the sunflower spraying contract later. The sunflowers in this field yielded less than 200 lbs/acre.

F3. The previous crop in 1990 was sunflower which was not worth harvesting costs and was tilled in September 1990. Bowman spring barley was planted no-till on May 16, 1991 and the field was sprayed with a mixture of 2,4-D and Buctril (6 oz ai/ac of each) on June 10, 1991. The field was combine harvested August 1, 1991 yielding 28 bu/ac (41 lb/bu). This field was no-till seeded to a mixture of winter wheat varieties September 24, 1991.

F4. On August 23, 1990 we established a subsoiling experiment after barley, using the Tye Paratiller operated at a 19-inch depth on 20-inch centers. Eight plots (50 by 100 feet) were established to provide 4 replications of paratilled and non-paratilled plots. We no-till seeded these plots and the remainder of this field to winter wheat on September 19, 1990 using the Haybuster no-till drill with 50 lbs/ac of 18-46-0 applied with the seed. This field had several winter wheat varieties that were combine harvested July 18, 1991 averaging about 35 bu/ac, 62 lb/bu, and 13.5% protein. The results of paratill treatments and 0 or 50 lbs N/ac topdressed on Roughrider winter wheat yields are shown in the following table.

Grain yield and test weight of roughrider winter wheat as influenced by subsoil treatment

Treatment	Paratilled		No-Paratill	
	Grain Yield	Test Wt.	Grain Yield	Test Wt.
0 lb N/ac	45.8	58.5	53.7	59.5
50 lb N/ac	45.9	58.5	43.2	58.5
Average	45.9	58.5	48.5	59.0

F5. ARS Land Lease - A major portion of this field area was uniform cropped to sunflower in 1990 and to spring wheat in 1991. This field was seeded to Amidon spring wheat May 14, 1991 and sprayed for weed control with 2,4-D plus Buctril (6 oz ai/ac each) June 10, 1991. The field was combine harvested August 13, 1991 yielding about 12 bu/ac (56 lb/bu).

NORTHERN GREAT PLAINS RESEARCH LABORATORY
1991 WHEAT AND BARLEY CULTIVAR TRIAL

These trials began in 1979 and have been conducted every year since. The seed is furnished by the Dickinson Experiment Station. A report has been submitted to the Dickinson Experiment Station annually.

<u>1991</u>

a) Planted on summerfallow with a Kirschman double-disk drill with six-inch spacing. Prior to planting, the site was tilled with a field cultivar followed by tines (harrow action).

b) Soil nitrate-nitrogen content at planting was 102 pounds nitrogen (N) per acre to four feet. (The content was corrected for bulk density). The content to two feet was 49.4 pounds per acre. At planting, 70 pounds per acre 18-46-0 were applied by drill attachment. Thirty pounds nitrogen (N) per acre from 34-0-0 were broadcast (dribbled over the row) with the grain drill attachment.

c) Planting rate was 1.2 million viable seeds per acre. The weight of seed planted per acre was based on seed measurements of kernel weight, germination percentage, and kernel water concentration. (Kernels are dried at 69°C (156°F). Planting date was May 2, 1991.

d) Soil available water content was measured weekly after the initial measurement on May 20. Precipitation after planting and the work schedule caused the delay in installing the access tubes to make the soil water measurements. Data of soil available water contents measured in Azure (barley) and Amidon (wheat) as shown in Tables 1 and 2, respectively. These tables also show the precipitation amounts between dates of soil water measurements. Note also the emergence data and the harvest dates for the two species.

Comment: Note that soil water use from the soil to either four or five feet from the date of first measurement to combine harvest was greater in wheat (7.43 to five feet) than barley (6.97 to five feet). Note too that the barley was harvested about two weeks earlier than wheat. We pointed out in an article in *Better Crops With Plant Food*, Summer 1989 issue why this occurs We also noted in three previous years that barley removed less water from the soil than wheat - at Mandan in these same trials. See the article by Bauer and Black in the 1991 May-June issue of *ND Farm Research*

e. Stakes to delineate a square meter area (m^2) in each plot were placed about three feet from one end of each plot shortly after emergence. These stakes were left in place for the entire season. The identical drill rows of each plot of each cultivar were represented. Measurements made in these m^2 areas were: count of plant population and count of head population. These m^2 areas also were harvested for yield and to calculate the number of kernels per head. (To convert from no/m^2 to no/yd^2, multiply by 0.836).

f) Agronomic measurements are shown in Table 3. The data from barley were analyzed separately from wheat.

g) Comments about the information in Table 3.

(1) Amidon (M) and Amidon (D) refer to seed source. (M) is from Mandan and (D) from Dickinson. I have no explanation for the differences. The average seed weight at planting differed by only 0.05 milligrams.

(2) The planting rate was 1.2 million viable seeds per acre and an average emergence was 201 and 216 plants per square yard for barley and wheat, respectively. This calculates to 81% and 88% of the potential number of plants based on planted seeds for barley and wheat, respectively. We weighed grain in and out of the grain box at planting. The actual planted rate averaged about 8% less than the calibrated rate).

(3) A small plot combine, threshing an area of at least 200 square feet per plot, is the basis for the grain yield (YIE).

(4) All weight measurements are based on oven-dry basis. Some report grain yield on a 12% water concentration basis.

(5) Susceptibility to diseases differed between the 2-rowed (Bowman, Gallatin, Hector) and the 6-rowed (Azure, Morex, Robust) barley cultivars. By July 8, all leaves on the 2-rowed cultivars had lost their green color. Severity of disease was much less on the 6-rowed cultivars, especially Azure. Dr. J. M. Krupinsky identified the primary disease affecting Bowman as being net blotch, and on Gallatin and Hector as spot blotch.

Table 1. Available soil water content to six feet and rainfall between dates of soil water measurements on Azure spring barley, 1991. (USDA-ARS, Mandan, ND).

		Soil depth (feet)						Rain
Date	DS[2/]	0-1	1-2	2-3	3-4	4-5	5-6	
mo/day		inches water						
								1.03[1/]
5/20	2.5	2.07	2.08	2.07	2.04	1.88	1.79	
								0.44
5/30		1.41	1.91	1.95	1.99	1.87	1.86	
								2.05
6/12		1.46	1.44	1.78	2.00	1.89	1.92	
								0.56
6/19		1.23	1.06	1.41	1.85	1.82	1.85	
								1.54
6/27		1.48	1.00	1.28	1.72	1.79	1.84	
								0.14
7/03		0.97	0.85	1.05	1.64	1.73	1.82	
								0.51
7/15	14.0	0.29	0.33	0.44	1.17	1.68	1.81	
								0.04
7/24	15.0	0.02	0.24	0.29	1.02	1.60	1.82	
5/20-7/24		2.05	1.84	1.78	1.02	0.28	-0.03	6.31

1/ Rain from planting to first soil water measurement date

2/ Development stage, modified Haun scale

Planted May 02
Emerged May 11
Harvest (M^2) July 19
Harvest (combine) July 26
Grain yield 57.0 bu/ac (oven-dry)

Table 2. Available soil water content to six feet and rainfall between dates of soil water measurements on Amidon spring wheat, 1991. (USDA-ARS, Mandan, ND)

Date mo/day	DS[2/]	0-1	1-2	2-3	3-4	4-5	5-6	Rain
		Soil depth (feet) - - - inches water - - -						
								1.03[1/]
5/20	2.3	2.16	1.85	2.37	2.15	1.91	2.00	
								0.44
5/30		1.74	1.66	2.29	2.13	1.88	2.01	
								2.05
6/12		1.66	1.23	2.23	2.14	1.95	2.09	
								0.56
6/19		1.16	0.69	1.89	2.00	1.86	2.03	
								1.54
6/27		1.53	0.67	1.75	1.90	1.87	2.02	
								0.14
7/03		0.93	0.52	1.46	1.82	1.82	2.01	
								0.51
7/15		0.17	0.09	0.69	1.37	1.79	1.99	
								0.04
7/24		-0.19	-0.10	0.38	1.03	1.68	1.97	
								0.82
7/31	15.0	0.12	-0.13	0.33	0.91	1.63	1.93	
								0.06
8/07	16.0	0.19	-0.15	0.33	0.98	1.66	1.94	
5/20-8/07		1.97	2.00	2.04	1.17	0.25	0.06	7.19

1/ Rain from planting to first soil water measurement date

2/ Development stage, modified Haun scale

Planted May 02
Emerged May 12
Harvest (m^2) July 30
Harvest (combine) Aug 13
Grain yield 40.1 bu/ac (oven-dry)

Table 3. Agronomic measurements of spring barley and spring wheat cultivars, 1991 at Mandan.

	Agronomic measurement										
Cultivar	POP	HEA	HGT	HEA/POP	YIE	TEW	TKW	STR	YIM	KPH	NEG
Azure	280	458	101	1.65	57.0	48.2	29.41	4775	73.6	29.4	
Bowman	260	761	93	2.92	42.6	44.6	25.93	4371	47.5	13.1	
Gallatin	232	725	94	3.12	41.0	43.2	21.90	4990	49.1	17.2	
Hector	226	648	90	2.87	36.8	43.5	24.08	4751	40.0	13.9	
Morex	234	469	96	2.01	39.2	43.1	21.33	4227	55.8	29.9	
Robust	208	417	99	2.01	43.9	46.7	26.29	4490	61.3	30.1	
LSD	20 no/m^2	90 no/m^2	5 cm	0.35 no.	4.8 bu/ac	0.6 lbs/bu	1.56 mg/kernel	331 lbs/ac	6.2 bu/ac	4.6 no.	
Amidon (M)	252	543	110	2.16	34.8	59.5	22.61	6387	42.7	23.4	
Amidon (D)	274	529	109	1.93	40.1	59.8	22.57	6046	42.9	24.2	
Butte 86	277	589	95	2.14	34.7	59.6	24.73	5393	42.3	19.5	
Cutless	260	571	93	2.20	30.8	58.6	21.95	5639	35.7	19.3	
Grandin	284	561	92	1.98	33.9	57.6	23.52	5576	42.1	21.5	
Gus	273	571	96	2.09	35.8	58.2	21.84	5476	44.2	23.8	
Marshall	248	496	85	2.00	34.3	55.8	20.30	5218	44.1	29.6	
Nordic	230	555	95	2.43	41.3	59.9	26.59	5519	47.1	22.1	
Stoa	239	556	106	2.35	35.2	58.4	22.13	5622	44.1	24.5	
Vance	248	441	92	1.79	38.2	57.7	26.00	5511	47.6	28.0	
LSD	17 no/m^2	43 no/m^2	4 cm	0.30 no.	2.4 bu/ac	0.8 lbs/bu	1.59 mg/kernel	444 lbs/ac	5.4 bu/ac	4.0 no.	

POP = Pre-tillering plant population
HEA = Head population
HGT = Height after heading
HEA/POP = An indication of number of heads from tillers. (One of these is from the main stem)
YIE = Grain yield, combine sample
TEW = Test weight
TKW = Thousand kernel or average individual kernel weight
STR = Straw yield (from m^2 samples)
YIM = Grain yield (from m^2 samples)
KPH = Kernels per head (from m^2 data)
NEG = Grain nitrogen (N) concentration

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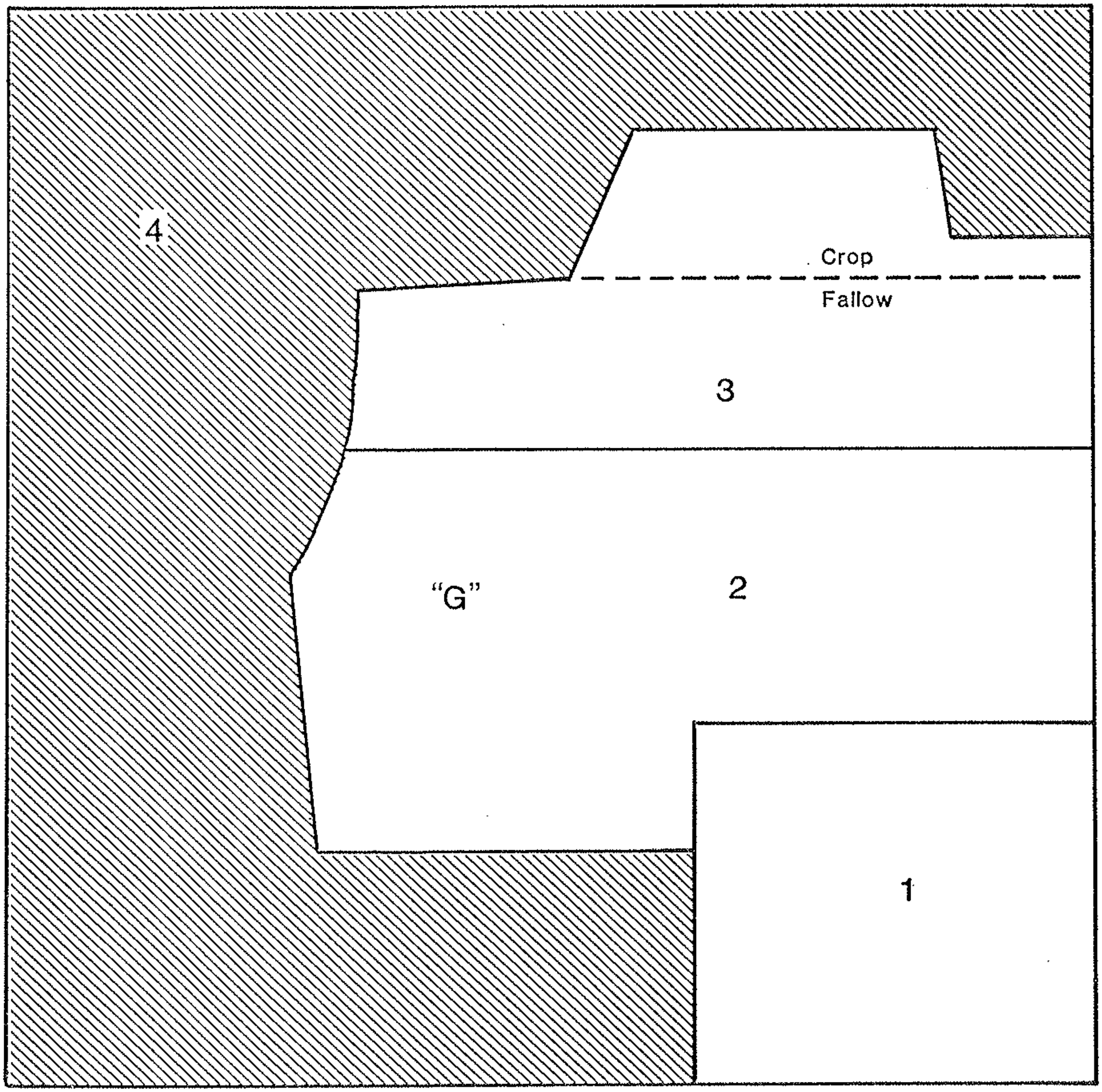

G. SW 1/4 Section 8

G1. Richard Cunningham & Joe Krupinsky

A. Poplar Clonal Tests - During the period 1983 to 1988, 240 hybrid poplar and cottonwood clones were planted in this area to compare their survival, growth rate, cold and drought hardiness, and pest resistance. Similar field tests have been established on eight other sites in North Dakota and Minnesota. Survival of all clones is scored annually, while total height and other traits are measured every five years at a minimum. The combined effect of the drought during the past four years is shown in the table below. The performance scores for the "standard nursery" clones and of several experimental clones show the superior adaptation to drought exhibited by the clones derived from "native" poplar species and hybrids. Northwest poplar, an old "standby", had the best combination of survival, total height and lack of die-back.

CLONE	SCORE[1]	SURV[2]	HEIGHT[2]	DIE-BACK[2]
NE-51	-757	0.0	89.3	945.9
Thieves	-20.7	-41.1	97.8	259.5
Norway	151.3	80.6	113.3	142.6
White Poplar	152.2	105.2	88.4	141.5
Towner	202.3	102.9	107.0	107.5
Imperial	220.8	85.2	128.6	92.9
Siouxland	256.3	129.3	88.1	61.0
Robusta	268.3	151.7	115.9	99.4
Brooks #2	335.2	181.2	82.4	28.4
Morden poplar #7899	339.1	173.4	117.6	51.9
Assiniboine	341.4	145.6	121.0	25.2
Northwest	342.3	191.2	80.5	29.5
Dunlop	346.1	145.6	100.5	0.0
OP progeny of Walker	348.0	132.0	131.0	15.1
Dacotah	354.4	169.3	104.8	19.7
Walker	356.7	183.4	110.7	37.4
Plains cottonwood Morton Cty.	366.3	163.9	118.6	16.2
Plains cottonwood Burleigh Cty.	367.8	160.7	110.6	3.6
Melville	382.9	190.5	123.4	31.0
CAG hybrid	385.5	257.7	96.7	69.0
Morden poplar #78101	402.2	209.3	133.6	40.6
Brooks #5	422.0	267.5	84.1	29.6
Himalayan Balsam Poplar	494.3	320.6	87.8	14.1
Northwest	510.6	346.9	97.3	91.6

[1]Score = 100 + Survival + Height - Die-back.
[2]Values for survival, height and die-back are percentages of plantation mean.

B. Cooperative Hackberry Provenance Test - A 26-acre site, immediately west and slightly north of Parcel G, has been leased from the Nelson Estate. This area serves as the site for a seed source trial of hackberry accessions collected from 180 native stands throughout the Great Plains. The planting stock was grown by the NDASCED's Oakes Nursery and was distributed in 1990 to test site cooperators at 16 locations, ranging from Manitoba to Oklahoma and Iowa to Colorado. About 3900 trees, covering 13.5 acres, were planted at the Mandan site. Average survival and height at Mandan after two growing seasons, are shown in the following table.

		SURVIVAL		
Performance	Acc.	County	State	%
Poorest	2131	Cleburne	Arkansas	5.0
Best[1]	3864	Morton	North Dakota	100.0
Average	3928	Lincoln	Kansas	85.0
		HEIGHT		
Performance	Acc.	County	State	cm
Shortest	2131	Cleburne	Arkansas	22.0
Tallest	4021	Brown	Nebraska	119.9
Average	3858	Pawnee	Kansas	71.3

[1]Several accessions survived at 100 percent.

G1b. USDA-ARS and NDSU Forage and Grass Breeding Activities Performed in 1991 (Dr. Ian Ray and Dr. John Berdahl)

The germplasm described in this report originated from 5,000 western wheatgrass plants that were collected from rangelands of western North and South Dakota. Two cycles of selection have been completed in this population using land made available by the North Dakota Area IV Soil Conservation District. A third selection cycle population was established in 1990 on USDA-ARS Northern Great Plains Research Laboratory land. The cycle-3 population was evaluated in 1991 for the following characteristics: forage yield, plant height, plant vigor, spike density, spikelets/spike, spike pubescence, and spike color. Forage samples were also collected from selected entries and are currently being evaluated for in vitro dry matter digestibility, protein content, NDF, ADF, Ca, Mg, and K. In this study, approximately 4% of the entries equaled or exceeded the forage yields of the cultivar, 'Rodan'. Heritability estimates indicate that significant gains can be made in improving forage yield, plant vigor, and seed production. Modifying plant height, however, will be more difficult. Heritability estimates of spike density, spike color, and spike pubescence require further data transformation prior to analysis. Forage quality parameters are not yet available. Future breeding research in western wheatgrass will focus more heavily on improving seed production while maintaining forage quality and yield, because seed production is currently one of western wheatgrass' major weaknesses. Seed and data collected from the cycle-3 population of western wheatgrass will be submitted to the National Plant Germplasm System.

'Manska' pubescent intermediate wheatgrass was selected from 11 different seed lots of 'Mandan 759' at the Northern Great Plains Research Laboratory. The cultivar will be released cooperatively in the spring of 1992 by the USDA-ARS, USDA-SCS, North Dakota Agricultural Experiment Station, and the Agricultural Research Division, Institute of Agriculture and Natural Resources, University of Nebraska. The name, Manska, is a contraction of Mandan and Nebraska. High nutritional quality is the primary advantage of Manska over other current intermediate wheatgrass cultivars. At Mead, Nebraska, daily gains of yearling steers averaged 2.7 and 2.1 lb., respectively, for Manska and 'Oahe' over 30-day grazing periods in 1989 and 1990 at a stocking rate of one animal per acre. Limited quantities of foundation seed are available from the USDA-SCS Plant Materials Center, Bismarck and the Foundation Seed Division, Department of Agronomy, University of Nebraska, Lincoln, NE.

G2. This field was in barley in 1990 and we used this barley stubble field for the Great Plains Conservation tillage "No-till and Conservation-till seeding demonstration August 20-23, 1990. On September 18-19, 1990 we no-till seeded seven winter wheat varieties (Roughrider, Agassiz, Archer, Norwin, Rocky, Winalta and Norstar) into the standing barley stubble using the Haybuster no-till drill and applying 50 lbs/ac of 18-46-0 just below the seed. The winter wheat was sprayed May 16, 1991 with 2,4-D and Buctril (4.2 and 4.4 oz ai/ac, respectively). The varieties were combine harvested July 17, 1991 yielding about 38 bu/ac, 62.0 lb/bu, and 13.5 to 14.0% protein.

Winter wheat grain yields as influenced by cultivar and N-fertilizer applied (Sunflower-spring barley-winter wheat rotation)

Winter Wheat Cultivar	Avg Test Wt.	Rate of N-fertilizer applied (lb/ac) 0	30	50	70	90	120	Avg.
	lb/bu	- - - Grain Yield bu/ac - - - -						
Norstar	58	35.0	29.9	31.2	30.0	31.8	29.0	31.2
Winalta	62	35.6	35.1	36.6	36.8	36.4	35.0	35.9
Rocky	62	45.0	41.9	43.9	40.9	43.0	37.1	42.0
Norwin	59	33.5	35.5	31.7	32.3	33.8	31.0	33.0
Archer	60	34.8	34.2	31.6	34.0	34.2	28.2	32.8
Agassiz	59	33.1	34.4	28.4	28.9	29.3	29.0	30.5
Roughrider	61	27.7	32.3	33.8	32.9	34.3	29.5	31.8
Avg.	60	35.0	34.8	33.9	33.7	34.7	31.3	33.9

G3. This field was summerfallow in 1990 and planted to Amidon spring wheat on May 2, 1991 using a cultivator and double-disk drill in tandem. About 42 lb/ac of 18-46-0 was applied with the seed. This field was sprayed with Tiller plus Buctril (5 oz. and 4 oz. ai/ac, respectively). The spring wheat was combine harvested August 14, 1991 yielding about 30 bu/ac, 58 lb/bu and 14.5% protein.

G4. This field was spring wheat in 1990 and summerfallow in 1991. The field was undercut May 29, 1990, sprayed with Roundup plus 2,4-D June 19, and sprayed again with Landmaster August 8, 1991.

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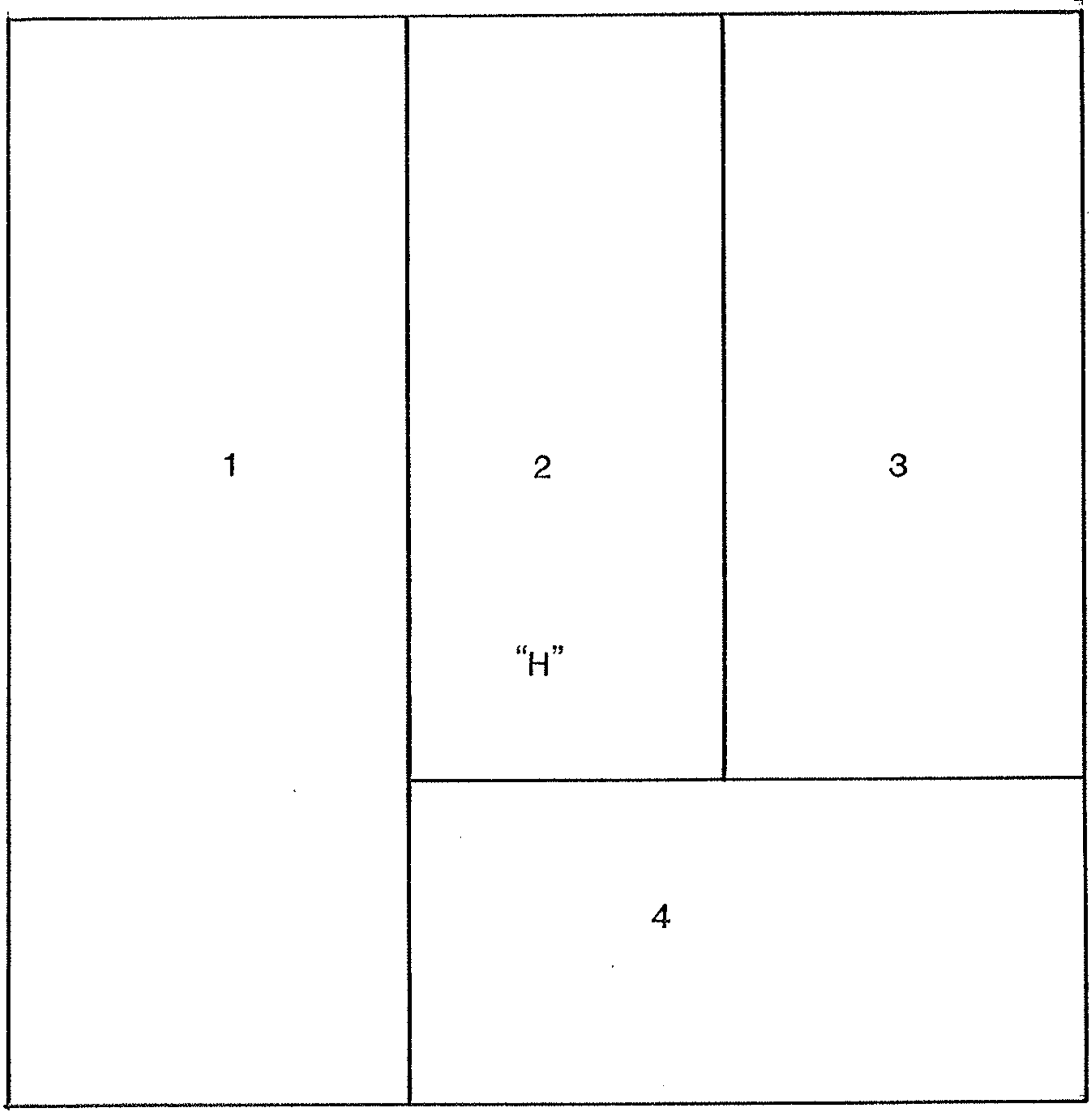


H. NE 1/4 Section 18 - Research Activities

H1a. Cropping Systems - Conservation Tillage Research Project (65 acre study)

(A1) Spring wheat-fallow (1991 spring wheat crop plots)

Spring wheat crop plots - schedule of operations for each tillage system

Date mo/day	Conventional-till No-residue	Conventional-till to <30% Cover	Minimum-till 30-60% cover	No-till >60% cover
4/-	No N-fertilizer applied because of high residual NO_3-N			
5/7	Disked	Disked	Undercut	- - -
5/8	Seeded Butte 86 and Stoa spring wheat in all tillages - - -			
6/8	Sprayed all plots (Tiller, 0.25 lb ai/ac + Buctril, 0.25 lb ai/ac)			
7/30	- - - - - Obtained hand harvest samples from all plots - - - - -			
8/13	- - - - - - - - - -Combine harvested all plots - - - - - - - - - - -			

(A2) Grain yields of spring wheat (1991) in the spring wheat-fallow rotation as affected by tillage system residual, N-rates, and cultivar.

Spring Wheat Grain Yield Data (1991)

Cultivar	Rate of Nitrogen	Conventional-till No Residue	Conventional-till <30% Cover	Minimum-till 30-60% Cover	No-till >60% Cover	Avg
	lbs N/ac	- - - - - - - - - - bu/ac - - - - - - - - - - - - - - - -				
Butte 86	0	20.4	28.4	30.8	30.2	27.5
	20	30.1	27.9	29.6	29.2	29.2
	40	22.9	24.6	29.6	28.0	26.3
	Avg.	24.5	27.0	30.0	29.1	27.7
Stoa	0	21.5	27.9	30.0	31.0	27.6
	20	25.5	28.4	27.2	30.7	28.0
	40	21.2	24.3	26.0	27.7	24.8
	Avg.	22.7	26.9	27.7	29.8	26.8
Avg.	(Tillages)	23.6	26.9	28.9	29.5	27.3

*No N-fertilizer was applied in 1991 because of high residual-N carry-over.

(A3) Spring wheat-summerfallow with schedule of operations performed for fallow series plots in 1991 as follows:

Date mo/day	Conventional-till No Residue	Conventional-till <30% Cover	Minimum-till 30% to 60% Cover	No-till >60% Cover
5/30	----	Undercut	Undercut	----
6/02	----	----	----	Landmaster
6/11	Offset Disk	----	----	----
6/12	----	Undercut	----	----
6/13	----	----	Roundup + 2, 4-D	----
6/27	----	Roundup + 2,4-D	----	Roundup + 2,4-D
7/02	Tandem Disk	----	----	----
7/19	----	----	Roundup	----
8/16	Undercut	Undercut	----	----
8/27	----	----	----	Roundup + 2,4-D

H1B Spring wheat-winter wheat-sunflower cropping system.

(B1) Spring wheat crop plots; schedule of operations for each tillage system.

Date mo/day	Conventional-till	Minimum-till	No-till
4/-	No N-fertilizer applied because of high residual NO_3-N		
5/07	Tandem disked	Undercut	Bronate (1 pt/ac)
5/08	Seeded Butte 86 and Stoa varieties with HB-1000 disk drill		
6/08	Sprayed plots with Tiller plus Buctril (0.25 lb ai/ac of each)		
7/29	- - - - - - - - - - Hand Harvest Sampling - - - - - - - - - - - - - - - -		
8/13	- - - - - - - - - - - Combine harvested - - - - - - - - - - - - - - - - -		
8/27	- - - - - Spot sprayed all plots with Roundup plus 2,4-D - - - - - - -		
9/19-20	Tandem Disked	Undercut	Roundup
9/23	- Seeded winter wheat Roughrider and Norstar (HB-furrow drill)		

(B1) Spring wheat grain yields (1991) in the spring wheat-winter wheat-sunflower rotation as influenced by tillage system, residual N-rates, and cultivar grown.

Cultivar	Rate of N*	Conv-till	Min-till	No-till	Avg.
	lbs N/ac		-bu/ac		
Butte 86	30	14.1	15.0	18 1	15.7
	60	14.1	13.8	16.0	14.6
	90	13.6	15.3	19.3	16.1
Avg.		13.9	14.7	17.8	15.5
Stoa	30	10.1	11.7	12.7	11.5
	60	11.6	12.0	13.4	12.3
	90	13.4	12.6	16.2	14.1
Avg.		11.7	12.1	14.1	12.6
Avg. (Tillages)		12.8	13.4	16.0	14.1

*No N-fertilizer treatments were applied in spring of 1991 because of high residual-N levels.

(B2) Winter wheat plots; schedule of operations for each tillage system following spring wheat in the 3-year rotation.

Date mo/day	Conventional-till	Minimum-till	No-till
8/31/90	- - - - - Sprayed Roundup + 2,4-D (all tillage plots) - - - - -		
9/17/90	Tandem Disked	Undercut	- - - -
9/17/90	- - -Seeded Roughrider and Norstar winter wheat (HB-8000 Drill) -		
4/-	- - No N-fertilizer applied because of high residual NO_3-N - -		
5/14	Sprayed all plots (Buctril + 2,4-D; 0.25 lb ai/ac of each) - -		
7/15	- - - - - - - - Hand Harvest Sampling - - - - - - - - - - - - - - -		
7/18	- - - - - - - - - Combine Harvested - - - - - - - - - - - - - - - - -		
8/27	Sprayed all plots; Roundup (16 oz/ac) plus 2,4-D (8 oz/ac) - - --		

B2. Winter wheat grain yields (1991) in the spring wheat-winter wheat-sunflower rotation as influenced by tillage system, residual N-rates and cultivar grown.

Cultivar	Rate of N*	Conv-till	Min-till	No-till	
	lbs N/ac	- - - - - - - - - -	bu/ac	- - - - - - - -	
Roughrider	30	29.3	33.1	35.2	32.5
	60	32.6	32.7	32.8	32.7
	90	26.6	33.5	35.4	31.8
	Avg.	29.5	33.1	34.5	32.3
Norstar	30	35.6	35.2	34.8	35.2
	60	32.5	34.8	37.0	34.8
	90	33.7	33.2	35.1	34.0
	Avg.	33.9	34.4	35.6	34.7
	Avg. (tillages)	31.7	33.8	35.1	33.5
Avg (Tillages)		31.7	33.8	35.1	33.5

*No N-fertilizer treatments were applied in the spring of 1991 because of high residual-N levels.

B3. Sunflower plots; schedule of operations for each tillage system following winter wheat in the 3-year rotation.

Date mo/day	Convention-till	Minimum-till	No Till
9/7/90	- - Sprayed all plots with Roundup (16 oz/ac) plus 2,4-D (8 oz/ac)		
10/24/90-	- - - - - - -	- - - - - - - -	Sunflan (1.5 lb ai/ac)
4/25		UC/Sonolan (1.0 lb ai/ac)	UC/Sonolan (1.0 lb ai/ac)
4/-	No N-fertilizer rates applied because of high residual NO_3-N		
5/22	Tandem disked	Undercut	Roundup + 2,4-D
5/24	Planted Sigco 452 and 458 cultivars with IH 800 row planter		
7/1	Cultivated	Cultivated	- - - -
8/8	Sprayed for insect control (Asana XL, 0.033 lb ai/ac)		
10/2	- - - -	Hand Harvest Sampling	- - - -
10/3	- - - -	Combine Harvested	- - - -

B4. Sunflower seed yields (1991) in the spring wheat-winter wheat-sunflower rotation as affected by tillage system, residual N-rates and cultivar grown.

Cultivar	Rate of	Conv-till	Min-till	No-till	Avg.
Sigco 452	30	170	420	460	350
	60	280	680	250	400
	90	380	370	480	410
Avg.		280	490	400	390
Sigco 458	30	220	480	610	440
	60	180	330	510	340
	90	180	600	550	440
Avg. (tillages)		240	480	480	400

*No N-fertilizer treatments applied in spring of 1991 because of high residual-N.

C1. Experimental plots were evaluated for leaf spot and root rot diseases. In general, 1991 was a poor year for disease development, good for the farmer but not as good for the plant pathologist trying to collect disease data.

Leaf spot diseases. Data were collected several times from each of five different studies: winter wheat in a continuous cropping system (WWCC), spring wheat in a continuous cropping system (SWCC), spring wheat in a crop-fallow system (SWCF), spring wheat with no residue (SWNR), and winter wheat cultivars fertilized with different rates of nitrogen (WWCUL). Tan spot caused by Pyrenophora tritici-repentis was the most common leaf spot pathogen. The tan spot fungus was found on 80% of the leaf pieces tested for fungi present. Tan spot was followed by Septoria nodorum blotch (Septoria nodorum) and spot blotch (Cochliobolus sativus) which were each found on 30% of the leaf pieces tested.

Overall, 22,000 leaves were rated for leaf spot diseases and 24 evaluations or analyses were done. No nitrogen effects were evident in 23 out of 24 analyses. Tillage effects were significant with WWCC, no-till had higher levels of leaf spot diseases than minimum till or conventional till. Tillage effects were not evident with the spring wheat crops. Cultivar effects were significant with WWCC (Roughrider had higher levels of disease than Norstar) and with SWCF (Stoa had higher levels of disease than Butte 86). Cultivar effects were not evident with SWCC or SWNF.

D1. Soil erodibility as influenced by conservation tillage system.

Wheat root growth and water use study in Cropping Systems Experiment (Merrill and Black).

Observations made in the 1991 season finalized a 4-year study of the effect of conservation tillage, cropping system, and N-fertilization upon wheat root growth and water use. In the 1991 season we concentrated on the interaction between conservation tillage level and nitrogen management under wheat-fallow. Because of high residual soil-N, no N was applied in 1991. Results for 1991 are shown with relevant parts of 1990 results here. In contrast to the significant increases in both belowground and aboveground growth that no-till can provide continuous rotationally cropped wheat under drought, as observed in 1988 to 1990, our 90-91 results show no-till having only small overall increase in root and shoot growth compared to conventional-till. In 1990, N-fertilization appeared to increase root growth amount under conventional-till, but not under no-till (see Table 1). There were also some very modest abovegound growth increases due to N-fertilization that year. In contrast, the 1991 data appear to show small to modest antagonistic effects (of doubtful statistical significance) of past N-fertilization upon root and aboveground growth. This observation is consistent with the character of the 1991 season, with adequate soil water in the vegetative part of the season, but a lack of precipitation during grain-filling; N-fertilization can show antagonistic effects under such conditions. Soil water depletions in 1991 (see Table 2) appear to be marginally greater under higher past N-fertilization; this is also consistent with an antagonistic effect.

Table 1. Total root length growth, total aboveground growth, and grain yield for spring wheat treatments under crop-fallow with one contrasting rotational treatment, for 1990 and 1991 seasons.

Treatment	1990 Root length	1990 Total above	1990 Grain yield	1990 Harv. index	1991 Root length	1991 Total above	1991 Grain yield	1991 Harv. index
	$mile/ft^2$	lb/A	lb/A		$mile/ft^2$	lb/A	lb/A	
FALL-CONV-HI	1.59	5430	2170	0.40	1.40	6163	1480	0.24
FALL-CONV-LO	1.16	4900	2010	0.41	1.48	6300	1700	0.27
FALL-NOTL-HI	1.33	5890	2320	0.39	1.52	6372	1680	0.26
FALL-NOTL-LO	1.43	5910	2060	0.35	1.58	6671	1810	0.27
ROTL-CONV-HI	0.62	2260	930	0.41	0.94	3710	820	0.22

FALL - fallow; CONV - conventional-till; NOTL - no-till; HI means high N-rate of 40 lb/A in fallow and 90 lb/A under rotation in 1990; LO means no N-fertilization under crop-fallow and 30 lb/A under rotation; no N-fertilization occurred in 1991 due to high soil-N residual.

Table 2. Soil water contents and soil water depletions in 1990 and 1991 spring wheat seasons (May through July) as measured by neutron moisture meter. Data are in units of inches per 6 feet of soil profile.

Treatment	1990 Initial	1990 Highest	1990 Lowest	1990 Diff. High-Low	1991 Initial	1991 Highest	1991 Lowest	1991 Diff. High-Low
FALL-CONV-HI	19.8	21.7	15.4	4.4	22.6	23.3	15.7	6.9
FALL-CONV-LO	21.3	24.3	16.8	4.5	21.2	22.0	14.9	6.3
FALL-NOTL-HI	20.7	23.6	16.6	4.1	21.8	22.5	14.8	7.0
FALL-NOTL-LO	20.4	23.5	15.7	4.7	21.9	22.6	15.2	6.7
ROTL-CONV-HI	13.3	16.5	13.3	0.0	15.0	15.9	11.2	0.5

Treatment designations as in Table 1 above.

D2. Wind erodibility study of wheat-fallow system (Merrill and Black)

Four years of study of the wind erodibility characteristics of the spring wheat-summerfallow system have been completed. These measurements were carried out in the Cropping Systems Experiment using the three regular management treatments of that experiment (no-till, minimal-till, and conventional-till) plus an additional low-residue treatment. For the purposes of this report, we summarize our results by the presentation of Figures A through D.

Figures A and B show the apparent aggregate size distributions of surface soil measured by rotary sieving and given as geometric mean diameter (GMD), a measure of the average apparent aggregate size. Apparent because soil does not actually have aggregate sizes indicated by GMD, rather, a low GMD (less than 2 mm) indicates fragile soil, ready to become dust at the least disturbance, high GMD (above 5 to 10 mm GMD) indicates good cohesion at the soil surface. Figure A, for plots fallowed on even years, shows the condition of surface soil becoming progressively worse during the course of the multiyear drought, reaching a low point under fallow conditions in the fall of 1990. A moderately good recovery occurred over the winter of 1990-1991. Figure B indicates that the land fallowed in even years reached an even worse soil surface condition in the spring of 1990, before and during wheat cropping. The over-winter recovery from dangerous conditions generated by the drought was evidently considerably better for the odd fallow-year land than for the even fallow-year land. The difference was that crop residue structures had been in a dead state about one-half year on the odd fallowed-year plots but about one and one-half years on the even fallowed-year plots at midwinter in the recovery period.

Our aggregate size distribution data as summarized in Figures A and B show an interesting and rather disturbing treatment effect of conservation tillage: during the years of better soil surface condition (1988, 1991) the GMD values for the no-till treatment are greater than for the other tillages, indicating less wind erodibility from soil factors alone. However, during years more obviously affected by the drought cycle (1989, 1990), the no-till treatment has approximately the same or even lower erodibility status as indicated by GMD. This is believed to be connected with the fact that surface soil under multiple years of no-till practice has a higher residue and organic content.

Figure C shows the percentage of residue cover on the study plots. The values are generally well below 30% for the low-residue treatment and generally above 60% for the no-till treatment, with intermediate values for the other treatments. However, the course of the multiyear drought, with poor crop growth in 1988 and 1989, results in rather low residue coverage even in the no-till treatment before and immediately after wheat seeding in 1990 (low values are circled on Figure). Figure D shows the amounts of standing residue as the amounts of horizontal-view area below about 1 1/2 feet blocked by residue. Values for the no-till treatment are almost always greater than for the other tillages. Standing residue values are relatively poor for the 1989 fallow year, but become very low at the end of this fallow period, in the spring of 1990, even in the no-till treatment.

FIGURE A. GEOMETRIC MEAN DIAMETER — EVEN FALLOW YEARS

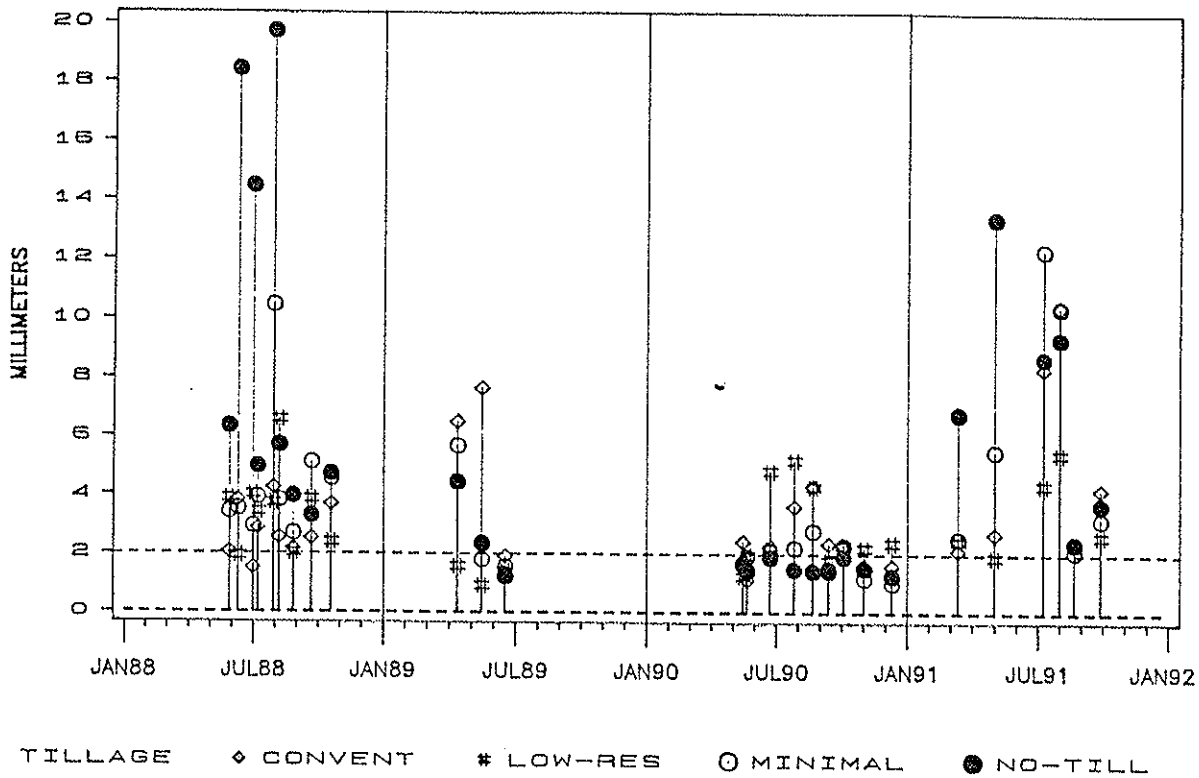


FIGURE B. GEOMETRIC MEAN DIAMETER — ODD FALLOW YEARS

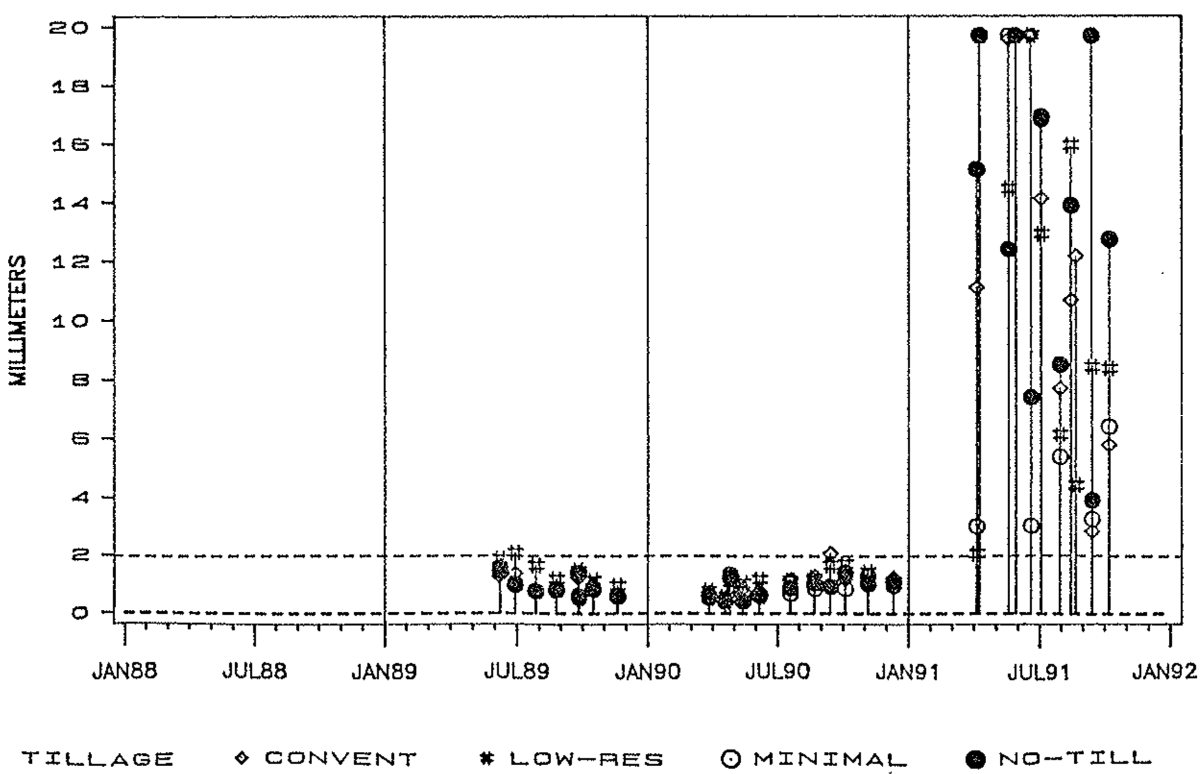


FIGURE C PERCENT SURFACE RESIDUE – ODD AND EVEN FALLOW YEARS

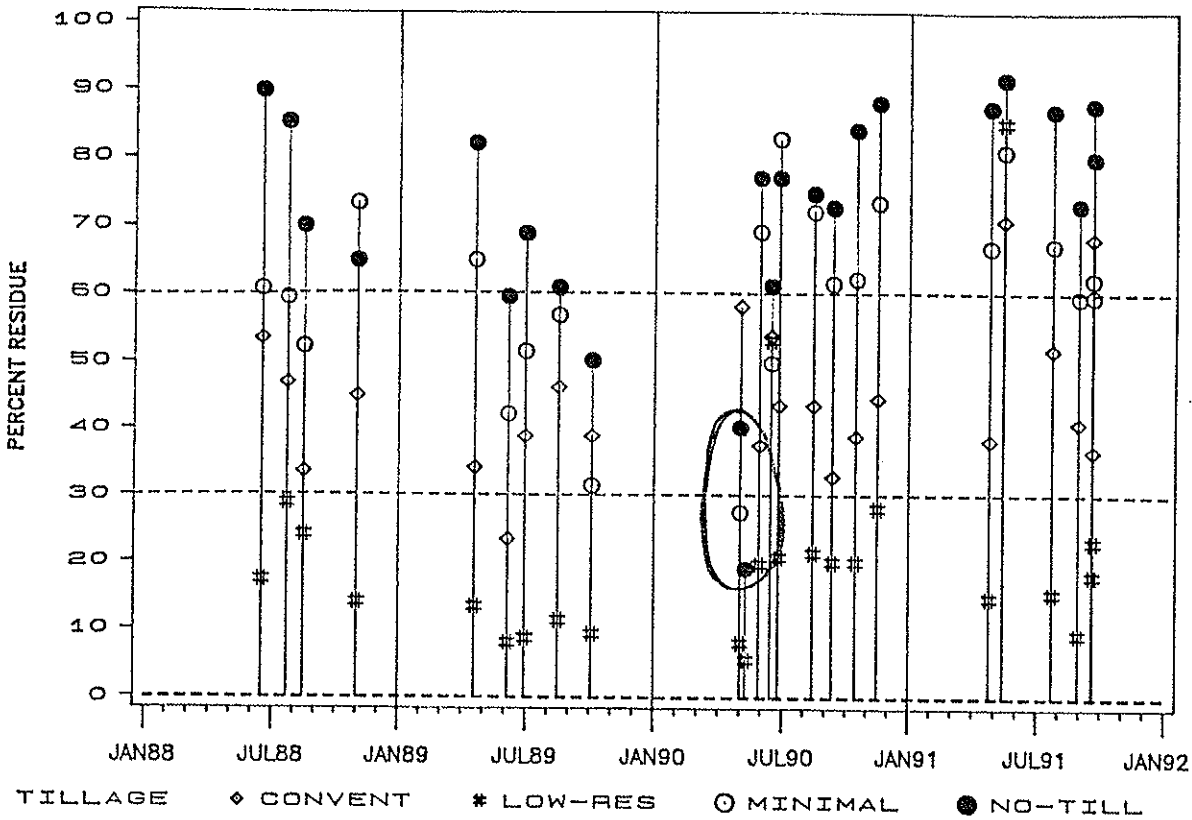
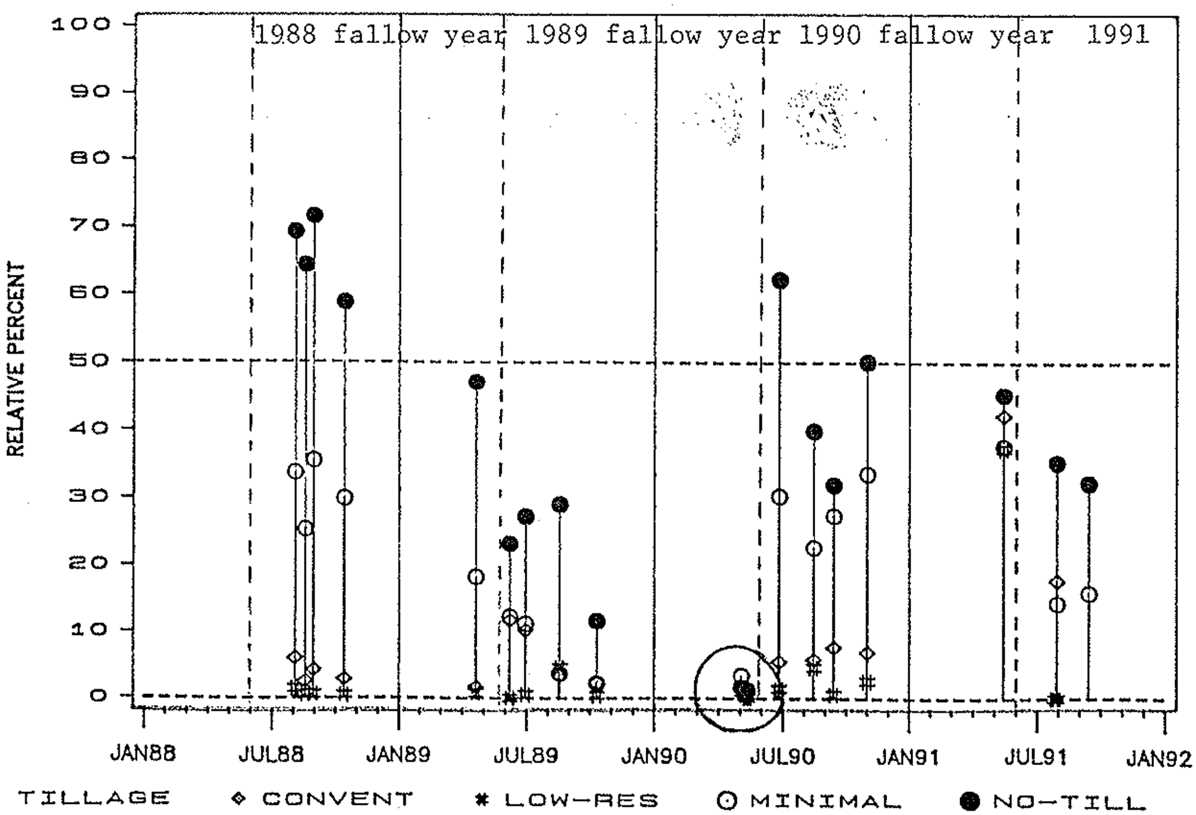


FIGURE D STANDING RESIDUE PROFILE – ODD AND EVEN FALLOW YEARS



Our observations indicate that multiyear drought will result in a weakened surface soil condition, rendering the soil more subject to wind erosion if unprotected by plant residues. The greater amounts of standing residue left by higher conservation tillages (no-till, minimal-till) become especially important under drought. However, the observations summarized here for this rather generic silt loam soil indicate that the low plant growth in the earlier part of the drought cycle (1988, 1989) results in inadequate residue structures under fallow in the latter part (1990) of the drought cycle. Recurrent multiyear drought is a normal feature of the Great Plains environment. Our observations raise a serious question about the long-term sustainability of the spring wheat-summerfallow cropping system in this semi-arid region.

H2. The previous crop in this field was winter wheat (various cultivars in 1990) This field was chem-fallowed; sprayed with Roundup plus 2,4-D after harvest on September 7, 1990, with Landmaster June 2, 1991 with Roundup plus 2,4-D, on July 7, 1991 and with Landmaster again on July 23, 1991.

H3. This field was used for the Sonolan and Treflan studies on sunflower in 1990. The sunflower stubble was tandem disked at shallow depth in the fall of 1990. Spring wheat was seeded May 11, 1991 using a cultivator-double disk drill in tandem. The field was sprayed June 10, 1991 using Tiller plus Buctril (0.25 lbs ai/ac of each). The spring wheat was combine harvested August 13, 1991 which yielded about 20 bu/ac, 55.5 lbs/bu, and 16% protein. This field, with spring wheat stubble (10-inch height) was sprayed August 21, 1991 with Roundup plus 2,4-D to control volunteer wheat and weeds. Winter wheat cultivars Norstar, Roughrider, Agassiz, Rocky, Archer, Norwin and Winalta were no-till seeded in two replications September 24, 1991 using the HB-1000 furrow drill.

H4. ARS Leased Land: Beginning in 1988 and 1989, field blocks of land were established in a spring wheat-spring wheat-fallow rotation to provide an opportunity to study annual legumes (Tangi flat pea, Simu-S-1 peas and chick peas in 1991) as a cover crop (partial summerfallow) practice for soil protection and to provide 30 to 50 lbs/ac of fixed-N.

Three cover crops were established in 1990. These were 1) no-cover (summerfallow), 2) Tinga flat peas, and 3) Semu-S1 peas planted May 30 at a rate to supply 250,000 seeds per acre. A portion of each of the pea cover crops was sprayed with Roundup on July 1 and August 3, 1990. A third strip was left untreated but the kill date is identified as September 25, 1990.

Amidon spring wheat was planted on the 1990 plots that had been in the peas and summerfallow on May 28, 1991 at a rate of 1.2 million viable seeds per acre. Weeds were controlled with 2,4-D and Tiller herbicides. The wheat crop was harvested on August 13.

The nitrate-nitrogen (NO_3-N) concentration in the soil in the autumn of 1990 for the plots with different cover crops and date of spraying to kill the legume is shown in Table 1.

Table 1. Nitrate-nitrogen in the soil in the autumn of 1990 to four feet depth.

Manage	Spray	Soil Depth feet) 0-1	1-2	2-3	3-4	0-4
		parts per million (PPM) NO_3N				
Tinga (1)	Jul 01	34.5	21.5	6.6	12.8	75.4
flats (2)	Aug 03	27.9	7.6	4.0	6.1	45.6
(3)	Sep 25	38.6	29.8	3.3	9.1	80.8
Fallow	--	49.3	33.1	5.5	12.6	100.5
Semu (1)	Jul 01	19.2	18.0	7.9	11.0	56.1
(2)	Aug 03	34.6	27.9	6.6	13.8	82.9
(3)	Sep 25	22.9	18.8	7.0	5.5	54.2

There was no apparent consistent trend in NO_3-N concentration due to date of spraying killing the legumes.

Table 2 shows the available soil water content on April 22, 1991 in the plots of different cover crops and date of spraying to kill the crop.

Table 2. Available soil water content on April 22, 1991 as affected by the 1990 cover crop and date of killing the cover crop.

Manage	Soil depth (inches) 0-6	6-12	12-18	18-30	30-42	42-54	54-66	0-42
	inches available water							
Tinga-1	1.09	1.20	0.84	0.37	0.29	1.13	1.24	3.79
-2	1.16	1.21	0.30	0.47	0.86	1.03	1.37	4.00
-3	1.01	1.04	0.55	0.31	0.35	1.25	1.44	3.26
Fallow	1.03	1.08	0.39	0.20	0.71	0.84	1.56	3.41
Semu -1	1.08	0.89	0.46	0.72	1.27	1.45	1.43	4.42
-2	1.03	0.73	0.40	0.43	0.57	0.56	0.80	3.16
-3	1.07	1.17	0.81	1.07	1.20	1.26	1.04	5.32

There was no apparent consistent trend in soil water content in the spring due to date of killing the legumes.

The spring wheat grain yields of the 1991 crop planted on the 1990 plots of different cover crops are shown in Table 3.

Table 3. Amidon spring wheat yields in 1991 grown on the 1990 plots of different cover crops.

Sprayed	Management		
	Tinga flats	Semu	Fallow
1990 date	- - - - - - - - - bu/acre - - - - - - - - -		
Jul 01 (1)	13.5	13.3	16.8
Aug 03 (2)	10.8	14.1	16.8
Sep 25 (3)	15.2	16.8	16.8
Avg.	13.2	14.7	16.8

The legume cover crop study initiated in 1989 was continued in 1991. The study was expanded to include three legumes - Semu-S1, Tinga flats, and Austrian vetch - and summerfallow. The legumes were planted May 28, 1991 at 250,000 viable seeds per acre. Access tubes to measure soil water were installed between June 19 and June 25. Strips of each legume - to effect a kill - were sprayed with Roundup at flowering (July 8 for Vetch; July 16 for Semu and Tinga), and at pod formation (July 24). A third treatment was to allow natural drying (October 1). Dry matter yields were measured immediately before spraying and on October 1, are shown in Table 4.

Table 4. Dry matter yields of three legumes at three harvest dates.

Legume	Harvest		
	1	2	3
		lbs/acre	
Semu	1759	2348	1348
Tinga	625	1190	580
Vetch	925	2065	1583

Available soil water content was measured on four dates, but only the October 1, 1991 data are shown in Table 5.

Table 5. Available soil water content to 42-inch soil depth on October 1, 1991 measured under three legumes killed on three dates and on summerfallow.

Kill date	Management			
	Semu	Tinga	Vetch	Fallow
		inches water		
Jul 8-16	2.63	3.13	3.80	-
Jul 24	2.64	2.43	2.91	-
Oct 1	3.05	2.35	2.71	5.33

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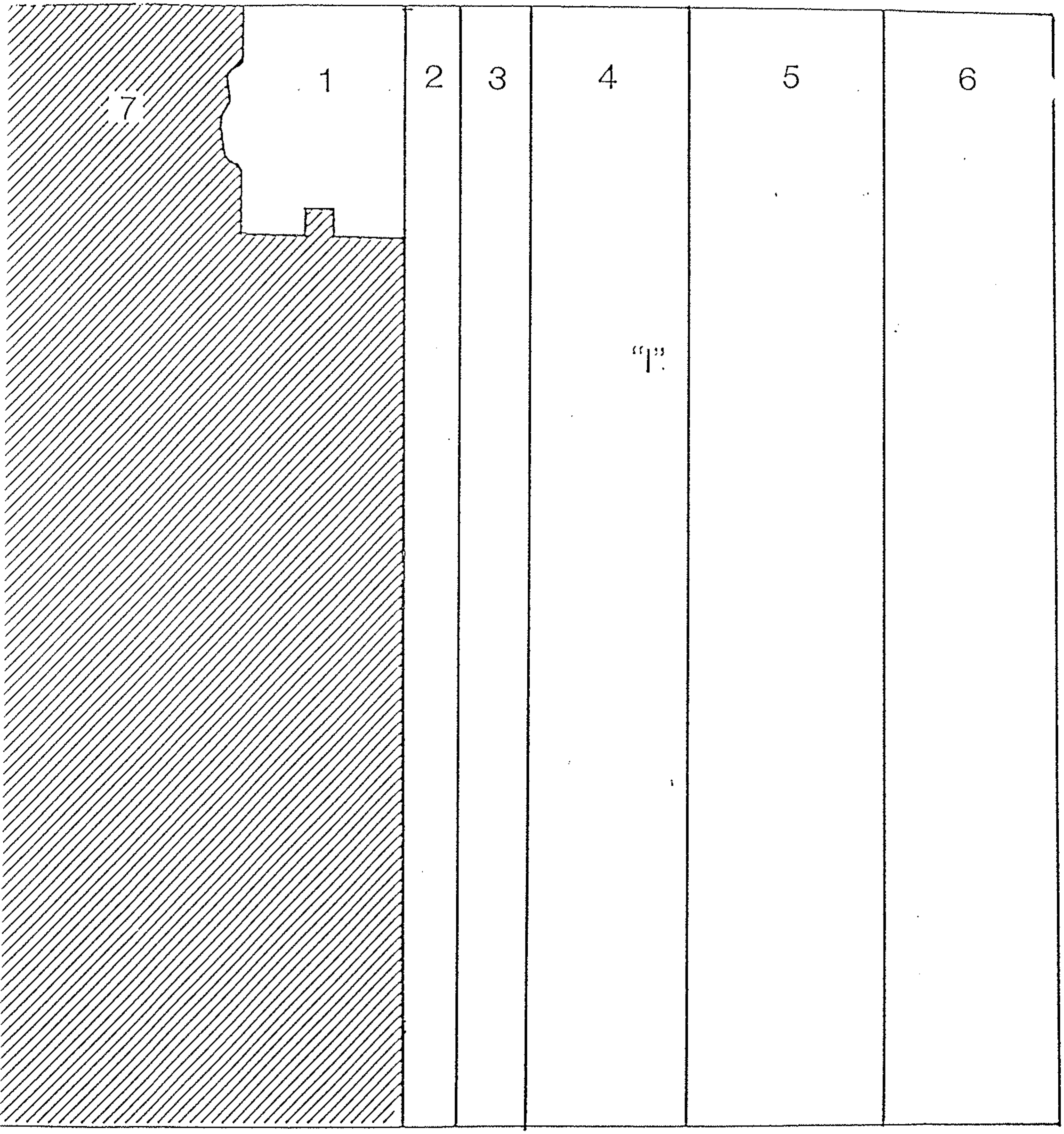

I. NE 1/4 Section 20 - Research Activities

I1. Root rot diseases. Spring wheat plants in three different studies were rated twice for root rot symptoms. The three studies included spring wheat in a continuous cropping system (SWCC), a crop-fallow system (SWCF), and a continuous wheat system (SWCW). Plants (8,200) were pulled, roots washed, and the subcrown internodes were rated as either clean, slightly infected, moderately infected, or severely infected. Results were similar for all three studies. Overall, 75% of the plants were classified clean, 22% were classified slightly infected, 3% were classified moderately infected, and only 0.3% were classified as severely infected. Obviously, common root rot was not a serious problem in our plots in 1991.

Four fungicide seed treatments for common root rot were tested in the continuous spring wheat field which was divided into no-till and conventional tillage treatments. With the low level of root rot present, differences among the 4 fungicide treatments were not evident. Only tillage effects were significant. With plant stand differences (231 plants (393 heads) per meter square for the no-till and 139 plants (241 heads) per meter square for the conventional till (40% less)) taken into account, no-till had a significant yield advantage over conventional till and the test weight was higher for no-till. Straw production was similar for no-till and conventional till but because of the yield differences, the straw to grain ratio was much higher with the conventional till treatment.

I2, I4 & I6.
These fields were minimum-till summerfallowed in 1990. Amidon spring wheat was planted May 1-2, 1991 using a cultivator-double disk, press-drill in tandem. The seeding rate was calibrated to plant 1-million viable seeds per acre. These fields were sprayed May 29-30, 1991 with Tiller plus Buctril (each at 0.25 lb ai/ac). These fields had no weeds of any kind present when combine harvested August 13, 1991. These fields averaged about 36.0 bu/ac, 58 lbs/bu and 14.0 to 14.5% protein.

I3 & I5.
These fields were cropped to spring wheat in 1990 and summerfallowed in 1991. These fields were undercut May 29, 1991, sprayed with Roundup plus 2,4-D June 16-18, 1991, sprayed with Landmaster July 31, 1991. These fields had about 1700 lbs/ac of surface residue (56% cover) at the end of the summerfallow period.

I1. 1991 NAPP - This is the fifth year of this type of trial, but it was conducted differently in that the supplemental water was applied by a trickle irrigation system, as in 1990, and all of the available nitrogen was present in the soil at planting.

Results shown in Table 1 are not typical of the results from previous years as these pertain to grain yield. Larger yields were expected from water levels 2 and 3. No reason is advanced at this time why our expectations were not realized.

Tissue nitrogen concentration and content data from this trial attempt to and others of previous years will be combined to develop the capability to predict post-emergence fertilizer nitrogen needs of spring wheat. (Bauer & Black)

Table 1. Effect of water and available nitrogen level on characters of Amidon spring wheat, 1991.

		Characters 3/					
WAT 1/	NIT 2/ lbs N/ac	POP no/m2	HEA no/m2	TKW mg	TEW lbs/bu	YIE lbs/ac	KPH no.
1	55	231	330	23.41	60.8	1698	27.7
	85	236	413	19.82	57.0	1482	21.6
	115	227	449	19.21	55.9	1432	18.7
2	55	236	398	23.39	60.8	1516	21.5
	85	244	455	18.31	55.5	1468	21.0
	115	238	488	19.01	56.3	1519	21.9
3	55	226	429	24.28	59.9	1819	22.5
	85	252	502	21.79	59.2	1868	21.8
	115	252	541	20.57	57.9	1687	20.6
WAT	1	231	397	20.81	57.9	1537	22.7
	2	239	447	20.24	57.5	1501	21.4
	3	243	490	22.21	59.0	1791	21.6
NIT	1	231	386	23.70	60.5	1677	23.9
	2	244	457	19.97	57.2	1606	21.5
	3	239	492	19.60	56.7	1546	20.4
LSD	WAT	NS	16	0.88	NS	140	NS
	NIT	NS	16	0.76	1.0	78	1.4
	W*N	NS	NS	NS	1.8	136	2.4

1/ Water levels 1, 2, and 3 represent increasing amounts of water.

2/ Refers to available nitrate-nitrogen to four feet at planting plus fertilizer nitrogen applied at planting.

3/ POP - seedling population before 3-leaf stage. Multiply no/m2 * 0.836 = no/yd^2.
HEA - head population near harvest.
YIE - grain yield, combine sample
TKW - kernel weight
TEW - test weight
KPH - kernels per head
(All expressed on oven-dry basis)