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SOIL SCIENCE AND BIOMETEOROLOGY

AN EVALUATION OF VARIETY--INTERACTIONS UNDER CONSERVATION TILLAGE WHEAT CROPPING SYSTEMS

by

Robert L. Newhall

A thesis completed in partial fulfillment of the
requirements for the degree

of

MASTER OF SCIENCE

in

Soil Science and Biometeorology

(Soil & Water Conservation)

UTAH STATE UNIVERSITY
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Robert L. Newhall

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ABSTRACT

An Evaluation of Variety--Interactions Under Conservation

Tillage Wheat Cropping Systems

by

Robert L. Newhall

Utah State University, 1983

Major Professor: Dr. V. P. Rasmussen

Department: Soil Science and Biometeorology

While many spring and winter wheat (Triticum aestivum L.) varieties have been evaluated for yield characterisitics under Utah's conventional dryland cropping systems, little is known about these same varieties under new conservation tillage farming management techniques. Farmers are rapidly adopting various reduced tillage systems and need information regarding proper varieties, fertility practices, weed control, etc. A two year field study, in Box Elder County, Utah on a DeJarnet Gravelly silt loam (Loamy-skeletal, mixed, mesic, Calcic Pachic Haploxeroll) and on a Mendon silt loam (fine-silty, mixed, mesic, Calcic Pachic Argixeroll) examined total dry matter, grain yield, percent protein, kernel weight, kernel volume, and average bushel weight responses to four fertility treatments superimposed upon five spring wheat and four winter wheat varieties. Also compared were one spring wheat variety "Komar" and one winter wheat variety "Weston" in a conventional verses conservation tillage dryland cropping system. Soil moisture and soil temperature (20 cm and 10 cm, respectively below the soil surface) readings were compared between the conventional and conservation tillage planting systems. The conservation tillage plantings were done with an air-seeding tillage planter and the conventional plantings were done with standard deep-furrow drills. Dry granular fertilizer (27-12-0-4 sulfur) was applied to both deep-furrow and conservation tillage plots with the air-seeder. Rates were 0, 168, 224, 280 kg/ha fertilizer material applied. Significant differences were obtained for all spring wheat varieties. Conservation-tilled "Komar" yielded significant yield increases over conventional-tilled "Komar". The opposite held true for "Weston", with the conventional-tilled plots yielding a slightly significant increase in grain over conservation-tillage "Weston". No relative difference in soil water or soil temperature were observed in either variety through time. However, at certain growth stages the differences were clearly discernable. Very little significant differences were established amoung the winter wheat varieties. Because of heavy infestations of snowmold (<u>Calonectria graminicola T.</u>) on all winter wheat plots, the true potential yield characteristics of conservation verses conventional tillage remain unproven on these winter wheat varieties.

(101 pages)

INTRODUCTION

There are approximately 420,000 acres of small grains planted annually in the state of Utah (Utah State Dept. Ag., 1983). With skyrocketing production costs and an ever increasing concern for controlling erosion, many grain growers are looking at alternative methods of production. One of these methods is air-seeded conservation tillage.

Conservation tillage has various definitions (Romander, 1982). Experts and researchers are not agreed as to a single definition. Some statements occuring repeatedly in these definitions, such as:

(1) reducing the number of tillage operations across the field;

(2) no moldboard plowing;

(3) very little, if any incorporation of crop residue, while leaving most on the soil surface.

The Soil Conservation Service, defines at least one ton per acre of residue, on the soil surface, to be conservation tillage. Conservation tillage implies increased residue and/or surface roughness to control soil erosion and conserve water. In recent years, it has been used increasingly to improve farm net profit. This is done by conserving energy inputs, machinery, and time.

"Minimum-tillage" or "Reduced tillage" are sometimes used synonymously with conservation tillage. However, they are relative terms. Most farmers practice the minimum amount of tillage that they think is advisable. Merely reducing tillage trips may or may not conserve soil, water, or energy.

There is increasing interest regarding many new conservation tillage methods and associated equipment amoung growers and researchers. Research is needed to 1) answer basic grower inquires, 2) define possible conservation tillage cropping practices, 3) establish a basis for future investigations. One method, investigated herein, is conservation tillage using an air-seeder.

The major thrust of this project was varietial response to an air-seeded conservation tillage management system. Rasmussen (1983), reported that an average 1.8 C. cooler environment exists under air-seeded conservation tillage wheat systems at the crown depth. Some commerical varieties, bred for conventional dryland seed beds, may not perform well under this cooler temperature regime. Other studies have shown a savings of 5 cm (2 inches) of moisture within the planting zone, in a conservation vs. conventional tillage system (Phillips and Young, 1973, and Rasmussen, 1983). Yield studies were conducted to determine how different varieties perform in this unique microclimate of conservation tillage.

The answers to the above questions are imperative to Utah farmers if they choose to use air-seeded conservation tillage or other conservation tillage methods. Growers need to know what varieties will produce a profitable yield. This is why information such as yield, percent protein, water use, growth stages and soil temperature were monitored. A clear picture of varietial response of conservation tillage compared to traditional techniques was needed in which to establish some baseline data.

Soil fertility under air-seeded conservation tillage has not been studied extensively. This was part of an overall objective to define suitable conservation tillage cropping practice recommendations. Using an air-seeder as the conservation tillage planting tool, provided the opportunity to easily study, (1) differing fertilizer rates, (2) certain placement effects of dry fertilizer banded with the seed, and most importantly, (3) the maximum amount of fertilizer that could be safely placed with the seed. It has been purported that deep placement of fertilizer at planting saves time, energy, soil moisture, machinery wear and labor (Walker, 1982, Murphy, 1978b, Rasmussen et al. 1983). Synergistic benefits of deep-placed N and P fertilizer on yield, over pre- or post- plant fertilizer applications, has been shown repeatedly by Murphy, (1978a, 1978b) and Leikam et al. (1983).

By testing several air-deep-placement fertilizer rates, the "safe" levels of fertilizer placement with the seed may be determined. The S.C.S.A. (1979) found that most organic nitrogen and phosphorus lost by both conventional and conservation tillage was carried away by eroded soil. By deep placement of the fertilizer and reducing erosion with residue management, surface fertilizer loss can be kept to a minimum.

The research discussed herein will aid growers, land managers and future researchers in making more intelligent decisions about how to use conservation tillage as a possible method to decrease farming costs, (fuel, labor, and machenery), soil erosion, and to optimize soil moisture and fertility management.

Objectives

1) To evaluate benefits and disadvantages of air-seeded conservation tillage verses current tillage practices.

2) To compare yield and percent protein of different varieties as influenced by fertilizer rate and placement with an air-seeder and more conventional methods.

3) To obtain data regarding yield, percent protein, water use, growth stages and soil temperature from different spring and winter wheat varieties in a dryland air-seeded conservation tillage operation.

LITERATURE REVIEW

History of Conservation Farming

The history of conservation-tillage farming, with fertilizer placement, in the United States dates back to the American Indians (Wiser, 1982). These first Americans planted maize seed and a fish into a hand-formed hole. Simple crude hand tools were sometimes used to cut a seed trench. It wasn't until 1800's with the introduction of the moldboard plow, that what we term "conventional tillage" came into being. Plowing was required to effectively break the dense virgin prairie sod. With horse-drawn plows and cultivators a farmer was able to tend more acres and reduced the back-breaking job of hand spading and weeding. It wasn't until after the "dust-bowl" era of the 1930's that the current conservation tillage movement came into being. As defined today conservation tillage is any tillage sequence that reduces loss of soil or water related to conventional tillage; often a form of noninversion tillage that retains protective amounts of residue mulch on the soil surface (S.C.S.A., 1982).

The conservation tillage tool known as the Prasco Air-seeder was invented by farmers, Preston Davies and Arthur Ross of Antlee, Saskatchewan, Canada (Walker, 1982). This chisel-drill has a air distribution system which blows seed and/or dry fertilizer into the soil in back of a field cultivator or chisel plow point. This allows minimum soil and residue disturbance. Hence, it is often called conservation or minimum tillage. By using a high clearence chiselplow, large amounts of residue can flow through it.

The major reason for using any conservation tillage system is to control surface runoff and erosion. This is achievied by leaving as much surface residue as possible relatively undisturbed during the erosion season. Each tillage operation reduces the amount of crop residue and decreases surface roughness (clods) on the soil surface. Because of this, each tillage operation increases the susceptibility of soil to any type of erosive force (McDole and Vira, 1980).

Modern conservation tillage started in the Central U.S. cornbelt (Kentucky, Ohio, Missouri, and Iowa) in a corn and soybean rotation (Phillips and Young, 1973). Even at the turn of the century Widtsoe, (1919) knew of the benefits of wheat stubble in hindering water runoff and soil erosion in dryland agriculture. Many studies dealing with cornstalk and soybean residue to reduce erosion have been reported in recent years (Gard et al. 1956; Kiddle et al. 1943; Mannering and Meyer, 1961). All these studies delt with the importance of maintaining adequate cover on the soil surface for protection from erosion. Duley and Russel, (1942) reported that their stubble plots, using combined wheat stubble and straw, showed only 1.07 cm (.42 inch) runoff and .067 mt/ha (.03 ton/acre) soil loss when compared to a bare cultivated soil with 23.01 cm (9.06 inch) runoff and 7.71 mt/ha (3.44 ton/acre) soil loss by erosion on a 4 percent slope. This loss rate was with a simulated rainfall of 3.8 cm/hr (1.5 inch/hour). An "in the field measurement" with wheat stubble, plots with straw left (subtilled) vs. no residue (plowed) showed continuing decrease of runoff and erosion in plots where residue was maintained (Johnson and Moldenhauer 1979).

Summer Fallow

Summer fallow is defined as a farming practice wherein no crop is grown and all plant growth is controlled by cultivation or chemicals during a season when a crop might normally be grown. Thus, production for one season is forfeited in anticipation that there will be at least partial compensation by increased crop production the next season (U.S.D.A., 1974). In the semi-arid Intermountain West, summer fallow is often associated with dryland small grain agriculture. It is essential for stable crop production in areas were the percipitation-evapotranspiration realtionships are such that annual crop production is unreliable (Brengle, 1982). Tillage during this fallow period has been historically used for control of weeds, dust-mulch management, and seedbed preperation (Brengle, 1982). The influence of different fallow methods and crop residue management on water harvest storage has been widely studied. Staple, et al. (1960) found an average of 37 percent of winter percipitation was stored when grain stubble was left standing, but only 9 percent stored when the soil surface was bare ("black" fallow). An average of 5.16 cm (2.03 inch) of water stored was found by Smika and Whitfield (1966) in plots left to standing stubble. Storage efficency ranged from 140 to 83 percent for these plots. Thysell (1983), at Mandan, North Dakota, showed that three times as much moisture was conserved from harvest to seed-time in stubble-mulch plots as in conventionally tilled fallow plots.

Conservation Tillage and Soil Environment

A plant residue mulch influences soil temperature and net radiation by 1) reflecting incident radiant energy, 2) by insulation, and by 3) lowering surface evaporation (Konke and Werkhoven, 1963, and McCalla and Army. 1961). A lower soil temperature at germination periods of spring and winter wheat has been repeatedly reported from measurements under high surface residues (Phillips and Young, 1973; Dubetz et al. 1963; Brengle and Whitfield, 1969; Rasmussen, 1983). These researchers reported differences of approximately 2 degrees C. lower temperature in high residue plots during the germinating period when compared to conventional low surface residue plots.

The deep-placement of nitrogen and phosphorus fertilizer has beneficial effects on nutrient uptake and yields, (Miller and Ohlrogge, 1958). The placement of a starter fertilizer; nitrogen, phosphorus, and sulfur, on high Ph soils is possible with the new technology and equipment like the Prasco Super Seeder and Chevron Chemical Company's Unipel Fertilizers (Walker et al. 1982). When comparing broadcast fertilizer applications verses deep-placement applications, a 1.35 mt/ha (20 bushel/acre) increase in winter wheat yields was obtained (Walker et al. 1982).

Yields in Conservation Tillage

In the past, mulches applied to a seedbed crop have depressed the early growth of corn (Burrows and Larson, 1962; Parker and Larson, 1962; Van Wijh et al. 1959). This lower soil temperature causes temperature stress and diseases that result in reduced yields (Boatwright et al. 1976). In spring and winter wheat, the yields have been mixed under such circumstances. Harder et al. (1979) showed little or no difference in yield in a conventional vs. conservation tillage trial, but had significant differences amoung the wheat varieties. Walker and Rasmussen (1981) showed small increases in winter wheat yields with conservation over conventional tillage with selected cultivators. Earlier these same researchers (1979) demonstrated a strong difference amoung varieties in conservation tillage of winter wheat in an air-seeded dryland cropping system.

MATERIALS AND METHODS

This research was initiated at the request of several dryland farmers who were already practicing conservation tillage within the state. Because its main purpose was to find the answers to "how-to" questions -- it was sponsored primarily with support from the Utah State University's Cooperative Extension Service.

The fact that the research was 1) on-farm (with inherent constraints of the farm cooperators); 2) primarily to develop a "recipe" to aid farmers already involved in conservation tillage; and 3) hampered by the extremely large size of the air-seeder unit (approximately 60 m X 60 m) -- made the standard small-replicated experimental design impossible. Hence, the design and the statistical analysis had to be adjusted accordingly. Exceptions from classical statistical procedures will be explicitly outlined.

Research was requested and preformed for both dryland spring and dryland winter wheat varieties.

Spring Wheat Trial

Research Site #1

The data for this experiment was collected in 1982. The spring wheat trial was conducted on a farm owned and operated by Earl Fuhriman and his son in Pocatello Valley, Box Elder Co., Utah and is bisected by the Utah-Idaho state line, T.15 N., R.5 W., Sec. 31. Mean annual air temperature varies between 8.3 to 10 degrees Celsius. Average annual percipitation varies between 38.1 to 45.7 cm, and the frost-free period is 110 to 140 days (U.S.D.A. et al. 1969). Elevation is at 1470 meters above standard sea level.

Soil in the experimental area is classified as DeJarnet gravelly silt loam (Loamy-sketetal, mixed, mesic, Calcic Pachic Haploxeroll). The site has a 6 to 10 percent slope. Permeability is moderate with a moderate ersoion hazard (U.S.D.A. et al. 1969). Gravel layers are randomly distributed with depths common near 1 m throughout the experimental area.

This area has in the past been used for the production of dryland small grains.

Plot Preparation

At site #1 the operations that preceeded planting were;

(1) fall roto-mowing of the stubble,

(2) a fall chiseling.

This land was to have been fallowed until the fall of 1983 at the time of the spring planting.

Residue samples were taken to determine the amount of stubble on the soil surface. The amount of residue was determined to be 3.74 mt/ha (1.67 ton/acre) at planting. This was a mixture of standing and ground surface residue.

On April 6, 1982 soil samples were taken. A composite sample of six separate probe samples were combined for each of three depths: 30, 61, and 91 cm (12, 24, 36 inch). Samples taken were analyzed by the Plant,Soil and Water Testing Lab. at Utah State University (see Table 1). Recommendations, for small grains, made by the lab were;

(1) phosphorus levels were between marginal and adequate

(2) potassium levels were adequate

(3) microneutrients levels were between marginal and adequate for Zinc, Iron, abd Sulfur

(4) nitrate levels were low with a recommendation of N-applications of 39.2 to 56.0 kg-N/ha (35 to 50 pounds-N/acre)

Varieties and Fertilizer

Four levels of fertilizer within five varieties were used as a reference for fertilizer rates on the spring wheat plots. The coding of the fertilizer rates are f0, f1, f2, and f3. This corresponds to 0, 168, 224, 280 kg/ha of fertilizer material applied.

The fertilizer used was Chevron Chemical Company's Unipel fertilizer (27-12-0-4(sulfur)). Expressed as kg/ha ofnitrogen, phosphorus, potassium, and sulfur: f0 = 0-0-0-0, f1 = 45.2-20.2-0-6.7, f2 = 60.5-26.9-0-9, and f3 = 75.7-33.6-0-11.2 for each increasing rate. Pounds per acre equivelents are: 0-0-0-0, 40.5-18-0-6, 54-24-0-8, 67.5-30-0-10. Pre-determined ratios were not

Table 1. Results of soil tests for spring wheat plots.

SAMPLE	CM	PH	ECe (mmhos/cm)	P	K	NO3-N	Fe	ZN	S	N%
				(ppm						)
#1	30	6.8	.4	26	383	1.4	26	.9	<10	.11
#2	30	7.5	.5	10	300	1.6	10	.4	<10	.10
#3	30	7.1	.2	14	198	0.6	15	.4	<10	.05
MEAN		7.1	.4	17	294	1.2	17	.6	<10	.07
#1	61	7.5	.4	16	400	0.9	11	6	<10	.08
#2	61	7.7	.4	11	398	1.4	11	.5	<10	.07
#3	61	7.9	.3	05	299	1.5	11	.5	<10	.05
MEAN		7.7	.4	11	366	1.3	11	.5	<10	.07
#1	91	7.3	.4	18	347	4.0	14	.4	<10	.07
#2	91	7.6	.5	09	259	1.3	11	.9	<10	.05
#3	91	7.9	.3	05	234	0.0	09	.4	<10	.05
MEAN		7.6	.4	11	280	1.8	11	.6	<10	.06

neccessary but desired because UNIPEL fertilizer has been found to move through an air-seeder better than bulk-blended fertilizer.

All fertilizer was applied using the Prasco model 30-40 Air Seeder, mounted with a Hess chisel plow with 15.3 cm (6 inch) sweeps on 17.8 cm (7 inch) centers. This same implement was used for the conservation tillage planting of all varieties.

Varieties used on the spring wheat experiment were;

(1) Komar, a hard-red spring wheat, usually produces on dryland areas;

(2) Vic, a durum spring wheat, also mainly produced on dryland farms;

(3) 906-R, a hard-red spring wheat breed for irrigated areas;

(4) Fremont, a hard-red spring wheat, produced on both dryland and irrigated areas;

(5) Bannock, another hard-red spring wheat produced on dryland farms (Albrechtsen and Dewey, 1982).

All seed planted was certified or foundation grade in purity.

The plots were planting on April 29, 1982, using the Prasco Model 30/40 Air-Seeder. Seeding depth was approximately 2.5 cm (1 inch). A strip for conventional tillage of 183 X 11 m (600 X 36 feet) was deep-fertilized at the f1 rate, using the Air-Seeder, and planted with a John Deere deep-furrow drill, on April 30, 1982. The same seeding depth and the variety Komar was used for proper comparison with conservation tillage. Seeding rates were set at 67.3 kg/ha (60 pounds/acre), with the Air-Seeder and at approximately the same using the John Deere drill. The variety Komar was planted using both planting implements.

Experimental Design

The Prasco Air-Seeder does not lend itself easily to putting in small randomized block designs for research work. Changing fertilizer rates and seed varieties are impossoble for that type of experimental design. It was decided to lay down long strips, with length sufficient to allow the Air-Seeder time to equilibrate air-turbine speed and set optimal ground speed rate for optimal residue and seed flow. A 3 m (10 feet) buffer zone was placed between treatments to change the fertilizer setting and purge/prime the air-turbine and seed/fertilizer flow system.

The primary deviation in classical statistical procedure results in an experiment that could not be randomized without bias. It was randomized with normal random number procedure to the extent that the large air-seeder would allow, but there is an inherent bias due to the placement of the large plots. Where this bias occurs, at least 10 subsamples were taken and appropriate ANOVA and "F" confidence tests applied. Since all plots had internal variability (probalities of greater "F") of less than 1% -- we have assumed that internal bias was small. Therefore, all later references to "significant" presume this assumption is correct with its possibility of error less than 1%.

Weed Control

In the spring wheat plots chemical weed control was needed after planting and 2,4-D Amine was applied. The chiseling during planting delt effectively with weeds growing at that time.

Weather Measurements

Rainfall and maximum and minimum temperatures, on the spring wheat plots, were monitored by Sid Fuhriman, at his house approximately 2.4 km (1.5 miles) due east.

Soil Water and Soil Temperature Measurements

Soil water content (percent by volume) was monitored by using a neutron probe in the spring wheat plots.

Three neutron access tubes were installed, in all varieties at the f1 fertilizer rate, one week after planting. Three access tubes also were installed in the conventionally drilled plot, variety, Komar. Several access tubes were placed in the different fertilizer rates of the air-seeded variety Komar. This allowed observation of the soil water changes between varieties and fertilizer treatments, along with the comparsion of the two planting systems, throughout the growing season.

Aluminum irrigation pipe, 2.4 m (8 feet) in length and 5.1 cm (2 inch) in diameter, was used as access tubing. Two tubes could not be placed to the desired depth of 2.4 m (8 feet), because of gravel layers, one in variety 906-R and the other in variety Fremont. All access tubes were installed at random. Care was exercised not to place an access tube within 1 m (3 feet) of any border area in the plots.

Neutron probe measurements were made using a CPN Neutron Moisture Probe, model 503 DR, on a 7-day (approximate) interval. Readings were recorded as volumetric water contents. Measurements taken were at the following depths, in cm; 15.2, 30.3, 45.7, 61.0, 91.4, 121.9, 152.4, 182.9, 213,4, and 243.8. These depths expressed in inches are: 6, 12, 18, 24, 36, 48, 60, 72, 84, and 96.

To estimate ET, the following equation was used:

$$ET = BM - EM + P - Ro - Dr \quad (1)$$

where:

ET = Evapotranspiration

BM = Beginning Soil Moisture

EM = Ending Soil Moisture

P = Precipitation

Ro = Runoff

Dr = Drainage

Drainage was assumed to be 0. No runoff events were evident, so runoff was also assumed to be at 0.

An Omnidata International, Datapod, model DP-222, was installed to record soil temperature, at 10 cm (4 inch), and soil moisture, using a gypsum block, at 20 cm (7.8 inch). They were placed in the variety Komar, which had been planted with both a conservation tillage air-seeder and a conventional tillage deep-furrow drill.

Plot Layout

The plots for the spring wheat experiment were bisected by a farm road. Treatments ran north to south. The south plot measured 188.9 X 49.4 m (620 X 162 feet), the north plot measured 188.8 X 27.4 m (620 X 90 feet). There was a total of 21 plots. Each of the five tested varieties were separated into differing treatments by the amount of fertilizer applied. These plots measured 60.9 X 5.4 m (200 X 18 feet) with about a 3.1 m (10 feet) buffer strip used to establish fertilizer rates. The f0 rate plots measured 188.9 X 5.4 m (620 X 18 feet). Each of these check plots were located to the west of their respective fertilized variety plots. The only exception was the air-seeder fertilized, deep furrow planted plot, representing the conventional drilled plot. It measured 188.9 X 16.4 m (620 X 54 feet.)

The east border of the entire spring wheat plots was near Mr. Fuhrimans winter wheat field (variety Manning). All other borders were next to fallow fields.

Management Problems

During the first running of the Air-Seeder on the spring wheat plots, a skip developed in the planted rows. One of the tubes feeding seed and fertilizer behind a sweep had become plugged with soil. Removal of the soil with a screwdriver proved successful and no further problems developed.

Harvest Procedure

Prior to harvesting, each plot was broken down into meter square sub-sampling areas and assigned a numerical value, starting with one. Using a random number generator program ten sites were selected to be harvested per plot. In the field, a red flag was placed into the center of the selected sample area.

All spring wheat plots were harvested on August 17, 1982, 110 days from planting with the Air-Seeder and 109 days from planting with the John Deere deep-furrow drill. Maturity (hard dough stage) was achieved in all treatments with the exception of the Air-Seeded variety Komar at the f0 fertilizer rate. It was still in the soft dough stage.

Harvesting was accomplished by placing a meter-square sampling ring around the red flag and cutting with a hand sickle. Wheat was harvested as close to the soil surface as possible, then tied into bundles. These bundles were placed heads-first, into paper bags, then the bags were tied again. Sacks were labled according to variety, fertilizer treatment, and harvest number. Hand held grass shears were also tried as a harvesting method, but proved unsatisfactory.

Harvested samples were taken, the same day, to the drying ovens at Utah State University's Greenville Experimental Farm. Drying was allowed to take place for at least two days at 105 C. Each sample was then weighed on a Mettler P1200 laboratory scale to determine dry harvest weight.

Threshing was accomplished with a Vogel-type plot thresher designed expressly for research use. It allows thorough a cleanout between each sample. All samples were threshed and grain dried in smaller bags, with the same identification as the sacks used for harvesting. These grain samples were then weighed on the same scale to determine dry kernel weight. After all samples were weighed they were adjusted to 10 percent moisture by weight.

Measurements also included 100-kernel counts, 100-kernel weights and 100-kernel volumes to determine an average weight and volume per kernel and average bushel weights for various treatments, as used in crop modeling studies.

Statistical Analysis

Analysis of variance was obtained by using Statistical Analysis version 4.0 from Basic Business Software Co. on an Apple-II+ microcomputer. One way analysis of variance on yield data was used for these computations. Other statistical data was obtained on the following: (1) soil moisture; (2) soil temperature; (3) ET. To test for differences between means of treatments, the LSD (least significant difference), was used. Alpha error levels were set at .05, to help determine any trends in the variables.

All of the statistical tests preformed have an inherent plot bias due to the design forced by the large air-seeder used. However, the extremely small "F" probabilities of error within the extremely large plots tend to minimize this bias. Accordingly, all effects shown as "significant" are by the standard "F" probability and LSD tests--assuming the forced bias was minimal. There is, however, a chance of <= 5% that our imposed bias caused the observed differences in means.

Winter Wheat Trial

Research Site #2

The site selected for the winter wheat trial in 1982-1983 was in an area leased and operated by Mr. Sherman Earl, in Beaver Dam, Box Elder Co., Utah (T.12 N., R.2 W., Sec. 12). Mean annual air temperature varies from 8.3 to 9.5 degrees Celsius. Average annual precipitation varies from 40.6 to 45.7 cm. Frost free period varies between 120 and 140 days (U.S.D.A. et al 1969). Elevation at this site is 1518 m above standard sea level.

Soil classification at the plot area is a Mendon silt loam (Fine-silty, mixed, mesic, Calcic Pachic Argixeroll). Slope on this site is 4 percent. Water permeability is moderately slow with a slight ersoion hazard (U.S.D.A. et al. 1969).

This area is historically used for dryland small grains.

Plot Preparations

The winter wheat plots, site #2, had been harvested three weeks prior to plot planting. No fallow time had been allowed on this site. However, an extremely wet year provided ample subsurface moisture for a grain crop.

Residue on the surface consisted mostly of standing stubble at the rate of 3.52 mt/ha (1.57 ton/acre). A disking operation, using a tandem offset disk, was used to cultivate a 244 X 18 m (800 X 60 feet) section of the area. This section was planted using a conventional deep-furrow drill. After cultivating, the amount of residue at the soil surface was depleted to 1.76 mt/ha (0.79 ton/acre).

On September 20, 1982 fertility samples were taken. A composite sample of four separate probe holes were combined for two depths, 30 and 61 cm (12 and 24 inch). Again the samples were analysed by the Plant Soil and Water Testing Lab. at U.S.U., (see Table 2). Recommendations of the lab were as follows:

(1) phosphorus levels were between marginal and adequate

(2) potassium levels were adequate for all small grains

(3) microneutrients levels were adequate

(4) Nitrate levels were low, the lab recommended 39.2 to 56.0 kg-N/ha (35 to 50 pounds-N/acre).

Varieties and Fertilizer

The same rates of fertilizer were applied on the winter wheat plot as the spring wheat, f0, f1, f2, and f3. Again Chevron's Unipel (27-12-0-4) was the fertilizer used to allow even distribution in the air system. On March 11, 1983, in the f0 rate plots, a top dressing was put down using a Gandy hand spreader. This was done across the plots, at right angles. Three rates were applied. These were the same as applied by the Air-Seeder, f1, f2, and f3. The strips were about 8 X 2.4 m (26 X 8 feet).

Varieties used in the winter wheat plots were;

(1) Manning, a hard-red winter wheat , produced in both a dryland and irrigated areas;

(2) Hansel, a hard-red winter wheat produced in dryland areas;

(3) Jeff, also produced in dryland areas and a hard-red winter wheat;

(4) Weston, another hard-red winter wheat produced on

Table 2. Results of soil tests for winter wheat plots

SAMPLE	CM	PH	ECe (mmhos/cm)	P	K	NO3-N	Fe	ZN	S (meq/l)	N%
				(----------ppm				----------)		
#1	30	7.8	.7	16	400	7.4	6.0	1.1	.63	.18
#2	30	7.9	.7	16	400	7.8	5.8	1.4	.53	.12
#3	30	7.9	.8	20	400	5.3	5.8	1.1	.46	.17
#4	30	7.8	.8	33	400	8.5	5.7	1.3	.41	.12
	MEAN	7.8	.8	21	400	7.3	5.8	1.2	.51	.15
#1	61	7.8	.7	12	400	1.9	5.1	1.3	.19	.13
#2	61	7.9	.7	08	400	1.7	4.8	1.3	.18	.13
#3	61	7.8	.7	08	400	1.7	5.0	1.4	.24	.07
#4	61	7.8	.6	09	400	2.3	4.9	1.4	.55	.13
	MEAN	7.8	.7	09	400	1.9	5.0	1.4	.29	.12

dryland farms (Albrechtsen and Dewey, 1982).

The seed planted was certified or foundation grade in purity.

A Prasco 30/40 Super Seeder coupled to a Melroe chisel plow fertilized and planted all varieties directly into the standing stubble. The air-seeder also fertilized a strip, at the f1 rate, so it could be disked and planted by a deep furrow drill. A Melroe deep furrow drill was used as the conventional drill. Seeding rates were the same for the two planting systems, at 95.3 kg/ha (85 pounds/acre). The approximate planting depth was 2.5 cm (1 inch) for both machines.

Planting dates were September 21, 1983 for the air-seeder and October 6, 1983 for the Melroe drill.

Weed Control

Chiseling during planting, destroyed the most troublesome weeds in the fall wheat plots. However a chemical treatment using "Brominal Plus" was needed later for control of several species of weeds. This spraying occurred on May 27, 1983. Several areas in the winter wheat plots had infestations with Field Bindweed (*Convolvulus arvensis*). These areas were eliminated as possible harvest sites. This bias was assumed to be insignificant.

Weather Measurements

A rain gage was set up in the winter wheat plots on September 22, 1982. Other parts of the meteorological station were established on November 13, 1982. This included; (1) a metal snow bucket; (2) a solar-radiation integrator; and (3) an air temperature sensor. An Omnidata International, Datapod, model DP-211, collected the solar radiation and air temperature. Readings consisted of a hourly average. This weather station was located in the NW corner of the plots.

Soil Water and Soil Temperature Measurements

Soil water content (percent by volume) was monitored by using a neutron probe in the winter wheat plots.

One aluminum neutron access tube was installed in each variety and fertilizer treatment in the winter wheat plots. Tubes were included in the conventionally drilled plots. Aluminum irrigation pipe, 2.4m (8 feet) in length and 5.1cm (2 inch) in diameter, was used as access tubing. Reading depths were at, in cm; 15.2, 30.3, 45.7, 61.0, 91.4, 121.9, 152.4, 182.8, 213.4, and 243.8. A Neutron probe was used to measure volumetric water contents. Weekly measurements were taken when possible, except for when winter snow conditions prohibited access to the plots or it was too cold for the neutron probe to function correctly (<= -15 C). Equation #1 was used to estimate ET. Again drainage and runoff were assumed to be 0.

Datapods DP-222 were used to record soil temperature, at 10 cm (4 inch), and soil moisture, using a gypsum block, at 20 cm (7.8 inch), in variety Weston.

Plot Layout

The entire winter wheat plot measured 253 X 50 m (830 X 164 feet). Plots ran from west to east. Each of the four fertilizer treatments, planted by the Air-Seeder, measured 60.9 X 7.3 m (200

X 24 feet). Every treatment was separated by a 3.1 m (10 feet) buffer strip in which to change the fertilizer setting. The plot that was Air-Seeder fertilized, disked twice with a tandem disk, and the deep-furrow drilled measured 253 X 15.2 m (830 X 50 feet). The cooperator when disking the already fertilized air-seeded strip, disked a strip 3.1 m (10 feet) which had not been fertilized. Also during planting with his deep-furrow drill he planted an additional 2.4 (8 feet), which had not been fertilized or disked, but planted directly into standing stubble.

The entire plot area was bordered by Manning wheat planted with the owner's Air-Seeder.

Management Problems

On the winter wheat plots a small erosion rill , measuring 44.5 X 16.5 cm (17.4 X 6.5 inch) developed, run through the east ends of the plot. A rill is defined as a small, intermittent water course with steep sides, usually only a few inches deep and, hence, no obstacle to tillage operations (S.C.S.A., 1982). No access tubes were near the rill so runoff was still assumed to be 0. No areas thus affected were allowed for any harvest sampling and no sample was taken within 1 m (3 feet) of the edge of the rill. Several rainfall events delayed harvesting the winter wheat plots by almost 8 days.

Harvest Procedure

A random number generator was used to select the 10 harvest sites per plots. However, due to size limitations, only three samples were harvested from each of the winter wheat top-dressed fertility plots.

The winter wheat plots were harvested on August 13, 1983. This was 327 days from planting with the Prasco Air-Seeder and 312 days after planting with the Melroe deep-furrow drill. All treatments had matured to hard dough stage by August 5, 1983.

Harvesting and thrashing procedures are identical to those used in the spring wheat plots.

Other measurements also included 100-kernel counts, 100-kernel weights, 100-kernel volume to determine average weights and volumes per kernel and average bushel weights for crop modeling studies.

Statistical Analysis

The same techniques for statistical analysis of data was used for the winter wheat as was used for the spring wheat data. Bias problems were identical to those with the spring wheat data, except somewhat lower due to better site design and placement.

RESULTS AND DISCUSSION

This study was conducted over two years (1982-1983). Hard-red spring and hard-red winter varieties were tested. Each years data will be discussed independently. In both cases the effects of fertilizer rates and varieties on yield components are presented.

Yield Response of Spring Wheat Varieties

Yield data of these varieties (total dry matter, grain weight, percent protein, kernel weight, kernel volume, and bushel weight) are given in Tables 3 and 4 , respectively. The data is presented by variety and fertilizer rates as an average of the ten harvest samples per plot.

There was a significant effect on total dry matter production for each spring wheat variety by increasing fertilization. Generally, as the fertilizer rates increased so did total dry matter.

The variety 906-R, shows a negetive yield response at the f2 and f3 fertilizer rates. The possible explanation could be that production had peaked at the f2 level and that any additional fertilizer could not be utilized, and thus became detrimental to growth, due to limiting soil water.

When comparing the conservation tillage planting to the conventional, the variety Komar showed a significant increase in total dry matter produced.

Figures 1 thru 5 show the response of the spring wheat varieties, grain yields, to increasing fertilizer rates within

Table 3. Average grain yields, total dry matter, and percent protien for spring wheat varieties.

TREATMENT	GRAIN YIELD (Kg/Ha)	DRY MATTER (Kg/Ha)	% PROTEIN
Komar f0	1300 a-c*	4390 c-e	13.0 k-n
Komar F1	3460 n-o	10720 q-r	10.7 a-f
Komar F2	3630 n-p	10000 p-q	10.3 a-d
Komar F3	4310 p	13010 s	12.1 h-j
Vic F0	1540 c-d	4030 a-d	12.3 h-l
Vic F1	2880 g-l	6910 g-k	10.2 a-c
Vic F2	4190 p	9590 o-p	10.9 b-g
Vic F3	6280 q	13490 s	11.8 g-j
906-R F0	1020 a-b	3300 a-b	12.8 m
906-R F1	1860 d-f	6000 f-g	10.4 a-e
906-R F2	2540 i-k	7870 l-m	11.7 f-j
906-R F3	2430 g-h	6960 h-l	11.3 d-h
Fremont F0	910 a-b	3200 a	13.3 l-n
Fremont F1	1770 d-e	5380 f	11.4 e-i
Fremont F2	2880 j-l	8130 m-n	11.7 f-j
Fremont F3	3030 l-m	8900 n-o	12.4 i-m
Bannock F0	1060 a-b	3650 a-c	12.0 h-k
Bannock F1	2040 e-g	6190 f-h	10.8 b-c
Bannock F2	2190 e-i	6590 h-j	9.7 a
Bannock F3	2500 h-j	7870 m-n	10.0 a-b
CD Komar F1	2100 e-h	6280 f-i	9.7 a

* Means within a column followed by a common letter are not statistically different at the 5 percent level using least significant differences.

Table 4. Average kernel weight, kernel volume, and bushel weight for spring wheat varieties.

TREATMENT	KERNEL WT. (grams)	KERNEL VOL. (cc)	BUSHEL WT. (lb/bu)
Komar F0	.0323 a*	.0440 a	57.75 a-e
Komar f1	.0297 a	.0415 a	55.66 a-d
Komar f2	.0321 a	.0460 a	54.41 a-d
Komar f3	.0316 a	.0450 a	54.87 a-d
Vic F0	.0462 a	.0585 a	61.46 e
Vic f1	.0429 a	.0555 a	60.18 c-e
Vic f2	.0443 a	.0570 a	60.40 d-e
Vic f3	.0444 a	.0590 a	58.55 b-e
906-R F0	.0412 a	.0525 a	61.11 d-e
906-R f1	.0395 a	.0505 a	60.83 d-e
906-R f2	.0388 a	.0515 a	58.53 b-e
906-R f3	.0401 a	.0535 a	58.35 b-e
Fremont F0	.0336 a	.0445 a	58.82 b-e
Fremont f1	.0377 a	.0490 a	59.79 b-e
Fremont f2	.0301 a	.0415 a	56.37 a-e
Fremont f3	.0278 a	.0380 a	56.85 a-e
Bannock F0	.0339 a	.0435 a	60.82 d-e
Bannock f1	.0352 a	.0475 a	57.75 a-e
Bannock f2	.0308 a	.0410 a	58.53 b-e
Bannock f3	.0312 a	.0415 a	58.49 b-e
CD Komar f1	.0295 a	.0433 a	52.36 a

* Means within a column followed by a common letter are not statistically different at the 5 percent level using least significant differences.

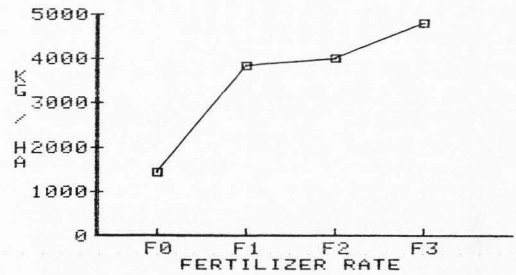

Figure 1. Grain yield for spring wheat variety Komar

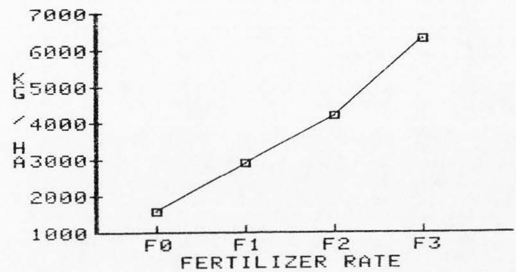

Figure 2. Grain yield for spring wheat variety Vic

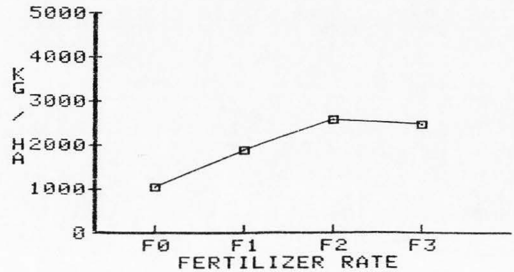

Figure 3. Grain yield for spring wheat variety 906-R

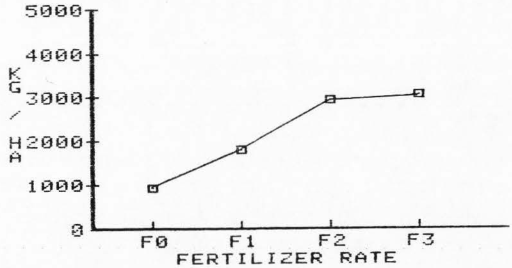

Figure 4. Grain yield for spring wheat variety Fremont

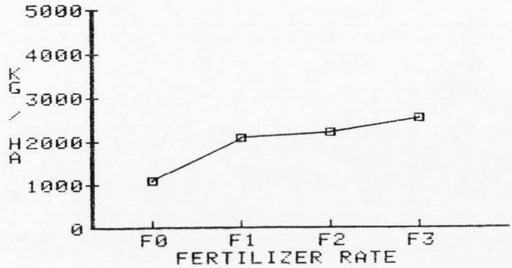

Figure 5. Grain yield for spring wheat variety Bannock

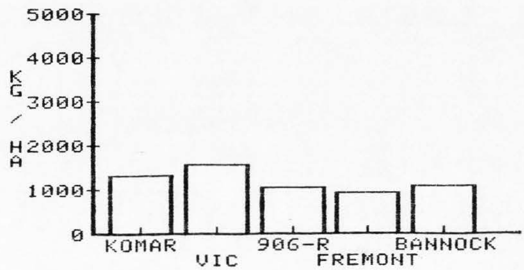

Figure 6. Spring wheat grain yield comparison at f0

a variety.

Again, some significant differences in yield was exhibited. With increasing rates of fertilizer, there is an increasing grain yield response. This was true for all varieties planted with the Prasco Air-Seeder.

When comparing the varieties at the same fertilizer rates, several varieties have larger yields in all treatments (Figures 6 thru 9). Varieties 906-R, Fremont, and Bannock were always inferior, to the other tested varieties, in grain yield, at all fertilizer levels. Komar and Vic were usually significantly higher in grain yield than the other varieties, at all fertilizer levels. Variety Vic had the most substantial increase in grain yield over the other tested varieties.

The average production of spring wheat, in the state of Utah, over the past five years is 2609.7 kg/ha (33.8 bushel/acre), (Utah State Dept. of Ag. et al. 1983). All of the f0 treatments were below this average. The f1 treated grain yielded above this state average, except 906-R and Fremont. All other treatments exceeded this average.

Variety Komar, when planted with the Prasco Air-Seeder, showed a significant grain yield increase over the same variety planted with a deep-furrow drill (Figure 10).

Regression analysis was used to estimate the grain yield fertilizer response so as to compare the conservation tillage air-seeded varieties with the nursery trials at the Utah State University, Blue Creek Experimental Farm. The nursery trails contained all the tested varieties, except for 906-R. The

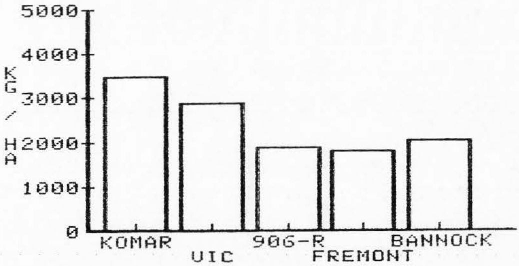

Figure 7. Spring wheat grain yield comparison at f1

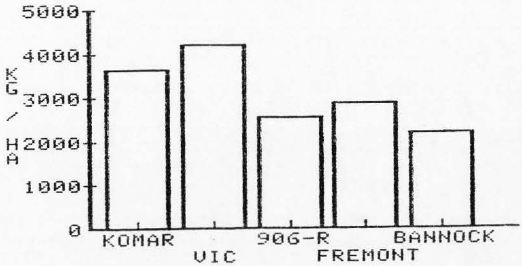

Figure 8. Spring wheat grain yield comparison at f2

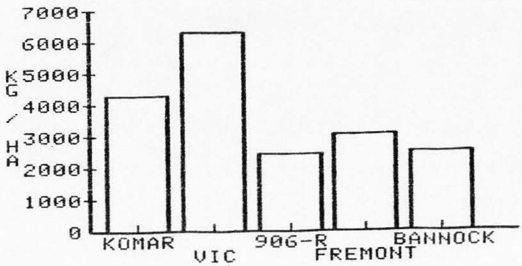

Figure 9. Spring wheat grain yield comparison at f3

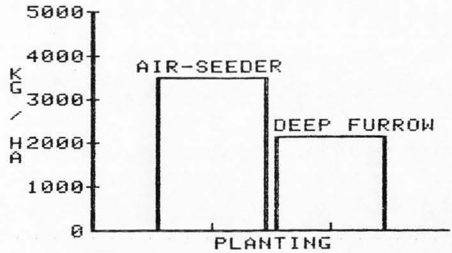

Figure 10. Conservation vs. conventional grain yield comparison variety Komar

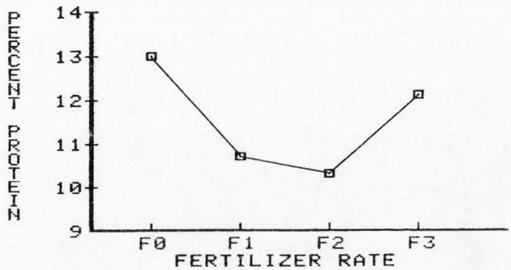

Figure 11. Protein % for spring wheat variety Komar

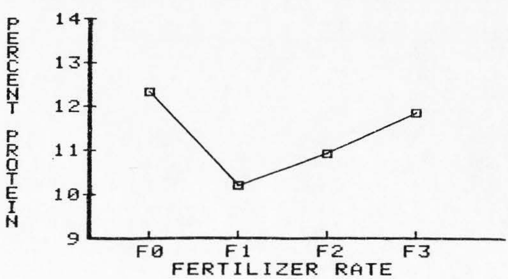

Figure 12. Protein % for spring wheat variety Vic

varieties planted at the Experimental Farm were done so with extensive seedbed preperation. Little crop residue of any kind was left prior to planting with a small deep furrow drill. Fertilization was at 56.1 kg-N/ha (50 pounds-N/acre) in the fall and 44.8 kg-N/ha (40 pounds-N/acre) in the spring (Albrechtsen and Dewey, 1982). In comparing the nursery trails to the conservation tillage trials, at the same total fertilizer level, the conservation tillage varieties yielded more, (Table 5).

A significant decrease in percent protein was found in all varieties from the f0 and f1 fertilizer levels (figures 11-15). All varieties, except Bannock, tended to decrease in percent protein with increasing fertilizer until the f3 level, in which most varieties showed a significant increase in protein. Variety Bannock showed a constant downward trend with increasing fertilizer.

When comparing the percent protein amoung the varieties, at the same fertilizer levels, most showed very little significant differences between them (Figure 16 thru 19). Variety Fremont was constantly higher in protein at all fertility levels.

There was a significant difference in percent protein in the variety Komar planted between the conservation tillage and the conventional planting system. The conservation tillage planting was higher (Figure 20).

In the first three yield components; total dry matter; grain yield; and percent protein, the conservation tillage planting has shown greater production than the corresponding variety planted with a conventional deep-furrow drill.

Table 5. Yield comparison of conservation tillage vs. conventional tillage for spring wheat varieties.

VARIETIES	MIN-TILL (Kg/Ha)	BLUE CREEK (Kg/Ha)	FERTILIZER (Kg N/Ha)
Komar	4452.6	2367.6	67.3
Vic	5172.3	2286.8	67.3
906-R	3928.0	3161.2	95.3
Fremont	3161.2	2153.3	67.3
Bannock	2630.0	2340.8	67.3

Table 6. Evapotranspiration and water use efficiency of spring wheat varieties.

TREATMENT	EVAPOTRANSPIRATION (cm)	WATER USE EFFICIENCY (kg / ha cm)
Komar F0	25.1 a	174.9
Komar F1	32.0 e	335.0
Komar F2	32.5 e-f	307.7
Komar F3	33.5 e-h	388.4
Vic F1	33.0 e-g	209.4
906-R F1	35.8 i	167.6
Fremont F1	28.2 b-d	190.8
Bannock F1	27.7 b-c	223.5
CD Komar F1	27.2 b	230.9

* Means within a column followed by a common letter are not statistically different at the 5 percent level using least significant differences.

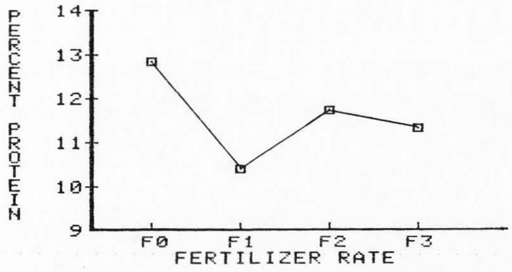

Figure 13. Protein % for spring wheat variety 906-R

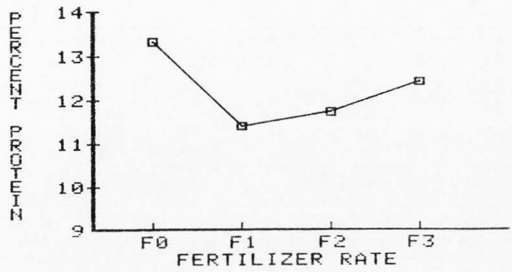

Figure 14. Protein % for spring wheat variety Fremont

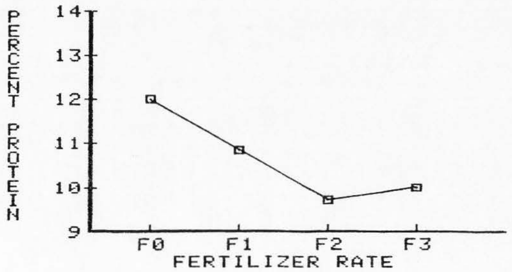

Figure 15. Protein % for spring wheat variety Bannock

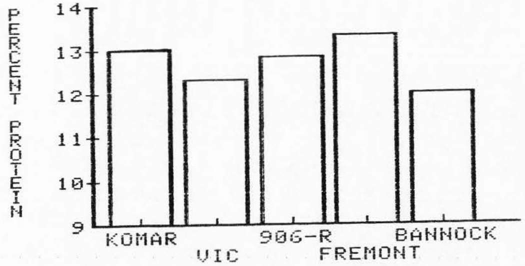

Figure 16. Spring wheat protein % comparison at f0

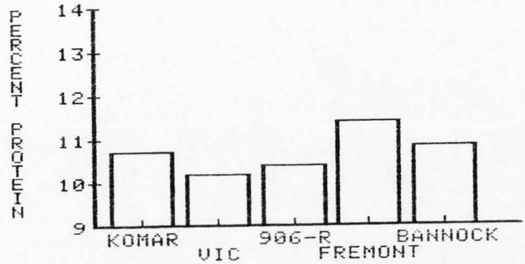

Figure 17. Spring wheat protein % comparison at f1

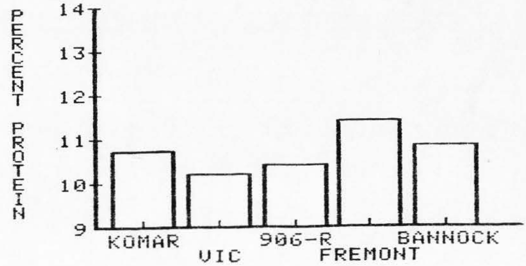

Figure 18. Spring wheat protein % comparison at f2

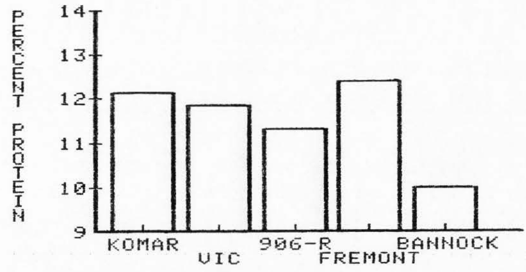

Figure 19. Spring wheat protein % comparison at f3

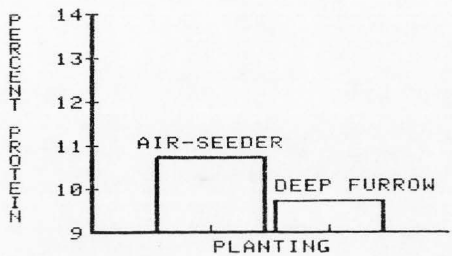

Figure 20. Conservation vs. conventional protein % comparison variety Komar

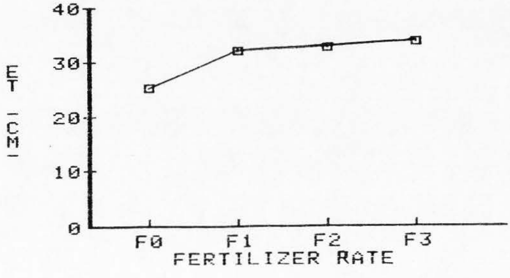

Figure 21. Evapotranspiration comparison for variety Komar

Most kernel weights showed a significant decrease, in weight, between the f0 and f1 fertilizer treatments, in each variety (Table 4). Variety Fremont showed a significant increase between the f0 and f1 treatments. It also showed a decrease from the f1 to f3 fertilizer treatments, as did all other varieties. This suggest that increased fertilizer tends to reduce seed weight, but increase seed number.

Very little significance was exhibited with increased fertilizer rates compared to decreased seed volume (Table 4). Fremont, an exception, showed a significant increase at each rate.

Table 4 also shows the bushel weight for each treatment. No significant difference was established for varieties: Komar; 906-R; and Bannock at the four fertilizer levels. Varieties Fremont and Vic did show a significance increase at one lower fertilizer level.

Analysis of Soil Water and Soil Temperature Measurements in the Spring Wheat Trial

Soil water use factors, evapotranspiration (ET) and water use efficiency (WUE) are shown in Table 6.

Figure 21 demonstrates a higher ET associated with higher fertilizer rates. This follows the yield factors of increased grain yield and dry matter for the same corresponding fertilizer rates.

When comparing all the spring varieties, at the f1 level,

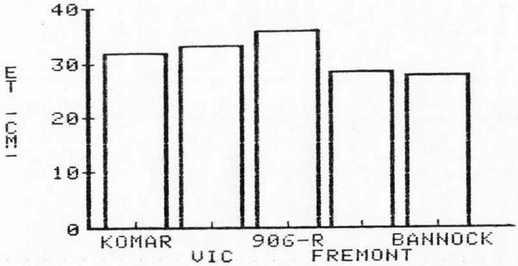

Figure 22. Evapotranspiration of spring wheat varieties at fl

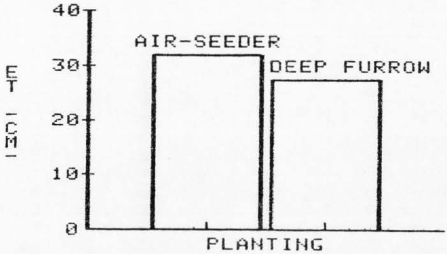

Figure 23. Conservation vs. conventional evapotranspiration comparison variety Komar

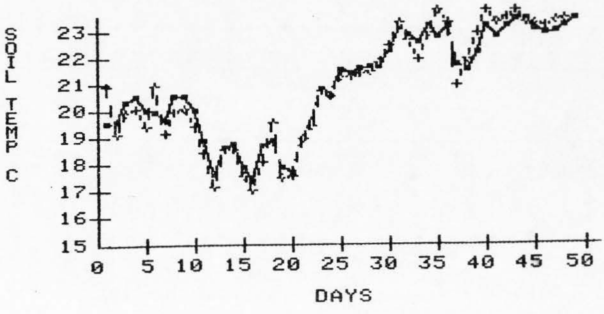

Figure 24. Conservation vs.conventional soil temperature comparison variety Komar

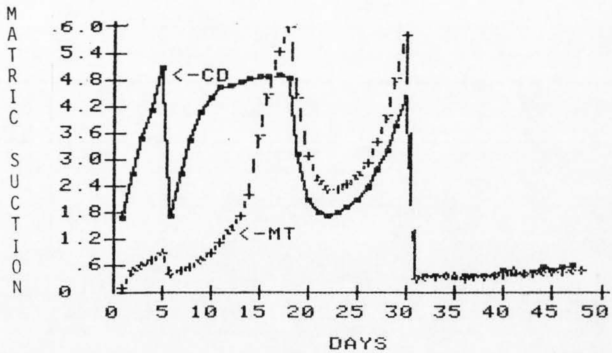

Figure 25. Conservation (MT) vs. conventional (CD) soil moisture (matric suction) comparison variety Komar.

the higher ET's were registered by the same varieties that produced the greatest yields (Figure 22).

There was no significant difference in ET between the conservation tillage and the conventional plots (Figure 23). However, a more efficient WUE is given for the conservation tillage plots over the coventional plots.

When analysing soil moisture recorded with the DP-222 in the conservation tillage and conventional plots there was no significance difference over the entire season. However, when observing Figure 24 a definite lower matric suction in the conservation tillage plot is shown earlier the growing season. Also the wetting fronts are not as sharp as the conventional plots, showing a more constant soil water condition. Later in the growing season the soil water content curves match rather closely.

Figure 25 shows a very close comparison of the soil temperatures for both the conservation tillage and conventional plots. There was no significance difference between the two plantings over the entire season. However, transient differences did occur.

Yield Response of Winter Wheat Varieties

The yield components of total dry matter, grain weight, and percent protein are given in Table 7. The yield components of kernel weight, kernel volume, and bushel weight are given in Table 8. This data represents the means of the ten harvest samples and is presented by variety and fertilizer rates.

Table. 7 Average grain yields, total dry matter, and percent protein for winter wheat varieties.

TREATMENT	GRAIN YIELD (Kg/Ha)	DRY MATTER (Kg/Ha)	% PROTEIN
TD MANNING f1	3171 t-u*	6758 j-m	10.2 a-f
TD MANNING f2	2784 n-u	6010 j-k	9.4 a
TD MANNING f3	3222 u	6808 j-n	10.4 b-e
TD JEFF f1	1836 b-g	4293 d-g	11.3 m
TD JEFF f2	2362 g-q	5572 j-n	11.8 m
TD JEFF f3	2054 c-l	4575 d-i	11.0 e-k
TD HANSEL f1	1876 b-h	4491 a-h	10.3 a-g
TD HANSEL f2	2241 d-p	5412 g-n	9.8 a-b
TD HANSEL f3	2616 l-t	6324 j-l	10.4 b-h
TD WESTON f1	861 a	1868 a	10.7 c-j
TD WESTON f2	1356 a-b	3100 b-c	10.3 a-g
TD WESTON f3	1356 a-b	2913 a-b	10.4 b-h
MANNING f0	2066 c-l	4686 d-g	10.2 a-f
MANNING f1	1737 b-e	4071 c-e	10.5 b-i
MANNING f2	1692 b-d	3966 b-c	10.4 b-h
MANNING f3	2449 i-r	5701 j-k	10.5 b-i
JEFF f0	3036 s-t	8060 o	11.1 e-l
JEFF f1	2248 d-n	6036 j-l	9.9 a-d
JEFF f2	2255 d-o	5537 j-k	9.9 a-d
JEFF f3	3154 t-u	7475 j-n	10.4 b-h
HANSEL f0	3018 s-u	6993 j-n	12.1 m
HANSEL f1	1757 b-f	4311 d-h	9.9 a-d
HANSEL f2	2000 c-j	4654 d-j	9.5 a-b
HANSEL f3	1901 b-i	4533 d-i	10.1 a-e
WESTON f0	2894 n-q	6379 j-l	12.0 m
WESTON f1	1637 b-c	3876 b-d	9.8 a-c
WESTON f2	2120 c-m	4743 d-h	10.1 -e
WESTON f3	2477 e-m	5720 j-k	11.1 e-l
CD WESTON f1	2036 c-k	4791 d-h	10.4 b-h

* Means within a column followed by a common letter are not statistically different at the 5 percent level using least significant differences.

Table 8. Average kernel weight, kernel volume, and bushel weight for winter wheat varieties.

TREATMENT	KERNEL WT. (grams)	KERNEL VOL. (cc)	BUSHEL WT. (lb/bu)
TD MANNING f1	.038 a*	.050 a	51.0 a
TD MANNING f2	.037 a	.050 a	58.0 b-f
TD MANNING f3	.039 a	.050 a	61.3 b-j
TD JEFF f1	.037 a	.045 a	65.1 j
TD JEFF f2	.036 a	.045 a	66.7 j
TD JEFF f3	.036 a	.045 a	63.5 e-j
TD HANSEL f1	.034 a	.040 a	65.6 j
TD HANSEL f2	.034 a	.040 a	65.2 j
TD HANSEL f3	.036 a	.045 a	62.5 c-j
TD WESTON f1	.037 a	.045 a	65.1 c-j
TD WESTON f2	.036 a	.050 a	55.3 a-b
TD WESTON f3	.038 a	.050 a	59.2 b-e
MANNING f0	.036 a	.047 a	60.8 b-j
MANNING f1	.036 a	.047 a	60.4 b-j
MANNING f2	.036 a	.047 a	59.7 b-e
MANNING f3	.037 a	.049 a	60.5 b-j
JEFF f0	.037 a	.050 a	59.2 b-e
JEFF f1	.036 a	.044 a	64.2 e-j
JEFF f2	.036 a	.047 a	59.4 b-e
JEFF f3	.040 a	.052 a	60.0 b-j
HANSEL f0	.037 a	.049 a	59.6 b-e
HANSEL f1	.033 a	.043 a	61.3 b-j
HANSEL f2	.033 a	.041 a	63.8 e-j
HANSEL f3	.034 a	.042 a	63.5 e-j
WESTON f0	.038 a	.053 a	56.3 a-c
WESTON f1	.038 a	.050 a	58.6 b-e
WESTON f2	.039 a	.053 a	57.8 b-e
WESTON f3	.041 a	.053 a	56.5 a-e
CD WESTON f1	.036 a	.048 a	59.1 b-e

* Means within a column followed by a common letter are not statistically different at the 5 percent level using least significant differences.

There was a significant difference in total dry matter production with increasing fertilization for all varieties but Hansel. However most of the significance was shown at the f0 and f3 fertilizer levels. No variety showed any significant increase at the f1 or f2 fertilizer levels. This negative or no response to increasing fertilization is probably accounted for in that snowmold (Calonectria graminicola, Typhus idahoensis) was heavely concentrated in the higher fertilizer rates. This reduced the potential stand and thus potential harvest.

There was very little evidence to support increasing total dry matter production with spring applied fertilizer (top dressed) when compared with fall applied deep-placed fertilizer. This, in part, could be tied to the entrapment of nitrogen by decomposing residue. This entrapment would not allow deeper penetration and utilization of this nutrient.

Table 7 shows differences within varieties of the differing fertilizer rates and the time and methods of application. Only the variety Manning showed significant increases in total dry matter with spring fertilizer applications. Hansel had significant increases for no fertilizer applied and the spring applied f3 fertilizer rate. Fall application of fertilizer was significantly higher than any spring treatments in both variety Jeff and Weston.

When yields are compared at corresponding fertility rates, Jeff is significantly higher at all levels. Hansel shows only a significant increase at the f0 fertilizer level and Weston at levels f0 and f2. No significant increase was shown for variety

Manning at any fertilizer level.

Figures 26-29 demonstrate the response of the winter wheat varieties to differing fertilizer rates on grain yields.

Unlike total dry matter production, significant differences due to fertilization were shown in each of the four varieties for grain yield.

Significance was established only on the f0 or f3 fertilizer rates for the varieties. The f1 and f2 fertilizer rates were consistently significantly lower in all varieties. Again snowmold (Calonectria graminicola, T. idahoensis) could be a possible explanation for this. Upon observing early spring growth, the higher fertilizer rates seemed more damaged then the f0 fertilizer rates. The f3 fertility level seemed to overcome the snowmold effects latter in the growing season, but the damage to yield had already occured.

When comparing yields at the same fertilizer rates, one variety, Jeff, is significantly higher at all levels. Figures 30-33 show this difference. At all fertilizer levels Manning was significantly lower then the other three varieties. Weston and Hansel were similar, being significantly higher at both the f1 and f2 levels.

The average production of winter wheat, in the state of Utah, over the past five years is 1882.4 kg/ha (28 bushel/acre), (Utah State Dept. of Ag. et al. 1982). The variety Jeff had yields higher than this at all fertility levels. With the exception of the f1 level in variety Weston, yields on all fertilizer levels were higher than the five year average. Only

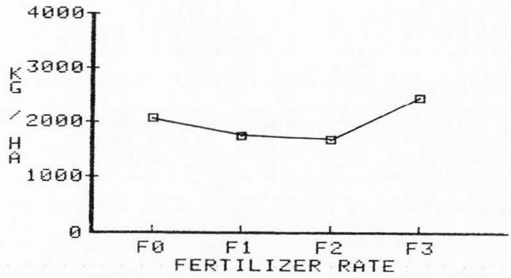

Figure 26. Grain yield for winter wheat variety Manning

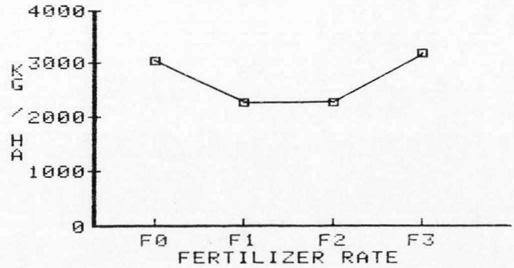

Figure 27. Grain yield for winter wheat variety Jeff

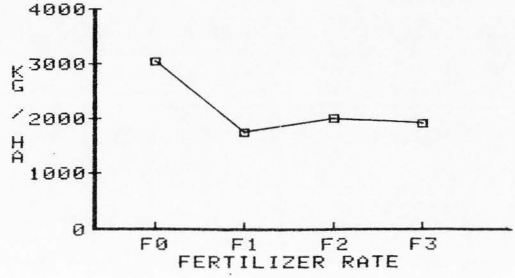

Figure 28. Grain yield for winter wheat variety Hansel

the f0 and f3 fertility levels, of variety Manning, were above the state average. Yields with Hansel fell below the state average only at the f1 fertility level.

Variety Weston, planted with the Melrow deep-furrow drill showed significant yield increase over the same variety when planted with the Prasco air-seeder (Figure 34).

There was no comparison of the grain yield of the winter wheatconservation tillage study to the nursery's trails of Utah State University. No comparable fertilizer application was done.

When comparing yield differences between the fall and spring fertilizer applications, there are no general trends. Overall the fall fertilizer treatments generally showed grain yield increases (Figures 35-38) over the spring treatments. Variety Hansel had one treatment for both spring and fall application with any significant difference. Both for variety Jeff and Weston no fall treatment was significantly higher in grain yield over spring applied treatments.

A significant decrease in protein was found for all varieties, except Manning, between the f0 fertility rate and all other rates (Figures 39-42).

When comparing between varieties at the same fertilizer rates no one variety was higher in protein overall (Figures 43-46). At the f0 fertilizer rate, Hansel and Weston had significantly higher protein contents, while at both the f1 and f2 fertilizer rates Manning was significanly higher. No significant difference was established amoung the varieties at the f2 level.

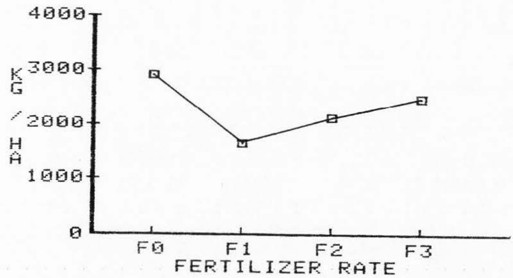

Figure 29. Grain yield for winter wheat variety Weston

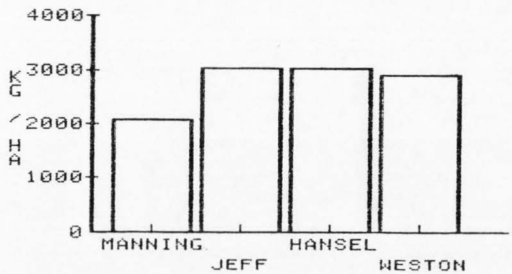

Figure 30. Winter wheat grain yield comparison at f0

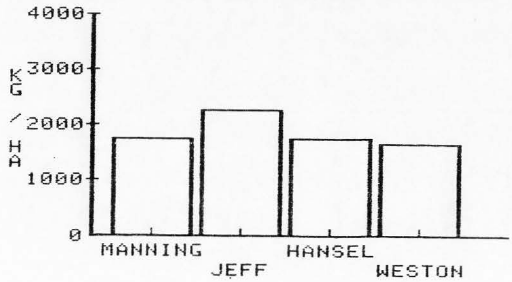

Figure 31. Winter wheat grain yield comparison at f1

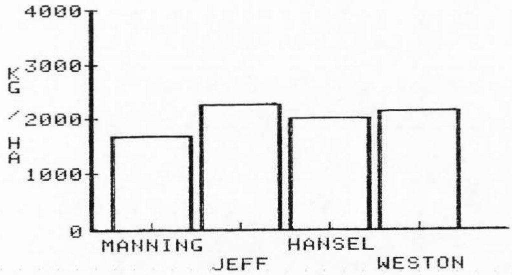

Figure 32. Winter wheat grain yield comparison at f2

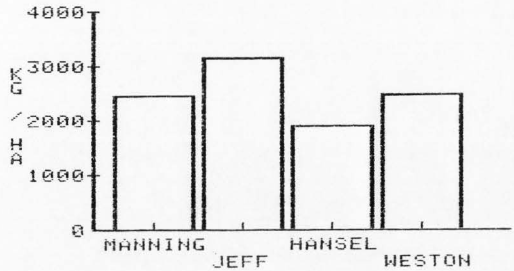

Figure 33. Winter wheat grain yield comparison at f3

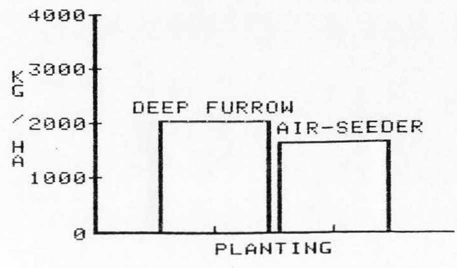

Figure 34. Conservation vs. conventioinal grain yield comparison variety Weston

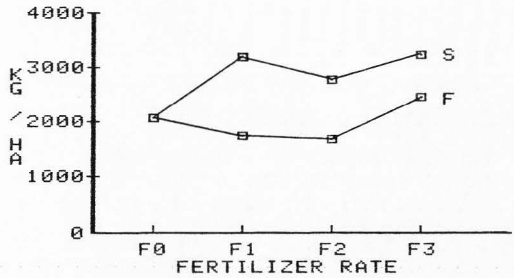

Figure 35. Fall vs. spring fertilizer application comparison of grain yield variety Manning

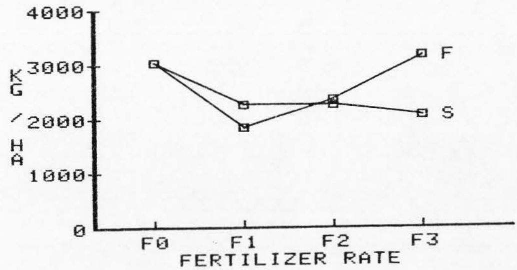

Figure 36. Fall vs. spring fertilizer application comparison of grain yield variety Jeff

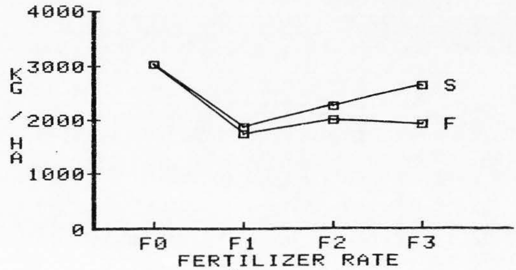

Figure 37. Fall vs. spring fertilizer application comparison of grain yield variety Hansel

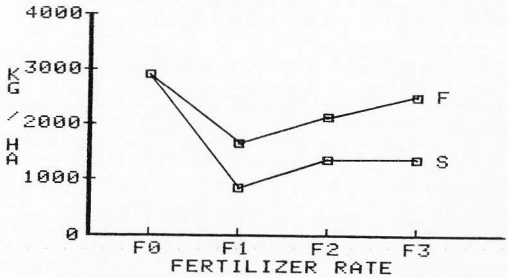

Figure 38. Fall vs. spring fertilizer application comparison of grain yield variety Weston

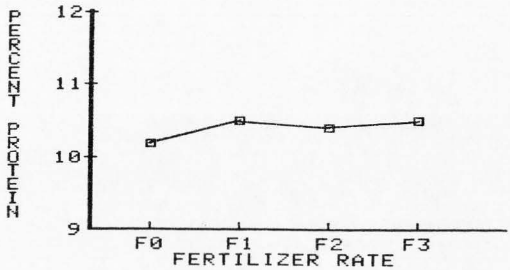

Figure 39. Protein % for winter wheat variety Manning

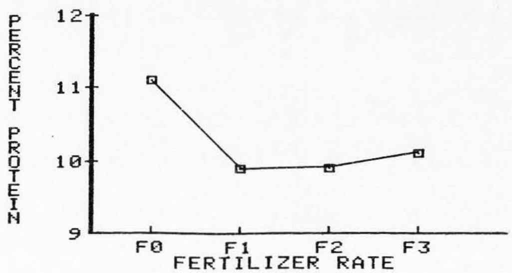

Figure 40. Protein % for winter wheat variety Jeff

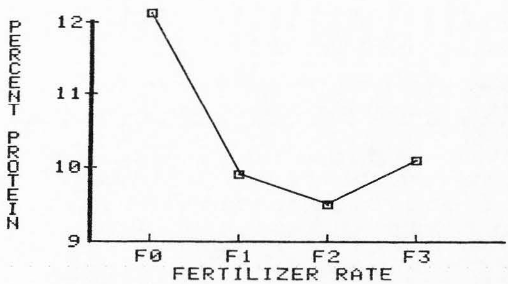

Figure 41. Protein % for winter wheat variety Hansel

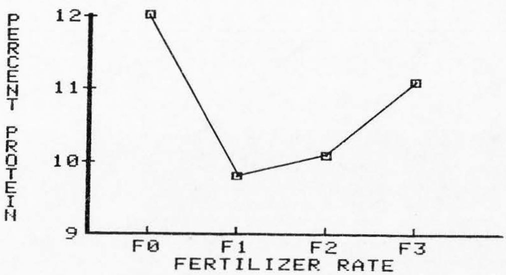

Figure 42. Protein % for winter wheat variety Weston

Figure 43. Winter wheat protein % comparison at f0

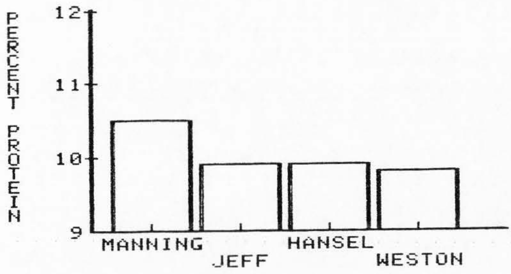

Figure 44. Winter wheat protein % comparison at f1

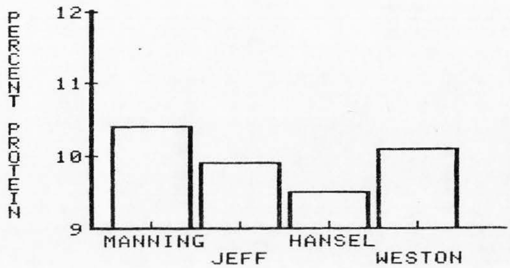

Figure 45. Winter wheat protein % comparison at f2

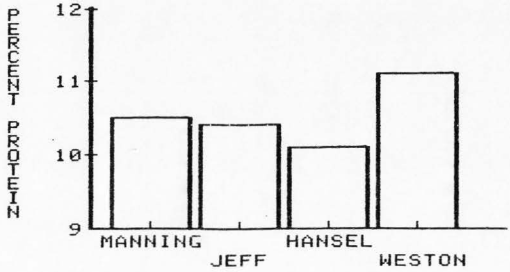

Figure 46. Winter wheat protein % comparison at f3

There was a significant increase in percent protein for the conventional deep-furrow drill planting, of variety Weston, over the air-seeded conservation tillage planting (Figure 47).

Differences in percent protein are varietial specific for fall and spring fertilizer applications (Figures 48-51). Variety Manning showed significant increases in protein for all fall applied rates, excluding the f0 fertility rate, and the spring rate of f3. Jeff showed almost the opposite result with significant increases in protein with all spring applied rates and the fall f0 treatment. Only the f0 fall treatment for variety Hansel showed any increased significant difference. This held true for variety Weston, with the exception of the f3 fall fertilizer treatment.

Total dry matter production was not influenced by type of planting. However, both grain yield and protein percent for the conventional deep-furrow planting was significantly higher than for the air-seeder planting.

There was generally no significant increase in kernel weights for any fertilizer rate, spring or fall applied (Table 8). Variety Jeff, the exception, showed significant increase at the fall applied f3 fertilizer level. There was also no difference in kernel weights with the air-seeder planting vs. the conventional deep-furrow planting.

The influence of fertilizer treatments on kernel volume was mixed, with no trend (Table 8). Two varieties, Manning and Weston had no significant differences at all. The spring top dressing seemed to increase kernel volume, (Table 8). All

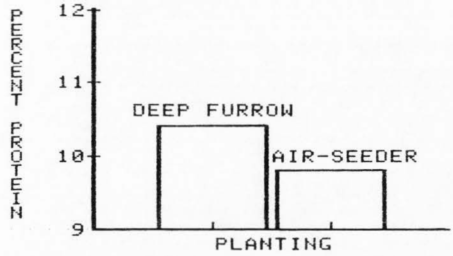

Figure 47. Conservation vs. conventional protein % comparison variety Weston

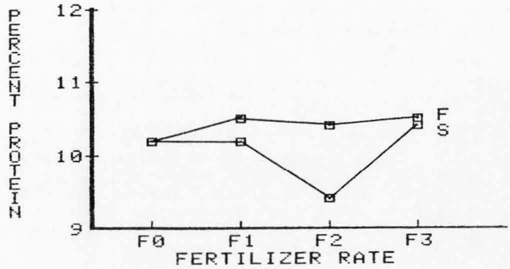

Figure 48. Fall vs. spring fertilizer application comparison of protein % in variety Manning

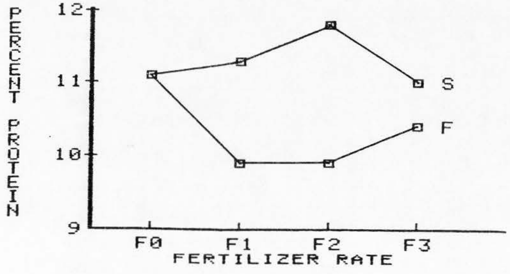

Figure 49. Fall vs. spring fertilizer application comparison of protein % in variety Jeff

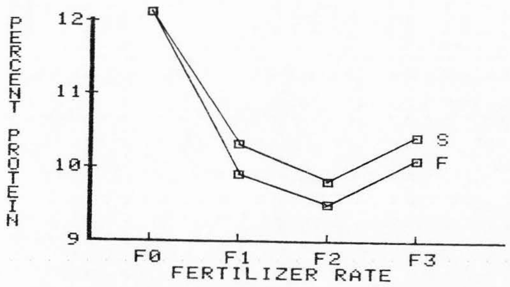

Figure 50. Fall vs. spring fertilizer application comparison of protein % in variety Hansel

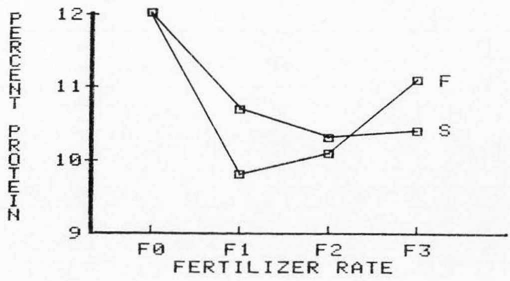

Figure 51. Fall vs. spring fertilizer application comparison of protein % in variety Weston

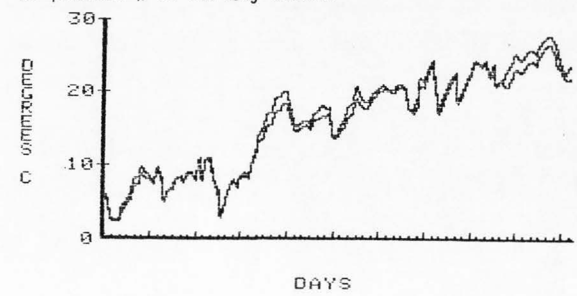

Figure 52. Conservation vs. conventional soil temperature comparison variety Weston

varieties had at least one spring treatment which was significantly higher in kernel volume than the fall fertilizer treatments. Varieties Manning and Jeff had all spring treatment significantly higher than fall treatments.

The fall applied Manning fertility treatments and the fl spring top dressed Weston had significant bushel weight or weight per unit volume differences. No significant difference in bushel weight was found amoung any the treatments when comparing varieties at all fall and spring fertility levels, Table 8.

Analysis of Soil Water and Soil Temperature Measurements in the Winter Wheat Trial

Soil water use factors, evapotranspiration (ET) and water use efficiency (WUE) are shown in Table 9.

Table 9 indicates a tendency to decrease ET with more fertilizer. This does not follow exactly what would be expected. Most varieties at the f3 (fall) fertilizer applied rate produced very near the f0 (fall applied) in both grain and total dry matter. However, at the f3 (fall) fertilizer applied rate it shows a better WUE than the f0 fall applied rate.

There was no significant difference between the ET for the air-seeded conservation tilllage and the conventional deep-furrow drill plots. A better WUE is shown for the conservation tillage plots.

No difference in soil temperature was shown between the conservation tillage plots and the conventional tillage plots

Table 9. Evapotranspiration and water use efficiency of winter wheat varieties.

TREATMENT	EVAPOTRANSPIRATION (cm)	WATER USE EFFICIENCY (kg / ha cm)
MANNING f0	50.3	93.2
MANNING f1	47.5	85.7
MANNING f2	40.1	98.9
MANNING f3	41.1	138.7
JEFF f0	49.0	164.5
JEFF f1	47.2	127.9
JEFF f2	46.5	119.1
JEFF f3	46.2	161.8
HANSEL f0	46.2	151.7
HANSEL f1	48.6	88.7
HANSEL f2	46.5	100.1
HANSEL f3	51.3	88.4
WESTON f0	50.8	125.6
WESTON f1	52.6	73.7
WESTON f2	44.5	106.6
WESTON f3	49.5	115.6
CD WESTON f1	53.9	88.9

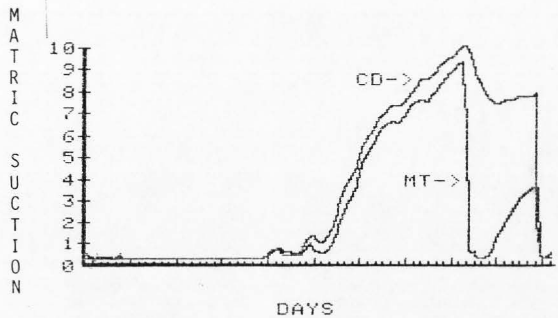

Figure 53. Conservation (MT) vs. conventional (CD) soil moisture (matric suction) comparison variety Weston.

(Figure 52).

When viewing Figure 53 a quicker and more substantial wetting curve was achieved in the latter part of the growing season by the conservation tillage plots. However, the conservation tillage and conventional plots showed no significant difference in soil matric suction when tested over the recorded season.

SUMMARY AND CONCLUSIONS

The major objectives of this project was to study yield factors of different varieties of spring and winter wheat (Triticum Aestivum) in a dryland conservation tillage system in Utah. When testing several spring wheat varieties, a significant difference in almost all yield components was found. Vic and Komar gave the higest yields in grain and percent protein with conservation tillage. The yield of all spring varieties was higher using conservation tillage than with conventional tillage planting methods, including yields taken at the Blue Creek Experimental Farm.

The winter wheat varieties showed less potential, than the spring variety trial, for increased yields due to conservation tillage in this experiment. There was no clearly significant difference between any of the winter wheat varieties. However, snowmold (Calonectria graminicola, T. idahoensis) problems confounded the data. It appeared that higher incidence of snowmold was always associated with high-residue conservation tillage areas.

The 1981-81 and 1982-83 water years, were the highest consecutive-year precipitation years in Utah's records. Thus, the true potential for any of the varieties tested in a dryland situation may not have been realistically tested. This increased moisture helped mask potential differences in the expected soil-water conserving aspects of both spring and winter wheat conservation tillage plantings. In the spring wheat tests the air-seeded conservation tillage variety showed greater yields than the conventionally planted variety. The inverse was true in the winter wheat plots. Conventional deep-furrow seeding on twice disked ground showed higher yields than did the air-seeded conservation tillage variety. However, the relative differences in the two winter wheat plantings were not as significantly different as compared to the spring varieties.

All spring wheat varieties showed a strong correlation between increased yields and increased fertilizer rates. No trend of this kind was shown with winter wheat. Snowmold infestation coupled with record precipitation resulted in confounding yield responses. There was no significant differences in yields due to fall or spring application of fertilizer for winter wheat. There may be a benefit to spring fertilization in normal years, but this study could not show it due to snowmold and high precipitation. Fall conservation tillage, for winter wheat, in areas susceptible to snowmold may be a poor practice because snowmold infestations may be greater as the amount of plant material on the soil surface increases.

It appears that the air-seeded conservation tillage can be used satisfactorly under carefully controlled circumstances in current spring wheat systems. Additional study is needed to define the limits of winter wheat conservation tillage systems.

SUGGESTIONS FOR FUTURE RESEARCH

Only one growing season was used in which to study varieties of both spring and winter wheat. This coupled with record precipitation and snowmold infestations made for a distorted picture of a normal dryland conditions. This prompts this suggestions.

1. Several years of varietial comparison are needed for both spring and winter wheat varieties under conservation tillage.

2. Fertilizer placement and application methods with nutrient movement and utilization under conservation tillage needs to be studied under a varietial comparison.

3. Amount of snowmold infestation correlated with surface residue amounts in a conservation tillage vs. conventional tillage experiment.

4. Varietial comparisons of no-till vs. min-till vs. conventionaltillage in dryland farming systems in various climatic regions in the state of Utah.

LITERATURE CITED

Albrechtsen, R. S. and W.G. Dewey. 1982. 1982 Small grains performance trails. Research Report 83, Utah Agricultural Experiment Station, Utah State University, Logan, Utah.

Boatwright, G. O., H. Ferguson, and J. R. Sims. 1976. Soil temperature around crown node influences early growth, nutrient uptake, and nutrient translocation of spring wheat. Agron. J. 68:227-231.

Brengle, K. G. 1982. Principles and practices of dryland farming. Colorado Associated University Press, Boulder, Colorado.

Brengle, K. G. and C. J. Whitfield. 1969. Effect of soil temperature on growth of spring wheat with and without wheat straw mulch. Agron. J. 61:377-379.

Burrows, W. C. and W. E. Larson. 1962. Effect of amount of mulch on soil temperature and early growth of corn. Agrom. J. 54:19-23.

Duley, F. L. and J. C. Russel. 1942. Effects of stubble mulching on soil erosion and runoff. Soil Sci. Soc. Am. Proc. 7:77-81.

Dubetz, S., G. C. Russell, and D.T. Anderson. 1963. Effect of soil temperature on seedling emergence. Can. J. Plant Sci. 42:481-487.

Gard, L. E., A. A. Klingebiel, and C. A. Van Doren. 1956. The effect of crop residue on soil and water lossed from corn and winter wheat. Soil. Sci. Am. Proc. 20:279-283.

Harder, R. W., C. C. Peterson, and W. A. Dowding. 1979. Soil Erosion Research, University of Idaho, unpublished data.

Johnson, C. B. and W. C. Moldenhauer. 1979. Effects of the chisel vs moldboard plowing on soil erosion by water. Soil Sci. Soc. Am. 43:177-179.

Kiddle, I. H., R. S. Staffer, and C. A. Van Doren. 1943. Effects on infiltration of surface mulches of soybean residues, corn stover, and wheat straw. Agr. Eng. 24:155-159.

Konke, H. and C. H. Werkhoven. 1963. Soil temperature and soil freezing as affected by organic mulch. Soil Sci. Am. Proc. 27:13-17.

Leikam, D. F., L. S. Murphy, D. E. Kissel, D. A. Whitney, and H. C. Moser. 1983. Effects of nitrogen and phosphorus application method and nitrogen source on winter wheat grain yield and tissue phosphorus. Soil Sci. Soc. Am. J. 47:530-535.

Mannering, J. V. and L. D. Meyer. 1961. The effect of different methods of cornstalk residue management on runoff and erosion as evaluated by simulated rainfall. Soil Sci. Soc. Am. Proc. 61:506-510.

McCalla, T. M. and T. J. Army. 1961. Stubble mulch farming. In Advances in Agronomy, vol. 13. A. G. Norman, Ed. Academic Press, Inc., New York, N. Y. pp. 125-196.

McDole, R. E. and S. Vira. 1980. Minimum tillage for soil erosion control under dryland crop production. University of Idaho, Current Information Series No. 523.

Miller, M. H., and A. J. Ohlrogge. 1958. Principles of nutrient uptake from fertilizer bands. I. Effect of placement of nitrogen fertilizer on the uptake of band-placed phosphorus at different soil phosphorus levels. Agron. J. 50:95-97.

Murphy, L. S. 1978a. Appling nitrogen and phosphorus at the same time into the same soil shows promise for winter wheat. Better Crops and Plant Food 62:16-22.

Murphy, L. S. 1978b. Dual application of nitrogen and phosphorus - better agronomics and economics. Fert. Solutions 22:4.

Parker, D. T. and W. E. Larson. 1962. Crop residue placement in soil and its effects upon growth of corn. Agrom. J. 54:263-267.

Phillips, S. H. and H. M. Young. 1973. No-till Farming. Reiman Associates, Inc., Mileaukee, WI.

Rasmussen. P. E., R. E. Ramig. and D. E. Wilkins. 1983. Wheat and barley fertilizer response in conservation tillage systems. Proc. 34th Annual NW Fertilizer Conference, Portland, Oregon, July 11-14, 1983.

Rasmussen, V. P. 1983. Personal Communication.

Rasmussen, V. P. and J. D. Walker. 1979. Comparison of snow-capture and water-use-efficienty in a no-till vs conventional tillage wheat crops. Ricks College, Minimum Tillage Field Day, Sept., 1979.

Romander, R. L. 1982. Tillage for The Times: Getting Down To Terms: Reduced and No Tillage Defined. Agrichemical Age, July, 1982.

Smika, D. E. and C. J. Whitfield. 1966. Effect of standing wheat stubble on storage on winter precipitaion. J. of Soil Water Conservation. 21:138-141.

Soil Conservation Society of America. 1979. Effects of tillage and crop residue removal on erosion, runoff, and plant nutrients. Soil Conservation Soc. of America Spec. Publ. No.25.

Soil Conservation Society of America. 1982. Resource Conservation Glossary. Soil Conservation Society of America, Ankeny, Iowa.

Staple, W. J., J. J. Lehane, and A. Wenhardt. 1960. Conservation of soil moisture from fall and winter precipitation. Can. J. Soil Sci. 40:80-88.

Thysell, J. C. 1983. Conservation and use of soil moisture at Mandan, N. Dakota. U.S.D.A. Tech Bull. 617.

U.S.D.A. 1974. Summer fallow in the Western United States. Conservation Research Report No. 17.

U.S.D.A., U.S.D.I., and Utah Agricultural Experimental Station. 1969. Soil Survey of Box Elder County, Utah, Eastern Part.

Utah State Department of Agriculture, U.S.D.A., and Utah Crop and Livestock Reporting Service. 1983. Utah Agricultural Statistics 1983.

Van Wijh, W. R., W. E. Larson, and W. C. Borroughs. 1959. Soil temperature around crown node influences early growth, nutrient uptake, and nutrient translocation of spring wheat. Agrom. J. 68:227-231.

Walker, J. 1982. A brief history of small grain minimum tillage. Ricks College, Minimum Tillage Series #430.

Walker, J. and V. P. Rasmussen. 1981. Reduced tillage management systems for irragated and dryland small grain crops in Southeastern Idaho. Final Project Report, Idaho Wheat Commission.

Walker, J., C. E. Blaser, and L. L. Stephens. 1982. Fertilizer placement necessary for top wheat and barley yields in minimum tillage, with the air seeder system. Ricks College, Minimum Tillage Series #443.

Widtsoe, J. A. 1919. Dry-farming. Macmillan Publishing Company, L. H. Baley ed., New York, NY. pp.98.

Wiser, A. 1982. Tillage for the Times: The History of No-till: Modern man comes full circle. Agrichemical Age, April, 1982.

APPENDIX

Table 10. Growth stages of spring wheat varieties.

Treatment	PD	T	B	H-S	H-C	H-D	HD
Komar f0	4/29	6/4	6/14	6/28	7/7	-	8/17
Komar f1	4/29	6/4	6/14	6/28	7/7	8/16	8/17
Komar f2	4/29	6/4	6/14	6/28	7/7	8/16	8/17
Komar f3	4/29	6/4	6/14	6/28	7/7	8/16	8/17
Vic f0	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Vic f1	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Vic f2	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Vic f3	4/29	6/4	6/22	6/28	7/7	8/16	8/17
906-R f0	4/29	6/4	6/22	6/28	7/7	8/16	8/17
906-R f1	4/29	6/4	6/22	6/28	7/7	8/16	8/17
906-R f2	4/29	6/4	6/22	6/28	7/7	8/16	8/17
906-R f3	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Fremont f0	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Fremont f1	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Fremont f2	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Fremont f3	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Bannock f0	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Bannock f1	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Bannock f2	4/29	6/4	6/22	6/28	7/7	8/16	8/17
Bannock f3	4/29	6/4	6/22	6/28	7/7	8/16	8/17
CDKomar f1	4/30	6/4	6/22	7/7	7/15	8/16	8/17

PD=planting date; T=tillering; B=booting; H-S=heading started; H-C=heading completed; H-D=hard dough; HD=harvest date; CDKomar=conventional drilled Komar

Table 11. Growth stages of winter wheat varieties.

Treatment	PD	T	B	H-S	H-C	H-D	HD
Manning f0	9/21	10/12	7/9	7/25	NR	8/5	8/13
Manning f1	9/21	10/12	7/9	7/25	NR	8/5	8/13
Manning f2	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Manning f3	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Jeff f0	9/21	10/12	7/9	7/25	NR	8/5	8/13
Jeff f1	9/21	10/12	7/9	7/25	NR	8/5	8/13
Jeff f2	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Jeff f3	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Hansel f0	9/21	10/12	7/9	7/25	NR	8/5	8/13
Hansel f1	9/21	10/12	7/9	7/25	NR	8/5	8/13
Hansel f2	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Hansel f3	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Weston f0	9/21	10/12	7/9	7/25	NR	8/5	8/13
Weston f1	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Weston f2	9/21	10/12	7/9	7/18	7/25	8/5	8/13
Weston f3	9/21	10/12	7/9	7/18	7/25	8/5	8/13
CDWeston f1	10/27	11/5	7/9	7/18	7/25	8/5	8/13

PD=planting date; T=tillering; B=booting; H-S=heading started; H-C=heading completed; H-D=hard dough; HD=harvest date; NR=no reading; CDWeston=conventional planted Weston

Table 12. Climatical data for spring wheat plots.

Date	Max.Temp. C	Min.Temp. C	Prec. cm
April 29	25.6	0.0	--
30	15.6	1.1	--
May 01	20.6	7.2	--
02	--	--	--
03	28.3	9.4	1.78
04	23.9	2.2	--
05	11.1	-4.4	--
06	16.7	-2.2	--
07	21.7	3.9	--
08	21.1	4.4	--
09	--	--	1.52
10	20.0	1.7	--
11	--	--	0.51
12	16.1	-0.6	--
13	16.7	0.0	--
14	--	--	--
15	17.2	3.9	--
16	--	--	T
17	23.9	5.0	--
18	24.4	10.0	0.51
19	22.8	6.1	1.02
20	17.8	1.7	--
21	--	--	--
22	28.9	4.4	--
23	18.3	0.6	--
24	22.2	5.6	--
25	21.1	5.6	--
26	27.8	10.0	--
27	29.4	6.7	--
28	15.0	-0.6	0.76
29	19.4	0.6	--
30	--	--	--
31	--	--	0.25
June 01	22.8	3.3	--
02	15.0	6.1	0.64
03	22.8	4.4	0.76
04	23.9	8.9	--
05	21.1	2.2	--
06	--	--	--
07	--	--	--
08	24.4	2.8	--
09	20.0	3.3	--
10	26.7	5.6	--
11	30.0	11.1	--
12	--	--	--
13	--	--	--

Table 12. Continued

Date		Max.Temp. C	Min.Temp. C	Prec. cm
	14	30.0	10.0	0.76
	15	23.9	11.1	T
	16	29.4	12.2	
	17	--	--	--
	18	30.0	9.4	--
	19	23.3	12.2	--
	20	--	--	--
	21	30.6	11.7	--
	22	32.2	12.8	--
	23	29.4	11.7	--
	24	30.0	13.3	--
	25	32.8	11.1	--
	26	31.1	10.0	--
	27	--	--	--
	28	32.8	15.6	--
	29	--	--	--
	30	32.8	16.1	--
July	01	24.4	10.0	--
	02	26.7	10.0	--
	03	--	--	--
	04	--	--	--
	05	27.8	7.2	--
	06	24.4	6.7	--
	07	28.9	13.3	0.25
	08	31.1	7.8	--
	09	28.9	8.3	3.05
	10	--	--	--
	11	--	--	--
	12	30.0	11.7	--
	13	32.8	20.0	--
	14	31.1	14.4	--
	15	31.1	12.8	--
	16	33.3	11.7	--
	17	29.4	12.2	--
	18	--	--	--
	19	32.8	13.3	--
	20	35.6	18.9	--
	21	36.1	18.3	--
	22	36.1	20.0	--
	23	36.1	20.6	--
	24	--	--	1.78
	25	30.6	13.9	--
	26	28.9	16.7	--
	27	32.2	18.9	T
	28	26.7	18.3	5.84
	29	24.4	15.6	0.51

Table 12. Continued

Date		Max.Temp. C	Min.Temp. C	Prec. cm
	30	26.7	13.3	--
	31	29.4	13.3	--
Aug.	01	--	--	--
	02	32.2	10.0	--
	03	28.3	17.2	--
	04	28.9	16.1	--
	05	31.1	13.3	--
	06	--	--	--
	07	33.3	14.4	--
	08	--	--	--
	09	34.4	16.7	--
	10	34.4	22.2	--
	11	35.6	21.1	--
	12	32.8	21.1	--
	13	--	--	--
	14	--	--	--
	15	29.4	18.3	--
	16	31.1	15.6	--

T= trace
(--) = no reading observed

Table 13. Climatical data for winter wheat plots

Date		Max.Temp. C	Min.Temp. C	Avg.Temp. C	Rad. Ly/day	Prec. cm
1982						
Oct.	06	--	--	--	--	10.80
	13	--	--	--	--	0.43
	27	--	--	--	--	3.30
Nov.	03	--	--	--	--	1.14
	19	--	--	--	--	3.43
	20	3.0	- 4.5	- 1.5	109.7	--
	21	2.0	-10.0	- 4.3	107.5	--
	22	0.0	-11.0	- 6.8	145.0	--
	23	- 3.5	-15.5	-10.2	165.0	--
	24	- 5.5	-14.0	-10.4	215.0	--
	25	3.0	- 6.5	- 2.6	140.0	--
	26	2.0	-10.0	- 3.2	177.5	--
	27	0.0	-11.0	- 6.1	155.0	--
	28	- 3.5	-13.0	- 8.9	107.4	--
	29	- 5.5	-13.5	-10.7	217.5	--
	30	- 5.0	-14.0	- 8.9	205.0	--
Dec.	01	- 0.5	-11.0	- 6.5	180.0	--
	02	- 2.0	-11.5	- 7.8	205.0	--
	03	1.0	-11.5	- 3.6	182.4	--
	04	1.0	- 3.5	- 1.6	27.5	3.47
	05	3.0	- 1.5	0.8	89.9	--
	06	0.0	- 1.0	- 0.6	00.0	--
	07	- 1.5	- 2.5	- 2.0	00.0	--
	08	- 1.5	- 4.5	- 3.1	00.0	--
	09	- 0.5	- 9.0	- 2.2	65.0	--
	10	0.5	- 8.5	- 2.9	145.0	--
	11	- 0.5	- 3.0	- 1.4	177.4	--
	12	3.0	- 3.0	- 0.3	165.0	--
	13	- 2.5	- 8.5	- 5.1	15.0	--
	14	- 7.5	-13.5	-10.5	190.0	--
	15	- 8.0	-14.0	-11.0	172.4	--
	16	- 6.5	-14.0	-11.1	182.4	--
	17	- 8.5	-15.5	-11.8	152.5	--
	18	- 4.0	- 7.5	- 5.6	89.9	1.32
	19	- 2.5	- 9.5	- 4.8	87.5	--
	20	- 3.5	- 8.5	- 5.3	125.0	--
	21	4.5	- 8.5	- 2.4	150.0	--
	22	- 1.5	-11.0	- 7.2	162.4	--
	23	1.0	-11.0	- 6.7	147.5	--
	24	4.0	- 8.5	- 0.7	97.5	--
	25	6.0	0.5	3.8	82.5	--
	26	4.5	0.0	1.2	52.5	--
	27	1.5	- 5.0	- 2.9	84.9	--
	28	- 3.5	-16.0	- 9.4	97.5	--
	29	- 8.5	-16.5	-13.1	189.9	1.80

Table 13. Continued.

Date		Max.Temp. C	Min.Temp. C	Avg.Temp. C	Rad. Ly/day	Prec. cm
	30	- 6.5	-12.0	- 8.0	97.5	--
	31	- 4.5	-19.5	-11.4	140.0	--
1983						
Jan.	01	-12.0	-20.0	-16.0	184.9	--
	02	- 2.0	-21.0	-17.1	157.5	--
	03	-13.0	-20.5	-17.4	172.4	--
	04	-13.0	-20.0	-17.0	180.0	--
	05	-12.5	-19.5	-16.5	185.0	--
	06	-11.0	-19.0	-14.7	177.4	--
	07	- 6.0	-11.0	- 7.8	105.0	--
	08	- 1.0	- 6.0	- 3.1	82.4	--
	09	4.5	- 0.5	2.2	122.5	--
	10	3.5	1.0	2.7	97.5	--
	11	2.0	0.5	1.0	57.5	--
	12	4.5	- 4.5	- 0.4	142.5	--
	13	2.0	- 6.5	- 3.6	142.5	--
	14	3.0	- 9.5	- 4.9	183.0	--
	15	4.0	- 9.5	- 4.9	207.5	--
	16	0.0	- 9.5	- 5.8	212.5	--
	17	- 0.5	- 8.0	- 5.2	210.0	--
	18	- 0.5	- 6.0	- 3.2	160.0	--
	19	- 0.5	- 2.5	- 1.0	89.9	--
	20	0.0	- 4.0	- 1.5	82.5	--
	21	0.0	- 4.0	- 1.8	84.9	--
	22	1.0	- 2.0	- 1.0	162.4	--
	23	0.0	- 5.5	- 2.3	120.0	--
	24	0.0	- 3.0	- 1.4	162.5	--
	25	1.0	- 7.0	- 3.3	175.0	--
	26	1.0	- 2.5	- 0.9	92.5	--
	27	1.0	- 4.5	- 1.8	100.0	--
	28	6.0	- 1.0	1.9	170.0	--
	29	6.0	- 1.5	1.4	112.5	--
	30	2.0	- 7.0	- 3.3	222.5	--
	31	- 0.5	- 4.5	- 1.8	107.5	--
Feb.	01	2.0	- 9.5	- 2.3	129.9	--
	02	- 1.5	- 8.0	- 4.5	197.5	--
	03	- 1.5	-11.5	- 5.7	182.4	--
	04	- 3.0	-14.5	-10.3	175.0	--
	05	- 5.0	-12.5	-10.2	140.0	--
	06	- 3.5	-16.0	- 9.1	235.0	--
	07	- 3.5	-17.0	-10.4	265.0	--
	08	- 0.5	-10.0	- 5.4	197.5	--
	09	0.5	- 5.5	- 2.8	155.0	3.12
	10	2.0	- 1.5	0.6	180.0	--
	11	--	--	--	--	--
	12	--	--	--	--	--

Table 13. Continued.

Date		Max.Temp. C	Min.Temp. C	Avg.Temp. C	Rad. Ly/day	Prec. cm
	13	--	--	--	--	--
	14	--	--	--	--	--
	15	--	--	--	--	--
	16	--	--	--	--	--
	17	4.0	- 5.5	- 1.9	255.0	--
	18	2.5	- 2.0	0.6	160.0	--
	19	7.5	- 1.0	1.9	142.5	--
	20	3.5	- 7.5	- 3.4	247.5	--
	21	5.0	- 4.5	- 1.8	287.4	--
	22	5.0	- 6.5	- 1.8	280.0	--
	23	2.5	- 6.5	- 2.4	245.0	--
	24	5.0	- 5.0	- 0.2	330.0	--
	25	7.0	- 0.5	2.8	345.0	--
	26	7.0	0.5	3.5	195.0	--
	27	2.5	- 3.0	0.0	130.0	--
	28	2.5	- 0.5	0.8	97.5	--
Mar.	01	5.5	1.5	3.2	167.5	--
	02	9.0	3.5	6.4	192.5	--
	03	9.0	1.0	4.7	275.0	--
	04	11.5	0.5	4.3	190.0	--
	05	7.0	1.0	3.9	152.5	--
	06	7.5	- 3.0	2.3	192.5	--
	07	6.5	- 2.0	1.8	140.0	--
	08	5.5	- 1.0	2.3	155.0	2.41
	09	9.5	2.5	5.2	279.9	--
	10	--	--	--	--	--
	11	15.0	2.5	8.2	317.4	--
	12	13.5	- 1.5	4.0	172.5	0.76
	13	10.0	4.0	6.2	277.4	--
	14	7.0	0.0	3.5	62.5	--
	15	4.5	- 3.5	- 1.2	282.4	--
	16	--	--	--	--	--
	17	--	--	--	--	--
	18	--	--	--	--	--
	19	--	--	--	--	--
	20	1.0	-11.0	- 5.5	310.0	--
	21	- 0.5	- 6.5	- 3.6	372.4	--
	22	5.5	- 1.5	1.5	378.4	--
	23	5.5	- 0.5	1.5	187.4	--
	24	0.0	- 8.0	- 3.5	192.5	--
	25	0.0	- 1.5	- 0.9	202.5	--
	26	3.0	- 2.0	0.2	300.0	--
	27	5.5	- 4.0	- 0.1	302.4	--
	28	5.5	- 6.0	- 1.0	212.5	--
	29	4.0	- 4.0	- 0.8	345.0	3.94
	30	11.0	4.0	6.0	305.0	--

Table 13. Continued.

Date		Max.Temp. C	Min.Temp. C	Ave.Temp. C	Rad. Ly/day	Prec. cm
	31	13.0	1.0	7.8	270.0	--
Apr.	01	6.0	- 3.5	0.2	205.0	--
	02	11.0	- 2.5	1.8	280.0	--
	03	7.0	- 3.5	- 3.5	180.0	--
	04	-2.0	- 5.5	- 3.6	165.0	--
	05	2.0	- 5.5	- 2.6	402.4	--
	06	--	--	--	--	--
	07	13.0	2.5	7.3	382.4	--
	08	5.0	- 2.0	1.1	144.9	0.71
	09	3.5	- 4.0	0.0	185.0	--
	10	2.0	- 2.5	- 2.5	187.5	--
	11	3.5	- 7.5	- 2.4	504.9	--
	12	--	--	--	--	--
	13	--	--	--	--	--
	14	--	--	--	--	--
	15	--	--	--	--	--
	16	--	--	--	--	--
	17	13.0	2.5	7.3	502.4	2.92
	18	5.0	- 5.0	1.1	389.9	--
	19	3.5	- 4.0	0.0	192.5	--
	20	2.0	- 5.5	- 2.5	317.4	--
	21	3.5	- 7.5	- 2.4	200.0	--
	22	15.5	- 4.0	3.0	377.4	--
	23	15.0	4.0	8.3	357.4	--
	24	13.5	3.5	5.2	262.4	--
	25	16.5	2.0	8.5	372.4	--
	26	15.0	- 6.0	3.7	417.4	--
	27	8.0	- 6.5	3.1	492.0	--
	28	13.5	0.5	6.7	600.0	--
	29	9.0	3.0	5.5	588.6	--
	30	11.0	0.5	5.7	597.8	--
May	01	15.5	0.5	7.3	551.0	--
	02	--	--	--	--	--
	03	--	--	--	--	--
	04	--	--	--	--	--
	05	--	--	--	--	--
	06	--	--	--	--	--
	07	14.5	- 0.5	5.8	542.4	--
	08	17.0	6.0	11.0	609.9	9.47
	09	17.5	0.5	6.1	537.4	--
	10	6.5	- 3.0	1.3	374.9	--
	11	4.5	- 0.5	1.0	77.5	0.62
	12	--	--	--	--	--
	13	--	--	--	--	--
	14	--	--	--	--	--
	15	--	--	--	--	--

Table 13. Continued.

Date		Max.Temp. C	Min.Temp. C	Avg.Temp. C	Rad. Ly/day	Prec. cm
	16	--	--	--	--	--
	17	--	--	--	--	--
	18	--	--	--	--	--
	19	--	--	--	--	--
	20	--	--	--	--	--
	21	--	--	--	--	--
	22	--	--	--	--	--
	23	--	--	--	--	--
	24	--	--	--	--	--
	25	--	--	--	--	--
	26	--	--	--	--	--
	27	--	--	--	--	--
	28	--	--	--	--	--
	29	28.5	9.5	18.4	689.9	2.95
	30	23.0	11.5	17.6	587.4	--
	31	27.5	13.5	19.1	589.9	--
Jun.	01	19.5	9.0	12.1	287.4	--
	02	17.5	6.0	11.6	467.4	--
	03	17.0	6.0	11.5	509.9	--
	04	20.0	5.0	12.3	614.9	--
	05	17.0	11.0	12.3	235.0	--
	06	19.5	6.0	12.0	629.9	--
	07	19.5	8.5	13.7	622.4	--
	08	22.0	6.5	13.8	689.9	--
	09	23.0	9.0	15.1	492.4	1.96
	10	22.0	9.0	14.2	307.4	--
	11	24.5	7.0	15.2	674.9	--
	12	24.5	9.5	13.2	130.0	--
	13	13.5	2.5	7.9	479.9	--
	14	16.0	4.0	8.6	569.9	1.27
	15	19.0	2.5	10.3	684.9	--
	16	23.0	5.0	13.1	614.8	--
	17	21.5	6.0	14.6	677.4	--
	18	26.5	6.0	15.0	684.9	--
	19	27.0	13.5	20.0	682.4	--
	20	21.5	4.5	14.1	689.9	--
	21	22.5	4.0	13.1	614.9	--
	22	22.0	7.0	14.3	582.4	--
	23	27.5	9.0	17.1	674.9	--
	24	28.5	8.0	19.2	554.9	--
	25	27.5	13.0	20.5	537.4	--
	26	27.5	11.0	18.6	582.4	--
	27	27.5	14.0	19.6	482.4	--
	28	25.5	3.5	14.5	632.4	--
	29	24.0	8.5	15.7	607.4	--
	30	26.5	12.5	18.8	504.9	--

Table 13. Continued.

Date		Max.Temp. C	Min.Temp. C	Avg.Temp. C	Rad. Ly/day	Prec. cm
July	01	25.0	12.0	17.6	557.4	--
	02	25.5	11.0	16.9	617.9	--
	03	17.5	4.5	12.0	422.4	--
	04	19.5	3.0	11.7	694.9	--
	05	25.5	9.0	16.5	689.9	--
	06	33.0	12.0	22.5	669.9	1.67
	07	31.0	13.0	21.7	429.9	--
	08	33.0	17.5	25.6	572.4	--
	09	31.5	16.5	24.6	597.4	--
	10	27.5	4.5	12.8	437.4	--
	11	16.5	3.5	10.5	552.4	1.02
	12	24.0	9.0	15.9	674.9	--
	13	27.5	10.0	18.1	672.4	--
	14	32.0	10.5	21.2	766.4	--
	15	32.5	10.0	19.6	579.9	--
	16	19.0	6.5	13.1	437.4	--
	17	25.0	6.5	16.7	652.3	--
	18	30.5	8.5	20.8	652.4	0.33
	19	33,5	13.5	23.2	642,4	--
	20	32.5	19.0	26.7	649.9	--
	21	30.0	9.5	19.9	642.4	--
	22	29.0	16.5	22.0	539.9	--
	23	29.5	15.0	21.7	579.9	--
	24	27.0	13.5	18.9	584.9	--
	25	31.0	16.5	23.2	512.4	--
	26	25.0	16.0	19.8	399.9	3.81
	27	29.0	11.0	19.9	634.9	--
	28	28.5	11.0	19.3	652.4	--
	29	30.5	13.0	21.3	647.4	--
	30	43.0	14.5	22.8	629.9	--
	31	34.5	17.0	23.5	387.4	--
Aug.	01	27.5	16.5	21.5	469.9	--
	02	29.5	12.5	21.0	589.9	--
	03	30.5	13.5	22.1	599.9	--
	04	31.0	14.5	21.8	457.4	--
	05	34.5	16.0	23.3	604.8	--
	06	35.5	18.0	25.6	599.9	--
	07	35.5	17.0	26.0	517.4	--
	08	33.5	17.0	25.9	527.4	--
	09	34.0	16.5	23.6	557.9	0.97
	10	32.0	17.5	24.1	589.4	--
	11	33.0	15.5	22.0	512.4	2.79
	12	27.5	14.0	20.3	589.9	--
	13	30.0	12.0	19.7	574.9	--

(--) = no reading observed

Table 14. Analysis of variance of spring wheat data

SOURCE	DF	MS	F-TEST	F (.05)	LSD (.05)	REMARKS
		DRY MATTER PRODUCTION VARIETY KOMAR				
Treatment	3	723582	120	3.24	114	S
Error	16	6077				
		DRY MATTER PRODUCTION VARIETY VIC				
Treatment	3	810241	206	3.24	91	S
Error	16	3923				
		DRY MATTER PRODUCTION VARIETY 906-R				
Treatment	3	349565	238	3.24	56	S
Error	16	1469				
		DRY MATTER PRODUCTION VARIETY FREMONT				
Treatment	3	342038	89	3.24	91	S
Error	16	3862				
		DRY MATTER PRODUCTION VARIETY BANNOCK				
Treatment	3	156532	29	3.24	107	S
Error	16	5370				
		GRAIN YIELD FOR VARIETY KOMAR				
Treatment	3	85113	59	3.24	36	S
Error	16	1432				
		GRAIN YIELD FOR VARIETY VIC				
Treatment	3	130242	38	3.24	85	S
Error	16	3388				
		GRAIN YIELD FOR VARIETY 906-R				
Treatment	3	24251	81	3.24	25	S
Error	16	301				
		GRAIN YIELD FOR VARIETY FREMONT				
Treatment	3	51524	81	3.24	37	S
Error	16	634				

Table 14. Continued

SOURCE	DF	MS	F-TEST	F(.05)	LSD (.05)	REMARKS
		GRAIN YIELD FOR VARIETY BANNOCK				
Treatment	3	18452	16	3.24	50	S
Error	16	1173				
		VARIETIAL COMAPRISON AT FRETILIZER LEVEL f0				
Treatment	4	1267	3.1	2.87	4	S
Error	20	407				
		VARIETIAL COMPARISON AT FERTILIZER LEVEL f1				
Treatment	4	25331	36	2.87	6	S
Error	20	705				
		VARIETIAL COMPARISON AT FERTILIZER LEVEL f2				
Treatment	4	17317	5	2.87	12	S
Error	20	3307				
		VARIETIAL COMPARISON AT FERTILIZER LEVEL f3				
Treatment	4	68403	86	2.87	6	S
Error	20	798				
		CONSERVATION GRAIN COMPARISON VS CONVENTIONAL				
Treatment	1	52897	46	5.32	8	S
Error	8	1144				
		PRECENT PROTIEN FOR VARIETY KOMAR				
Treatment	3	15.7	17	2.66	0.9	S
Error	36	0.9				
		PRECENT PROTIEN FOR VARIETY VIC				
Treatment	3	8.9	10	2.66	0.8	S
Error	36	0.9				
		PERCENT PROTIEN FOR VARIETY 906-R				
Treatment	3	10.0	24	2.66	0.6	S
Error	36	0.4				

Table 14. Continued

SOURCE	DF	MS	F-TEST	F (.05)	LSD (.05)	REMARKS
		PERCENT PROTIEN FOR VARIETY FREMONT				
Treatment	3	7.5	11	2.66	0.7	S
Error	36	0.7				
		PERCENT PROTIEN FOR VARIETY BANNOCK				
Treatment	3	11.0	26	2.66	0.5	S
Error	36	0.4				
		VARIETIAL COMPARISON OF PROTIEN AT FERTILIZER LEVEL f0				
Treatment	4	2.7	8	2.59	0.5	S
Error	45	0.3				
		VARIETIAL COMPARISON OF PROTIEN AT FERTILIZER LEVEL f1				
Treatment	4	2.1	2.1	2.59	0.9	NS
Error	45	1.0				
		VARIETIAL COMAPRISON OF PROTEIN AT FERTILIZER LEVEL f2				
Treatment	4	7.5	12	2.59	0.7	S
Error	45	0.6				
		VARIETIAL COMPARISON OF PROTIEN AT FERTILIZER LEVEL f3				
Treatment	4	9.6	3.7	2.59	1.5	S
Error	45	2.6				
		CONSERVATION PROTIEN COMPARISON VS CONVENTIONAL				
Treatment	1	6.3	4.7	2.59	1.0	S
Error	18	1.4				
		VARIETIAL COMPARISON OF ET AT FERTILIZER LEVEL f1				
Treatment	8	44.6	12.6	2.51	1.4	S
Error	18	7.9				
		CONSERVATION ET COMPARISON VS CONVENTIONAL				
Treatment	1	4.9	28.4	7.71	4.3	S
Error	4	0.2				