
WHEAT PRODUCTION SYSTEMS FOR SOUTHWESTERN NORTH DAKOTA

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SUMMARY

The wheat-black fallow rotation has been used extensively as a production strategy for spring wheat in western North Dakota and throughout the Great Plains. There are several benefits the black fallow period provides: organic nitrogen can be mineralized, weeds can be mechanically controlled, soil water recharge can occur, and crop loss risk can be reduced and farm income stabilized (Smika, 1970). Along with these benefits have come costs, including the formation of saline seeps, uncontrolled wind and water erosion, and reduced soil nutrient levels over time (Haas et al., 1957; Halvorson and Black, 1974). Moreover, the idling of productive land in a wheat-black fallow rotation has raised economic efficiency questions (Ali and Johnson, 1981). Soil conservation mandates, as exemplified by the Conservation Compliance Provision of the 1985 Farm Bill, suggest that alternatives to the wheat-black fallow rotation must be developed for the long-term viability of wheat production in North Dakota.

OBJECTIVES

1. Determine if a cultivar by seeding rate interaction exists across wheat-black fallow, wheat-ecofallow, and wheat-chemical fallow systems.
2. Evaluate N fertilizer and N fertilizer by fungicide interactions for tan spot suppression, grain yield and phenotypic response in a continuous wheat monoculture across conventional-, reduced-, and no-tillage

environments.
3. Compare the agronomic performance of several spring wheat cultivars across wheat-black fallow, wheat-wheat, and wheat-corn rotations.

INTRODUCTION

Objective 1

Most hard red spring wheat is sown on black-, eco-, and chemical-fallow in the Southwest. Generally several cultivars are sown each year, depending on seed costs, seed availability, and other factors (Solemaas, ASCS, per. comm.). A cultivar by tillage system (C by TS) interaction has not been considered across fallow environments even though a C by TS interaction has been reported across recropped environments (Ciha, 1982). Knowledge of a C by TS interaction across different fallow environments would aid producers in selecting cultivars best suited to their fallow management strategies. Also needed is information on whether seeding rates (SR) should be adjusted according to the cultivar and tillage system used. Knowledge about C by TS and C by TS by SR interactions might result in more efficient spring wheat production in reduced- and no-till systems.

Objective 2

An alternative to a spring wheat-black fallow rotation is to grow wheat continuously. A benefit of continuous wheat compared to alternating wheat and fallow is that productive land is not idled. However, Tan Spot (incited by *Pyrenophora tritici-repentis* [Died.] Drechs.) can be a major pest in continuous wheat systems because this fungus overwinters in crop stubble. Tan spot and other fungal infestations can be accentuated in reduced-till and no-till systems. These fungi must be controlled for profitable wheat production.

Nitrogen (N) fertilizer applications have sometimes reduced outbreaks of tan spot in winter wheat (Huber et al., 1987), but the ability of N applications to suppress tan spot in spring wheat has not been demonstrated. Similarly, N fertilizer by tillage system interactions have not been identified regarding tan spot. Knowledge about these interactions would support profitable production in fields where wheat is grown during two or more continuous years.

Objective 3

Spring wheat cultivars respond differently in contrasting environments. It is unclear how wheat grain yield and quality, and other phenotypic characteristics, are influenced by cropping sequence. North Dakota producers need this information as they explore alternatives to black fallow in a wheat-black fallow rotation. Understanding the cultivar by crop rotation interaction is needed to explain why crop yields vary in regions of the state where rotations differ.

MATERIALS AND METHODS

Objective 1

A field experiment was conducted under dryland conditions at Dickinson in 1994. Plots were arranged in a modified randomized complete block design in a split split-plot arrangement. Tillage system comprised main plots, seeding rate comprised subplots, and spring wheat cultivar comprised sub-subplots. Tillage systems included: (1) conventional-till (spring disking and leveling with a cultivator and culti-harrow until less than 5% of residue remains at the soil surface at planting); (2) reduced-till (leveling with a cultivator and culti-harrow in attempts to maintain between 30%-60% of residue at planting); and (3) no-till (direct sowing into standing stubble). Subplots consisted of seeding rates of 750,000, 1,000,000, and 1,500,000 PLS per acre. Sub-subplots consisted of 2 conventional height (AC Minto, Amidon) and 3 semidwarf (Bergen, Grandin, Norm) spring wheat cultivars representing a range of genotypes and phenotypes presently grown in the Northern Great Plains Region.

Both phases of each tillage system (crop and fallow) were established and will be maintained throughout the trial's duration. As a result, 50% of the space allocated for plots was not be planted in 1994 (i.e., fallow plots); weeds in these plots were either mechanically controlled (conventional-till), controlled both mechanically and with herbicides (reduced-till), or controlled solely using herbicides (no-till).

Main plots were 4500 square feet (90 by 50 ft). There were 6 main plots per replicate and four replicates in the experiment. Sub-subplot dimensions were 50 by 6 ft.

Plant nutrients were supplied as needed for a grain yield goal of 60 bu per acre, based on soil test results.

Postemergent herbicides were used during the crop phase in conventional- and reduced-till systems to control weeds. In the fallow plots, mechanical cultivation was used to control weeds in the conventional-till system. Two herbicide applications and a light disking were used in the reduced-till system. Non-incorporated herbicides were used in the no-till system.

Variables measured on each cropped plot included: number of plants at emergence, plant height, grain yield, 100 seed weight, grain volume weight, and grain protein content. Number of tillers at the six-leaf stage and at maturity were counted.

Data were analyzed using a computer-driven statistical program.

Objective 2

The experiment was arranged in a randomized complete block design in a split split-plot arrangement. Tillage system comprised main plots, fungicide treatment comprised subplots, and N applications comprised sub-subplots. Tillage systems were established as described for Objective 1.

A single application of mancozeb at 1.0 lb a.i per acre along with a control (no fungicide) constituted subplot treatments. Applications of mancozeb at this rate may be economical in western North Dakota if severe tan spot infestations exist. The fungicide treatment was also used to assess if applications of N fertilizer were effective in suppressing tan spot.

Nitrogen as ammonium nitrate was applied, based on soil test results, at high and low rates. The high rate corresponded to a fertilizer plus soil N amount of 100 lbs N per acre and the low rate to 50 lbs N per acre.

Main plots were 2200 square ft. Sub-subplot dimensions were 55 by 10 ft. There were four replicates.

The following variables were measured on each plot: foliar leaf spotting at anthesis, plant height, grain yield, 1000 seed weight, and grain volume weight. Data were analyzed using a computer-driven statistical program.

Objective 3

The experiment was arranged in a modified randomized complete block design in a split-plot arrangement. Cropping sequence comprised main plots and consisted of wheat-black fallow, wheat-wheat, and wheat-corn rotations. Five conventional-height and five semidwarf spring wheat cultivars comprised subplots treatments.

Both phases of wheat-black fallow and wheat-corn rotations were established in 1994 and will be maintained throughout the trial's duration. Hence, two main plots will be maintained each year for both rotations. By having both phases represented each year, wheat grain yield and quality data will be generated annually by each rotation. These data can then be compared with that produced by the wheat-wheat rotation each year the experiment is conducted.

Main plots were 1680 square feet. There were five main plots per replicate (two each for both wheat-black fallow and wheat-corn rotations and one for the wheat-wheat rotation). There were four replicates. Subplot dimensions were 6 by 28 ft.

Variables measured on each plot included: plant height, grain yield, 1000 seed weight, grain volume weight, and grain protein content.

The data were analyzed using a computer-driven statistical program.

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RESULTS

Objective 1

Seeding wheat at 500,000 PLS per acre resulted in a lower grain yield with lighter test weight than seeding wheat at either 1,000,000 or 1,500,000 PLS per acre. Seeding wheat at 1,500,000 PLS per acre tended to produce more grain with heavier test weight than seeding wheat at 1,000,000 PLS per acre, except in a reduced-tillage environment.

Successfully establishment of plants, on the basis of planted seed, was much lower (average = 56%) than expected (80%). This low success rate of establishment can partially be explained by the poor quality of the seed that was sown. Seed used in 1994 was small and, in some instances, infected with scab and other fungal pathogens as a result of environmental conditions in 1993, when the seed was produced. Better quality seed than what was used was not available.

The data reveal that the success at establishing plants was more difficult in no-till compared to conventional-tillage seedbeds. A no-till research seeder was used across each tillage system. This trial will be continued over the next three years.

Objective 2

Applications of mancozeb have failed to significantly reduce leaf spotting in the two years this trial has been conducted, although incidence of leaf spotting tended to be less when fungicide was applied in 1994 than when it was not. Similarly, tillage environment has failed to affect grain yield in both years. Application of N fertilizer did increase grain yield in 1994; it is unknown whether similar results would have occurred in 1993 since soil N levels were high without applying fertilizer.

Some results have been inconsistent in the two years this trial has been conducted. Leaf spotting was most prominent on plants in a reduced-till environment in 1993, while in 1994 leaf spotting was not significantly different across the three tillage environments. Grain produced by plants in a conventional-tillage environment had lighter test weight than that produced in reduced- or no-till environments in 1994 but not in 1993. The tillage by fungicide interaction was significant in 1993 but not in 1994. These data reveal that this trial should be continued so more definitive conclusions can be reached.

Objective 3

More grain yield was produced when wheat followed corn or fallow than when wheat followed wheat. This probably was explained by the higher incidence of tan spot and septoria that was observed in the wheat plots following wheat than those following corn or fallow. Grain yield was comparable when wheat was recropped after corn compared to following fallow.

Wheat varieties responded differently across the crop sequences. In 1994, grain yield of the conventional-height varieties (AC Minto, Amidon, Butte 86, Sharp, and Stoa) tended to be slightly elevated following fallow compared to that following corn, whereas that of the semidwarf varieties (Bergen, Grandin, Hi Line, Norm, and 2371) was not. Yield tended to be less in a wheat-wheat sequence compared to a wheat-fallow sequence for all varieties except Bergen and Grandin. These trial will be continued over the next three years so more definitive conclusions can be made about the relative performance of selected wheat varieties across alternative cropping sequences.

Spring Wheat Variety by Seeding Rate by Tillage System Trial -- Dickinson, ND, 1994					
	Tillage	Established plants number/acre	Established success % of planted	Yield bu/ac	Test weight lbs/bu
	Conventional	587,004	59	48.7	60.3

	Reduced-till	559,521	56	43.6	58.7
	No-till	542,267	54	48.6	59.3
Seeding rate PLS/acre					
500,000	Conventional	269,719	54	43.6	59.6
500,000	Reduced-till	263.025	53	38.9	58.1
500,000	No-till	259,270	52	41.4	59.1
1,000,000	Conventional	626,950	63	47.8	60.4
1,000,000	Reduced-till	580,256	58	47.4	59.2
1,000,000	No-till	540,744	54	49.3	59.4
1,500,000	Conventional	864,343	58	54.7	60.7
1,500,000	Reduced-till	865,281	56	44.3	58.8
1,500,000	No-till	826,791	55	55.0	59.6
Varieties					
AC Minto	Conventional	872,942	87	46.7	59.8
	Reduced-till	724,639	72	42.4	58.7
	No-till	752,939	75	48.1	59.0
Amidon	Conventional	568,990	57	51.2	60.7

	Reduced-till	523,275	52	45.2	59.2
	No-till	560,827	57	49.5	59.5
Bergen	Conventional	612,528	61	53.1	60.5
	Reduced-till	622,325	62	47.2	58.7
	No-till	540,690	54	52.0	59.6
Grandin	Conventional	477,560	48	45.3	60.6
	Reduced-till	542,323	54	41.3	58.9
	No-till	500,690	50	46.4	59.8
Norm	Conventional	403,001	40	47.3	59.7
	Reduced-till	385,041	38	41.7	58.1
	No-till	356,197	36	46.7	58.8
Tillage (T)		NS		NS	*
Seeding rate (SR)		*		*	*
Variety (V)		*		*	*
T x SR		NS		NS	NS
V x T		NS		NS	NS
V x SR		*		NS	NS

V x SR T		NS		NS	NS

N-Fertilizer by Fungicide by Tillage System Trial -- Dickinson, ND, 1994						
	Leaf spotting		Yield		Test weight	
Treatment	1993	1994	1993	1994	1993	1994
	% of flag leaf		bu/ac		lbs/bu	
Tillage system						
No-till	26.0	36.2	31.9	43.2	57.7	60.6
Reduced-till	37.1	30.9	34.6	45.4	57.4	60.2
Conventional	33.7	46.7	38.3	40.6	57.6	59.7
Fungicide						
No Fungicide	31.5	41.6	35.1	43.7	57.5	60.2
Fungicide	33.0	34.2	34.7	42.4	57.6	60.2
N Fertilizer						
Low Rate	----	37.5	----	40.6	----	60.5
High Rate	----	38.4	----	45.5	----	59.8
No-till + Low N	----	36.5	----	40.9	----	60.9
No-till + Low N +	----	40.7	----	42.5	----	60.7

Fungicide						
No-till + High N	25.6	32.2	29.8	42.8	57.6	60.2
No-till + Fungicide + High N	26.4	35.3	33.9	46.6	57.8	60.5
Reduced-till + Low N	----	34.0	----	46.6	----	60.5
Reduced-till + Low N + Fungicide	----	24.5	----	39.6	----	60.6
Reduced-till + High N	33.1	40.3	37.4	50.7	57.5	59.9
Reduced-till + High N + Fungicide	41.2	24.8	33.6	44.6	57.2	60.0
Conventional + Low N	----	56.2	----	38.2	----	60.4
Conventional + Low N + Fungicide	----	33.0	----	35.7	----	60.0
Conventional + High N	35.9	50.4	38.1	42.6	57.5	59.1
Conventional + High N + Fungicide	31.6	47.1	38.4	45.7	57.6	59.4
Tillage	*	NS	NS	NS	NS	*
Fungicide	NS	NS	NS	NS	NS	NS
Tillage x Fungicide	NS	NS	*	NS	NS	NS
N Rate	---	NS	---	*	---	*****
N Rate x Tillage	----	NS	----	NS	----	**NS**
N Rate x Fungicide	----	NS	----	NS	----	**NS**

N Rate x Fungicide x Tillage	----	NS	----	NS	----	**NS**

Spring Wheat Variety by Cropping Sequence Trial -- Dickinson, ND, 1994					
	Crop sequence (CS)				
Variety	wheat-fallow	wheat-corn	% of fallow	wheat-wheat	% of fallow
	bu/acre				
AC Minto	48.0	45.3	0.94	44.7	0.93
Amidon	54.0	50.5	0.94	48.5	0.90
Bergen	50.5	57.3	1.13	53.9	1.07
Butte 86	49.7	46.2	0.93	45.5	0.92
Grandin	44.2	51.8	1.17	45.4	1.03
HiLine	51.1	53.7	1.05	47.8	0.94
Norm	49.7	52.9	1.06	48.7	0.98
2371	44.7	45.8	1.02	44.2	0.99
Sharp	53.0	49.9	0.94	46.9	0.88
Stoa	54.0	49.8	0.92	50.2	0.93

Mean	49.9	50.3		47.6	
Cropping sequence	*				
Variety	*				
CS x V	*				

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