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Agronomy Section

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Long-Term Organic and Tillage Study (LOTS)
Results from a Cropping System in Transition from Conventional to Synthetic-Chemical Free Management

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Research Summary

Many cropping systems are diversifying because of economic and environmental considerations. The objective of the Long-Term Organic and Tillage Study (LOTS) is to identify alternative cropping systems that optimize economic returns and non-renewable energy use. The study began in 1999 and includes a 6-yr rotation in which no synthetic fertilizers or pesticides are used (organic). This rotation originally included flax (*Linum usitatissimum* L.), but in 2001an intercrop of oats (*Avena sativa* L.) and peas (*Pisum sativum* L. subsp. *sativum*) was substituted for flax in the rotation because of recurring weed infestations when flax was grown. Other crops in the 6-yr rotation include alfalfa (*Medicago sativa* L. subsp. *sativa* var. *sativa*), corn (*Zea mays* L.), and hard red spring wheat (HRSW) (*Triticum aestivum* L. emend. Thell. Yields of HRSW in the organic rotation were similar to yields rotations where synthetic fertilizers and pesticides were used (conventional) and HRSW was grown continuously, or HRSW was rotated in alternate years with peas and canola (*Brassica napus* L.) in 2002. Corn averaged 62 bu/acre in a conventional rotation but was disced under in the organic rotation because of a weed infestation along with a severe deficiency in nitrogen among corn plants. The LOTS is ongoing.

Introduction

Dryland wheat-fallow monoculture is declining in much of the Great Plains because of economic and environmental inefficiencies. Interest in "chemical-free" production systems (i.e., organic farming) is expanding in the region. In response to these developments and also

directives by two independent agronomy boards, the Long-Term Organic and Tillage Study (LOTS) was established.

Materials and Methods

Two 4-yr rotations and one 6-yr rotation were established in 30 ft x 100 ft plots in a replicated and randomized design at the Dickinson Research Extension Center in 1999. The rotations were developed jointly by scientists and commercial agriculturists in North Dakota. The 4-yr rotations include: (i) [1] HRSW - [2] pea - [3] winter wheat [(1)] - [4] canola; and (ii) [1] HRSW - [2] pea - [3] corn - [4] buckwheat (*Fagopyrum esculentum* Moench.) The 6-yr rotation include: [1] HRSW + alfalfa - [2] alfalfa - [3] alfalfa plowdown - [4] HRSW - [5] corn - [6] oat + pea for hay. Continuous HRS wheat also is included in the study.

The 2, 4-yr rotations and the continuous HRS wheat monoculture are managed without tillage, while tillage is used in the 6-yr rotation. Conventional fertilizer and pesticides are used in the 4-yr rotations and the HRS wheat monoculture, but not in the 6-yr rotation.

Soil nutrient and water content, crop and weed vegetative growth, grain production, and other data are being collected. Data will be analyzed using PROC MIXED from SAS once the contrasting cropping systems have achieved a new steady state, which will not occur for several more yr. Means of yields for crops from the various rotations and the continuous HRS wheat monoculture are reported for 2001.

Results and Discussion

No differences occurred between the yield of HRSW in the organic rotation and in the continuous HRSW monoculture, or when HRSW was rotated in alternate years with pea and canola (Table 1). Yield of HRSW averaged 45 bu/acre in the organic rotation. An additional 11 bu/acre were produced when HRSW was grown conventionally in the 4-yr rotation with pea, corn, and pea compared with the organic rotation. The design of the study prevents the impact of management (organic vs. conventional) and rotation from being evaluated independently for their abilities to explain differences in yield of HRSW in the organic rotation and the conventional rotations.

Protein concentration of HRSW grain tended to be lower in the organic rotation than in the conventional systems (Table 1). Rotation and management system did not affect grain test weight but did influence kernel weight. Heaviest kernels resulted when HRSW was grown every forth year in a rotation with pea, corn, and buckwheat. There was no difference in kernel weight of HRSW grain among the other rotations and production systems.

The organic rotation failed to produce higher yields of HRSW than the conventional management systems included in the study during 2001, and in one instance produced less grain (Table 1). Protein concentration sometimes was less for HRSW grain produced in the organic rotation than in conventional production systems. However, the premium paid for HRSW in the organic market resulted the organic production system generating the greatest gross returns for HRSW.

Grain/seed yields of other crops in the LOTS study during 2002 were: canola - 1200 lb/acre; corn -62 bu/acre; and peas - 41 bu/acre average across both rotations that included peas. Average yield for alfalfa forage was 1.1 tons dry matter (DM)/acre for second and third

year stands in the organic rotation. Average yield for oat + pea forage in the organic rotation was 1.2 tons DM/acre.

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Table 1. Performance of hard red spring wheat for selected traits in different crop rotations.

Rotation[1]	Plant Height	Yield	Kernels	Test Weight	Protein	Return
	---inches---	----bu/ac----	----no./lb----	----lbs/bu----	------%------	-----$/ac-----
Organic -(1)	39	45.2	15,112	57.8	13.8	226.00*
Organic -(4)	38	45.4	14,638	59.4	13.9	227.00*
Continuous	34	44.8	14,774	60.2	15.5	129.38
Cool (1)	39	46.5	14,880	60.1	14.9	130.61
Cool (3)	39	49.3	15,314	59.3	13.6	129.67
Cool/Warm	36	56.0	13,704	58.7	14.9	156.76
Trial Mean	37	47.9	14,737	59.3	14.4	131.02
C.V. %	7.3	10.9	4.6	2.1	5.4	12.9
LSD .05	NS	6.9	887	NS	1.0	22.34

NS = No statistical difference at the $P < 0.05$ level.

[1] Organic = (1) HRSW + alfalfa - (2) alfalfa - (3) alfalfa plowdown - (4) HRSW - (5) corn - (6) oat + pea (hayed); Continuous = HRSW grown continuously; Cool = (1) HRSW - (2) field pea - (3) HRSW [dormant seeded] or HRWW - (4) canola; Cool/Warm = (1) HRSW - (2) field pea - (3) corn - (4) buckwheat

*Organic returns were calculated based on a $5 per bushel rate.

Returns were calculated by multiplying the 2001 yield by protein premium or discount paid at the Southwest Grain Terminal located at Gladstone, ND on September 17. The price paid on this date was $2.74/bu, assuming that grain protein concentration was 14%. An additional $.02/bu was paid for each additional 0.25% increase in grain protein up to 15% protein, where an additional $0.05/bu was paid. An additional $0.01/bu was paid for each additional 0.25% increase in grain protein up to 17%, above which an additional premium was not paid. Grain was discounted $0.05/bu for each 0.25% reduction in grain protein from 14% to 11%, below which no additional discount was not assigned. Returns factored in discounts for grain with a test weight <58 lb/bu [-$0.01/bu for 0.5 lb/bu between 58 and 57 lb/bu; -$0.02/bu for 0.5 lb/bu between 57 and 55 lb/bu; -$0.03/bu for 0.5 lb/bu between 55 and 50 lb/bu; and -$0.04/bu for 0.5 lb/bu between 50 and 46 lb/bu].

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