PROPER MANAGEMENT – Key To Successful Winter Wheat Recropping In Northern Great Plains

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Since controlling saline-seep areas requires more intensive cropping of seep recharge areas to reduce water loss by deep percolation, we examined the potential of including winter wheat in intensive cropping systems in northwest North Dakota with various levels of N fertilizer. Ammonium nitrate (33-0-0) and urea (45-0-0) were applied at seven rates from 0 to 120 lb N/A to three winter wheat varieties: Winalta, Froid and Centurk. After two years of recropping, third-crop average grain yields for all three varieties increased from 16.4 bu/A with no N added to 41.5 bu/A with 60 lb/A of N added. N-fertilizer significantly increased protein content, straw production and income per acre. With proper management, winter wheat has an excellent potential to be included in intensive cropping systems in northcentral and western North Dakota and northeastern Montana.

INTRODUCTION

The increasing incidence of saline seeps in the northern Great Plains has prompted researchers to seek solutions to this problem. Halvorson and Black (5) suggested more intensive cropping of the upslope recharge area to control the continued development and growth of saline seeps. They suggested that water losses to deep percolation could be greatly reduced if a flexible cropping system permits the rotation of several small grains and oil seed crops, while using summer fallow only on a limited basis. Halvorson and Reule (7) reported that intensive cropping with small grains controlled and dried an existing saline-seep area in eastern Montana. Mosser (9), a Fortuna, North Dakota, farm operator, also reported that he successfully used intensive cropping for controlling saline seeps.

Recropping with small grains involves some risk, usually caused by inadequate water and plant nutrients in the root zone. As cropping intensity increases; weeds, disease, and insect problems may also increase. Halvorson, Black and Reule (6) suggested that with proper management, many risks involved in intensive cropping can be reduced. Black and Siddoway (4) have used single or double rows of tall wheatgrass, spaced at 50 ft. intervals, to trap snow and reduce evaporation and help provide the additional water needed for recropping.

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They found that proper fertilization was necessary and weed and disease problems could be minimized by proper crop rotation. Sobolik (10) reported that successful spring wheat recropping was possible if the nitrogen needs of the crop were satisfied.

Winter wheat production is limited by the winter climate of extreme northeastern Montana and northern North Dakota because of winterkill problems. In 1974, Black and Ford (2) demonstrated that winter wheat will survive a low-snowfall and low-temperature winter under proper stubble management. There was nearly 100 per cent winterkill of Froid winter wheat seeded on bare stubble ground (no residue — typical of summer fallow). This same variety seeded in standing stubble had a good stand and yielded 22 bu/A. Standing stubble trapped snow and provided a protective microclimate, which increased winter wheat survival. Because information is limited, our objective was to determine survival and nutrient requirements of winter wheat under recrop conditions.

PROCEDURES

In the fall of 1974, we initiated a study to examine the survival and production of three winter wheat varieties — Froid, Winalta and Centurk — each with different winter hardiness ratings of very good, good and fair in northwestern North Dakota as indicated by State Experiment Station variety trials (8, 11). Stubble management treatments were: (1) bare soil (no stubble to simulate summer fallow), (2) stubble chiseled (once with a tool bar), and (3) standing stubble (no tillage). Within each stubble and variety treatment, we studied the nitrogen requirements by broadcasting N at seven rates (0, 20, 40, 60, 80, 100, 120 lb N/A) on May 21, 1975, using two sources [ammonium nitrate (33-0-0) and urea (45-0-0)].

The study site was on a clay loam glacial till soil on the Burtil Olson farm southwest of Crosby, North Dakota. Previous cropping history of the site was: summer fallow, 1972; durum, 1973; spring wheat, 1974; and winter wheat, 1975. The soil tested very low in available phosphorus (P). Sodium bicarbonate extractable P was 7.52 ppm for the 0- to 3-inch depth and 2.64 ppm for the 3- to 6-inch depth.

Winter wheat was seeded on September 12, 1975, with a deep furrow drill with 85 lb/A of 9-45-0 fertilizer with the seed, which supplied 7.7 lb N/A and 16.6 lb P/A. Soil test results show that 31 lb N/A was present in the upper 4 ft of soil at seeding. At seeding, the surface 12 inches of soil was moist, with a gravimetric soil water content of about 14.5 per cent. The 1- to 3-ft soil depth was much drier (about 10.6 per cent), because water which had been removed by the spring wheat had not yet been replenished. Water content at the 3- to 4-ft soil depth was about 18.3 per cent. A total of 6 inches of precipitation, received between September 1974 and April 30, 1975 (U.S. Weather Bureau records for Crosby, North Dakota), rewet the dry part of the root zone. Precipitation recorded 1 mile away from May 1 to July 30, 1975, totaled 9.6 inches.

All plots were hand harvested August 6, 1975, and grain and straw yields, protein content and test weight were determined. Soil samples for soil water and residual NO_3-N content were collected on September 9, 1975, by 1-ft increments to a 4-ft soil depth from each N treatment of the Froid winter wheat plots. Market value with protein premiums for winter wheat on September 30, 1975 at Sidney, Montana, was used to compute income per acre for each N treatment. A cost of $.30/lb N was used to calculate the cost of the N fertilizer applied in each treatment.

RESULTS AND DISCUSSION

The winter of 1974-75 was extremely mild, and all three winter wheat varieties survived with little, if any, winterkill. No visual signs of winterkill were observed in the standing stubble or chiseled stubble treatments for any of the varieties. There was some winterkilling of Centurk on the bare soil without stubble protection, but yields were not seriously decreased.

Since there were essentially no yield differences between stubble treatments (35.7 vs 35.9 vs 36.7 bu/A for the standing, chiseled, and no stubble treatments respectively); we used stubble treatments as replications in a two-factor factorial statistical analysis of the N treatments for each variety.

Winalta

Winalta, a variety with good winter hardiness (8, 11), had the highest average grain yield, test

Table 1. Average agronomic and monetary data for Winalta (average of stubble treatments and both N sources).

Fertilizer rate	Grain yield	Test weight	Protein content	Straw yield	Straw/ grain ratio	Crop value	Gross income	Gross income less fert. cost
lb N/A	bu/A	lb/bu	%	lb/A		$/bu	$/A	$/A
0	17.7	63.4	11.2	1428	1.35	3.60	63.72	63.72
20	29.4	63.4	11.2	2475	1.41	3.57	104.96	98.96
40	37.6	63.4	11.5	3381	1.50	3.64	136.86	124.86
60	41.9	63.4	12.5	3744	1.49	3.82	160.06	142.06
80	44.1	63.6	13.8	3903	1.48	4.03	177.72	153.72
100	45.5	63.3	14.0	4143	1.51	4.06	184.73	154.73
120	45.8	63.3	14.7	4113	1.49	4.15	190.07	154.07
LSD .05	3.4	N.S.	0.8	384	0.09	0.15	15.28	15.28
Mean								
Ammonium nitrate	37.1	63.3	12.8	3228	1.44	3.87	145.42	127.42
Urea	37.8	63.5	12.5	3397	1.48	3.81	145.64	127.42
LSD .05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V., %	7.5	0.7	5.6	9.8	5.0	3.2	8.8	10.1

Table 2. Average agronomic and monetary data for Froid (average of stubble treatments and both N sources)

Fertilizer rate	Grain yield	Test weight	Protein content	Straw yield	Straw/ grain ratio	Crop value	Gross income	Gross income less fert. cost
lb N/A	bu/A	lb/bu	%	lb/A		$/bu	$/A	$/A
0	16.8	61.8	10.8	1455	1.46	3.52	59.14	59.14
20	29.5	61.5	10.3	2722	1.54	3.42	100.89	94.89
40	39.7	61.2	11.8	3603	1.51	3.67	145.70	133.70
60	41.2	61.5	12.8	3922	1.59	3.88	159.86	139.86
80	42.9	61.1	13.8	4336	1.69	4.02	172.46	148.46
100	41.9	61.0	14.4	4123	1.64	4.12	172.63	142.63
120	42.7	61.2	14.9	4338	1.70	4.20	179.34	143.34
LSD .05	3.3	N.S.	1.2	383	0.12	0.21	13.98	13.64
Mean								
Ammonium nitrate	36.4	61.3	12.6	3434	1.56	3.82	140.94	122.66
Urea	36.3	61.4	12.8	3566	1.62	3.84	141.62	123.33
LSD .05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V., %	7.6	0.8	8.3	9.2	6.5	4.7	8.3	9.3

weight, protein content and gross income (Table 1) as compared with the other varieties (Tables 2 and 3). Grain yields increased as rate of N application increased up to 60 lb N/A. Above this rate, yield increases were small. Yield increases per lb N added were largest for the 20 and 40 lb/A application rates. Although N rates had no influence on grain test weight, grain protein content increased significantly at rates above 60 lb/A, as compared with the unfertilized check. Nitrogen significantly increased straw yield at all N rates, with as much as a 2,316 lb/A increase over the check when 60 lb N/A was added. Increased protein content at the highest N rate resulted in a protein premium of $.55/bu. At 60 lb N/A, the protein premium was $.43/bu, which significantly increased crop value as compared with the check. The best gross income less N-fertilizer cost was for the 80 lb N/A rate. Winalta responded the same to both N sources.

Froid

Froid, the most winter hardy variety (8, 11), yielded about the same as Winalta (Table 2). Again, grain yields leveled off at about 60 lb N/A. Test weight was not affected by N rates. Protein content, straw yield, straw/grain ratio and crop value generally increased as the N rate increased. Protein content and protein premium were significantly greater than for the check when N requirements for grain yield had been satisfied (at about 60 lb N/A). Maximum gross income less fertilizer costs, occurred at the 80 lb N/A rate. Froid responded similarly to both N sources.

Centurk

Centurk, only fair in winter hardiness (8,11), had the lowest yield (Table 3) of the three varieties. In State Experiment Station variety trials, Centurk consistently had a higher yield potential than did Froid and Winalta, but had low spring vigor and winter hardiness (8, 11). There may have been some winterkill of Centurk, but more likely yield was decreased by poor spring vigor under the cooler climatic conditions at Crosby. As N rates increased up to 60 lb N/A, grain yields increased substantially, but as N rates increased test weights decreased and protein content, straw yield, straw/grain ratios, crop value and gross income increased. Because of generally lower protein premium and crop value of Centurk vs Winalta or Froid, protein premium and crop value of Centurk were slightly lower. Centurk generally responded more favorably to urea (45-0-0) than to ammonium nitrate (33-0-0).

After-harvest soil water

A total of 4.37 inches of precipitation was recorded between August 6 and September 9, 1975, wetting the soil surface to near field capacity. However, we found differences in water content caused by N treatment, with less water at the 1- to 2- and 2- to 3-ft depths as N application rate in-

Table 3. **Average agronomic and monetary data for Centurk (average of stubble treatments and both N sources).**

Fertilizer rate	Grain yield	Test weight	Protein content	Straw yield	Straw/ grain ratio	Crop value	Gross income	Gross income less fert. cost
lb N/A	bu/A	lb/bu	%	lb/A		$/bu	$/A	$/A
0	14.8	62.0	10.2	1319	1.48	3.40	50.32	50.32
20	26.1	61.2	10.3	2209	1.41	3.42	89.26	83.26
40	32.3	61.3	10.6	2880	1.48	3.48	112.40	102.40
60	41.3	61.0	12.2	3637	1.47	3.77	155.70	135.70
80	42.1	61.7	12.3	3973	1.57	3.80	159.98	135.98
100	44.1	60.6	14.1	4163	1.57	4.07	179.49	149.49
120	40.7	60.9	14.0	3882	1.59	4.06	165.24	129.24
LSD .05	2.6	0.7	0.9	307	0.08	0.15	12.05	12.44
Mean								
Ammonium nitrate	33.3	61.3	11.7	2983	1.48	3.67	124.39	106.58
Urea	35.7	61.2	12.2	3320	1.53	3.77	136.60	118.31
LSD .05	1.4	N.S.	0.5	165	0.04	0.08	6.44	6.65
C.V., %	6.4	1.0	6.2	8.3	4.6	3.4	7.8	9.3

creased (Table 4). Differences in water content due to N treatment for the 0- to 1- and 3- to 4-ft soil depths were not significant. We found no significant differences in water content between sources of N. These data indicate that fertilizing winter wheat will not only increase yield and crop value, but also the amount of soil water used. Since our main objective in controlling saline-seep areas is

Table 4. **Total soil water to a 4-ft depth by 1-ft increments for each N treatment on the Froid winter wheat plots after harvest (September 9, 1975).**

Depth	Soil water* N application rate, lb N/A: 0	20	40	60	80	100	120	LSD .05
ft	inches							
0-1	3.46	3.40	3.50	3.34	3.53	3.34	3.08	N.S.**
1-2	3.22	2.65	2.68	2.18	2.11	2.18	2.03	0.78
2-3	3.20	2.49	2.31	2.56	2.46	2.71	2.39	0.45
3-4	3.16	2.93	2.91	2.99	3.15	3.22	2.96	N.S.
Total								
0-3	9.88	8.54	8.49	8.08	8.10	8.23	7.50	1.17
0-4	13.04	11.47	11.40	11.07	11.25	11.45	10.46	1.42

Assuming a soil bulk density (B.D.) of 1.5.
***N.S. = Differences not significant at P = .05.*

Table 5. Residual soil NO_3-N present in the Froid winter wheat plots after harvest (September 9, 1975).

Depth	Soil NO_3-N N application rate, lb N/A 0	20	40	60	80	100	120	LSD .05
ft				ppm				
0-1	0.97	0.75	0.87	0.98	1.94	3.30	3.71	2.06
1-2	0.68	0.44	0.43	0.58	1.21	1.43	1.26	N.S.*
2-3	1.56	0.82	0.97	1.49	1.11	3.29	1.35	1.32
3-4	2.39	1.72	2.27	2.23	2.92	4.14	2.11	1.37
Total, ppm 0-4 ft	5.60	3.72	4.54	5.28	7.18	12.16	8.42	4.07

**N.S. = Difference not significant at P = .05.*

to reduce the amount of water lost to deep percolation below the root zone, this is very important.

After-harvest residual soil NO_3-N

Results of soil analyses for residual NO_3-N are reported in Table 5. In general, residual soil NO_3-N increased at all soil depths for N rates above 20 lb N/A. The 100 and 120 lb N/A treatments had significantly higher residual soil NO_3-N per 4-ft depth than the 20 lb N/A treatment. Residual NO_3-N increased greatly at N rates above 60 lb N/A, which was expected, since yield increases were not large at N rates above 60 lb N/A.

The check treatment had a higher level of residual NO_3-N than did the 20 lb N/A treatment at all depths. Without the addition of N, the winter wheat plants were stunted and not growing vigorously enough to efficiently use mineralized N and available soil water late in the growing season.

SUMMARY

Average grain yield and protein content for all three varieties and both N sources are summarized in Fig. 1. Results indicated that the optimum N rate would be 50 to 80 lb N/A, although protein content continued to increase at rates above 80 lb N/A. Results of earlier work (3) indicated that with the amount of water available for winter wheat in this study, 80 lb/A of available N is required to produce a yield of 40 bu/A. Since the soil already contained 31 lb of N/A (as NO_3-N) at seeding, a minimum of 49 lb/A of fertilizer N was required. Average gross

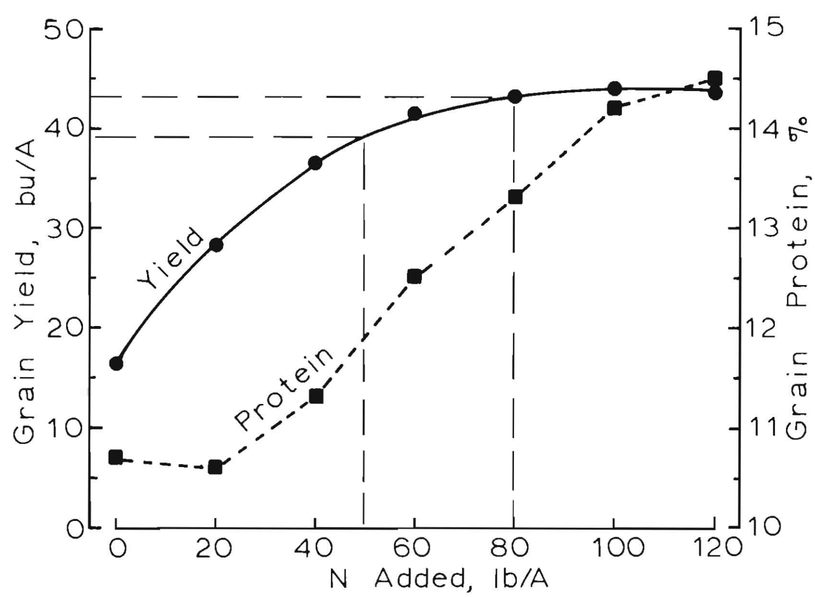

Figure 1. Average grain yield and protein content of all three winter wheat varieties (Winalta, Froid, and Centurk).

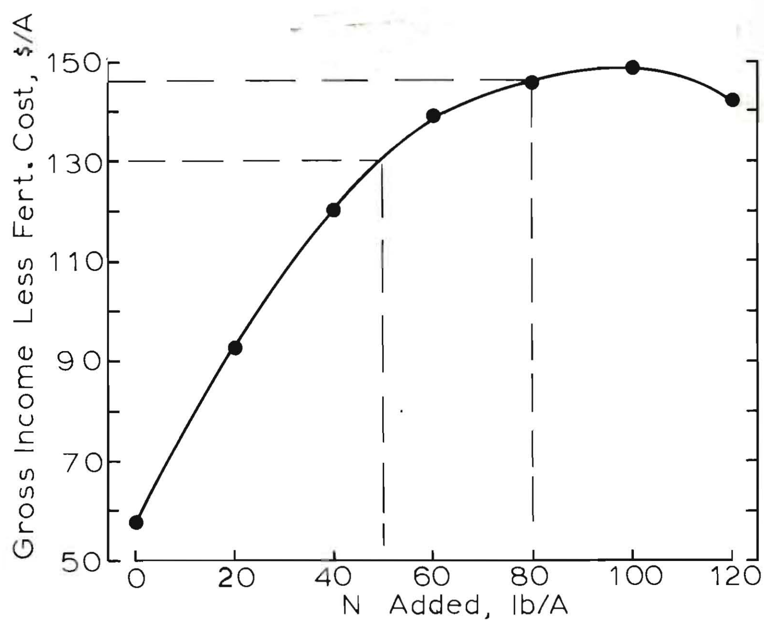

Figure 2. Average gross income less fertilizer costs for all three winter wheat varieties (Winalta, Froid, and Centurk).

income less fertilizer costs was near maximum at the 80 lb N/A rate (Figure 2). At these potential yield and income levels, summer fallowing cannot be justified when soil water and rainfall are near normal.

We do not recommend recropping without adding needed plant nutrients, because yields would be low and frequently uneconomical. Nitrogen is the major deficient nutrient under recropping situations, but adequate P is necessary to fully benefit from any added N. The risk of having inadequate soil water can be minimized by using management techniques for snow trapping like tall wheatgrass barriers, or leaving 10 to 12 inches of standing stubble. Proper management of fertilizer, stubble and crop sequences is the key to successful recropping. Over an 8-year period, winter wheat yields on recrop have equaled spring wheat yields on summer fallow in the cropping systems in northeastern Montana (4).

Nitrogen fertilization will increase the amount of straw produced under recrop conditions, however a deep furrow drill used in conjunction with straw choppers, bunchers or balers will minimize potential seeding problems. Burning the straw is not recommended. Black and Siddoway (4) found that straw produced in intensive cropping systems was about 35 per cent lower than in a crop-fallow system, independent of N fertilization. Therefore, the problem of excessive straw production on fallow would not be encountered in intensive cropping systems. Although we obtained no measurable benefit with

MANAGEMENT TIPS FOR RECROP WINTER WHEAT

1. Think winter wheat recropping while harvesting the spring grain crop. Leave a spring grain stubble at about 12-inch height if possible, and chop or remove excessive straw to prevent seeding problems.

2. Immediately after spring grain harvest, undercut the stubble only if weeds are a problem. Leave as much of the stubble standing as possible.

3. Insure that the winter wheat crop being seeded has adequate N and P fertilizer. Adequate P should be drill applied at seeding, but drill - applied N rates should not exceed 10 lb N/A.

4. If sufficient soil water is available to establish a good stand, seed 50 to 60 lb/A of an adapted hardy winter wheat variety in standing stubble with a narrow point furrow drill between September 1 and 15.

5. In the spring, evaluate winter wheat stand and soil water condition and broadcast additional N fertilizer, as indicated by soil test, no later than May 15.

6. Spray for broadleaf weeds as necessary.

the standing stubble treatment in this study because of the mild winter, to minimize winterkilling we still recommend seeding a good winter hardy variety of winter wheat in standing stubble with a deep furrow drill. As Black and Ford (2) demonstrated near Plentywood, Montana, even a hardy variety, such as Froid, will winterkill on bare soil without stubble protection. Seeding winter-wheat on summer fallow with a disc drill is not recommended for northcentral and northwestern North Dakota. Alessi and Power (1) found significantly greater survival and grain yield for furrow planted than for surface planted winter wheat.

Weed problems can be minimized by proper crop rotation, use of herbicide and timely after-harvest tillage operations with proper equipment. We observed that the standing stubble had considerably fewer weeds than did the chiseled stubble, which, in turn, had less weeds than did the bare soil treatment tilled four times before seeding. Thus, the increased number of tillage operations will bury more weed seeds, whereas viability of seeds left on the surface is decreased by drying, freezing and exposure. We also noted that wheat produced with adequate N fertilizer had less disease problems than did the check and low N-rate treatments.

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(Whitman . . . from page 2)

might have been more effective, but this is hindsight, and I don't really know. Evaluating what I have seen as a whole over the years in the research program of the Agricultural Experiment Station, I believe I have seen an economical, effective operation with my colleagues using great ingenuity and enterprise to achieve their research objectives with the relatively limited resources they have had at their disposal. It is axiomatic among research workers that they never have enough money, help or facilities to really conduct their research the way that they think it ought to be done, but they go right ahead producing the results that have meant so much to the development of our agricultural potential.

There is, however, one area in which I believe we can do better, and this is in planning our overall research programs. By this I do not mean to imply that our planning has been inadequate, only to imply that it is an area in which I believe we can do better if we approach the planning operation in a comprehensive, positive, objective, and yet creative manner. Probably I see this as an area in which we can do better because of the recent development of the Grass-and-Beef Program within the Agricultural Experiment Station and the Cooperative Extension Service.

Here is a program which began with a research review by the Experiment Station and Extension Consultation Board. The Grass-and-Beef Committee was then put together to develop a series of goals for the program. With the goals defined, the program has already begun to produce results, with the initiation of at least three new research projects, the institution of a strong educational program by the Extension Service, and the continuing development of further long-range plans all designed to secure better utilization of our extensive native grass and seeded forage resources. Witnessing the commitment of funds, personnel and effort to this comprehensive program has been a very heartening experience for me, and has served to strengthen my opinion that we can do better through improved planning.

Perhaps one of the highest priority projects of the Experiment Station for the next quarter century could well be the development of improved planning procedures for all phases of its research program. In my opinion the effort toward improved planning is already underway, and the retiree of the year 2000 will be able to say, "We saw what could be done better, and we did it better!"