Chemical Fallow in a Spring Wheat-Fallow Rotation

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In Western North Dakota crop production is often limited by low precipitation. The amount and distribution of rainfall during the growing season can vary greatly from year to year. Even though a high percentage of the total precipitation occurs during the growing season, it is not always enough to insure good crop production. Summerfallowing is widely practiced to increase soil moisture and help to stabilize crop yields and farm income. Summerfallow is inefficient in storing moisture, but the relatively small amount of moisture stored takes on special significance in those years of below normal precipitation during the growing season.

The primary purpose of fallow in a crop rotation is to store water and nutrients and make them available to subsequent crops in larger quantities than could be retained under an annual cropping system. To accomplish this it is necessary to control the weed growth on the fallow land, since a heavy growth of weeds will continuously use moisture and nutrients. The tillage operations that are used to control weed growth also decrease the amount of soil water that is stored because the moisture evaporates from the soil surface after each operation. Tillage also decreases the quantity of crop residues remaining on the soil surface, therefore each successive tillage operation makes the land more susceptible to wind and water erosion. To obtain the greatest benefit from the tillage and obtain maximum weed control with a minimum amount of moisture and residue loss, good fallow management practices are needed.

Timeliness of the first operation seems to be the most important variable in managing fallow (1). Delaying initial tillage until late spring results in greater weed growth throughout the season, which reduced soil water reserves and crop yields the following year (2). Several investigators have reported very little difference in the effect of various tillage implements on water stored during the fallow period if weeds were controlled (3) (4). But these various tillage implements can have a widely different effect on the amounts of crop residue left on the soil surface for protection against erosion. Fall tillage may possible be beneficial in years of relatively high precipitation and excessive weed growth after harvest. But as a general rule, the moisture gained from preventing weed growth in the fall is more than offset by the gain in moisture that comes from the snow trapped by the standing stubble. The benefits of wind and water erosion control, as well as fewer tillage operations, usually favor delaying the first tillage on fallow until spring.

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Control of the weeds with herbicides during the fallow period could reduce the number of tillage operations and thereby conserve more surface residues to decrease wind and water erosion. In past years, chemicals have been used on fallow in combination with mechanical tillage to control weeds but generally the results have not been satisfactory. In many cases the control was not of long enough duration or only certain types of weeds could be controlled or the chemical residue would carry over into the crop year and cause damage. Recently developed herbicides have prompted an increase in interest in chemical fallow and the benefits it may offer.

An experimental trial was initiated in 1974 at the Williston Experiment Station to determine whether chemical fallow was feasible and how chemicals could be used in combination with mechanical tillage to reduce tillage operations during the summerfallow period in a crop-fallow rotation. The herbicides used in the trial (cynazine, propachlor, and glyphosate) were considered to be the best available to achieve the objectives of the trial. They did not have label clearance for use on fallow at the time the trial was initiated but cynazine and glyphosate have both been cleared since that time.

Materials and Methods

Plots 25 feet by 75 feet were established on two adjacent strips in the fall of 1974. The strips were alternated between fallow and spring wheat in each cropping season. The first fallow season was 1975 and the first crop was taken in 1976.

The first herbicide application to plots, in all but the tilled only fallow treatment was a tank mix of cynazine (Bladex) at 2 lbs/ac; propachlor (Ramrod) at 3 lbs/ac and glyphosate (Roundup) at 6 oz/ac. Following this 3-way chemical application, tillage and/or glyphosate (Roundup) at 6 oz/ac, was used alone or in combination, to control weeds for the remainder of the fallow period.

The six treatments used were:

Treatment 1: **3 way chemical in late August - early September; tillage when needed in following spring; glyphosate thereafter as needed.**

Treatment 2: **Tillage in late August - early September; 3 way chemical in late October; glyphosate in spring and thereafter as needed.**

Treatment 3: **Spring tillage mid-May; 3 way chemical**

later when needed; glyphosate as needed thereafter.

Treatment 4: 3 way chemical in early April; tillage thereafter as needed.

Treatment 5: Chemical only; 3 way chemical in late August - early September; 3 way chemical in spring when needed; glyphosate as needed thereafter.

Treatment 6: Tilled only; tillage in late August and as needed thereafter.

Spring wheat was seeded with a disk press drill in early May each year. The plot area was worked one time with a field cultivator prior to seeding. The plots were sprayed with a phenoxy herbicide at the appropriate time to obtain good broadleaf weed control. Nitrogen fertilizer was broadcast prior to seedbed preparation and the plots were fertilized with 34 lbs/acre N in 1976, 50 lbs/acre N in 1978 and 40 lbs/acre N in 1979. No nitrogen was broadcast on the plots in 1977 because of extremely dry conditions. Each year 50 lbs/acre of 18-46-0 fertilizer was applied with the drill when the plots were seeded. Soil samples were taken in the fall each year, except in 1975, after the fallow season to determine nitrate nitrogen and phosphate levels in each treatment. The samples from the 1975 fallow were taken in the spring of 1976 prior to seeding.

The herbicides were generally applied to the fallow plots when the weeds were 3 to 4 inches tall. At times it was not always possible to get the spraying done at specified times because of windy weather or wet soil conditions. The spray volume used for all the herbicide applications was 20 gallons per acre. Table 1 shows the number of tillage and spraying operations performed during the fallow seasons. Soil water was measured prior to seeding each spring. These measurements were made with a neutron probe in 1976 and by the Gravimetric Method in 1977, 1978 and 1979.

A small plot combine was used to harvest 172 square feet from each plot and the wheat yields were determined for each replicated treatment.

Table 1

Chemical Fallow
Fallow Tillage & Spray Operations
Summary 1976-78

Treatment	1975	1976	1977	1978	Average
1	1 till 2 spr	1 till 2 spr	1 till 3 spr	1 till 3 sp	1 till 2.5 Spr
2	1 Till 5 Spr	1 Till 3 Spr	1 Till 3 Spr	1 Till 4 Spr	1 Till 3.7 Spr
3	1 Till 2 Spr	1 Till 2 Spr	1 Till 2 Spr	1 Till 2 Spr	1 Till 2 Spr
4	1 Till 1 Spr	1 Till 1 Spr	1 Till 1 Spr	1 Till 1 Spr	1 Till 1 Spr
5	4 Spr	3 Spr	4 Spr	2 Spr	3.2 Spr
6	4 Till	4 Till	4 Till	3 Till	3.7 Till

Results and Discussion

Soil Water: The amount of water stored in each of the treatments during the fallow period was measured in the spring prior to seeding. There was no significant difference between fallow treatments in the amount of water stored after the 21 month fallow period (table 2). The soil water content was highest in fallow treatments 4 and 5.

Spring Wheat Yields: There was no significant difference in yields (table 3) from the fallow treatments during the first three years, only in 1979 was there a significant difference. The highest average yield was from fallow treatment 1, and the lowest average yield was from fallow treatment 3. Fallow treatment 5, the chemical only plot, had a higher average yield than the fallow treatment 6, the tilled only plot. There were no weed problems during the cropping year on any of the fallow treatments. The one tillage operation performed for seedbed preparation was adequate to work down the drop residue remaining on the plots so that no problems were encountered in seeding with a disk drill on any of the plots. Good stands were obtained every year.

Table 2

Chemical Fallow
Total Soil Moisture to 4 Feet
Prior To Seeding

Treatment	1976	1977	1978	1979	Average
	Inches				
1	9.82	7.63	10.83	11.47	9.94
2	9.74	8.12	10.76	10.43	9.76
3	9.21	7.90	10.72	11.87	9.93
4	10.02	8.44	11.62	10.77	10.21
5	9.50	8.09	12.48	10.84	10.23
6	9.22	8.00	11.78	10.72	9.93

Table 3

Chemical Fallow
Yield - HRS Wheat

Treatment	1976	1977	1978	1979	Average
	Bushels/Acre				
1	27.6	23.1	46.6	21.9	29.8
2	26.8	20.9	44.4	22.1	28.6
3	29.6	22.3	40.3	20.2	28.1
4	28.9	21.8	39.4	24.4	28.6
5	28.3	23.0	42.7	24.2	29.6
6	29.5	22.0	41.0	20.9	28.4
LSD 5%	N.S.	N.S.	N.S.	2.1	

Wheat Test Weight and Protein Content: There was no significant difference in the test weight (table 4) of the wheat harvested from the various fallow treatments. The test weight, averaged over three years, varied from a low of 60.0 lbs per bushel on fallow treatment 6, the tilled only plot, to 60.6 lbs on fallow treatments 1 and 4.

Table 4

Chemical Fallow
Test Weight - HRS Wheat

Treatment	1976	1977	1978	1979	Average
			Pounds/Bushel		
1	60.7	60.9	61.2	59.4	60.6
2	60.0	61.2	60.6	59.3	60.3
3	59.9	61.5	60.7	58.6	60.2
4	60.3	61.5	61.2	59.5	60.6
5	60.4	61.3	61.1	58.5	60.3
6	60.2	60.8	60.6	58.4	60.0

The wheat from fallow treatment 6, tilled only plot, had the highest protein content in the three years that measurements were made (table 5). Soil tests indicated that in 3 out of 4 years this plot had the greatest amount of nitrate nitrogen (to a depth of 2 feet) at the end of each fallow season (table 6).

protein level as a uniform application of nitrogen was applied to all plots in the spring and this plot would have had a higher level of nitrogen than other plots. In all the other plots, there was no consistent correlation of protein content with nitrate nitrogen in the soil.

Table 5

Chemical Fallow
Wheat Protein Content

Treatment	1976	1977	1978	Average
		Percent		
1	13.8	14.0	14.3	14.0
2	15.1	14.4	14.2	14.6
3	14.0	14.0	14.4	14.1
4	14.4	13.0	13.9	13.8
5	13.0	14.1	14.0	13.7
6	15.9	14.5	14.7	15.0

Weed Control During Fallow Season: The fall application of the 3 way chemical, fallow treatments 1 and 2, did not control weeds as long in the fallow season as did the spring application, fallow treatments 3 and 4. More spray operations with glyphosate during the fallow season were required on treatments 1 and 2.

The time of tillage in the four treatments that used combinations of tillage and chemicals influenced the number of spraying operations required to control weeds. The greatest number of spray operations was required on fallow treatment 2 where tillage was performed prior to the herbicide application. The fall tillage apparently covered many of the weed seeds and during the fallow period these seeds germinate, making it more difficult for the herbicide to control the weeds. Volunteer grain was more of a problem in the plot than in the others. Fallow treatment 4 had the fewest spraying operations. Only one tillage operation was needed each year in this plot to control the weeds after the herbicides had degraded. Two factors are perhaps responsible for this: a) the longer period of control during the fallow season that spring applied 3 way chemical gave as compared to the fall applied and b) the tillage operation was performed in mid-July after which time precipitation amounts were low and conditions were not conductive for any great amount of weed growth. This tillage operation did not cause a greater weed growth later in the season, nor were the weeds observed to be any more troublesome on this plot in the following crop than on any of the other plots.

The residual chemicals, cynazine and propachlor, worked well during the trial. In 1977 it was very dry in the spring when these herbicides were applied but their activity or effectiveness did not seem to be affected. The glyphosate worked well at 6 oz/acre when the weeds were young and small but at times later in the season when the weeds were larger and harder-to-kill, the 6 oz rate would not do an adequate job.

Table 6

Chemical Fallow
Soil Test Results
1976-78

	Site A		Site B		
Treatment	1975 Fallow 1976 Crop*	1977 Fallow 1978 Crop	1976 Fallow 1977 Crop	1978 Fallow 1979 Crop	Average
			NO_3-N Lbs/Acre to 2 ft.		
1	50	46	47	42	46
2	55	37	68	42	51
3	48	49	92	50	60
4	49	27	59	41	44
5	34	52	49	53	47
6	58	64	57	58	59

*Samples taken spring of 1976.

Summary

1. The number of tillage operations required on fallow for good weed control can be reduced by the use of residual type herbicides without causing a loss of spring wheat yields.

2. Applying the residual type herbicides in early spring gives longer and more effective weed control than when the herbicides are applied to the fallow in the fall.

3. When the fallow is tilled prior to the application of the residual herbicides, the weed control is not as effective as when the herbicide is applied to untilled fallow.

4. The use of herbicides on fallow to control weed growth during a part of the fallow season can result in less fuel being used for tillage, will provide a cover on the fallow which effectively reduces wind and water erosion, and can reduce excessive tillage that adversely affects soil tilth, soil structure, and increases soil organic matter losses.

LITERATURE CITED

1. Douglas, Raymond J. and Thomas J. Conlon, 1955. **What Is The Best Time for First Tillage of Fallow in Southwestern North Dakota.** North Dakota Agricultural Experiment Station Bimonthly Bulletin. Vol XVII (No. 3) 106-107.

2. Geiszler, G. N., 1957. **Crop Yields are Affected by Tillage Practices.** North Dakota Bimonthly Bulletin. Vol. XIX (No. 6) 3 - 8.

3. Progress Report 1948-54, Soil Research Laboratory, Swift Current, Saskatchewan, Canada Department of Agriculture. P. 14.

4. Aasheim, Torlief S. 1949. **The Effect of Tillage Method on Soil and Moisture Conservation and on Yield and Quality of Spring Wheat in the Plains Area of Northern Montana.** Montana Agricultural Experiment Station Bulletin 468.