Nitrogen Content of Mida Wheat Grown On Fargo Clay, 1941-1945

By
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The studies upon the nitrogen content of wheat (grain only) which follow report results upon a single variety, Mida, a hard red spring wheat grown each year for the period 1941 to 1945 on a series of rotation trials on the Fargo Clay soil on the Experiment Station Farm at Fargo, North Dakota. The soil is a black clay mapped by the Bureau of Chemistry and Soils, U. S. Department of Agriculture and the North Dakota Agricultural Experiment Station as Fargo Clay. (Soil Survey of Cass County, North Dakota, 1924).

The area now occupied by the series of plots grew typical tall grass native vegetation until 1882 when the land was broken from the virgin prairie and continuously cropped to wheat by private parties from then until it was acquired for the use of the Experiment Station in 1892. Plot 2 has continued to be kept under annual cropping to spring wheat without the use of manure or fertilizers.

The Growing Season Precipitation and Temperatures 1941-1945

1941

April precipitation above normal, with mean temperature markedly above normal.

May precipitation below normal, with temperatures generally above normal.

June precipitation heavily above normal, with mean temperature above normal except for ten days (June 6-15).

July precipitation greatly below normal with temperatures generally above normal, markedly so in last ten days of July.

August precipitation about normal with first ten days in August excessively warm.

1942

April precipitation nearly double normal with mean temperature greatly above normal.

May precipitation nearly normal, with mean temperatures usually below normal.

June precipitation definitely below normal, with most of last half of June with below normal temperatures.

July rainfall very low, only about ¼ of normal, with mean temperatures slightly above normal.

August precipitation was more than twice normal, with mean temperatures slightly above normal except for August 21-25.

1943

April precipitation about half of normal, with mean temperatures slightly above normal.

May precipitation somewhat above normal, with mean temperatures markedly below normal.

June precipitation much above

normal, with first ten days of the month having mean temperatures greatly below normal but with June 11 to 25 temperatures above normal falling to below normal in last five days of the month.

July precipitation was below normal, with temperatures generally above normal.

August precipitation very heavy, being more than twice normal with mean temperatures generally above normal.

1944

April precipitation markedly below normal with mean temperatures nearly normal.

May precipitation nearly two inches above normal with temperatures above normal except for very cool first ten days.

June precipitation slightly below normal with temperatures somewhat above normal except for two separate five-day periods.

July precipitation double normal or greater with mean temperatures only slightly above or below normal by five-day periods.

August precipitation enormous, especially in first five days when over five inches was received; mean temperatures were well above normal in the first ten days and generally slightly below normal the rest of the month.

1945

April precipitation was about normal with mean temperatures slightly below normal.

May precipitation was about a half inch below normal with the entire month showing temperatures markedly below normal.

June precipitation was slightly over three inches below normal but with all mean temperatures markedly below normal except for one five-day period.

July precipitation was less than half normal with the first half of the month showing mean temperatures markedly below normal and the last half with temperatures above normal.

August precipitation was slightly above normal with temperatures nearly normal the first half, one very hot five-day period, August 16-20, followed by a below normal five-day period, and that by an above normal five-day period.

The growing seasons of 1942 and 1945 were definitely cool seasons with 1943 averaging almost normal as to mean temperatures. The normal figure used for precipitation was the 1878-1935 fifty-eight year record, and the normal mean temperature the 1881-1935 fifty-five year record of the Moorhead, Minn., Station of the U. S. Weather Bureau.

In this set of experiments three rotations, A, C, and B are compared with Plot 2, the continuous culture plot. Each of the three rotations is duplicated in a set of plots on which manure is applied in the fall to the grain stubble for the benefit of the succeeding crop of corn. The columns headed "manure" in this paper accordingly show the residual effect of manure upon the wheat crop. The rotations here reported upon are:

A: Corn, barley, sweet clover, wheat.

B: Corn, barley, field peas, wheat.

C: Corn, barley, foxtail millet, wheat.

A legume, red clover, was grown on rotation A for the first time in 1915 but the rotation was not in full swing, with clover once every four years, until 1919. Field peas were grown for the first time in rotation C in 1915 and again in 1918 but the rotation was not in full swing, with peas once every four years, until 1919. Timothy was grown on rotation B for the first time in 1915—since then it has failed frequently. German millet has been substituted for it most of the years since 1919.

All plots in this series are regularly seeded on the same day each spring on fall plowed land using the same rate of seeding per acre, namely five pecks per acre. The seed is regularly treated each spring with New Improved Ceresan. The dates of seeding were April 29, in 1941; April 22, in 1942; April 17 in 1943; April 21 and 22, in 1944; and May 9, in 1945. The respective dates when the crop was fully ripe follow:

Year	Plot 2 Cont. Wheat	Rotation A Wheat after S. Clover		Rotation C Wheat after Field Peas		Rotation B Wheat after Millet	
		No Manure	Manure	No Manure	Manure	No Manure	Manure
1941	7/31	7/30	7/30	7/31	7/31	7/31	7/31
1942	8/4	8/3	8/5	8/6	8/6	8/6	8/6
1943	8/3	8/2	8/1	8/3	8/4	7/30	7/29
1944	8/1	7/29	8/11	8/1	8/3	7/27	7/29
1945	8/11	8/14	8/14	8/14	8/14	8/16	8/16

The chemical analyses for nitrogen were all made on the whole grain by the standard unmodified Kjeldahl process which does not get nitrate nitrogen, the presumption being that the ripened grain contains no nitrate nitrogen. All analyses are expressed upon the basis of grain containing 13.5 percent moisture. It is recognized that in converting to nitrogen per acre the data for the yields are on an air dry basis rather than on a uniform moisture basis; the same error enters into the calculations of the pounds of nitrogen per bushel of wheat. The term bushel as used in this paper means 60 pounds. All yields have been calculated from the actual yield of one-fifteenth acre plots.

Nitrogen Content of Soil

E. F. Ladd reported the nitrogen content of Plot 2, the continuous wheat plot, as 0.36 percent (12th Annual Report of the North Dakota Agricultural Experiment Station, dated February 1, 1902—page 26), for a sample taken from one to ten inches of the top soil; a sample taken at the bottom of the second foot contained 0.13 percent nitrogen. According to J. H. Shepperd and R. C. Doneghue (North Dakota Agricultural Experiment Station Bulletin 100, October 1912) the continuous wheat plot had grown at least 19 successive crops of wheat since the soil had been broken out from the virgin prairie in 1882. Willet M. Hays (Table XI opposite Page 49—Bulletin 10, North Dakota Agricultural Experiment Station) states that all of Rotation Series I was annually cropped to wheat from 1883 to 1891. The first

sampling of the soil appears to be that taken by Ladd in 1902. Walster reviewed the history of the continuous wheat plot in 1942 (N. Dak. Ag. Exp. Station, Bimonthly Bulletin V, No. 1, pp. 1-8, 1942). The nitrogen content of plots on which rotations A, C, and B have been conducted can be safely assumed to have been the same as Plot 2 in 1902. The present level of the nitrogen content of these plots has not been determined.

Although there has, presumably, been a decline in the total nitrogen level it is of interest to note that Plot 2 returned its highest yield on record since 1892 in 1942 when the outturn was 37.8 bushels per acre containing 53.32 pounds of nitrogen.

Effect of Season on Yield of Mida Wheat
Bushels Per Acre

Year	Plot 2 Wheat after Cont. Wheat	Rotation A Wheat after Sweet Clover		Rotation C Wheat after Field Peas		Rotation B Wheat after Foxtail Millet	
	No Manure	No Manure	Manure	No Manure	Manure	No Manure	Manure
1941	29.2	29.8	39.0	32.5	39.3	22.3	37.5
1942	37.8	45.8	50.5	46.3	48.5	29.3	44.8
1943	20.3	25.5	26.9	23.5	26.5	10.8	19.3
1944	17.1	25.0	24.1	21.0	23.7	14.4	23.3
1945	28.2	24.0	34.6	30.4	41.4	11.9	15.9

The season of 1942 was the "top" season of the five seasons. The highest yield for the five years was on manured land after sweet clover in 1942, the lowest yield on unmanured land after foxtail millet in 1943.

How Much Nitrogen Per Acre to Produce a Crop of Wheat?

Mida grown in continuous culture for the five-year period 1941 to 1945 obtained from the soil an average of 38.04 pounds of nitrogen annually for each crop of wheat produced, the average annual production being 26.5 bushels of wheat per acre.

The wheat crops (grain only) grown on each acre in the three different crop rotations noted above contained the following average amounts of nitrogen annually, the average yield per acre being set alongside:

Rotation and Crop Sequence	Soil not manured		Soil manured	
	Bus. of wheat per acre	Lbs. of nitrogen per acre	Bus. of wheat per acre	Lbs. of nitrogen per acre
A, wheat after sweet clover	30.0	42.55	35.0	50.16
C, wheat after field peas	30.7	46.37	35.9	55.33
B, wheat after foxtail millet	17.7	22.5	28.2	41.32

How Much Nitrogen to Produce One Bushel of Wheat?

Mida wheat grown in continuous culture each year for the five-year period 1941 to 1945 obtained from the soil an average of 1.426 pounds of nitrogen annually for each bushel of wheat produced, exclusive of the nitrogen in the straw. Wheat crops

(grain only) grown in the three different crop rotations contained the following average amounts of nitrogen for each bushel of wheat produced:

Rotation and Crop Sequence	Pounds of Nitrogen per bushel	
	Soil not manured	Soil manured
A, wheat after sweet clover	1.438	1.457
C, wheat after field peas	1.501	1.548
B, wheat after foxtail millet	1.278	1.456

Effect of Season on Amount of Nitrogen Per Acre in the Wheat Grain In Pounds Per Acre

Year	Plot 2 Wheat after Cont. Wheat	Rotation A Wheat after Sweet Clover		Rotation C Wheat after Field Peas		Rotation B Wheat after Foxtail Millet	
	No Manure	No Manure	Manure	No Manure	Manure	No Manure	Manure
1941	46.41	42.35	52.14	47.89	59.57	31.69	59.21
1942	53.32	58.82	71.23	73.59	78.11	33.93	65.08
1943	32.48	42.95	45.31	38.09	44.91	13.87	28.64
1944	20.60	36.84	38.05	30.06	35.67	16.98	30.41
1945	37.40	31.83	44.07	42.24	58.40	16.03	23.21

The largest amount of nitrogen per acre entered the grain from a crop raised on manured land following field peas in 1942; the lowest amount from a crop raised on unmanured land after foxtail millet in 1943.

Effect of Season on the Amount of Nitrogen in One Bushel of Mida Wheat

Pounds

Year	Plot 2 Wheat after Cont. Wheat	Rotation A Wheat after Sweet Clover		Rotation C Wheat after Field Peas		Rotation B Wheat after Foxtail Millet	
	No Manure	No Manure	Manure	No Manure	Manure	No Manure	Manure
1941	1.589	1.421	1.337	1.474	1.516	1.421	1.578
1942	1.411	1.284	1.410	1.589	1.611	1.158	1.452
1943	1.600	1.684	1.684	1.621	1.695	1.284	1.483
1944	1.205	1.474	1.579	1.431	1.505	1.179	1.305
1945	1.326	1.326	1.274	1.389	1.411	1.347	1.462

The largest amount of nitrogen in a bushel of wheat was from a manured plot after field peas in 1943; the smallest amount was from an unmanured plot after foxtail millet in 1942.

Acknowledgments

The crop rotation trials reported in this paper were under the supervision of T. E. Stoa, Agronomist, assisted by C. E. Swallers, Assistant Agronomist, and by Al Secord, Field and Seed House Assistant. All chemical analyses were made under the supervision of R. H. Harris, Cereal Technologist.