Relative Merits of Fall- and Spring-Applied Nitrogen Fertilizer

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The band placement of fertilizer on the plow sole has proved to be an effective method of increasing crop yields on many Indiana soils. Since the investigations with this method had been conducted on spring-plowed land, one of the first questions asked was whether this plow-sole fertilizer technique would be as effective on fall-plowed land as on spring-plowed land. Many farmers find it desirable, because of technical and economic reasons, to do part or all their plowing in the fall or winter months. Consequently, the question as to whether fall-applied fertilizer on the plow sole may be efficiently utilized by a crop the following year is of considerable importance in Indiana.

Of the three main fertilizer elements, nitrogen presents the greatest danger of loss. Fall applications of nitrate might be leached from the upper soil horizons during the winter, while nitrogen in the ammonium form might nitrify during the winter and then be leached as nitrate. Therefore, this study of fall applications of fertilizer was concerned more with nitrogen than with phosphate and potash.

REVIEWS OF LITERATURE

Many investigators have studied the relative merits of fall and spring-applied nitrogen on the yield and quality of winter cereals, but little work has been done on plowing under fertilizer in the fall of the year for growing a crop the following summer.

Ammonium ions are held by the soil colloids while nitrate ions are free to move with the soil water. Smith (12) reported that in Rhode Island there was little actual loss of easily nitrifiable nitrogen from the upper 2 feet of soil in fallow plots, but variations in weather conditions and the activity of soil microorganisms caused temporary disappearances of nitrate. Under midsummer conditions, nitrate that were leached from the upper soil layers were returned by upward movement of soil water. Fraps (2) in Texas, Mathew (6) in Georgia, Rouselle (7) in France, and others have found that when nitrate were applied to growing crops, there was seldom any appreciable loss of nitrate due to leaching except on sandy soils or during seasons of excessive rainfall. Sievers and Holtz (11) found that nitrate leached as far down as 3 to 5 feet during a wet winter in Washington. Sarazin (9) working with fallow plots in the vicinity of Paris, France, in 1929-38, found that most of the ammonium sulfate when applied on the surface of the soil in November was nitrified by the following March in all of the 9 years studied. He observed that of the nitrate formed during the period of November to March, little remained in the surface 8 inches. Ivanov (3) found that in typical sierozems with deep ground water levels, nitrogen applied in the fall was rapidly nitrified and leached during the winter to a depth less than 60 inches. Most of it was concentrated in a layer between 15 to 40 inches.

There is considerable literature on the influence of temperature, moisture, and soil reaction on nitrification. It is generally agreed that the favorable temperature for nitrification in soils varies between 15° and 40° C, although exceptions have been noted. Russell, Jones, and others found that nitrification was active even at temperatures of 5°C. King and Whitson (4) observed that nitrification proceeded very slowly at a temperature of 2°C.

EXPERIMENTAL PROCEDURE

A fallow experiment, which consisted of two small fallow plots, was laid out in the fall of 1944 to study the movement and transformation of fall applied fertilizer. The plow sole horizon of an area of 10 by 12 feet was sampled at the following depths in inches: 0-1/2, 1/2-1, 1-3, 3-5, 5-7, 7-9, 9-11, 11-13, 13-15, 15-17, and 21-23. The other series at Lafayette, Ind., on Crosby silt loam (plow depth of 8 inches) was sampled at the following depths in inches: 0-1/2, 1/2-1, 1-3, 3-5, 5-7, 7-9, 9-11, 11-13, 21-23. The plots were sampled immediately after plowing and applied five times during 1945. Ammonium analyses were made on fresh toluene-extracted samples by a modification of Olsen's method (13), and samples for total nitrogen were analyzed by the Gunning method. The pH determinations were made with a glass electrode using a soil-water ratio of 1:5.

A corn experiment, which measured the relative effect of fall and spring-plowed-under fertilizer on corn yields, was conducted in connection with the nitrogen studies on Miami sandy loam and Crosby silt loam. A third soil, Yigo silt loam, which is seldom plowed in the fall for spring planted crops, was also used. A split plot design with four replications was used consisting of eight blocks of four treatments as follows: (a) 1,000 pounds per acre of 8-8-8 fertilizer; (b) 1,000 pounds of N$_2$O as the nitrogen carrier plus 1.5 tons of straw per acre; (c) same as (b) except with the nitrogen carrier plus 1.5 tons of straw per acre; and (d) 2,000 pounds of N$_2$O fertilizer containing NaNO$_3$ as the nitrogen carrier plus 1.5 tons of straw per acre.

RESULTS AND DISCUSSION

The weather of the 1944-45 season (Fig. 2) was characterized by a dry and cold winter, and a very dry and hot spring and summer, with an unseasonal