The Effect of Time, Rate, and Method of Application of Fertilizer on the Yield and Quality of Hard Red Winter Wheat

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The yield response of wheat to large amounts of available nitrate nitrogen in the soil, or to nitrogen applied at varying intervals during the early vegetative growth of the wheat plant, has been demonstrated by numerous investigators. Notable among these experiments are those conducted by Burke (1), Davidson and Le Clerc (3), Neidig and Snyder (5), Sivers and Holtz (6), Vandecaveye and Baker (7), and Gainey, Sewell, and Myers (4).

EXPERIMENTAL PROCEDURE

The experiment reported here was conducted on Geary silt loam soil at the Agronomy Farm, Manhattan, Kan. The land, in preparation for the seeding of the experimental plots, was plowed on July 22, 1946. Pawnee wheat was planted on October 25, 1946. No apparent damage to germination occurred even where the very large amounts of fertilizer were applied with the seed.

The fertilizer materials used in this experiment included 20% superphosphate, ammonium nitrate, and muriate of potash. These materials were used alone or in such mixtures as to provide the proper ratio of the various fertilizer elements.

Those plots given broadcast applications of fertilizer received it just prior to the plowing operation. Fertilizer applications on the plowsole were made by means of the conventional fertilizer attachment on a standard two-bottom plow. Fertilizer applications other than those mentioned above were all made by means of a fertilizer attachment on a standard grain drill. Those plots which received the fertilizer at seeding time had the material applied in the drill row with the seed. Spring topdressings of nitrogen fertilizer were applied by means of the same drill. The spring topdressing was made on March 25, 1947, at a time when the wheat plants were just beginning spring growth.

Each plot consisted of a single drill strip which was 125 feet in length. Each treatment was replicated four times. The various treatments were placed at random within each block of plots.

The wheat was harvested on July 10, 1947, by means of a combine. Test weights of a sample from each plot were taken on July 12 by means of a standard test weight apparatus. A portion of the same sample used for this determination was saved for total nitrogen determination. Total nitrogen determinations were made by means of the modified Kjeldahl method. The percentage protein was calculated by multiplying the total nitrogen content by the factor 6.25.

The soil used in this experiment was found to possess the following chemical properties in pounds per acre plow layer according to laboratory studies: Total nitrogen, 3.330 pounds; available phosphorus, 89 pounds; and exchangeable potassium, 405 pounds.

The results of this investigation are presented in Table 1. Included in this presentation are those data relative to the yield of wheat, test weight of wheat, percentage protein, and the total nitrogen content of the harvested wheat. Each plot consisted of a single drill strip which was 125 feet in length. Each treatment was replicated four times. The following chemical properties in pounds per acre plow layer were determined: Total nitrogen, 3,330 pounds; available phosphorus, 89 pounds; and exchangeable potassium, 405 pounds.

The use of potassium-bearing fertilizer in combination with nitrogenous and phosphatic fertilizer was highly significant. An application of ammonium nitrate at the rate that provided 50 pounds per acre each of nitrogen and P$_2$O$_5$; and from the application of mixed fertilizer which provided 25 pounds per acre each of nitrogen and P$_2$O$_5$ at the rate of 25 pounds per acre on the plowsole, while the other involved the use of 25 pounds per acre of 20% superphosphate, ammonium nitrate, and muriate of potash as a spring topdressing.

YIELD DATA

Highly significant increases in the yield of wheat were obtained as the result of four fertilizers. An application of superphosphate at a rate that provided 25 pounds per acre of P$_2$O$_5$; combined with a spring topdressing of ammonium nitrate; that provided 25 pounds per acre of nitrogen resulted in the greatest increase in yield. Highly significant increases of just slightly smaller magnitude were obtained as the result of using a complete fertilizer at seeding that provided 25 pounds per acre each of P$_2$O$_5$ and potash; from the use of a mixed fertilizer at seeding time that supplied 25 pounds per acre each of nitrogen and P$_2$O$_5$; and from the application of mixed fertilizer on the plowsole that supplied 25 pounds per acre each of nitrogen and P$_2$O$_5$ at the rate of 25 pounds per acre.

Significant increases in yield were obtained from an application of superphosphate at a rate of 25 pounds per acre of P$_2$O$_5$ at seeding; and from a spring topdressing of ammonium nitrate at the rate that 50 pounds per acre each of nitrogen and P$_2$O$_5$ were provided; from a similar application of superphosphate and nitrogen fertilizer, except that the superphosphate was applied on the plowsole; and from the application of mixed fertilizer which provided 25 pounds per acre each of nitrogen and P$_2$O$_5$ at the rate of 25 pounds per acre.

Increases in yield from the use of either superphosphate or nitrogen alone were not statistically significant. An application of ammonium nitrate at a rate of 25 pounds per acre of nitrogen on the plowsole produced a decrease in yield. No other addition of nitrogen fertilizer alone caused a similar decrease in yield. An application of 300 pounds per acre of ammonium nitrate applied by drilling with the drill row just prior to the planting time apparently did not damage germination of the seed and actually resulted in a very slight increase in the yield of wheat, although this increase was somewhat lower than that obtained from the application of ammonium nitrate made at seeding time.

It was noted that of the various combinations of nitrogen and phosphoric acid in the mixtures, only two treatments failed to produce significant increases in yield. These were the application of ammonium nitrate at a rate of 25 pounds per acre of nitrogen on the plowsole, while the other involved the use of 25 pounds per acre of 20% superphosphate, ammonium nitrate, and muriate of potash as a spring topdressing.

It is concluded that the results of this investigation demonstrate that highly significant increases in yield of wheat can be obtained through the use of proper rates and combinations of nitrogen, phosphoric acid, and potash applied in the drill rows with the seed and from a spring topdressing.