8-1982

Efficiency of Nitrogen Use with Corn on a Tiled and Untiled Soil

Lloyd W. Murdock
University of Kentucky, lmurdock@uky.edu

John Kavanaugh
University of Kentucky

Harold F. Miller
University of Kentucky

Grant Thomas
University of Kentucky

Monroe Rasnake
University of Kentucky, mrasnake@uky.edu

UNIVERSITY OF KENTUCKY
COLLEGE OF AGRICULTURE
Lexington, Kentucky 40546

COOPERATIVE EXTENSION SERVICE

AGRONOMY NOTES

Volume 15, No. 6 Aug. 1982

EFFICIENCY OF NITROGEN USE WITH CORN ON A TILED AND UNTILED SOIL

Lloyd Murdock, John Kavanaugh, Harold Miller*,
Grant Thomas and Monroe Rasnake

INTRODUCTION

Excessive water is one of the largest contributors to the inefficient use of nitrogen in Kentucky. Because of this, nitrogen is often lost by both leaching and denitrification. The amount of these losses can be great depending on soil type and weather. Well-drained soils in Kentucky have been shown to lose less nitrogen than poorly drained soils. The nitrogen lost from well-drained soils is usually due to leaching. The nitrogen in the soil, even soon after applying non-nitrate forms of fertilizer N, is mostly in the water soluble nitrate form. When more water falls onto a well-drained soil than the soil can hold, then both water and nitrogen move through the soil below the root zone and are lost for plant use. On poorly-drained soils, the mostly likely method of nitrogen loss is due to denitrification. Nitrogen loss by this mechanism is due to the soil becoming saturated with water (waterlogged) and forcing the air out of the soil. In an effort to survive, some of the microorganisms in the soil take oxygen from nitrate. This process (denitrification) turns the nitrogen into a gas that will diffuse out of the saturated soil and be lost into the air. It usually occurs when the soil temperature is above 50°F and the soil is saturated for more than a two day period. If nitrogen fertilizer has been added to the soil prior to the existence of the above conditions, then fairly large amounts of nitrogen can be lost. These conditions are most prevalent in Kentucky on poorly drained soil in April and May. In the past, most farmers have tried to manage this problem by adding excess fertilizer nitrogen to still obtain maximum yields after the loss has been sustained. This management practice may not be economically feasible in the future if nitrogen prices continue to escalate. An alternative management practice used by many farmers is to reduce the amount of nitrogen lost by simply delaying the application of nitrogen until the conditions for denitrification have little chance of occurring. This usually means that the nitrogen is applied in late May or June after the corn has been planted and the risk of waterlogged soil conditions is greatly reduced.

* A special thanks to Mr. Harold Miller, a dedicated extension specialist who is now retired. Due only to his insights and tireless efforts is this project a reality. This project and many others with which he has been associated has formed the basis for many of the fertilizer recommendations in Kentucky.

To determine the magnitude of such factors, we began an experiment on a poorly drained bottom soil in 1970 to determine 1) the proper rates of preplant nitrogen 2) effectiveness of sidedressing nitrogen and 3) effect of soil tiling on the above two factors.

METHOD

The experiment was carried out on the Dane Milligan farm in Ohio County, on a poorly drained Melvin silt loam located in the Rough River bottoms. The trials were begun in 1970 and conducted through 1976 before the field was tiled. The experiments were continued on the same field from 1977 to 1981 after the field had been tiled. Since corn production practices used before and after tiling were very similar, direct comparisons have been made between tiled and untiled effects.

The site was usually chisel plowed in the fall and disked twice in the spring. Herbicides were incorporated during the last disking and weed control was very good. The corn variety planted was Pioneer 3369A from 1970 to 1979, and Bo Jac 83 from 1979 to 1981. The corn was planted each year as soon as the soil dried sufficiently for preparation and planting. Due to the wet nature of this soil, the planting date was usually late and ranged from April 30 to June 8. Phosphorus and potassium were added by the farmer at or above the rate recommended by the University of Kentucky. The soil nutrient status as tested by the University of Kentucky Soil Testing Laboratory in 1978 was P, 88 (high); K, 224 (medium); pH, 6.2.

The plots were 20 feet wide and, depending on the year, were either 36 or 43 feet in length. All of the nitrogen was weighed and broadcast by hand on each plot in the form of ammonium nitrate. The nitrogen applied "at planting" was broadcast over the surface shortly after planting. The sidedressed nitrogen was applied 4 to 6 weeks after planting.

The field was tiled in the fall of 1976 with the tile lines being evenly spaced and 80 feet apart.

RESULTS

Before Tiling (1970-1976)

Figure 1 shows the effect of rate and time of nitrogen application on corn yields before the field was tiled. The results include data from the years 1970 through 1976. As with most poorly-drained soils, there was a dramatic response to the addition of nitrogen, and large amounts of nitrogen fertilizer produced high yields and were economically feasible.

The nitrogen applied at planting increased yields to a high of almost 150 bu. per acre. A rate of 300 lb. N per acre was tested three of the seven years, but not found to be economically dependable since in two of the three years, the yield was increased only 3 to 5 bushels per acre over the 200 lb. N per acre rate applied at planting. However, during the third year, a very wet year (1976), the yield increase was over 20 bushels per year. The yield increase for additional nitrogen was very favorable up to 200 lb. of nitrogen per acre, increasing about 10 bushels for every 25 lb. of nitrogen per acre added between 100 and 200 lb. N per acre and 100 bu. per acre for the first 100 lbs. of N per acre.

Adding the nitrogen four to six weeks after planting increased the efficiency of the use of nitrogen. Sidedressed nitrogen resulted in 23 and 10 more bushels per acre at the 100 and 150 lbs/acre rates respectively, as compared to applying the same rates at planting. The yield with 100 lbs. N/acre sidedressed was about the same as 150 lb. N/acre applied at planting. This difference decreased as rates, at both times of application, increased. The yields at the 200 lb. N/acre were very similar, indicating that 25 to 50 lb. N/acre had been lost when the nitrogen was added early. As higher rates of nitrogen were added this loss became less important and was eventually masked at the highest rate.

After Tiling (1977-1981)

Figure 2 shows the effect of rate and time of nitrogen application on corn yields after the field had been tiled (1977 through 1981). After tiling, the soil was better drained and began to respond as if it were a moderately well-drained soil. Although yields were again in a high range, the response to nitrogen was different. Yields began to "top out" in the 150 to 175 lb. N/acre range when applied at planting. There was an average of only 3 bu/acre increase for each 25 lbs. of nitrogen added between 100 and 175 lb. N/acre. Delaying the application of nitrogen 4 to 6 weeks after planting did not improve the yields, indicating the efficiency of the nitrogen use was not improved. The improved drainage probably reduced the chances for waterlogging which would cause high amounts of early season nitrogen loss due to denitrification.

Comparison of Tiled and Untiled

Figure 3 compares yields of corn at the same nitrogen rates applied at planting before and after tiling. The improved drainage evidently increased the amount of nitrogen carry-over from year to year since yields with no added nitrogen were higher after tiling. The yields for all rates up to and including 175 lb. N/acre were higher after tiling, indicating lower loss and more efficient use of the nitrogen. It appears for tiled fields that 25 to 50 less lbs. of N/acre is required to "top out" the yield. There was only one nitrogen rate (200 lb. N/acre) at which the untiled had a higher yield than the tiled (untiled plots averaged 8 bu/acre more). It is unclear as to whether or not this difference is real. Since the two practices were not compared during the same years, a comparison of the yields could be affected by a number of factors such as different environmental conditions and planting dates. A comparison of planting dates is shown in table 1. The widest range of planting dates occurred before tiling. However, the average planting dates are very similar. If the latest date (1973) is not considered, the average planting dates are identical. It is interesting to note (data not shown) that the 1973 yields were the highest obtained throughout all 12 years of the experiment.

SUMMARY AND CONCLUSIONS

The poorly drained Melvin soil before tiling produced high yields if high amounts of nitrogen were added. If the nitrogen was applied at planting, there was a good economical response up to 200 lbs. nitrogen/acre. If the nitrogen was sidedressed 4 to 6 weeks after planting, 25 to 50 lbs. per acre less nitrogen was required to get maximum yields. This nitrogen was probably lost due to denitrification which took place when the soil was waterlogged early in the season. Tiling the soil improved the drainage and reduced the nitrogen loss to the point that nitrogen applied at planting was as efficient as sidedressed nitrogen.

Figure 1. Effect of Rate and Time of Nitrogen Application on the Yield of Corn Before Tiling

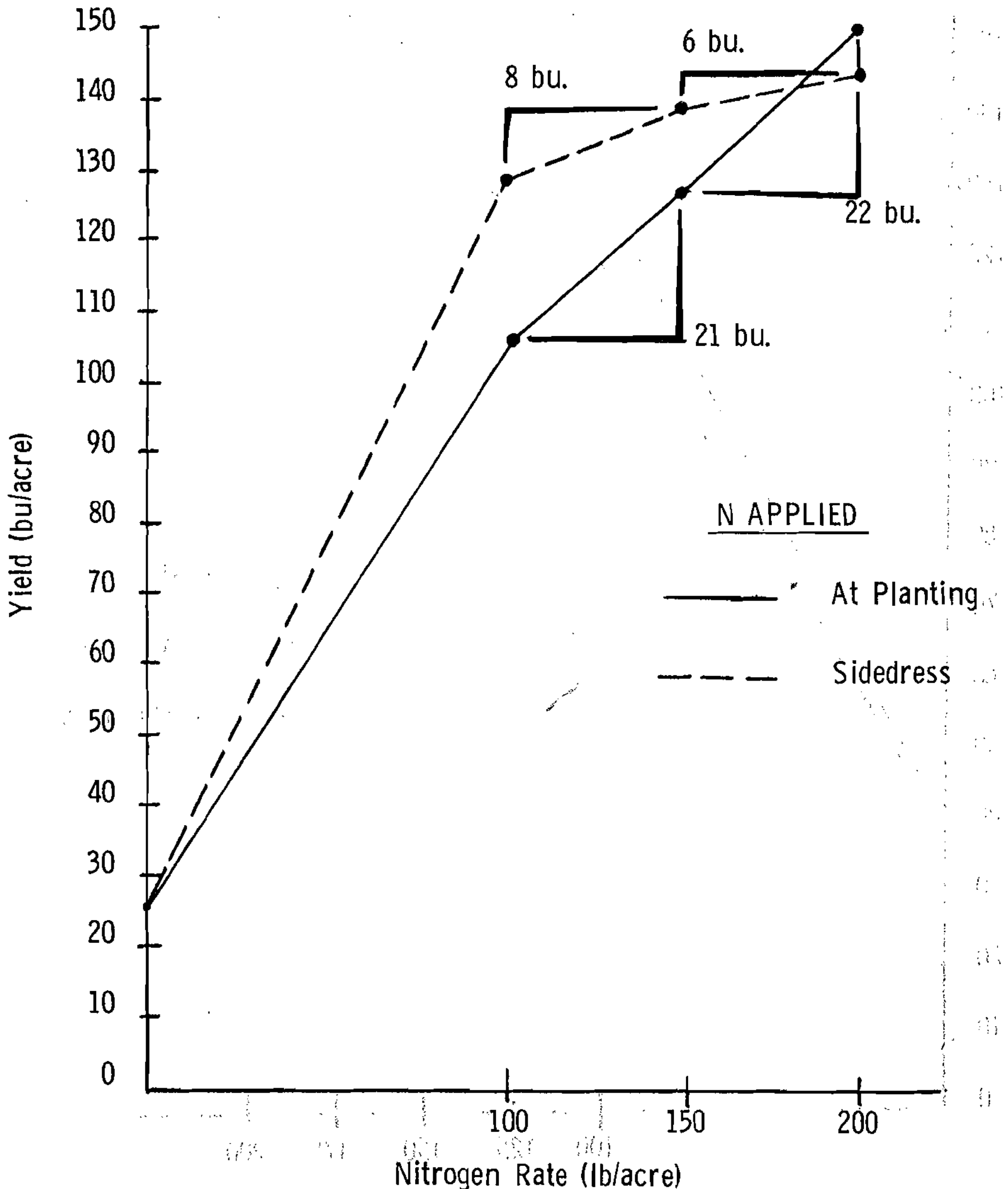

Figure 2. Effect of Rate and Time of Nitrogen Application on the Yield of Corn After Tiling

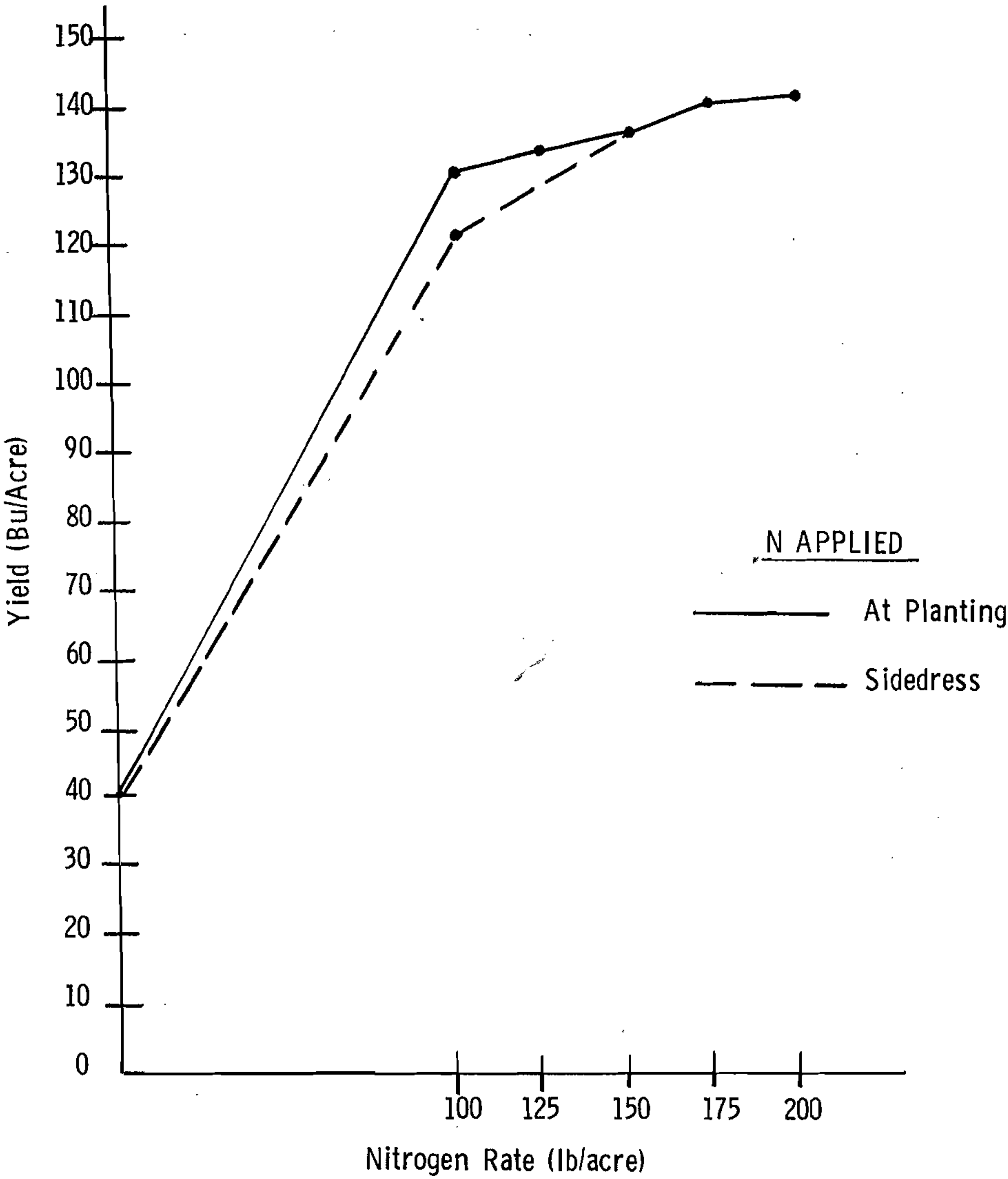

Figure 3. Effect of Tiling on Corn Yields at Different Nitrogen Rates Applied at Planting.

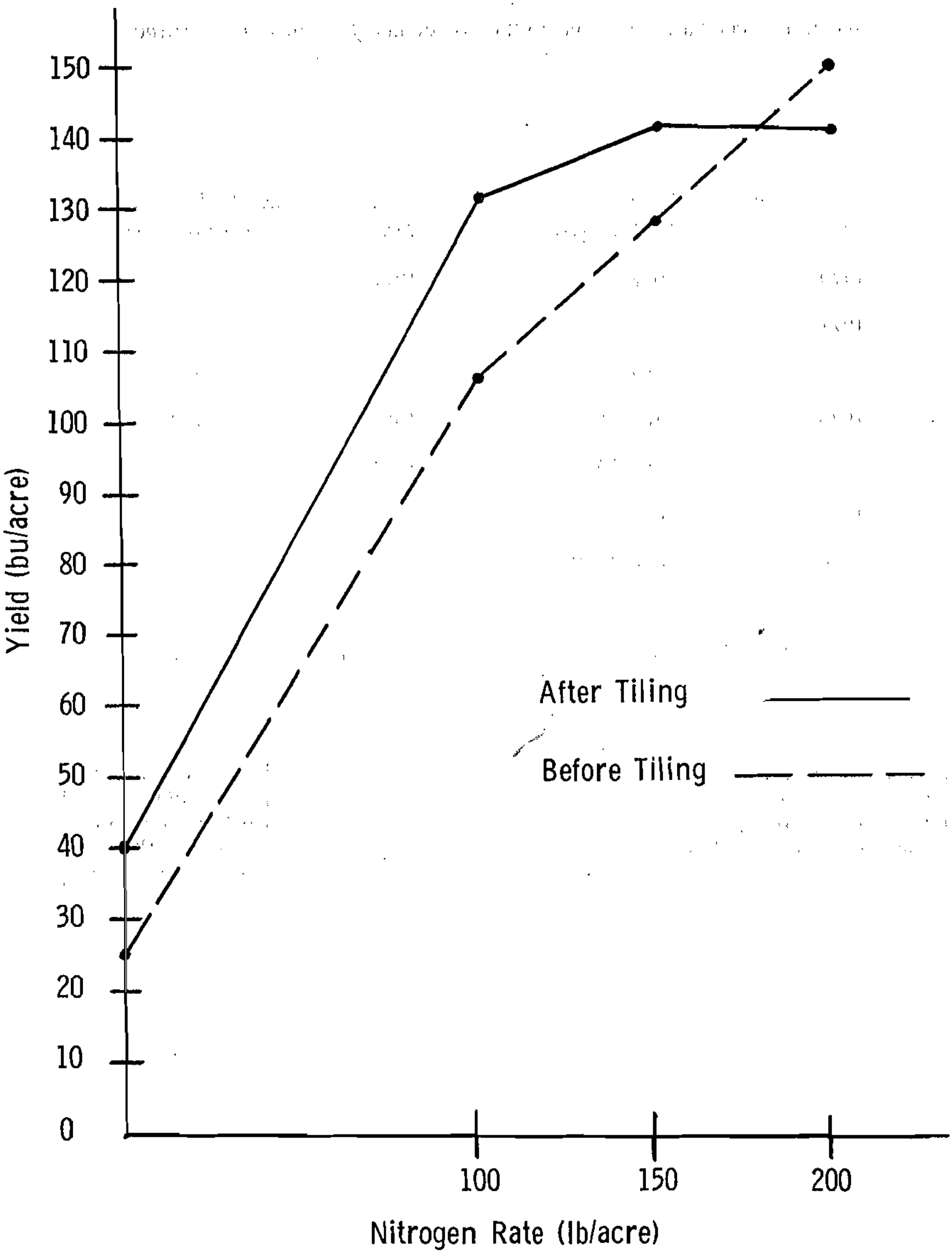

TABLE 1. COMPARISON OF PLANTING DATES BEFORE AND AFTER TILING.

BEFORE TILING		AFTER TILING	
YEAR	PLANTING DATE	YEAR	PLANTING DATE
1970	May 6	1977	May 11
1971	May 22	1978	May 23
1972	May 11	1979	May 21
1973	June 8	1980	May 2
1974	May 14	1981	May 4
1975	May 19		
1976	April 30		
AVERAGE	May 16	AVERAGE	MAY 12

AGRONOMY NOTES
College of Agriculture
University of Kentucky
Lexington, Kentucky 40546

U.S. POSTAGE
PAID
NON-PROFIT ORG.
PERMIT NO. 51
LEXINGTON, KY.