PREPLANT SOIL NITROGEN TEST FOR CORN

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ABSTRACT

Soil ammonium N and nitrate N were measured at the pre-plant and sidedress stages on 59 Michigan fields in 1992. Total inorganic soil N (ammonium N plus nitrate N) at pre-plant stage averaged to 12.6 ppm, about 50% of which was present in the nitrate form and 50% in the ammonium form. Total inorganic N at sidedress stage was 18.9 ppm, of which the nitrate N component was 12.2 ppm. The NH_4/NO_3 ratio decreased from 1.06 at preplant stage to 0.54 at sidedress stage. Multiple correlation analysis revealed that 32% of the variability in the sidedress nitrate N was explained by preplant nitrate N and ammonium N levels.

INTRODUCTION

Previous studies at Michigan State University indicate that measuring only nitrate N in early spring (prior to planting) under-estimates the soil N availability. Other observations indicate that there is a buildup of ammonium N in soil from fall to spring under Michigan conditions. Presumably, this N is derived from mineralization of organic matter during the winter and early spring months. As the soil warms up in spring (late May and early June), this ammonium N is converted to nitrate N through microbial action.

The pre-sidedress soil nitrate test (PSNT) which has been used in Michigan, Iowa and a number of Northeastern states, is designed to measure N availability at the sidedress stage when the corn is 10-12 inches tall. It's use in Michigan has been restricted because most corn growers currently apply their N preplant rather than at sidedress time. Thus, the availability of a reliable preplant soil N test would benefit Michigan corn growers at present.

OBJECTIVES

The objective was to determine whether the measurement of soil ammonium N, in addition to nitrate N, would provide an improved assessment of soil N availability. The relationships between the preplant soil ammonium N and nitrate N levels with nitrate N values observed at the sidedress stage were investigated through correlation and regression procedures.

METHODS

In the spring of 1992, county Extension agents were asked to submit soil samples from fields where the bulk of the N fertilizer was to be applied at sidedress time. Samples from 59 corn fields located in 16 counties were submitted. Each field was sampled twice from the surface foot, once prior to planting and again at sidedress time. The samples taken at sidedress time were taken from the middle of the corn row to avoid contact with any starter fertilizer that might have been applied. Soil ammonium and nitrate N was measured in KCl extracts by the MSU soil testing laboratory. Previous crop and manure history for each of the fields was obtained from growers.

RESULTS AND DISCUSSION

The average soil ammonium N and nitrate N in the preplant and sidedress samples for 59 corn fields are presented in Table 1. Total inorganic soil N (ammonium N plus nitrate N) at pre-plant stage averaged to 12.6 ppm, about 50% of which was present in the nitrate form and 50% in the ammonium form. Total inorganic N at sidedress stage was 18.9 ppm, of which the nitrate N component was 12.2 ppm. The NH_4/NO_3 ratio decreased from 1.06 at preplant stage to 0.54 at sidedress stage. At the sidedress stage, a substantial quantity of N (6.7 ppm) which was higher than expected, was still present in the ammonium form. This could be attributed to the unusually cool and wet summer conditions that prevailed in 1992 contributing to slower rates of N mineralization. The ammonium N fraction is not detected by the current PSNT.

The amount of available soil N in the preplant samples based on the ammonium N test, amounts to 24 lbs N/A-ft (6.52 ppm x 3.6, assuming 300,000 lbs of soil per acre inch). The soil ammonium N and nitrate N appears to be slightly higher in the previous legume and manured fields, however, due to an insufficient number of samples the values were not significantly different. The amount of pre-plant nitrate N in the non-manured/non-legume system was the lowest (14 lb N/A-ft). Testing for ammonium N in these fields would have provided an additional credit of 23 lb N/A.

Linear and multiple correlation analysis was applied to the data to evaluate the effects of preplant nitrate N and ammonium N on the presence of nitrate N at sidedress time. The linear correlation coefficients for selected variables are presented in Table 2. Although some of the coefficients are statistically significant ($p=0.01$), they do not imply a strong linear relationship. The scatter diagrams for variables having significant correlations are presented in Figures 1-3. Multiple correlation analysis was used to determine the combined effects of preplant nitrate N and ammonium N on the sidedress nitrate N. The multiple correlation coefficient was 0.57, which was statistically significant ($p=0.01$). Accordingly, 32 percent of the variability in sidedress nitrate values was explained by preplant nitrate and ammonium levels. The multiple regression equation is represented as:

$$Y' = 7.78 + 0.7\ X_1 + 0.03\ X_2$$

where Y' is the predicted value of nitrate N at sidedress stage, X_1 is the nitrate N measured at preplant stage, and X_2 is the ammonium N at preplant stage. This regression equation is depicted in Figure 4.

This study needs to be repeated for a number of years to assess and calibrate the full effects of seasonal and crop management variables on the soil N availability in Michigan. Of special interest is the contribution of soluble organic N that was recently reported by European scientists as being an important source of available N to plants. This N fraction was not measured in the current study but may provide additional clues to improve our soil N assessment. Although the soluble organic N fraction could be easily extracted with a dilute solution of $CaCl_2$, a rapid laboratory procedure to measure this fraction is currently unavailable to us. We plan to pursue this aspect of research in future studies.

Table 1. Average nitrate and ammonium levels (ppm) in the pre-plant(pp) and side-dress(sd) soil samples taken from 59 corn fields in 16 counties in 1992.

Cropping System	# of fields	NO3-N pp	NH4-N pp	Tot N pp	NO3-N sd	NH4-N sd	Tot N sd	NH4/NO3 pp	NH4/NO3 sd
No manure/No legume	27	3.8	6.4	10.3	9.1	7.8	16.9	1.67	0.86
+ Manure /No Legume	14	8.4	5.6	14.0	18.4	5.1	23.5	0.67	0.28
No Manure / + Legume	15	6.5	7.0	13.5	10.7	6.6	17.3	1.08	0.62
+ Manure / + Legume	3	13.0	9.0	22.9	18.7	4.0	22.7	0.70	0.21
All Samples	59	6.1	6.52	12.6	12.2	6.7	18.9	1.06	0.54

Table 2. Correlation coefficients for nitrate N and ammonium N measured in the preplant and sidedress soil samples.

X and Y Variables	Linear Correlation Coefficient (r)
Tot N pp vs. NO3-N sd	0.47**
Tot N pp vs Tot N sd	0.42**
NO3-N pp vs NO3-N sd	0.55**
NH4-N pp vs NH4-N sd	0.25

** Statistically significant at 1% level.

Fig 1. Correlations of preplant and sidedress soil N in corn fields 1992

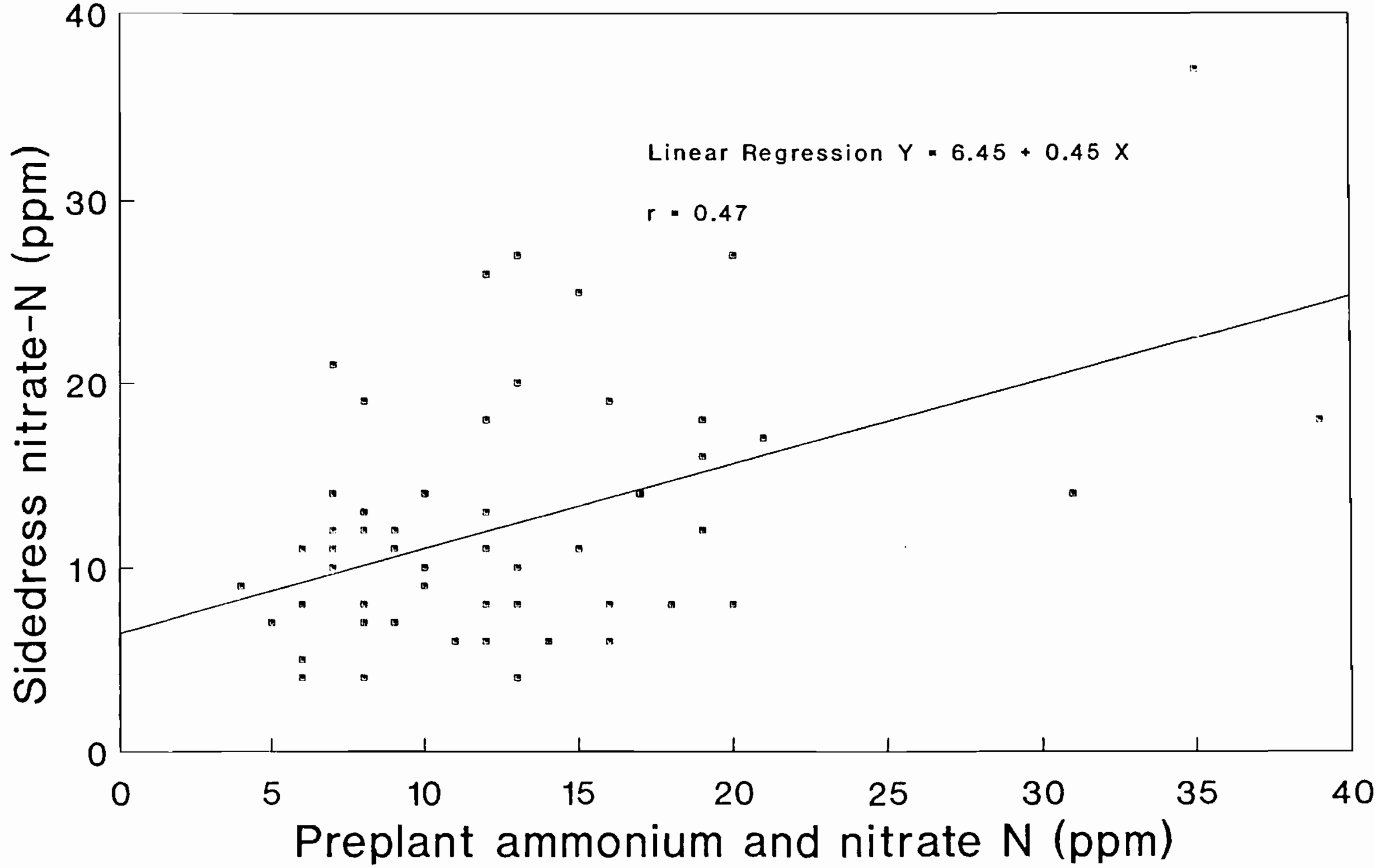


Fig 2. Correlations of preplant and sidedress soil N in corn fields 1992

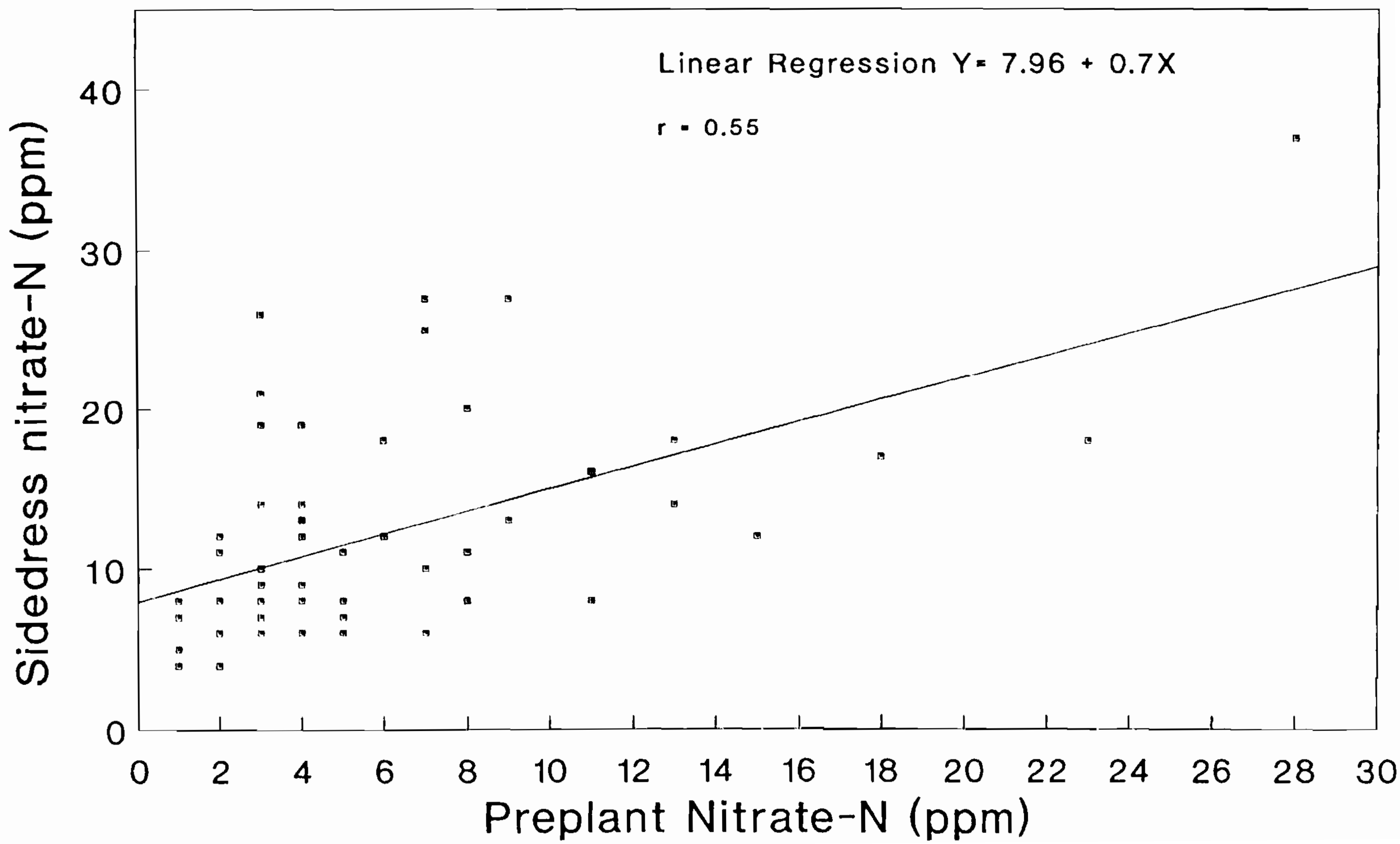


Fig 3. Correlations of preplant and sidedress soil N in Corn fields 1992

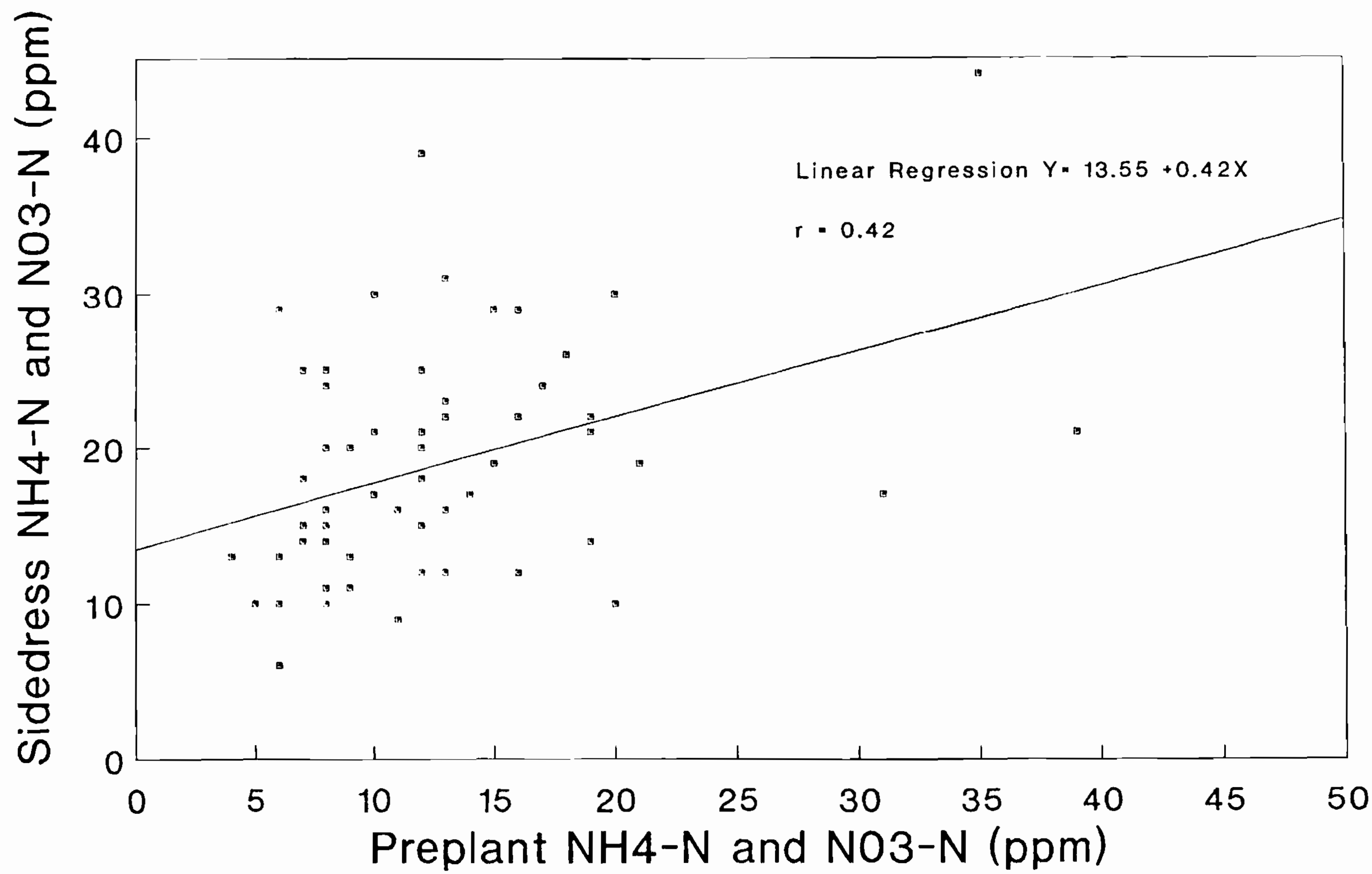
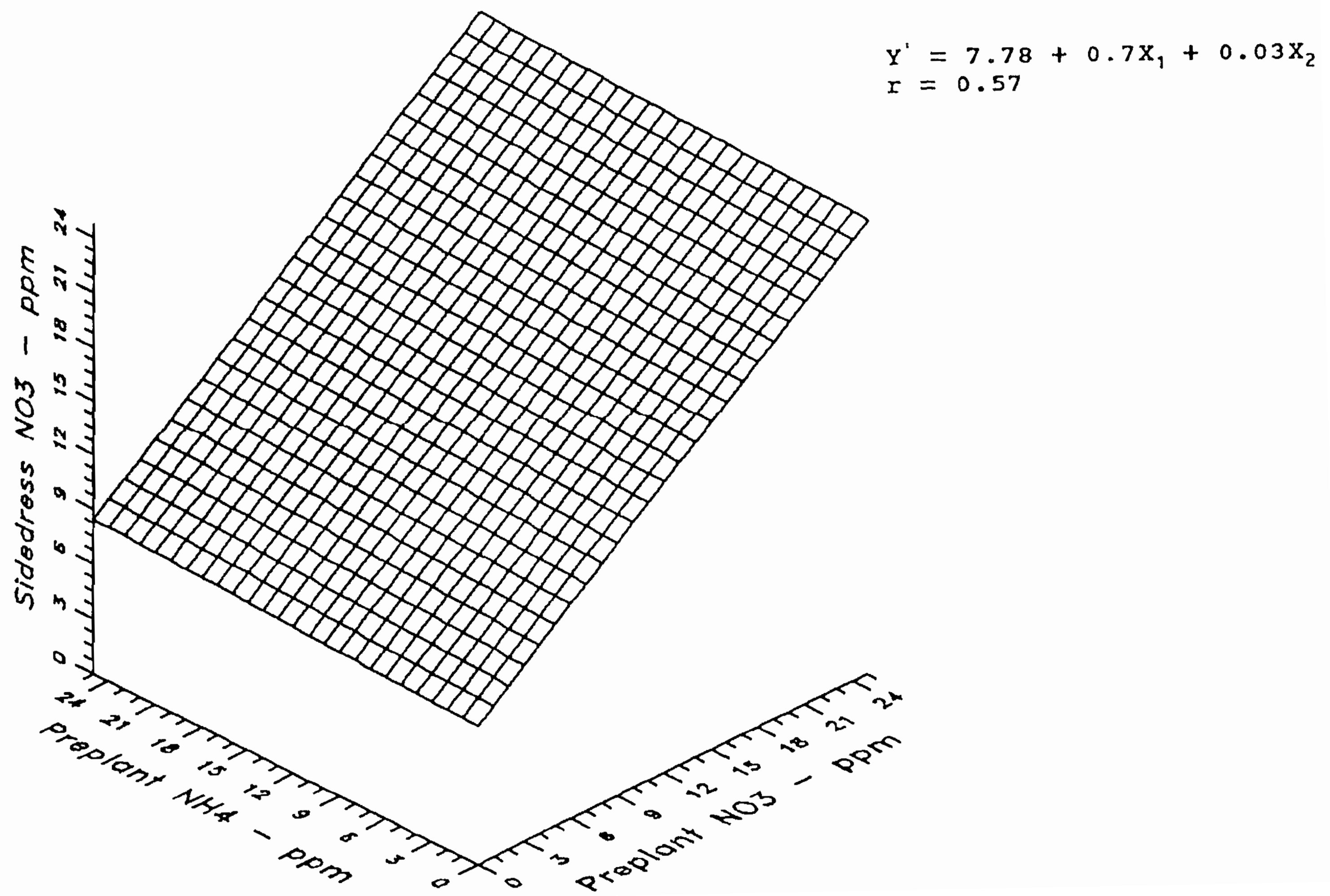


Fig. 4. Multiple Regression Equation for Soil N Availability.



PROCEEDINGS OF THE TWENTY-SECOND NORTH CENTRAL EXTENSION - INDUSTRY SOIL FERTILITY CONFERENCE

November 18-19, 1992, Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 8

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