NITROGEN MINERALIZATION RESPONSE TO TILLAGE PRACTICES ON LOW AND HIGH NITROGEN SOILS

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ABSTRACT

In strip tillage, crop residue is left on soil surface, decreasing the contact between soil and the residue, and therefore reducing decomposition rates compared to conventional tillage methods. Decomposition rates directly affect carbon and nitrogen ratios, which can affect nitrogen mineralization rates. The objective of this research is to determine the effect of tillage method and nitrogen rate on nitrogen available to sugar beets planted after a cereal crop. This two-year field study conducted in Kimberly, Idaho, consisted of three tillage methods (moldboard plow, chisel plow, and strip tillage), two tillage timings (fall and spring), and four fertilizer N rates plus a control. Soils from each plot were sampled shortly after nitrogen fertilization and incubated at average seasonal temperatures for Kimberly, Idaho to monitor nitrogen mineralization patterns. In 2008, we found that at N fertilizer rates of 0, 50, and 100 lbs N/acre, intensive tillage (moldboard plow and chisel plow) in the spring had the greatest potential for decreasing plant available nitrogen and increasing soil carbon, while intensive tillage in the fall slightly increased plant available nitrogen. No tillage method or tillage timing effects were detected in 2009, likely due to unexpectedly high residual nitrogen concentrations in the soil. It appears that tillage method and timing are more likely to impact nitrogen mineralization in growth limiting (low N) environments.

INTRODUCTION

With the introduction of Roundup Ready® sugar beets in 2008, sugar beet growers in Idaho became interested in utilizing strip-tillage to potentially increase economic returns. The advantages associated with strip tillage over conventional tillage in sugar beet production are reduced soil compaction, soil erosion, weed pressure, and labor costs, while increasing total yields, sugar content, soil carbon concentrations, and overall soil quality. Growers are concerned that changing tillage practices will alter nitrogen mineralization dynamics in the soil. Sugar beets have very specific nitrogen needs, producing low yields if the overall available nitrogen is too low, and producing low sugar yields if the nitrate concentrations are too high late in the season. Tillage practices have the potential to impact residue decomposition. Conventional moldboard plowing increases the constant exposure of the residue to air, moisture, soil, and soil microbes, which could hasten the conversion of organic carbon to carbon dioxide. In strip tillage, crop residue is left on soil surface, decreasing the contact between soil and the residue, and therefore reducing decomposition rates compared to conventional tillage methods. Decomposition rates directly affect carbon and nitrogen ratios, which can affect nitrogen mineralization rates. Understanding the effect that tillage operations have on N mineralization will allow growers to develop efficient nutrient management plans specific to tillage operations.

The objective of this research is to determine the effect of tillage method and nitrogen rate on nitrogen available to sugar beets planted after a cereal crop.

METHODS

The study was performed in collaboration with a field study conducted by David Tarkalson and David Bjorneberg at the USDA-ARS station in Kimberly, Idaho. The experimental design of the field study consisted of three tillage methods (moldboard plow, chisel plow, and strip tillage), two tillage timings (fall and spring), and four fertilizer N rates plus a control. Fifteen soil samples from each plot were extracted from a depth of 12 inches one week after the only application of nitrogen fertilizer (urea) and composited. Soils from each plot were incubated at temperatures adjusted weekly to match the most recent four-year average temperature at an 8 inch soil depth for the ARS station in Kimberly. Samples were analyzed every three weeks for nitrate and ammonium concentrations to estimate nitrogen mineralization and immobilization in the soil. Soils were also analyzed for total carbon and nitrogen content through combustion. Plant available nitrogen in the soil was estimated by summing nitrate and ammonium concentrations at the conclusion of a 4-month incubation period in each of the soil bags (Table 1).

RESULTS AND DISCUSSION

In 2008, tillage timing (fall vs. spring) had no significant effect on plant available N accumulation over a growing season for strip-till and chisel plowed soils, although there was a trend toward less available N at the 50 and 100 lb N/acre rate (Table 1). The expectation is that timing will have minimal effect on N availability under conservation tillage in comparison to moldboard plowing, as the disturbance to the soil at either time is relatively small. Spring moldboard plowing immobilized a significant proportion of added fertilizer N at all N rates (Table 1). The fall moldboard plow treatment also had significantly less carbon content than all of the spring tillage treatments as an apparent result of residue decomposition over the winter. It is likely that the lower carbon content in the fall moldboard plow treatment in comparison to the spring moldboard plow treatment allowed for increased nitrogen mineralization of the organic N from the residue and from soil organic matter.