SOME FACTORS AFFECTING NITROGEN TRANSFORMATION IN SOME SOILS OF EGYPT USING-^{15}N.

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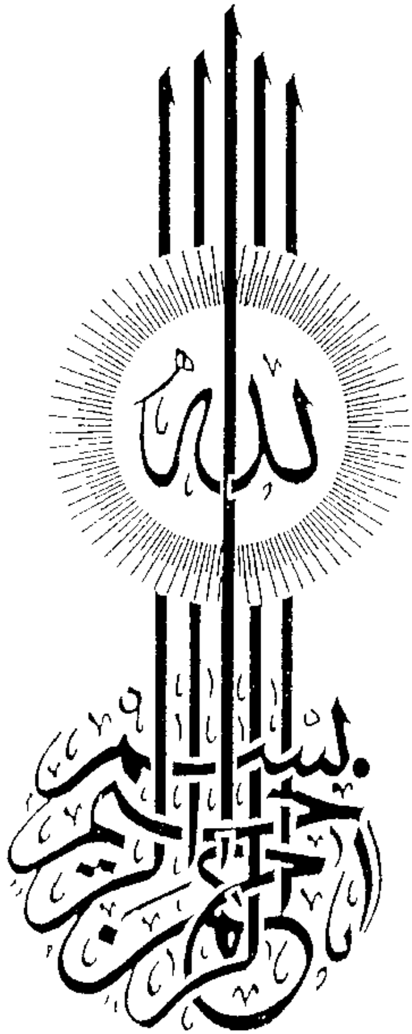
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INTRODUCTION

1. INTRODUCTION

Nitrogen occupies a unique position among the essential elements needed for plant growth. It is also considered as an important component to every life cycle. The combined nitrogen in soil is largely bound to organic matter and mineral material. In most cropping systems, the nitrogen required for crop production is derived from several sources (i) mineralization of soil organic nitrogen, (ii) decomposition and mineralization of nitrogen returned in crop residues, and (iii) nitrogen added as fertilizers. Also, biological fixation by legumes, manures, wastes, or other nitrogenous materials may be important nitrogen sources when used.

Inorganic nitrogen (NH_4-N & NO_3-N) and organic forms are the major components of nitrogen in soil. Mineral nitrogen is considered the most available form required by most agricultural crops. The subject of soil nitrogen is broad and deals with transformation of organic and inorganic forms and interrelationships that exist with the atmosphere and biosphere. The transformations includes, mineralization, nitrification of organic forms, immobilization, denitrification, and volatilization.

The nitrogen transformations are governed by a number of factors, i.e. organic residues additives, inorganic fertilizers or amendments, temperature, soil moisture content, soil pH, living microorganisms in soil.

The present study was undertaken to elucidate the effect of different organic residues additions, during the breakdown in soil, under different temperature and soil moisture content using incubation technique, on nitrogen transformations. Also, the effect of inorganic nitrogen fertilizer additions on the decomposition of organic residues and consequently mineralization had been studied using N-15 tracer technique with other chemical procedure.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. Nitrogen transformation processes

2.1.1. Mineralization and immobilization:

Mineralization and immobilization are biochemical in nature, and both are bound to the activities of the organisms making up the heterotrophic biomass (Bartholomew, 1965; Jansson, 1971).

Nitrogen mineralization is defined as the transformation of nitrogen from organic state into the inorganic forms of NH_4 or NO_3-N. This process is performed by heterotrophic soil microorganisms that utilize nitrogenous organic substances as an energy source.

Nitrogen immobilization is defined as the transformation of inorganic nitrogen compounds, (NH_4-N, NH_3, NO_3, NO_2) into the organic state. Soil organisms assimilate inorganic nitrogen compounds and transform them into organic nitrogen constituents of their cells and tissues, the soil biomass.

The continuous transfer of mineralized-N into organic products of synthesis and of immobilized-N beck into inorganic decay products-underlying the building up and dying away of the heterotrophic biomass- can be defined as mineralization-immobilization turonver (MIT)(Knowles & Chu, 1969; Ladd & Paul, 1973; Shields et al., 1973; Westerman & Tucker, 1974; Campbell, 1978; Jansson & Persson, 1982). Changes in chemical and physical soil properties often affect microbial activity and thereby MIT and its manifestations.

Sudden changes in the chemical and physical conditions of the soil caused, for example, by wetting and drying or freezing and thawing may kill microorganisms and may be followed by sudden and temporary flushes of energy stimulating MIT (Ladd et al., 1977b; Campbell, 1978).

In this connection, a favourable soil environment is created to bring about an equilibrium between mineralization and immobilization processes. This critical balance may be upset if the C/N ratio is less than 25 when mineralization is likely to exceed immobilization leading to accumulation of ammonium and nitrate forms of nitrogen. The nitrogen will eventually be mineralized even though the organic material added has a wide C/N ratio, but a lengthy waiting period is required.

Allison and Cover (1960), Iritani and Arnold (1960), and Bartholomew (1965), they indicated that the nitrogen requirements needed by microorganisms may be influenced the nitrogen mineralization and immobilization. If the organic residues contains less nitrogen than needed by microorganisms for decomposition, inorganic nitrogen will be immobilized by the organisms. On the other hand, if the residues contains more nitrogen than needed by organisms, the excess will be mineralized and appear as inorganic nitrogen in the soil.

According to the abovementioned results, the release of nitrogen in association with the decomposition of crop residues and organic materials has important influences on N-availability in soils (Bartholomew, 1972).

Tisdale and Nelson (1975), reported that the mineralization process pass through three step-by step reactions:

aminization, ammonification, and nitrification

The first two are affected through the medium of heterotrophic microorganisms, and the third is brought about largely by autotrophic soil bacteria. The ammonia released from ammonification process is subject to several fates in the soil:

It may be converted to nitrates by nitrification, may be absorbed directly by higher plants, utilized by heterotrophic organisms, and may be fixed in a biologically unavailable form in the lattice of clay minerals. Rosswall (1982) showed that the low concentration of NH_4-N in the soil is not indication of low mineralization rates, as it can indicate rapid nitrification or plant uptake.

2.1.2. Nitrification:

The decomposition of nitrogenous organic substances in soils leads to the release of NH_3 which equilibrates to the ionic species, NH_4^+, in all but highly alkaline soils. In the presence of readily available carbonaceous materials, the NH_4^+ is assimilated rapidly into newly forming microbial biomass. Under the more usual soil circumstances in which microbial development is limited by available carbon and energy, most of the NH_4^+-N is oxidized to NO_3^--N is referred to as nitrification.

It is generally assumed that the organisms chiefly responsible are the chemoautotrophic (chemolithotrophic) bacteria, Nitrosomonas (oxidizes NH_4 ions to nitrite) and Nitrobacter (oxidizes NO_2 to nitrate). These two organisms, however, apparently function well only in soils with pH's nearly neutral or slightly alkaline.

The main factors which limit nitrification in the soil are substrate NH_4^+, O_2, CO_2, pH, and temperature. In general, nitrification appears to proceed in soils under a much broader range of conditions than is predictable on the basis of the biochemistry of the process and the physiology of the autotrophic nitrifiers.

Autotrophic nitrification is a strictly aerobic process can occur only where the soil is sufficiently well aerated to allow the organisms to function and it is often inhibited at low pH values, (Campbell & Lees, 1967; Rosswal, 1982) and in alkaline soil, Nitrosomonas activity out-strips Nitrobacter, activity, and there may be an accumulation nitrite. Similar conclusion had been obtained by Anthonisen, et al., (1976) who reported that nitrite oxidation is more sensitive to low pH values than is ammonia oxidation, and this may lead to nitrite accumulation under acid conditions. But Scarsbrook, (1965), found that nitrite also accumulate at high pH in alkaline soils, especially after addition of ammonium fertilizers.

The nitrifiers obtains their CO_2 for cell synthesis from the air or from any available carbonate sources present

(Allisson, 1973).

The temperature is one of the most favourable conditions, has been influenced nitrification process. The optimum temperature for nitrification appears to vary widely among soils. Mahendrappa et al., (1966) reported maximum nitrification rates at 20 - 25° for a group of soils from the north-western U.S., and at 30 - 40°C for soils of the south-western U.S. The value of 40°C was found to be the maximum temperature for nitrification in the midwestern U.S. soils examined by Keeny and Bremner (1967) whereas a tropical Australian soil was found by Myers (1975) to nitrify at temperature up to 60°C. Under Egyptian soils and conditions, Taha et al., (1967) reported that the maximum temperature for nitrification rate was 35°C. Too low or too high soil temperature is not conducive for the optimum functioning of nitrifiers (Subba Rao, 1977).

The nitrification process only proceeds rapidly in warm soils, and goes on very slowly when the soil temperature is below 4 to 5°C (Anderson, 1960; Anderson and Boswell, 1964; Frederick, 1965).

The number of nitrifying bacteria in soil is dependent on the levels of organic matter. Soils receiving a good amount of organic matter appears to be congenial for the growth of nitrifying bacteria (Subba Rao, 1977).

Drying a soil tends to kill off the nitrifying bacteria, and in the semi-arid tropics and subtropics there may be a considerable interval between the onset of the rains