Nitrogen Balance in Calcareous Soils

By

Hessein Kamel Abd El - Maksoud

B. Sc. Agric. (Soils), University of Cairo, 1965

THESIS

Submitted in Partial Fulfilment of the Requirements

for the Degree of

MASTER OF SCIENCE

in

Agricultural Bacteriology

Faculty of Agriculture

Ain Shams University

1971

APPROVAL SHEET

Approved by : Salah Taha

M. Mounir

S. A. Z. Mahmoud

Date : 6 / 6 / 1971.

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ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation and gratitude to Dr. S.M. Taha, Dean of the Faculty of Agriculture (Shebeen-el-Kom) and Professor of Agricultural Bacteriology, Faculty of Agriculture, Ain Shams University, Shoubra-El-Khaima, and Dr. M.N. Zayed, Assistant Research Professor, National Research Centre for suggesting the problem, constant help, guidance and encouragement throughout the work reported.

The author also wishes to express his grateful appreciation to Dr. H. Moawad, Researcher in National Research Centre for his assistance in the preparation of this manuscript.

He also acknowledges his indebtedness to the authorities of the National Research Centre, for the grant of a scholarship to carry out this work in the Soil Microbiology Unit.

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INTRODUCTION

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Nitrogen is commonly the most important fertilizer element applied to soil,its effects being manifested quickl on plant growth and ultimately on crop yields. The marked increase in crop yields, in the world, recorded during the past 30 years could largely be linked with the steadily increasing rates of nitrogen application.

Phosphorus, potassium, as well as the other essential nutrients are in a sense less important, as they are needed in smaller amounts besides that agricultural soils are commonly able to provide a larger percentage of the crop requirements for these elements compared to nitrogen. Recently larger rates of application of nitrogen, especially to soils that are low in this element has been greatly increased.

From a scientific standpoint, there has been extensive studies lasted for many years to investigate the efficiency of nitrogen applied to soils, What is the fate of the nitrogen after it reaches the soil ? How much of it is actually recovered in harvested crops and how much is lost, and through what channels, or by what mechanism ?

All those questions [illegible] answers. The extension in agriculture area is carried out on the western coastal calcareous soilsof U.A.R. Thus, it seems reasonable to study the N balance in these soils, in a trail aiming to clarify nitrogen losses and gains under our local conditions.

REVIEW OF LITERATURE

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During the past fifty years or more, many attempts have been made to draw up nitrogen balance sheets for both cropped and uncropped soils.

On the side of income, accurate values for additions in forms of rainfall, irrigation water, seeds, fertilizers and manures are usually available. However, if legumes are grown, there are difficulties because the quantity of nitrogen supplied from the air by Rhizobia is not likely to be known accurately under field conditions.

On the expenditure side of the balance sheet, accurate values for the nitrogen removed in harvested crops are commonly available. As for wind and water erosion, there are usually of only minor importance in carefully planned field studies. Leaching, however, presents a major problem.

Nitrogen Gain

Maintenance of soil nitrogen depends mainly on symbiotic and non-symbiotic nitrogen fixing organisms. The nitrogen fixation is carried out by two types of biological systems:

1) the free-living micro-organisms which fix the atmospheric nitrogen,

2) the plant-bacteria symbiosis in which the nitrogen is fixed by close co-operation between higher plants and micro-organisms, particularly in root or leaf tissues.

1- <u>Non-symbiotic nitrogen fixation</u> :

Fixation by higher plants themselves had never been proved unequivocally, although claims to have done so have been made periodically since the discovery of nitrogen fixation. As an example is the claim by Chakraborty and Gupta (1959) that rice plants grown in nutrient solution fix nitrogen. This was, however, refuted by Hart and Roberts (1961) who repeated these experiments under more carefully controlled conditions. Müller (1963) reported gains of nitrogen by pea and maize plants grown with their root system in sterile nitrogen-free nutrient solutions to which vitamin B_{12} was added.

Russian workers claim to have extracted from higher plants, an enzyme which is capable of N-fixation. Such extracts from birch, tobacco and begonia leaves and from rye, wheat, oats and timothy showed enrichment of up to 2 atom percent excess N^{15} in the ammonia + amide fraction after 30 minutes exposure to labelled N_2 (Turchin, Berseneva and Zhidkikh, 1963).

Nitrogen fixation can also take place in soils by blue-green algae. This view has been confirmed by Singh (1961) in his monograph on the role of blue-green algae in the nitrogen economy of Indian agriculture. The inoculation experiments made by Bjalfve (1956, 1962) also indicated that algae may fix appreciable amounts of nitrogen in soil. Using flasks for his experiments, he found that algae fixed 350 lb/ac/an in light in contrast to 20 lb/ac/an for those kept in dark, using sandy soil supplemented with P, K, Ca and straw. Relwani (1963) inoculated a soil with a mixed culture of blue-green algae. His experiments were also repeated in pots and field. His results indicated that the algae provided an effective substitute for dressing of ammonium nitrogen.

Soils contain a number of free living nitrogen-fixing organisms, and though most investigations had been focused on two groups of bacteria i.e. Azotobacter and clostridia; the demonstration in recent years shows that a wide variety of micro-organisms posses nitrogen-fixing ability. Many workers (Jensen, 1950 and Allison, 1955), at least those outside of Russia and India, consider that the average quantity of nitrogen fixed in the soil by free-living organisms is small; thus some believe that their effect should be neglected in the balance.

Other reports, however, indicate that appreciable amounts of nitrogen could be fixed in field plots, or lysimeters, usually attributed to non-symbiotic bacteria. Chapman, Liebig and Rayner (1949) reported gains up to 40 pounds of N per acre annually under mustard, and Gel'Tser (1961) reported from 45 to 66 kg/hectar/year under perennial grasses and iries. On studying the changes occurring in the nitrogen fractions in sharaqi soils Abdel-Malek and Rizk (1966) found that the increase in nitrogen specially organic fraction is due to the increase in Azotobacter counts. Such is supported by the findings of Taha et al. (1967) who stated that the increase in the amount of nitrogen fixed could be attributed to the presence of high densities of Azotobacter and clostridia. The average amounts of nitrogen fixed per week were found to be 0.61, 0.49, 0.97, 1.22 and 2.60 g N/100 g of carbon oxidized in the 0, N, NP, NPK and FYM treatments respectively.

Call for soil inoculation by the free living N-fixing has appeared recently from the belief that certain beneficial micro-organisms could be scanty in a particular soil. This had been practiced on a wide scale, usually with Azotobacter cultures, by the Russians. In contrast, other views find a little critical evidence concerning the increases in [illegible] (Mishustin, 1963).

The extensive studies conducted by several workers on the action of mineral nitrogen on nitrogen fixation evidenced that high concentrations of mineral N suppress nitrogen fixation (Jensen, 1950). Delwiche and Wijler (1956) found that 1.0 - 1.5 m.e. nitrate/g soil prevented nitrogen fixation by Azotobacter. Ebert (1959) showed that amide-, NH_4^+-, and NO_3-N strongly depressed fixation due to preferential uptake of the applied nitrogen. Iswaran (1960) found that the added N inhibited nitrogen fixation, ammoniacal nitrogen showed the smallest effect while NO_3-N exhibited the largest one. Greenland (1962) found that 200 p.p.m. NO_3-N was sufficient enough to prevent any increases in soil N during incubation, while in the absence of nitrate increases up to 10% of the initial total N were obtained.

Shawky (1970) on studying the availability of soil ammoniacal nitrogen to Azotobacter and its effect on nitrogen fixation found that the fixation took place in spite of the presence of relatively big amounts of