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SOIL NITROGEN ACCUMULATION IN DIFFERENT AGES OF VEGETABLE GREENHOUSES

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***Abstract*—The accumulation of nitrogen in different utilization age (0, 1, 2, 3, 4, 5, 10, 13-year) vegetable greenhouses soil with multi-point mixed samples was examined in Shenyang suburb, Liaoning province, China. The results showed that the content of N of all samples was increased with the utilization ages of the vegetable greenhouses. For all the samples, the concentration of total nitrogen (TN) and nitrate in the 0-40 cm layer was higher than that in the 40-120 cm. Compared with other samples, the content of TN and nitrate of 13 years of vegetable greenhouse soil is the highest throughout the 0-120 cm. In the 0-20cm layer, the TN concentrations in 13-year vegetable greenhouse soil is 2 times higher than that in the bare soil, and the concentration of nitrate range from 19.66 mg kg^{-1} in bare soil to 56.32 mg kg^{-1} in 13-year vegetable greenhouse soil. These results demonstrated that long-term continuous N input from chemical fertilizers and manure can cause N accumulation in soils and enrich in topsoil.**

Keywords- soil nitrogen accumulation; different ages; vegetable greenhouses

I. INTRODUCTION

China is the world's largest country of greenhouse cultivation. With the adjustment of agricultural planting structure, the area of greenhouse cultivation in China was expanded to 723 000 hectares in 2006; in the short frost-free period of the Northeast region, greenhouse cultivation have become the main form of farm production, the area was 114 000 thousand hectares in 2006[1]. Because vegetables are higher demand for fertilizer than other crop, to meet the needs of vegetable growth, farmers commonly apply "blind" quantities of fertilizer and manure in order to harvest higher yields and achieve higher efficiency. For example, at the greenhouse cultivation in Shandong Province, the application of N fertilizer was 1351 kg hm^{-2}, which is far above the average of other crop and far exceeds the crop demand. This not only causes a waste of fertilizer, but also leads to serious accumulation of nutrients in soil and can cause water, air, and soil pollution [2-6].

Nitrogen, especially in the NO_3–N, represents one of the top factors in water quality degradation and nonpoint source contamination to the environment [7]. Increasing applications of N fertilizers for agricultural productivity have caused accumulation of NO_3–N in the soil profile [8-9], and water quality problems for surface water and groundwater resources [10]. And NO_3–N leaching is a major problem for calcareous soils in which ammonium (NH_4) is quickly nitrified to NO_3–N [11]. Therefore, it is of importance to quantify N transport and transformation processes in field soils, especially greenhouse soil which nitrogen fertilizer applied in excess of crop needs.

The objective of this study was to determine the relationship between soil N content with different utilization ages of the vegetable greenhouses of Shenyang suburb and analyze N accumulation in soil profile.

II. MATERIALS AND METHODS

A. Study Site

The study was conducted at a vegetable production base of Shenyang suburb, Liaoning province, China (41°55'N and 122°58'E). After more than ten years development, the vegetable production base has became the largest greenhouse vegetable production of Liaoning province. The base is located in Liao River alluvial plain, and the topography is relatively flat. It has a dry-cold winter and a warm-wet summer. The mean annual temperature is 7.0-8.0 °C, cumulative temperature (>10 °C) is 3100-3400 °C, annual precipitation is 650-700 mm, and non-frost period is 147-164 days. The soil is gley meadow soil (silty loam Hapli-Udic Cambisols in Chinese soil taxonomy), a main soil type for agricultural production in Northern China. Before the base established, chemical analysis showed that TOC and pH in this soil were 7~11g kg^{-1} and 6.5~8.5 [12]. Cultivars of vegetables in greenhouses are tomato, cucumber (winter and spring), beans and a variety of leafy vegetables (summer and autumn).

According to investigation, the manure used in the greenhouses are cow and poultry manures. The usage of the organic manure is about 80~110 t hm^{-2} each year. Other fertilizers used in there are urea (500 kg hm^{-2}) or $(NH_4)_2SO_4$ (1000 kg hm^{-2}), $(NH_4)_2HPO_4$ (1000-1500 kg hm^{-2}), K_2SO_4 (1000 kg hm^{-2}) and compound fertilizer (1200-1400 kg hm^{-2}).

B. Sampling and Analysis

The tested soil was collected from different utilization ages of the vegetable greenhouses and at the depth of 0~120 cm with multi-point mixed sampling in 2008.

Soil total N concentrations were measured by dry combustion using an elemental analyzer on air-dried samples that were homogenized with a ball grinder to pass a 100-μm mesh. Ammonium and nitrate were extracted from field fresh soil samples using a 0.5 mol L^{-1} K_2SO_4 solution (1:10 soil/solution) as described by Mulvaney [13]. Ammonium and nitrate concentrations in the extracts were determined using a Technicon Auto Analyzer.

All data were subjected to statistical analysis of variance (ANOVA) in the SPSS 13.0 statistical package.

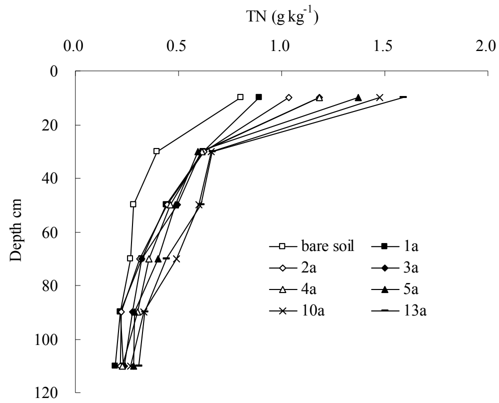

Figure 1. Trend of change in TN in the soil profile with the utilization ages of the vegetable greenhouses.

III. RESULTS AND DISCUSSION

A. Change of total N (TN) in the soil profile

The change with different utilization ages of the vegetable greenhouses in the concentration of TN in soil is shown in Figure1. The concentration of TN was drop suddenly in the 0-40 cm. In the 0-20 cm soil profile, the concentration of TN of 13 years of vegetable greenhouse soil was 2 times higher than that of the bare soil, and TN of all samples were increased with the utilization ages of the vegetable greenhouses. For the bare soil, the concentration of TN was low with little change throughout the 40-120 cm soil profile. For all the samples, the concentration of TN in the 0-40 cm layer was higher than that in the 40-120 cm. This implies that accumulation of N was most pronounced in 0-40 cm layer. Compare to all samples, TN of 13 years of vegetable greenhouse soil is the highest throughout the 0-120 cm.

B. Change of nitrate in the soil profile

The trend of nitrate is similar to that of TN. The concentration of nitrate of all samples was higher than the bare soil in the 0-120 cm soil profile in Figure 2. In the 0-20 cm layer, nitrate was increased with the utilization ages of the vegetable greenhouses. Accumulation of N was most pronounced in 0-40 cm layer. In the 40-120 cm layer, nitrate of 10 a and 13 a of the greenhouse soil was higher than the other soils, it implies that long-term continuous N input from chemical fertilizers and manure can cause N translocation in soils.

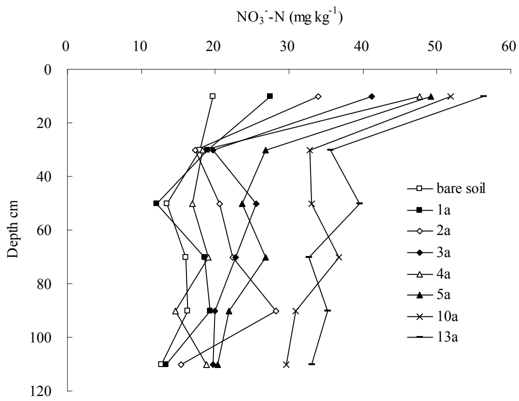

Figure 2. Trend of change in nitrate concentrations in the soil profile with the utilization ages of the vegetable greenhouses.

C. Relationship between soil N and different utilization ages

Figure 3 is shown the relationship of soil N (content of TN and nitrate) with utilization ages of the vegetable greenhouses in the 0-20 cm layer. After analysis 38 vegetable greenhouses soil samples of different utilization ages, the results showed that the content of N was increased significantly with the utilization ages of the vegetable greenhouses. It implied that continuous addition of fertilizer N in years increased the concentration of TN and nitrate over those in the bare soil. Long-term N input can result in N accumulation in the top soil.

ACKNOWLEDGMENT

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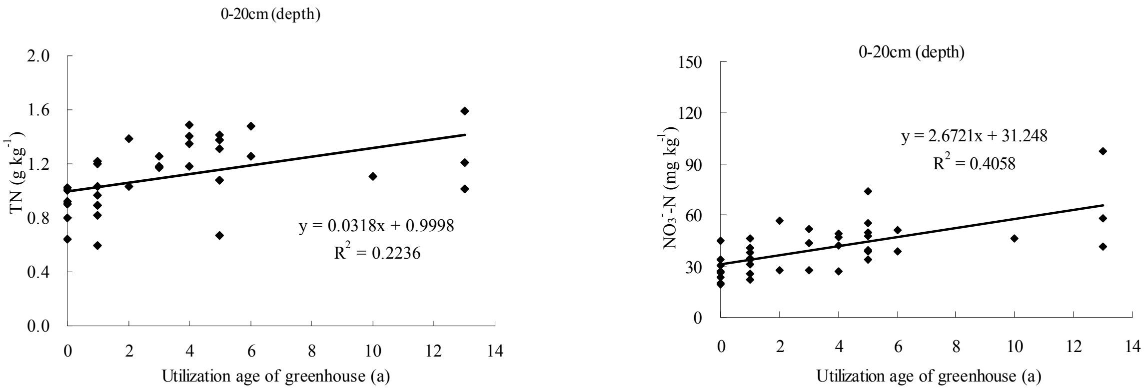

Figure 3. Changes of soil TN and nitrate concentrations in vegetable greenhouses with different utilization ages.