論 文 の 内 容 の 要 旨

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論文題目: Effects of chicken manure and eggshell application on amelioration of low pH soils in the Mekong Delta of Viet Nam

(鶏ふん堆肥および卵殻の施用がベトナムメコンデルタの低 pH 土壌の改良に与える影響)

Agriculture plays key roles in livelihood of farmers and economic development in the Mekong delta of Viet Nam. To grow up well, plants require many necessary elements like sunlight, water, soil, temperature, nutrients... Among them, a soil plays a crucial element as intermediate medium to provide necessary demands for plant growth. Any soil problems would affect directly crop growth and yield. Total land area in Mekong delta of Viet Nam is 4 million ha, but about 1.4 million ha and 1 million ha are salt affected soil and acid sulfate soil, respectively (Viet Nam – Netherlands cooperation, 2011). Reclamation of these soils to meet the demand of plant growth in a sustainable way is essential. This issue is being attracted great interests. However, soil aggregate degradation which could affect soil productivity and crop production is less concerned. The main questions following to this problem are given: How is the stability of aggregates of acid sulfate and salt affected soil? Which key factors cause aggregate breakdown? How does aggregate stability increase? For sustainable agriculture in the Mekong delta region, where salt affected and acid sulfate soils are distributed, understanding aggregate behaviours and applying proper measures to minimize aggregate disintegration are necessary.

To solve above problems, laboratory experiment was conducted to obtain with three objectives: (1) evaluating aggregate stability under various conditions (2) observing effects of chicken manure and eggshell application on changes in aggregate stability and (3) discussing the changes in soil organic matter and the relationships between soil pH and CO_2 emission associated with aggregate stability.

Field work was conducted to observe and identify soil problems in the south of Viet Nam. Three soils were collected in the three locations: Can Tho city, Ca Mau province and Hau Giang province. Soil properties in each horizon were described in the field and the laboratory. Based on diagnostic horizon, diagnostic properties and diagnostic materials, the name of soil main groups was defined as saline and

sodic soil (SS), alluvial soil (AS) and acid sulfate soil (ASS), which corresponded to three locations: Ca Mau province, Can Tho city, and Hau Giang province, respectively.

To achieve the first objective, aggregate stability test was conducted to evaluate under various conditions: initial clod sizes, initial soil moisture and breakdown processes. The three soils were used: saline and sodic soil (SS), alluvial soil (AS) and acid sulfate soil (ASS). Soil samples were collected at the 0-20 cm depth from the surface. Three initial clod sizes: 1-3 mm, 2-5 mm and 5-10 mm were prepared. Two moisture levels of clods were adjusted: moist and dry conditions. Fast wetting, slow wetting and mechanical breakdown were employed as breakdown processes. Results showed that initial clod sizes, initial soil moisture and breakdown processes affected aggregate stability. Among the treatments, the greatest degree of aggregate disintegration, which corresponded with the lowest mean weight diameter (MWD) value was found in dry clods under fast wetting. It implied that soils at dry condition could be seriously degraded when they were exposed to fast wetting like heavy rainfall, or abrupt irrigation. This was followed by moist clods under mechanical breakdown and both moist and dry clods under slow wetting, corresponding higher MWD value. The most serious deterioration of aggregates was found in SS, followed by AS and ASS. The initial 2-5 mm and 5-10 mm clods were durable more than the initial 1-3 mm clods.

The two remaining objectives were conducted with soil incubation experiment. After aggregate stability test in the first objective, 2-5 mm dry clods under fast wetting were employed for evaluation of aggregate stability of the soils after the incubation. Soil incubation experiments were designed with seven treatments and three replicates. The eggshell application rates of lime requirement (LR) and a half (1/2 LR) and chicken manure application rates of 25 and 50 g kg $soil^{-1}$ were employed. Soils and either or both eggshell and chicken manure were mixed and put into a 500 ml glass bottle. Then, soil amendment mixtures were incubated for 45 days in a constant room temperature at 25 °C. CO_2 concentration of head space of the glass bottle was periodically measured during the incubation period. Soil pH, soil organic matter and aggregate stability were measured after incubation days of 3, 10, 20 and 45. Results showed that the application of eggshell enhanced pH of three soils. The chicken manure application could increase pH of SS and AS. There was less effect on pH rise of ASS when the amount of chicken manure application increased. The highest pH was shown in all the soils, where the combinations of chicken manure and eggshell were added. Rapid increase in CO_2 emission rate within the first two days was found in the three soils with the application of eggshell. After the chicken manure application, the increase in CO_2 emission rate occurred within the first five days in SS and AS, whereas its increase started from the 5^{th} day to the 20^{th} day in ASS. For the combination of eggshell and chicken manure, similar periodic

changes in CO_2 emission rate within the first five days were shown in SS and AS, while it behaved differently in ASS. The first rise occurred within the first two days and the second rise occurred from the 5th day till the 20th day. At the same period of the 5th day to the 20th day, the emission rate of CO_2 from the combined application was twice as much than that from only chicken manure application. It implied that more rise in microbial activity was found in the soils with the addition of combinations of chicken manure and eggshell. The only eggshell application deteriorated soil aggregates, while the application of only chicken manure and combination of chicken manure and eggshell could improve aggregate stability. Close relationships between soil pH and CO_2 emission from microbial activity with the addition of chicken manure and combinations of chicken manure and eggshell implied that microbial activity increased as soil pH increased. The rise in soil pH by $CaCO_3$ in combined application enhanced microbial activity contributing to decomposition of chicken manure. This involved in aggregate stability, where organic components produced from decomposition of chicken manure could enhance aggregate cohesion. It was demonstrated that soil organic matter was accumulated high in all the soils, where only chicken manure and the combination of chicken manure and eggshell were added. From the result, the application of chicken manure and eggshell was more effective in not only soil pH but also aggregate stability than either chicken manure or eggshell application.