

## 学 位 論 文 要 旨

Effect of green manure application on soil microbial activities and soil nutrient characteristics in Sugarcane cropland field of Kitadaito, Okinawa, Japan

沖縄・北大東島のサトウキビ畑における緑肥導入が  
土壌微生物活性および土壌養分特性に与える影響の解明

Biological Production Science, Plant Production Science  
Susan Marlein Mambu

Okinawa prefecture is located in the southernmost part of the Japanese archipelago, consisted of a large number of small islands. In Okinawa, sugarcane is the major crop, and represents a significant component of the regional economy. Especially in the isolated islands of Okinawa such as Kitadaito and Minamidaito, where were far from the popular touristic island of Okinawa, sugarcane monoculture is generally conducted. Thus, these isolated island's economies are mainly dependent on sugarcane yields and it is important to increase the sugarcane yields by sustainable land management. However, over the past years, sugarcane yields have consistently decreased, mainly due to the continuous cropping and inefficient fertilization, resulting in serious soil degradation.

To achieve the sustainable sugarcane cultivation with increasing sugarcane yields in sub-tropical cropland of Okinawa, Japan, it is necessary to improve and maintain the soil fertility by organic matter application. In most islands of Okinawa, green manure (GM) application is commonly used to improve the soil organic matter content, because of its cost effectiveness. However, there is little information about GM significance for soil nutrient characteristics in relation to microbial activities, such as soil enzymes or microbial biomass, which are sensitive indicators to the land management rather than various soil chemical values. Thus, the objective of this thesis is to evaluate the effect of GM application on soil nutrient characteristics in sugarcane cropland of Okinawa, with reference to microbial activities.

The first experiment was conducted in sugarcane field of Kitadaito, Okinawa, from August 2016 to April 2017. I evaluated and compared the effect of different GM application, i.e., *Crotalaria juncea* (CRO) and *Sesbania cannabina* (SES), on soil nutrient dynamics in relation to soil enzymes, which are sensitive indicators of land management. I evaluated the fluctuation of soil enzymes (dehydrogenase (DH),  $\beta$ -glucosidase (BG), and phosphomonoesterase (PHO)), soil nutrients (extractable carbon (Ext-C) and nitrogen (Ext-N)), and available phosphorus (Avail-P)) with environmental conditions after GM application for 7 months. I also measured the sugarcane growth parameters 7 months after planting. Application of CRO and SES clearly increased the BG and PHO activities throughout the experimental period and increased the number of cane (ca. 11%–20%), while they did not increase the DH activity and soil nutrients (e.g., Ext-C and Avail-P). These results indicated that BG and PHO activities must be the better indicator of soil quality and land management in this ecosystem. Because Ext-N was increased in the CRO, while not in the SES, CRO application would be better to improve the soil N fertility in this condition. These differences between the CRO and SES were possibly due to the different quality and decomposition patterns of plant materials.

The second experiment was conducted at the same field experiment as the first experiment, and was conducted from May 2016 to January 2018. I evaluated the fluctuation of soil microbial biomass (MBC, MBN and MB C:N ratio) and inorganic N (i.e.,  $\text{NO}_3^-$  and  $\text{NH}_4^+$ ) under different land management through the experimental period. In addition, I also measured the sugarcane growth parameters 16 months after planting. The incorporation of both GM clearly increased MBC and MBN temporarily, and this occurred within ca. 1 month after application. CRO maintained the larger amount of MBC and MBN for 4 months after the incorporation, compare to SES and Cont plots. CRO had also immediately increased  $\text{NO}_3^-$  and/or  $\text{NH}_4^+$ , while SES application did not immediately increased the  $\text{NO}_3^-$ . Sugarcane parameters were clearly increased by CRO and SES application (ca. 25%). The different MBN and inorganic N dynamics for the CRO and SES was probably because of the quality of the plant residues, and based on these results, it indicates the CRO species would be useful for better N management in this condition.

This study clearly demonstrated that CRO and SES application had increased the soil enzyme and microbial biomass temporarily, and these applications caused the better N supply and increased the sugarcane crop growth. In addition, there were clear differences for the CRO and SES, in terms of soil enzyme and MBN dynamics, possibly due to the different plant residue quality. Since CRO had clearly increased the specific soil enzyme and MBN rather than SES in my study, CRO is the preferred GM species, in terms of improvement of soil microbial activities and hence soil nutrient characteristics, for sustainable GM-sugarcane cropping system in Kitadaito, Okinawa, Japan.