December 2015 Vol. 22 No. 4 7-14
Journal of Northeast Agricultural University (English Edition)

Impact of Microbial Inoculants on Microbial Quantity, Enzyme Activity and Available Nutrient Content in Paddy Soil

Liu Xiao-jie[1], Duan Xue-jiao[2], Ma Na[2], Sun Tao[2], and Xu Jing-gang[2]

[1] National Soybean Engineering Technology Research Center, Northeast Agricultural University, Harbin 150030, China

[2] College of Resources and Environment, Northeast Agricultural University, Harbin 150030, China

Abstract: The experiment was conducted to study the impact of application of microbial inoculants, compared with no microbial fertilizer, on enzyme activity, microbial biomass and available nutrient contents in paddy soil in Heilongjiang Province. The application of soil phosphorus activator was able to increase the quantity of bacteria and fungi in soil, but its effect on actinomycetes in soil was not significant. The application of microbial inoculants increased the urease and sucrase activities in soil over the growing season, but only at the maturing stage soil acid phosphatase activity was enhanced with the applying soil phosphorus activator. The application of soil phosphorus activator increased alkali-hydrolyzable nitrogen and available phosphorus contents in soil, but did not increase available potassium content in soil. The optimal microbial inoculant application rate as applied as soil phosphorus activator was 7.5 kg·hm^{-2}.

Key words: microbial fertilizer, paddy soil, soil microorganism, soil enzyme activity

CLC number: S144; S155 **Document code:** A **Article ID:** 1006-8104(2015)-04-0007-08

Introduction

Since the reform and opening up, the agriculture is developing continuously fast and the use of chemical fertilizer is also increasing dramatically at the same time. At present, China is the country which is the most productive and using chemical fertilizers in the world. From the intensity of application of fertilizers, China is in the fourth place in the world, far higher than the world average (Guo *et al*., 2010). A large amount of chemical fertilizer application plus unreasonable structure of different fertilizers led to the emergence of large problems, such as pollution and high cost/low profit situation (Tand and Zheng, 2004). The emergence of microbial fertilizer (or microbial inoculants) is one of the methods to solve the problems of chemical fertilizer over application, which is also one of the important indexes of soil quality and components of soil biochemical characteristics (Bhushan and Sharma, 2002; Zhang *et al*., 2006; Jiao and Wei, 2009). Reasonable application of microbial fertilizer combined with chemical fertilizers can not only improve the soil fertility, supply crop nutrients, promote crop growth and development, but also provide better environment for crop and microorganism living in soil.

The microbial fertilizer used in this experiment was called soil phosphorus activator, which provided the beneficial microbial strains, not only activating soil phosphorus, potassium and trace elements, improving fertilizer utilization efficiency, reducing the amount of fertilizer application rate, but also improving crop resistance, and enhancing the abilities of crops to resist disease. Many research results showed that the soil phosphorus activator could increase the yield of

Received 16 July 2015
Liu Xiao-jie (1963-), female, researcher, engaged in the research of crop breeding and cultivation. E-mail: xjlmarry@163.com

rice and improve the rice taste (Wang *et al*., 2003). In addition, soil microorganisms play a major role in soil formation process, such as helping forming aggregated structure, driving nutrient cycling and energy transformation (Long *et al*., 2003; 2004).

The soil enzyme is abundant and widespread in soil and most of the soil enzymes were from microorganisms as well as a small part of plants (Perucci *et al*., 2000; Burns, 1982). Different fertilization methods have great influences on soil enzyme activities, which affect metabolism process in plant-soil ecosystem. Therefore, the relationship between the soil microorganism and soil enzyme activity need to be further studied. Also the soil available nutrients are related to microbial activity in soil and need to be clearly studied to provide scientific theoretical basis for the agricultural practice in the northeast cold region of China. In this paper, the soil phosphorus activator was used as a representative of microbial fertilizers and its effect on microbial quantity, enzyme activity and nutrient availability were studied.

Materials and Methods

Experimental design

The field experiment was located in Acheng District, Harbin City, Heilongjiang Province, where the soil was a typical black soil with organic matter content 45.4 $g \cdot kg^{-1}$, available phosphorus content 35.2 $mg \cdot kg^{-1}$, available potassium content 142 $mg \cdot kg^{-1}$. The alkali solution nitrogen content in soil was 20.9 $mg \cdot kg^{-1}$ and pH was 5.45. The variety of rice used in the experiment was Daohuaxiang-Ⅱ. The microbial inoculants used were the soil phosphorus activator produced by Heilongjiang New-Green Biological Co., Ltd. The soil samples were collected at the tillering stage, jointing stage, heading stage and maturing stage respectively at five points in each experimental plot at each sampling time. In order to avoid the influence of air on the surface soil microorganism, 0-5 cm soil were removed before each sampling and 5-15 cm soil were sampled and roots and rocks in the samples were picked and separated from soil by hands. The microbiological properties of soil were determined from the fresh soil as soon as possible after each sampling or placed in the refrigerator under 4℃. The physical and chemical properties of another part of soil samples were determined in the laboratory.

The random block design was used in this experiment. Traditional fertilization was used as the background fertilization treatment. The application amount of microbial fertilizers was set up into three treatments: without microbial fertilizer (CK); 7.5 $kg \cdot hm^{-2}$ phosphorus activator (P1); 15 $kg \cdot hm^{-2}$ phosphorus activator (P2) with three replications. Each experimental cell was 10 m long and 6.7 m wide, totally 66.7 m^2. The cell was separated with plastic sheet with 10 cm underground and 35 cm aboveground. The experiment cell was irrigated and drained independently.

Experimental methods

The basic physical and chemical properties of soil included pH (1 : 2.5 soil to water ratio), soil organic matter content (SOM), total nitrogen, total phosphorus, alkali hydrolizable nitrogen, available phosphorus, available potassium in soil were determined using conventional method (Jiao and Wei, 2009).

Microbial quantity was determined by dilution plate counting method (Long *et al*., 2003). Bacteria, fungi and actinomycetes were cultured with beef extract peptone culture medium, Bengal red culture medium and Gao culture medium (starch medium), respectively.

The urease activity in soil was determined by phenol sodium hypochlorite colorimetric method. It was expressed by the quantity (mg) of NH_3-N in 1 g soil at 37℃ after 24 h. The acid phosphatase activity in soil was determined by sodium phosphate two sodium colorimetric methods. The sucrase activity was determined by 3, 5-two nitro acid colorimetric method. The sucrase activity was expressed by the quantity (mg) of glucose formed in 1 g soil at 37℃