Effects of Soil Water Content on Soil Microbial Biomass and Community Structure Based on Phospholipid Fatty Acid Analysis

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Abstract: Three different kinds of soils collected from Heilongjiang, Jiangsu and Guangxi province of China were used to test the effects of different water contents on soil microbial biomass and community structure. Soils were moistened to 40%, 60% and 80% of water holding capacity (WHC) first. Then the moist soils were incubated in the dark room at 25 ℃ for 56 days. Phospholipd fatty acid (PLFA) analysis were carried on days 0, 3, 7, 14, 28 and 56 to track the changes of soil microbial organisms. The results showed that soil microbial biomass and community structure based on PLFA analysis did not response to the different soil water contents. Soil microbial organisms might get used to a wide range of soil water contents.

Keywords: Water content; Soil microbial biomass; Soil microbial community; Phospholipid fatty acid (PLFA)

Introduction

Soil moisture can influence a number of soil physic-chemical properties, such as redox potential, pH, O_2 and CO_2 levels (Barros *et al.*, 1995) and the concentrations of mineral nutrients in soil solutions (Misra and Tyler, 1999), which in turn influence the microbial population and its activity. There are some researches about the effects of soil water contents on soil microbial organisms. However, most of them were about soil microbial organisms respond to extreme environment conditions, like flooding (Bossio and Scow, 1995; Bossio and Scow, 1998) and drying and rewetting (Gordon *et al.*, 2008; Xiang *et al.*, 2008). There are no reports about how soil microbial biomass and communities respond to natural gentle soil moistures. The aim of this study was to compare the differences of soil microbial biomass and community structure under three different gentle water content regimes. This was accomplished by moistening three different kinds of soils to 40%, 60% and 80% of water holding capacity (WHC) and incubated at 25 ℃ for 56 days. PLFA analyses were conducted intervals to investigate the changes of soil microbial organisms.

Materials and Methods

Three different kinds of soils collected from Heilongjiang, Jiangsu and Guangxi province of China were used in this study (Wu *et al.*, 2009b). The fresh soils were taken to the laboratory in cool boxes with ice bags in, sieved (2 mm) and stored at 4 ºC before use. Heilongjiang soil is an argiustoll in U.S. taxonomy with a pH of 5.38, organic C content of 32.1 $g \cdot kg^{-1}$ and clay content of 36.4%. Jiangsu soil is a Typudalf. The pH, organic C and clay content were 5.12, 15.5 $g \cdot kg^{-1}$ and 25.2% respectively. Guangxi soil is a Plinthudult with a pH of 4.23, organic C content of 10.7 $g \cdot kg^{-1}$ and clay content of 37.0%. Before the main incubation, moist soils were pre-incubated at 25 ℃ for a week to activate soil microbial organisms. The soils were then adjusted to three different moisture levels (40%, 60% and 80% of WHC) and incubated at 25 ℃ for 56 days. At days 0, 3, 7, 14, 28 and 56, 5 g soil samples were collected respectively for the PLFA analysis. PLFAs were extracted and identified according to Wu *et al.* (2009a).

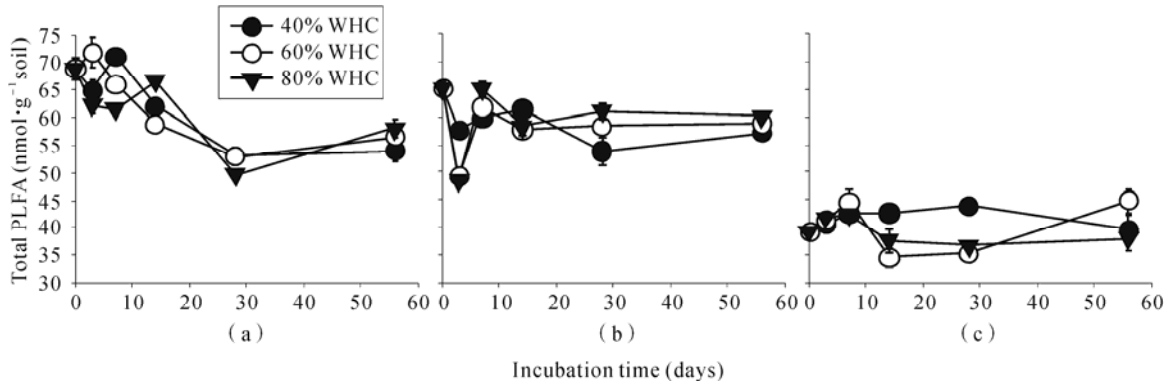

Fig. 1 Total PLFA concentrations during incubation at 40%, 60% and 80% Water Holding Capacity (WHC) of soils collected from Heilongjiang (a), Jiangsu (b) and Guangxi (c) provinces

Results and Discussion

Soil microbial biomass indexed by total phospholipid fatty acid concentration (total PLFAs) was not significantly different in the different soil moisture regimes in all the three soils (Fig. 1). Total PLFAs in the Heilongjiang soils were decreased with the incubation time in all the three soil water contents (Fig. 1(a)). The reason for this may be that the temperature of 25 ℃ caused thermal stress to soil microbial organisms inhabited in Heilongjiang soils. Heilongjiang soil was collected in the coldest region of China with a mean annual temperature of 1.2 ℃. Raising the incubation to 25 ℃ can increase the mortality of Heilongjiang soil microbes by thermal denaturation (Wu *et al.*, 2009b). For the Jiangsu and Guangxi soils, after some initial fluctuations, soil microbial biomass was kept consistent till the end of incubation (Fig. 1(b) and 1(c)).

Principle component analysis (PCA) was carried to check the dynamic changes of soil microbial community under different soil moisture regimes. PLFA profiles did not change regularly when increasing soil moistures from 40% WHC to 80% WHC in all the three kinds of soils for the whole 56 days' incubation (Fig. 2).

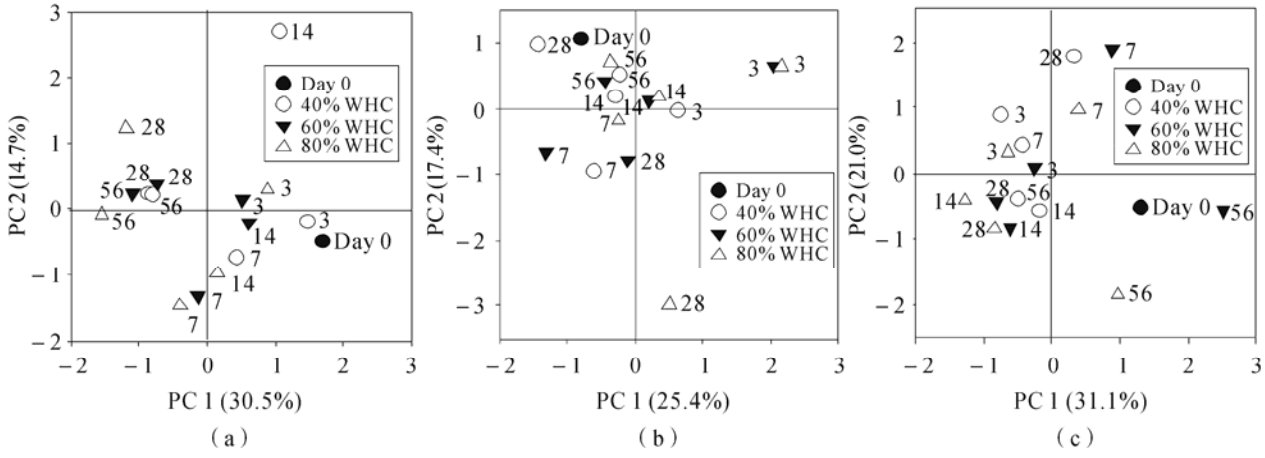

Fig. 2 Principal component analyses (PCA) of phospholipid fatty acid (PLFA) profiles in Heilongjiang (a), Jiangsu (b), and Guangxi (c) soils incubated at different water content (40%, 60% and 80% WHC) for up to 56 days

Theoretically, increasing soil moisture will reduce the aeration of soil pores and increase the utilization of nutrients, thus influence the growth of soil microbes. In this study, we did not find any significant differences when increasing soil moistures from 40% WHC to 80% WHC. This is consistent with Gordon *et*

al. (2008) and Bossio and Scow (1995). The reason why increasing soil moistures did not affect soil microbial biomass and community structures might be that the moisture range in the present study was not bigger enough to change microbial available oxygen, substrates and water in the soil pore space. The size of soil microbes (including bacteria and fungi) is about 0.3~20 μm (Cao, 2007), which is almost three times smaller than their habitat space the soil pore space (Young and Ritz, 2000). Soil pore space is a very complicated network with surprisingly structures and tortuosities. Over the past decade, research has moved from highly qualitative descriptors of pore shape to more quantitative measures of pore connectivity and tortuosity. However, it is progressing slowly. Till now, we do not know where and how soil microbes living in the soil pores (Young and Crawford, 2004).

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