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Effects of organic fertilizer replacing chemical fertilizer on organic carbon mineralization and active carbon fractions in yellow paddy soil of Guizhou Province

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Abstract

The aim was to decrease
chemical fertilizer use and improve soil carbon sequestration. Replacing 50 % chemical nitrogen fertilizer with organic fertilizer can inhibit the mineralization of organic carbon in yellow paddy soil by increasing the active organic carbon components（科学假设）. Four fertilization treatments (no fertilization, conventional fertilization, 50% organic fertilization and 50% chemical nitrogen fertilization, and organic fertilization instead of chemical nitrogen addition) were used to investigate the effects of using organic fertilizer instead of chemical fertilizer on soil organic carbon mineralization and active organic carbon components in paddy fields. The soil organic carbon, total nitrogen, available phosphorus, and available potassium contents were markedly higher for the organic fertilizer treatment than the no fertilization treatment. The cumulative soil organic carbon mineralization rates for
all treatments decreased during the incubation period, decreasing strongly in the early stage (2–5d), slightly in the middle stage (5–26d), and stabilizing in the later stage (26–60d). The ROC, dissolved organic carbon, and MBC contents were in 24.46%, 55.45%, and 17.60% higher, respectively, before and 19.34%, 74.98%, and 66.83%, respectively, after mineralization for 50% organic fertilization than no fertilization. The active carbon component contents were lower after each treatment, and the ROC content decreased the most. The cumulative soil organic carbon mineralization rate and MBC content before and after mineralization significantly negatively correlated. In summary, replacing 50% of chemical fertilizer with organic fertilizer inhibited soil organic carbon mineralization, which would improve carbon sequestration and fertilization. ROC and MBC were the main organic carbon sources mineralized

Materials

Four
treatments were used. These were no fertilization (CK), single chemical
fertilization (NPK), organic fertilizer replacing 50% chemical fertilization
(1/2NPKM), and only organic fertilization (M). Each treatment was performed in triplicate, and thus
12 plots were used. The plots were separated by cement ridges. Each plot had an
area of 24 m^2. The treatments were performed on randomly selected
plots.

Rice seedlings
were grown in April 2021 and transplanted in June 2021. The seedlings were planted
20 cm apart in rows 30 cm apart. Phosphate and organic fertilizers were applied
once as base fertilizers. The base to nitrogen topdressing fertilizer ratio was
5:5. Topdressing was performed when the tillering:panicle ratio was 3:2. Topdressing
was also performed at the heading stage, and other management practices were
consistent with local paddy field management practices.

The fertilizers were urea (46.2% N), calcium
superphosphate (16.5% P_2O_5), and potassium chloride
(60.3% K_2O). The organic fertilizer was a commercial organic
fertilizer with an organic matter content of 45.1%, a N content of 2.02%, a P_2O_5
content of 2.2%, and a K_2O content of 1.1%. The rice varieties are Jincheng Yahe (Jincheng 2A × Yahe),
Tianxiangdao
(first-class high-quality) national approved rice 20206073, Sichuan Tianyu
Seed Industry Co., Ltd., one-season mid-season rice, and the whole growth
period is 152 days.

Soil properties

1 The pH was determined using a composite electrode method, and the organic carbon content
was determined using the $K_2Cr_2O_7$–H_2SO_4
external heating method, and the total nitrogen content was determined using the Kjeldahl method, and the alkaline hydrolysable nitrogen content was determined using the alkaline hydrolysis diffusion method, and the available phosphorus content was determined using the $NaHCO_3$ method, and the available potassium content was determined using the flame photometric method

Active carbon components of soil

2 The MBC content was determined using the chloroform fumigation method with extraction using 0.5 mol/L K_2SO_4, and the DOC content was determined using a previously
published method[and the ROC content was determined using the 0.333 mol/L $KMnO_4$ oxidation method

SOC mineralization culturesction

3 The alkali absorption method
was used. A 30.0 g aliquot of fresh soil was added to a 50 mL beaker and the water content was adjusted to 30% of the field capacity.
The beaker was placed at the bottom of a 1000 mL culture flask. The soil was then kept in the dark at 25 °C for 7 d. A lye absorption cup containing 10 mL of 0.1 mol/L NaOH was then placed at the bottom of the flask. The flask was then sealed and kept in the dark at 25 °C. Each treatment was repeated three times. Six blank controls were analyzed. A total of 42 groups of mineralization cultures were performed. The absorption cup was removed and a fresh lye
absorption cup was added on days6,18,24......60, and water was added to the soil to maintain the soil moisture content. A 2 mL aliquot of 1 mol/L$BaCl_2$
was added to a used lye absorption cup, then two drops of phenolphthalein reagent were added. Then, 0.1 mol/L HCl (calibrated with borax) was used to titrate the mixture until the color disappeared. SOC mineralization was determined from the amount of CO_2 released.

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