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Study on the Activation of Trace Nutrient Elements in Soil by Freeze-thaw Action

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Abstract. In order to explore the mechanism of action that the freezing-thawing cycle times and freezing temperature to the nutrient forms and enzyme activity of zonal soil (Lou soil, feldspathic sandstone), using indoor freezer to simulate different freezing temperature (20 °C intense frozen and - 10 °C weak frozen), with different freezing and thawing cycles (onece and twice). The results shows that the total nitrogen content of the two samples of the freeze-thaw cycle increases, and the increment trend of feldspathic sandstone is more pronounced than Lou soil's; The increase of potassium content in Lou soil and feldspathic sandstone is 4.7% and 5.3% respectively compared with that before frozen. The effective phosphorus content of 2 kinds of soil in freezing-thawing cycle decreases, and the reducing trend of Lou soil is more pornounced than feldspathic sandstone's. The peroxidase activity was enhanced by freezing-thawing cycle; however, the activity of urease was decreased. The effect of freezing temperature on the active nutrient and enzyme activity of tillage soil is not significant.

1. Introduction

Soil is an important site for material circulation and energy conversion in ecosystems. Soil available nutrients and enzymes as a component play a crucial role in the recycling process [1]. The leaching and changeability of available nutrients and enzymes not only directly reflect the availability of nutrients in the soil and the biological activity in the soil, but also the direct nutrient and transforming ability of the crop. The cyclic transformation of total nitrogen, available phosphorus and available potassium nutrients in soil is affected by many factors such as topography, hydrology, climate, and biology. Freezing-thawing of soil is a natural phenomenon commonly found in mid-, high-latitude and high-altitude areas [2]. This phenomenon has a great influence on the physical, chemical and biological characteristics of soil. Changes in the crushing or formation of soil aggregates, soil structural stability [3], soil temperature, soil microbial community structure and quantity [4], and even affect carbon dioxide emissions in soil [5]. Previous studies focused on changes in physical and chemical properties of alpine forest soils and wetland soils under freeze-thaw cycles [6]. The lack of studies on typical zonal soils such as aeolian soils and cultivated soils in the Northwest China has been studied. The number of cycles directly affects the content of available nutrients in the soil, which in turn plays a key role in crop growth and maturation [7]. At present, the effect of total nitrogen, available phosphorus, and available potassium on the transformation of nutrient form is not comprehensive, so the implementation of freeze-thaw cycles for typical soil nitrogen and phosphorus available nutrients has certain guidance for the cultivation of soil cultivation and fertilization schemes in the northwest and the improvement of aeolian soil significance.

2. Materials and methods

2.1 Test materials
The soil for the test was bauxite and sandstone, two typical zonal soils. Alumina is from Lin-tong District of Xi'an City. It is a warm temperate, semi-humid continental monsoon climate with dry and wet seasons, and cold and warm. The annual average temperature is 13.1°C, the extreme maximum temperature is 41.9°C, the extreme minimum temperature is -17°C, and the average annual precipitation is 555 mm. Frost-free period 219 days, suitable for planting a variety of crops. The sandstone is taken from hengshan, District of Yulin City and is a temperate continental monsoon semi-arid grassland climate. The average rainfall is about 390 mm, and most of them are concentrated in July, August and September. The average annual temperature is 8.6°C, the annual extreme maximum temperature is 38.4°C, and the extreme minimum temperature is minus 29°C. Frost-free period is about 146 days, with an average of 2815 hours of sunshine. 2 kinds of soil samples were air-ground and polished through 100 mesh screen. Prepare several 550m L plastic jars. There are 2 refrigerators and freezers, and 2 sets of temperature freeze tests are performed at the same time.

2.2 Sample culture

2.2.1 Long-term frozen soil. 20 kg of fresh soil samples from each layer were divided into 4 parts, frozen at -10°C, -20°C, and -30°C respectively, and frozen for 0.5h, 1h, 2h, 4h, 7h, 11h, 16h and 22h, observed and recorded soil sample frozen state. On the 30th, 60th, and 90th days, 1kg of each soil sample was taken and thawed at 5°C, 10°C, 15°C, and 20°C, and thawed for 0.5h, 1h, 2h, 4h, 7h, 11h, 16h. At 22h, observe and record the melting state of soil samples. Melting 24h, determine its nutrient content.

2.2.2 Freezing and thawing alternation. 20 kg of fresh soil samples from each layer were divided into 4 parts, frozen at -10°C, -20°C, and -30°C respectively, and frozen for 0.5h, 1h, 2h, 4h, 7h, 11h, 16h, 22h, observed and recorded soil sample frozen state. After 15 days of freezing, the samples were thawed at 5°C, 10°C, 15°C, and 20°C and thawed for 0.5h, 1h, 2h, 4h, 7h, 11h, 16h, and 22h. The soil samples were observed and recorded for thawing. Melt 15 days. This is a freeze-thaw cycle. At the end of the 1st, 2nd, and 3rd cycles, 1kg of each soil sample was taken to determine its nutrient content.

2.3 Sample measurement
The soil total nitrogen was measured according to the method of soil total nitrogen determination (Semi-micro Kelvin method) NY/T 53-1987; the available phosphorus was measured according to NY/T 1121.7-2014 soil test part 7: available soil phosphorus. The method of determination was used for the detection; the method of measuring soil available phosphorus was used; the determination of available potassium was performed according to the method of "determination of soil available potassium and slow-acting potassium content in NY/T 889-2004". The instruments used in the experiment were Kjeldahl, ultraviolet/visible spectrophotometer and flame photometer.

2.4 Data processing and statistical analysis.
All test data were collected using Microsoft Excel 2010 software. All data in the Figurers are expressed as mean ± standard error. The test results of differences in significance test, etc. were analyzed in the software of Origin2017, and compared with Duncan's new compound difference method, different letters represented significant difference at 0.05 levels.

3. Results and analysis

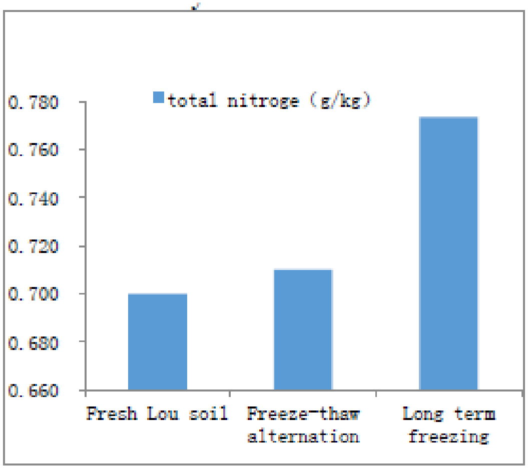

Figure 1. Contrast diagram of total nitrogen content in Lou soil

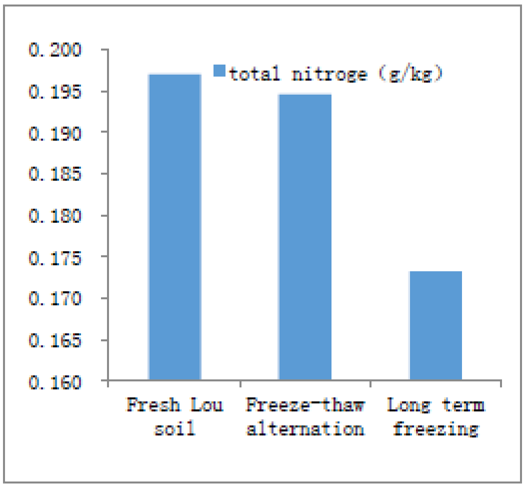

Figure 2. Comparison of different nitrogen content in sandstone

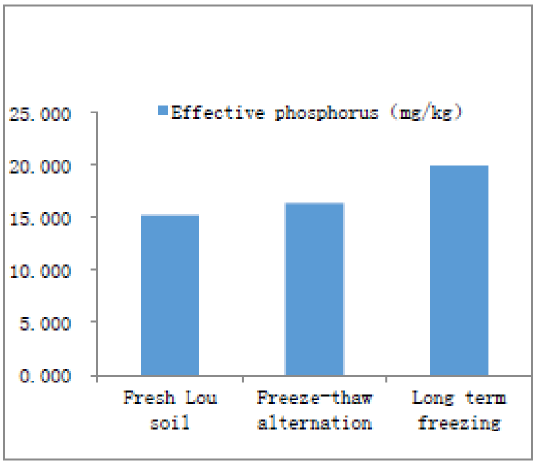

Figure 3. Contrast diagram of effective phosphorus content in Lou soil

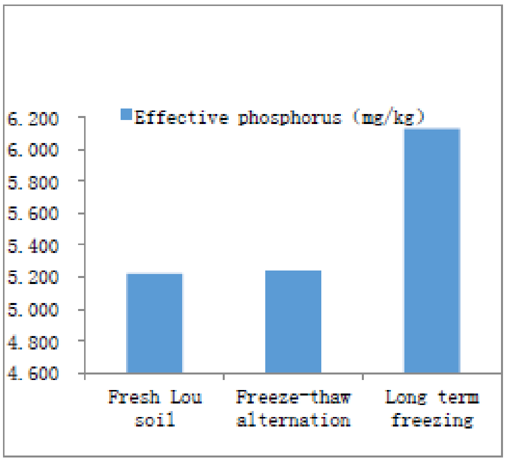

Figure 4. Contrast diagram of effective phosphorus content in sandstone

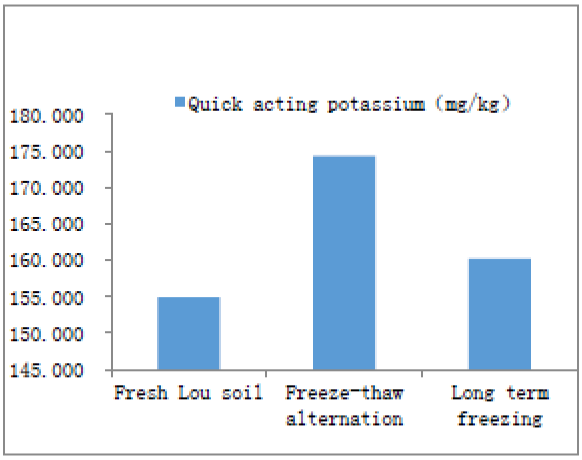

Figure 5. Comparison of the content of quick effect potassium in Lou soil

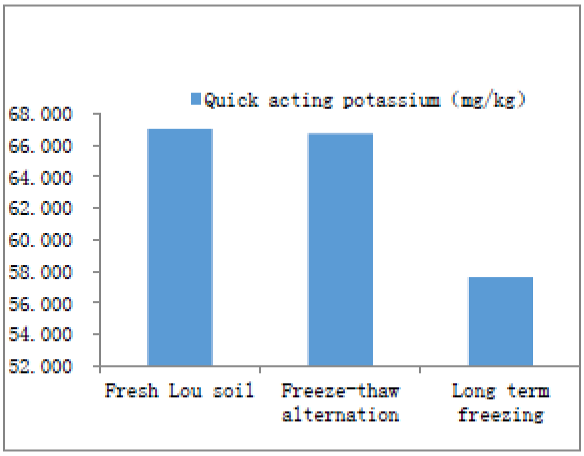

Figure 6. Comparison of the content of quick effect potassium in sandstone

Figurers 1 – 6 show that, we can see that the freeze-thaw alternation and long-term freezing have an effect on the nutrient content of nitrogen, phosphorus and potassium in soil samples. The specific effects are as follows:

(1) The contents of total nitrogen, available phosphorus, and available potassium in the soil treated with freeze-thaw alternation were increased, but the increasing trend was not significant. They increased by 0.01g/kg, 1.149mg/kg, and 19.36mg/kg, respectively.

(2) The content of total nitrogen, available phosphorus and available potassium in the long-term frozen cenozoic soil samples increased by 0.074 g/kg, 4.746 mg/kg, and 5.302 mg/kg, respectively.

(3) The content of total nitrogen and available potassium showed a decreasing trend in the soft sandstone soils treated alternately with freeze-thaw cycles, but the decreasing trend was not significant. They were reduced by 0.002g/kg and 0.262mg/kg respectively; the available phosphorus showed an increasing trend and increased by 0.023 Mg/kg.

(4) The content of total nitrogen, available phosphorus and available potassium in long-term freeze-dried sandstone soils showed a significant decrease trend, which was decreased by 0.024g/kg and 9.386mg/kg, respectively; effective phosphorus showed an increasing trend, increasing by 0.91mg/ Kg.

4. Conclusions

Different soil samples, alternating freeze-thaw cycles and long-term freezing have basically the same effect on the activation of nutrients in soil samples. They only have different degrees of promotion or inhibition, and they have positive effects on the activation of nitrogen, phosphorus and potassium nutrients in the soil samples. The role played a positive role in promoting nitrogen and potassium nutrients in the sandstone soil samples, but inhibited the activation of phosphorus nutrients.

5. References

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