Effect of freezing and thawing on available phosphorus content of soil

Lei Shi1,2,3,4*
1 Shaanxi Provincial Land Engineering Construction Group Co., Ltd, China
2 Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710075, China.
3 Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Land and Resources, Xi'an 710075, China.
4 Shanxi Provincial Land Engineering Construction Group Co., Ltd, Xi'an 710075, China.

*Corresponding author e-mail: asl19890419@foxmail.com

Abstract. The process of freeze-thaw not only directly affects the phosphorus cycle in non growing season, but also shows that the impact of cold winter and frequent freeze-thaw on the ecosystem will continue to the following growing season. This effect is closely related to soil properties, microbial activity and community structure, climate conditions, vegetation composition and management methods. However, due to the differences in research methods, many results about the effects of freeze-thaw on soil nitrogen and phosphorus cycle are quite different. After the freeze-thaw cycle, the content of available phosphorus in the two soils decreased, and the decreasing trend was Lou soil > arsenic sandstone.

1. Introduction
Under the background of global warming and the increase of atmospheric nitrogen deposition, a lot of researches have been done on the cycling process of soil nitrogen and phosphorus [1]. There are few researches on the effects of freezing and thawing on soil nutrients and soil enzymes, which are directly related to soil fertility and biological activity [2-3], and have important theoretical and practical significance for their research. These effective substrates can be directly used or lost by plants and soil organisms [4], which is of great significance to the soil carbon and nitrogen mineralization in winter, nutrient turnover and plant growth in the growing season [5].

2. Materials and methods

2.1. Natural condition of test site. According to the characteristics of soil zonal distribution in Shaanxi Province, the soil in this experiment is from two soil types, namely, aeolian sand soil in Hengshan District of Yulin City and Lou soil in Lintong District of Xi'an city. The retrieved soil samples were treated immediately and 1 kg was taken for nutrient content determination as control data.
2.2. Test material. For the long-term frozen soil treatment, take 20 kg of fresh soil samples from each layer, divide them into 4 parts, and freeze them at -10 °C, -20 °C, -30 °C, respectively, 0.5h, 1H, 2h, 4h, 7h, 11h, 16h, 22h, observe and record the frozen state of soil samples. On the 30th, 60th and 90th day, 1kg of each soil sample was taken and melted at 5 °C, 10 °C, 15 °C and 20 °C respectively. When it melted for 0.5h, 1H, 2h, 4h, 7h, 11h, 16h and 22h, the melting state of soil sample was observed and recorded. The nutrient content was measured after melting for 24 hours [6-7].

For each layer of fresh soil sample, 20 kg was taken and divided into 4 parts, respectively frozen at -10 °C, -20 °C, -30 °C, frozen for 0.5h, 1H, 2h, 4h, 7h, 11h, 16h and 22h, and the frozen state of soil sample was observed and recorded. Freeze for 15 days, take out and melt at 5 °C, 10 °C, 15 °C and 20 °C respectively, and observe and record the melting state of soil samples when melting for 0.5h, 1H, 2h, 4h, 7h, 11h, 16h and 22h [8]. The thawing period is 15 days. At the end of the first, second and third cycles, 1kg of each soil sample was taken to determine its nutrient content [9].

2.3. Data Statistical Method. All the test data are plotted by Microsoft Excel 2003 software. Statistical analysis such as difference significance test of test results was carried out in SAS 9.0 software application.

3. Results and analysis

From Fig. 1, under the condition of room temperature, the content of available phosphorus in the soft rock soil samples changed obviously, the lowest value was 1.7 mg / kg in the eighth month, and the highest value was 3.0 mg / kg in the fourteenth month. Under the alternative treatment of freezing and thawing, the change of available phosphorus content of arsenic sandstone soil samples showed an increasing trend, which was 1.5mg/kg in the 16th month and 2.9mg/kg in the 14th month, respectively. Under long-term freezing treatment, the change of available phosphorus content of arsenic sandstone soil samples showed a decreasing trend, which was 1.8mg/kg in the lowest value in the 16th month and 3.5mg/kg in the highest value in the 12th month.

![Figure 1](image1.jpg)

**Figure 1.** The change of available phosphorus content of arsenic sandstone under different conditions

From Fig. 2, Under the condition of no treatment or room temperature, the content of available phosphorus in Lou soil samples changed obviously, the lowest value was 17.2 mg / kg in the second month, and the highest value was 40.6 mg / kg in the fourteenth month. Under the alternative treatment of freezing and thawing, the available phosphorus content of Lou soil samples showed an increasing trend, which was 14.9 mg / kg in the lowest August and 41.2 mg / kg in the highest August. Under long-
term freezing treatment, the available phosphorus content of Lou soil samples showed an increasing trend, with a wide range of changes, 18.3mg/kg in the lowest April and 39.2mg/kg in the highest December, respectively.

![Image of available phosphorus content of Lou soil under different conditions]

**Figure 2.** The change of available phosphorus content of Lou soil under different conditions

4. **Conclusion**

The effects of different room temperature, alternative freeze-thaw cycles and long-term freeze-thaw on soil nutrient activation are basically the same. They only have different degrees of promoting or inhibiting effects, and have positive effects on the activation of nitrogen, phosphorus and potassium nutrients in the soil. It can promote the nitrogen and potassium nutrients in sandstone soil, but inhibit the activation of phosphorus nutrients.

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