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Effects of Soil Conditioners on Physical and Chemical Properties of Understory Soil in the Northern Foot of Qinling Mountains

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Abstract

In view of the common phenomenon of heavy adhesion in the soil under the forest in the northern foot of Qinling Mountains, in order to make more efficient use of the soil under the forest, the random block method was used to set up the experimental field, and EM bacteria and vermiculite were selected as soil conditioners. Two concentration gradients were set up for each conditioner to study the effect of composite soil conditioner on the soil under the forest in the northern foot of Qinling Mountains. The study found that the application of different proportions of soil conditioners has significantly improved and improved the physical and chemical properties of the soil. A good soil structure is more conducive to the growth of bupleurum, in order to provide a theoretical basis for the sustainable management and protection of forest land in Qinling Mountains, ecological restoration, and the correct and rational use of forest space.

Keywords

Soil Conditioner; Northern Foot of Qinling Mountains; Soil Physical and Chemical Properties.

1. Introduction

Qinling Mountains is an important ecological security barrier in China, which has many functions such as regulating climate, maintaining water and soil, conserving water resources and maintaining biodiversity[1]. The Huyi District of Xi'an City, Shaanxi Province is located in the south of Qinling Mountains. The terrain is mainly three different natural areas: mountainous area, piedmont slope and plain area. Among them, the mountainous area is an ecological protection area with no development potential. The plain area has good farming conditions, high land utilization rate and small room for improvement. The piedmont slope has a large area and good hydrothermal resources. At present, it is mainly forest land and has great potential for land use. However, under the long-term development of single tree species cultivation mode, the utilization rate of land resources is low, which is easy to cause the reduction of biodiversity and can not meet the requirements of healthy ecosystem, resulting in the waste of land resources. Therefore, it is very necessary to carry out the research on the efficient cultivation of understory economic crops.

Planting Chinese medicinal materials under the forest has a very important ecological function. It has a unique role in soil improvement, promotion of soil nutrient cycling and improvement of forest soil quality[2].On this basis, it can also bring certain economic benefits. The Chinese medicinal materials that can be applied to the compound management of forest medicine in Shaanxi include Radix Bupleuri, Gynostemma pentaphyllum, Radix Salviae Miltiorrhizae, Radix Codonopsis, Radix Bupleuri, Radix Astragali seu Hedysari, Rhizoma Gastrodiae, Polyporus

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umbellatus, Poria cocos, etc.[3].Among them, Radix Bupleuri is easy to survive, easy to manage, and has a strong ability to adapt to the environment, which is of great significance to the development of forest medicine compound management. However, the soil under the forest in the study area is generally sticky. In order to make more efficient use of the soil under the forest to plant Chinese medicinal materials, it is proposed to add soil conditioners with different functions to further improve the soil structure and improve the soil quality, so as to make it more suitable for the cultivation of economic crops under the forest. EM microbial agent is a kind of efficient compound microbial flora in the existing soil conditioner, which can create a benign soil ecology, so that crops can grow healthily and provide higher yield[4-5]; vermiculite is a kind of natural inorganic and non-toxic mineral. It has good cation exchange and adsorption, which can improve the structure of soil, store water and preserve moisture, and improve the permeability and water content of soil[6].Therefore, in this study, EM bacteria and vermiculite were selected as soil conditioners in the planting process of understory economic crop Bupleurum chinense. The functions of different materials were complemented, and the effects of different combinations of EM bacteria and vermiculite on the physical and chemical properties of understory soil were analyzed, so as to provide theoretical basis for sustainable management and protection, ecological restoration and correct and reasonable utilization of understory space in Qinling Mountains.

2. Overview of the Study Area

The test site is located in Huafeng Village, Pangguang Town, Huyi District, Xi'an City, Shaanxi Province. The Huyi District is located in the Weihe River Basin in Guanzhong, Shaanxi Province. The land is fertile and the climate is mild. It belongs to the warm tropical and semi-humid continental monsoon climate zone. The four seasons are cold, warm and dry. The average frost-free period is 219 days, the average precipitation is 879 mm, and the average annual temperature is 13 degrees. Through on-the-spot investigation, it is found that the soil layer in the project area is thick, which is eluviated cinnamon soil with heavy texture, and the pH is about 7.0~7.5. The overall vegetation coverage is high, and the unused wasteland is scattered. Apricot trees and plum trees are planted in many places, and there are no other economic crops under the tree.

3. Experimental Design

Table 1. Experimental design

Plot number	Treatment	EM agent (EM)	Vermiculite (V)
T1	E1+V1	E1	V1
T2	E1+V2	E1	V2
T3	E2+V1	E2	V1
T4	E2+V2	E2	V2
T5	CK1	E2	/
T6	CK2	/	V2
CK	CK3	/	/

In this study, a total of 7 treatments, 2 replicates, a total of 14 experimental plots of 2m×3m were set up, and the experimental field was set up by random block method. EM agent and vermiculite were selected as soil conditioners in the planting process of understory economic crop Bupleurum Chinese. The functions of different materials were complemented. Each

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conditioner had two concentration gradients, which were EM agent (15,30ml/m^2) and vermiculite (0.5,1L/m^2). The specific experimental design is shown in table 1.

4. Results and Analysis

4.1. Effects of Different Treatments on Soil Physical Properties

(1) Effects of different treatments on soil compaction.

Soil compactness is a state index of soil resistance to compaction and fragmentation under the combined action of shear resistance and compression force, which is used to characterize the deterioration of soil structure. The surface soil particles of compacted soil have strong agglomeration and cementation ability, the number of aggregates is large, and the agglomeration effect is strong. With the deepening of soil depth, the compacted soil layer is shallow, the number of soil aggregates is reduced, the cementation ability of soil particles is weakened, the soil porosity is reduced, the water and fertilizer retention ability is weakened, and the soil is compact and hard. The elements of soil particles are mainly oxygen, silicon and aluminum. The soil compaction of different treatments was measured and analyzed by soil compaction meter, and the results are shown in figure1. There was no significant difference in soil compactness between 0~20cm and 20~40cm by applying different proportions of EM bacteria and vermiculite.

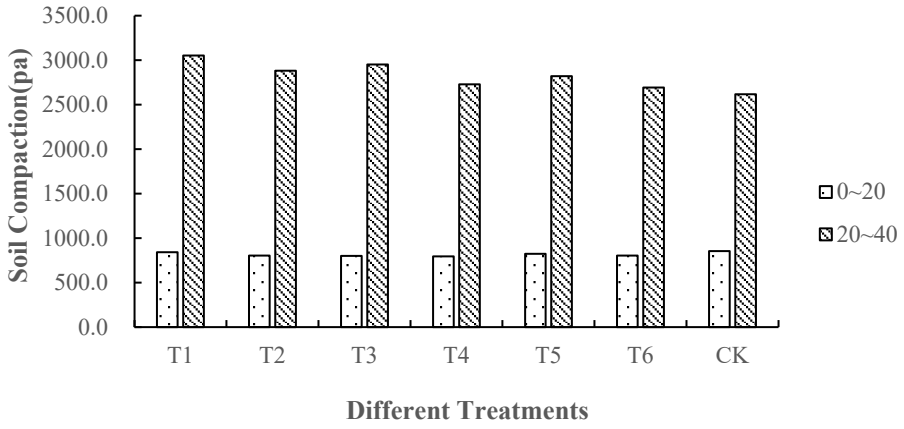

Fig 1. Effects of different treatments on soil compaction

(2) Effects of different treatments on soil water content

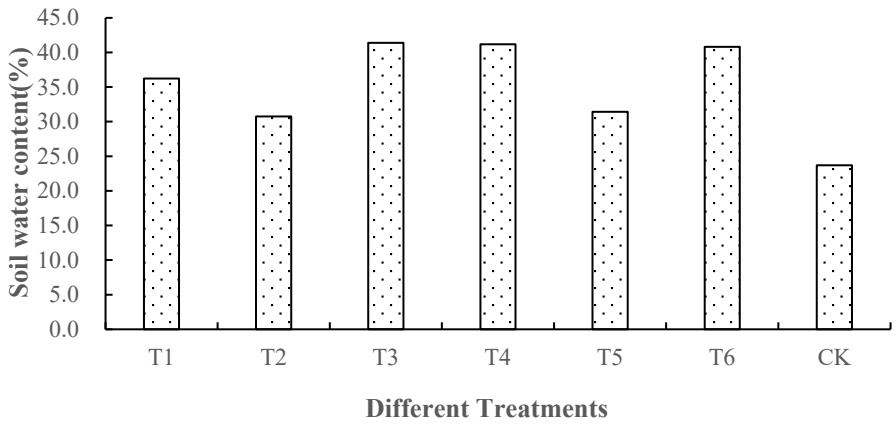

Fig 2. Effects of different treatments on soil water content

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Soil moisture is a comprehensive response to natural conditions such as climate, vegetation, topography and soil factors. It has a very important impact on the normal growth and development of plants. The hydrological characteristics of soil also reflect the performance of vegetation on soil structure improvement to a large extent. Soil moisture is a key factor of soil-plant-atmosphere continuum, and it is the carrier of nutrient circulation and flow in soil system. It not only directly affects the characteristics of soil and the growth of plants, but also indirectly affects the distribution of plants. According to figure2, the average soil water content of different treatments ranged from 30.75% to 41.37%, with a large gap, which was 52.89%, 29.78%, 74.63%, 73.77%, 32.65% and 72.27% higher than that of CK treatment.

4.2. Effects of Different Treatments on Soil Chemical Properties

(1) Effects of different treatments on soil organic matter content

Organic matter is an important part of soil. It not only contains various nutrient elements, but also is the energy source of soil microbial life activities. It can improve soil structure and regulate soil water, gas, heat and other conditions. The effect of different treatments on soil organic matter is shown in figure3. The application of different ratios of EM bacteria and vermiculite has a significant effect on the content of soil organic matter in 0~20cm. The soil organic matter content of T5 treatment is the highest, which is 35.8g/kg, which is significantly higher than CK treatment by 30.68%. It has little effect on the content of soil organic matter in 20~40cm. It can be seen that the application of soil conditioners has a significant effect on soil organic matter.

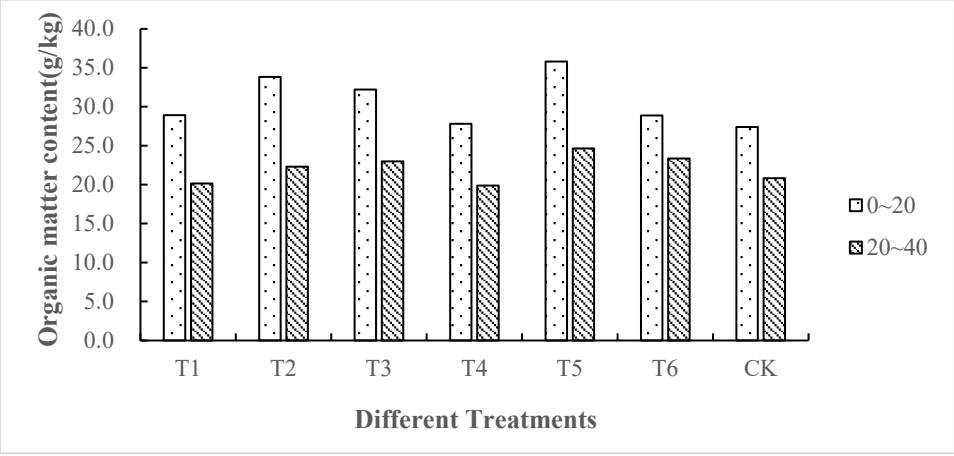

Fig 3. Effects of different treatments on soil organic matter content

(2) Analysis of the effects of different treatments on soil nitrogen, phosphorus and potassium

Soil total nitrogen refers to the sum of various forms of nitrogen content in soil, including organic nitrogen and inorganic nitrogen. The total nitrogen content in soil is in dynamic change, and its growth and decline depend on the relative amount of nitrogen accumulation and consumption, especially on the biological accumulation and hydrolysis of soil organic matter. Soil available phosphorus refers to the phosphorus element that can be absorbed and utilized by plants in the soil. Phosphorus is one of the important components of nucleic acid, phospholipid, ATP and other important substances in plant cells. It is a necessary nutrient element for plant growth and development. Soil available potassium refers to the potassium that is easily absorbed and utilized by crops in the soil, including soil solution potassium and soil exchangeable potassium. The content of available potassium is one of the important indicators to characterize the supply of soil potassium. Available potassium accounts for 0.1%-2% of the total potassium in soil, of which soil solution potassium accounts for 1%-2% of

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available potassium. Because of its low proportion, it is often included in the exchange of potassium. In this study, the effects of different treatments on soil total nitrogen, available phosphorus and available potassium were measured. The results are shown in figure 4, figure 5 and figure 6.

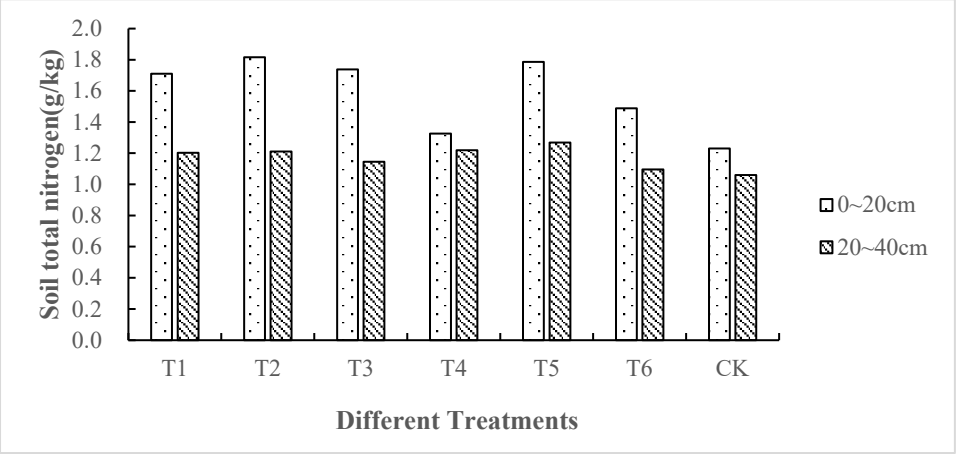

Fig 4. Effects of different treatments on soil total nitrogen content

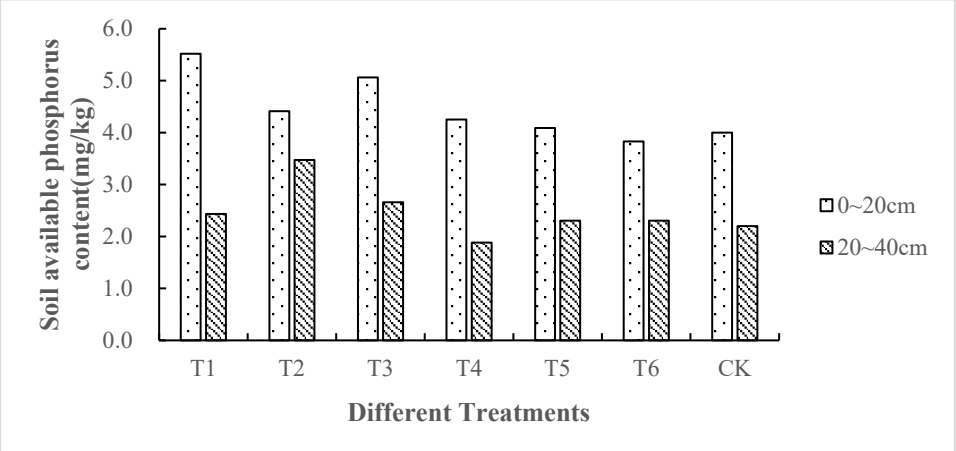

Fig 5. Effects of different treatments on soil available phosphorus content

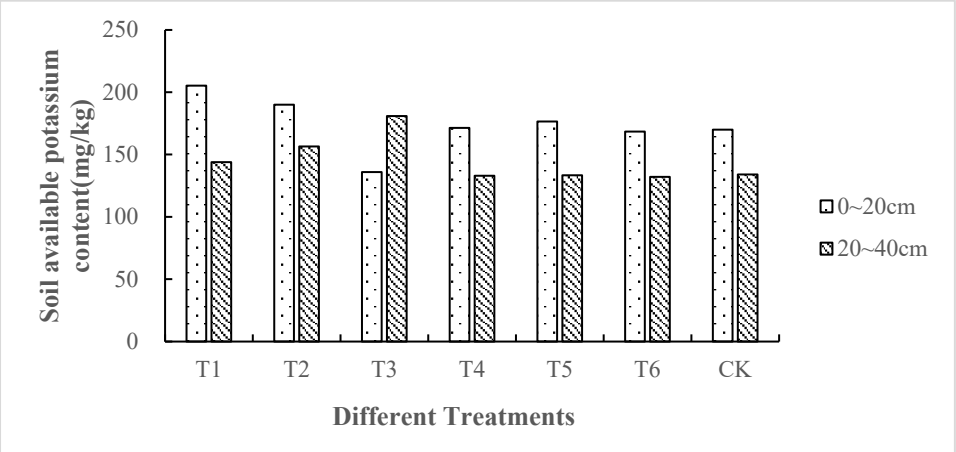

Fig 6. Effects of different treatments on soil available potassium content

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It can be seen from Fig.4,5 and 6 that the application of different proportions of EM bacteria and vermiculite had a significant effect on the nutrient content of 0~20cm soil. The total nitrogen content of different treatment groups increased by 39.04%, 47.62%, 41.28%, 7.78%, 45.21% and 21.01% respectively compared with the control group. When 18ml bacteria + 6L vermiculite was applied, the difference reached the peak. The content of available phosphorus in different treatment groups increased by 37.94%, 10.33%, 26.57%, 6.27%, 2.21% and -4.28% respectively compared with the control group. The content of available potassium in different treatment groups increased by 20.74%, 11.79%, -20.04%, 0.78%, 3.82% and -0.94% respectively compared with the control group. When 18ml bacteria +3L vermiculite was applied, the difference of available phosphorus and available potassium reached the peak.The application of different proportions of EM bacteria and vermiculite had a significant effect on the nutrient content of 20~40cm soil. The total nitrogen content of different treatment groups increased by 13.47%, 14.22%, 8.00%, 14.99%, 19.63% and 3.34% respectively compared with the control group. The content of available phosphorus in different treatment groups increased by 10.55%, 57.79%, 20.89%, -14.54%, 4.65% and 4.65% respectively compared with the control group. The content of available potassium in different treatment groups increased by 7.34%, 16.80%, 34.99%, -0.74%, -0.45% and -1.47% respectively compared with the control group.

5. Conclusion

From the perspective of soil physical properties, the application of different proportions of soil conditioners has a significant improvement effect on soil compaction and water content. From the perspective of soil chemical properties, the application of different proportions of soil conditioners has a significant effect on soil organic matter ; there were significant differences in soil nutrient total nitrogen, available phosphorus and available potassium.

Acknowledgments

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