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Research Article

Ecological Relationship between Vascular Plants and Crusts after Sand Fixation Project in Desert

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Abstract: In order to understand more about the relationship between vascular plants and crusts after the biological sand fixation project, the vascular plants, composition, coverage and composition changes of crusts in artificial sand fixation vegetation area in Shapotou are studied by quadrat survey method. It is found that the height and coverage of shrubs will decrease with the increase of years after the sand fixation project until reaching a balanced state. The number and height of herbaceous plants will increase in the same period of time, and the thickness of crusts will also increase continuously. According to the water storage property of crusts, when the number of years increases, the thicker the crusts are, the more shrubs will be provided with growth conditions. In addition, shrub roots directly affect biological sand fixation ability, so this paper studies the ecological relationship between vascular plants and crusts after the desert sand fixation project, providing reference for more effective sand fixation work.

Key words: Crusts; Vascular Plants; Desert; Ecological Significance

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Introduction

The area of desert, Gobi and desertified land in China has reached 1.673 million square kilometers. With economic losses as high as 54 billion yuan, Desertification has done great harm to the ecological environment and social economy. Therefore, the relationship between vegetation after sand fixation must be studied to further understand the future trend and sustainable development capacity of artificial vegetation in sand fixation areas, so as to provide reference for artificial sand control projects in other areas. In addition, with the increase of sand fixation time, the dynamic trend of the population develops from fast growth to slow growth and gradually declines. Finally, only a small population can be maintained in the artificial vegetation area. The main reason is that the deterioration of soil water condition leads to the decrease of its total biomass, reproductive biomass, number of flower heads, reproductive allocation and flower head allocation. Thus, it is of great importance to study the relationship between vegetation after sand fixation. As a representative of China's sand control project, Shapotou Station has a shelterbelt network spanning different eras, which effectively prevents the Tengger Desert from moving forward, ensures the smooth flow of Baotou-Lanzhou Railway and Yinchuan-Lanzhou Highway, and at the same time enables normal industrial and agricultural production in Zhongwei, with obvious ecological, economic and social benefits. Based on this, this paper takes Shapotou area as the main research object, analyzes the ecological relationship between vascular plants and crusts after sand fixation in this area, and finds the growth law between vascular plants and crusts, try to effectively solve the problem of desertification in the area through artificial cultivation.

1 Experimental Materials and Methods

1.1 Experimental Materials

In the process of carrying out this experiment, tape measure, vernier caliper, crust measuring tools and other experimental materials are used. Among them, tape measure is used to circle sample plots and measure basic data while vernier caliper is applied to measure

ground diameter.

1.2 Survey of Research Area

In Shapotou area, there are few shrubs and herbs and no crusts on the unshaded land (quicksand) (37°28′ 18.1″N, 104°59′ 50.1”E, altitude: 1348m). After 32 years of sand fixation (37°28′ 14.5″N, 104°59′ 59.4″, altitude: 1351m), there are more shrubs and herbs with crusts. After 63 years of sand fixation, the land (37°28′ 06.4″N, 105°0′ 03.5″, altitude: 1327m) has a large number of shrubs and herbs with crusts and thick crusts.

1.3 Experimental Methods

The experiment carried out in this paper mainly use the following three methods: (1) Quadrat survey method. During the experiment, the author selected a great many of the vascular plants and crusts in Shapotou area as the main research objects, and obtained the population density to facilitate the further experiment. (2) Space represents time. In view of the particularity of desert sand fixation project, this experiment uses quicksand (representing sand fixation before), initial vegetation area in 1987 (representing sand fixation for 32 years) and 1956 (representing sand fixation for 63 years) to construct vegetation succession sequence in Shapotou area. (3) Quantitative analysis. After collecting all relevant data, the statistical software is used to analyze them and display them in the form of graphs so as to grasp the experimental results more intuitively.

1.4 Experimental Purpose

After the measurement, according to the change trend of vascular plants and cryptogamous plants in the experiment and their own characteristics, the different relationships between crusts and vascular plants in the desertification control project are deduced, the contribution and changes made by these plants to their land at different times after the desertification control are understood, and how to carry out manual intervention again after the sand fixation project is analyzed, so that these plants can recover the desertified land faster and prevent the land desertification from happening again.

2 Experimental Results

2.1 Vascular Plants

2.1.1 Shrubs

Judging from the number and types of shrubs, according to the experimental results, a small number of vascular plants such as shrubs and herbs appeared on the quicksand before the sand fixation project. Although the number of shrubs has raised greatly and the species have also increased after the sand fixation project (these plants are Caragana korshinskii and Artemisia ordosica, which are suitable for growth in arid areas), it has obviously decreased from 32 to 63 years after the sand fixation, as shown in Figure 1. The number of dead shrubs around the area indicates that the arid area is unfavourable for the growth of shrubs. If there is a long-term lack of artificial irrigation, the number and species of shrubs will gradually diminish until reaching stable values.

From the view of shrubs height, it is also affected by the sand fixation project. After a large number of shrubs were planted artificially, the average shrub height was significantly lower than that before sand fixation. There are two main reasons for this phenomenon. One is the shortage of soil moisture. The other is the significantly reduced shrub diameter. The shrubs in 32 and 63 years after the sand fixation project are newly grown, which is lower than the height of the shrubs that have grown for decades in the place without sand fixation. Under such circumstances, it is quite reasonable. As the number of shrubs decreases from 32 to 63 years after sand fixation, the height of shrubs tends to rise.

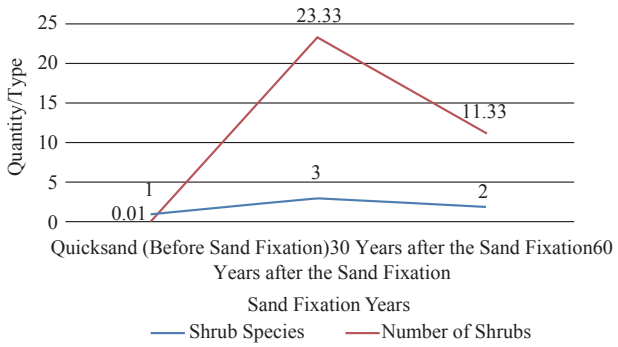

Figure 1 Shrub Species and Quantity Trend before and after Sand Fixation

2.1.2 Herbs

The second type of vascular plants are herbaceous plants. After the sand fixation project, their height has increased obviously, because their water demand is far less than that of shrubs, and the root length is not as large as that of shrubs. Therefore, compared with shrubs, vascular plants such as herbaceous plants are in a more stable state after the sand fixation project. However, as the root system of the plant can fix quicksand, the withered branches and leaves are

beneficial to the accumulation of organic matter in the sand layer and promote the formation of loose sand crusts and zonal soil. In terms of the sand fixation effect of the plant and the favorable degree for soil formation, shrubs have more advantages than herbs.

2.2 Crusts

The thickness difference of biological crusts is very obvious in 32 and 63 years after the quicksand and sand fixation projects, as shown in Figure 2. The main reason for this situation is that quicksand cannot form crusts. That is, the crust thickness here is 0mm, which is not involved in the comparison of the latter two. With the passage of time after the sand fixation project, the thickness of crusts will gradually increase. The process is relatively slow, but according to experimental data, it increases steadily. The increase of crust thickness will also leave more water in the crust layer after rainfall for the water demand of vascular plants, as shown in Figure 3.

Since crusts form a water-retaining layer after

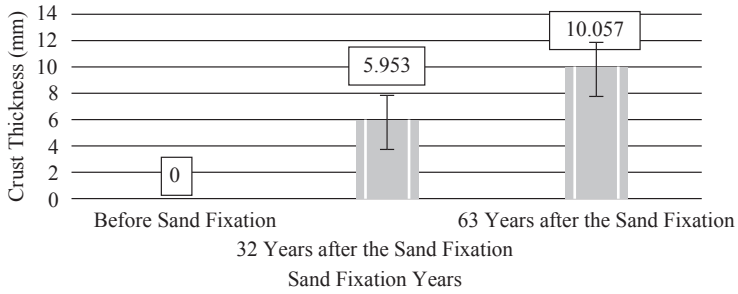

Figure 2 variation of crust thickness with sand fixation years

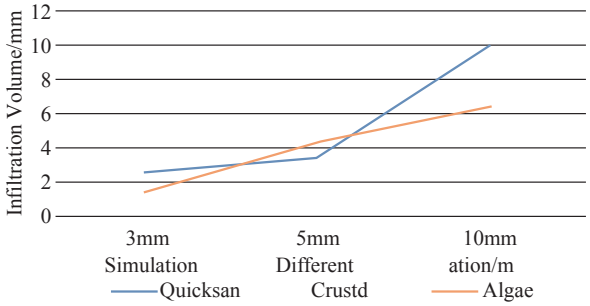

Figure 3 Water Infiltration of Quicksand, Crust and Algae

rainfall to store groundwater, and crusts need to be formed on a fixed surface. Vascular plants like shrubs and herbs consume the water stored in the crusts, and biological sand fixation method is applied to effectively solve the formation of crusts in non-quicksand areas. It can be inferred that the relationship between crusts and vascular plants is complementary. For sand areas with rainfall less than 200 mm, soil moisture between 2% and 5%, and groundwater not available to plants, the supported artificial sand-fixing vegetation should have shrub coverage of about 10%, herb coverage of about 35%, biological soil crust coverage of less than 60%, and shrubs are mainly distributed in patches. After the sand fixation project, if irrigation is not continued manually, when the groundwater stored in the upper layer is exhausted, vascular plants will grow incompletely or even die due to water shortage. However, the stored water will slowly increase and more vascular plants will grow in that area again, eventually reaching a balance of water storage and consumption, as the data shown in Figure 3.

3 Discussion

3.1 Summary of Experimental Results

3.1.1 Experimental Conclusion

According to the experimental results, the following conclusions can be drawn. First, herbaceous plants and shrubs have their own advantages. The former is in a more stable state, while the latter is more conducive to soil formation and contributes to sand fixation. Nevertheless, shrubs need to be irrigated manually, otherwise the number will decrease continuously. Second, the crust thickness will increase with the years of sand fixation, and the crust layer can store more water to meet the water demand of vascular plants. Third, the relationship between crusts and vascular plants is complementary. Crusts can provide water for vascular plants, while vascular plants are conducive to

the formation of crusts.

3.1.2 Inadequacies of Experiments

In the process of experiment and data processing, there are still many values that are not accurate enough. Firstly, estimation of coverage without much experience will make the result inaccurate; Secondly, three regions were randomly selected in such a large area, but it was difficult to find three lands separated by a certain distance during the experiment. Besides, the adjacent lands have many similarities so they cannot represent the vegetation changes after sand fixation in the whole decade. Thirdly, herbaceous plants and crusted plots cannot be randomly selected, and in most cases, the experiment is carried out on herbaceous or crusted plots. Fourth, when calculating the height of shrubs and herbs in total, the average value will vary greatly due to the different number of different plants species. Fifth, long-term northwest wind may blow some seeds out of the original experimental area. Although the precise data cannot be completely guaranteed, the accuracy of the overall direction of the data can be achieved, and the veracity is sought when selecting sample sites and processing data.

3.2 Measures

For the sake of rapid control of desertification areas, it is necessary to carry out artificial intervention for vegetation restoration. It is suggested that in 1m*1m wheat straw squares, more shrubs can be planted for biological sand fixation. Through irrigation, the crusts can fully absorb water and thicker crusts will be formed in a short time. Moreover, weeds and surplus shrubs should be removed in time to ensure that the crust can enjoy adequate sunlight. And the number of shrubs and herbaceous plants should be controlled according to the natural quantity change rule. The disadvantage is that it will cost a lot of manpower and financial resources to do this part of the experiment, so if the sand prevention project is established, it is not suitable for this way, but suitable for regularly controlling the number of shrubs and herbs after finding the natural balance rule, so as to make the crusts grow faster. Although the efficiency is not as high as that of the former, it has saved some expenses.

4 Conclusion

After the sand fixation project, vascular plants and crusts are closely related and complement each other. Artificial intervention affects the number of vascular plants, so that crusts have enough sunlight under the condition of containing water, and can play a role in improving the growth efficiency of crusts. Since the formation and growth of crust depend on fixed sand, water and sunlight, and crust soil is formed by capturing dust from the air, it is speculated that human intervention may be tried. It is relatively expensive, but such an immediate method is urgently needed in areas with extremely serious desertification.

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