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Study on the colonization of AM Fungi in Mu Us Sandy Land

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Abstract

16 species separately from 8 genera were collected from Mu Us Sandy Land (107.2°~ 112.1°E, 36.1°~38.5N). The root length colonization, hyphas colonization, arbusculos colonization and vesicle colonization were tested by cross method. The results showed that the AM fungi in the sand-fixing plants in Mu Us sandy land had high colonization and significant differences were discovered among different species (P＜0.05) , but there was no significant difference among different families (P＞0.05). The arbuscular and vesicle colonization of Astragalus adsurgens Pall is superior to other species and may be related to its specific physiological structure.

Keywords

Mu Us Sandy Land; sand Fixing Plant; colonization.

1. Introduction

Arbuscular mycorrhiza (AM) fungi landed on the earth about 400 million years ago. They are widely present in the ecosystems of all continents. They can form a mycorrhizal-based symbiosis with more than 2/3 of the plants and promote host plants. The absorption and utilization of soil moisture and nutrients enhance the ability of plants to resist stress and help plants grow better [1-2]. The existence of AM fungi in the ecosystem has an irreplaceable effect on the destruction of the ecosystem, the restoration of vegetation, productivity, and species diversity [3-4].

The Ordos Plateau is located at 37.41°～40.81 N, 106.31～112.21°E, and the altitude is 1000～1500 m. It is located in the complex and changeable geographical zone of the ecological transition zone. The environment and ecology are very fragile and sensitive. It is vulnerable to the effects of human activities and natural disturbances to produce land degradation and desertification phenomena [5]. Among them, the Mu Us Sandy Land is one of the most severely desertified areas in China. The annual evaporation is much greater than the rainfall. In this specific habitat, sand plants may have formed their unique morphological structure and physiological characteristics, which can well Adapt to the desert environment, play a very important role in preventing wind and sand fixation, preventing soil erosion, and maintaining the ecological balance and safety of sandy land [6].

He *et al*. studied the AM fungal hyphae infection of the root system of the legume *Caragana korshinskii* in the Mu Us sandy land, and found that *Caragana korshinskii* is a typical AM plant. One of the main reasons for its excellent sand-fixing ability is that of *Caragana korshinskii*. The result of symbiosis and complementarity between the specific root system and AM fungus [7]. In this paper, 16 species of common sand-fixing plants in the Mu Us sandy land were selected from 4 families and 8 genera. The cross method was used to determine the root length

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colonization (RLC) and hyphas colonization (HC) of the sample. Arbusculos colonization (AC) and veslcles colonization (VC), in order to find out whether sand-fixing plants can be generally infested by AM fungi, which is important for making full use of AM fungi resources and rebuilding sand ecology.

2. Materials and Methods

2.1. Overview of the study area

The sampling point is located in the northern sandy area of Yulin, Shaanxi Province (107.2°~ 112.1°E, 36.1°~ 38.5°N). The soil is mainly aeolian sandy soil, with an altitude of about 1000 m and an average annual temperature of about 8℃. The annual rainfall is 425 mm, mainly from July to September, and the evaporation is 2000 mm.

2.2. Sample collection and detection

In this experiment, 16 species belonging to 8 genera and 4 families were selected for sand fixation and soil improvement. There are 9 species in *Leguminosae*, followed by 4 species in *Compositae*, 2 species in Gramineae and 1 species in *Salicaceae*, based on APG III. The angiosperm classification system classifies the collected species into families and genera [8-9].

2.3. Separation and extraction methods of microplastics

The separation and extraction methods of microplastics in farmland soil mainly include heating method, air flotation method and density separation method [8]. Among them, the density separation method is widely used in the separation and extraction of microplastics in the soil. Before separating and extracting soil microplastics, the air-dried soil sample needs to be screened through a metal sieve, and the soil sample on the sieve is taken, and the mineral components in the soil are removed by density separation. The density of microplastics is lower than that of soil, but microplastics will be absorbed by soil aggregates [9], which reduces the extraction efficiency of microplastics. The density separation method can solve this problem. Use distilled water or a high-density extraction salt solution to separate microplastics from soil aggregates. The higher the density of the extract, the greater the density range of the microplastics that can be extracted.

In August 2020, 5 plants of each of the above plants were randomly selected from the sampling point. The plant root system is the core sample of this experiment. The excavated root system shakes off the root soil, then washed with water, dried naturally, and brought back to the soil Laboratory - stored at 20℃[10].

Trypan blue is used for dyeing. The specific experimental steps are as follows: take out the pretreated root sample from the - 20℃ refrigerator and put it into the test tube. Use 10% The KOH solution was treated in a water bath at 80℃ for 15 min, the waste liquid was poured out and used as a stream Wash with water for several times, then acidify with 2% HCl at room temperature for 15 min, pour out the waste liquid, wash with running water for several times, and then add an appropriate amount to the test tube Dye with 0.5% trypan blue solution at room temperature for 10 minutes, discard the waste liquid, wash with running water until the liquid is clear, and finally add an appropriate amount of eluent, subject to no root sample. According to experience, the colorization treatment is generally 3 days and 3 days. After that, take out the root sample from the test tube, cut it into root fragments about 1 cm in size, and then put it on the glass slide coated with PVLG in advance. Generally, seven root fragments are evenly placed on one glass slide, cover the cover glass slide, and receive it with your thumb Press the tablet with uniform force, and press 5 pieces of each root sample [11-13].

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2.4. Data analysis

The experimental data were summarized by Excel 2007. The differences of RLC, HC, AC and VC in roots of different species were analyzed by SPSS and plotted by origin.

3. Results and discussion

It can be seen from Table.1 that 16 species of sand fixing plants in 4 families, 8 genera collected in this experiment can be infected by AM fungi. The total infection rate is more than 50% and the infection intensity is high. This may be related to the developed roots of desert plants, in which *Psammochloa villosa* and *Achnatherum splendens* are *Gramineae*, the roots are fibrous roots, and other families and genera are straight roots, but many lateral roots are densely growing on the straight roots, and dense capillary roots are attached to the lateral roots [14]. It is observed under the microscope, Fibrous root system and capillary root system are easy to be infected by the hyphae of AM fungi. The mycelial infection rate ranges from 2% to 92%. Among them, the mycelial infection rates of *Psammochloa villosa* and *Hedysarum fruticosum* are relatively low compared with other species. At the level of about 50%, the mycelial infection rate of *Artemisia ordosica Krasch* is the highest, more than 90% , which is consistent with the observation results of he Xueli in Yulin. The results of analysis of variance showed that the total infection rate and hyphal infection rate of different species were significantly different ($P < 0.05$), which may be related to the species and growth habits of host plants, root micro-environment of host plants and soil available nutrients [15]. But there was no significant difference between different families and genera ($P > 0.05$).

Table 1. The hyphal infection of AM fungi in the roots of 16 species.

Species	root length colonization/ (%)	hyphas colonization/ (%)	arbusculos colonization/ (%)	vesicle colonization/ (%)
Salix cheilophila	65.23	58.23	1.22	0.78
Psammochloa villosa	59.65	44.25	5.58	4.67
Achnatherum splendens	48.57	46.23	12.25	11.23
Artemisia ordosica Krasch	88.75	83.78	15.68	14.25
Artemisia sphaerocephala krasch	66.23	61.25	14.56	11.68
Artemisia annua	79.68	80.23	21.23	11.76
Artemisia capillaris	80.21	72.56	6.57	7.98
Medicago falcata L	60.23	68.56	22.32	21.32
Astragalus adsurgens Pall	62.34	62.31	44.68	52.35
Hedysarum fruticosum	54.68	47.89	19.32	17.68
Hedysarum scoparium	75.23	64.58	22.35	18.33
Hedysarum fruticosum	53.65	46.89	20.32	6.35
Caragana korshinskii Kom	79.62	64.58	18.78	12.68
Caragana stenophylla Pojark	78.32	62.54	14.32	21.32
CaraganabrachypodaPojark	76.82	63.54	13.98	19.8
Caragana roborovskyii Kom	77.63	65.32	14.01	11.20

The hyphae expanded in the root cortical cells to form typical intracellular structures of AM fungi, such as mycelial circles, clumps, vesicles and so on. The cluster branches are dendritic

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and cauliflower shaped, but mainly dendritic. Most vesicles are regular round, oval, etc., and ccasionally irregular. Arbuscular infection rate and vesicular infection rate except *Astragalus adsurgens Pall,* the arbuscular infection rate and vesicular infection rate of other species are about 20%. The infection rate of plant roots, branches and vesicles in the alpine meadow of the Qinghai Tibet Plateau is at a higher level, which may be related to the arid and harsh natural conditions of Mu Us sandy land. Studies have shown that *Astragalus adsurgens*, as a pioneer species in desert ecological restoration, may be specific to it Related to the physiological structure of [16].

Mycelium is a common structure in the roots of AM fungi. It is widely distributed in root cortical cells almost throughout the whole growth period of plants, and high mycelial infection rate can help plants absorb water and nutrients in arid environment. Symbiosis between AM fungi and sand plants may be one of the effective strategies for sand fixing plants to adapt to stress. The life of clumps is short, which will be dissolved in the cortical cells of plant roots in a few days, and vesicles will be formed when the plant is about to age, so the hyphal infection rate is much higher than that of clumps and vesicles [17].

4. Conclusion

The total infection rate, hyphal infection rate, arbuscular infection rate and vesicle infection rate of AM fungi of sand fixing plants in Mu Us sandy land were higher. There are significant differences among different species, but there are no significant differences among different families and genera. Compared with other species, *Astragalus adsurgens Pall* has obvious advantages in cluster branch infection rate and vesicle infection rate, which may be related to its specific root physiological structure. Future studies will focus more on the mechanism of AM fungi assisting sand fixing plants to resist stress.

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