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Distribution of microscopic fungi in the different types of soil in Kazakhstan

Abstract

The paper presents the results of the species community number and structure of microscopic fungi research in different types of soils of Kazakhstan.

Key words: type of soil, microscopic fungi, fungal diversity, number of micromycetes.

Introduction

To date, the information about the distribution and diversity of microscopic fungi in the soil of do vast and diverse natural environment of the region as the Republic of Kazakhstan is very limited. It is known that each natural area, which is formed by a certain type of soil, vegetation type is characterized by a certain type of vegetation and specific climatic conditions. All this also determines the structure of soil microorganisms, including the specifics of soil fungi of each area [1-4]. The aim of the study was to determine the number of microscopic fungi in the different types of soils of Kazakhstan in accordance with their distribution in the soil profile and to investigate the composition of species of their communities.

Materials and methods

We studied the different types of soils of Kazakhstan representing biogeocenosis of varying climatic and geological conditions. Soil samples were collected from depths of 0-10, 10-20 and 20-30 sm. Determining the number and species composition of the soil microscopic fungi complex was performed using standard methods of investigation [5, 6].

Results and their discussion

First of all, the stock of organic matter has an impact on a distribution of microorganisms in the soil profile. As a rule, profile distribution of microorganisms corresponds to the content of humus soil horizons: their greatest strength is found in the upper layers of the biogenic, and decreases with the depth more or less sharply, depending on the soil type. With strong summer soil desiccation maximum number cannot be found in the upper layer, but at a certain depth, where moisture is retained [1-3]. Analysis of the number of fungi in the sowing on solid nutrient medium in the soil survey revealed some features. Distribution of the number of fungi in the soil profile has a pattern (Table 1). The greatest number of fungi found in a layer of 10-20 cm due to the fact that more favorable moisture and aeration take place in this layer, basic biochemical conversion processes of organic substances necessary for the life of a variety of microorganisms proceeds there. In the surface layer of 0-10 cm less microscopic fungi were found. Harmful effects of ultraviolet rays of the sun, drying, soil erosion, etc affects such dispersal of fungi. Significant reduction in the number of fungi, which is due to depletion of downstream layers of soil organic matter, as well as the deterioration of aeration are typical to 20-30 cm horizon. Thus, the number of microscopic fungi, as determined in the southern chernozem Akmola region for the horizon of 0-10 cm on Chapek's medium, was 1046.1 ± 11.4 thousand CFU / g of soil. The maximum number of fungi characterized to the layer of 10-20 cm ± 1352.3 ± 9.3 thousand CFU. With the depth, the number of fungi greatly decreased ± 839.4 ± 8.8 thousand CFU / g of soil, respectively (Table 1).

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Table 1 – The number of micromycetes in the different soils of Kazakhstan

Type of soil	Horizone, cm	Number of fungi (thousand CFU / g of soil)
serozem ordinary, Almaty region	0-10	83,4±2,1
	10-20	102,1±3,2
gray – brown desert, Zhambyl region	0-10	68,1±1,6
	10-20	86,3±2,5
gray – brown, Karaganda region	0-10	74,2±2,2
	10-20	95,5±1,7
brown desert, Karaganda region	0-10	82,3±1,1
	10-20	90,7±1,6
brown desert, Atyrau region	0-10	70,2±1,3
	10-20	93,1±1,2
light-chestnut, East-Kazakhstan region	0-10	152,6±3,7
	10-20	203,7±4,3
light-chestnut, Karaganda region	0-10	130,2 ± 5,2
	10-20	160,2 ± 6,4
middle – chestnut, Karaganda region	0-10	167,4±2,1
	10-20	229,1±3,4
dark-chestnut, Akmola region, Zharkain area	0-10	178,5±1,4
	10-20	218,8±3,8
dark-chestnut, Akmola region, Erementau area	0-10	241,5±5,2
	10-20	401,2±7,4
chernozem ordinary, Kostanai region	0-10	832,8±9,1
	10-20	1204,6±6,5
chernozem ordinary, North – Kazakhstan region	0-10	902,3±6,3
	10-20	1471,4±8,6
	20-30	870,2±6,1
chernozem southern, Akmola region	0-10	1046,1±11,4
	10-20	1352,3±9,3
	20-30	839,4±8,8
chernozem southern, Kostanai region	0-10	721,4±5,5
	10-20	1057,3±7,5
	20-30	632,1±6,9

The type of soil and its cultural status have a great influence on the size and species composition of fungi. It is shown that the number of microscopic fungi in different types of soils varies. Comparing the different types of soil in the degree of enrichment by microscopic fungi revealed some patterns. Largest population of fungi are typical to chernozem soil, the number are reckoned to 1471.4 thousand CFU / g of soil in a layer with thickness of 10-20 cm, taking into account on Chapek medium.

Obviously, this is due to a high content of organic matter, favorable water-air and trophic regime. The total content of microscopic fungi in the chestnut soils is much lower, ranging from 130,2 ± 5,2 to 401,2 ± 7,4 thousand CFU / g of soil. Number of microscopic fungi in the gray-brown and brown desert soils is low, ranging from 68,1 ± 1,6 to 95,5 ± 1,7 thousand CFU / g of soil. Serozem soils also have low occupancy of mushrooms – in the range of 83,4 ± 2,1 to 102,1 ± 3,2 thousand CFU / g of soil. Thus, from the chernozem soil to chestnut, gray-brown desert and to serozem the number of fungi is decreasing.

Set of species that can be isolated from soil is var-

ied. Depending on the number of samples taken from the soil hundreds of species can be isolated, since besides the soil spores get into it from the litter, from the surface of plants, from the air. However, the complex of constantly occurring species is limited to a particular 15-20 species, different for different soils [1]. Microscopic fungi isolated from the soils are classified in two classes: Zygomycetes (represented by single genus – *Mucor*) and Deuteromycetes (found 7 genera – *Aspergillus, Penicillium, Fusarium, Cladosporium, Trichoderma, Verticillium, and Beauveria*). A total of 18 species were identified.

Properties of fungal communities of studied soils revealed based on the composition of microscopic fungi.

Communities of soil micromycetes were assessed by the frequency of representatives' occurrence of various genuses. Frequency of occurrence (%) was defined as the percentage of samples in which the particular species were found from the total number of analyzed samples [3].

According to the frequency of occurrence, fungal species were ranked in 3 groups: 1 – dominant (frequency of occurrence is more than 60%). 2 – typical (from 30% to 60%). 3 rare (less than 30%). Main attention was paid to the dominant fungi species.

Table 2 – Occurrence of the dominant fungi species in the different types of soil

Types of soil	Dominant
serozem ordinary, Almaty region	*Aspergillus ustus, Aspergillus terreus, Aspergillus versicolor,Penicillium commune*
gray – brown desert, Zhambyl region	*Aspergillus ustus, Fusarium solani, Fusarium oxysporum*
gray – brown, Karaganda region	*Aspergillus ustus, Fusarium solani, Fusarium oxysporum*
brown desert, Karaganda region	*Cladosporium herbarum, Aspergillus ustus, Fusarium solani, Fusarium oxysporum*
brown desert, Atyrau region	*Cladosporium herbarum, Aspergillus ustus, Fusarium oxysporum, Fusarium solani*
light- chestnut, East-Kazakhstan region	*Penicillium chrysogenum, Penicillium commune, Fusarium oxysporum, Fusarium solani, Aspergillus ustus*
light- chestnut, Karaganda region	*Penicillium chrysogenum, Penicillium commune, Fusarium oxysporum, Fusarium solani, Aspergillus ustus, Aspergillus terreus*
middle – chestnut, Karaganda region	*Penicillium chrysogenum, Penicillium commune, Fusarium oxysporum, Fusarium solani, Aspergillus ustus*
dark-chestnut, Akmola region, Zharkain area	*Penicillium chrysogenum, Penicillium commune, Fusarium oxysporum, Fusarium solani, Aspergillus ustus*
dark-chestnut, Akmola region, Erementau area	*Penicillium chrysogenum, Penicillium commune, Fusarium oxysporum Fusarium solani, Aspergillus ustus*
chernozem ordinary, Kostanai region	*Penicillium expansum, Penicillium terrestre, Penicillium rugulosum, Penicillium commune, Aspergillus oryzae*
chernozem ordinary, North – Kazakhstan region	*Penicillium expansum, Penicillium terrestre, Penicillium rugulosum, Penicillium commune, Aspergillus oryzae*
chernozem southern, Akmola region	*Penicillium expansum, Penicillium terrestre, Penicillium rugulosum. Penicillium commune, Aspergillus oryzae*
chernozem southern, Kostanai region	*Penicillium expansum, Penicillium terrestre, Penicillium rugulosum, Aspergillus oryzae*

The Table 2 data show that the fungal community of serozem soils is characterized by dominance of *Aspergillus* fungi. Species diversity of these fungi is large. Among the species of *Aspergillus* genus, thermotolerant and thermophilic species, which determines their widespread use in these soils, are known. There are many species of *Penicillium* fungi in the serozem soils. *P.commune* is dominant, while others such as *P.chrysogenum* and *P.terrestre* attributed to typical. Sufficiently serozem soils are rich with mushrooms with dark-colored mycelium – *Cladosporium herbarum*, the frequency of occurrence of which is from 38 to 54% depending on the horizon. A small number of *Beauveria bassiana* and *Fusarium oxysporum* are found.

In the gray-brown desert and brown desert soils a significant number of fungi of *Aspergillus* and *Fusarium* are found. In the structure of fungal communities the soil with high occurrence (60-85%) the dominate species are *F. solani*, *F. oxysporum* and *A. ustus*. Significant abundance of *Cladosporium* dark-colored fungi is typical for this type of soil. It was found that in the gray-brown desert soils, *C. herbarum* is dominant, while in brown desert soils, its frequency of occurrence is less than 60%, and this type of fungi is related to the typical. *A.terreus, P. terrestre, P. lanosum* are typical to these soils.

The composition of the fungi in the chestnut soils is characterized by a high occurrence of such species as*: F. oxysporum, F. solani, P.chrysogenum, P.commune* and *A. ustus*. In the soil, fungi of the *Fusarium* genus are widespread, they are able to exist in the active form and multiply rapidly. These fungi in large quantities are found in the soils of median area covered by vegetation and very poorly represented in forest soils [3, 4]. Eurytopic kinds of microscopic fungi, which have a wide distribution area, were typical. They are representatives of the *Aspergillus* and *Penicillium* genera: *A. versicolor, A. terreus, P. terrestre* and *P.lanosum*. *A. terreus,* a typical for chestnut soils of different regions of Kazakhstan, is dominated to light chestnut soil of Karaganda region.

In the structure of the fungal community of chernozem soils *P.expansum, P. terrestre, P. commune, P. rugulosum* and *A.oryzae* are dominant. Characteristically, that significant number of accounted fungi at chernozem soil is fungi of the *Penicillium* genus, their high abundance and diversity of species are noted. The section Asymmetrica is most richly represented (*P.expansum, P. terrestre, P. commune, P. lanosum, P. chrysogenum*), also there are representatives of the Biverticillata section (*P. rugulosum*).

Thus, comparing the different soil types on the degree of enrichment of microscopic fungi it was shown, which from the chernozem soil to chestnut, gray-brown and brown desert and further to serozem the number of fungi is decreasing. The structure of communities of microscopic fungi is specific for each type of soil. Differences are marked as by frequency of occurrence and by diversity of species.

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