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Species composition of Trichoderma Pers. common for Technogenically violated Cenosis in the conditions of Azerbaijan

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Abstract

The paper presents the studies of the species composition of Trichoderma Pers. common for Apsheron Peninsula of the Republic of Azerbaijan. The plants (grasses, bushes and trees) and the soil exposed to the technogenic impact of different degree (clean and irrigated soils, as well as the soils heavily, moderately or slightly contaminated with oil) were used to extract the fungi. The analysis of the samples taken revealed that 8 species of Trichoderma are common for the investigated territories *(T. album, T. asperellum, T. citrinoviride, T. hamatum, T. harzianum, T. koningii, T. longibrachiatum, T. viride)* 1 of which *(T. citrinoviride)* is new for mycobiota common for the nature of Azerbaijan. It is established that the anthropogenic load on the soils has the negative impact on the prevalence of these fungi, and it cannot be found in the heavily and moderately contaminated soils.

Keywords: Trichoderma species, species composition, frequency of occurrence, anthropogenic impacts.

Introduction

It is commonly known that the fungi are the mandatory components of the heterotrophic unit of any ecosystem, and they perform the various functions in them. The impact of fungi on the biocenotic processes as well as the structure and functions of communities is confirmed by a number of works, though their role is studied to a lesser extent, compared to the role of plants. The issues of prevalence and species composition of the plant pathogenic fungi, especially of those species which parasitize on the cultivated plants are addressed the most detailed in the literature [10]. The lesser attention is paid to the study of biological diversity in the natural and anthropogenically (or technogenically) violated cenosis and agricultural ecosystems of the saprotrophic species of micromycetes one of which are the *Trichoderma Pers.* fungi.

The representatives of this specie being also included into the heterotrophic unit of ecosystem affect the soil-forming processes, contribute to the improvement of structure and formation of humus in the soil at the expense of bioconversion and mineralization of plant residues, participate in the regulation of the soils microbiota complex and are able to limit the development of plant pathogenic species because the fungi of this specie have the antagonistic relations with plant pathogenic fungi [1-3, 7]. The biology, phylogeny and prevalence as well as a number of important aspects associated with the mechanisms of

biocontrol, biosynthesis of enzymes and antibiotics by the *Trichoderma* micromycetes is widely studied by now and in the last decades the fungi of this specie occupied one of the leading places as the main biotechnology [4, 6] objects because the fungi of this specie synthesize a lot of secondary metabolites having different biological activity [14].

However, regardless of a large number of studies, the potential of *Trichoderma Pers* fungi is not disclosed completely, and there are many territories at which the data dedicated to the goal-oriented study of the prevalence of this species cannot be found. One of such region is Apsheron Peninsula of the Republic of Azerbaijan there the goal-oriented study of *Trichoderma Pers* fungi is almost absent.

The selection of Apsheron Peninsula is also associated with that this territory (total area 222 thous. ha) is the problematic area with the critical acuity of the geoecological problem complex [11] that, on the one hand, is associated with technogenic impact (contamination with oil and oil products, toxic waste of chemical industry, inappropriate use of natural resources, etc.) and, on the other hand, with natural degradation processes (wind erosion, soil salination, desertification).

In this regard, the purpose of the presented paper was the study of the species composition of *Trichoderma Pers.* in the conditions of Apsheron Peninsula of the Republic of Azerbaijan.

Materials and Methods of Studies

The sampling of soils (clean and anthropogenically violated), plants (grasses, bushes and trees) and plant residues was performed at the territory of Apsheron Peninsula of the Republic of Azerbaijan in order to separate the strains as the material for assessing the species composition of *Trichoderma Pers.*

It should be noted that Apsheron Peninsula is one of the arid areas of Caucasus, and the main type of soil is grey-brown [12]. That is why, in general, namely this type of soil different by the degree of contamination was used for sampling.

The sampling, analysis, preparation of suspensions, extraction of microorganisms and their identification were carried out according to the method which is currently used in the same studies [13].

When identifying the extracted *Trichoderma Pers.* fungi the methods and determinants proposed by different authors were used [3]. The description of fungi was performed at the growth of cultures on the potato dextrose agar medium (PDAM) and malt-agar medium (MAM) on the 5-7 day at 28°C. The cultural and morphological features (the structure of mycelium, conidiogenous cells and conidia) as well as the life cycle of *Trichoderma Pers.* fungi was observed in the micro culture in the Van Tiegham cells.

The frequency of occurrence (%) for the separate species of *Trichoderma Pers.* was determined by the formula

$$P = (a/n) \text{ X } 100,$$

where, *P* is a prevalence (%), *n* is a number of the samples taken, *a* is a number of detected samples of this specie of fungi.

Results and Discussion

As it was noted, the detailed study of *Trichoderma Pers* species prevalence at the territory of Azerbaijan was not performed, though in the separate studies the *Trichoderma Pers.* species were detected by some authors [8]. But these studies are occasional and sector-specific. The separate biotopes which differ by the degree of anthropogenic or technogenic load were not studied completely. In addition, the use by the author of those works of different keys and methods of identification complicates the comparison of the obtained results.

According to the results of works conducted by us in 2010-2014, 234 strains of *Trichoderma Pers.* specie were separated which were used as the basic material for the species composition assessment. During the identification of the separated cultures using the determinant composed under the cultural and morphological features 8 species were identified, among which *T. citrinoviride Bissett* was for the first time found at the territory of Azerbaijan (Table 1).

As it can be seen in the tables 1 and 2, under the common prevalence the *Trichoderma Pers.* species differ between each other, and *T. harzianum Rifai* was the most common – 26.0%. The representatives of this species were extracted from all the samples (clean, irrigated and slightly contaminated soils, plant residues, separate plants, etc.; herewith the most of

extracted isolates of these species are soilborne, and this fungus is not found in the oil-contaminated soils (moderately and heavily contaminated soils).

The second place was occupied by fungus *T.asperellum* Samuels, Lieckfelt et Nirenberg the prevalence of which at the investigated territories was 22.2%. The strains of this specie were predominantly extracted from the virgin and anthropogenic (irrigated) soils, underlay and plants, but were not found in the technogenically violated (oil-contaminated) soils.

Table 1. Common characterization of Trichoderma fungi strains extracted from the different territories of Apsheron Peninsula of the Republic of Azerbaijan

Item No.	Name of Trichoderma species	Number of strains	
		Quantity of strains	Share in the total number (%)
1	*T. album* Preuss.	21	9.0
2	*T. asperellum* Samuels, Lieckfelt et Nirenberg	52	22.2
3	*T. citrinoviride* Bissett	10	4.3
4	*T. Hamatum* (Bon) Boner	14	6.0
5	*T. harzianum* Rifai	61	26.0
6	*T. koningii* Oudem.	15	6.4
7	*T. longibrachiatum* Rifai	26	11.1
8	*T. viride* Pers.	35	15.0
Total		234	100

The share of prevalence for *T. viride Pers*. is 15.0%; this specie was extracted mainly from the underlay and the samples of decaying wood and plants which included the medical plants.

The other species (*T. album, T. citrinoviride, T. hamatum, T. koningii, T. longibrachiatum* and *T. viride*), the prevalence of which was 4.3-11.1%, were also extracted from the clean soils, plants and plant residues.

Table 2. Prevalence of Trichoderma Pers. fungi depending on the technogenic load

Item No.	Name of species	Prevalence (in %)					
		1*	2	3	4	5	6
1	*T. album*	52.1	41.3	2.1	0	0	4.5
2	*T. asperellum*	58.7	36.5	0	0	0	6.0
3	*T. citrinoviride*	59.1	30.1	3.2	0	0	7.6
4	*T. hamatum*	47.2	44.5	2.7	0	0	5.6
5	*T. harzianum*	54.3	40.2	1.1	0	0	4.3
6	*T. koningii*	53.7	41.1	1.5	0	0	3.7
7	*T. longibrachiatum*	51.1	37.3	3.4	0	0	8.1
8	*T. viride*	58.4	32.4	2.5	0	0	6.7

*** Note:** 1 – clean soils; 2 – irrigated soils; 3 – oil-contaminated soils (slightly contaminated: up to 10 g of oil per 1 kg of soil); 4 – oil-contaminated soils (moderately contaminated: 10 to 40 g of oil per 1 kg of soil); 5 – oil-contaminated soils (heavily contaminated: more than 40 g of oil per 1 kg of soil) and 6 –contaminated with the waste of chemical industry.

Some authors notes that the different species of *Trichoderma Pers*, though they are found practically everywhere and are not very demanding in relation to the environment, but still they prefer different substrates, have the ranges of temperature and humidity for their development and normal life-sustaining activity [15-16]. In general, all the *Trichoderma Pers* fungi are more common in the soils not exposed to the anthropogenic or technogenic impact. The anthropogenic and technogenic soils were characterized by the decrease in the frequency of occurrence and species composition of *Trichoderma Pers*, and the fungi of this specie were at all not found in the oil-contaminated soils.

It is known that the suppressivity of the different types of soils is associated with the micobiota complex presence which includes the certain fungi capable to limit the infectious potential of phytopathogenes. One of this is the representatives of *Trichoderma Pers* species [5, 9]. However, the results of other conducted studies established that the technogenic contamination affects strongly the structure of micocomplex not only in the quantitative but also in the qualitative manner [11]. The essence of the latter is in increasing the share of phytopathogene fungi (for example, Fusarium fungi) in relation to which the *Trichoderma Pers* species demonstrate the antagonism. Therefore, the technogenic contamination not only violates the mechanical and physical as well as the chemical composition of soils, but, increasing the share of phytopathogenes, deteriorates the phytosanitary condition of soils.

Thus, as a result of the conducted studies it is established that 8 species are common for the territory of Apsheron Peninsula, 1 of which is new for micobiota specific for the nature of Azerbaijan, and the anthropogenic changes have the strong impact both on the quantitative and qualitative indicators of the fungi of these species.

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