CROP PRODUCTION

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STRUCTURE OF SOIL COMPLEXES OF MICROSCOPIC FUNGI UNDER *VICIA FABA L.*

Research article

Abstract

Vicia faba was grown on a natural infectious background on the territory of the Botanical Garden of NRU BelSU (Belgorod, Russia) and, taking into account the frequency of occurrence and abundance of species, they determined the structure of soil myco-complexes. In the micromycetes complex under *Vicia faba*, the share of toxigenic species increased by 2.5-29%, opportunistic species - by 1.3-31%, allergens - by 2-24% compared to the control soil. After cultivation of *Vicia faba*, phytopathogenic species *Ascochyta fabae, Clasdosporium herbarum, Fusarium graminearum, F. oixysporum* var. *orthoceras, F. oxysporum, F. solani* and *Ulocladium botrytis*, which must be considered when selecting the next crop in crop rotation.

Keywords: broad beans, microscopic fungi, micromycetes, phytopathogens, opportunistic fungi, toxigenic fungi, allergenic fungi.

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СТРУКТУРА ПОЧВЕННЫХ КОМПЛЕКСОВ МИКРОСКОПИЧЕСКИХ ГРИБОВ ПОД *VICIA FABA L.*

Научная статья

Аннотация

На территории Ботанического сада НИУ БелГУ (г. Белгород, Россия) на естественном инфекционном фоне выращивали *Vicia faba* и, с учетом показателей частоты встречаемости и обилия видов, определили структуру почвенных микокомплексов. В комплексе микромицетов под *Vicia faba* отмечено усиление доли токсигенных видов на 2,5-29%, оппортунистических видов – на 1,3-31%, аллергенов – на 2-24% по сравнению с контрольной почвой. После культивирования *Vicia faba* в почве остаются фитопатогенные виды *Ascochyta fabae, Clasdosporium herbarum, Fusarium graminearum, F. oxysporum* var. *orthoceras, F. oxysporum, F. solani* и *Ulocladium botrytis*, что необходимо учитывать при подборе следующей в севообороте культуры.

Ключевые слова: овощные бобы, микроскопические грибы, микромицеты, фитопатогены, грибы оппортунисты, токсигенные грибы, аллергенные грибы.

1. Introduction

Vicia faba var. *major* have a great bioresource potential and are excellent predecessors, since plants actively fix nitrogen from the soil and from the atmosphere, leaving behind in the soil up to 50-80 kg / ha of nitrogen. Consequently, *V. faba* can become an integral part in the biologization of agriculture and crop production by reducing the anthropogenic load on the agrocenosis [1]. However, in the cultivation of all leguminous crops, a number of factors should be taken into account, including biological ones, among which microscopic fungi occupy a special place, which can cause up to 90% of all plant diseases and can be toxigenic, opportunistic and allergenic [2, 3]. It is known that the process of intravital root exudation by leguminous plants changes the number and composition of soil micromycetes, but the information on this issue is still very small and sometimes contradictory [3, 4]. Knowledge of the structure of micromycete complexes under *V. faba* will provide information about changes in the micromycetes species composition, accumulation of phytopathogenic, antagonistic and dangerous for humans microorganisms and it will be possible to assess the degree of microbiological disturbance of mycoflora due to the specifics of agricultural technology and take measures to create the optimal balance of mycoflora. Therefore, the purpose of this work was to determine the structure of soil mycocomplexes under different varieties of *V. faba*, as well as to identify the content of toxigenic, opportunistic, and allergenic for humans species of fungi.

2. Materials and methods

Varieties of *V. faba* were studied in the Botanical Garden of the Belgorod State University Research Institute (Belgorod) on a natural infectious background. The plants were grown in an ordinary way (according to the scheme 20x45 cm) on the accounting plots of 5 m2 in 2 times. The soil at the experimental site is ordinary chernozem (medium loamy medium loam, pH of the aqueous extract is 7.6). Identification of micromycetes was carried out on a combination of cultural and morphological traits using special guidelines [5, 6]. Characterization of the structure of soil complexes of micromycetes in various elements of ecosystems was carried out on the basis of indicators of the frequency of occurrence and abundance of species. Abundance is the ratio of the number of isolates of a particular species to the total number of isolates of all species, expressed as a percentage. The spatial frequency of occurrence was defined as the ratio of the number of samples in which the species was found to the total number of samples, and the temporal frequency of occurrence was defined as the ratio of the number of analysis periods when the species was detected to the total number of analysis periods. Species with a spatial and temporal occurrence of more than 60% were considered dominant, more than 30% were frequent, and spatial occurrence less than 30% were rare, and a temporary occurrence was more than 30%. Random species had a frequency of less than 30%. The degree of species dominance in the complex was assessed using the Simpson index.

3. Result and discussion

Analysis of myco-complexes showed that the majority of micromycetes in the rhizosphere under the bean varieties belonged to the Ascomycota department and the classes Sordariomycetes, Dothideomycetes, Eurotiomycetes and Saccharomycetes, 8 orders and 11 families. The species diversity of the soil mycobiota of the control soil was characterized by 13 genera, including 26 species, and under the studied bean varieties 57 species of fungi were identified. However, the species diversity under the beans decreased by 7-17 species compared with the control.

The most represented by the number of species was the genus Penicillium (18 species); fewer species numbered p. *Aspergillus* and *Fusarium* (10 species each), *Alternaria, Cladosporium, Rhizopus* and *Trichoderma* (2 species each). In the myco-complex of control, only *A. niger* was revealed in the rank of dominant species, 2 types are frequent: *A. ustus* and *Rh. microsporus*. In the rank of rare were 4 species: *A. alternata, A. ochraceus, F. oxysporumi, Rh. stolonifer*. By the random attributed 19 other species. Compared with the soaring soil, the rare species *F. ohysporum* moved to the rank of dominants, and the species *A. niger*, on the contrary, reduced the rank to frequent. In general, species of different ranks of the frequency of occurrence, which are not noted in the soaring soil, developed in the myco complex under *V. faba*. For example, *A. tenuissima* and *Stemphyllium solani* were rarely and accidentally found in the control soil, but were not found under the beans during budding – flowering. This can be explained by the fact that the different composition of exudates in the root zone of the soil under the plants contributes to the development of different types of microorganisms.

It should be noted that under *V. faba* the number of propagules of micromycetes is significantly higher than in the soaring soil. The total number of micromycetes averaged 31 thousand CFU / g of soil, which is higher by 13 thousand CFU / g compared to the soil of control. In the micromycetes complex under *V. faba*, the proportion of typical species increased by 7.7-47% and their abundance increased by 4-28% compared with the control. Among the genus *Fusarium*, there are phytopathogenic representatives. When analyzing the soil mycobiota studied by *V. faba*, 10 species and varieties were found: *F. caucasicum* Letov, *F. culmorum* (Sm.) Sacc, *F. graminearum* Schwabe, *F. heterosporium* Hees, *F. oxysporum* Schl. var. *orthoceras* (App. EtWr.) Bilai, *F. oxysporum* Schltdl., *F. redolens* Wr., *F. sambucinum* Fuckel, *F. solani* (Mart.) Sacc., *F. sporotrichiella* Bilai var. *sporotrichiella* (Sherb.) Bilai. So, in the *V. faba* rhizosphere micromycetes complex, the proportion of random species decreased and, at the same time, the degree of dominance of typical species increased. An increase in the dominance index was observed under the studied bean varieties (Simpson index 0.09-0.24) compared with the control soil, with the dominance index D = 0.07.

Compared with the steaming soil, the share of opportunistic species in the rhizosphere micocomplexes of the studied bean varieties increased from 1 to 31%. Among typical species, toxigenic species were found in soil samples under *V. faba: A. alternata, F. oxysporum, Mucor strictus, S. solani, U. botrytis*, and many members of the genus *Aspergillus, Penicillium, Rhizopus, Trichoderma*. In the control, the share of toxigenic species was 27%, and their abundance was 76%. In most varieties of *V. faba* in the mycocomplex, a decrease in the abundance of toxigenic species was observed compared with the control (4-21%).

Species of micromycetes, opportunistic for humans and animals, developed in the soil micocomplex: *A. alternata, A. niger, A. ustus, C. krusei, F. oxysporum, S. solani, U. botrytis*, and representatives of the genera *Penicillium* and *Trichoderma*. Compared with the control soil, in which the proportion of opportunistic species was 15%, and their abundance was 49%, an increase in the proportion of opportunistic species by 1-31% was found in the rhizosphere mycocomplex under *V. faba*. It was also established that allergic fungi were present in the myco-complex under *V. faba*, in which the share of species was 15.8-46.2%, abundance - 47.2-88.2%. In the soil control complex, allergenic species were also identified with a share of 23% and an abundance of 71%. The share of allergenic fungi in most of the studied varieties exceeded control by 1-23%.

4. Conclusion

Thus, in the soils under the *V. faba* varieties, specific micromycete complexes were noted with species of the genus Penicillium, Aspergillus and Fusarium predominating, with an increase in the number of micromycetes 2.3 times as compared with the control soil and a decrease in species diversity (with manifestation of "dominance concentration"). Compared with the control in the micromycetes complex under *V. faba*, the share of toxigenic species increased by 2.5-29%, opportunistic species - by 1.3-31%, allergens - by 2-24%. The obtained data on the distribution of soil micromycetes studied by *V. faba* can be used to adjust the technology of their cultivation. Since after cultivation of V. faba, phytopathogenic species remain in the soil (*A. fabae, C. herbarum, F. graminearum, F. oxysporum var.orthoceras, F. oxysporum, F. solani* and *U. botrytis*), which can harm other agricultural plants, It is necessary to choose the cultures that are least sensitive to this mycoflora following in crop rotation.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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