

Root rot grain crops on Cereals caused by the phytopathogenic fungi

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Abstract. Researching the special and infraspecial structure in causative agent populations of the most dangerous diseases root rots of cereals in various regions of the Russian Federation has been carried out. The defeat of cereals root rots old in Russia causes in the a complex patogenic. More often meet *Fusarium culmorum* (W.G.Sm.) Sacc., *F. oxysporum* (Schlecht.) Snyd.et Hans., *F. heterosporum* Nees., *F. sporotrichiella* nom.nov. Bilai F. *gibbosum* App.et Wr.emend Bilai., *F. avenaceum* (Fr.) Sacc. and *Bipolaris sorokiniana* (Sacc.) Shoem., *Alternaria* spp.

1 Introduction

Today, the population is growing. For this reason, the need for food is growing [1]. High human activity in different areas (for example, construction, industry, agriculture, etc.) creates a high technogenic burden on the environment [2-7]. For this reason, there are many difficulties with preparing the soil for planting the crop. This affects the quality and quantity of the crop during harvesting. There are great difficulties in controlling the quality of the products from such a crop, especially in the form of a liquid phase [8-9]. The decrease in yield leads to consequences. There is an increase in prices or a stop of the agricultural enterprise. This is the sort of ecological balance (agricultural fields are overgrown with weeds). These weeds can mutate and suppress natural plants. This leads to a disturbance of the microclimate in the given territory. This affects the technosphere safety.

The problem of strengthening the threat for human life and natural processes are all worse in recent years. They are caused by increasing population and depletion of natural resources and increasing environmental pollution. Great efforts are being made to develop new ways of environmental monitoring but this is not enough [11-14].

The use of technology while minimizing the mechanical impact on soil and short crop rotations has led to expressive dynamics of root rot in agriculture of Russia [1, 15].

The defeat of crops root rots in Russia causes is a patogenic complex. More often meet *Fusarium culmorum*(W.G.Sm.) Sacc., *F.oxysporum* (Schlecht.)Snyd.et Hans., *F. heterosporum* Nees., *Bipolaris sorokiniana* (Sacc.) Shoem, *Alternaria*.

Root rots is one of the most severe diseases of small grain cereals and are able to produce various mycotoxins. Infection of grain by *Fusarium* species, *Bipolaris* species, *Alternaria*

species, not only reduces crop yield, but also destroys the quality of grain by contaminating it with mycotoxins [16].

In addition, microorganisms cause the biodegradation of building structures and materials granaries [17-23].

The main factors of pathogen transmission have been able to contain the infection in soil, stubble and seed infected by the fungus. Fungi of the genus *Fusarium* are capable to long saprotrophes development in the soil.

The intensity of development and the prevalence of *Fusarium* spp. have depended on weather of vegetation period, genotypic and field resistance of grain cultivars, agronomical and technological methods of cultivation. Seeds have been transmitted to 60% of plant diseases. Contamination of spring wheat seeds of *Fusarium* spp. is 3-5% annually. Infected seeds have got low germination rate, their viability has reduced.

The mechanism of toxic action of fungi has been the ability to inhibit protein synthesis of living beings. Mycotoxins have been characterized by exhibiting strong anabolic and estrogenic effects.

Pathogenicity of the *Fusarium* fungi has been determined due to their ability to hydrolytic enzymes and toxin produce [22-24]. For example, *F. graminearum*, *F. tricinctum* isolates have generated zearalenone, *F. moniliforme* and *F. proliferatum* – fumonisin, *F. moniliforme*, *F. acuminatum*, *F. avenaceum*, *F. oxysporum* – moniliformin identified different levels of *Fusarium* toxicity have depended on the host plant and the cultivation conditions [25].

The goal of the work was the collation of data on species composition and frequency of occurrence of fungi of the genus *Fusarium* for the selection of the state collection for keeping and use in breeding studies as infectious material.

2 Materials and methods

The infected material was sampled from plants of wheat, barley and rye collected in 1995-2016 on the territory of the Russian Federation. Mycological analysis of diseased samples of seeds and roots was carried out on a nutrient medium 2% potato-dextrose agar according to standard methods in a 5-10 replications.

Isolates of *Fusarium* spp. were specified according to morphology of colonies and conidia [26].

Phytopathological analysis of seed was conducted by the method of roll-examination by the V. A. Chulkina.

Isolates were cultivated on agar medium for 14 days at 18-22°C. Fungal species were identified by conidium morphology taking into account their occurrence [27].

Pathogenicity and toxicity of fungus isolates were evaluated by the degree of inhibition of seed germination, growth of coleoptiles and the roots. The data of seed germination and growth of seedlings in water was used as a check.

All experiments were performed in three replicates. Statistical processing of results was performed using a modified program developed in the environment of Windows 98-based, Microsoft Excel.

3 Results and discussion

Russia Research Institute of Phytopathology there the pathogens of genus *Fusarium* *Bipolaris*, *Alternaria*, causing Root Rot of grain crops have been monitored in the regions of the Russian Federation. As a result of long-term studying the special composition of root rot populations more than 40000 fungal isolates were collected and identified in various Russian

regions (Central, Volga-Vyatka, Central Black Soil Region, Middle-Volga and Dawn-Volga Regions). (Figure 1).



Fig. 1. Morphology of colonies

There were identified 15 *Fusarium* spp.: *F. culmorum*, *F. heterosporum* (*Gibberella gordonii*), *F. sporotrichioides*, *F. oxysporum*, *F. nivale* (*Monographella nivalis*), *F. graminearum* (*G. zae*), *F. avenaceum* (*G. avenacea*), *F. gibbosum* (*G. intricans*), *F. sambucinum* (*G. pulicaris*), *F. moniliforme* (*G. moniliformis*), *F. semitectum* (*F. incarnatum*), *F. poae*, *F. lateritium* (*G. baccata*), *F. solani* (*Nectria haematococca*), *F. redolens*.

In the areas of cereal cropping the composition of *Fusarium* fungi was represented by the same species among which in the mycorrhiza of barley, wheat and rye there were most often identified the following 10 species: *F. culmorum*, *F. oxysporum*, *F. heterosporum*, *F. sporotrichioides*, *M. nivale*, *F. avenaceum*, *F. sambucinum*, *F. gibbosum*, *F. poae*, *F. solani* (Figure 2). The incidence of *F. culmorum*, *F. heterosporum*, *F. sporotrichioides*, *F. oxysporum* together has accounted for more than 50 % of all identified isolates of the fungi.

With a view to determining the most favorable and critical temperatures for the development of certain types of pathogens *in vitro* we studied the effect of the temperature factor on the vegetative growth, morphology and sporulating the ability of the isolates. As a result of researches revealed that the types of pathogens that cause diseases of grain crops, ambiguously reacted to the same temperature conditions. Marked differences in the speed of growth, morphology and sporulating the ability colonies of each of the types of mushrooms depending on the temperature. (Figure 3).

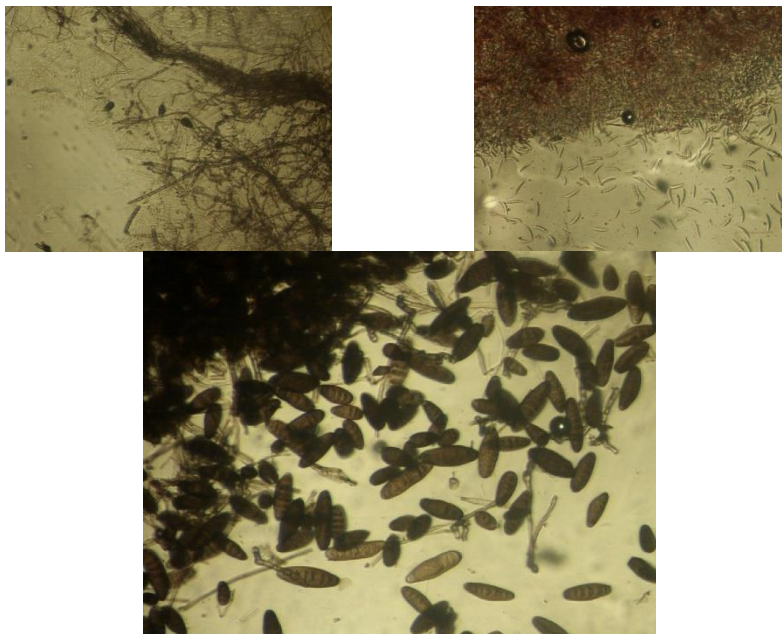


Fig. 2. Fungus spores *Alternaria* , *Fusarium*, *Bipolaris*

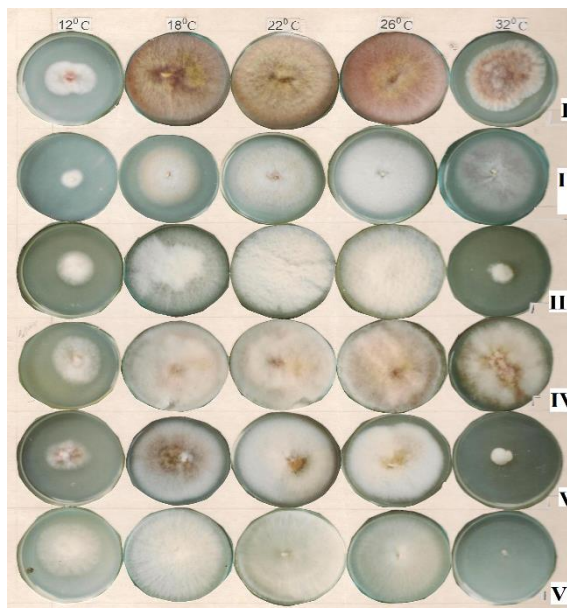


Fig. 3. Effect of the temperature factor on the vegetative growth, morphology and sporulating the ability of the isolates *F. culmorum* *F. oxysporum*, *F. heterosporum*, *F. sporotrichiella*, *F. gibbosum*, *M. nivale*

It is known that the *Fusarium* infection accumulates in the soil and crop residues. There in the soil the fungus infects the primary roots of germinating seeds. During the growing season the infection (spores and hyphae) is transmitted by layers of plant colonizing the leaves, spike and grains. The place of localization of *Fusarium* spp., *Bipolaris*, *Alternaria* competition for food substrate affects on the composition and frequency of their occurrence.

Mycological researches of the affected plants collected in 2012-2014 in the Central region have been showed that the frequency of occurrence of *Fusarium* spp., *Bipolaris*, selected from roots and ears was ambiguous (Figure 4).

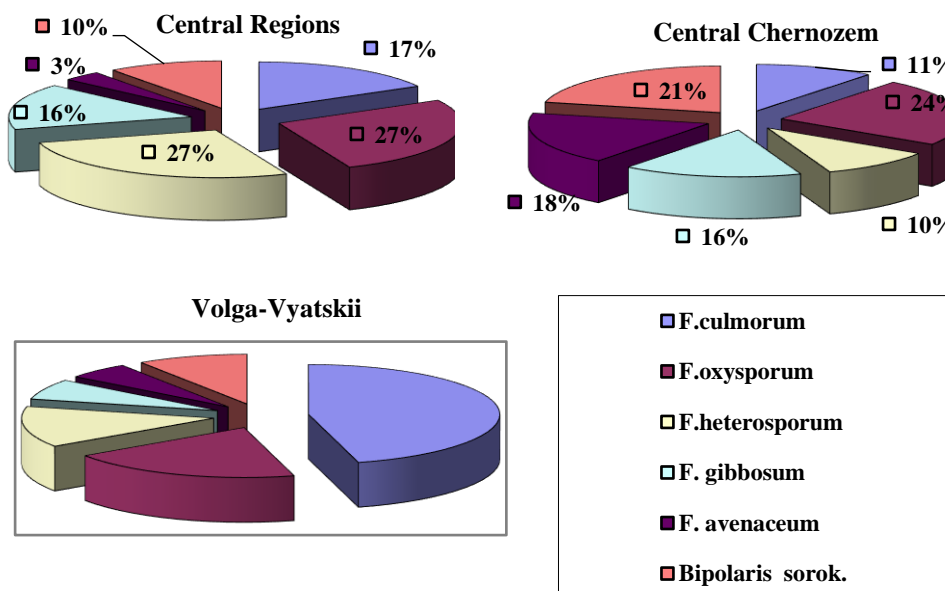


Fig. 4. The mean frequency of occurrence of *Fusarium* spp. and *Bipolaris* isolates in the major areas of grain cultivation for the period 1995-2015, %

The investigation of the special structure of causative agent population of the most dangerous diseases (root rots) of grains in various regions of the Russia has been carried out. The defeat of crops by root rots in Russia caused by a pathogenic complex. More often occur *F. culmorum*, *F. heterosporum* (*Gibberella gordonii*), *F. sporotrichioides*, *F. oxysporum*, *F. avenaceum* (*G. avenacea*), *F. gibbosum* (*G. intricans*). In the Central region prevail *F. oxysporum*, *F. heterosporum*, Central-chernozem region *F. oxysporum*, *Bipolaris*, in the Povolzski region *F. heterosporum*, *F. oxysporum*, Volgo-Vyatski region *F. culmorum*. There have been studied pathogens requirements to temperatures, soil acidity and types of their interaction in pathogenic complex.

To find out the causes of certain pathogens prevalence in different regions we studied the influence of temperatures on the growth, morphology qualities, sporulating ability of the fungus colonies in the Petri dishes under constant temperatures during their growth period.

Having estimated this, we noticed fungi *F. culmorum* and *F. nivale* be growing better at temperatures from +5-12°C, *F. culmorum*, *F. heterosporum*, *F. gibbosum*, *F. sporotrichiella* preferred higher temperatures from 10- to 26 °C, while *F. oxysporum*, *F. avenaceum*, *Bipolaris sorokiniana* had their better growth at the temperature from 18- to 32 °C.

The joint growth of pathogenic species *in vitro* at showed the lack of any antagonisms between them; temperature was the main growth limiting factor. The fungus populations had high abiotic factors adaptability.

As the natural morphotypes of these fungi were highly heterogeneous and consisted of mycelium mixtures we had to purify them and detect some stable morphotypes to deal with. So we detected 6 morphotypes *F. culmorum*, 4- *F. oxysporum*, 2 morphotypes *F. heterosporum*, 4- *F. nivale*. The most changeable of all was fungus *F. culmorum*.

Having done a number of experiments with fungi we worked out our recommendation on the infection background structure for plant breeding programmes to create Snow Mold and Root Rot resistant or tolerant winter rye cultivars. We used these pathogene morphotypes and the idea in testing the rye cultivars. The most quantity of all 500 cultivars were susceptible to Root Rot, though some amount of them were determined as middle-resistant to *F culmorum* (about 20%) , and to *F. oxysporum* (above 25%).

4 Conclusions

The composition of *Fusarium*, *Bipolaris*, *Alternaria* pathogens in cereals was represented widespread and rare species of fungi. The results of the monitoring of fungi in stalks and roots of grain crops has been indicated relatively high uniformity of *Fusarium* spp. in the regions of the Russian Federation due to the susceptibility of crops to the soil-inhabiting micromycetes.

The frequency of occurrence of micromycetes has been stable for the roots, and it has been determined by the weather during the growing season of plants.

The annual occurrence of *Fusarium*, *Bipolaris*, *Alternaria* on the ear and grain mainly has been associated with active reproduction of the fungus on the underground parts of plants.

Consistent long-term monitoring of the dynamics and frequency of occurrence of *Fusarium* *Bipolaris*, *Alternaria* in a wide range of climatic areas there has made it possible to characterize the state of the species of fungi in the Russian regions and also to study their intraspecific and interspecific variability in toxicity and pathogenicity depending on biotic and abiotic factors.

The prevalence of *Fusarium* spp. have been determined by their plasticity and viability in the soil, on the weed roots and in the stubble of many crops and high competitive ability in the mycobiota of agriculture expressed pathogenic and toxic activity.

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