Abstract. In order to prevent crop yield losses from the most dangerous and economically important pathogenic organisms, it is necessary not only to monitor the virulence gene pool, but also to study the nature of pathogen variability and determine the potential for the emergence of new genes and races. This requires centralized collections of fungal cultures characterized by a set of stable strains to provide for phytopathological, immunological, breeding, genetic, toxicological, parasitological and other studies. The State Collection of Phytopathogenic Microorganisms of the ARSRIP is the State Depository of Phytopathogenic microorganisms that are non-pathogenic to humans or farmed animals. Currently, it has more than 4,500 accessions of plant pathogenic strains of fungi, oomycetes, bacteria, viruses, phytoplasmas, and the collection is updated annually. For this purpose, the study of the inter- and intraspecific genetic diversity of genus Fusarium was carried out in agricultural systems of the Krasnodar Territory. In 2020, the State Collection of Phytopathogenic Microorganisms was supplemented with 13 strains of Fusarium fungi isolated from tissues of winter wheat plants collected in several locations of the Krasnodar region. The complex of Fusarium fungi revealed on winter wheat usually included Fusarium oxysporum, F. culmorum, F. lolii, F. graminearum, F. fujikuroi, F. sporotrichioides, etc. The effect of the preceding crop on the frequency of Fusarium species isolated from winter wheat was observed. After series cloning of collected isolates, 21 strains of different fungal species characterized by stable morphology traits and known pathogenic and phytotoxic properties were selected for collection replenishment. Significant differences in pathogenic activity were revealed between fungi belonging to either the same or different species; the manifestation of this activity varied from the absence of any effect of spore suspensions on seedling development to a complete inhibition of their growth. The phytotoxic activity towards wheat seedlings varied from medium to high. Species possessing a high intensity of phytotoxic activities are the most dangerous for wheat, since they promote accumulation of dangerous phytotoxins in plant tissues.

Key words: microorganism collections; micromycetes; genetic diversity; winter wheat; plant pathogens; Fusarium.

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Introduction

To successfully solve the problems of food security of the country, it is necessary to create varieties resistant to particularly dangerous diseases. In order to prevent crop yield losses from the most dangerous and economically significant pathogenic organisms, it is necessary not only to monitor the virulence gene pool, but also to study the nature of pathogen variability, determine the potential for the appearance of new genes and possibly dangerous races in different fungi populations. This requires centralized collections of cultures characterized by a set of stable properties to provide for phytopathological, immunological, breeding, genetic, toxicological, parasitological and other studies. Such collections of phytopathogenic organisms have been created and are successfully functioning in most developed countries of the world.

The State Collection of Phytopathogenic Microorganisms of the All-Russian Scientific Research Institute of a Phytopathology (ARSRIP) is the main gene pool of races, biotypes, pathotypes of phytopathogenic fungi, bacteria and viruses distributed over the vast territory of the Russian Federation. This is the first such gene pool created in Russia. Until recently, there were only scattered working collections of individual species of phytopathogenic microorganisms in various institutions and departments of the institute. Collection of phytopathogenic microorganisms of ARSRIP by the decree of the Government of the Russian Federation “On measures for the conservation and rational use of collections of microorganisms” dated 24.06.1996. No. 725-47c was given the name “State Collection of Phytopathogenic Microorganisms and Varieties-Identifiers (Differentiators) of Pathogenic Strains of Microorganisms” and the status of the State Depository of phytopathogenic microorganisms that are not pathogenic to humans and farm animals was determined. Currently, it has more than 4,500 storage units of plant pathogenic strains – fungi, oomycetes, bacteria, viruses, phytoplasmas – and is updated annually. For this purpose, the study of inter- and intraspecific diversity of Fusarium fungi in agricultural systems of the Krasnodar Territory was carried out.

According to the literature, facultative parasites from the genus Fusarium are often observed on winter wheat. These micromycetes are well adapted to changing external environmental factors, which ensures their survival in a wide range of weather conditions, and therefore are distributed almost everywhere where winter wheat is cultivated (Rukavitsina, 2008; Chulkina et al., 2009; Toropova et al., 2013). Monitoring the structure and localization of Fusarium populations in wheat ecosystems is of great practical importance not only for selecting disease-resistant varieties, but also for increasing the effectiveness of protective measures and improving the environmental situation of agricultural crops.

Recently in the southern regions of Russia, where winter wheat is widely cultivated, there has been an increase in diseases caused by fungi of the genus Fusarium (Zhalieva, 2010). It is known that 28 species of fungi of this genus parasitize wheat. The species Fusarium graminearum, F. poae, F. sporotrichioides, F. tricinctum, F. nivale prevail on wheat in the North Caucasus. As a rule, they are observed as pathogens of root rot, causing the weakening and death of seedlings, reducing the productivity potential of affected adult plants.

In some years, Fusarium head is widely spread, causing significant damage to grain production. On vegetative and generative organs of plants, the species composition of fungi can be ambiguous depending on weather conditions, the stability of cultivated varieties, wheat precursors, agricultural technology and many other factors (Chulkina et al., 2009; Zhalieva, 2010).

Assessment of the diversity of morphological features of Fusarium spp., identification of the amplitude of their variability, including the level of pathogenicity and phytotoxicity, is important for the selection and replenishment of the collection with micromycete strains (Booth, 1971; Thrané et al., 2004; Kolomiets et al., 2018).

The need to preserve the material of Fusarium spp. strains and isolates and the constant selection of samples to replenish the collection is explained by the relevance of conducting scientific research for the development of methods of biolo-
Fusarium micromycetes in winter wheat agrocenoses of the North Caucasus in the ARSRIP State Collection

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Materials and methods

The research material was plants of zoned varieties of winter wheat with signs of fungal infections on the leaves and roots. The samples were selected in the second decade of May 2019 from winter wheat crops for different predecessors in the Pavlovsky, Korenovsky, Ust-Labinsky, Kanevsky and Primorsko-Akhtarsky districts of the Krasnodar Territory. The samples contained 10–20 wheat plants in the earing-grain formation phase. All the works were performed using the equipment of the Center of Collective Usage SCPM ARSRIP (http://www.vnif.ru/vnif/page/ckp-gkmf/1373).

Fungi were isolated from the affected plants using 2% potato-glucose and potato-carrot agar. Fungi from wheat samples were isolated according to the standard method (Bilai, 1977; Bilai, Ellanskaya, 1982). The infected plants of each sample washed with tap water were cut into fragments of 5–10 mm in size, sterilized in 50% alcohol for 20–30 seconds and, under aseptic conditions, laid out on the surface of 2% potato-glucose agar in Petri dishes (4–6 fragments each). Each sample was represented by at least 150–200 fragments of the affected tissue. Petri dishes were placed in a thermostat with a temperature of 22–24 °C.

Observation of the development of fungi was carried out daily. As the fungal colonies grew, a piece of mycelium was sifted onto the nutrient medium in the center of the Petri dish. The growth rate, the color of the mycelium and its structure, pigmentation; by the shape and size of the apical and basal cells of macroconidia, by the presence of microconidia. 300 conidia were estimated for an average size of macroconidia. For determining the species of the fungus (Gerlach, Nirenberg, 1982; Leslie, Summerell, 2006; Dictionary..., 2008; Watanabe, 2010) were used as reference literature.

The assessment of the degree of sporulation was carried out on 14-day colonies of the fungus. At the same time, the results of sporulation were determined by the average value of the number of spores per cup when flushing from 10 Petri dishes of one morphotype. The sporulating ability of fungal colonies was determined by the standard method of counting spores in the Goryaev chamber (Bilai, 1977).

Series of monospore cloning of micromycete isolates were carried out according to the generally accepted method for the selection of strains of Fusarium fungi stable by morphological and cultural characteristics (Bilai, 1977; Bilai, Ellanskaya, 1982).

Fungal isolates isolated from the affected wheat samples were stored in a refrigerator at a temperature of 7–10 °C in biological test tubes on the nutrient medium – potato-glucose agar (Bilai, Ellanskaya, 1982).

The pathogenic and toxic properties of the strains were studied using the method of bioassay on seeds. The pathogenicity of spore suspensions and phytotoxicity of filtrates of culture fluids (FCF) of fungi of the genus Fusarium were tested on wheat seeds (Mironovskaya 808 variety). The degree of pathogenicity and toxicity of the strains was judged by the effect of suspensions of conidia and FCF on the germination of wheat seeds, the development of sprouts and primary roots of seedlings. However, the main indicator was considered the length of the roots.

The degree of pathogenicity and toxicity was determined on the 5th day from the beginning of seed germination. If the length of seedlings and roots (in mm) in the experimental version was 0–30 % of the control length, this indicated strong pathogenic (P) and strong toxic (T) activity of the fungus; 31–50% – moderate pathogenicity (MP) and moderate toxicity (MT); 51–70% – weak pathogenicity (WP) and weak toxicity (WT); 71–100% – non-pathogenic (NP) and non-toxic (NT) properties of the isolate. The length of the sprouts and primary roots of seeds sprouted in water was considered as control and was taken as 100 %.

Results and discussion

During the mycological studies of experimental samples it was noted that fungi of the genus Fusarium had the same symptoms on plant organs, but the pieces of tissue of different organs, washed and flamed over the fire, decomposed into wet chambers, formed a characteristic mycelium and conidia for 3–5 days, which made it possible to identify the type of micromycete. The study of the main micro- and macro-morphological features of fungi in culture by the presence, shape and size of macroconidia and microconidia (if present), the growth rate of the colony, the color and structure of the mycelium, carried out on more than 400 isolates of fungi, allowed us to identify the following 13 species of the genus Fusarium: F. oxysporum Schlecht., F. culmorum (Sm.) Sacc.,
Fusarium species from the genus Fusarium found on winter wheat crops in the Krasnodar Territory, 2019, (in %)

| Species of fungus | Precursor      | Frequency of occurrence of species |
|-------------------|----------------|---------------------------------|
|                   | wheat          | pure soil | sunflower | corn | peas |
| F. acuminatum     | 1.2            | 0.9       | 0.7       | 0    | 0    | 2.8  |
| F. avenaceum      | 1.2            | 0         | 0.7       | 1.2  | 0.9  | 3.9  |
| F. chlamydosporum | 0.7            | 0         | 0.5       | 0    | 0    | 1.2  |
| F. culmorum       | 5.8            | 1.2       | 5.3       | 2.8  | 3.5  | 18.2 |
| F. equiseti (F. gibbosum) | 0     | 0         | 1.2       | 0.7  | 0    | 1.8  |
| F. graminearum    | 5.5            | 1.2       | 0.5       | 5.1  | 0    | 12.0 |
| F. lolii          | 6.2            | 2.8       | 3.5       | 2.8  | 0    | 15.8 |
| F. moniliforme (F. fujikuroi) | 7.2 | 1.2     | 2.3       | 4.2  | 0    | 9.7  |
| F. oxysporum      | 1.2            | 1.2       | 5.5       | 2.3  | 4.2  | 20.1 |
| F. poae           | 1.2            | 0.7       | 0.7       | 0.7  | 0    | 3.6  |
| F. sambucinum (F. roseum) | 1.2 | 0.5     | 1.2       | 0.5  | 0    | 3.2  |
| F. solani         | 0.0            | 0         | 0.2       | 0    | 0.7  | 0.9  |
| F. sporotrichioides | 1.8           | 1.8       | 0.9       | 2.5  | 0    | 7.1  |
| Total isolates, % | 33.9           | 11.3      | 22.6      | 21.7 | 10.4 | 100  |
| Total isolates, unit | 147           | 49        | 98        | 94   | 45   | 433  |

Isolates of *F. graminearum* Schwabe (teleomorph *G. zeae* (Schwein.) Petch.) were discovered on the roots and basal stems of winter wheat in most areas of infectious material, and the fungus was isolated more frequently if predecessors were wheat and corn (5.1 and 5 %, respectively).

Isolates of *F. moniliforme* J. Sheld. (teleomorph *G. moniliformis* Wineland; syn. *F. fujikuroi* Nirenberg), the causative agent of pink mold and root rot of cereals, were found on the leaves, stems and roots of winter wheat in the Primorsko-Akhtarsky, Pavlovsky and Kanevsky districts. More often, the fungus was isolated from wheat, the precursors of which were corn (4.2 %), sunflower (2.3 %) and wheat (2.1 %).

Isolates of *F. sporotrichioides* Sherb. were isolated from the affected roots, root neck and stems of winter wheat (7.1 %) from the Pavlovsky and Korenovsky districts.

Isolates of *F. avenaceum* (Fr.) Sacc. (teleomorph: *G. avenae* (Cook)) were found on leaves, ground parts of stems and roots of winter wheat from the Pavlovsky and Korenovsky districts. In the complex of fungi from the genus *Fusarium* isolated from winter wheat samples, the frequency of occurrence of *F. avenaceum* was 3.9 %. The fungus was observed in samples of winter wheat, the previous crops of which were wheat and corn.

The isolates of *F. poae* (Peck) Wollenw. were found with low frequency (3.6 %) in the Pavlovsky district. More often, isolates of this type were noted on samples of wheat, the precursors of which were wheat and peas.

It should be noted that in some cases two or more phytopathogens from the genus *Fusarium* were isolated from one sample of the affected winter wheat tissue. Such isolates of *F. acuminatum* Ellis & Verh. (teleomorph *G. acuminata* Wr.) were isolated together with *F. oxysporum* more than half of the cases.
Table 2. Characteristics of fungal strains of 13 species of the genus *Fusarium* selected in the SCPM ARSRIP, according to macro- and micromorphological properties

| Fungus            | Code of strains | Morphological characteristics of colonies of fungal strains of 13 species of the genus *Fusarium* | Sporulation, million/ Petri dish | The size of macroconidia, microns | The presence of micro-conidia |
|-------------------|-----------------|-------------------------------------------------|-----------------------------------|----------------------------------|-------------------------------|
|                   |                 | Mycelium | Reverse | Sporulation, million/ Petri dish | The size of macroconidia, microns | The presence of micro-conidia |
|                   |                 |          |         | X_{min}–X_{max} | LSD_{05} | X_{min}–X_{max} |
| *F. avenaceum*    | CK-7l           | Dark pink, weak developed | Brown   | 195.0 ± 4.6 | 30.5–85.7 | 35.7 | 3.3–6.1 | – |
| *F. acuminatum*   | CK-13k          | White-pink, low with lysis sectors | Light brown | 210.3 ± 6.8 | 18.5–22.4 | 5.7 | 4.0–5.0 | – |
|                   | CK-16k          | White-pink, cotton-like | Dark brown | 195.5 ± 5.2 | 18.1–22.7 | 5.9 | 4.0–5.0 | – |
| *F. chlamydosporum* | CK-3k          | Light cream, velvety | Cream | 45.7 ± 3.2 | 30.5–40.5 | 11.1 | 3.6–4.1 | + |
| *F. culmorum*     | CK-14k-1        | Olive-red, loose-flaky | Brown | 201.5 ± 5.8 | 16.0–48.5 | 18.5 | 3.9–6.5 | – |
|                   | CK-14k-5        | Pale pink, fluffy | Light brown | 115.7 ± 2.7 | 16.7–49.3 | 21.1 | 3.8–6.7 | – |
| *F. equiseti*     | CK-8l           | White-cream, low, loose-fluffy | Brown | 195.1 ± 7.8 | 15.5–70.5 | 38.8 | 4.0–4.5 | – |
| *F. graminearum*  | CK-10k-2        | Olive-pink, flaky-fluffy | Brown | 112.0 ± 2.2 | 21.5–75.0 | 31.5 | 4.3–4.5 | – |
|                   | CK-11k-3        | Dark brown | 175.5 ± 3.7 | 23.1–77.7 | 28.7 | 4.3–4.5 | – |
| *F. lolii*        | CK-6k-1         | Light cream, fluffy | Light cream | 55.2 ± 3.2 | 20.5–35.5 | 13.9 | 4.0–4.3 | – |
|                   | CK-6l           | Milk light cream | Light brown | 140.5 ± 4.2 | 19.7–35.5 | 15.3 | 4.0–4.3 | – |
|                   | CK-6k-5         | Light brown | 109.1 ± 8.7 | 19.1–36.7 | 14.5 | 4.1–4.3 | – |
| *F. moniliforme*  | CK-4l           | Light cream to purple, creeping | Light brown | 75.3 ± 3.3 | 23.0–60.5 | 25.8 | 3.6–4.0 | + |
| *F. oxysporum*    | CK-5k           | Pale lilac, creeping | Light brown | 23.3 ± 4.1 | 28.3–35.2 | 17.5 | 3.5–4.5 | + |
|                   | CK-9l           | White with purple areas, cotton-like | Dark purple | 110.7 ± 3.4 | 26.5–37.1 | 23.1 | 3.3–4.5 | + |
|                   | CK-9k           | Pale purple | 95.5 ± 2.5 | 29.4–40.0 | 12.7 | 3.2–4.6 | + |
| *F. poae*         | CK-7k           | Cream-pink, creeping | Light cream | 24.7 ± 7.7 | 17.2–40.5 | 22.6 | 3.5–5.5 | + |
|                   | CK-15k          | Olive-pink, fluffy | Brown | 10.5 ± 2.9 | 17.0–40.1 | 20.3 | 3.5–5.5 | + |
| *F. sambucinum*   | CK-5k-1         | Light cream, loose | Cream | 70.0 ± 4.3 | 17.5–24.5 | 8.2 | 3.6–4.5 | – |
| *F. solani*       | CK-13k-1        | Cream-pink, felt-fluffy | Brown | 105.1 ± 5.0 | 21.5–42.5 | 19.4 | 3.5–4.9 | + |
| *F. sporotrichioides* | CK-4k         | White-pink, fluffy | Brown | 150.4 ± 5.8 | 26.0–45.0 | 15.1 | 3.5–5.0 | + |
Table 3. Characteristics of *Fusarium* fungal strains by pathogenicity of spore suspensions and phytotoxicity of culture liquid on wheat seedlings of cultivar Mironovskaya 808 (in % of control)

| Code of strain | Pathogenicity (spore suspension) | Toxicity (culture liquid) |
|----------------|----------------------------------|---------------------------|
|                | Seed germination, % | Sprout length, % | Root length, % | Degree of influence | Seed germination, % | Sprout length, % | Root length, % | Degree of influence |
| F. avenaceum (Fr.) Sacc. | | | |
| CK-7l          | 96.7                  | 92.3 ± 1.5           | 63.5 ± 1.4     | WP                    | 100.0               | 96.9 ± 2.1             | 71.3 ± 2.0        | NT                 |
| F. acuminatum Ellis & Everh. | | | |
| CK-13k         | 100.0                 | 102.3 ± 1.9          | 93.9 ± 2.1     | NP                    | 96.7                 | 85.0 ± 3.7             | 49.2 ± 2.4         | MT                 |
| CK-16k         | 100.0                 | 101.9 ± 3.1          | 85.7 ± 2.3     | NP                    | 100.0               | 90.6 ± 4.0             | 61.4 ± 2.5         | WT                 |
| F. chlamydosporum Wollenw. & Reinking | | | |
| CK-3k          | 100.0                 | 90.9 ± 1.8           | 68.9 ± 1.8     | WP                    | 96.7                 | 88.8 ± 2.3             | 48.8 ± 2.2         | MT                 |
| F. culmorum (Sm.) Sacc. | | | |
| CK-14k-1       | 101.0                 | 96.7 ± 2.1           | 63.5 ± 1.4     | WP                    | 100.0               | 96.9 ± 2.1             | 71.3 ± 2.0         | NT                 |
| CK-14k-5       | 95.5                  | 84.1 ± 2.6           | 47.5 ± 3.1     | MP                    | 83.3                 | 63.3 ± 1.5             | 22.3 ± 1.5         | T                  |
| F. equiseti (Corda) Sacc. | | | |
| CK-8l          | 100.0                 | 94.4 ± 2.2           | 87.4 ± 2.1     | NP                    | 100.0               | 87.1 ± 2.5             | 87.7 ± 2.7         | NT                 |
| F. graminearum Schwabe | | | |
| CK-10k-2       | 96.4                  | 38.5 ± 5.2           | 12.6 ± 5.1     | P                     | 63.3                 | 36.2 ± 3.1             | 5.7 ± 2.3          | T                  |
| CK-11k-3       | 96.7                  | 72.0 ± 5.5           | 56.7 ± 5.2     | MP                    | 70.0                 | 24.4 ± 1.6             | 10.9 ± 1.2         | T                  |
| F. lolii (Wm. G. Sm.) Sacc. | | | |
| CK-6l          | 100.0                 | 94.4 ± 2.2           | 87.4 ± 2.1     | NP                    | 100.0               | 87.1 ± 2.5             | 87.7 ± 2.7         | NT                 |
| F. moniliforme J. Sheld. | | | |
| CK-4l          | 100.0                 | 101.9 ± 3.0          | 103.9 ± 4.0    | NP                    | 100.0               | 96.2 ± 3.1             | 65.0 ± 1.6         | WT                 |
| F. oxysporum Schlecht. | | | |
| CK-5k          | 100.0                 | 93.1 ± 3.8           | 67.7 ± 3.0     | NP                    | 100.0               | 39.0 ± 1.7             | 13.0 ± 1.7         | T                  |
| CK-9l          | 100.0                 | 33.3 ± 3.1           | 27.7 ± 2.3     | P                     | 100.0               | 79.0 ± 1.8             | 63.0 ± 1.9         | WT                 |
| F. poae (Peck) Wollenw. | | | |
| CK-7k          | 100.0                 | 101.3 ± 1.8          | 93.8 ± 2.2     | NP                    | 100.0               | 92.3 ± 2.6             | 65.4 ± 1.8         | WT                 |
| CK-15k         | 100.0                 | 99.1 ± 2.8           | 95.3 ± 4.1     | NP                    | 100.0               | 96.9 ± 2.0             | 74.2 ± 2.9         | NT                 |
| F. sambucinum Fuckel | | | |
| CK-5k-1        | 90.0                  | 58.6 ± 5.1           | 19.5 ± 1.6     | P                     | 90.0                 | 83.1 ± 4.1             | 61.6 ± 2.7         | WT                 |
| F. solani (Mart.) Sacc. | | | |
| CK-13k-1       | 100.0                 | 89.1 ± 3.8           | 90.3 ± 2.1     | NP                    | 96.7                 | 84.3 ± 2.8             | 62.8 ± 1.9         | WT                 |
| F. sporotrichioides Swerb. | | | |
| CK-4k          | 100.0                 | 38.5 ± 3.5           | 14.8 ± 1.9     | P                     | 100.0               | 29.7 ± 1.8             | 6.3 ± 1.0          | T                  |

Note. NP/NT is non-pathogenic/non-toxic; WP/WT – weakly pathogenic/weakly toxic; MP/MT – moderately pathogenic/moderately toxic; P/T – pathogenic/toxic.
A similar pattern was noted for *F. sambucinum* Fockel (teleomorph *G. pulicaris* (Fr.) Sacc.). This fungus, regardless of the location on the plant (leaf, stem, root), was always isolated together with *F. oxysporum*, while it was often accompanied by a bacterial infection.

*F. acuminatum* isolates were found in the Ust-Labinsk and Pavlovsky districts with low frequency (2.8%) in the affected roots of winter wheat, the precursors of which were wheat, steam and sunflower.

Isolates of *F. equiseti* (Corda) Sacc. (teleomorph *G. intra­cans* Wollenw.; syn. *F. gibbosum* Appel & Wollenw. Emend Bilai) were detected mainly on browned winter wheat stalks in the Ust-Labinsk and Kornovensky districts.

The proportion of isolates of *F. chlamydosporum* Wollenw. & Reinking in the complex of Fusarium fungi did not exceed 1.2%. The fungus was isolated from the roots of two wheat samples from the Kornovensky district. Along with *F. chlamydosporum*, saprophytic and pathogenic fungal species were abundantly isolated from the same roots.

Several isolates of *F. solani* (Mart.) Sacc. (teleomorph *Nectria haematococca* Berk. & Broome) were found in the Pavlovsky district on the roots of wheat.

As it was noted earlier, based on the study of morphological features, the obtained isolates of fungi of the genus *Fusarium* are assigned to 13 taxonomic groups. After a series of monoclonal cloning of isolates, strains of fungi of different species with stable morphological and cultural characteristics were selected for the collection. When selecting fungi cultures for the collection, special attention was paid to the macro- and micromorphological features characteristic of each species.

The *Fusarium* spp. strains differed in the morphology, in the size and shape of macro- and microconidia, and in the sporulation of colonies. Differences between strains within the same species were often noted only when studying macromorphological features – the color and structure of the mycelium, sporulation. When analyzing the data of micromorphological features, i.e., the shape and size of conidia, the method of their formation, the differences between the strains of the same species were minimal.

21 strains of *Fusarium* spp. identified on winter wheat crops of the North Caucasus in 2019 were transferred to the collection (Table 2).

The obtained biological material of *Fusarium* spp. was studied by the degree of pathogenic and phytotoxic severity. The results of the influence of spore suspensions and metabolites of filtrates of culture fluids of 21 strains of fungi from the genus *Fusarium* on the development of wheat seedlings in cultivar Mironovskaya 808 (seed germination, sprout and root length) were shown in Table 3.

It was shown that the strains of fungi within the same species differed in the pathogenic or phytotoxic degrees. The strains of *F. oxysporum* (CK-5k, CK-9l, CK-9k) and *F. lolii* (CK-6k-1, CK-6l, CK-6k-5) had a wide intraspecific diversity according to these characteristics. Among them, there were different categories – from pathogenic/toxic to non-pathogenic/ slightly toxic.

Phytotoxic and pathogenic isolates of *F. culmorum* and *F. graminearum* suppressed the development of seedlings of cv. Mironovskaya 808 to a wide extent. Isolates of *F. acuminatum* (CK-13k, CK-16k) were found to be non-pathogenic to the seedlings of the tester variety, but had weak and moderate phytotoxicity.

Isolates of *F. avenaceum* (CK-7l), *F. equiseti* (CK-8l), *F. poae* (CK-7k, CK-6k-1) and *F. chlamydosporum* (CK-3k) and others were characterized by very weak pathogenic and phytotoxic properties.

It was found that spore suspensions of fungal isolates had little effect on seed germination (80–100%), but subsequently affected the development of seedlings: pathogenic isolates of fungi inhibited their growth (up to 33.3% strain of *F. oxysporum* CK-91) or non-pathogenic ones stimulated it (up to 102.3% strain of *F. acuminatum* CK-13k). A stronger effect of spore suspensions on the growth and development of primary roots was noted (12.6–95.3%).

Seeds’ treatment of filtrates of culture fluids of *Fusarium* strains had a weak effect on their germination (63.3–100%), although in the future the intensity of development of seed seedlings significantly slowed down. The length of seedlings under the action of filtrates of fungal culture fluids compared to the control was 24.4–96.9%. The average length of the primary roots was 5.7–74.2%, which allowed the isolates to be grouped according to the degree of toxicity.

The obtained results indicate that the Krasnodar populations of *Fusarium* differ by morphological, pathogenic and phytotoxic characteristics.

**Conclusion**

The influence of the precursor of winter wheat, from which experimental samples were taken, on the frequency of isolated of the genus *Fusarium* was noted. It is shown that the pathogenic activity of fungi both between *Fusarium* species and within the same species differs significantly: from the absence of signs of the influence of spore suspensions on the development of seedlings to their complete suppression. Phytotoxic activity against wheat seedlings varied from medium to high. The greatest danger for wheat seedlings is represented by species with a high intensity of phytotoxic activity associated with the fact that they contribute to the accumulation of dangerous toxins in plant tissues.

Based on the results of the data obtained, the strains of 13 species of the genus *Fusarium* from the agroecosystems of the lowland part of the North Caucasus were selected and placed in the collection. All strains are characterized by morphological, pathogenic and phytotoxic properties.

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