Fusarium diseases of sunflower and wheat in Tambov region

A A Vypritskaya, A A Kuznetsov, V V Chekmarev, G N Buchneva, N N Dubrovskaya, O I Korabelskaya, I V Gusev

Middle Russian branch FSSI I.V. Michurin FSC, 1 Molodezhnaya str., Novaya Zhizn settlement, 392553, Tambov district, Russia

E-mail: chekmarevviktor@yandex.ru; vypritskaya2014@mail.ru

Abstract. The study of prevalence and species composition of Fusarium fungi on sunflower and winter wheat crops was carried out in Tambov region. In 1992-2020, 15 Fusarium fungi were identified on sunflower crops. It was identified that the predominant species infecting sunflower plants and seeds are Fusarium oxysporum, F. oxysporum var. orthoceras, F. verticillioides, and F. tricinctum. The prevalence of these pathogens was 16.3-21.8%. On the grain of winter wheat, Fusarium poae, F. equiseti and F. sporotrichioides were more common (19.6-28.6%). It was found that the seeds of Lgovskaya 8, Don Awnless and Don’s Governor were less affected by fusarium infection (by 3 - 4%). It was observed that Fusarium fungi are associated with certain winter wheat varieties. Research results may be useful for specialists studying diseases of sunflower and wheat.

1. Introduction
Fusarium Lk. et Fr fungi are facultative pathogens with pronounced parasitism, expressed in the clogging of vascular vessels of plants with mycelium hyphae and tissue decomposition products secreted by toxins [1]. More than 200 plant species, including sunflower and wheat, are affected. For a long time, publications on sunflower fusarium were descriptive [1-2]. In 1995, V.I. Yakutkin who isolated several fungi species from the seeds in Belgorod and Voronezh regions concluded that they were seriously affected by fusarium [3].

Scientists have studied the species composition, signs of culture damage, prevalence, pathogenicity and found that Fusarium spp. occur on sunflower in all phases of plant development, causing damage to the roots and all aboveground organs (rot, tracheomycotic wilting, pink rot of baskets, general depression and premature wilting) [4-6]. A high toxicity of Fusarium pathogens persists even when they are processed into feed [7-10]. The harmfulness of pathogens depends on their type, climatic conditions, the time of manifestation of damage and the number of affected plants [6]. On wheat plants, Fusarium fungi cause root rot, Fusarium head and grain. In central Russia, including Tambov region, the last of these diseases are detected only when carrying out a mycological analysis [11]. Fusarium spikes and grains have no visual signs.

Currently, there are methods used to identify Fusarium fungi using a PCR analysis [7]. The main danger of fusarium is accumulation of various mycotoxins in wheat and sunflower seeds, which cause are poisonous for humans and farm animals [7-10, 12]. These substances are produced by Fusarium fungi. Grain containing mycotoxins above the maximum permissible concentration should not be used...
for food and feed purposes. It has been established that the infection of seeds with Fusarium fungi depends on the moisture content - the amount of precipitation during the period from flowering to crop maturation [13].

There are no wheat and sunflower varieties resistant to Fusarium diseases. It is necessary to screen existing plant forms for selecting varieties that are less affected by Fusarium. The results obtained can find application in the production of sunflower for immunity purposes [14]. Due to the fact that these crops are important in food production and occupy large areas, it is necessary to study pathogens that can significantly reduce the yield and quality of the crop products. The purpose of this research is to determine the level of damage to sunflower and winter wheat plants by Fusarium fungi, as well as to identify Fusarium fungi species that cause this disease.

2. Materials and methods

Plants and seeds of sunflower and winter wheat were used as a research material. Route surveys of these crops were carried out in Tambov region; the prevalence of fusarium diseases was determined and plant materials were collected for a mycological analysis. When conducting field studies, the appropriate methods were used [12, 15, 16]. Fragments of affected organs of sunflower plants, 0.5 cm in size, were washed, treated with 96% alcohol, rinsed in sterile distilled water and laid out in Petri dishes with starvation agar, with the addition of paramorphogen newt and antibiotic streptomycin. Then they were incubated in light installations under fluorescent lighting for 7-14 days.

The cultural and morphological signs of sporulation organs were studied. The wheat seeds were also washed in running water for one hour, treated in a solution of silver nitrate (AgNO3, concentration - 0.1%) for one minute and washed several times in sterile water. After that, they were dried between layers of filter paper and laid out in Petri dishes on potato-glucose agar (CHA). Then the Petri dishes were placed in a thermostat and incubated for 48 hours at 24.5-25.0 C. Then, the fungi were isolated in separate Petri dishes, which were placed in a thermostat for five days at the same temperature. Then they were taken out and left at a room temperature. After 7-15 days (depending on the species), the morphological and cultural characteristics were determined and the fungus species were identified. The percentage of seeds infected with fusarium was calculated by the well-known formula; the ratio of the number of seeds affected by the disease to their total number was determined.

3. Results and discussion

As a result of long-term (1992–2020) studies, it was found that in Tambov region, fifteen species of Fusarium pathogens parasitize sunflower (Table 1). Most of all Fusarium species were isolated from sunflower seeds. Nine species were found on roots and stems; seven species were found on heads and six species were found on leaves. The level of damage was different. The roots were dominated by Fusarium oxysporum var. orthoceras and F. verticillioides.

The prevalence of fusarium diseases in the root system was 10.0 and 13.8%, respectively. These species occupied a leading position on sunflower stalks as well. The level of damage was higher - 20.1-21.8%. On sunflower stems, Fusarium oxysporum, F. sambucinum and F. sporotrichioides prevailed (10.0-14.2%). ON the leaves, the dominant position was occupied by Fusarium oxysporum var. orthoceras and F. sambucinum. The prevalence of the disease was 16.7 and 12.1%, respectively. Sunflower heads (9.0%) were affected by Fusarium acuminatum. On the seeds, Fusarium oxysporum, F. oxysporum var. orthoceras and F. tricinctum prevailed. The prevalence of the disease was 21.8%, 20.0% and 16.3%, respectively.

The research conducted in 2017 - 2018 on promising and zoned varieties of winter wheat established that the infection of grain with fusarium was 3-10% (Table 2). This disease was noticeable on the seeds of Lgovskaya 8, Don awnless and Don’s Governor (3 - 4%). The prevalence of Fusarium on Tarasovskaya 29 and Laguna’s grain amounted to 8-10%. Six Fusarium species were isolated from winter wheat seeds. The dominant species were Fusarium poae, F. equiseti, and F. sporotrichioides. Their frequency was 28.6; 27.1 and 19.6%, respectively. The confinement of Fusarium species to the studied wheat varieties was observed. Thus, on Tarasovskaya 29, Laguna and Doneko, the most
The common species was Fusarium poae (62.5 - 71.4%); on Ermak, Surava and Donskaya awnless - F. equiseti (50.0 - 66.7%); on Don’s Governor and Lgovskaya 8 - F. sporotrichioides; on Zvonitsa - F. avenaceum.

Table 1. Species composition of Fusarium fungi and prevalence of fusarium on sunflower crops in Tambov region

| Fusarium fungi | Fusarium prevalence, % |
|----------------|-------------------------|
|                | roots | stems | leaves | head | seeds |
| F. acuminatum  | 3,8   | 5,4   | -      | 9,0  | 1,8   |
| F. avenaceum   |       | 5,6   | 2,4    | -    | -     |
| F. culmorum    |       | 1,2   | -      | -    | 5,5   |
| F. equiseti    |       | 1,2   | -      | -    | 5,5   |
| F. graminearum |       | -     | -      | -    | 1,8   |
| F. heterosporum| 0,5   | -     | -      | -    | 7,3   |
| F. javanicum   | 5,6   | 12,1  | 12,1   | -    | 5,5   |
| F. oxysporum   | 5,6   | 14,2  | 9,7    | 6,7  | 21,8  |
| F. oxysporum var. orthoceras | 10,0 | 20,1 | 16,7 | 2,9 | 20,0 |
| F. sambucinum  |       | 12,1  | 12,1   | -    | 5,5   |
| F. solani      | 1,2   | -     | -      | -    | 1,8   |
| F. sporotrichioides | 2,4 | 10,0 | 1,7 | 1,2 | 9,1 |
| F. tricinctum  | 1,7   | 4,3   | 2,3    | 1,7  | 16,3  |
| F. verticilliioides | 13,8 | 21,8 | -     | 5,0  | 1,8   |

Table 2. Fusarium infection of grain and occurrence of Fusarium fungi on winter wheat seeds

| Variety          | Fusarium infection of seeds, % | F. poae | F. equiseti | F. sporotrichioides | F. oxysporum | F. avenaceum | F. solani |
|------------------|--------------------------------|---------|-------------|---------------------|--------------|--------------|-----------|
| Tarasovskaya 29  | 10                             | 70,0    | 10,0        | -                   | -            | 10,0         | 10,0      |
| Laguna           | 8                              | 62,5    | 12,5        | -                   | 25,0         | -            | -         |
| Doneko           | 7                              | 71,4    | -           | 14,3                | -            | 14,3         | -         |
| Ermak            | 6                              | 33,3    | 66,7        | -                   | -            | -            | -         |
| Surava           | 5                              | 20,0    | 60,0        | -                   | 20,0         | -            | -         |
| Zvonitsa         | 5                              | -       | 20,0        | 20,0                | -            | 60,0         | -         |
| Don’s governor   | 4                              | -       | 25,0        | 50,0                | 25,0         | -            | -         |
| Don awnless      | 4                              | -       | 50,0        | 25,0                | 25,0         | -            | -         |
| Lgov 8           | 3                              | -       | -           | 66,7                | -            | 33,3         | -         |
| Average          | 5,8                            | 28,6    | 27,1        | 19,6                | 10,6         | 13,1         | 1,1       |
4. Conclusion
Thus, for the first time in Tambov region, the species composition of Fusarium spp. found on sunflower was determined. It was found that the dominant species on plant stems were Fusarium oxysporum, F. oxysporum var. orthoceras and F. verticillioides; on seeds - F. oxysporum, F. oxysporum var. orthoceras and F. tricinctum. The prevalence of Fusarium diseases caused by these fungi was 16.3-21.8%. On winter wheat, the leading position was occupied by Fusarium poae, F. equiseti, and F. sporotrichioides. The frequency of their occurrence was 19.6-28.6%. It was identified that Lgovskaya 8’, Don awnless’ and Don’s Governor’s seeds were less affected by Fusarium (3-4%). The results obtained can be used by phytopathologists and mycologists studying the species composition, prevalence and harmfulness of pathogens of sunflower and wheat diseases in the regions of Russia.

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