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Bioecological Peculiarities of Fungi Species, Affecting Seed in Granaries of South Kazakhstan.

Ardak Bostanova, Nurlibek Abdimutalip, Gaziza Toychibekova, Zayda Azhibayeva, Bakhadyr Yusupov, and Madina Akeshova.

H.A.Yassawe International Kazakh-Turkish University, Turkistan, Kazakhstan.

ABSTRACT

On July 3, 2002, the President of Kazakhstan Nursultan Nazarbayev signed Law № 331-II «On plant protection » [1] in which the legal, economic and organizational basis for activities in the field of plant protection directed to preserve the crop and its quality, prevention of harmful impact of pesticides on human health and the environment in the implementation of phytosanitary measures was defined. By the Resolution of the Government of the Republic of Kazakhstan № 1295 dated December 10, 2002 "The list of especially dangerous harmful organisms» [2], the following diseases of cereal crops: stem rust, brown rust, yellow rust, crown rust, septorios and helminthosporium-spotting were introduced. In this regard, it is necessary to develop effective methods for combating seeds diseases during storage period, to study the species composition of fungi on seeds, their biological peculiarities, their distribution depending on storage conditions and the peculiarities of their development depending on environmental factors and their impact on sowing quality [3-6]. This allows to adjust the modes of storage and extends the conservation of high quality of seed and provides an opportunity to obtain high and stable yields of grain and leguminous crops [7-10]. Seed storage has an important practical and scientific importance without reducing the quality indicators. The purpose of the research is the study of biological and ecological characteristics of fungi species that infect the seeds of grain and leguminous crops in the granaries of southern Kazakhstan, the identification of factors that reduce their development.

Keywords: bioecology, fungi species, phytosanitary, environmental, aflatoxins, infectious, cultivation.

Corresponding author

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INTRODUCTION

So far, some researchers have studied only species composition of fungi in the seeds and their harmfulness, while others found the penetration of fungi in the seeds and their distribution [11-14]. "In all these works the possibility of infection transmission by seeds and other planting material were shown, but the mechanism of this process lit poorly. M.V.Gorlenko states that "seeds can be a source of infection of plant by pathogenic fungi, bacteria and viruses" [15-16]. Under certain conditions, they can save pathogens of many infectious diseases, be a source of their renewal for the following year; seed pathogens can be transferred to new locations where they have not been before, i.e. they are important in the migration of pathogen microorganisms and spread of infectious diseases of plants. V.V.Remele's research of micromycetes [17] and content of aflatoxins in grain of major agricultural crops, cultivated in Kazakhstan during their production, storage and realization have shown that almost all the investigated samples (1530 samples) were struck by micromycetes. 59 species of fungi were studied and belonged to 18 genera. She revealed the patterns of fungi distribution infecting normally and grain of a reduced quality depending on the type of crops and their cultivation areas. In his works A.I.I.Abdel-Hafez [18] singled out fungal isolates belonging to 69 species, 4 species of 22 genera, mostly Deuteromycetes from obtained samples of seeds of broad bean, chickpea and lentil from 8 districts of Egypt. In Chapek's medium with glucose (10g / l) 59 species and 4 varieties of 18 genera were identified. In Chapek's medium with cellulose (19g / l), 48 species and 2 varieties of 15 genera were isolated. *Aspergillus, Penicillium, Rhizopus, Mucor, Fusarium* were the most frequently detected isolates, in particular, in both mediums *Aspergillus niger, Aspergillus flavus, Aspergillus nidulans, Aspergillus terreus, Aspergillus flavus var. columnaris, Penicillium chrysogenum, Penicillium citrinum, Penicillium funiculosum, Rhizopus stolonifer, Mucor hiemalis, Fusarium moniliforme* were dominated (regardless of the plant type).The allocated ones were typical only on an agar medium with cellulose *Chaetomium globosum, Chaetomium olivaceum, Chaetomium spirale, Acremonium strictum, Stachybotrys chartarum, Microascus trigonosporus, Beauveria bassiana, Macrophomina phaseolina.*

In his research, E.Goyman [19] provides data about the allocated ones from the culture liquid *Fusarium oxysporum f.licopersici*, fusaric acid - a nonspecific parasite of herbs, apples, rice, and regarded them as a toxin. A.E.Desjanths, H.K.Mananthar, R.D.Plather, G.G.Mananthar, S.M.Poling, C.M.Maragos [20] studied the species of the Fusarium genus from Nepalese rice and mycotoxin formation and gibberellic acid with its individual species. Herewith it turned out that Fusarium verticilloides, belonging to the complex of species Giberella fujikuroi, referring to the population of type A, pairing type C (anamorph *Fusarium fujikuroi*) and type D (anamorph *Fusarium proliferatum*). There have also been isolated Fusarium graminearum, Fusarium senitectum appeared dominant among the isolated surface-sterilized rice seeds. The rest of species (Fusarium acunimatum, Fusarium anguioides, Fusarium avenaceum, Fusarium chlamydosporum, Fusarium equiseti, Fusarium oxysporum) were met considerably rarely. These obtained isolates produced 8 microtoxins. However, the level of their content is very low due to the traditional methods of drying and storing rice.

OBJECTS AND METHODS OF RESEARCH

The objects of study were the seeds of cereal crops: wheat, barley, oats, corn, rice, sorghum, millet. The samples were collected by the method of M.K.Firsovoy [21] N.A.Naumovoy [22], and also GOST 13586.3 - 83 [23] with the help of feeler in only three levels (top, middle and bottom), and not throughout the depth of the mound. The results of the analysis of an average sample apply are spread to the entire batch of seed. Organoleptic characteristics determined in all the samples taken from the batch of grain for the determination of moisture, contamination, contamination. Conventional methods were used to clarify the diagnosis of disease: macroscopic (external examination of seed counting solids), biological GOST 12036-66 [24] (germination of seeds in a moist chamber and a nutrient medium), anatomical (determination of the pathogen in the tissues of the seeds). When identifying the fungi, determinants of L.D.Kursanova [25], B.D.Ermekovoy and others [26], «Flora of spore plants in Kazakhstan» [27] were used. In identifying plants infected by the fungi species, "Flora of Kazakhstan» was used [28]. The method microcultures of V.I.Bilay and I.A.Ellanskoy [29] were used to determine the species of the Fusarium genus. M.A.Litvinova's method was used to determine the soil fungi [30], penicillium was determined by the method of N.M.Pidoplichko [31].

Experiments on determination of the characteristics of vegetative organs of infected crops seedlings with *Alternaria alternata* (Fr.) *Keissl*, and *Macrosporium commune* Rabh., isolated from the seeds of *Triticum aestivum* L., were carried out by the method of V.I.Bilay [32]. For inoculation, 15-20 day fungal culture with

abundant sporification was usually used. Spore suspensions were prepared in such a way that at low magnification microscope, for about 35-50 conidia of the fungus came in field of view accounts, wherein prior to inoculation the percentage of conidia germination was checked by placing the spores in a hanging drop of water on the inner surface of the petri dish lid and viewed under a microscope.

The mycoflora of cereal crop seeds. Fungi isolated from the seeds of *Triticum aestivum* L.

From 2008 to 2014, fungi were identified and studied in the degree of lesion of wheat seeds with the samples of *Triticum aestivum*. As a result, we identified 28 species of fungi belonging to 18 genera, 11 families and 3 divisions of Zygomycota, Ascomycota, Basidiomycota. Rhizopus nigricans Ehr. Sporangiophores 1-3, rare solitary of 2-4 mm high, sporangia of 100-150 mkm, sporangia are large, mostly spherical, ellipsoidal angular spores, often incorrect, 8-14x6-11 mkm, the zygote 170-220 mkm. Black mold overwinters and is stored on plant residues of *Triticum aestivum*, as well as in other substrates, transmitted by seeds and causes plants disease.

Research in the granary of Guldala village.

Macrosporium commune Rabh. Conidiophores are with partitions. usually unbranched, straight or curved, knotted, of 35-120x3-10 mkm, brown, brown-olive, brightening on the top and sometimes serrated, single or bundles. Conidia are with 3-7 transverse and 1-3 (rare till 5) longitudinal partitions, relaced, obovate, cylindrical, clavate, of 16,5-62x6,6-16,5 mkm, smooth, sometimes warty, light brown or olive brown. It is transmitted by seeds and causes plants disease.

Research in the granary of Saymasay village

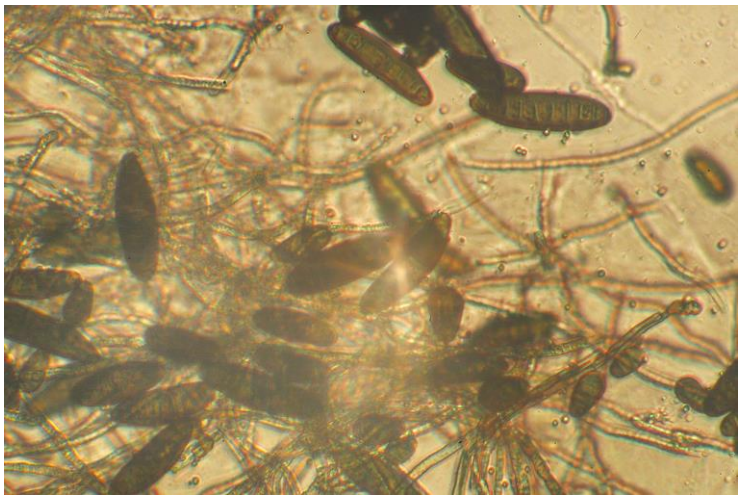


Figure 1: Conidia of *Helminthosporium sativum* on seeds of *Triticum aestivum.* (increased up to 600h)

Alternaria alternata (Fr.) Keissl. Spores are olive or blackish-brown, back clavated, with 3-6 transverse and one or more of the longitudinal partitions, with banners, of 30-50x14-18 mkm. The fungus infects wheat-ears in wet weather, the grain contamination occurs between milk and wax ripeness. The fungus penetrates into the germ part. It is most commonly found in the pericarp of the embryo, at least in the endosperm. Fungus does not penetrate into the tissues of the embryo. Non-ripened seeds are infected physiologically.

Dark velvety plaque appears on the seeds and blackens tissue in the embryo. Harmfulness of disease is manifested in shriveled seeds. Such seeds have very low sprouting energy and often lose their germination. From immature seeds with a black embryo, weakened plants develop, strongly struck with root rot. A large number of grains with black fetus in the grain batch change the color of the grain flour and degrade its commercial value and baking quality. It is transmitted by seeds and causes plants disease.

Fungi isolated from the seeds of Hordeum vulgare L.

With the samples of *Hordeum vulgare*, 21 species of fungi belonging to 15 genera of 10 families, 3 divisions were identified.

Seeds of *Hordeum vulgare*, are affected by many fungal pathogens, such as *Erysiphe graminis* DC f. hordei spont Jacz., *Claviceps purpurea* Tul, *Trichotecium roseum* Link, *Cladosporium herbarum* Link, *Helminthosporium sativum* Pammel, King et Bakke, *Macrosporium commune* Rabh. (Fig. 2), *Alternaria alternata* (Fr.) Keisse (Fig. 3), *Fusarium moniliforme* Sheldon (Fig. 4), *Septoria nodorum* Berk., *Ustilago nuda* (Jens.) Kell. Sw et., hordei Ustilago (Pers.) Lagerheim, Puccinia graminis Pers. f. hordei Erikss. et Henn. Symptoms and effects, which are very diverse (destruction, hollowness, grain discoloration, raid). Many pathogens can develop during storage of Rhizopus nigricans Ehren. (Fig. 5), *Mucor racemosus Fres., Mucor mucedo* Fres*., Aspergillus fumigatus* Fres*., Aspergillus niger* Thiegh*., Aspergillus flavus* Link*., Aspergillus mucheli* Fr*., Aspergillus candidus Fr, Penicillium* verrucosum Dierk by reducing the sowing qualities of seeds.

Erysiphe graminis D.C. f. hordei spont Jacz. Mushroom spawn is on the stems in off-white, powdery, then dirty gray felted plaque with fruit bodies - Cleistocarpios. Conidia are cylindrical, of 22,4-32x9,6-12,8 mkm. Cleistocarpios are ovate, submerged, of 144-192 mkm in diameter, with numerous, colorless or light brown, short, simple, often very underdeveloped appendages.

Bags are 9-30, they are ellipsoid, stems are short of 64-80x28,8-35,2 mkm. Ascospores in an amount of 4-8, celled, colorless, elliptical or ovoid form is of 20-23x10-13 mkm. In the south of Kazakhstan, this species is spread everywhere.

Research in the granary of Tashtykara village.

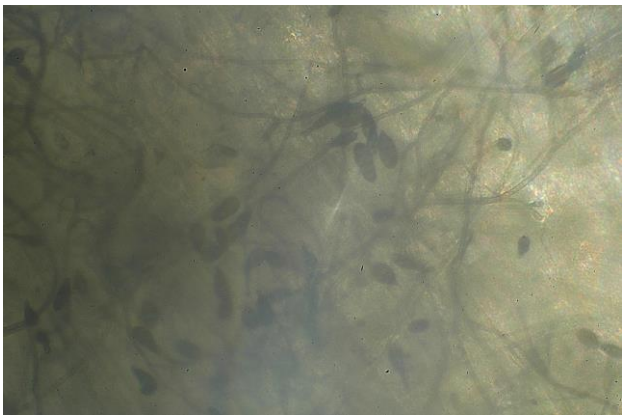


Figure 2: Conidia of *Macrosporium commune* on the seeds of *Hordeum vulgare*, (increased up to 600h)

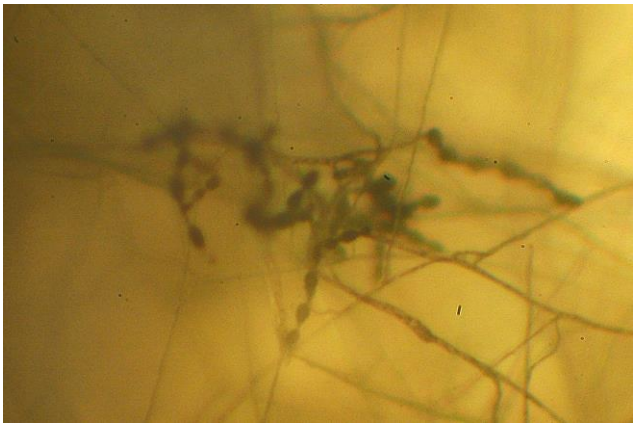


Figure 3: Conidia of *Alternaria alternata* on seeds of *Hordeum vulgare*, (increased up to 600h)

Aspergillus mucheli Fr. The mycelium is light colored or brown. Conidiophores with bubble-bulge are on the top. On the surface of bulge, sterigmata are arranged in one or two rows radially or in the form of columns wherein the chain of conidia is formed. Conidia are unicellular, ellipsoidal or spherical, smooth or spinous 2,5-6x2-5 mkm.

Research in the village of Saymasay.

Aspergillus candidus Fr. Colonies on a nutrient medium are white, creamy with age. Conidiophores are of 500-1000x5-10 (sometimes 20) mkm. Conidial heads are white, radial; sterigmata are in 2 rows. Conidia are colorless, smooth, spherical, of 2.5-3.5 mkm in diameter.

Research in the granary of Saymasay village.

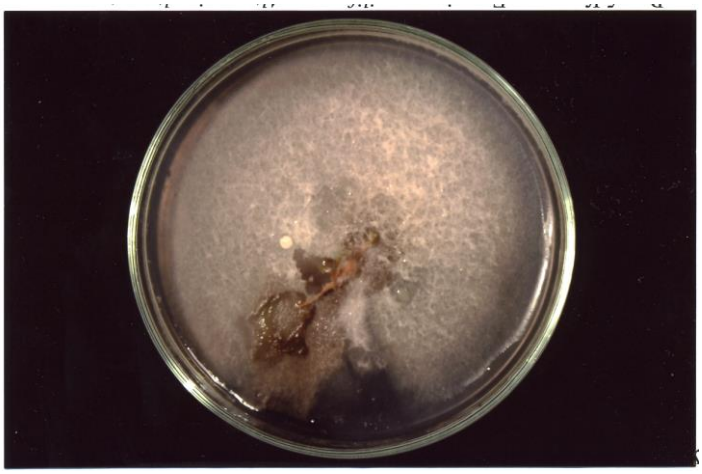


Figure 4: Colony of *Fusarium moniliforme* and *Alternaria alternata* on the seeds of *Hordeum vulgare.*

Ustilago nuda (Jens.) Kell. et Sw. Smut spores spread by air currents fall on the stigma and sprout giving fragmobazidii. Basidiospores are not formed on them, and the haploid cells of fragmobazidii copulate in pairs. The cells, in which dikaryons are obtained grow in the secondary mycelium penetrating into the ovary and developing inside the forming grains - in the endosperm and the germ, but not destroying them.

Affected grains almost do not differ from healthy grains. Chlamydospores are spherical, ellipsoid, sometimes oblong or angular with 9x5 mm diameter, light brown shell covered with spines. They affect the ear that comes out of the leaf sheath and is covered with a thin sheet of transparent film; through it, black mass of spores is rayed. Later, the film is torn, releasing spores.

The life cycle of the parasite is the same as that of wheat smut *Ustilago tritici*.

Fungi isolated from the seeds of Avena sativa L.

17 fungi species belonging to 13 genera, 9 families and three divisions were isolated with Avena sativa samples. The storage fungi Rhizopus nigricans Ehren., Mucor mucedo Fres., Aspergillus niger Thiegh., Aspergillus flavus Link., Penicillium rugulosum Thom., as well as soil fungi, such as Erysiphe graminis DC. f. avenae Marchal., Cladosporium herbarum Link, Helminthosporium sativum Pammel, King et Bakke, Helminthosporium avenae Eidam., Macrosporium commune Rabh., Alternaria alternata (Fr.) Keissl (Fig. 5), Fusarium moniliforme Sheldon, Colletotrichum cereale Manns, Phoma avenae Sacc ., Ustilago levis (Kell. et Sw.) Magn., Ustilago avenae (Pers.) Jensen, Puccinia coronifera Kleb. f. avenae Erikss were isolated from the seeds of Avena sativa.

Erysiphe graminis DC. f. avenae Marchal. Powdery mildew. On the spikelets, plaque is whitish, powdery, later gray, felt, dense; conidia are cylindrical or barrel-shaped, of 16-27x7-14 mkm, in chains, sitting on swelling of the conidiophores base; Cleistocarpios are dark brown, spherical, of 135-280 mkm in diameter, with numerous, colorless or light brown, short appendages, simple, very often underdevelopment; Bags are 9-

30, cylindrical, ellipsoidal or ovoid, with as short stem, 70-100x15-40 mkm; ascospores are in an amount of 4-8, 1-cell, colorless, ellipsoidal or ovoid, of 20-23x10-13 mkm.

Research in the granary in Kordai village

Helminthosporium avenae Eidam. The disease manifests in the form of spots on the seeds and mycelium is retained in the tissues of the films and grains during storage. The spores of the fungus are light olive, cylindrical, sometimes slightly thicker in the middle, rounded at the ends, with a 3-6 (8) transverse bulkheads, smooth, of 100-115x20 mkm. Ascomycetous stage is Pyrenophora avenae.

Research in the village Tashtykara

Figure 5: Conidia *Alternaria alternata* on seeds *Avena sativa,* (increased 600h)

Colletotrichum cereale Manns is a pathogen of Anthracnose. The pads of sporification are superficial, small, oval, supplied with dark bristles, of 60-120 mkm in length and about the base of 6-8 mkm of thicknesse, sometimes with one, two partitions. Conidiophores are of 2-6x1-2 mkm. Conidia are fusiform, curved, colorless, of 18-20h3-4 mkm.

Fungi isolated from the seeds of Zea mays L.

Figure 6 - Sporangia of *Mucor mucedo* on the seeds of *Zea mays*, (increased up to 600h)

With the seed Zea mays, we have identified 18 species of fungi belonging to 14 genera, 6 families and 3 divisions. Mycoflora of seeds Zea mays is presented by storage fungi of Rhizopus nigricans Ehren., Rhizopus oryzae Went. et Print., Mucor racemosus Fres., Mucor mucedo Fres. (Fig. 6), Aspergillus fumigatus Fres., Aspergillus niger Thiegh. (Fig. 7), Aspergillus flavus Link., Penicillium rugulosum Thom, Penicillium verrucosum Dierk., as well as by soil fungi Oospora verticilloides Sacc., Botrytis cinerea Pers., Cladosporium herbarum Link,

Helminthosporium sativum Pammel, King et Bakke, Alternaria alternata (Fr .) Keissl, Fusarium sporotrichiella Bilai var. poae (Pk.) Bilai., Fusarium moniliforme Sheldon, Ustilago zeae (Beckm.) Unger., Sorosporium reilianum (Kuhn) McAlpin.

Rhizopus oryzae Went. et Print. Sporangiophores are straight, often meandering, simple, sometimes at the top double, triple or wrong whorled branched with intermediate swellings, of 300-55x11-22 mm, light brown, with numerous oil drops, beam (2-3), at least singly away from rhizoids. Sporangia are spherical of 100-250 mkm in diameter, brownish fulvous.

The column is hemispherical, laterally flattened, of 44-77x33-66 mkm, brownish. Sporangiespores are wrong spherical, angular, widely ellipsoidal, of 4,4-8,8x4,4-7,7 mkm, brownish fulvous, smoky olive with strongly striated, streak shell. Chlamydospores are spherical, widely ellipsoidal, ellipsoidal cylindrical, of 44-55 mkm in diameter. Zygospores are spherical, sometimes laterally flattened, of 132-165 mkm in diameter, dark brown, large warty. Copulate spurs are of the same size. Fungal colonies in Chapek's medium are closely or loosely-felted with a well-developed aerial mycelium, white, later light yellow or brownish-gray.

Research in the granary of Shelek village

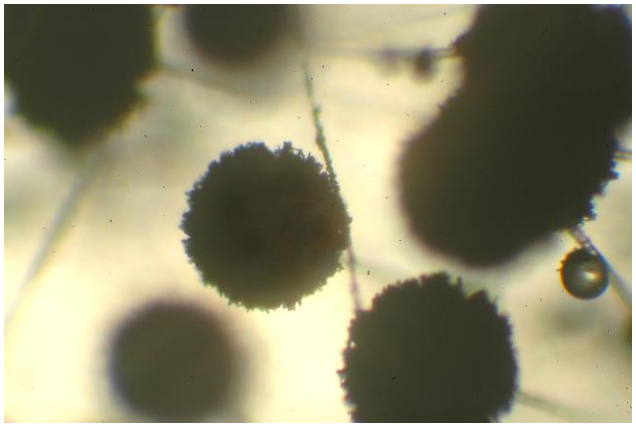


Figure 7: Conidiophores with *Aspergillus niger* conidia on seeds of *Zea mays,* (increased 600h)

Oospora verticilloides Sacc. The mycelium is in white felt pads. Conidiophores are simple, forked or nearly whorled branched, of 70x3mkm, ending with a conidia chain, often divided into separate conidia. Conidia are colorless, unicellular, back club-shaped, oblong-fusiform, of 8-10x2,5-3 mkm.

The disease is characterized by rotting ears, pinkness of grains and the appearance of white-pink plaque on the stem, seeds, wrapper and stamenal filaments.

Research in the granary of the villages Saymasay, Baltabay

Botrytis cinerea Pers. Hyphae are colorless or gray-olive, 4-10 mkm thick. Conidiophores are of 0,3-1 mkm length, 6-17, 5-10 mkm thickness, with a fairly thick shell, brownish at the bottom, at the top almost colorless, more or less branched, with branches mostly of 50-150x7,5-12,2 mkm which, in its turn, is also branched typically with short end branches terminating with swirls shaped protrusions with small teeth, on which clustered conidia are arranged closely. Conidia are ovate or rounded-ellipsoidal, of 9-15x6,5-10 mkm, smoky in mass. Sclerotia are grayish-white, then black, of 2-7 mm in length with a knobby surface.

Fungi isolated from the seeds of Sorghum vulgare Pers

On the seeds Sorghum vulgare, we discovered 12 species of fungi belonging to 9 genera, 5 families, 3 divisions. Mycoflora seeds are represented by the following storage fungi *Rhizopus nigricans Ehren., Mucor mucedo Fres., Aspergillus fumigatus Fres., Penicillium rugulosum Thom., as well as soil fungi Helminthosporium turcicum Pass., Alternaria alternata (Fr.) Keissl, Fusarium nivale (Fr.) CES ., Fusarium sporotrichiella Bilai var.*

poae (Pk.) Bilai., Fusarium moniliforme Sheldon (Fig. 8), Sphacelotheca sorghi Clint, Sphacelotheca cruenta (Kuhn) Potter, Sphacelotheca holci Jackson.

Helminthosporium turcicum Pass. Conidiophores are straight or slightly curved, with 2-3 septa to 130mkm in length. Conidia are oblong-ellipsoidal or spindle-shaped, slightly acuminate at the ends, of 50-105x13-26 mkm, with 5-8 septa and thickened shells.

Sphacelotheca sorghi Clint. Individual ovaries are affected in the inflorescence sorghum. Oblong or egg-shaped bulges of 3 - 12mm in length are formed in them that are protruded from the scales. The overgrown ovaries are covered with white plaque consisting of colorless hyphae. The inner part of the ovary is filled with powdery olive-brown spore mass.

After the destruction of the shell, chlamydospores are scattered and a column which is formed from plant tissue remains in the middle of destroyed ovary. Chlamydospores are spherical or ovoid, less angular, of 4 - 8 mm in diameter, with an olive or olive-brown smooth shell. Infection is maintained on the seeds.

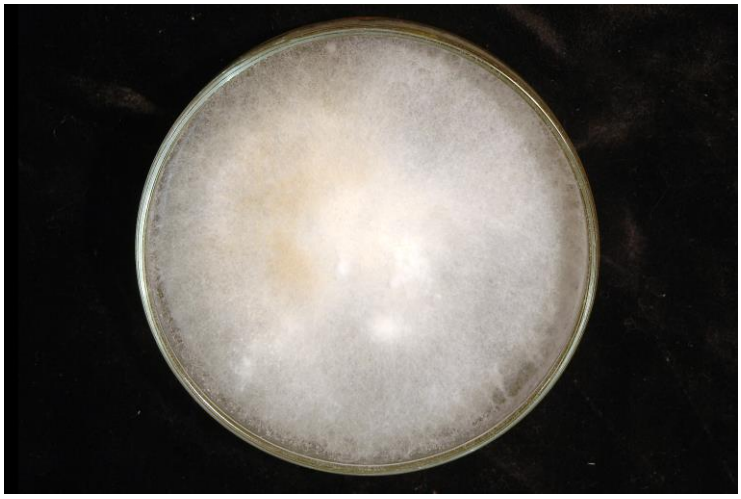


Figure 8: Colonia Fusarium moniliforme on Czapek (20th day) dedicated to seed Sorghum vulgare

Sphacelotheca cruenta (Kuhn) Potter. The disease affects the generative organs. Reddish-brown or light brown sack-like bulges are formed that are filled with a mass of black spores. Chlamydospores are spherical or ellipsoidal, of 7-11x7-9 mkm, brown, smooth or slightly punctured, with thickened shells.

Sphacelotheca holci Jackson. They affect the ovaries, which are elongated and protruded from unaffected spikelet glumes. First, the affected ovaries are covered with whitish thin shell, and later it is broken, revealing a dark brown mass of spores. After spraying of the spore, a part of the ovary tissues remains in the form of a column. Chlamydospores are spherical, of 9-8 mm in diameter, dark brown, clustered or scattered, visible at high magnification.

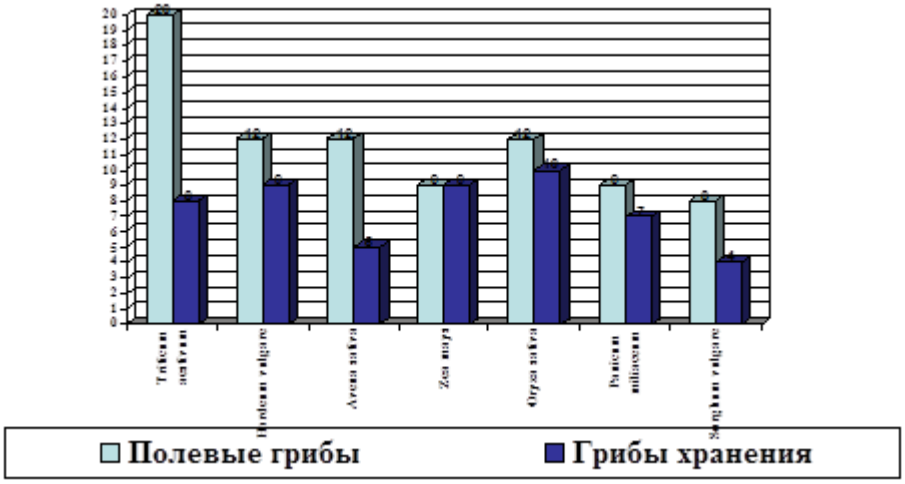
The degree of contamination and spread of fungi in seeds

The degree of contamination of seed by fungi species in the storage conditions.

A group of fungi of genera Helminthosporium, Alternaria, Fusarium is differentiated by variety of effects on the host tissue. Firstly, these pathogens affecting seeds can cause root rots, or accompany with the development of the disease and accumulate in the soil. Fusarium fungi in the soil (outside plant residues) can form a morphological structure contributing to the survival of the fungus.

Thus, we have found with the germination of conidia Fusarium with a form of chlamydospores. Mushrooms of genera Helminthosporium, Alternaria, Fusarium in storage can cause destructive changes of seeds or intoxication and reduce their crop quality. In addition, they continue to develop in storage (almost everyone in different ways). Some of them, for example, such as species of Fusarium, can contaminate healthy

seeds in granaries. Sources of infection are diverse (seeds, soil, air), and the role of some of them is much more difficult to determine than the smut fungi, and hence more difficult to limit the disease progression. Species composition of the pathogens complex on seeds of certain types of crop plants is not constant, but in certain environmental conditions it can survive. The number of field mushrooms and fungi storage on cereal seeds and legume crops is shown in Figure 9.



полевые грибы– field mushrooms грибы хранение – storage mushrooms

Figure 9 - The contamination degree of crops seeds by fungi species in the storage conditions

A certain type of injury can be caused by (in most cases) a single predominant species. The composition of pathogens may vary depending on several factors (temperature, humidity, etc.). As can be seen from the picture, the degree of fungi occurrence in various crops is different. On the seeds of soft wheat 20 types of field fungi, 8 kinds of storage fungi, on the seed of the ordinary barley - 12 and 9, on the seed of the sowing oats - 12 and 5, on the seeds of corn - 9 and 9, the seeds of sowing rice - 12 and 10, on the seeds of sowing millet - 9 and 7, on the seeds of the ordinary sorghum 8 and 4 fungi species respectively were discovered. This is due to the fact that Triticum aestivum, Oryza sativa, Hordeum vulgare are cultivated with the onset of the Neolithic, and the seeds are constantly kept in storage, which led to a gradual decrease in immunity to various diseases.

By their impact on the fabric of seed, fungi of this pathogens complex are divided into destructive and moderate parasites and mold itself. The first group (that produces their own food through the destruction of host tissues) includes species of the genera Helminthosporium, Fusarium, to the second group (which is used in food substances, due to any reason, unused host) includes Alternaria alternata. Molding of seeds can cause Rhizopus nigricans, Trichothecium roseum, Cladosporium herbarum, Botrytis cinerea and others. Their role in the process of deterioration of seeds is determined by the prevailing conditions of storage (or crop conditions before the harvest). For each part of the crop, conditions of contamination are often different.

The impact of these fungi on tissues of the embryo and plantlets depends on the depth of penetration of the mycelium and the intensity of the toxins formation, and the factors that contribute to it are so numerous (temperature, humidity, timing of infection, etc.) and variants of their combinations are so diverse that setting the pattern in the manifestation of pathogenic properties of pathogens is quite difficult.

THE DISCUSSION OF THE RESULTS

By the methods of detection of fungal infection and anatomic method, we identified the types of disease pathogens transmitted by seeds. Particular attention should be paid to the species of Alternaria alternata, ubiquitous, manifesting itself as a saprophyte; it can lead semi-parasitical or parasitic lifestyle under

favorable conditions. In wet conditions this kind can be a real "danger" for healthy plants. It forms spots on the leaves, which are then transferred to the stems, flowers, even to seeds under favorable conditions.

The effect of the granary temperature on the growth and development of fungal species

The room temperature influences on the morphology of the fungi and the conditions of their normal development. In accordance with standard temperature recommended by the International Association of Seed Testing (ISTA), the optimum temperature for all fungi is either the lowest standard + 190C (+ 200 ° C in our experiments), or the highest standard + 280C (+ 260S in our experiments) or with both temperatures. To identify the optimal conditions for development of fungi, seeds were contained in a humid chamber at different temperatures: + 260S + 200C + 170c + 140C, + 100C, and + 40C for two weeks.

Temperature effect on the mycoflora of the studied seed is largely determined by the various optima growth of its individual representatives. The temperature of +40 provided a limiting effect on the development of fungi on the seeds in a granary. At this temperature, field mushrooms were eliminated (killed) slowly, the growth of mold storage is slowed. There were changes in the species composition of mycoflora. At a temperature of +40C (Table 1) in a humid chamber, on seeds of Triticum aestivum, Hordeum vulgare, Oryza sativa, Sorghum vulgare - Alternaria alternata (Fig. 10); on the seeds of Avena sativa - Cladosporium herbarum, Alternaria alternata, Phoma avenae; on the seeds of Zea mays - Penicillium rugulosum, Alternaria alternata; on seeds Panicum miliaceum - Cladosporium herbarum, Macrosporium commune, Alternaria alternata; on the seeds of Pisum sativum, Phaseolus aureus, Glycine sativum, - sterile mycelium; on the seeds of Phaseolus vulgaris - Penicillium rugulosum, sterile mycelium were detected. At a temperature of +40C, Penicillium rugulosum forms generally well developed mycelium mass from conidia much longer than in other higher temperatures.

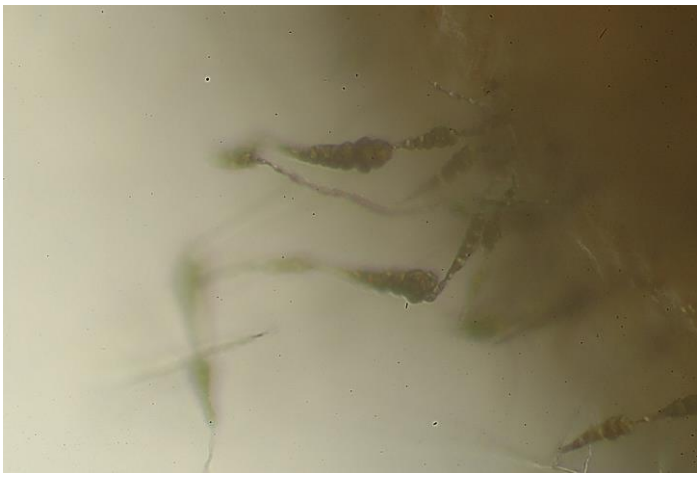


Figure 10: Conidia of *Alternaria alternata* on seeds of *Triticum aestivum* at + 40C (increased 600h)

Table 1: The species composition of fungi on the seeds of grain crops at a storage temperature of +40C

Plant species	Types of fungi					
	Penicillium rugulosum	*Cladosporium herbarum*	*Macrosporium commune*	*Alternaria alternata*	*Phoma avenae*	Total
1	2	3	4	5	6	7
Cereal crops						
Triticum aestivum				+		1
Hordeum vulgare				+		1
Avena sativa		+		+	+	3

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Zea mays	+			+		2
Oryza sativa				+		1
Panicum miliaceum		+	+	+		3
Sorghum vulgare				+		1
Total	1	2	1	7	1	12

Table 2: The species composition of fungi on the seeds of grain and leguminous crops at a storage temperature of + 100C

Plant species	Types of fungi							
	Aspergillus niger	*Penicillium rugulosum*	*Cladosporium herbarum*	*Macrosporium commune*	*Alternaria alternata*	*Phoma avenae*	*Fusarium nivale*	Total
1	2	3	4	5	6	7	8	9
Cereal crops								
Triticum aestivum				+	+			2
Hordeum vulgare					+			1
Avena sativa		+		+	+	+		4
Zea mays	+	+	+		+			4
Oryza sativa		+		+	+		+	4
Panicum miliaceum					+			1
Sorghum vulgare					+		+	2
Total	1	3	1	3	7	1	2	18

Table 3: The species composition of fungi on the seeds of grain and leguminous crops at a storage temperature of + 140C

Plant species	Types of fungi					
	Rhizopus nigricans	*Mucor mucedo*	*Penicillium rugulosum*	*Alternaria alternata*	*Fusarium nivale*	Total
1	2	3	4	5	6	7
Cereal crops						
Triticum aestivum	+			+		2
Hordeum vulgare				+		1
Avena sativa				+		1
Zea mays		+	+	+		3
Oryza sativa			+	+	+	3
Panicum miliaceum				+		1
Sorghum vulgare		+		+	+	3
Total	1	2	2	7	2	14

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Table 4: The species composition of fungi on the seeds of grain crops at a storage temperature of + 170c

Plant species	Types of fungi						
	Mucor mucedo	*Botrytis cinerea*	*Aspergillus niger*	*Penicillium rugulosum*	*Alternaria alternata*	*Fusarium nivale*	Total
1	2	3	4	5	6	7	8
Cereal crops							
Triticum aestivum	+				+		2
Hordeum vulgare	+				+		2
Avena sativa	+		+		+		3
Zea mays	+	+		+	+		4
Oryza sativa				+	+	+	3
Panicum miliaceum					+		1
Sorghum vulgare	+	+			+	+	4
Total	5	2	1	2	7	1	19

Table 5: The species composition of fungi on the seeds of grain and leguminous crops at a storage temperature of + 200C

Plant species	Types of fungi									
	Rhizopus nigricans	*Mucor mucedo*	*Botrytis cinerea*	*Aspergillus niger*	*Penicillium rugulosum*	*Alternaria alternata*	*Fusarium nivale*	*Ustilago zea*	*Puccinia graminis*	Total
1	2	3	4	5	6	7	8	9	10	11
Cereal crops										
Triticum aestivum		+		+	+	+			+	5
Hordeum vulgare	+	+		+		+				4
Avena sativa		+		+		+				3
Zea mays		+	+		+	+		+		5
Oryza sativa		+		+		+	+			4
Panicum miliaceum	+					+				2
Sorghum vulgare		+				+	+			3
Total	2	6	1	4	2	7	2	1	1	26

Table 6: The species composition of fungi on the seeds of grain and leguminous crops at a storage temperature of + 260S

Plant species	Types of fungi							
	Rhyzopus nigricans	*Mucor mucedo*	*Aspergillus niger*	*Penicillium rugulosum*	*Cladosporium herbarum*	*Helminthosporium sativum*	*Alternaria alternata*	Total
1	2	3	4	5	6	7	8	9
Cereal crops								
Triticum aestivum		+	+				+	3
Hordeum vulgare		+	+	+			+	4
Avena sativa	+		+		+	+	+	5
Zea mays	+	+		+			+	4
Oryza sativa		+	+	+			+	4

Panicum miliaceum				+			+	2
Sorghum vulgare		+	+	+			+	4
Total	2	5	5	5	1	1	7	26

Table 7: Infected seeds of cereals and legumes species of fungi at various storage temperatures

Crop	Number of samples	Temperature ^{0}C					
		+4^{0}C	+10^{0}C	+14^{0}C	+17^{0}C	+20^{0}C	+26^{0}C
1	2	3	4	5	6	7	8
Cereal crops							
Triticum aestivum	22	1	2	2	2	5	3
Hordeum vulgare	22	1	1	1	2	4	4
Avena sativa	22	3	4	1	3	3	5
Zea mays	22	2	4	3	4	5	4
Oryza sativa	22	1	4	3	3	4	4
Panicum miliaceum	22	3	1	1	1	2	2
Sorghum vulgare	22	1	2	3	4	3	4
Total		12	18	14	19	26	26

Organization of seeds storage is an important link in the seed industry. Decisive importance here is the preservation of the conditioning germination. Most types of agricultural crops seeds can retain high viability for 3-5 years; it is sharply reduced under adverse storage conditions. In production conditions, storage terms are determined from cleaning to sowing, for winter crops - 1-2 months, spring crops - 7-9 months, carryover funds of winter crops - 13-14 months, and insurance funds of spring crops - from 7-9 to 20 months or more. In accordance with these terms it is necessary to establish the method and technology of seeds storage to save their sowing qualities in accordance with the requirements of the standards at the lowest cost of labor and resources.

There is a long-term seed storage technology adopted in a national repository of world plant collections; this technique was developed by All-Union Scientific Research Institute of Plant named after Vavilov.

The identified species of the field fungi of Botrytis cinerea Pers., Helminthosporium sativum Pammel, King et Bakke, H. avenae Eidam, H.oryzae van Br. de Haan Subram, H.panici-miliacea Nisikado, H.turcicum Pass., Alternaria alternata (Fr.) Keissl, Fusarium nivale (Fr.) CES., F.sporotrichiella var.poae Bilai, F.moniliforme Sheldon, F.graminearum Schwabe, F.oxysporum var. orthoceras App. et Wr., cause great harm to seeds of crops during their vegetation season.

In the freshly harvested corn, microscopic field fungi such as Cladosporium herbarum Link., Helmintosporium sativum Pammel, King et Bakke, Alternaria alternata (Fr.) Keissl, Fusarium nivale (Fr.) CES., Ustilago zea (Beckm.) Unger., Tilletia tritici (Bjek) Winter., Sorosporium reilianum (Kuhn) McAlpin and others were detected. The storage of freshly harvested grain is accompanied by a change in the number and species composition of mycoflora. A decrease in the total number of characteristic mycoflora is characteristic for dry grain (with humidity at limits or below the critical).

Representatives of the saprophytic flora - species of the genera of Rhizopus nigricans Ehren., Rh.oryzae Went. et Prin., Mucor racemosus Fres., Mucor mucedo Fres., Aspergillus fumigatus Fres., A.niger Thiegh., A.flavus Link., Penicillium rugulosum Thom, P.chrysogenum Thom, P.verrucosum Dierk. et al. - harm the seed material in the wrong storage conditions. The impact of generic and species diversity is indicative in the distribution of families and genera of mycoflora.

Internal infections are caused by the genera species of Oospora, Rhizopus, Penicillium, Helminthosporium, Macrosporium, Alternaria, Fusarium, Ustilago, Botrytis, Verticillium. Saprophytic fungi are found on the surface of immature seeds and dead seeds tissue. Some pathogenic species, together with saprophytic destroy the tissue and penetrate into the seed. At high humidity, saprophytic species evolve rapidly causing the rotting of seeds. They mainly manifest themselves during the storage period when the conditions for their development (high humidity, poor ventilation, fever and others.) are created.

As a result of studies, the following conclusions are necessary:

- 1. The species composition of fungi in the seeds of cereal crops in southern Kazakhstan is represented by 137 species of fungi belonging to 30 genera, 19 families and four divisions. From them, we have identified and described 72 species. The division Oomycota was represented by one family of a single species. The division Zygomycota was represented by one family, 3 genera and 7 species. The Ascomycota Division was represented by 15 families and 99 species. The division Basidiomycota was represented by 3 genera and 30 species. For the first time 3 species were described for the south of Kazakhstan: Piricularia grisea Sacc., Phoma avenae Sacc., Stemphylium macrosporoideum (Berk.) Sacc. The identified species affect the seed shell and the inner part of it.
- 2. The species composition of the pathogens complex on seeds of certain types of crop plants is not constant, but it can survive in certain environmental conditions. On the seeds of soft wheat –28, the seeds of ordinary barley – 21, on seeds of sowing oats – 17, on the seed of corn – 18, for the seeds of sowing rice– 22, for the seeds of sowing millet – 16, on the seed of sorghum 12 species of fungi.
- 3. In granaries except for plant pathogenic fungi, large damage on seed material can be caused by saprophytic mold and fungi storage, including species Rhizopus nigricans, Trichotecium roseum, Botrytis cinerea, Cladosporium herbarum, Stemphylium macrosporoideum, Alternaria alternata, as well as species of the genera of Mucor, Aspergillus and Penicillium. An increased development of fungi in seed weight is due to the content of a large range of hydrolytic enzymes that allow intensive work on the covering and storing grain tissue.

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