MODERN TRENDS IN THE DEVELOPMENT OF AGRICULTURAL PRODUCTION

PROBLEMS AND PERSPECTIVES

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The monograph presented for review is a collection of the results of actual achievements of domestic agricultural scientists, obtained directly in real conditions. The authors are recognized experts in their fields, as well as young scientists and postgraduate students of Ukraine. Research is conceptually grouped into 5 sections: modern technologies in crop production and fodder production; economy of the agro-industrial complex; breeding and breeding in the 21th century; protection and quarantine of plants; agrochemistry and soil science. The monograph will be interesting for experts in plant breeding, economics, plant protection, selection, agrochemistry, soil science, scientific workers, teachers, graduate students and students of agricultural specialties of higher education institutions, and for all those who are interested in increasing the quantity and quality of agricultural products.

Keywords: modern technologies, crop production, fodder production, plant protection, quarantine, agrochemistry, soil science, economy of agro-industrial complex.

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PATHOLOGY OF WINTER BARLEY SEEDS

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The importance of winter barley in agricultural production is shown. It was established that in the conditions of the Kherson region in 2019–2021, the pathogens of head blight, net blotch, seed mold and bacterial kernel blight became the most widespread among winter barley seeds. The harmfulness of the identified diseases and measures to limit their development are given.

***Key words**: winter barley, head blight, net blotch, seed mold, bacterial kernel blight, harmfulness, protective measures.*

Winter barley is an agricultural crop, which, like most crops, has its advantages and disadvantages when grown. In particular, unlike spring barley, with normal overwintering, it is more productive, matures 10–16 days earlier, which makes it possible to improve the supply of concentrates to animals during the summer depletion of the previous years' grain stocks. It withstands high summer temperatures well, tolerates little in the days of prolonged heat, and is distinguished by its resistance to drought.

Grain of winter barley has an important economic value in the production of cereals, as well as in the brewing industry. Its straw and chaff are used in animal husbandry. It is also grown in a green conveyor belt.

The high plasticity of plants, excellent nutritional qualities of grain and its processing products create the conditions for the wide spread of this crop in the southern region of Ukraine. With modern processing technology, the prime cost of winter barley is lower compared to other grain crops. The potential opportunities of winter barley can be realized using the knowledge of its biological features and methods of satisfying plant requirements at various stages of its growth and development. At present, increasing the yield of winter barley grain and improving its quality are impossible without the use of modern growing technologies.

Diseases are one of the factors limiting the further increase in barley grain production. The supplying of plants with micro– and macro–elements is one of the most important factors contributing to a significant increase in the yield and improvement of the grain quality of winter crops. In turn, the most effective method for decontamination of seeds is the use of tank mixtures, as the applied microelements and growth regulators contribute to increasing the protection of the plant against soil and partly aerogene infection at the early stages of organogenesis.

Materials and methods

Under favorable conditions for development, the pathogens of fungal and bacterial etiology can parasitize the seeds of grain crops, which leads to a significant deterioration in the quality of the seed material. In 2019 the pathogens of head blight, net blotch, seed mold and bacterial kernel blight became the most widespread among barley seeds in the conditions of the Kherson region.

Results of the research

The most intensively the head blight (*Fusarium* spp.) manifests itself in the phase of forming the spikes and grain maturing. A pink thin coating appears on the spike, pale pink or orange–red pads appear on the spike scales, which later merge into a continuous mycelium coating. In hot weather the affected parts of the spike turn white, and the healthy ones remain green. The affected spike becomes fragile, later turns black as a result of the formation of a thin coating of dark–colored semi–saprophytic and saprophytic fungi (Kyryk M., 2012).

When the plants are affected in the flowering phase, the grain in the spike becomes pale green, and covered with a pale pink coating. The development of the head blight after the plant flowering causes the grain to be fragile. It becomes light greenish–gray in color. Sometimes you can see pinkish–red spots on the seeds. The affection of the spike before harvesting leads to the development of a hidden infection (outwardly the grain looks healthy, but during the microscopic examination the pathogen mycelium is found in the endosperm). The seeds become pink, fragile and lose their glitter. Such grain and fodder can be dangerous as fodder (Markov I., 2017).

The harmfulness of the disease is manifested itself in a shortage in the yield and in the grain weight. The affected seeds lose their germination completely, or sprouts with the signs of Fusarium root rot are formed when sown in the soil. There is a direct correlation between the number of the affected seeds and germination. Even if the seed affected with the head blight has germinated, in the future it will either die or produce weak sprouts affected by the Fusarium root rot.

It should be noted that the pathogens from the genus *Fusarium* spp. react to moisture and temperature in various ways. In particular, *Fusarium culmorum* grows and develops well in cold and wet conditions, *Fusarium graminearum* needs warm weather and moisture, *Fusarium langsethiae* and *Fusarium poae* feel good in warm conditions and moderate moisture. Therefore, depending on the weather conditions, one can expect the development of certain pathogens from the genus *Fusarium* spp. (Shvartau V., 2016).

The vast majority of species from the genus *Fusarium* spp., which cause Fusarium head blight and Fusarium root rot, produce mycotoxins belonging to the classes of trichothecenes. However, a number of *Fusarium* species produce fumonisins, moniliformin (MON), and zearalenone (ZEA), which can be found worldwide in the grain spikes affected with Fusarium head blight (Golrnski P. et al., 1996).

Trichothecenes are accumulated in grain due to the Fusarium head blight and are toxic to humans and animals. The main mechanism of toxicity manifestation may be the inhibition of eukaryotic protein synthesis (Godfray H., 2010; Arunachalam C., 2013).

DON is the dominant mycotoxin in the class of trichothecenes. Therefore, in the countries with mass grain production (including Ukraine), the maximum amounts of DON in plant products are regulated.

To identify the Fusarium head blight pathogens in the seeds and the intensity of damage to the spouts caused by root rot, the seeds are germinated in the filter paper rolls. Thin, delicate snow–white, pink, crimson, and sometimes orange–colored scabs appear on the sprouts and on the caryopsis affected by the Fusarium head blight. The plant roots rot on the base and become brown or glassy transparent. The coleoptile and the stalk become brown in color, the latter becomes twisted and the whole sprout changes its form. (Pikovskyi M., 2018).

The system of protection against damage caused by the pathogens from the genus *Fusarium* spp. includes the following technological requirements: compliance with the crop rotation, high–quality soil preparation, and cultivation of varieties tolerant to the disease. It also includes a number of agricultural methods, in particular: treatment of seeds with fungicides to reduce the development of root rot; balanced crop nutrition; spraying plants during the growing season with the recommended fungicides (in order to control the development of the Fusarium head blight); harvesting in a short period of time followed by drying and high–quality refining of the grain; careful covering of the post–harvest residues.

The seed is affected by the pathogens from the genus *Helminthosporium* spp. in the phase of flowering and grain maturing. The mycelium develops intercellularly in the plant tissues. In case of late infection or resistant varieties seeds, the fungus penetrates only the seed coat, and in the case of early infection and the susceptible varieties the endosperm and embryo are often affected. The affected grain is fragile, lightweight, physiologically underdeveloped, has reduced germination energy and seed germination (up to 60*%)*.

During the storage of the affected seeds, the fungi that cause net blotch are able to continue their development with the release of poisonous substances – toxins that worsen the sowing properties of the seed even during the period of storage, especially when the moisture conditions are not proper.

The harmfulness is very high, the shortage in the grain yield can reach 30–40%, not considering the large amount of hidden losses due to the death of the sprouts before reaching the surface of the soil

The pathogens of seed mold are polyphagous fungi that have a saprotrophic lifestyle and can develop on a variety of plant substrates, including the seeds of many agricultural crops. Significant damage to the seed material is caused by the saprophytic mold fungi, among which the most widespread species of the genus Penicillium, Aspergillus, Mucor, Rhizopus, Cladosporium, Epicoccum and others. In the field these fungi develop at high air humidity during the maturing and harvesting period on the weakened or dead plants, causing damage to the spikelet. Under complete colonization of the spike by saprotrophs, the crop losses can reach 80%, and with partial colonization – up to 32%. The seeds affected by the saprotrophic fungi can be infected again during storage, which leads to a decrease in germination.

The pathogens are harmful in the regions with a large amount of atmospheric precipitation and a decrease in air temperature during the period of sowing and harvesting. The injury to seeds and storage of the high humidity seed material contributes to the development of the disease. Under favorable conditions the disease manifests itself in the form of a thin coating of various colors on the caryopsis. When the caryopsis is affected by the pathogens from the genera *Penicillium* spp. a yellowish–greenish–gray, gray–blue, gray–green or dark green thin coating is formed. In the case of *Alternaria* spp. the coating is light and smoky gray at the beginning, and then darkens to olive–black; and in the case of *Mucor* spp. the head mold appears, the coating is light, then it becomes gray–green or dark brown.

The fungus *Alternaria. alternata* is able to develop on the dead plant remains and parasitize many types of plants. Alternaria black embryo is characterized by darkening of the seed in the area of the embryo or directly in the germ corymb. It can spread to any part of the seed, while its color changes from dark brown to olive, and the filling of the caryopsis can be preserved. The mycelium *Alternaria* spp. concentrates in the fruit capsule of the grain, more often under the embryo and only occasionally penetrates into the endosperm. During the germination of the infected seeds, the following symptoms are observed: deformation of the sprout, the appearance of aerial mycelium (gray or ash in color), darkening of the primary roots, the root neck and the stalk bed. The frequency of seed damage caused by fungi from the genus *Alternaria spp.* can be quite high, but the infection is often superficial.

The harmfulness of the disease manifests itself in the deterioration of the seed quality, sometimes to the point of complete loss of germination. The use of such grain as fodder can lead to poisoning due to the toxins that the pathogens secrete into the seeds during their vital activity (Kyryk, 2012).

The disease can be controlled with the help of the following measures: maintenance of crop rotation; timely harvesting; gater in the seeds from the least affected areas followed by thorough refining, calibration and bringing to standard humidity; treating the seed material with the recommended fungicides (Lyhochvor V., 1999).

In addition to the diseases of fungal etiology, net blotches play a significant role in the deterioration of the seed quality. The plants are infected primarily by bacteria that enter the sprouts from the infected seeds, where the bacteria spread diffusely through the vascular with the water flowing up to the leaves and spikes.

Two types of bacterial kernel blight are most widespread among winter barley crops: basal glum rot and bacterial stripe (or black) one.

Basal glum rot is widespread in the southern and eastern regions of Ukraine. The most intensive development of the disease is observed during the period of grain maturing. The spike scales begin to turn brown or black at the inside base, forming dark brown spots, which later become black. The embryo in the grain turns black. The pathogen of the disease is the bacteria *Pseudomonas syringae pv. atrofaciens Young et al.,* which, in addition to barley, infect wheat, Sudan grass, millet and other cultivated and wild cereals.

During the plant growing season in the field, the bacteria are transferred with air flows, raindrops, insects, and also during threshing. They penetrate plant tissues through spiracles and mechanical damage such as wounds, insect bites, and microcracks (Markov I., 2015).

An important factor in the spread of bacterial blights is the increase in the number of insect pests, which not only transmit the infection, but also, by damaging the spikes, open the way for penetration of the bacteria.

In the case of bacterial stripe development, blackening of the grain in the form of separate spots is often observed on the spikelet. In places where the spots are situated the seed coat becomes soft, and a pale pink liquid appears in the middle of the grain. Such a lesion is often called barley bacterial endosperm. The affected caryopsis in the spikelet is exposed, and the cracks are formed along the groove. The affected grain is deformed, and it is reddish–brown or brick–red in color. On a cross–section this coloration is observed under the epidermis in the aleurone layer. In a moist environment, a red bacterial mass forms in the cracks of the affected grain.

The pathogen of the disease is the bacteria *Xanthomonas translucens pv. cerealis Vauterin et al.* In addition to barley, the bacteria affect sorghum, Sudan grass, bromus secalinus, and various types of wheat grass. The optimum temperature for the development of bacteria is in the range of 20–25°C. They are resistant to sunlight. The disease develops more intensively on plants in dry years.

The grain affected by bacterial blight is shriveled, sometimes yellow stripes appear on it, which consist of dried bacterial exudate. In the embryonic part the grain acquires a dark gray or dark brown color. Often the affected part of the grain is separated from the healthy one by a dark thin rim. The embryo acquires a scorched appearance and dies. The field germination of such seeds correlates with the percentage of the seeds affected by bacterial blight (Holosna L., 2021).

The harmfulness of the disease manifests itself in the reduction of the assimilation surface of the leaves, shortage in the yield, decreasing the energy of sprouting and germination, as well as in the deterioration of the technological quality of the grain. The shortage in the crop yield can reach up to 50% or more. The disease–resistant varieties of barley have not yet been identified.

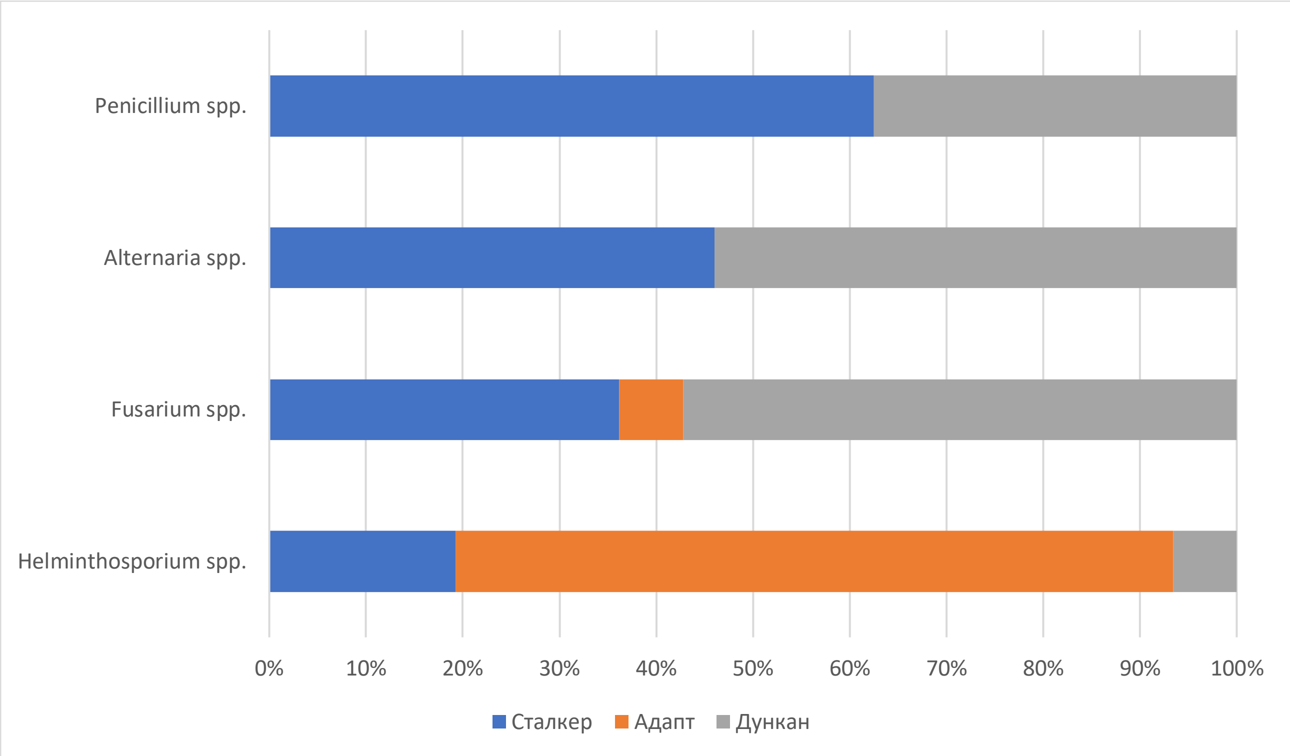

Figure 1. Seed infection of researched winter barley varieties of 2019 yield

According to the results of the phytosanitary examination of barley seeds of the Stalker, Adapt and Duncan varieties, the most common pathogens in 2019 were *Helminthosporium* spp. (23,5%, 90,5% and 8,0%, respectively), *Fusarium* spp. (30,0%, 5,5% and 47,5%), *Alternaria* spp. (29,0%, 0,0% and 34,0%), and *Penicillium* spp. (2,5%, 0,0% and 1,5%). The pathogens of cereal bacterial blight accounted to 4,0%, 1,0% and 2,5%, respectively (Fig. 1).

The Duncan variety had the highest laboratory germination (96,0%), the Adapt variety had the lowest one (90,5%). Besides, the Duncan variety was less affected by the pathogens compared to other varieties. The analysis of the seeds from the 2020–2021 yield also showed the presence of the pathogens that were found in 2019 (Fig. 2). The pathogens from the genus *Fsarium* spp. (23,5–53,5 %) were dominant.

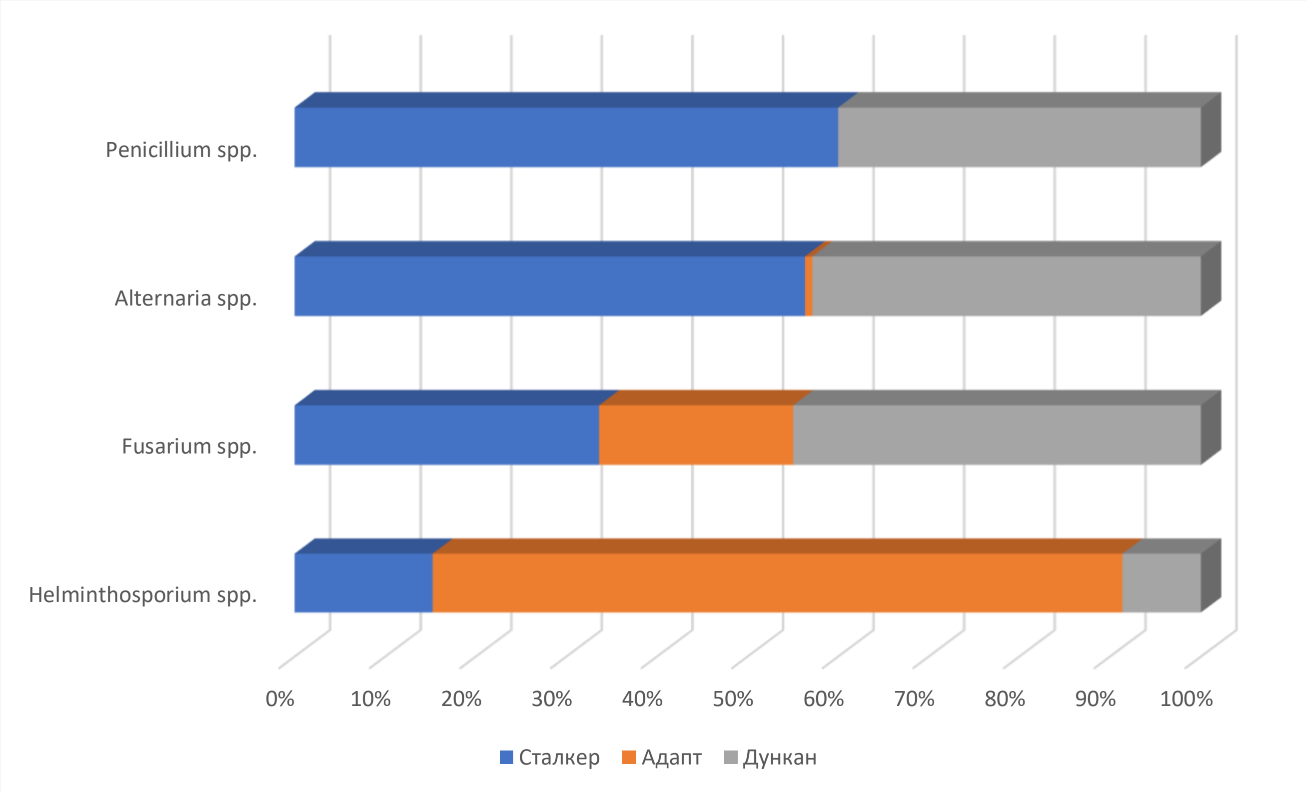

Figure 2. Seed infection of researched winter barley varieties of 2020–2021 yield

Conclusions. Therefore, considering rather high harmfulness of grain diseases, special attention should be paid to the quality of the seed treatment process (Cherviakova L., 2019). So, considering the species composition of the pathogens and the conditions of barley cultivation, the treating agent should be carefully chosen.

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