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Ecological significance of winter wheat varieties in phytosanitary optimization of agroecosystems

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Problem statement and analysis of recent research. Recently, organic farming has become especially widespread in Ukraine, denying the use of chemical plant protection products, genetically modified organisms and synthetic fertilizers. In this regard, the urgent problem is to find ways to control the number of pests in crops agroecosystems in organic farming [1, 2].

Infectious diseases of plants, including winter wheat, caused by phytopathogenic micromycetes are listed as dangerous factors of environmental pollution along with radionuclides, heavy metals

Mycobiota of Podolyanka and Poliska 90 winter wheat varieties seeds was found to be represented mainly by fungi of the *Alternaria*, *Fusarium*, *Penicillium*, *Aspergillus*, *Chaetomium*, *Trichothecium* genera which are characterized by various levels of pathogenicity, depending on the physiological and biochemical properties of the host variety. Significant increase is air temperature and relative humidity during the wheat flowering and milking stage of grain ripening contributed to the spread of micromycetes of the genus *Alternaria* Nees. (50 %). The seeds affected by fungi *Alternaria* were physiologically underdeveloped, had low energy and germination, which averaged 40 %. Plants from such seeds lag behind in growth and development.

It is established that the physiological and biochemical mechanism of Podolyanka winter wheat variety stimulates mycelium radial growth and intensity of fungi *Alternaria* sporulation indicating the rapid reproduction of micromycetes, which contributes to the contamination of agrophytocenoses by propagative structures of the pathogen. However, the intensity of spore formation and the rate of mycelium radial growth on Poliska 90 variety seeds, was significantly lower. This fact gives reason to believe that the physiological and biochemical mechanism of the Poliska 90 variety plants is able to restrain the intensity of the genus *Alternaria* micromycetes spore formation at an ecologically safe level.

It was found that the seeds of the Podolyanka and Poliska 90 winter wheat varieties are low in protein content and have high humidity. In terms of raw gluten content, they are classified in the quality group 3. Isolates of fungi the genus *Alternaria* developed more intensively on the Podolyanka winter wheat variety grain, which is characterized by a lower content of protein and gluten. However the development of fungi was significantly lower on the Poliska 90 variety grain, which is characterized by a slightly higher content of protein and gluten.

System-ecological approach to the improvement of agroecosystems in organic farming can be carried out using indicators of the variety physiological and biochemical properties interaction with physiological properties of phytopathogenic fungi, namely sporulation intensity and mycelial radial growth rate. This can increase the level of biosafety in agroecosystems and improve the quality of plant raw materials.

Key words: the frequency of occurrence, mycelium radial growth, sporulation intensity, phytosanitary optimization, wheat winter agrophytocenoses.

and chemical pesticides. These factors can quickly overcome the crops resistance, multiply intensively and cause epiphytotics. Epiphytotics of ecologically dangerous diseases, such as brown leaf, stem and yellow rust, powdery mildew, septoria, pyrenophora, virus types are increasingly observed in the structure of winter wheat crops in Ukraine [3, 4, 5]. In the conditions of invariable wheat crops dominance or crop rotations with short alternation, similar crops saturation, introduction of zero or minimum tillage, cultivation of disease-resistant, homogeneous varieties, caus-

es disruption of the natural connections between the host plant and the pathogen which results in the expansion of species diversity and increased pathogens harmfulness of winter wheat [6, 7].

Studying the mechanisms and factors determining the rate of natural ecological fungi-parasites formation is of great practical importance. Simplification of multiple ecosystems transforms their optimal functioning and stability, which leads to the deterioration the ecology agroecosystems [8]. Particular attention should be paid to the toxic properties of pathogens and their ability to accumulate in the soil, seeds and plant residues. This will allow to improve the ecological safety of agro-ecosystems, the food and feed industry, which will greatly improve human and animal health.

Peculiarities of phytopathogenic background formation of micromycetes, pathogens of winter wheat diseases in the conditions of organic production are analyzed. In the phytopathogenic complex, the leading place is occupied by micromycetes. The pathogens of root rot and powdery mildew prevail. The area of crops affected by these diseases ranges from 32.5 to 75.0 %, and it reaches 100 % in some years. The spread of diseases in winter wheat plants ranges from 4.2 to 19.8 %, and their development ranges from 1.6 to 14.0 %. *Alternaria* and *Fusarium* dominate among the wheat ear diseases. Reduction of crop yields under intensive development and spread of diseases can reach 60–70 % [9–11]. Also, according to scientific data [12], global warming, especially in the winter months, causes the range of pathogens expansion in areas where they have not occurred before [13, 14]. Thus, numerous studies are aimed at studying meteorological conditions during the growing season, which is an important factor in the implementation of cereals productivity, their resistance to lodging and the development of pathogens of major diseases [15–18]. Genetic variability (gene mutations, recombination) and their use in selections that open access get plants is of great interest for foreign authors given since it provides comprehensive resilience to the harmful organisms and various agro-climatic conditions [19, 20]. However, the advantages of many resistant varieties are short-time, because new types of resistant phytopathogenic microorganisms arise during their production. Varieties that have lost their resistance become reservoirs of highly pathogenic races and strains of phytopathogenic microorganisms, which can multiply and cause epiphytotic [21, 22]. Thus, agroecosystems recovery in organic farming can be achieved through agroecosystems phytosanitary status optimization the using a plant variety as a trophic factor

influencing the phytopathogenic fungi population.

The aim of the research is to determine the ecological role of winter wheat varieties in the agroecosystems phytosanitary optimization.

Materials and methods of research. The research was carried out in the laboratory of agroecosystems biocontrol and organic production in the Institute of Agroecology and Nature Management of NAAS and in the research field of Skvyra research station of organic production of IAP NAAS. Two varieties of winter wheat were used for research: Poliska 90 (STC of the Institute of Agriculture of NAAS) and Podolyanka (Institute of Plant Physiology and Genetics of the NAS of Ukraine, Myronivsky Wheat Institute named after V.M. Remeslo, UAAS). Plant samples were taken in agroecosystems populations of winter wheat varieties grown using organic technology. To detect endophytic and ectophytic plant diseases, a biological method was used according to DSTU 4138-2002 (National Standard of Ukraine) [23].

Four samples, 50 seeds each, were selected according to DSTU 4138. The seeds were disinfected for 5 min in 0.5 % potassium permanganate solution and washed with sterile water. The seeds were decomposed in petri dishes on agar nutrient medium and germinated in thermostats at a temperature of 27–30 °C for 7–10 days according to the generally accepted methods [23–25]. The fungi were identified on the 10th days after the mycelium colonies formation and sporulation beginning. Determinants were used to identify ectophytic and endophytic structures of the phytopathogenic fungi [26–28]. Indicator of frequency occurrence (FO) in some fungus species in the seeds of various crops was calculated according to the formula [29]:

$$A = \frac{B \times 100\%}{C}$$

where: A – the frequency of occurrence in species;

B – the number samples in which this species was detected;

C – the total number of selected species.

A common method was used to determine the indicator of variability of the obtained isolate of *Alternaria*, extracted from the seeds of Podolyanka and Poliska 90 winter wheat varieties [30, 31]. The fungi *Alternaria* cultures were grown on solid potato-glucose nutrient medium with addition of 1 ml of the variety exudates per 10 ml of nutrient medium [30]. To obtain the metabolites of winter wheat plant varieties, 50 seeds of each studied variety were selected and sterilized in accordance with DSTU 4138 [23]. The seeds were soaked in water and kept for 3–5 days until the formation

the seedlings 2–3 cm long. Ten seedlings of each variety were placed in petri dishes with sterile distilled water, where they were kept for 72 hours in diffused light at a temperature of 22–24 °C. The exudates were washed and filtered through a microporous bacterial filter (0.02 µm).

To determine the fungi growth rate, the diameter of the colonies was measured every 24 hours. The fungi culture speed growth was calculated according to the formula:

$$Kr = \frac{(r1 - r0)}{(t1 - t0)}$$

where: Kr – radial rate of the colonies growth;

r0 – radius of the colonies at time t0;

r1 – radius of the colonies at time t1.

Spore formation intensity was determined by direct counting of the spores number in the Goryaev-Tom chamber [32]. Mathematical analysis of experimental data was performed using Microsoft Office Excel software.

Qualitative indicators were studied according to DSTU 3768: 2019 Wheat. Technical conditions [33, 34]. The method is based on the use of dependences of the absorption spectral characteristics, light transmission or reflection in the infrared section of the spectrum on the grain content and (or) its processing products components.

Research results and discussion. According to the results of the research, the seeds of winter wheat varieties Podolyanka and Poliska 90, sown by organic technology, were analyzed. It is established that the mycobiome of winter wheat seeds of Poliska 90 variety is represented mainly by fungi genera: *Alternaria*, *Fusarium*, *Penicillium*, *Aspergillus*. The amount of affected seeds of this winter wheat variety was 67.5% and 6 species of phytopathogenic micromycetes were found to par-

asitize on Podolyanka winter wheat variety seeds: *Alternaria*, *Fusarium*, *Penicillium*, *Aspergillus*, *Chaetomium*, *Trichothecium*. The seed damage was 60 %. Significant increase in air temperature above +24 °C and relative humidity 95–97 % during the flowering of wheat and milk ripeness the grain contributed to spreading genus *Alternaria* Nees. micromycetese which were characterized by a high frequency of occurrence (50 %). The seeds the affected by fungi *Alternaria* were physiologically underdeveloped, had low germination energy, which averaged 40 %. Plants with such seeds lag behind in growth and development. Therefore, the study was aimed on studying the characteristics synecological relationships between winter wheat varieties grown with organic technology and phytopathogenic isolates of *Alternaria* genus fungi. Other species were not characterized by a low frequency (1–13 %) (Fig. 1).

The variability indicators obtained from *Alternaria* isolate extracted from Podolyanka and Poliska 90 winter wheat varieties seeds were studied to determine the ecological role of the variety in phytosanitary optimization of grain agroecosystems (Fig. 2).

According to the results presented in Figure 2, it was found that the radial mycelium growth of the *Alternaria* fungus cultures that passed through the Podolyanka variety genotype increased significantly compared to the Poliska 90 variety, where the radial growth rate was lower. The high rate of radial growth of mycelium, which passed through the Podolyanka variety genotype, indicates insufficient resistance to the environment and rapid reproduction of the fungus *Alternaria*, which contributes to the contamination agrophytocenoses by the pathogen propagative structures.

A similar dependence was observed in determining the intensity of fungi sporulation of the ge-

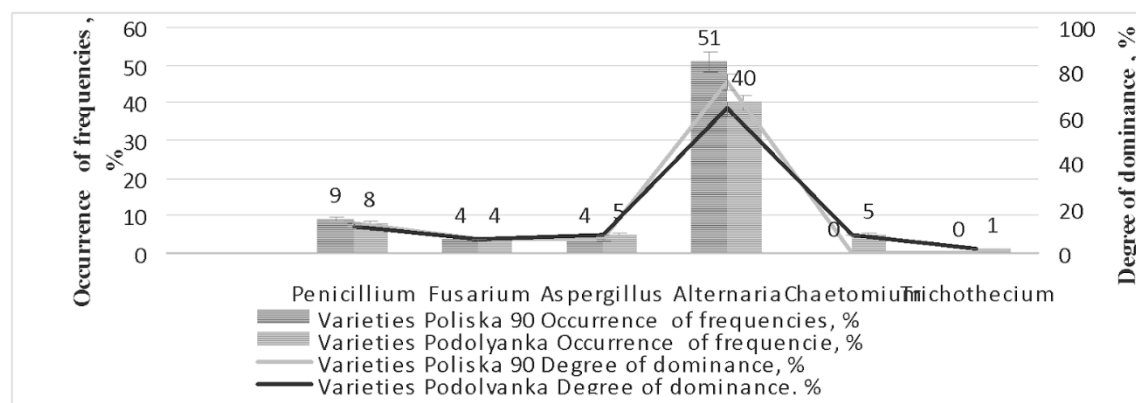


Fig. 1. Mycobiome of Podolyanka and Poliska 90 winter wheat varieties seeds grown with organic technology.

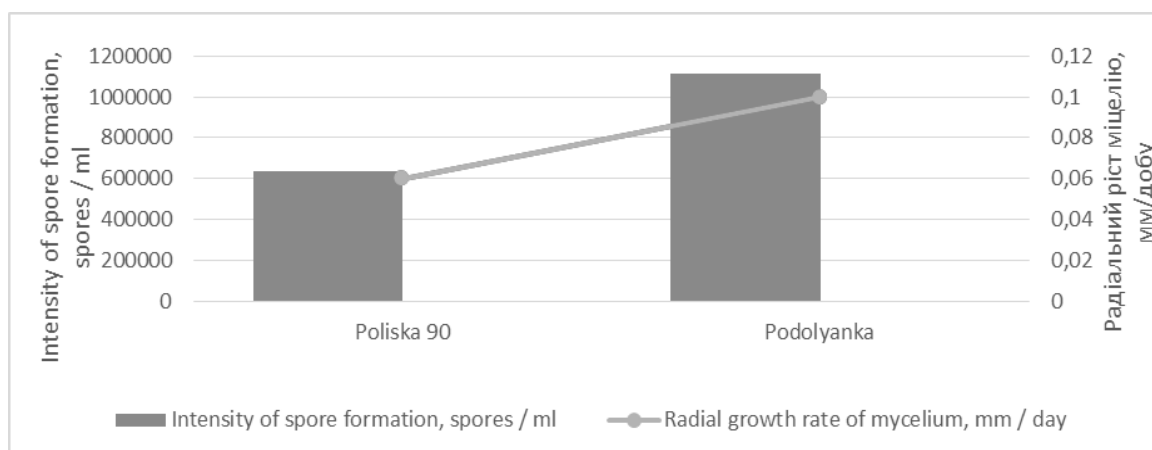


Fig. 2. Spore intensity and radial growth rate of a micromycete of the *Alternaria Nees* genus.

nus *Alternaria* under the influence of the Poliska 90 and Podolyanka winter wheat varieties. On the seeds of Podolyanka variety the intensity of genus *Alternaria* micromycetes spore formation was high and amounted to 1.1 million spores/ml. It is known that 100 % of crops are damaged at optional parasitic conidia fungi concentrations within 1 million pcs/ml (Geshele, 1954). Therefore, the Podolyanka seeds are able to stimulate the fungi spore formation, which can contribute to the epiphytic development of the disease on winter wheat plants and result in biological contamination of agroecosystems. At the same time, the intensity of spore formation was almost twice lower on the Poliska 90 variety seeds. This gives reason to believe that the physiological and biochemical mechanisms of the Poliska 90 crops are able to restrain the intensity of micromycetes spore formation of the genus *Alternaria* at an environmentally safe level (Fig. 2).

Were studied the quality indicators winter wheat sowing varieties Poliska 90 and Podolyanka, grown by organic technology (Fig. 3).

The results presented in Figure 3 show that the Podolyanka and Poliska 90 winter wheat varieties seeds are characterized by low protein content (7–9 %) and high humidity (12.5 %). By raw gluten content, they belong to the quality group 3, in accordance with the requirements of DSTU 3768: 2019 "Winter processing. Specifications". Fungi *Alternaria* isolates developed intensively on the Podolyanka winter wheat variety grain, which is characterized by low protein and gluten content. However, the development of the fungi was significantly lower on the Poliska 90 variety grain, which is characterized by a slightly higher content of protein and gluten. The development of saprophytic mycoflora, including the genus *Alternaria* fungi on the winter wheat grain is known [35] to contribute to poor yields and deterioration of grains technological qualities.

Thus, system-ecological approach to the improvement of agroecosystems in organic farming is possible through the use indicators of interaction physiological and biochemical properties of

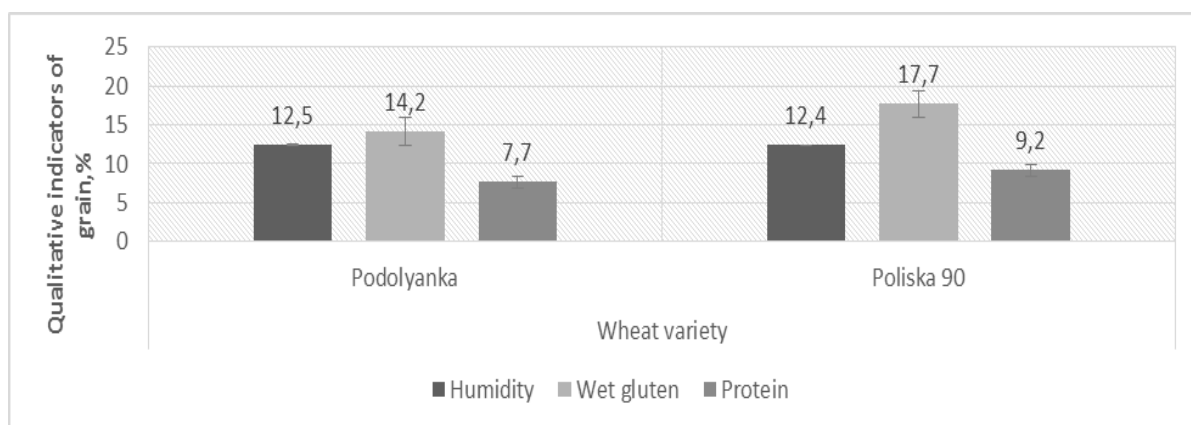


Fig. 3. Indicators of Poliska 90 and Podolyanka winter wheat varieties grain quality.

the variety with physiological properties of phytopathogenic fungi, namely intensity sporulation and speed radial growth mycelial. This will make it possible to obtain ecological clean and safe crop products using organic technologies cultivation.

Conclusions. Mycobiota of Podolyanka and Poliska 90 winter wheat varieties seeds is represented mainly by genera *Alternaria*, *Fusarium*, *Penicillium*, *Aspergillus*, *Chaetomium*, *Trichothecium* fungi. They are characterized by various levels of pathogenicity, depending on the physiological and biochemical properties of the host variety. Significant increase in air temperature above +24 °C and relative humidity 95–97 % during the wheat flowering and milking stage of grain ripeness contributed to spreading of micromycetes of the genus *Alternaria* Nees., wh (50 %). The seeds affected by fungi *Alternaria* were physiologically underdeveloped, had low germination energy which averaged 40 %. Plants from such seeds lag behind in growth and development.

The physiological and biochemical mechanism of the Podolyanka winter wheat variety stimulates mycelium radial growth and intensity of fungi *Alternaria* culture sporulation, which contributes to the contamination of agrophytocenoses by propagative structures the pathogen. However, the intensity of spore formation and the rate of mycelium radial growth on Poliska 90 variety seeds, was significantly lower. This fact gives reason to believe that the physiological and biochemical mechanism of the Poliska 90 variety plants is able to restrain the intensity of the genus *Alternaria* micromycetes spore formation at an ecologically safe level.

The Podolyanka and Poliska 90 winter wheat varieties seeds are characterized by low protein content (7–9 %) and high humidity (12.5 %). According to the content of raw gluten, they belong to the third quality group, in accordance with the requirements of DSTU 3768: 2019 "Winter processing. Specifications". *Alternaria* fungi isolates more intensively developed on the Podolyanka winter wheat variety grain, which is characterized by a lower content of protein and gluten.

System-ecological approach to the improvement of agroecosystems in organic farming can be carried out using indicators of the variety physiological and biochemical properties interaction with physiological properties of phytopathogenic fungi, namely sporulation intensity and mycelial radial growth rate. This will ensure phytosanitary optimization of agroecosystems considering the laws of interaction of plants and micromycetes, without disturbing the biological balance, which will further create stable ecosystems in winter wheat agrophytocenoses, and thus reduce their biological and chemical pollution.

LIST OF REFERENCES

1. Dankevych Ye., Dankevych V., Chaikin O. Ecologically certified agricultural production management system development. Agricultural and Resource Economics. 2016. Vol. 2. № 4. С. 5–16.
2. Фурдичко О.І. Агроєкологія – фундаментальна основа формування збалансованої агросфери. Агроєкологічний журнал. 2014. № 3. С. 7–13.
3. Маркелова Т.С. Фитосанитарная ситуация в агроценозе злаковых культур Поволжья. Защита и карантин растений. 2015. № 5. С. 22–23.
4. Дьяков Ю.Т. Инвазии фитопатогенных грибов. М.: URSS, 2018. 260 с.
5. Мостов'як І.І., Дем'янюк О.С., Бородай В.В. Особливості формування фітопатогенного фону мікроміцетів – збудників хвороб в агроценозах зернових злакових культур Правобережного Лісостепу України. Агроєкологічний журнал. 2020. № 1. С. 28–38.
6. Соколова Г.Д. Патогенность *Fusarium graminearum*, *F. culmorum* и резистентность зерновых культур. Микология и фитопатология. 2005. Т. 39. Вып. 5. С. 1–11.
7. Dighton J. Fungi in ecosystem processes. Marcel Dekker Inc. 2003. P. 22–26.
8. Gilbert J., Haber S. Overview of some recent research developments in fusarium head blight of wheat. Plant Pathol. 2013. Vol. 35. P. 149–174.
9. Сільськогосподарська фітопатологія / Марков І.Л. та ін. К.: Інтерсервіс, 2017. 574 с.
10. Replacement of the European wheat yellow rust population by new races from the centre of diversity in the near-Himalayan region / Hovmoller M.S. et al. Plant Pathol. 2015. Vol. 65. P. 402–411.
11. Голячук Ю. Розвиток основних грибних хвороб пшениці озимої в умовах Навчально-науково-дослідного центру Львівського національного аграрного університету. Вісник Львівського національного аграрного університету. 2015. № 19. С. 165–168.
12. Швартау В.В., Михальська Л.М., Зозуля О.Л. Поширення фузаріозів в Україні. Агроном. 2017. № 4. С. 40–43.
13. Левитин М.М. Изменение климата и прогноз развития болезней растений. Микология и фитопатология. 2012. № 46. С. 14–19.
14. Мікози зерна пшениці озимої / Ретьман С.В. та ін. Карантин і захист рослин. 2018. № 11–12. С. 1–3.
15. Маркевич И.М., Буштевич В.Н. Результаты изучения исходного материала для селекции яровой мягкой пшеницы в условиях Беларуси. Земледелие и селекция в Беларуси. 2013. Вып. 49. С. 282–291.
16. A 1BL/1RS translocation contributing to kernel length increase in three wheat recombinant inbred line populations / Li S.Q. et al. Czech J. Genet. Plant Breed. 2020. 56. P. 43–51. DOI: <https://doi.org/10.17221/79/2019-CJGPB>
17. Cytological and molecular characterization of *Thinopyrum bessarabicum* chromosomes and structural rearrangements introgressed in wheat / Jianyong Chen et al. Molecular Breeding. 2019. 39. P. 10–11. DOI: <https://doi.org/10.1139/gen-2016-0095>
18. Lacko-Bartocova M., Otepka P. Evaluation of chosen yield components of spelt wheat cultivars. J. Central Eur. Agric. 2001. № 2. P. 279–284.

19. Парфенюк А.І. Методологічні підходи до оцінювання сорту рослин за стійкістю до фітопатогенних грибів та впливом на інтенсивність утворення їх пропагул. Агроєкологічний журнал. 2012. № 3. С. 90–93.
20. Парфенюк А.І. Сорти сільськогосподарських культур, як фактор біоконтролю фітопатогенних мікроорганізмів в агрофітоценозах. Агроєкологічний журнал. 2009. С. 248–250.
21. Парфенюк А.І. Сорт рослин як чинник біологічної безпеки в агроценозах України. Агроєкологічний журнал. 2017. № 2. С. 155–163.
22. Екологічне оцінювання культурних рослин за впливом на формування популяцій фітопатогенних грибів: методичні рекомендації / Парфенюк А.І. та ін. Київ, 2015. 40 с.
23. ДСТУ 4138-2002. Насіння сільськогосподарських культур. Методи визначення якості. [Чинний від 2004.01.01]. Вид. офіц. К.: Держспоживстандарт України, 2003. 173 с.
24. ДСТУ 2240-93. Насіння сільськогосподарських культур. Сортові та посівні якості: технічні умови. [Чинний від 1997.07.01]. Вид. офіц. К.: Держстандарт України, 1994. 73 с.
25. Билай В.І. Методы экспериментальной микологии. К.: Наукова думка, 1982. 550 с.
26. Пидопличко Н.М., Милько А.А. Атлас мукоровых грибов. К.: Наук. думка, 1971. 115 с.
27. Пидопличко Н.М. Грибы-паразиты культурных растений: определитель в 3-х т. К.: Наук. думка. Т. 1. 1977. 295 с.; Т. 2. 1977. 299 с.; Т. 3. 1978. 230 с.
28. Kirk P.M., Cannon P.F., Davidand P.M. Ainsworth hand Bisbys Dictionary of the Fungi. Wallingford: CAB International. 2001. P. 655–656.
29. Мирчинк Т.Г. Почвенная микология. М.: Изд-во МГУ, 1988. 205 с.
30. Петюх Г.П. Визначення стимуляції росту діазотрофних бактерій ексудатами проростків ячменю: метод. рекомендації. К.: ЛОГОС, 2004. 13 с.
31. Лемеза Н.А. Имунитет растений: практикум для студентов биол. фак. Минск: БГУ, 2008. 96 с.
32. Методы экспериментальной микологии / Дудка И.А. и др. К.: Наукова думка, 1982. 548 с.
33. Казаков Е.Д. Методы оценки качества зерна. М.: Агропромиздат, 1987. 215 с.
34. ДСТУ 3768:2019. Пшениця. Технічні умови [Чинний від 2019.07.13]. Вид. офіц. Київ: ДП "Укр НДНЦ", 2019. 19 с.
35. Волощук О.П., Воробйова Ю.В. Зниження хіміко-технологічних показників якості зерна сортів пшениці озимої під впливом ензимо-мікозного виснаження зерна. Передгірне та гірське землеробство і тваринництво. 2011, Вип. 53 (II). С. 17–22.
3. Markelova, T.S. (2015). Fitosanitarnaya situatsiya v agrotsenoze zlakovykh kultur Povolzhya [Phytosanitary Situation in the Agrocenosis of Grain Crops of the Volga Region]. Zashchita i karantin rasteniy [Plant protection and quarantine], no. 5, pp. 22–23.
4. Dyakov, YU.T. (2018). Invazii fitopatogennykh gribov [Invasions of phytopathogenic fungi]. Moscow, URSS, 260 p.
5. Mostovyak, I.I., Demyanyuk, O.S., Boroday, V.V. (2020). Osoblyvosti formuvannya fitopatohennoho fonu mikromitsetiv – zbudnykiv khvorob v ahrotsenozakh zernovykh zlakovykh kultur Pravoberezhnoho Lisostepu Ukrainy [Peculiarities of phytopathogenic background formation of micromycetes – pathogens in agrocenoses of grain cereals of the Right-Bank Forest-Steppe of Ukraine]. Ahroekolohichnyy zhurnal [Agroecological journal], no. 1, pp. 28–38.
6. Sokolova, G.D. (2005). Patogennost *Fusarium graminearum*, *F. culmorum* i rezistentnost zernovykh kultur [Pathogenicity of *Fusarium graminearum*, *F. culmorum* and resistance of cereals]. Mikologiya i fitopatologiya [Mycology and phytopathology]. Vol. 39, Issue 5, pp. 1–11.
7. Dighton, J. (2003). Fungi in ecosystem processes. Marcel Decker Inc. pp. 22–26.
8. Gilbert, J., Haber, S. (2013). Overview of some recent research developments in fusarium head blight of wheat. Plant Pathol. Vol. 35, pp. 149–174.
9. Markov, I.L., Bashta, O.V., Hentosh, D.T. (2017). Silskohospodarska fitopatologiya [Agricultural phytopathology]. Kyiv, Interservis, 574 p.
10. Hovmoller, M.S., Walter, S., Bayles, R.A. (2015). Replacement of the European wheat yellow rust population by new races from the centre of diversity in the near-Himalayan region. Plant Pathol. Vol. 65, pp. 402–411. Available at: <https://doi.org/10.1111/ppa.12433>
11. Holyachuk, Y.U. (2015). Rozvytok osnovnykh hrybnykh khvorob pshenytsi ozymoyi v umovakh Navchalno-naukovodoslidnoho tsentru Lvivskoho natsionalnoho aharnoho universytetu [Development of the main fungal diseases of winter wheat in the conditions of the Educational and Research Center of Lviv National Agrarian University]. Visnyk Lvivskoho natsionalnoho aharnoho universytetu [Bulletin of Lviv National Agrarian University], no. 19, pp. 165–168.
12. Shvartau, V.V., Mykhalska, L.M., Zozulya, O.L. (2017). Poshyrennya fuzarioziv v Ukraini [Distribution of fusarium wilt in Ukraine]. Ahronom [Agronomist], no. 4, pp. 40–43.
13. Levitin, M.M. (2012). Izmeneniye klimata i prognoz razvitiya bolezney rasteniy [Climate change and forecast of development of plant diseases]. Mikologiya i fitopatologiya [Mycology and phytopathology], no. 46, pp. 14–19.
14. Retman, S.V., Kyslykh, T.M., Shevchuk, O.V. (2018). Mikozy zerna pshenytsi ozymoyi [Mycoses of winter wheat grain]. Karantyn i zakhyst Roslyn [Quarantine and plant protection], no. 11–12, pp. 1–3.
15. Markevich, I.M., Bushtevich, V.N. (2013). Rezultaty izucheniya iskhodnogo materiala dlya seleksii yarovoy myagkoy pshenitsy v usloviyakh Belarusi [Results of the study of the source material for the selection of spring soft wheat in the conditions of Belarus]. Zemledeliye i selektsiya v Belarusi [Agriculture and breeding in Belarus]. Issue 49, pp. 282–291.
16. Li, S.Q., Tang, H.P., Zhang, H., Mu, Y., Lan, X.J., Ma, J. (2020). A 1BL/1RS translocation contributing to ker-

REFERENCES

1. Dankevych, Ye., Dankevych, V., Chaikin O. (2016). Ecologically certified agricultural production management system development. Agricultural and Resource Economics. Vol. 2, no. 4, pp. 5–16.
2. Furdychko, O.I. (2014). Ahroekolohiya – fundamentalna osnova formuvannya zbalansovanoi ahrosfery [Agroecology is the fundamental basis for the formation of a balanced agrosphere]. Ahroekolohichnyy zhurnal [Agroecological journal], no. 3, pp. 7–13.

nel length increase in three wheat recombinant inbred line populations. Czech J. Genet. Plant Breed. no. 56, pp. 43–51. Available at: <https://doi.org/10.17221/79/2019-CJGPB>

17. Jianyong, Chen, Yuqing, Tang, Lesha, Yao, Hao, Wu, Xinyu, Tu, Lifang, Zhuang, Zengjun, Qi. (2019). Cytological and molecular characterization of *Thinopyrum bessarabicum* chromosomes and structural rearrangements introgressed in wheat. Molecular Breeding. no. 39, pp. 10–11. Available at: <https://doi.org/10.1139/gen-2016-0095>

18. Lacko-Bartocova, M., Otepka, P. (2001). Evaluation of chosen yield components of spelt wheat cultivars. J. Central Eur. Agric. no. 2, pp. 279–284.

19. Parfenyuk, A.I. (2012). Metodologichni pidkhody do otsinyuvannya sortu roslin za stiykisty do fitopatohennykh hrybiv ta vplyvom na intensyvni utvorennia yikh propahul [Methodological approaches to the evaluation of plant varieties for resistance to phytopathogenic fungi and the impact on the intensity of their propagating]. Ahroekologichnyy zhurnal [Agroecological journal], no. 3, pp. 90–93.

20. Parfenyuk, A.I. (2009). Sorty silskohospodarskykh kultur, yak faktor biokontrolyu fitopatohennykh mikroorganizmiv v ahrofitotsenozakh [Crop varieties as a factor of biocontrol of phytopathogenic microorganisms in agrophytocenoses]. Ahroekologichnyy zhurnal [Agroecological journal], pp. 248–250

21. Parfenyuk, A.I. (2017). Sort roslin yak chynnyk biolohichnoyi bezpeky v ahrofitotsenozakh Ukrayiny [Plant variety as a factor of biological safety in agroecosystems of Ukraine]. Ahroekologichnyy zhurnal [Agroecological journal], no. 2, pp. 155–163.

22. Parfenyuk, A.I., Horhan, T.M., Sterlikova, O.M., Beznosko, I.V. (2015). Ekologichne otsinyuvannya kul'turnykh roslin za vplyvom na formuvannya populatsiy fitopatohennykh hrybiv: metodychni rekomendatsiyi [Ecological assessment of cultivated plants by influence on the formation of populations of phytopathogenic fungi]. Kyiv, 40 p.

23. DSTU 4138-2002. Nasinnya silskohospodarskykh kultur. Metody vyznachennya yakosti. [Chynnyy vid 2004.01.01] [DSTU 4138-2002. Seeds of agricultural crops. Methods for determining quality. [Effective from 01.01.2004]]. Kyiv, Derzhspozhyvstandart of Ukraine, 2003, 173 p.

24. DSTU 2240-93. Nasinnya silskohospodarskykh kultur. Sortovi ta posivni yakosti: tekhnichni umovy. [Chynnyy vid 1997.07.01] [DSTU 2240-93. Seeds of agricultural crops. Varietal and sowing qualities: technical conditions. [Effective from 07.01.1997]]. Kyiv, Derzhspozhyvstandart of Ukraine, 1994, 73 p.

25. Bilay, V.I. (1982). Metody eksperimentalnoy mikologii [Experimental mycology methods]. Kyiv, Scientific thought, 550 p.

26. Pidoplichko, N.M., Milko, A.A. (1971). Atlas mukorovykh gribov [Atlas of mucor mushrooms]. Moscow, Scientific Thought, 115 p.

27. Pidoplichko, N.M. (1977, 1978). Griby-parazyty kul'turnykh rastenyi [Parasitic fungi of cultivated plants]. Moscow, Scientific Thought, Vol. 1, 295 p., Vol. 2, 299 p., Vol. 3, 230 p.

28. Kirk, P.M., Cannon, P.F., Davidand, P.M. (2001). Ainsworth and Bisby's Dictionary of the Fungi. Wallingford: CAB International. pp. 655–656.

29. Mirchink, T. (1988). Pochvennaya mikologiya [Soil mycology]. Moscow, Publishing House MGU, 205 p.

30. Petyukh, H.P. (2004). Vyznachennya stymulyatsiyi rostu diazotrofnnykh bakteriy eksudatamy prorstokiv yachmenyu: metod. rekomendatsiyi [Determination of stimulation of growth of diazotrophic bacteria by exudates of barley seedlings]. Kyiv, LOHOS, 13 p.

31. Lemeza, N.A. (2008). Immunitet rastenyi: praktikum dlya studentov biol. fak. [Plant immunity]. Minsk, BGU, 96 p.

32. Dudka, I.A., Vasser, S.P., Ellanskaya, I.A. (1982). Metody eksperimentalnoy mikologii [Experimental mycology methods]. Kyiv, Scientific Thought, 548 p.

33. Kazakov, Ye.D. (1987). Metody otsenki kachestva zerna [Grain quality assessment methods]. Moscow, Agropromizdat, 215 p.

34. DSTU 3768:2019. Pshenytsya. Tekhnichni umovy [Chynnyy vid 2019.07.13]. Vyd. ofits. [DSTU 3768: 2019. Wheat. Technical conditions [Effective from 2019.07.13]]. Kyiv, DP "Ukr NDNTS", 2019, 19 p.

35. Voloshchuk, O.P., Vorobyova, YU.V. (2011). Znyzhennya khimiko-tekhnolohichnykh pokaznykiv yakosti zerna sortiv pshenytsi ozymoiy pid vplyvom enzy-mo-mikoznoho vysnazhennya zerna [Reduction of chemical-technological indicators of grain quality of winter wheat varieties under the influence of enzymatic-mycosis depletion of grain]. Peredhirne ta hirs'ke zemlerobstvo i tvarynnystvo [Foothill and mountain agriculture and animal husbandry]. Issue 53 (II), pp. 17–22.

Екологічне значення сортів пшениці озимої у фітосанітарній оптимізації агроєкосистем

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Мікобіота насіння пшениці озимої сортів Подолянка і Поліська 90 представлена переважно грибами родів: *Alternaria*, *Fusarium*, *Penicillium*, *Aspergillus*, *Chaetomium*, *Trichothecium*, що характеризуються різним рівнем патогенності, залежно від фізіолого-біохімічних властивостей сорту-живителя. Значне підвищення температури повітря і відносної вологості в період цвітіння пшениці і молочної спілості зерна сприяло поширенню мікроміцетів роду *Alternaria* Nees. (50 %). Насіння, уражене альтернаріозом, було фізіологічно недорозвинене, мало низьку енергію проростання і схожість, що становила в середньому 40 %. Рослини з такого насіння відставали у рості і розвитку.

Встановлено, що фізіолого-біохімічний механізм рослин сорту пшениці озимої Подолянка стимулює радіальний ріст міцелію та інтенсивність споруляції культур гриба *Alternaria*. Це свідчить про швидке розмноження мікроміцетів, що спричиняє забруднення агрофітоценозів пропативними структурами патогену. Водночас, на насінні сорту Поліська 90 інтенсивність споруутворення і швидкість радіального росту міцелію була істотно нижчою. Це дає підстави вважати, що фізіолого-біохімічний механізм рослин сорту Поліська 90 здатний стримувати інтенсивність споруутворення мікроміцету роду *Alternaria* на екологічно безпечному рівні.

Доведено, що насіння сортів пшениці озимої Подолянка та Поліська 90 характеризується низьким вмістом білка та високою вологістю. За вмістом сирої клейковини вони належать до третьої групи якості. Ізоляти грибів роду *Alternaria* інтенсивніше розвивалися на зерні пше-

ниці озимої сорту Подолянка, яке характеризується нижчим вмістом білка і клейковини. Водночас, на зерні сорту Поліська 90, яке характеризується дещо вищим вмістом білка і клейковини, розвиток грибів був істотно нижчим.

Системно-екологічний підхід до оздоровлення агро-екосистем в умовах органічного землеробства можливий завдяки використанню показників взаємодії фізіолого-біохімічних властивостей сорту із фізіологічними властивостями фітопатогенних грибів, а саме інтенсивність споруляції та швидкість радіального росту мицелію. Це дасть змогу підвищити рівень біобезпеки в агроекосистемах та покращить якість рослинної сировини.

Ключові слова: частота трапляння, радіальний ріст мицелію, інтенсивність споруляції, фітосанітарна оптимізація, агрфітоценози пшениці озимої.

Экологическое значение сортов пшеницы озимой в фитосанитарной оптимизации агроэкосистем

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Микобиота семян пшеницы озимой сортов Подолянка и Полесская 90 представлена грибами родов: *Alternaria*, *Fusarium*, *Penicillium*, *Aspergillus*, *Chaetomium*, *Trichothecium*, характеризующимися различным уровнем патогенности, в зависимости от физиолого-биохимических свойств сорта-хозяина. Значительное повышение температуры воздуха и относительной влажности в период цветения пшеницы и молочной спелости зерна способствовало распространению микромицетов рода *Alternaria* Nees. (50 %). Семена, пораженные грибами родов *Alternaria*, были физиологически недоразвитыми, имели низкую энергию прорастания и всхожесть, которая составляла в среднем 40 %. Растения из таких семян отставали в росте и развитии.

Установлено, что физиолого-биохимический механизм растений сорта пшеницы озимой Подолянка сти-

мулирует радиальный рост мицелия и интенсивность споруляции культур гриба *Alternaria*. Это свидетельствует о скором размножения микромицетов, что способствует загрязнению агрофитоценозов propagативными структурами патогена. В то же время, на семенах сорта Полесская 90 интенсивность спорообразования и скорость радиального роста мицелия была существенно ниже. Это дает основания полагать, что физиолого-биохимический механизм растений сорта Полесская 90 способен сдерживать интенсивность спорообразования микромицетов рода *Alternaria* на экологически безопасном уровне.

Доказано, что семена сортов пшеницы озимой Подолянка и Полесская 90 характеризуются низким содержанием белка и высокой влажностью. По содержанию сырой клейковины они принадлежат к третьей группе качества. Изоляты грибов рода *Alternaria* интенсивнее развивались на зерне пшеницы озимой сорта Подолянка, характеризующимся низким содержанием белка и клейковины. В то же время, на зерне сорта Полесская 90, характеризующимся несколько более высоким содержанием белка и клейковины, развитие грибов было существенно ниже.

Системно-экологический подход к оздоровлению агроэкосистем в условиях органического земледелия возможен за счет использования показателей взаимодействия физиолого-биохимических свойств сорта с физиологическими свойствами фитопатогенных грибов, а именно интенсивность споруляции и скорость радиального роста мицелия. Это позволит повысить уровень биобезопасности в агроэкосистемах и улучшить качество растительного сырья.

Ключевые слова: частота встречаемости, радиальный рост мицелия, интенсивность споруляции, фитосанитарная оптимизация, агрфітоценози пшениці озимої.



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