

1 Proceedings

 2 **Complex of barley leaf spots in Ukraine †**

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 13

 14 **Abstract:** Barley is one of the most important cereal crops globally. In Ukraine it is grown on an
 15 area of 2.4–2.8 million hectares annually and is the second largest grain crop in Ukraine after wheat.
 16 Barley grain export is about 4.3 million tons p.a. At the same time, one of the limiting factors for
 17 obtaining a high-quality yield are diseases, in particular, leaf spots. In recent decades, there have
 18 been significant changes in the technology of cultivation, the composition of varieties and the
 19 pathogenic complex. Net blotch (*Pyrenophora teres* Drechsler) in net and spot forms and spot blotch
 20 (*Bipolaris sorokiniana* Shoem.) remain the most common among the diseases of barley leaves. They
 21 occur in all regions where barley is grown. Barley scald (*Rhynchosporium secalis* (Oudem.) Davis) is
 22 distributed mainly in Forest and Western part of Forest-Steppe zones and has become more
 23 widespread in years with rainy summers. Outbreaks of stripe spot (*Pyrenophora graminea* S. Ito &
 24 Kurib.) occur sporadically. Ascochyta leaf spot (*Ascochyta* spp.) was found in Lviv and Dnipropetrovsk
 25 regions in 2020, and in Lviv, Donetsk and Zaporizhia regions in 2021. In the field, spots can
 26 be misdiagnosed as barley scald, so its prevalence can be much higher. In 2021 during seed ripening
 27 period, ramularia leaf spot was found in Kherson and Vinnytsia regions. The disease was di-
 28 agnosed in the laboratory by obtaining a typical conidial sporulation of the fungus *Ramularia col-*
 29 *lo-cygni* B. Sutton & J.M. Waller on affected tissues (wet chamber). So, last years the composition of
 30 the barley leaf spot pathogens has become wider and needs further investigation.

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 31 **Keywords:** barley; leaf disease complex; emerging pathogens

 33 **1. Introduction**

 34 Barley is one of the most important cereal crops globally. In Ukraine it is grown on
 35 area of 2.4–2.8 million hectares annually and is the second largest grain crop in Ukraine
 36 after wheat. Both winter and spring barley are grown in Ukraine. The area of spring
 37 barley is 1.3–1.6 million hectares, winter - 1.0 - 1.2 million hectares. Barley grain export is
 38 about 4.3 million tons p.a.

 39 Diseases are one of the limiting factors for obtaining a high-quality yield of barley.
 40 The most noticeable effect is observed in the case of leaf spots. In almost all regions of
 41 barley cultivation in the world the most common and harmful is net blotch caused by
 42 *Pyrenophora teres* Drechsler [1, 2, 3, 4]. Direct crop losses can reach 10–40% [3, 4, 5], also it
 43 causes grain quality loss [5]. Manifestation of the disease can be as typical (net) form, in
 44 the case of *P. teres* f. *teres*, and as spot form, in the case of *P. teres* f. *maculata* [3].

 45 Stripe blotch (*Pyrenophora graminea* S. Ito & Kurib) and spot blotch (*Bipolaris soro-*
 46 *kiniana* Shoemaker) also belong to the complex of diseases that have historically been

called helminthosporium spots [3]. Scald, along with net blotch is one of the most common and harmful diseases of barley in the world [6, 7]. Ramularia leaf spot become an important disease of barley in Europe, Canada, South America and New Zealand [8, 9, 10]. It can cause yield losses of up to 20% [10]. Other leaf spots that occur sporadically include septoria leaf blotch (*Phaeosphaeria nodorum* (E. Müll.) Hedjar, *Stagonospora avenae* f.sp. *tritici* Bissett, *Septoria passerinii* Sacc.) [11] and ascochyta leaf spot (*Ascochyta hordei* Hara, *Ascochyta graminea* (Sacc.) R. Sprague & Aar.G. Johnson) [3, 12].

In recent decades, there have been significant changes in the technology of cultivation, composition of varieties, climate conditions and the pathogenic complex. The aim of our investigations was to determine the composition and ratio of barley leaf spots in Ukraine.

Materials and Methods

Surveys of barley crops and selection of plant material were conducted in 24 regions of Ukraine in 2020-2021 during the flowering period - milk ripeness. At four points in the field, 100 leaves with symptoms of lesions were collected. They were labeled, stored in paper bags and transported to the laboratory. The material was examined in the laboratory by microscopy. The proportion of each disease was determined based on its incidence.

In order to identify the pathogen of ramularia leaf spot, segments of leaf with symptoms were placed in a humid chamber [13] and maintained in a thermostat at a temperature 24°C.

Results and Discussion

The maximum manifestation of the complex of spots was observed in the period of flowering-wax ripeness. Symptoms of ramularia leaf spot were observed from the period of grain filling.

Net blotch prevailed among the barley leaf spots (Fig. 1). Its share ranges from 31 to 78%. The incidence of the disease under favorable weather conditions reached 100%. The maximum manifestation was observed in the central regions. Both the typical manifestation of the disease (net form) and lenticular spots (spot form) were noted. The symptoms characteristic for *P. teres* f. *teres* prevailed.

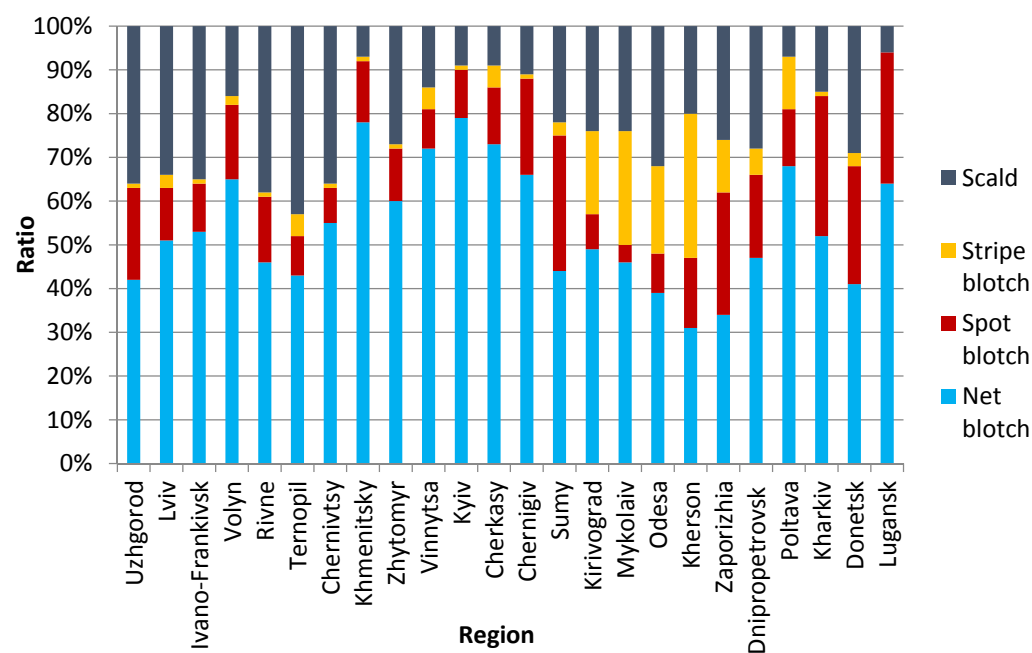


Figure 1. The ratio of the main barley leaf spots in Ukraine (2020-2021).

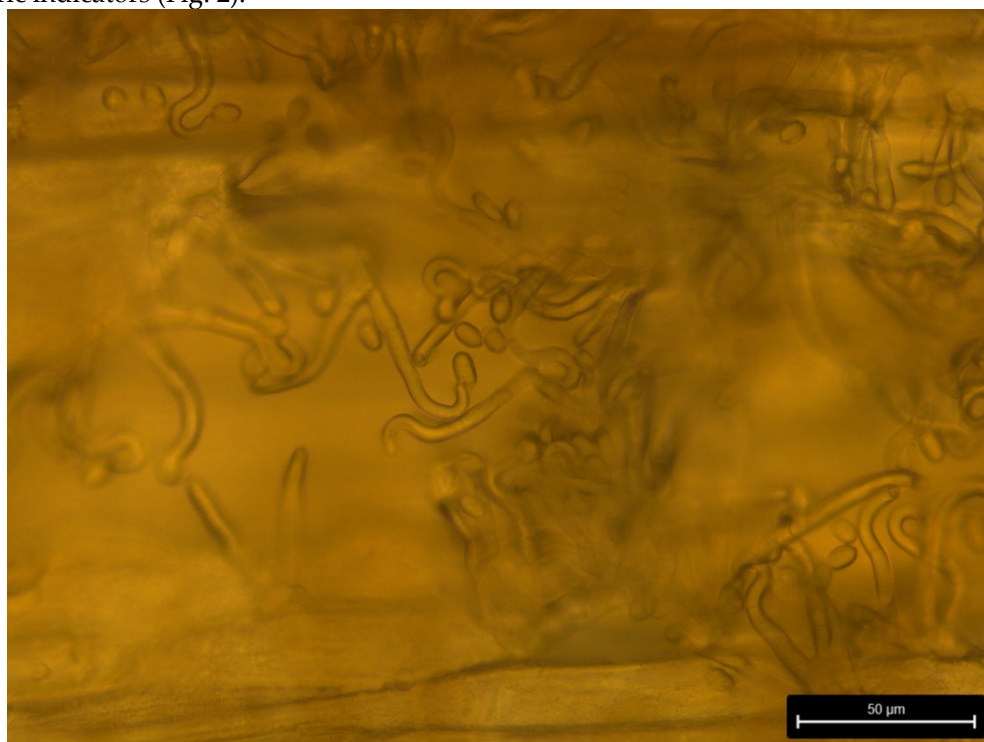
1 The share of spot blotch ranged from 4 to 32%. The highest rates were found in the
2 northern and eastern regions of Ukraine.

3 Outbreaks of stripe blotch were observed in the southern regions, where the pro-
4 portion of the disease was 12-33%. In the rest of the regions, it was either not found or did
5 not exceed 3%.

6 In recent years, there has been an increase in the incidence and severity of scald. The
7 disease was found everywhere, but it was most common in Polissya and the western re-
8 gions of the Forest-Steppe of Ukraine, especially in the rainy summer. The proportion of
9 the disease ranges from 6 to 43%.

10 During 2020-2021, the spread of ascochyta leaf spot was detected. In 2020, the dis-
11 ease was detected in Lviv and Dnipropetrovsk regions, and in 2021 - in Lviv, Donetsk
12 and Zaporizhia regions. In the field, its symptoms can be misdiagnosed as scald. Spots
13 had light center and were rounded or irregularly shaped, with a dark brown border and
14 more or less noticeable pycnidia. The size of the pycnidia was 110.1-171.4 x 91.3-134.2
15 μm , pycnospores - 14.6-19.4x5.2-6.3 μm .

16 During the ripening period in 2021, barley was affected by ramularia leaf spot in
17 Kherson and Vinnytsia regions. Small brown spots were found on both sides of the leaf
18 blades, in addition, symptoms were observed on stems, ears and spikes. Microscopy re-
19 vealed the mycelium of fungi that penetrated the tissues. After keeping in a humid
20 chamber for 12-16 hours, it was possible to observe the formation of conidiophores,
21 which came out of the stomata in bundles and had a characteristic curve resembling a
22 swan's neck. The fungus was identified as *R. collo-cygni* on a set of morphological and
23 metric indicators (Fig. 2).



24
25 **Figure 2.** Conidiophores and conidia of *R. collo-cygni*.
26

27 So, barley plants in Ukraine are affected by net blotch, stripe blotch, spot blotch,
28 scald, ascochyta leaf spot, ramularia leaf spot. Net blotch is the most common among the
29 barley leaf spots. It was found in all regions and its incidence was higher

30 Ascochyta leaf spot is considered a minor disease of barley [3]. There are few reports
31 of its spread, but the disease importance may be underestimated. As it is evidenced by
32 the results of our observations, the main problem for identification is that in the field its
33 symptoms can be misdiagnosed as scald. Other researchers noted the similarity of asco-

chyta leaf spot to other necrotrophic foliar pathogens or frost injury [12, 14], what can lead to underestimating of the disease incidence.

Ramularia leaf spot occurs sporadically. Previously this disease was recorded in the northern and northeastern regions (Chernihiv, Sumy, Kharkiv, Luhansk) of Ukraine [15]. This is a late-season disease. It may be asymptomatic during the season and then cause fast premature leaf senescence [8, 10]. In our investigations symptoms appeared during seed ripening period when the window for fungicide application is closed. Also in the field it can be confused with symptoms caused by other pathogens or abiotic factors [8-10], therefore, it is difficult to determine the actual spread of the disease.

Conclusion

In Ukraine, net blotch is the most widespread leaf spot disease of barley. However, attention needs to be paid to the new diseases such as ramularia leaf spot and ascochyta leaf spot, which can be threatening. The species composition of the causative agents of ascochyta leaf spot requires further investigations.

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