

# Monitoring of Leaf and Berry Diseases of Strawberry <sup>†</sup>

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<sup>†</sup> Presented at the 1st International Electronic Conference on Horticulturae, 16–30 Apr 2022; Available online: <https://iecho2022.sciforum.net/>.

**Abstract:** Strawberry (*Fragaria ananassa* Duch.) is valuable for its high taste, nutritional, medicinal and dietary properties of the fruits. Strawberries are the first to open the season of fresh berries. They are especially rich in sugars, organic acids, pectin, vitamins and mineral elements. The total area of strawberry plantations in Ukraine, according to the State Statistics Service, is 8200 ha. The average yield reaches 6.9 tons/ha. In order to develop an effective disease protection system, it is necessary to detect and diagnose the disease in time. An assessment of disease spread and severity was conducted in 2020–2021 in the Right Bank Forest-Steppe of Ukraine. The most common diseases were gray mold (*Botrytis cinerea* Pers.), leaf scorch (*Diplocarpon earlianum* (Ellis & Everh.) F.A. Wolf), powdery mildew (*Podosphaera aphanis* (Wallr.) U. Braun & S. Takam.), black spot (*Colletotricum acutatum* J.H. Simmonds), white leaf spot (*Ramularia grevilleana* (Tul. & C. Tul. ex Oudem.) Jørst.). On strawberry plantations, diseases appeared in the following order: gray mold, white leaf spot, powdery mildew, black spot, leaf scorch. The most spread and the most harmful were gray mold, white leaf spot and leaf scorch.

**Keywords:** strawberry; disease complex; harmfulness; dynamics

**Citation:** Mykhailenko, S.; Dzham, M.; Shevchuk, O.; Afanasieva, O. Monitoring of Leaf and Berry Diseases of Strawberry. *Biol. Life Sci. Forum* **2022**, *1*, x.

<https://doi.org/10.3390/xxxxx>

Academic Editor(s):

Published: 16 April 2022

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## 1. Introduction

Strawberry (*Fragaria ananassa* Duch.) is valuable for its high taste, nutritional, medicinal and dietary properties of the fruits, which are consumed fresh and processed. In Ukraine, strawberries are the first to open the season of fresh berries. They are especially rich in sugars, organic acids, pectin, vitamins (C, PP, B<sub>2</sub>, B<sub>9</sub>, E, K) and mineral elements (K, P, Ca, Mg, Na, Fe, I). The total area of strawberry plantations in Ukraine, according to the State Statistics Service, is 8200 ha. The average yield reaches 6.9 tons/ha [1].

Numerous pests and diseases cause significant damage to strawberries. The most widespread worldwide diseases of strawberry are black spot (*Colletotricum acutatum* J.H. Simmonds), powdery mildew (*Podosphaera aphanis* (Wallr.) U. Braun & S. Takam.), gray mold (*Botrytis cinerea* Pers.), white leaf spot (*Ramularia grevilleana* (Tul. & C. Tul. ex Oudem.) Jørst.), leaf scorch (*Diplocarpon earlianum* (Ellis & Everh.) F.A. Wolf), phytophthora crown rot (*Phytophthora fragariae* var. *fragariae* Hickman), fusarium wilt (*Fusarium oxysporum* f. sp. *fragariae* Winks et Williams), brown spot (*Phomopsis obscurans* (Ellis & Everh.) B. Sutton) [2–7]. Reduction in yield due to the leaf diseases is from 12 to 92% [2,5,8]. Diseases cause general weakening of plants what leads to reduced yields in the next year [8]. Also, diseases cause significant losses in nurseries. As an example, due to the impact of white leaf spot on plant growth, the yield of standard seedlings in the nursery decreased by 45% [9].

In recent decades, there have been significant changes in the climate conditions which affected in the structure of phytopathogenic complexes. In order to develop an effective disease protection system, it is necessary to detect the diseases in time and establish

an optimal period for their control. The aim of our investigations was to determine the composition of leaf and berry diseases of strawberry in the Right Bank Forest-Steppe of Ukraine.

## 2. Materials and Methods

Regular observations were carried out in the Right Bank Forest-Steppe of Ukraine (Cherkassy region) in 2020–2021 on 2-years old plantations of cv. 'Clery'. Four fixed plots of 200 m<sup>2</sup> was selected. At 10 places in the plot, 10 plants were inspected (100 plants per plot). Disease incidence was determined according to following formula:

$$P = \frac{n}{N} 100$$

where  $P$ —disease incidence, %;  $n$ —number of plants with disease symptoms;  $N$ —total quantity of plants in assessment.

Severity of leaf diseases was measured as proportion of the leaf area visibly diseased. Disease severity of gray mold was estimated on a 0 to 4 scale [10], where 0 = no visible symptoms; 1 = up to 10% of fruits infected; 2 = 11–25% of fruits infected; 3 = 26–50% of fruits infected; 4 = more than 50% of fruits infected. The scale was converted to a percentage using the following formula:

$$R = \frac{\sum nb}{N \cdot K} 100$$

where  $R$ —disease severity, %;  $n$ —number of plants with disease symptoms;  $N$ —total quantity of plants in assessment;  $b$ —infection score;  $K$ —the highest score in scale.

Leaves with symptoms of disease were collected, labeled and stored in paper bags. The material was examined in the laboratory. Microscopy techniques were used for the assessment of symptoms detected on plant parts and for fungal sporulation. In order to identify the pathogens of gray mold, black spot and white leaf spot to stimulate mycelium growth and improve sporulation humid chamber was used. Segments of tissues with symptoms were washed with tap water, surface sterilized with 96% ethanol and rinsed twice with sterile water. Then they were placed in a humid chamber and maintained in a thermostat at a temperature 24 °C. Pathogens were identified by morphometrics characteristics of sporulation.

## 3. Results and Discussion

The disease complex included gray mold, leaf scorch, powdery mildew, black spot, and white leaf spot. During both years of investigation, the first of the diseases was gray mold. The first disease symptoms were recorded in the second decade of May with disease severity 5% in 2020 and –1.7% in 2021 and in the third decade of June reached 22 and 16% correspondingly (Figure 1).

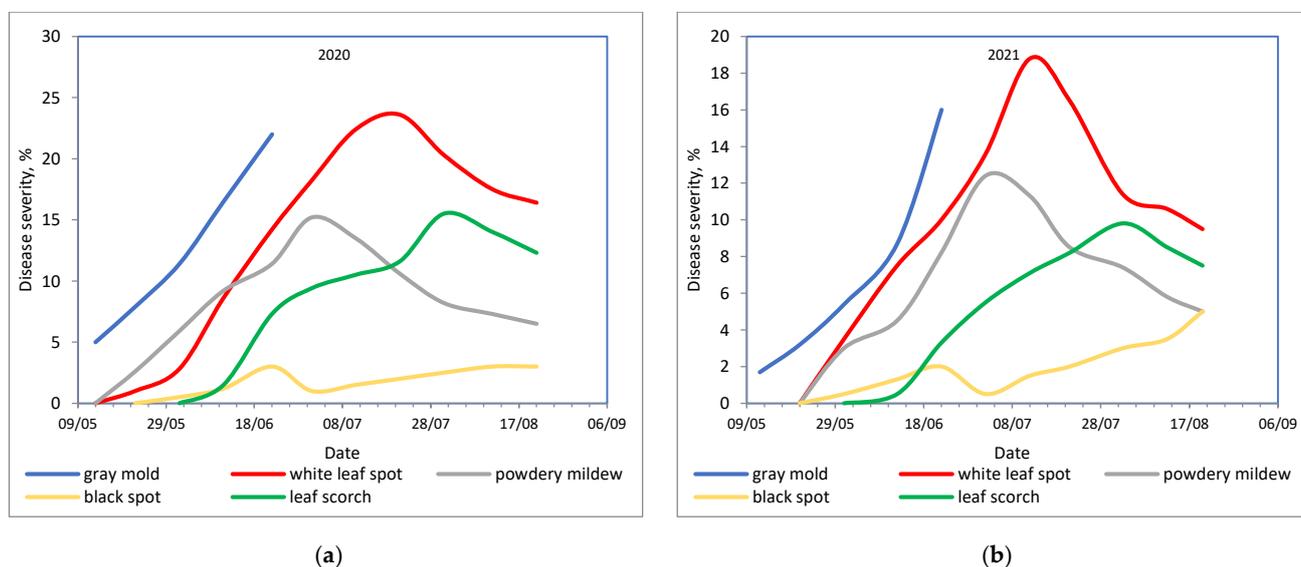
White leaf spot and powdery mildew appeared in the third decade of May in 2020 and in the first decade of June in 2021. These diseases developed till the end of vegetation. Maximum of white leaf spot severity was observed in the first-second decades of July and maximum of powdery mildew- in the first decade of July. Further weather conditions (high air temperature and low precipitation) restrained disease development.

First symptoms of black spot in both years were noted from the first decade of June. The disease severity was very low and did not exceed 3%. Mostly it appeared on fruits. Subsequently we observed the disease on leaves and petioles, but it was also insignificant (3–5%)

Symptoms of leaf scorch appeared on leaves in the second decade of June and till the third decade its severity grew to 3.3–7.3% This disease level didn't affect the yield, but after harvesting its severity increased up to 9.8–15.5%, that can affect fruit bud formation.

So, white leaf spot, powdery mildew and black spot had the highest levels of disease severity among the leaf diseases. Among the fruit diseases the most harmful was gray

mold. Similar results were obtained by Pavluk V.V. et al. [11], who note that the most harmful diseases that reduced the quality and quantity of the crop were powdery mildew and gray mold. In Norway grey mold is the main disease on strawberry fruit and causes very significant crop losses in rainy seasons [3]. Studies conducted by Rusin O.O. in the same zone in 2005–2007 [12] indicated the dominance of white leaf spot.



**Figure 1.** The severity of strawberry diseases in 2020 (a) and 2021 (b).

Black spot severity was low but taking in account that it is considered to be the second most economically important pathogen worldwide affecting strawberries [2] and its importance is growing, it is necessary to pay attention to the disease monitoring.

#### 4. Conclusions

The most common diseases were gray mold, leaf scorch, powdery mildew, black spot, white leaf spot. On strawberry plantations, diseases appeared in the following order: gray mold, white leaf spot, powdery mildew, black spot and leaf scorch. The most spread and the most harmful were gray mold, white leaf spot and leaf scorch.

**Author Contributions:** Conceptualisation, O.A., M.D.; methodology, S.M., M.D. and O.S.; investigation, S.M. and M.D.; writing—original draft preparation, S.M. and O.S.; writing—review and editing, O.S.; visualization, O.S.; project administration, O.A. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by National Academy of Agrarian Sciences of Ukraine, project number 24.01.02.08.P.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Data are available upon request.

**Conflicts of Interest:** The authors declare no conflict of interest. The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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