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Proceeding Paper

Monitoring of Leaf and Berry Diseases of Strawberry †

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Abstract: Strawberry (*Fragaria ananassa* Duch.) plants are valuable for the high taste, nutritional, medicinal and dietary properties of their 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 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 and Everh.) F.A. Wolf), powdery mildew (*Podosphaera aphanis* (Wallr.) U. Braun and S. Takam.), black spot (*Colletotricum acutatum* J.H. Simmonds), white leaf spot (*Ramularia grevilleana* (Tul. and 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 out and the most harmful were gray mold, white leaf spot and leaf scorch.

Keywords: strawberry; disease complex; harmfulness; dynamics

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1. Introduction

Strawberry (*Fragaria ananassa* Duch.) plants are valuable for the 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_2, B_9, 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 and S. Takam.), gray mold (*Botrytis cinerea* Pers.), white leaf spot (*Ramularia grevilleana* (Tul. and C. Tul. ex Oudem.) Jørst.), leaf scorch (*Diplocarpon earlianum* (Ellis and Everh.) F.A. Wolf), phytophthora crown rot (*Phytophthora fragariae var. fragariae* Hickman), fusarium wilt (*Fusarium oxysporum* f. sp. *fragariae* Winks and Williams), brown spot (*Phomopsis obscurans* (Ellis and 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 which leads to reduced yields in the next year [8]. Moreover, 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 -year-old plantations of cv. 'Clery'. Four fixed plots of 200 m^2 were selected. At 10 locations in the plot, 10 plants were inspected (100 plants per plot). Disease incidence was determined according to following Equation:

$$P = \frac{n}{N}100 \quad (1)$$

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 Equation:

$$R = \frac{\sum nb}{N \cdot K}100 \quad (2)$$

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, a 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 of 24 °C. Pathogens were identified by morphometric characteristics of sporulation.

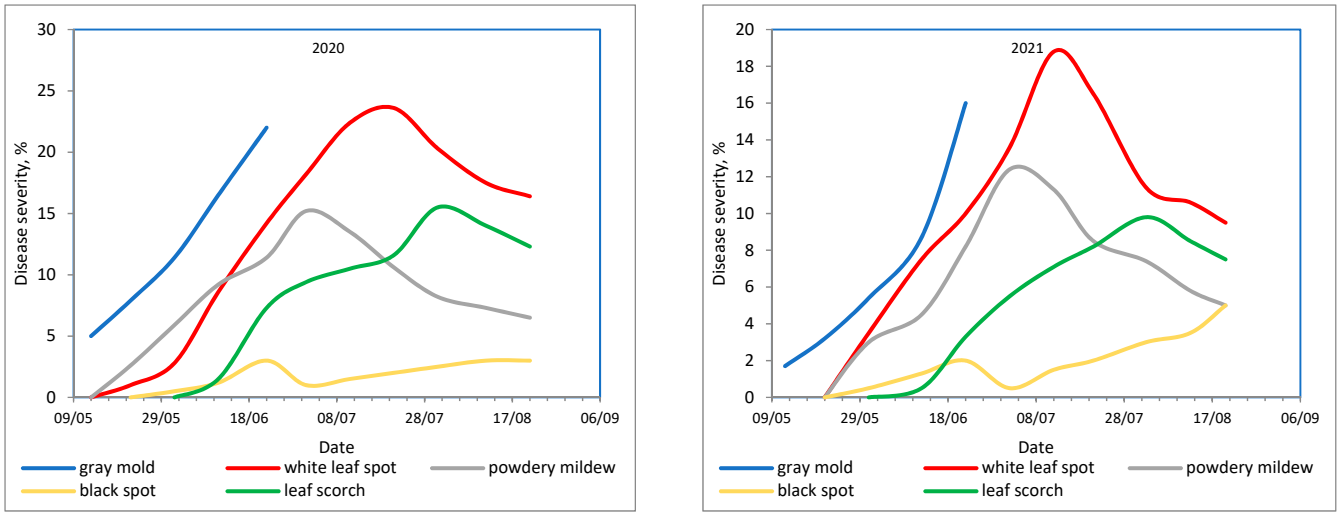
3. Results and Discussion

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

White leaf spot and powdery mildew appeared in the third part of May in 2020 and in the first days of June in 2021. These diseases developed till the end of vegetation. The maximum white leaf spot severity was observed in the first–second weeks of July and the maximum of the powdery mildew, in the first part 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 part 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 during the second week of June and till the third week its severity grew to 3.3–7.3% This disease level did not affect the yield, but after harvesting its severity increased up to 9.8–15.5%, which can affect fruit bud formation.



(**a**) (**b**)

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

Therefore, 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 et al. [11], who noted 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 during rainy seasons [3]. Studies conducted by Rusin [12] in the same zone from 2005–2007 indicated the dominance of white leaf spot.

Black spot severity was low but taking into 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 monitor the disease.

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 out and the most harmful were gray mold, white leaf spot and leaf scorch.

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