Monitoring of Sowing Oats for Disease Infection in the Conditions of the Collective Farm “Russia” Spk of Novgorod Region

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Abstract. Phytosanitary diagnostics and phytosanitary expertise are the main stages of the overall phytosanitary monitoring system. The aim of the study was to monitor oats of the seed variety Borrus for disease incidence in the conditions of the collective farm “Russia” SPK of Soletsky district of Novgorod region. According to the results of the research, two main diseases were identified on crops of common oats - red-brown spotting and powdery mildew. The spread and development of these diseases on oat crops was influenced by the prevailing weather conditions of the growing seasons of 2019 and 2020. Based on the monitoring of the phytosanitary diagnostics of crops, the study of the spread and development of diseases, the farm proposed measures to reduce the degree of manifestation and infection of all grain crops, regardless of weather conditions and allowed to improve the quality of grain.

1. Introduction

Recently, the frequency of a burst of widespread development and harmfulness of diseases that previously had no economic significance ( fusarium spike and leaves, alternaria, rhynchosporium, etc.) has increased. Every year agricultural producers in Russia lose from 6 to 25 million tons of grain from diseases of grain crops [1, 2].

Timely diagnosis of diseases of agricultural crops, the ability to identify the causes of their occurrence, the formation and nature of the development process are the basis for the correct implementation of preventive and protective measures for plant protection [3, 4].

Modern security systems based on the principles of integration of various methods, techniques and operations are complex, science-intensive, cost-effective complexes of production processes. At the same time, with the reasonable purchase of such systems, their timely and correct implementation, high profitability and quick payback of the measures applied are achieved.

The phytosanitary, agroecological and economic diversity of current situations necessitates the analysis of a significant amount of a wide variety of information when choosing the right decisions. In this case, it is not enough only to diagnose the disease, but also to form the intensity (level) of development. In the context of the multifactorial nature of the analyzed processes and the multivariance of the decisions made, it is necessary to speak not only about phytosanitary diagnostics, but also about phytosanitary examination of a diseased field (culture). Phytosanitary diagnostics and phytosanitary expertise are the main stages of the overall phytosanitary monitoring system [5].

Phytosanitary diagnostics includes identification of diseased and inhabited plants, identification of species, forms of races, strains, determination of genome and virulence, assessment of resistance to used
pesticides, etc. Phytosanitary examination provides for a systematic study of the entire set of factors affecting the development of a disease or a complex of diseases, determination of the risk of mass development of a harmful biological object and a reasonable choice of a biologically and economically effective system of protective measures acceptable for the economy.

The complexity and multifactorial nature of the situational analysis make it necessary to involve modern computer technology and advances in information technology (electronic databases, e-mail, the Internet, phytosanitary computer mapping of the territory, computer advisory systems, etc.). The systems for collecting and analyzing phytosanitary information currently used by specialists of state structures in the field of plant protection and phytosanitary monitoring, unfortunately, do not allow such an analysis to be fully carried out.

To predict the risk of developing a particular disease, to assess the need for protective measures, to correctly determine the nature of these measures, it is necessary to take into account a large number of factors characterizing the state of all interacting components of the “pathogen – plant – environment – human economic activity” complex [6, 7].

The aim of the study was to monitor oats of the seed variety Borrus for disease incidence in the conditions of the collective farm “Russia” SPK of Soletsky district of Novgorod region.

The collective farm “Russia” SPK is engaged in the breeding of dairy cattle and the production of raw milk.

Oats are grown in the collective farm “Russia” SPK for fodder purposes; accordingly, a minimum of pesticides is used. In 2019, the collective farm “Russia” SPK sowed oats of the “Borrus” variety of mass reproduction on an area of 229 hectares. This year, only chemical weeding was used on 31 hectares with the herbicide Magnum, VDG with a consumption of 10 liters/hectare. The seeds were not treated before sowing.

In 2020, oats of the Borrus variety of mass reproduction were sown on an area of 158 hectares. Before sowing oats, the steam was thoroughly treated with Tornado, BP + Magnum, VDG (working fluid consumption 3l/ha + 10l/ha), and after the appearance of the first weeds, chemical weeding was carried out on an area of 40 hectares with Agritox, VK 1.131l/ha.

Let us dwell in more detail on the characteristics of the weather conditions that develop during the growing seasons of 2019 and 2020.

In 2019, early May was characterized by cloudy, cool weather with occasional precipitation. On May 6, night frosts on the soil were observed in the Soletsky district. By the middle of the month, warm, calm and little cloudy weather was established, the temperature on some days rose to +28 °C, night temperatures did not drop below +10 °C. From the beginning of the third decade, the weather deteriorated sharply. There was a strong gusty wind with rains and thunderstorms. Daytime temperatures did not differ much from temperatures at night and ranged from +8 to +15 °C. From the second decade, the air temperature increased by 6–8 °C, there were short rains. The average air temperature in May was +13 – +15 °C during the day, and +8 – +12 °C at night.

In the first decade of May in 2020, the weather was cloudy, but quite warm. Daytime temperatures ranged from 10° to 15°C, night temperatures ranged from 8 °C to 10 °C. From the second decade, with the arrival of an extensive Arctic cyclone, a cold snap began with frequent rains, sleet and gusty winds. Daytime temperatures dropped to +2 °C – +8 °C, and nighttime temperatures dropped to +1 °C, on some nights in the region frosts were observed down to –3°C. The air temperature was more than 10 °C below the climatic norm.

In June 2019, warm, slightly cloudy and calm weather prevailed. In the middle of the month there were heavy rains with thunderstorms and gusty winds. Basically, the month was very poor in terms of precipitation. In the last week of the month, the weather deteriorated sharply. There were heavy rains with strong gusts of wind, the temperature, both in the daytime and at night, dropped by almost 8 – 10°C. The average monthly temperature in the daytime was +20 – +23 °C, and at night +15 – +17 °C.

Daytime temperatures in June 2020 varied from +14°C to +30°C. The average daily temperature was +20 – +25 °C. The beginning of the month was characterized by cloudy and cloudy weather with an air temperature of +14 °C – +16 °C. By the beginning of the second decade of the month, hot weather was
established with daytime temperatures +25 °C – +28 °C, on some days up to +32 °C. This weather lasted until the end of the month. Precipitation in the form of rain was noted three times a month and was of a short-term rainstorm with thunderstorms and an increase in wind up to 18–20 m/s.

The weather conditions for July in 2019 were changeable, the temperature regime varied from +7 to +30 °C. The relative humidity ranged from 42% to 98%. The first two days of the month were warm and cloudless. Then the cyclone brought cool, cloudy, windy and rainy weather. At night, the air temperature did not rise above +10°C, and during the day it did not rise above +15 °C. The last decade of the month was warm enough, there were days when the air warmed up to +30 °C, night temperatures did not drop below +20 °C. In the last week of the month, another cyclone brought northerly winds, cloud cover and heavy rains. At night, the air temperature did not rise above +9 °C, and during the day it did not rise above +15 °C. The average monthly temperature during the day was +18 – +25 °C, at night +14 – +16 °C.

The month of July 2020 was characterized by unstable weather. Precipitation often fell in the form of torrential rains with thunderstorms, and wind intensification up to 18 m/s. There was a large difference between day and night temperatures, which caused the formation of abundant dews. Daytime temperatures varied from + 15 °C to + 28 °C, nighttime temperatures varied from +6 °C to +15 °C. The average daily air temperature was +15 – + 19 °C.

In 2019, in the first ten days of August, it was cool, cloudy, and it rained. Since the second decade it has become warmer, the amount of precipitation has decreased. The average daily air temperature for the month was +20 – + 23 °C; average night temperature +13 – +15 °C.

August 2020 was characterized by cloudy weather with clearings and occasional rains with thunderstorms. Daytime temperatures ranged from +18 °C to +22 °C, on some days up to +28 °C, the average night temperature was +12 °C – +14 °C. The tendency for a large difference between day and night temperatures persisted.

2. Methods for monitoring the main diseases
Powdery mildew is a disease that affects the aboveground organs of the plant – leaves, leaf membranes, stems, and in years of strong development, spike scales and awns. The fungus parasitizes mainly on young, actively growing tissues. Typical symptoms of the disease: the formation on both sides of the leaf blade of a white spider-like coating of the mycelium of the fungus, which then condenses and takes the form of convex felt pillows of various sizes, dirty gray or brown. Later, the pads darken, forming a continuous felt coating with black pycnidia dots. The severity of a disease is determined by the time of its manifestation. Severe damage to plants in the fall can lead to the death of 15–40% of the stems during the winter. Earlier damage to the lower layer of leaves reduces the number of productive stems and reduces yields by 8–25%. With late development of the disease and damage to the upper layer of leaves, the weight of 1000 grains decreases [8].

Sowings of oats are examined, starting from the tillering phase and up to grain filling with an interval of 7–10 days. At the first examination, the disease is detected and its prevalence is assessed. To determine the appropriateness of protective treatments, accounting is carried out at the end of the tube exit phase – the beginning of milk ripeness, that is, at the moment of the most severe manifestation and maximum harmfulness of the disease. The intensity of the lesion is determined by scales. At the same time, the assessment of damage is sometimes put down immediately upon examination of the field, and sometimes the infection of each plant in the sample is first evaluated in points, and then the result is compared with the standard of the scale.

On fields with an area of up to 100 hectares, 20 samples are taken, 10 plants in each. On large areas (up to 30 hectares), 2 additional samples are taken for every 100 hectares. Very large arrays are conventionally divided into smaller fields and keep records in accordance with the above standards. Samples are taken evenly throughout the site, but not closer than 100–200 m from the edge of the field. All samples take into account the defeat of each leaf (sheath) on 10 stems taken in a row. The arithmetic mean values of the intensity of the lesion indicate the development of the disease (lesion) in percent.
On the basis of the data on the infestation of crops, the approximate yield losses are determined. The economic threshold of harmfulness for powdery mildew on oats: in the phase of development – the beginning of the growing season is 10% of the development of the disease [9, 10].

Lower thresholds should be used when conditions are favorable for pathogen development. In other cases, you can use the upper threshold values.

Reddish-brown spot of oats. Dark gray or brown spots are formed on the leaves with a reddish-brown rim and a brown area around, limited by veins on the sides. The edges of the spots are more intensely colored in the central part. Sick leaves wither and fall off.

It is taken into account in the period from the beginning of earing to the milk ripeness of grain according to an illustrative 4–point scale: 1 point – up to 10% of the organ surface is affected, 2 – 11–25%, 3 – 26–50%, 4 – more than 51% of the surface.

Route surveys are carried out 3 times a season: during the periods of emergence, flowering and ripening of grain crops. On fields with an area of 100 hectares, 20 samples are taken from 10 plants, then the percentage of affected plants is determined and the degree of damage is established in points on a scale. The spread and development of the disease is calculated according to generally accepted formulas.

The economic threshold of harmfulness for reddish-brown spotting of oats is looked at at the stage of development – panicle emergence and with 15% of the development of the disease.

3. Results of research on the main diseases of oats

3.1. Reddish-brown spotting

2019 year. The rains in the third decade of May contributed to the manifestation of the disease on crops. In the experimental field, the disease manifested itself with a weighted average prevalence of 6% and a development of 2.5%. A maximum of 20% appeared on an area of 120 hectares, with the development of the disease 3% (table 1).

The dry and hot weather in June held back the spread and development of the disease. During monitoring in the controlled area, the disease was detected with a weighted average percentage of spread of 16% with the development of the disease 1.3%, the maximum infection of 37% was noted on 44 hectares.

Moderate air temperatures and sufficient humidity in July were favorable for the further spread and development of the disease. The average value of the percentage of spread was 18, with the development of the disease 1.3.

Weather conditions in the first half of August contributed to the further spread and development of the disease. The weighted average percentage of the spread of the disease was 20%, the development – 2.

2020 year. The weather conditions in May with sufficient moisture created favorable conditions for the manifestation of the disease. The manifestation of the disease in the experimental field was noted with a weighted average percentage of damage of 0.2 and development of 0.2% (table 1).

Table 1. Comparative data on monitoring red-brown spotting.

| Year-month | % of spreading 2019 / 2020 | % of development 2019 / 2020 |
|------------|----------------------------|----------------------------|
| May        | 6/0.2                      | 2.5/0.2                    |
| June       | 16/7                       | 1.3/0.5                    |
| July       | 18/90                      | 1.3/2                      |
| August     | 20/94                      | 2/3                        |

In June, conditions were favorable enough for the further spread and development of the disease. The disease was revealed with the defeat of 7% of plants with the development of 0.5%.
The weather conditions in July favorably affected the further spread and development of the disease. In the second half of the month, the disease reached its maximum spread and development. The weighted average percentage of spread was 90%, maximum 100% on an area of 100 ha, disease development was 2%, maximum 2.5%.

In August, on the experimental field, the weighted average percentage was 94%, with the development of 3%.

3.2. Powdery mildew

2019 year. A sufficient amount of moisture, as well as a moderate temperature regime in May, were favorable for the pathogen. The disease manifested itself in the controlled area with a weighted average prevalence of 1%, with a development of 0.5% (table 2).

Dry and hot weather during the first two decades of June held back the spread and development of the disease. The spread and development of the disease remained at the level of the month of May.

In July, sufficient moisture created conditions for the spread of the disease. The disease in the experimental field manifested itself with a spread of 1.2% and a disease development of 0.3%.

The weather conditions in August were relatively favorable for the disease. The development and spread of the disease remained at the July level.

2020 year. June conditions were not favorable for the spread and development of the disease. The dry and hot weather in June held back the spread of the disease. The disease was noted with a weighted average prevalence of 1% with a development of 0.1% (table 2).

Table 2. Comparative data on monitoring powdery mildew.

| Year-month | % of spreading | % of development |
|------------|----------------|------------------|
| May        | 1 / -          | 0.5 / -          |
| June       | 1 / 1          | 0.5 / 0.1        |
| July       | 1.2 / 1        | 0.3 / 0.1        |
| August     | 1.2 / 1        | 0.3 / 0.1        |

Insufficient moisture in the first half of July and fluctuations in high and low temperatures were not favorable for the pathogen. Monitoring carried out on the experimental field showed that the disease remained at the level of May.

In August, a total of 158 hectares of oat crops were examined to detect the disease, the area affected by powdery mildew remained unchanged.

4. Conclusion

As a result of monitoring for disease prevalence, a survey of sowing oats was carried out in the conditions of the collective farm “Russia” of the SPK of the Novgorod region and the diseases of powdery mildew and red-brown spot were revealed.

In order to minimize the incidence of diseases in oat crops, it is necessary to pickle the seeds before sowing, observe the crop rotation established on the farm and the agricultural technology of cultivating this crop. Fulfillment of these requirements will maximally reduce the degree of manifestation and contamination of crops of all grain crops, regardless of weather conditions, and will improve the quality of grain.

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