Propagation and development of some aerogen diseases that cause damage to the crop in the wheat plant

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Abstract. Wheat crop losses due to aeronautical diseases have been observed in all countries, especially in the observations carried out in several districts of the Syrdarya region, this situation has also found its proof. In studies conducted on yellow and brown rust and powdery mildew diseases from aerogen diseases, they were studied at what time of season they appeared, spread, development and damage to the crop. Of these diseases, it was found that yellow rust disease spreads rapidly and develops, and also causes great damage to the fruit. Yellow rust disease wheat did spread and the damage is noted to be a lot on the farms of Bayaut district. The arrival of the spring season seryog in 2018 year caused a strong spread and development of wheat diseases, especially yellow rust disease, and there was a significant damage to the grain crop in chemically untreated areas with some fungicides. For this reason, constant control over the phytosanitary condition of grain fields during the growth period requires the use of rapid measures to protect the crop when there is a risk of a strong spread and development of any diseases.

1. Introduction

Soft wheat (Triticum aestivum L.) provides 40% of the population of the world with food and 20% of the calories and proteins [1]. On a global scale, wheat occupies 17% of all crop areas [2]. According to experts of the International Food Organization (FAO), in 2007, 20% of all field crops (about 213 million) were cultivated in the world and the grain harvest collected in the same year amounted to 619 million tons [3]. It is known that the demand for flour and bakery products of mankind is increasing year by year. In 1993-2000, the growth rate of the world population was about 1.5%, in 1985-1995, the growth rate of wheat grain in the world was 0.9%. If the population increase against the cultivation of wheat grain growth continues in the same manner, if it is inevitable to encounter severe difficulties in providing the next generation with wheat products [4]. The government of Uzbekistan has put forward the task of growing agriculture in our country, which is being successfully carried out. At a short opportunity, our country joined the ranks of the countries with the highest yields among the countries of Central, Western Asia and North Africa [4]. There is a lot of information in the history of the science of farming about the fact that gross lesions of grain crops with diseases have severe consequences. Due to the fact that there are modern and reliable methods of protecting plants from epiphytes – the gross development of diseases in a certain area – such destructive consequences are less observed in the current period, but plant diseases are still causing great damage to agriculture.
today. For example, due to rust diseases of grain crops, in most cases 30-40% of the crop is destroyed. According to RASHN academician V.A. Zakharenko [5] at the end of the 1980’s, 34% of the world's wheat crop was lost due to harmful organisms, including 12.4% due to diseases. When scientifically based protective measures are not used in developed countries, only fungi lose an average of 10% of the yield due to pathogenic diseases, and in the fields where intensive technology is used, 20% [5]. In the following period, the yield of wheat grain was 0.81-10.0 tons per hectare in India, 12.1 tons in Argentina, 16.1 tons in North America, 37 tons in Belgium and 40 tons in Denmark [6]. The government of Uzbekistan has set the task of growing agriculture in our country, and this task is being successfully fulfilled. At a short opportunity, our country took the first place among the countries of Central Asia in terms of yield, and joined the ranks of the countries with the highest yields among the countries of Central, Western Asia and North Africa.

In many cultivated regions of the People’s Republic of China, yellow rust is considered the most dangerous diseases of this crop, and the negative effect of the pathogen is estimated to reach 20 million rubles every season. observed in hectares [7]. Yellow rust on the fields of Central Asia, including Uzbekistan, is often met yellow rust, and in some years it is widely spread and strongly developed, which leads to considerable crop destruction. In the seasons when strong epiphytotes are observed (for example, in the Bayaut district of Sirdarya region and Bekabad district of Tashkent region in 2009, 2010 and 2016 years), yellow rust mites appear early (in the second half of February), and in the middle of April, the prevalence of the disease in most of the fields reaches 100%, the degree of damage reaches in untimely protected areas with fungicide, rust development can reach up to 90-100%, the height of the plant remains low, and they completely lose their leaves, the spike is small and the grain stops developing [8].

2. Materials and Methods

Our research was carried out in March, April, May and June of 2017-2019 in the planted fields of several districts of Sirdarya region, namely Gulistan, Bayaut, Akaltyn and Sirdarya districts. Observations of the route to determine the phytosanitary state of the plantations were conducted according to the methodological recommendations of the GISRPP (General-Russian Institute of Protection of Plants) [9]. In conducting these observations and field experiments, the stages of development of wheat plant were determined according to the international macrophenological decimal scale [10].

![Figure 1. Yellow (left) and brown (right) rust disease of the wheat](image)

In the route observations, the field was checked at a distance of every 3-10 km. Here wheat plants, the presence or absence of the diseases, the degree of spread and development of the diseases in its presence were taken into account. To do this, from the inside of 20-30 meters from the edge of each field, all plants on an area of 100-200 m² were examined. And taking into account the prevalence and development of the diseases, 10 bush from each of the 3-4 points in this area was held in the plant (according to the main stem). In order to take into account the development of yellow rust and brown
rust diseases of wheat (see Figure 1), Cobb scale and James modified by Manners [9,11,12,13] scale, Peterson et al., [14] scale, which were presented in the above recommendations and methodological guidelines were used.

Taking into account the fact that flour-shudging diseases was transferred from the formation of grain to the period of milk ripening of cereals, 20 samples were taken from the fields, consisting of 10 plants. In large areas, two samples were taken in addition to each 10 pieces [15, 16].

Taking into account the degree of development of the disease was carried out at the stage of 3-4 leaf formation of the plant, at the end of the seeding period – at the beginning of the fertilization period and 6-7 days after the formation of the spike, and was calculated on the scale of the Geshele [17].

If the diseases were evenly distributed in the investigated fields, the samples were taken in a diagonal direction or along the height. At a time when the spread of the disease was not smooth, samples were taken in a chess method according to several parallel lines.

Figure 2. Powdery mildew disease of the wheat

The prevalence of brown and yellow rust and powdery mildew diseases of wheat (see Figure 2 for powdery mildew diseases) was found on the basis of the following formula [5]:

\[ P = \frac{n \cdot 100}{N} \]

Here, 
- \( P \) – disease prevalence, %;
- \( n \) – number of sick plants in the sample, pieces;
- \( N \) – total number of plants in the sample, pieces.

The level of development of the above-mentioned diseases was found according to the formula [5]:

\[ R = \frac{\sum (a \cdot b)}{N}, \]

Here,
- \( R \) – degree of development of the diseases, in %;
- \( \sum (a \cdot b) \) – the sum of the multiples of (a) the number of plants corresponding to a certain % or points (b);
- \( N \) – total number of calculated plants.

The studied diseases of wheat were found on the basis of the following formula. [5]:

\[ B = \frac{(A - a) \cdot 100}{A} \]

Here,
B – lost harvest, %;
A – harvest of healthy plants, c/ha;
a – harvest of sick plants, c/ha.

3. Results and Discussions

Our research was carried out on the spread and development of the most common yellow and brown rust and flour-dew diseases. The harm of these diseases will depend on such factors as the period of their appearance, the prevalence, the degree of damage to the plant, the resistance or intolerance of the planted wheat varieties to the diseases, as well as whether the fungicide has been used or not against the diseases. It is observed that the highest degree of loss of harvest is observed in varieties that are resistant to diseases, from the formation of flag leaves to the period of grain filling. yellow rust diseases is common in more than 35% of all wheat plantations in the world [18].

Yellow rust is considered one of the most harmful diseases. The causative agent of this disease is Puccinia striiformis, a synonym Puccinia glumarum fungus. The causative agent of the disease damages the leaf of the wheat, sometimes other organs, causing its strengthening breathing, the stem to become thin, brittle and its development is disrupted. When damaged by yellow rust, the process of photosynthesis slows down, the root does not develop well, the number of flowers and grains in the spike decreases, the amount of protein in the grain decreases, the yield is lost.

Table 1. Development of yellow rust disease in the conditions of Sirdarya region (on average, 2017-2019 years)

| Controlled area | April Decade | May Decade | June Decade |
|----------------|--------------|------------|-------------|
|                | I     | II    | III | I     | II    | III | I     | II    | III |
| District       |       |       |     |       |       |     |       |       |     |
| Galistan       | 5.1   | 0.8   | 10.1 | 1.1 | 18.6 | 1.2 | 26.6 | 2.0 | 31.2 | 3.7 | 49.2 | 4.5 | 37.7 | 2.9 | -    | -  |
| Chinabad       | 4.4   | 0.5   | 7.8  | 1.2 | 12.5 | 2.3 | 26.4 | 4.1 | 33.1 | 4.8 | 47.1 | 6.0 | 40.0 | 4.0 | -    | -  |
| Syrdarya       | 16.2  | 4.1   | 36.1 | 12.8 | 61.2 | 22.1 | 100  | 33.0 | 100  | 40.0 | 100  | 36.7 | 100  | 50.1 | -    | -  |
| Akaltyn        | 3.0   | 0.1   | 7.9  | 0.4 | 15.7 | 1.2 | 28.5 | 2.0 | 45.6 | 3.5 | 52.0 | 6.4 | 56.7 | 6.5 | -    | -  |
| Ulugbek        | 6.4   | 1.0   | 21.4 | 4.0 | 54.3 | 5.5 | 72.6 | 11.1 | 100  | 16.3 | 100  | 14.2 | 94.1 | 12.1 | -    | -  |
| Narkul         | 6.2   | 1.1   | 19.8 | 3.0 | 32.4 | 3.2 | 52.1 | 5.4 | 72.1 | 6.9 | 73.5 | 8.2 | 73.1 | 8.8 | -    | -  |
| Humo           | 7.1   | 0.9   | 22.3 | 3.5 | 45.2 | 5.1 | 68.1 | 8.9 | 80.1 | 11.1 | 86.1 | 12.5 | 40.5 | 10.4 | -    | -  |
| Bayaut         | 20.8  | 4.2   | 33.1 | 4.6 | 71.4 | 11.1 | 100  | 22.5 | 97.7 | 19.2 | 96.7 | 27.4 | 92.8 | 25.6 | -    | -  |
| Navbahorlik    | 12.5  | 2.2   | 29.6 | 3.6 | 52.3 | 6.4 | 81.4 | 7.1 | 72.6 | 6.5 | 68.1 | 5.5 | 62.4 | 4.3 | -    | -  |
| Uvvoqulik      | 18.2  | 3.9   | 34.3 | 7.7 | 71.3 | 25.6 | 90.0 | 18.5 | 100  | 23.0 | 100  | 18.9 | 91.5 | 16.3 | -    | -  |
| Elkebov Azizbek| 10.4  | 2.1   | 22.6 | 3.0 | 48.2 | 4.5 | 80.1 | 8.4 | 86.0 | 9.1 | 88.4 | 10.9 | 82.6 | 10.3 | -    | -  |

Our observations and experiments were conducted on the farming areas such as “Orol Ne’matlari”, “Chinabad” of Gulistan district, “Khasan Chiltanov”, “Amir Temur” of Sirdarya districts, “Ulugbek”, “Narkul”, “Khumo” of Akaltyn district, and “Bayautlik Ravshan”, “Navbahorlik Khayrullo”, “Uvvoqulik Fakhriddin” and “Elkebov Azizbek” of Bayaut district were carried out during 2017-2019 years. In the areas where the study was conducted (Table 1), the prevalence of yellow rust disease in wheat in the first decade of April was up 3.0-20.8%, the highest rate of disease prevalence was up to 47.1-100%, corresponding to the second and third decade of May. When the average indicator of the disease on farms for three years was obtained, its maximum prevalence coincided with the second
decade of May (Table 1). The damage caused by yellow rust disease in the farms we observed was different, the minimum indicator was observed in the “Orol Ne’matlari” of Gulistan district (49.2%) and “Chinobod” (47.1%), “Amir Temur” (52.0%) of Sirdarya district, while the wide spread of yellow rust was observed in the farming area of Sirdarya district “Khasan Chiltanov” (100%), “Humo” (96.7%) of Akaltyn district, “Ulugbek” (100%), as well as “Bayauvultik Ravshan” (100%) and “Uvvqoqlik Fahriddin” (100%) of Bayaut district. The most frequent prevalence of the disease for three years, which was carried out on yellow rust diseases of wheat, was observed in 2018. Wheat’s brown rust disease is also common in almost all cultivated countries. Brown rust on the wheat fields of Uzbekistan was widely spread in 1941, 1947, 1949, 1952, 1963, 1978, 1979, 1981, 1991, 1995 and 2005 and it is noted that strongly damaged crops [11].

Table 2. Development of brown rust disease in the conditions of Sirdarya region (on average, 2017-2019 years)

| Controlled area | April | May | June |
|-----------------|-------|-----|------|
|                 | Decade |     |      |
|                 | i | II | i | II | i | II | i | II |
| District/Name of the farm | Development of disease | Mortality rate | Development of disease | Mortality rate | Development of disease | Mortality rate | Development of disease | Mortality rate |
|------------------------|----------|--------|----------|--------|----------|--------|----------|--------|
| Gulistan | Orol Ne’matlari | - | - | - | - | 1.5 | 0.1 | 29.9 | 2.2 | 28.1 | 2.3 | 28.0 | 2.4 | - | - |
| | Chinobod | - | - | - | - | 2.1 | 0.2 | 18.7 | 2.1 | 59.7 | 2.7 | 89.6 | 2.7 | - | - |
| | Khasan Chiltanov | - | - | - | - | 2.0 | 0.1 | 20.8 | 2.1 | 27.7 | 2.5 | 2.7 | 2.3 | - | - |
| | Amir Temur | - | - | - | - | 1.7 | 0.1 | 21.6 | 2.3 | 31.4 | 2.8 | 31.5 | 2.8 | - | - |
| | Ulugbek | - | - | - | - | 1.0 | 0.1 | 17.3 | 1.8 | 34.6 | 3.0 | 34.4 | 1.9 | - | - |
| | Nodkol | - | - | - | - | 2.4 | 1.0 | 13.4 | 4.9 | 46.5 | 6.3 | 57.8 | 7.2 | 57.4 | 5.1 | - | - |
| | Humo | - | - | - | - | 3.7 | 0.2 | 19.6 | 3.0 | 58.2 | 7.7 | 62.9 | 5.9 | 61.3 | 5.5 | - | - |
| Bayaut | Bayautlik Ravshan | - | - | - | - | 2.0 | 0.4 | 33.1 | 3.0 | 76.2 | 3.6 | 90.1 | 3.8 | 79.9 | 5.1 | - | - |
| | Navbahurk Khayrye | - | - | - | - | 1.8 | 0.1 | 9.5 | 2.0 | 48.3 | 5.3 | 60.2 | 5.0 | 60.1 | 4.0 | - | - |
| | Uvvqoqlik Fahriddin | - | - | - | - | 4.2 | 0.6 | 25.0 | 2.1 | 77.3 | 6.5 | 80.0 | 10.6 | 82.2 | 8.3 | - | - |
| | Elboec Alichbek | - | - | - | - | 1.9 | 0.3 | 16.2 | 0.4 | 70.5 | 9.5 | 72.3 | 5.9 | 73.1 | 5.0 | - | - |

Puccinia triticina synonyms of fungal rust disease P.recondita f. sp.tritici, P.dispersa f. sp.tritici, P.persistens provoke fungi. In the areas where our studies were conducted, the first signs of the diseases were observed from the third decade of April, when its indicator was 1.8-4.2%, the most frequent prevalence of the disease was observed in the third decade of May, and its indicator reached 28.1-90.0% (Table 2). The prevalence of brown rust diseases on farms was different. Here, relatively low prevalence of the disease was observed in farming areas such as “Khasan Chiltanov” (27.7%) of Sirdarya district and “Orol Ne’matlari” (29.9%) of Gulistan district, its wide prevalence was recorded in farming areas “Uvvqoqlik Fahriddin” (82.2%) “Bayautlik Ravshan” (90.1%) of Bayaut district. It was noted that this disease is the most frequent in 2018 and the least frequent in 2019, when it is considered a diseases by years.

One of the main diseases of wheat is powdery mildew diseases. Its causative agent is the fungus Erysiphe graminis. Due to this diseases, along with a decrease in the yield of wheat, its quality deteriorates. Flour-dew disease is met in all areas where wheat is grown. One of the factors contributing to the widespread spread of this disease is that measures to combat the diseases have not been adequately developed [19, 20].

In the observed areas, the first signs of powdery mildew diseases were observed from the first decade of April, when its prevalence was 1.0-5.8%, its greatest prevalence coincided with the second decade
of May, with the figure equal to 57.4-96.1% (Table 3). If the prevalence of the disease was found in the farms of “Amir Temur” (57.4%) of Sirdarya district and “Narkul” (57.8%) of Akaltyn district, its much wider distribution was observed in the farms of “Khasan Chiltanov” (96.1%) of Sirdarya district and “Navbadorlik Khayrulla” (94.3%) and “Elibo Azizbek” (95.1%) of Bayaut district. During the three years of the study, the prevalence of powdery mildew diseases was relatively low in 2018, the prevalence was observed in 2017 and 2019. We advance the idea that the differences in the prevalence of these diseases by farms, months and years are caused by temperature, humidity and precipitation. On the natural background of wheat yellow rust, brown rust and powdery mildew diseases, the effect on the crop using fungicides, that is, their harm has also been studied.

Table 3. Development of powdery mildew disease in the conditions of Sirdarya region (on average, 2017-2019 years)

| Controlled area | April Decade | May Decade | June Decade |
|-----------------|--------------|------------|-------------|
| District        | I            | II         | III         | I            | II         | III         | I            | II         |
| Gudistan        |              |            |            |              |            |            |              |            |
| Orel nezistari  | 5.7          | 0.7        | 18.3       | 1.0          | 23.4        | 1.7         | 24.8         | 2.1        | 80.5        | 10.4      | 83.0        | 11.1      | 46.9        | 2.5       | -          | -         |
| Chinbash        | 5.8          | 0.4        | 10.2       | 4.7          | 27.8        | 2.4         | 34.1         | 3.0        | 88.2        | 8.3       | 63.5        | 4.2       | 30.5        | 2.7       | -          | -         |
| Syrdarya        |              |            |            |              |            |            |              |            |              |            |              |            |              |            |            |            |
| Khasan Chiltanov| 1.1          | 0.1        | 9.2        | 0.3          | 33.7        | 2.6         | 55.2         | 7.4        | 90.1        | 11.8      | 94.0        | 12.2      | 97.2        | 15.1      | -          | -         |
| Amir Temur      | 3.7          | 0.3        | 14.5       | 1.6          | 25.7        | 2.0         | 29.6         | 2.8        | 57.4        | 4.6       | 30.2        | 4.5       | 30.0        | 4.3       | -          | -         |
| Uflagbek        | 1.2          | 0.1        | 9.4        | 2.0          | 18.3        | 2.7         | 31.6         | 5.4        | 78.2        | 14.3      | 77.3        | 14.1      | 72.3        | 12.0      | -          | -         |
| Narkul          | 1.0          | 0.1        | 5.3        | 1.7          | 14.6        | 2.0         | 24.5         | 3.7        | 57.8        | 8.7       | 60.1        | 8.7       | 51.4        | 7.7       | -          | -         |
| Humo            | 2.8          | 0.2        | 9.4        | 1.1          | 12.7        | 1.3         | 15.8         | 2.4        | 74.7        | 3.0       | 38.1        | 2.8       | 38.0        | 2.6       | -          | -         |
| Bayaut          |              |            |            |              |            |            |              |            |              |            |              |            |              |            |            |            |
| Bayantik Ravshan| 2.1          | 0.3        | 5.6        | 0.7          | 30.0        | 2.4         | 58.9         | 7.2        | 88.2        | 7.4       | 88.1        | 6.7       | 85.1        | 6.3       | -          | -         |
| Navbadorlik Khayrulla| 1.3   | 0.1        | 4.8        | 1.0          | 29.4        | 2.0         | 39.4         | 5.8        | 95.5        | 16.6      | 94.3        | 12.3      | 90.3        | 11.6      | -          | -         |
| Uvvolik Fakuddin| 1.4          | 0.3        | 5.0        | 1.3          | 21.3        | 1.8         | 55.5         | 6.0        | 91.0        | 15.1      | 91.0        | 14.9      | 88.6        | 14.3      | -          | -         |
| Elibo Azizebek  | 1.8          | 0.2        | 3.9        | 0.4          | 28.5        | 1.1         | 60.9         | 6.4        | 95.8        | 17.6      | 95.1        | 17.4      | 93.5        | 16.8      | -          | -         |

Note: the harvest of healthy plants in the field is 49.0-55.4 c/ha

In the period of milk ripening of wheat with yellow rust, the absolute weight reduction of 1000 grains compared to a healthy plant was 26.0%, while the loss of harvest was 26.0%. In this phase of development, when brown rust damages 75.5%, the absolute weight of 1000 grains compared to a healthy plant decreases 12.5%, the loss of harvest 15.1%, the absolute weight of 1000 grains when damaged 66.5% with powdery mildew was 5.3%, and the loss of harvest was 12.2%. Therefore, in the conditions of Syrdarya region, the yield of wheat is most often lost due to yellow rust diseases, relatively low in the influence of powdery mildew disease.

4. Conclusions
We observed the wide spread of rust and flour-dew diseases and causing great damage to the crop in several districts of Sirdarya region in 2017-2019, as in all the countries where it is grown, in the regions of our republic. We believe that the fall of 2017 and spring of 2018 rain caused wheat diseases, especially yellow rust disease, a strong spread and development. Widespread prevalence of diseases, yellow rust disease was recorded in the second, third decades of April and the first decade of May (47.1-100%), brown rust diseases was recorded in the second and third decade of May (28.1-90.0%), powdery mildew diseases was recorded in the second decade of May (57.9-86.1%). The strong prevalence and development of diseases was observed in the farms of Bayaut district of the
region. When we studied the effects of diseases on yield, it was found that the most harvest is lost due to yellow rust diseases.

Proceeding from our experiments, it is necessary to take into account the fact that the planting of disease-resistant varieties in optimal terms, the more precipitation in October and November of autumn, the greater the probability that in the spring the disease will be especially yellow rust diseases, the creation of a reserve of fungicides and the processing of effective fungicides with the crop.

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