Distribution and harmful root decay of wheat

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Abstract. Root decay is a disease of the roots and basal part of the stems of wheat, caused by one species or a complex of species of semi-parasitic fungi. This article presents the results of a survey of wheat crops in the conditions of irrigated agriculture in the farms of the Tashkent region in Uzbekistan. It has been established that wheat root decay is ubiquitous and varies from 20.8-60.8%. This disease reaches its greatest development in the seedling phase. The intensive variety was the most affected by root decay. The harmfulness of root decay is manifested in the shortening of the length of the stem, a decrease in the number of grains per ear, and the deterioration of the sowing qualities of seeds. The manifestation of root decay is affected by temperature, humidity and wheat precursors. It has been established that infection of plants occurs at a moisture content of 40% of the total moisture capacity. The most favorable effect on limiting the disease is provided by such a precursor as alfalfa. Keywords: wheat, susceptibility, distribution, development, disease, predecessors, harmfulness, symptoms, seedlings, variety, spike, Fusarium oxysporum

1 Introduction

Wheat, after cotton, is one of the leading agricultural crops in Uzbekistan. In the conditions of irrigated agriculture, various diseases of wheat significantly reduce its yield and cause great damage to the agricultural economy of the Republic. One of the most common and harmful diseases of wheat is root decay [1-4].

Root decay - a disease of the roots and basal part of the stems of wheat, caused by one species or a complex of species of semi-parasitic fungi (*fusarium, helminthosporium, ophiodisease , cercosporella , pytium , rhizoctonia , etc*) [5, 6].

Under the conditions of Uzbekistan on irrigated lands, the root decay of wheat has not been sufficiently studied. In this regard, the study of the harmfulness, distribution and influence of environmental factors on the development of wheat root decay is of current importance [7, 8].

The study in more detail of the above features of the development of wheat root decay will help develop more effective measures to combat wheat root decay. Grain crops are affected by several types of root decay, differing in the nature of the manifestation of the disease, the species composition of pathogens and their range. On winter wheat, there are *cercosporella* , *ophiodisease* , *helminthosporia*, fusarium forms [9-12].

Root decay of wheat is ubiquitous. It is found in all areas of its cultivation of works were devoted to studying the bioecological features of wheat root decay pathogens, elucidating the

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conditions that promote or limit the manifestation and development of the disease , and substantiating measures to combat it [13-19]. However, this disease manifests itself from year to year and damages grain growing.

In the Republic of Uzbekistan, the areas under grain crops are increasing every year due to irrigated lands. However, on irrigated crops, more favorable conditions are often created for the development of epiphytotic ally dangerous diseases, namely root decay.

The purpose of this article was:

1. Study of the spread of wheat root decay on irrigated lands in the conditions of the Tashkent province.
2. Determine the harmfulness of wheat root decay.
3. To study the effect of rainfall on wheat precursors on the development of root decay.

2 Materials and Methods

The studies were carried out at the Department of Agricultural Phytopathology of the Tashkent State Agrarian University (TSAU). An examination of wheat crops of irrigated agriculture for its susceptibility to root decay was carried out in several farms of the Tashkent province: Kibrai province - farms of UzNIIR; "Limonchilik", Turon and experimental station of TSAU; Tashkent province - in the farm them. G.A. Abdullaeva; Urta-Chirchik province - in the farm of Yangi turmush; Buka province - in the farm them. I. Khozhimetov and Chinaz provinces - in the economy of Uzbekistan.

The prevalence of diseases and the degree of plant damage were determined by the method of route surveys and stationary observations [20-23].

The spread of the disease usually corresponds to the percentage of diseased plants in the sample and is determined by the formula:

$$R = n \times 100 / N;$$

R - the percentage of infestation or spread of the disease;
N - the total number of analyzed plants;
n - number of diseased plants in the sample;

The intensity of the development of the disease, as an integrated indicator, is determined by the formula:

$$P = W (a \times b \times 100) / k \times n;$$

P - the intensity of the development of the disease, %;
W (a x b) - the sum of the products of the number of plants and the corresponding score or percentage of damage;
K - the highest score on the scale;
N - the total number of plants in the sample.

The degree of infection of plants is determined as a percentage or points on a 4-point scale [11]:

0 - no signs of damage;
1 - at the base of the stem or on its underground part, brown strokes or narrow stripes;
2 - at the base of the stem or on its underground part, root stripes covering more than half of the surface of the organ;
3 - continuous browning of the first stem and underground internode;
4-lack of productive stems in the presence of symptoms on a score of 3.

The harmfulness of the disease was determined by weighing separately the harvest obtained from healthy and diseased plants. To study fungi developing directly on the surface of leaves, stems, and roots of wheat, the wet chamber method was used [1].

3 Results and Discussion

To identify wheat root decay and determine its pathogens, we carried out route surveys of winter wheat crops in the germination and tillering phases.

The results of the survey of wheat crops in 2019-2020 are presented in ***Table 1*** show that the most intensive development and spread of the disease in the phase of germination and tillering was noted in the economy of the Kibrai province, UzNIIR (60.8% and 26.8%; 51.6% and 21.4%).

The spread of root decay in the Tashkent province in 1999-2000 is presented in ***Table 1***. As the data show, in the farms of the Kibrai province at the experimental station of TDAU, the spread of the disease reached 43.3%, and the development was up to 19.6%. In the tillering phase, respectively, 40.0% and 17.5 %. In the UzNIIR farm, distribution and development reached 41.6% and 17.7%, and in the tillering phase, respectively, 37.5% and 16.8%.

Conducted data indicate that in 2019 - 2020, the least development and spread of root decay was noted on the “Limonchilik” farm, and the largest on the farm of the Tash GAU Experimental Station. A similar pattern manifests itself in the tillering phase.

There is evidence in the literature that the percentage of plants with root decay varies depending on the predecessor, unfavorable meteorological conditions, and a low level of agricultural technology. This apparently can explain the unequal distribution and development of the disease in different farms of the Tashkent province over the years.

[15].

Under natural conditions, wheat root decay often manifests itself with a lack or sharp fluctuation of moisture in the soil, especially in the first half of the growing season. These conditions limit the normal development of plants and disrupt the relationship between plants and the pathogen.

An increase in air and soil temperature in the initial period of wheat vegetation dries out the upper soil horizons, disrupts the normal water supply of plants and adversely affects the formation of a secondary root system; plants weaken and become more susceptible to disease [9, 17].

Table 1. Distribution of wheat root decay on farms Tashkent province in 2019-2020.

Place of experiment	Area,ha	Seedlingphase						
		Plantsaffectedbypoints					Distributionofdiseases,%	Developmentofthedisease,%
		0	1	2	3	4		
Kibrai province, experimental station of the TSAU	5	68	25	14	11	2	43.3	19.6
Kibrai province, farm “ Limonchilik ”	45	75	17	18	10	0	37.5	17.2
Kibrai province. UzNIIR	10	70	23	19	8	0	41.6	17.7
Tashkent province, farm them. G. Abdullaeva	80	80	18	14	8	0	33.3	14.5
Urta-Chirchik province, Yangi Turmush farm	215	71	17	21	10	1	40.8	19.3
Bukinsky province, farm them. Y.Khozhimetova	410	73	20	17	10	0	39.1	17.5
Chinaz province, economy “Uzbekistan”	335	87	13	14	6	0	27.5	12.2
Kibrai province, Turon farm	110	84	16	12	8	0	30.0	13.3
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		Plantsaffectedbypoints					**Distributionofdiseases,%**	**Developmentofthedisease,%**
		0	**1**	**2**	**3**	**4**		
Kibrai province, experimental station of the TSAU	5	72	22	16	10	0	40.0	17.5
Kibrai province, farm “Limonchilik”	45	97	9	9	5	0	19.1	8.7
Kibrai province. UzNIIR	10	75	20	14	11	0	37.5	16.8
Tashkent province, farm them. G. Abdullaeva	80	92	10	9	9	0	23.3	11.4
Urta-Chirchik province, Yangi Turmush farm	215	85	17	11	7	0	29.1	12.5
Bukinsky province, farm them. Y.Khozhimetova	410	81	19	12	8	0	32.5	13.9
Chinaz province, economy “Uzbekistan”	335	97	10	8	5	0	19.1	8.5
Kibrai province, Turon farm	110	93	12	8	7	0	22.5	10.2

According to S.M. Tupenevich [17] in the conditions of Northern Kazakhstan, a strong development of root decay on wheat was observed in dry years, when wheat plants experienced a lack of moisture in the soil. Drought-tolerant weakened plants fell out from root decay. This pattern is confirmed by A.F. Korshunova [10].

The study of the influence of rainfall on the development of root decay over the years is presented in Table 2. From the data presented in the table, it can be seen that the highest damage to plants by the disease was noted in 2019 year at.

In 2019, the autumn was dry until mid-January 2020, and only in January and early February there were slight precipitations, and in the spring, starting from March, there were heavy rains. This unstable water regime in the soil seems to make wheat plants dependent on rare and uneven rainfall, and this reduces the resistance of plants to the pathogen. Root decay, as our observations show, manifests itself and increases with an increase in temperature and relative humidity.

Consequently, the resistance of wheat to root decay depends on the temperature and humidity of the air (Table 2).

Table 2. Influence of rainfall on wheat root decay susceptibility.

Years	Rainfall (mm)			Temperature t0 - quarter			Root decay susceptibility,%	Grain yield per 1 ha, quintals	Crop losses, %
	IV	I	II	IV	I	II			
2018-2019	9.4	7.6	20.6	67.9	254.5	141.8	15.9	37.3	8.3
2019-2020	7.7	7.3	23.7	162.9	149.8	10.6	14.3	40.7	8.0

Root decay affects wheat in the germination and tillering phase. In the first phases of vegetation (germination - tillering), plant death is observed more. But with a strong infection of seeds, their seedlings are bent, shoots do not give nodal roots and often die. In the tissue of a diseased host plant, the fungus releases toxic substances, which causes a lag in growth and development in infected plants.

There is a lot of data in the literature on the effect of soil moisture on wheat root decay. In this regard, the next stage of our work was to study the effect of soil moisture on the susceptibility of wheat to root decay.

Wheat was grown against an infectious background in vessels with soil under different moisture regimes from germination to the middle of tillering and from tillering to the end of the growing season (Table 3).

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Table 3. Infection of wheat by the fungus Fusarium *oxysporum* with varying soil moisture.

Soil moisture per phase: (% of total water capacity)		Height plants before harvest, cm	Top sheet length, cm	Dead leaves in the feeding phase per 1 plant, %	Root weight (% To general weight of 1 plant)	Number of plants affected root decay, %	Grain harvest, mg
Seedlings - middle of eating	**Tillering - harvest**						
60	60	65.2	8.8	10.7	17.2	26.4	615
40	40	55.2	9.7	3.6	15.7	23.2	602
25	25	14.8	7.4	8.7	26.9	62.2	317
60	20-25	27.8	4.8	31.9	19.8	91.3	236

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The most unfavorable conditions for wheat plants turned out to be normal 60% soil moisture until the middle of the cutting phase and then a sharp decrease in moisture to 20–25% in the period from the cutting phase to ripening. At the same time, well-developed plants in the first period, after reducing the humidity to 20-25%, experienced a lack of moisture, which led to the early death of the leaves.

The moisture regime in the soil influenced the ratio of the weight of the root system to the weight of the above-ground plant organs. Optimum humidity at the beginning of the growing season contributed to the better development of the above-ground mass compared to the root system. With a lack of moisture in the soil from the tillering phase to the end of the growing season, a relatively poorly developed root system could not provide moisture to a powerful green mass of plants, this caused the death of the lower leaves, increased the susceptibility of plants to root decay (91% of plants were affected by the disease – Figure 1). The most resistant to root decay were plants provided with moisture during the entire growing season. The results of the experiment confirm the importance of soil moisture in reducing the development of wheat root decay. This pattern is consistent with the statement by Korshunova et al. [11].

Our observations have shown that all plant organs are affected by root decay: roots, stems, sheaths of lower leaves and ears. Affected roots become brittle and break off when the plants are pulled out of the soil. The tillering nodes become loose and lose their strength. Severely affected seedlings often die before reaching the soil surface. In diseased seedlings, the tops of the leaves often turn yellow and dry out. The roots first turn brown, thin out, necrotic spots appear on them. The greatest number of dead plants occurs during germination and tillering. Plants affected in subsequent phases are rare and suffer less from the disease, plants are stunted, ears are underdeveloped and either contain many empty and feeble spikelet's and die less frequently.

Fig. 1. Symptoms of root decay of wheat.

The harmfulness of root decay is manifested in a shortening of the length of the stem, a decrease in the number of grains in the ear and the length of the ear (Table 4).

The table shows that in plants affected by root decay, the height of the stem is noticeably reduced compared to healthy ones. Thus, in the Sanzar variety, the height of a healthy plant was 80 cm, and in diseased plants it was 49.0 cm, while the length of a healthy spike was 7.2 cm, and that of a diseased one was 6.6 cm.

In addition, damage to grain by fusarium reduces its technological qualities. In the grain unaffected by Fusarium, the amount of starch is 67.9 to 73.6%, in the affected grain no more than 67%. In diseased grain, the amount of total nitrogen decreases. If in an unhealthy grain the content of total nitrogen is 0.90%, then in a diseased grain it is only 0.67%.

Table 4. Effect of root decay on the growth and development of wheat.

Variety	Plant growth	Height of plants (cm)	Length of ears (cm)	Quantity (pcs)		Coef. Malware
				Ear of wheat	Grains in a spikelet	
2019						
Sanzar-8	Healthy Stricken	80.0 49.0	7.2 6.6	15.0 12.5	33.0 26.0	11.8
Intensive	Healthy Stricken	90.0 55.0	7.5 6.9	16.4 14.0	35.0 28.0	8.3
Unumli	Healthy Stricken	75.5 67.4	6.6 5.9	14.0 11.0	30.0 26.0	10.1
Scythian	Healthy Stricken	81.2 72.4	7.4 6.2	15.0 13.0	31.5 27.0	6.9
yongbosh	Healthy Stricken	78.6 70.4	7.0 6.4	12.5 10.0	30.0 27.5	9.2
2020						
Intensive	Healthy Stricken	87.0 59.4	7.4 6.5	16.0 13.4	32.0 26.4	9.3
Unumli	Healthy Stricken	79.6 72.1	7.0 6.3	14.0 12.0	30.0 26.0	9.9
yongbosh	Healthy Stricken	79.5 71.4	7.3 6.2	15.0 13.5	34.0 29.0	9.3
Yuna	Healthy Stricken	75.4 66.9	6.8 6.0	13.0 11.0	28.0 24.0	7.4

In our research, we studied the harmfulness of root decay wheat by determining the yield of grain from 1 hectare in quintals. The results presented in Table 5 show that the highest grain yield was obtained on the farm "Uzbekistan" in the Chinaz province (40.5 c/ha), and the lowest in UzNIIRe Kibrai province (22.8 q/ha).

These data indicate that root decay has a negative impact on grain yield, and if wheat varieties are renewed annually on farms and crop rotation is observed, then yield losses are not significant (Table 5). It should be noted that the greatest development of root decay on wheat manifested itself in the fields where cotton had previously grown. It should also be noted that if another crop is sown after cotton, and then again cotton, then the susceptibility of wheat to root decay is higher compared to other predecessors.

Table 5. Harmfulness of root decay of wheat in the fields of Tashkent depending on the predecessor 2019-2020.

Place of examination	Variety	Definitions	Development of the disease, %	Coefficient harmfulness, %	Grain harvest from 1 ha, quintals	Losses of harvest, %
Kibrai province, experimental station of the TSAU	Sanzar-8	Wheat	22.7	11.8	30.8	10.4
Kibrai province, farm “Limonchilik”	Intensive	Peas	14.1	8.6	41.2	8.3
Kibrai province. Uz.NIIR	Unumli	Wheat	24.1	10.1	22.8	9.8
Tashkent province, farm them. G. Abdullaeva	Intensive	Corn	9.8	8.5	42.5	8.4
Urta-Chirchik province, Yangi Turmush farm	Scythian	Cotton	17.1	6.8	30.5	6.8
Bukinsky province, farm them. Y.Khozhimetova	Yonbosh	Cotton	19.9	9.2	32.2	9.0
Chinaz province, economy “Uzbekistan”	Scythian	Wheat	9.0	7.0	40.5	8.0
Kibrai province, Turon farm	Intensive	Tomato	11.2	8.0	41.5	7.9

Similar results were obtained by us. So, in the Tashkent province in the farm them. G. Abdullayev, the variety “Intensive” was sown for three years in a row, while the alternation of crops under wheat was observed, and the degree of development of the disease did not increase over the years. Of all the examined varieties, the Intensive variety turned out to be the most susceptible to root decay, in comparison with other varieties. The Yuna variety turned out to be less susceptible.

The above data indicate that the introduction of crop rotation under wheat limits its susceptibility to root decay. The alternation of crops improves soil fertility, improves the water regime, activates the soil microflora and positively affects the development of wheat, increasing its resistance to the pathogen.

4 Conclusions

Thus, on the basis of the conducted research, the following conclusions can be drawn:

1. Root decay on winter wheat in the conditions of the Tashkent province in the surveyed farms is widespread, while all organs of wheat are affected - roots, stems, sheaths of the lower leaves and ears.

2. Root decay is harmful in the initial phases of plant development, when plants feed on the primary root system and do not yet have secondary roots.

3. The harmfulness of the disease is manifested in the shortening of the stem length, a decrease in the number of grains in the ear and the length of the ear, as well as in the deterioration of the sowing qualities of seeds, the percentage of defective, feeble grains increases.

4. Wheat predecessors have a great influence on limiting the development of wheat root decay. The most favorable effect on disease control was exerted by such predecessors as alfalfa and corn.

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