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Cotton Morbidity by Verticillosis Depending on the Load of the *V. Dahliae* KL Fungus

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1. Introduction

Cotton wilt damage volume and intensity is highly dependent on the amount of infection in the soil. Evenwilt-resistant cotton varieties fall ill in large amounts with relatively high soil saturation with fungus.

Accumulation of a large amount of infection in the soil is often the reason that relatively resistant varieties in natural conditions become very sick with wilt. At the progression of the disease, it is often concluded that the bred new resistant varieties have lost their original resistance due to a change in the virulence of the parasite, which, as some researchers assume, to adapt to the newly bred varieties [4, 5].

It is not always possible to agree with this conclusion, since individual varieties of cotton have been sown in industrial crops for more than twenty years and it is not noted that they are more affected by wilt than newly bred resistant varieties to which the mushroom could not yet adapt [6, 7].

A fact that during long-term storage in the collection they have been preserved for a long time, for decades, the relative resistance of cotton varieties to verticillosis resistance is preserved.

2. Research Methods

Investigations were carried out in vessels. Different amounts of oats infected with the fungus were introduced into healthy soil from 20 g to 80 g. Wagner vessels were designed for 30 kg of soil.

In a vegetation experiment, where a different amount of oats infected with a fungus was introduced into a healthy vascular soil, the incidence of cotton plants varied greatly.

With an increase in the content of infected oats from 20 to 80 g, the number of plants infected with verticillosis increased from 28 to 100%.

With an increase in infection, plants became sick earlier, they sharply stunted in growth, their disease manifested itself more strongly, as a result of which most plants wilted during the growing season, without giving a harvest.

At the lowest infection dose (20 g), plants fell ill relatively late, they all survived, but compared to healthy plants, the yield of raw cotton decreased significantly.

The plants appearance, growing under different loads of parasitic fungi depended not only on the amount of oats introduced into the soil, but also on the resistance to strain of the cotton variety

3. Results and Discussions

In AN-14 variety cotton plants that were severely affected by verticillosis, under a large load of infection, the disease externally manifested itself much more sharply than in plants of the relatively stable IL-32 variety (Fig -1).

The same design is observed for other varieties differing in degree of resistance to verticillosis.

In another growing experiment, we studied various infectious loads (20, 40, 80 g) on the harvest of raw cotton.

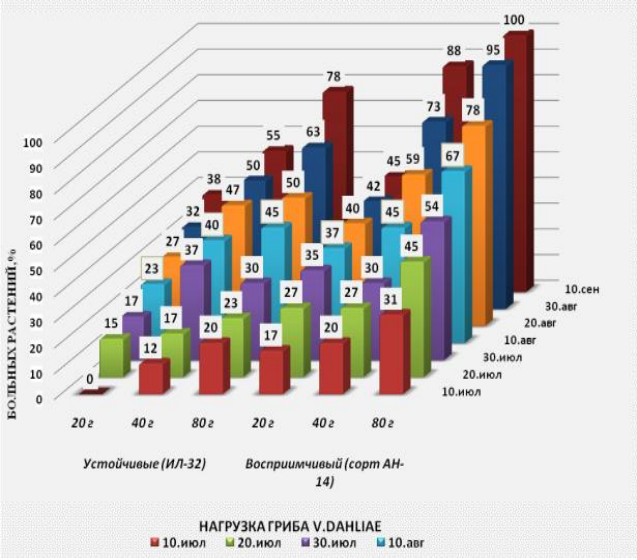

Figure 1: Dynamics of the wilt development at various loads

According to the dynamics of plants' morbidity, as it can be seen from the data of Fig. 2, the harvest of raw cotton. In the experiment variant, where the disease manifestation was earlier observed, the yield sharply decreases, more sharply in the AN-14 variety,which is very affected by verticillosis, than in the relatively stable IL-32 variety. Most of the plants of the susceptible cultivar AN-14 are apparently very ill.

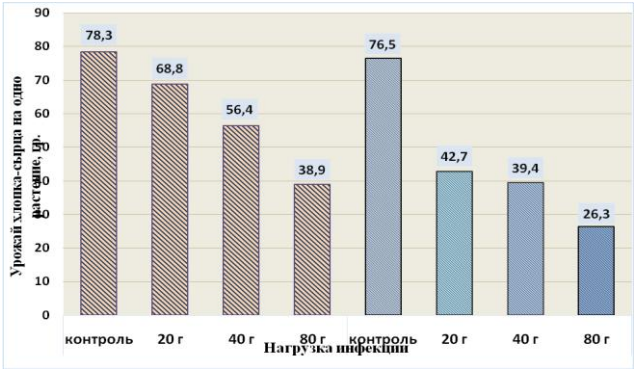

Figure 2: Harvest of raw cotton per plant for various infectious loads

In our vegetation experiment with varieties differently related to verticillosis, it was shown that the dynamics and the general level of damage of plants by the wilt and the yield of raw cotton also strongly depend on the infection load in the soil.

On the naturally infected background in the field conditions, an experiment was also carried out on two IL-32 varieties (stable) and AN-14 (susceptible), as well as the interspecific hybrid F_4 *G. hirsutum x G. barbadense*.

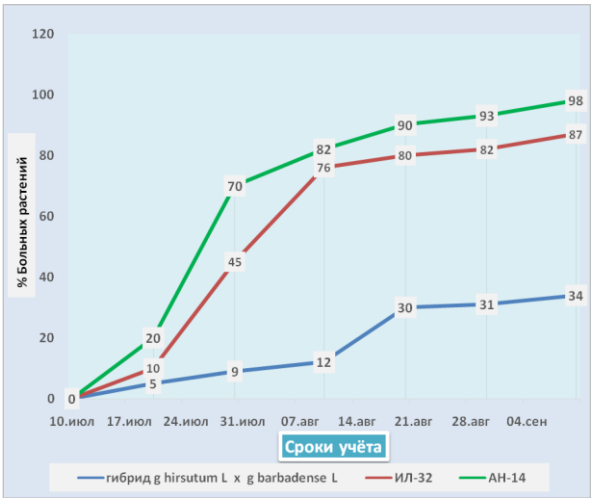

Figure 3: The morbidity of cotton by verticillosis depending on the load of *V.dahliae* fungus

Figure 3 shows a diagram showing the degree of variation in the morbidity of cotton plants depending on the resistance of varieties and forms taken into investigations.

In the relatively stable interspecific F_4 hybrid (*G.hirsutum x G.barbadense*) by the end of the growing season, diseased plants had only 34%, while in the susceptible AN-14 variety, 98% among registered plants fell ill.

In plants of AN-14 variety severely affected by verticillosis with the same infection load, the pathology externally manifested itself much sharper than in plants of the relatively stable IL-32 variety and even more so than in the interspecific hybrid in the F_4 interspecific hybrid (*G. hirsutum x G.barbadense*) .

It was revealed influence of the temperature factor on the growth of certain species of fungi (*Verticillium* and *Fusarium*), which cause wilt in cotton and many other plants. As saprophytes they live in the soil, and a parasitic lifestyle is carried out in the vascular system of plants, populating the gaps of the conducting vessels [2, 3].

Causative agent of the fungus *V.dahlia* belongs to the order of hyphomycetes of the class of imperfect fungi. It can affect cotton, starting from the cotyledon formation phase and until the end of the growing season. Infection of plants occurs mainly through the roots. Under the influence of root secretions, at the corresponding humidity (13% of the full moisture capacity and above) and temperature (23-26°C) microsclerotia begin growing. Soils most favorable for the fungus with a reaction of the medium close to neutral [1].

Oidia and conidia of the fungus formed inside the plant move along conducting vessels along with an upward flow of water from the root to the leaves, systemically infecting all plants

The beginning of the disease with a verticillosis wilt is confined to a certain phase of plant development. Damage to cotton usually begins before the onset of the flowering phase, and then the disease can grow, until the end of the growing season. The growth rate, as a rule, is uneven and varies greatly during the growing season. The fluctuation depends on various factors, among which the water regime, mineral nutrition and the amount of infection in the soil are of great importance. However, the determining factor here is obviously temperature. It determines not only the general incidence of plants, but also the rate of manifestation of wilt during vegetation.

We were interested in finding out the reaction to the temperature of various varieties of cotton, which were sown on naturally contaminated soils by *Verticillium* fungus. Among the varieties were both resistant and susceptible to verticillosis.

The varieties resistance to verticillosis wilt was studied against a naturally highly infected infectious background. In the experiment, varieties susceptible KS-1, AN-14 and resistant IL-296, IL-1378, IL-32 varieties took part.

The connection of the wilt with the air temperature was taken into account systematically with an interval of five days

Results of this experiment are given in table 1. As it can be seen from the table, all susceptible varieties show increased infectivity with wilt compared to resistant varieties, while the nature of the manifestation of the disease in dynamics remains approximately the same for both resistant and highly affected varieties. The first diseased plants in the experiment appeared in the second half of June and then the disease began to progress and only towards the end of July the rate of its growth sharply slowed down, which is a reflection of the increased external temperature during this period (see Fig. 2).

Reverse correlation between the increase in wilt and the increase in air temperature is well pronounced in both

groups of varieties, the difference is manifested only in the fact that the susceptibility of the disease is much higher.

Above mentioned results do not give reason to doubt that fluctuations in air temperature during the growing season have a greater impact on the rate and level of susceptibility of cotton to a verticillosis wilt. Warming the air to about 35°C and above creates a temperature in the leaves and other organs of plants that is not suitable for the development of the fungus verticillosis in them, resulting in wilt depression.

The limit temperature for the development of the fungus - 30 – 31°C, but in the leaves of cotton it can grow and develop at a higher external temperature (34-35°C) since the leaves and a relatively large amount transport water, which takes heat to evaporate, and therefore their temperature decreases by about 4-5°C.

Possibly this fact is one of the reasons that contributes to the accumulation of more infection in the leaves of a sick wilt of cotton compared to other plant organs, which evaporate water to a lesser extent and, therefore, with an increase in air temperature can overheat more than leaves.

It is characteristic that when the air temperature drops, the disease progresses again, but no longer reaches the high rates observed in the first half of the cotton growing season. This is obviously explained by the fact that the main number of plants was already affected before the onset of temperature depression, and the remaining more resistant plants were less intensely affected by the end of the growing season

Some disturbances of the inverse correlation between an increase in air temperature and a decrease in the rate of disease are also possible due to vegetative irrigation, which significantly reduces the heat balance of the cotton field and, therefore, to some extent lead to an increase in cotton wilt.

Our investigations have shown that the temperature regime of air, and not soil, affects the growth rate of wilt in cotton. Fluctuations in the temperature of the plant affect the condition and development of the fungus in it, the manifestation of the disease depends on the degree of activity

It has been shown that the spread of *Verticillium* fungus in a plant is greatly influenced by the ambient temperature, which usually fluctuates very much during the day and throughout the growing season. In summer, at individual intervals, the air temperature reaches 35-40°C and higher. At such a high temperature, the body of the aerial parts of the plant warms up to more than 30°C, which undoubtedly leads to depression of the parasite fungus located in the sick wilt plant. As a result of an increase in air temperature, the morbidity of plants by verticillosis decreases.

Temperature regime of leaves and other above-ground organs changes due to changes in the temperature of the air surrounding them. However, the air temperature in hot weather is almost always about 3-6°C lower than the air temperature, this is due to the large heat consumption for water evaporation. Therefore, the temperature regime of leaves and other transpiring organs of plants are different than the air regime. Depression of a parasite fungus in a plant occurs, obviously, when air warms up to 35-36°C, at a temperature the plant warms up to 30-31°C and higher, which leads to inhibition of the parasite fungus.

In this way, fluctuations in air temperature during the growing season have a great influence on the rate and level of susceptibility of cotton to a verticillosis wilt. Air warming up to 35° C and higher creates such a temperature regime in the leaves and other organs of the plant that is unsuitable for the development of the fungus verticillium in them, as a result of which wilt depression occurs.

Cotton varieties' morbidity by verticillosis wilt depends on the load of the infection in the soil. As the soil is saturated with a fungus - parasite, the difference in the number of affected plants between the resistant and susceptible forms is smoothed out. Differences between varieties are manifested only in the dynamics and in the degree of damage to plants, which are faster and more intense in susceptible varieties of cotton.

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Table 1: Dynamics of incidence (in% of diseased plants) with verticillosis of various varieties of cotton

Variety	May	June		July						August						September	
	20	25	30	5	10	15	20	25	30	5	10	15	20	25	30	5	10
Tolerance IL-32	0,1	0,3	0,5	1,6	2,2	5,8	7,5	8,1	8,4	8,7	9,1	9,7	10,4	11,5	12,3	14,1	15,7
IL-1378	0,4	0,9	1,1	1,9	2,8	6,1	7,9	8,9	8,9	9,7	10,4	12,2	13,4	16,9	18,9	18,9	19,9
IL-296	0,5	0,6	1,4	1,5	1,6	7,2	9,6	10,8	10,8	11,8	12,0	12,9	13,5	15,6	16,9	18,3	19,8
On average for a group of resistant varieties	0,3	0,6	1,0	1,6	2,2	6,4	8,4	9,3	9,4	10,0	10,5	11,6	12,4	14,2	15,2	17,1	18,5
Susceptible Tashkent-6	0,8	1,0	1,1	3,3	8,8	16,8	20,9	22,8	23,8	24,1	25,6	26,4	28,3	30,4	33,5	39,9	44,3
AN-14	1,2	3,1	4,3	7,8	10,6	17,7	27,8	36,4	36,4	38,8	39,1	40,0	45,4	53,4	58,8	63,1	73,4
KC-1	1,4	3,1	4,6	10,3	20,1	30,2	47,4	50,8	50,8	54,1	56,8	59,6	65,4	71,8	78,6	84,0	85,2
On average for a group of susceptible varieties	1,1	2,4	3,3	7,1	13,2	21,5	32,0	33,4	37,0	39,6	40,5	42,0	46,4	51,8	56,9	62,3	67,6