

Spread and development of *Verticillium* wilt or cotton wilt in the western part of Azerbaijan

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ABSTRACT

Almost 136 thousand hectares of cotton crops in Azerbaijan, the unique climate allows growing almost all cultivars of cotton. More than half of the cotton crops are in the Ganja-Kazakh geographical zone of the country. The development of cotton growing in Azerbaijan as a highly profitable sector of the economy is inextricably linked not only with active selection work, the introduction of new cultivars and progressive technologies, but also with the creation of an effective set of protective measures. In recent years, with the increase in areas under cotton and the growth of its productivity, the likelihood of the spread of harmful mycoses has significantly increased. Among the widespread diseases in cotton crops, *Verticillium* wilt occupies a special place. *Verticillium* wilt is a very harmful disease. During its development in the plant, the osmotic pressure and cell turgor decrease, transpiration increases, the flow of water and minerals to the roots and aboveground organs of the plant slows down, the parenchymatous cells of the wood die off and the leaves fall prematurely, which leads to a sharp decrease in the yield and quality of cotton. In connection with the above, the objective of our research was to study and diagnose *verticillium* wilt of cotton in the conditions of the western part of Azerbaijan. In the 2022-2024 research years, an assessment was made of the prevalence and intensity of *verticillium* wilt of cotton in the region, and a scientifically based and improved control system was developed. For this purpose, the following preparations were tested in the fight against *verticillium* wilt of cotton: Kolosal Pro, EC, Fitolavin, VRK and control without chemical treatment. Analysis of the conducted field studies show that the fungicide Fitolavin, VRK on all cultivars of cotton showed high biological efficiency against the disease.

Keywords: cotton, *verticillium* wilt, prevalence, development, harmfulness

INTRODUCTION

Cotton is one of the most valuable agricultural plants of the spinning group. The main product for which it is cultivated is fiber. It is formed in the form of hair-like growths on the seeds. This distinguishes cotton from bast spinning plants, in which the fiber develops in the bast part of the stem (Mukhamedzhanov, 1960).

Despite the great successes achieved in the production and use of various types of artificial fiber, cotton fiber, due to its versatility, still retains its exceptional importance. It is mainly used for the production of various cotton fabrics. There is not a single branch of the national economy that would not use cotton materials and products to one degree or another (Kurbanov *et al.*, 2018). In addition to regular yarn and a wide cultivar of clothing and underwear fabrics, cotton fiber is used to produce sewing threads, ropes, cables, fishing tackle, drive belts, conveyor belts, special fabric for rubber hoses (sleeves), filters, electrical insulation winding, artificial silk (viscose), and cotton wool. The fiber of some cultivars of cotton is used to produce special cord fabrics used in the automobile industry for tire gaskets, for making parachutes, tarpaulin, etc. Cotton fiber can also be used to make celluloid, photographic films, varnishes, high grades of writing paper, and many

other different materials and products. It is also used as an admixture to wool and silk (Firsov 2006; Fedotov *et al.*, 2015).

Cotton seeds are of great value; after the fibers are removed, they are partly used for sowing, and mainly processed to obtain various products, in particular oil. It is used as food and for technical purposes. Refined cottonseed oil has very high nutritional qualities and is considered almost equivalent to Provencal oil, so it is widely used in the canning industry. It is also used to make margarine, artificial lard, laundry and toilet soap, technical oils and drying oil. Glycerin, stearin and a number of other products are obtained from it. The cottonseed cake and meal remaining after oil separation are good concentrated feed for some domestic animals (Baranov *et al.*, 1994; Stupin *et al.*, 2014). Gossypol is extracted from the seed kernel, from which polymers, varnishes, heat-resistant coatings, medicines, dyes and some other materials are produced. A waste product of the cotton oil industry, gossypol resin (tar), is very heat-resistant and can be used to produce heat-resistant varnishes, and in foundry - to make molds. A polymer used to make very durable products has been isolated from cotton tar, and as an admixture it can be used for hard road surfaces. Cotton is an excellent honey plant, so beekeeping can be successfully developed near its crops (with some restrictions on the use of pesticides to control pests and diseases). In total, more than 150 types of various materials and products are produced from cotton fiber, seeds and other parts of the plant (Pasypanov 2015; Savelyev 2019).

All types and forms of cotton make up one genus - gossypium (*Gossypium* L.), which is part of the mallow family (*Malvaceae* Juss.) (Figure 1). It originated in the tropical zone of the globe, where the air temperature in the coolest month of the year is not lower than 18 °C. Cotton is a perennial woody plant. In its homeland, it grows not only in culture, but also in the wild, representing bushes and trees of various sizes up to 6-7, less often up to 10-12 m in height. The longevity of different forms of cotton is not the same. Usually tall forms are more durable. Low-growing forms (small bushes), cultivated in the former USSR and other countries, are also perennial by nature. However, in the cotton-growing regions of the former USSR (including Azerbaijan), there are frosts in winter, so cotton can only grow as an annual crop. If it is placed in a greenhouse during the period of frost, it will live for several years (Kozlovskaya 2015). The first centers of cotton cultivation and the use of its fiber for spinning and weaving were India and, apparently, Southeast and Central Africa in the Old World; Peru, Mexico and the Antilles in the New World (Torikov *et al.*, 2020).

Verticillium wilt (*Verticillium dahliae* Kleb.) is registered everywhere in the cotton area of the former USSR. The disease is most severe in Uzbekistan, Kyrgyzstan, a number of regions of Tajikistan, Kazakhstan and Transcaucasia (Peresypkin 1989; Nerozin 2005; Beloshapkina 2015). The causative agent of tracheomycotic wilt of cotton is the fungus *Verticillium dahliae* Kleb. It has only an anamorphic stage in its life cycle. Structurally, it is represented by microsclerotia up to 0.1 mm in size and septate colorless mycelium with whorled conidiophores, on the sterigmata of which unicellular, colorless conidia are formed in the heads. With the help of microsclerotia, the fungus is able to survive in the soil for several years. In humid conditions, a white sporulation coating appears on the affected cotton. The causative agent of the disease is polyphage. Since, in addition to cotton, it affects many field crops, grasses and tree species.

The main symptom of cotton wilt is tracheomycotic wilt, caused by damage to the vascular system, due to mechanical blockage of vessels by a mass of pathogens or their destruction by toxins (Pospelov *et al.*, 1979; Durinina *et al.* 1984; Karbozova *et al.*, 2015).

The aim of our work was to study the prevalence, intensity of development and harmfulness of verticillium wilt (*Verticillium dahliae* Kleb.) in the conditions of the western part of Azerbaijan, as well as to develop a system of measures to protect cotton bushes from this disease.

MATERIALS AND RESEARCH METHODS

The investigations took place within Goranboy region describe the place, located in the west of Azerbaijan. For three consecutive years (2022-2024) the spread, development and harmfulness of verticillium wilt of cotton (*Verticillium dahliae* Kleb.). The soil of the experimental plot is chestnut. The area of the experimental plot is 20 hectares, the experiment was repeated 4 times. Different varieties of cotton were used in the studies ('*Ganja-160*', '*AzNIHI-195*', '*Agdash-3*' and '*Marash*'). The disease was monitored from the beginning to the end of the growing season. Cotton bushes affected by the disease were examined in the fields and samples were taken from their infected plant organs. They were studied in the laboratory. Microscopic analysis of the collected material was carried out in the Central Phytosanitary Laboratory of the Azerbaijan Institute of Food Safety. Meteorological conditions during the years of study were generally favorable for the growth and development of cotton. The prevalence and development of the disease were considered according to M.I. Dementyeva. (Dementyeva, 1985). The intensity of damage to cotton bushes by verticillium wilt (*Verticillium dahliae* Kleb.) was assessed on a scale: 0 points - no damage; 1 point - 1 to 10% of the leaf surface is damaged; 2 points - 11 to 25% of the leaf surface is damaged; 3 points - 25 to 50% of the leaf surface is damaged; 4 points – more than 50% of the leaf surface is damaged.

RESULTS AND DISCUSSION

As a result of the conducted route surveys, verticillium wilt of cotton (*Verticillium dahliae* Kleb.) was registered in all western regions of Azerbaijan (Table 1).

Table 1. Spread and intensity of development of verticillium wilt of cotton (*Verticillium dahliae* Kleb.) in the conditions of the western part of Azerbaijan (Goranboy district, 2022-2024)

Cultivars	2022 year		2023 year		2024 year	
	P (%)	R (%)	P (%)	R (%)	P (%)	R (%)
' <i>Ganja-160</i> '	23.4	15.8	23.8	16.0	24.1	16.3
' <i>AzNIHI-195</i> '	56.7	29.8	57.9	30.1	59.5	30.8
' <i>Agdash-3</i> '	61.1	30.3	62.7	30.7	63.8	31.5
' <i>Marash</i> '	22.0	15.0	22.5	15.2	22.6	15.2

Note: P – disease prevalence, %; R – disease development intensity, %



Figure. 1. Cotton field (*a*-close-up and *b*-view from a distance)

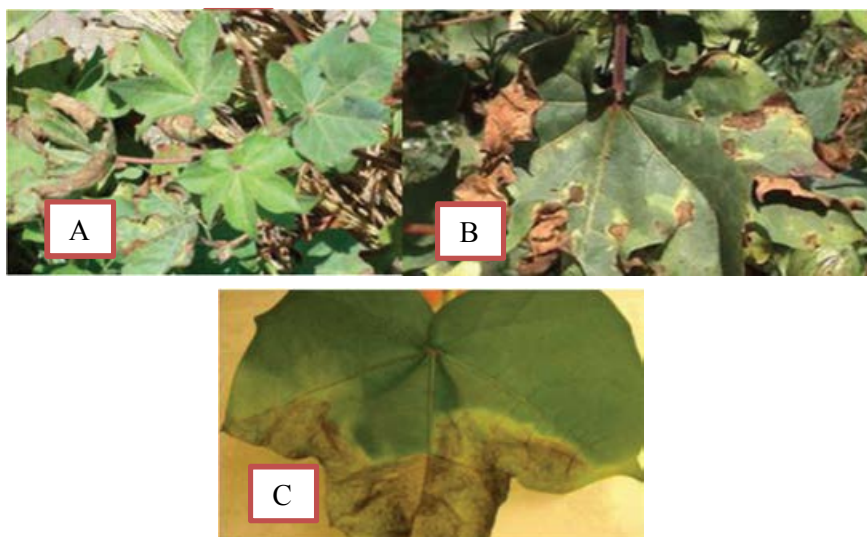


Figure. 2. *a* – affected leaves; *b* - the formation of necrotic areas on diseased leaves; *c* - drying cotton leaves affected by wilt

The first signs of wilt appear in the phase of 3-4 true leaves between the veins. Intensive manifestation of the disease is observed at the beginning of flowering. The affected leaf tissue first loses turgor, then becomes pale green or yellow, and then dries up (Figure 2). The disease, reaching the capsules, penetrates the seeds. The affected tissue of the conducting vessels of the leaves, petioles, stems and capsules becomes dark brown, which is a characteristic sign of the disease. In case of epiphytotic, the crop acquires the appearance of being burnt by fire. Populations of *Verticillium dahliae* Kleb. are heterogeneous in terms of virulence. The causative agent of the disease most severely affects cotton at an air temperature of 23-25°C and a soil moisture of 60%. The disease is most intense in irrigated agriculture and in areas with high saturation of field crop rotations with cotton and untimely replacement of susceptible varieties with resistant ones.

Verticillium wilt (*Verticillium dahliae* Kleb.) is an extremely harmful disease of cotton, since its infestation can exceed 60%. The disease is most harmful to medium-fiber varieties (*Gossypium hirsutum* L.). Fine-fiber cotton (*Gossypium barbadense* L.), although affected by wilt, exhibits a certain tolerance to *Verticillium dahliae* Kleb., so its yield losses from the disease are significantly less.

In Azerbaijan, located in the very center of the "Silk Road", they were also engaged in the production of snow-white fiber. During expeditions, archaeologists of the country discovered ancient irrigation systems, which indicated that cotton was grown in our country in ancient times. Cotton (*Gossypium* L.) is affected by many diseases, among which Verticillium wilt (*Verticillium dahliae* Kleb.) causes considerable harm, reducing the quantity and quality of the harvest or causing premature death of plants (Figure 4).

The conducted studies have established that in the western part of the country (in the Goranboy region), verticillium wilt of cotton is very widespread. Regarding the response of the cultivars to this disease, in the years 2022-2024, the greatest damage was observed in the cultivars 'AzNIHI-195' and 'Agdash-3' cv. and 'Agdash-3' where disease prevalence was between 61.1 % and 53.8 for 'Agdash-3', and 56.7 and 59.5 for 'AzNIHI-195' cv.

At the opposite pole, the results showed high tolerance to this disease for the cotton cultivars "Ganja-160" and 'Marash'. For the latter, the prevalence of the disease in the three years of studies was between 22.0% and 22,6 % for the Marash cv. and varied between 232.4 % and 21.1for the *Ganja-160*cv.



Figure 3. The cutting of an affected cotton stem

Figure 4. Death of a cotton bush under the influence of wilt

Therefore, the cultivation of resistant cultivars of cotton (*Gossypium* L.) to the cryptogram disease attack could be one of the agronomic control measures for the western part of Azerbaijan.

As already noted, we paid some attention to the development of a chemical method against verticillium wilt of cotton (*Verticillium dahliae* Kleb.). The following fungicides were tested for this purpose: Kolosal Pro, EC (300 g/l propiconazole + 200 g/l tebuconazole) and Fitolavin, VRK (BA-120000 EA/ml), applied in the periods mentioned in table 2.

Table 2. Effect of fungicides on the spread and development of verticillium wilt of cotton (*Verticillium dahliae* Kleb.) (2022-2024)

Fungicides	Period and number of treatments	Cultivars	2022 year			2023 year			2024 year		
			P (%)	R (%)	BE (%)	P (%)	R (%)	BE (%)	P (%)	R (%)	BE (%)
Kolosal Pro. EC (300 g/l propiconazole + 200 g/l tebuconazole)	In the phase after flowering (3)	'AzNIHI-195'	28.0	16.7	50.1	26.1	14.9	57.3	22.0	13.6	63.0
		'Agdash-3'	26.0	15.9	64.0	25.5	15.0	66.1	20.1	14.7	67.0
		'Marash'	15.5	7.9	74.0	15.0	6.9	76.0	15.0	6.8	77.0
		'Ganja-160'	14.4	6.6	77.0	14.5	6.7	76.0	14.2	6.1	79.4
Fitolavin. VRK (BA-120000 EA/ml)	Before flowering (3)	'AzNIHI-195'	20.0	13.2	61.0	19.2	12.0	66.0	18.5	10.0	73.0
		'Agdash-3'	19.9	9.8	78.0	19.4	9.0	80.0	19.0	8.8	80.3
		'Marash'	15.0	7.1	76.3	15.0	7.0	76.0	14.5	6.5	75.3
		'Ganja-160'	14.5	6.3	78.0	14.2	6.1	78.1	14.0	6.2	79.1
Control (without chemical treatment)	x	'AzNIHI-195'	66.9	33.5	0	71.0	34.9	0	75.5	36.6	0
		'Agdash-3'	77.7	44.0	0	77.9	44.3	0	80.5	44.6	0
		'Marash'	49.0	29.9	0	48.2	28.9	0	49.1	29.0	0
		'Ganja-160'	48.8	28.7	0		27.9	0		29.6	0

Note: **P** – disease prevalence, %; **R** – disease development intensity, %; **BE** - biological efficiency, %

CONCLUSIONS

The article presents the results of stationary and route studies on the study of *Verticillium* wilt of cotton, analyzes the parasitic features of the fungus *Verticillium dahliae* Kleb. The results and analyzes of field experiments conducted over 3 years are presented. The experiment included 4 cultivars of cotton ('*Ganja-160*', '*Agdash-3*', '*AzNIHI-195*' and '*Marash*'). In the field experiment of 2022-2024, cotton bushes were treated with fungicides - Kolosal Pro, KE (300 g / l propiconazole + 200 g / l tebuconazole) and Fitolavin, VRK (BA-120000 EA / ml). Analysis of the obtained data showed that in 2024, as well as in 2023, the best result against wilt was obtained in the case of Fitolavin.

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