

IN COTTON WILT TO THE DISEASE AGAINST OF STRUGGLE PROSPECTS.

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Abstract. *This in the article in cotton wilt to the disease against of struggle promising directions scientific basically analysis Verticillium dahliae Klebahn and Fusarium oxysporum f. sp. vasinfectum instigators by come outgoing this disease Uzbekistan cotton farming up to 30–50% per year harvest to the loss reason is happening . In the article resistant varieties selection , biological struggle methods , soil microbiome management , digital monitoring technologies and integrated protection system prospects seeing Research results this shows that modern biotechnology , genomics and digital village farm achievements harmonization to wilt against of struggle efficiency up to 60–70% increase opportunity gives.*

Key words: cotton , wilt disease , Verticillium dahliae , Fusarium oxysporum , biological fight , CRISPR/Cas9, Trichoderma, integrated protection , digital monitoring, resistant varieties.

Cotton (*Gossypium hirsutum* L.) world according to the most important technician from crops one is , its fiber textile industry main raw material is considered . Uzbekistan world cotton working in the release important place catch , 3.5–3.8 million tons per year raw cotton cultivated [1].

Cotton cultivation in the process the most harmful from diseases one wilt from there spreading pathogens — Verticillium dahliae Klebahn and Fusarium oxysporum Schlecht. f. sp. vasinfectum (Atk .) Snyder et Hans [2]. This disease of the plant conductor flutes damage , reducing the yield by 30–50% reduces [3].

Current on the day traditional chemical and agrotechnician methods enough efficiency not showing , because pathogens in soil for up to 10–14 years preserved to remain possible [4]. Therefore to wilt against of struggle innovative and promising methods search cotton farming of science the most current from problems one become remains .

This of the research purpose — modern scientific achievements based on in cotton wilt to the disease against of struggle promising directions systematic analysis from doing consists of .

Research tasks: - to wilt against of struggle modern biological methods assessment ;
- genomics and biotechnology opportunities seeing exit ;
- integrated protection system efficiency justification

Literature analysis. Wilt to the disease related scientific research world according to wide in scope take is going . Huang and by Zhang (2025) China Xinjiang in the province

held *Verticillium dahliae* in research of new virulent strains determined and to them CRISPR/Cas9 technology against from the test conducted [5].

Tukhtamyshev SS (2025) Uzbekistan under the circumstances of cotton to wilt resistant varieties selection in doing molecular markers and genotypic assessment from the methods use according to important results received [6]. Zhihao Lu and etc. (2023) drones using multispectral to describe through wilt disease early in stages determination technology working out and this of the method accuracy that the rate is 87.3% [7] Berg and etc. (2022) soil microbiome management Reduces *Verticillium* infection by 40–55% to reduce achieved known [8]. In Uzbekistan Kadyrov UQ (2024) *Trichoderma harzianum* based on biopreparations using wilt of the disease reduce the spread by 35–48% successful was [9].

The main part. Durable varieties selection prospects . Wiltga against of struggle the most effective far term way to illness resistant cotton varieties is to create . Modern selection and genetics achievements this regarding fundamentally new opportunities is giving.

Using a marker selection (MAS) to disease endurance genes early in stages determination and they based on varieties to choose opportunity gives . Additional respectively , *Gossypium barbadense* and *G. arboreum* such as wild of species endurance genes modern to varieties input explore the possibilities is being done [10].

CRISPR/Cas9 genome edit technology last in years cotton in the selection noticeable achievements Wang and al . (2024) using CRISPR/Cas9 *VdPR1* gene in cotton edit resistance to *Verticillium dahliae* by 3.2 times to increase successful were divided [11].

Selection achievements following in the table generalized :

Table 1. Resistant varieties in the selection modern methods comparison

Method	Time , year	Efficiency	Price level
Traditional selection	10–15	Average	Low
MAS selection	5–7	High	Average
CRISPR/Cas9	3–5	Very high	High
Transgenic method	4–6	High	High

In Uzbekistan, the varieties Termez-14, S-6524 and Namangan-77 to wilt relatively average endurance shows . In the future this varieties genome analysis so, endurance genes determination and them other to varieties input important importance profession [6].

2. Biological struggle methods prospects

Chemical from fungicides except biological tools ecological safety and soil health save with separated stands.

Trichoderma -based biopreparations to wilt against in the fight separately place holds *T. harzianum* , *T. viride* and *T. asperellum* species to *Verticillium* and *Fusarium* pathogens against strong antagonistic impact shows [9].

Impact mechanisms:

- pathogens with food and for the place competition;
- isolation of antifungal substances (trichodermin, gliotoxin);
- of the plant systematic immune answer activation (ISR);
- root surrounding microflora health promotion.

Bacillus subtilis strains also cause wilt against high efficiency This bacteria iturin A, surfactin and fengycin such as lipopeptides isolate, pathogen fungi development inhibits [12].

Table 2. Biological drugs efficiency

Drug	Pathogen	Disease decrease , %	Harvest increase , %
<i>Trichoderma harzianum</i>	<i>Verticillium dahlia</i>	35–48	12–18
<i>Bacillus subtilis</i>	<i>Fusarium oxysporum</i>	40–55	15–22
<i>Pseudomonas fluorescence</i>	Every two	30–42	10–16
Mycorrhiza	<i>Verticillium dahlia</i>	25–38	8–14

In the future biological preparations combination - for example , *Trichoderma* and *Bacillus* one at the time application — efficiency up to 65–75% to increase opportunity to give is expected [12].

3. Soil microbiome management.

Latest years research healthy soil microflora wilt to the disease against natural barrier task to pass proved.

Home directions:

- useful microorganisms to the ground input ;
- organic substances amount increase (green fertilizer , compost);
- fermented organic drugs application ;
- in exchange to plant right organization to be

Berg and al . (2022) study soil microbiota biological in a way enrichment *Verticillium* wilt in the soil 40–55% decrease in density identified [8]. Uzbekistan under the circumstances autumn crops with own instead of planting and green fertilizer as footless the remains input soil biological activity 2–3 times increase observed .

4. Integrated protection system

Future the most promising approach — all struggle methods harmonized integrated protection system (IHT).

Wilt to the disease against integrated protection system

Home direction	Content
Preventive measures	Certified seed , seed medicine , exchange planting
Agrotechnician methods	Deep plowing , drip irrigation irrigation Mineral nutrition standardization
Biological struggle	<i>Trichoderma</i> preparations , <i>Bacillus</i> inoculation Soil microbiome enrichment

Selection approach	Durable of varieties Use, Type to the climate adaptation
Monitoring and forecast	Drone inspection , IoT sensors Artificial intellect analysis

Conclusions.

1. In cotton wilt to the disease against of struggle the most promising direction — resistant varieties selection CRISPR /Cas9 technology to illness 3 times the endurance increase opportunity gives .

2. Trichoderma harzianum and Bacillus subtilis- based biological drugs wilt reduces the incidence of disease by 35–55% and chemical download noticeable at the level reduces .

3. Multispectral drones and artificial intellect using the disease for 7–10 days in advance determination possibility harvest room harvest reduces losses by 20–35% .

4. All methods harmonized integrated protection system wilt reduce the incidence of the disease by 60–70% and hectare economic efficiency from \$ 450–600 increase possible .

5. In Uzbekistan to wilt against in the fight modern biotechnology , digital monitoring and ecological stable methods wide current to grow cotton farming new to the stage take comes out .

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