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DISTRIBUTION DYNAMICS AND DEVELOPMENT CHARACTERISTICS OF FUNGAL DISEASES IN GREENHOUSE-GROWN VEGETABLE CROPS

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ISSIQXONA SHAROITIDA YETISHTIRILADIGAN SABZAVOT EKINLARIDA ZAMBURUG‘LI KASALLIKLARNING TARQALISHI VA RIVOJLANISH XUSUSIYATLARI

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ДИНАМИКА РАСПРОСТРАНЕНИЯ И ОСОБЕННОСТИ РАЗВИТИЯ ГРИБКОВЫХ ЗАБОЛЕВАНИЙ ОВОЩНЫХ КУЛЬТУР В УСЛОВИЯХ ТЕПЛИЦ

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Abstract: The article examines the distribution dynamics and development severity of fungal pathogens in greenhouse-grown vegetable crops, focusing on tomatoes and cucumbers. Utilizing empirical phytopathological field assessments, the microclimatic correlations driving Powdery Mildew, Downy Mildew, and Fusarium Wilt outbreak patterns are systematically analyzed.

Annotatsiya: Maqolada issiqxona sharoitida yetishtiriladigan sabzavot ekinlari (pomidor va bodring)da zamburug‘li kasalliklarning tarqalish dinamikasi va rivojlanish darajasi tadqiq etilgan. Empirik fitopatologik kuzatuvlar asosida Un-shudring, Soxta un-shudring va Fuzariozli so‘lish kasalliklarining mikroklimat bilan bog‘liqligi tizimli tahlil qilingan.

Аннотация: В статье исследуются динамика распространения и степень развития грибковых патогенов овощных культур (томатов и огурцов) в условиях теплиц. На основе эмпирических фитопатологических наблюдений систематически анализируется корреляция вспышек мучнистой росы, ложной мучнистой росы и фузариоза с микроклиматом.

Keywords: Greenhouse cultivation, fungal pathogens, disease incidence, development severity, Powdery Mildew, Fusarium Wilt, microclimate, phytopathology, tomatoes, cucumbers.

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Kalit so‘zlar: Issiqxona madaniyati, zamburug‘li patogenlar, kasallik tarqalishi, rivojlanish darajasi, Un-shudring, Fuzariozli so‘lish, mikroklimat, fitopatologiya, pomidor, bodring.
Ключевые слова: Тепличное выращивание, грибковые патогены, распространение болезней, степень развития, мучнистая роса, фузариозное увядание, микроклимат, фитопатология.

Introduction

Greenhouse vegetable cultivation has emerged as a cornerstone of modern agricultural production, securing year-round food supply, stabilizing market prices, and significantly enhancing crop yield per unit area. In the Republic of Uzbekistan, the expansion of hydro-ponic and conventional greenhouse complexes stands as a key strategic component for optimizing agricultural exports and resource efficiency. However, the artificial microclimate within enclosed greenhouse environments—characterized by elevated relative humidity, localized ambient temperatures, and structural condensation vectors—creates a highly favorable ecosystem for the propagation and rapid evolutionary virulence of plant pathogens, particularly mycological (fungal) organisms.

Fungal diseases represent the primary biotic constraint degrading greenhouse harvest weight and post-harvest market quality. Pathogens such as Leveillula taurica (Powdery Mildew), Pseudoperonospora cubensis (Downy Mildew), and Fusarium oxysporum (Fusarium Wilt) can spread exponentially within a short period under unmanaged protective parameters. While modern agronomy relies heavily on routine chemical interventions, the emerging resistance of fungal strains and changing consumer demands for zero-residue organic vegetables require a deeper understanding of epidemiology.

Investigating the precise ecological factors driving spore germination and mapping out the specific correlation between microclimatic variations and disease severity is highly essential for designing non-hazardous bio-control mechanisms. This study aims to evaluate the distribution dynamics, infestation pathways, and physiological development profiles of prominent fungal strains affecting greenhouse tomatoes and cucumbers under varying environmental protocols.

Materials and Methods

The empirical infrastructure of this investigation is based on an integrated phytopathological monitoring design conducted across experimental greenhouse blocks over a full multi-seasonal crop cycle. The tracking program focused on intermediate varieties of indoor tomatoes (Solanum lycopersicum) and cucumbers (Cucumis sativus). Fungal disease distribution and development kinetics were evaluated using standard international agricultural scaling matrices, calculating metrics through McKinney and Abbott formulations to gauge spatial severity profiles.

In local agricultural science, the fundamental taxonomies of mycological plant infections and the regional mapping of crop vulnerabilities across central Uzbekistan were structured by Sh.T. Xodjayev, who emphasized the economic utility of balancing chemical inputs with targeted microclimatic modulation [1, P. 114]. Furthermore, the specific evolutionary adaptations of Fusarium and Oidium

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strains within protected soil ecosystems have been comprehensively traced by B.A. Sulaymonov [2, P. 85].

On the global scientific stage, the exact environmental thresholds accelerating fungal sporulation, mycelial extension, and host-tissue penetration were mathematically modeled by G.N. Agrios [3, P. 210]. Modern developments in greenhouse disease management, including the deployment of precision sensor tracking to predict early-stage oomycete outbreaks, have been critically documented in the works of Jarvis and Chet [4, P. 142; 5, P. 94].

Building on these established theories, a localized synchronous field study was executed. Quantitative monitoring utilized automated air-soil sensor arrays to record ambient temperature and relative humidity hourly, matching environmental fluctuations directly against weekly macroscopic visual crop inspections to quantify real-time pathogen expansion rates [6, P. 18].

Results

The clinical data compiled throughout the multi-month monitoring loop confirms a direct correlation between greenhouse environmental control settings and the absolute operational metrics of fungal infestation. Disease performance was cross-evaluated between automated microclimate structures (Experimental Group - managed at 65-70% Relative Humidity via automatic ventilation and sub-surface watering) and traditional manual greenhouses (Control Group - prone to humidity peaks exceeding 90% during evening cooling phases).

Table 1

Phytopathological Distribution Dynamics and Development Severity of Fungal Strains Across Controlled Greenhouse Tracking Lines [3, P. 215; 6, P. 24]

Targeted Vegetable Crop & Specific Fungal Strain	**Control Group: Disease Incidence (%)**	**Control Group: Development Severity (%)**	**Experimental Group: Disease Incidence (%)**	**Experimental Group: Development Severity (%)**	**Statistical Certified Value**
Tomato: Powdery Mildew (L. taurica)	48.5%	24.2%	**18.2%**	**6.4%**	$t=4.62^{**}$
Tomato: Fusarium Wilt (F. oxysporum)	16.4%	11.8%	**5.1%**	**1.2%**	$t=2.85^{*}$

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Cucumber: Downy Mildew (P. cubensis)	62.8%	34.6%	**22.5%**	**8.1%**	$t=5.14^{**}$
Cucumber: Powdery Mildew (E. cichora.)	54.1%	28.5%	**19.4%**	**7.0%**	$t=4.38^{**}$

* Significant at $p \leq 0.05$; ** Highly significant at $p \leq 0.01$.

The statistical indicators displayed in Table 1 reveal an overwhelming containment of mycological pathogen development within automated microclimatic profiles. The most critical variation was recorded in the parameter of Cucumber Downy Mildew (P. cubensis), where the control track reached an intense 62.8% Disease Incidence with a destructive 34.6% Development Severity score, causing severe foliar necrosis and loss of photosynthetic tissue. Under the automated humidity-suppression protocol (Experimental Group), the incidence was effectively reduced to 22.5% and the severity score dropped to a minor 8.1% (t=5.14).

A parallel protective response was documented in the Tomato Powdery Mildew (L. taurica) evaluation lines. Traditional manual greenhouses exhibited a high infestation incidence of 48.5%, whereas the eco-managed blocks successfully lowered disease incidence to 18.2% and reduced the development severity to a negligible 6.4% (t=4.62).

For vascular soil-borne pathogens like Fusarium Wilt, maintaining stable soil temperature matrices through sub-surface irrigation in the experimental units minimized stress-induced roots exudation, cutting F. oxysporum incidence from 16.4% down to just 5.1% (t=2.85). This empirical proof confirms that precision humidity and temperature management acts as a powerful non-chemical shield, breaking the kinetic requirements necessary for fungal spore propagation.

Discussion

The empirical outcomes extracted from our phytopathological monitoring trials provide firm validation for modern integrated pest management (IPM) paradigms within transition agricultural sectors. As Sh.T. Xodjayev noted, relying entirely on chemical fungicides to manage greenhouse pathocenoses creates a hidden loop of structural failure, triggering chemical resistance in pathogens while elevating toxic accumulation risks in consumers [1, P. 120]. The extraordinary drop in development severity achieved across our experimental greenhouse units confirms that modifying the localized microclimate below the physical activation threshold of the fungus serves as the most effective defense mechanism.

These observations directly validate the physiological models published by G.N. Agrios, which show that the germination of oomycete and deuteromycete spores is dependent on the presence of free

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moisture on the leaf surface for sustained periods [3, P. 222]. In the manual control greenhouses, the drops in temperature at night regularly caused the air to reach its dew point, producing structural condensation films on the crop canopy. This micro-layer of liquid moisture allowed P. cubensis and L. taurica conidia to germinate and penetrate the host's stomatal structures effortlessly [4, P. 156]. By running automated ventilation cycles to displace moisture-laden air before temperature drops occur, the experimental group successfully denied the pathogen the physical conditions necessary for colonization.

To scale these phytopathological insights effectively across national agricultural networks, the independent research community must bridge the gap between abstract academic biology and real-world greenhouse engineering [2, P. 94]. Modern agronomy curricula should transition toward advanced training programs that prepare future plant pathologists to manipulate greenhouse environmental hardware alongside biological tools. Transitioning from reactive, post-outbreak chemical responses to predictive microclimatic disease prevention represents an essential step toward establishing a sustainable, ecologically secure, and commercially viable green agricultural sector in Uzbekistan.

Conclusion

The comprehensive agricultural and scientific evaluation of fungal pathogen behavior within greenhouse vegetable systems leads to the following conclusions:

First, protected soil environments under non-automated manual control protocols function as high-risk replication vectors, triggering high fungal disease incidence rates (up to 62.8%) due to structural humidity accumulation and condensation films.

Second, the systematic implementation of automated microclimatic management acts as a powerful non-chemical control method, cutting disease incidence and reducing fungal development severity metrics by over 70% across tomatoes and cucumbers.

Third, the long-term optimization of greenhouse crop security demands the wide integration of real-time sensor technology and advanced automated ventilation. Shifting national agronomic training models toward proactive climate manipulation will secure sustainable agricultural outputs and protect regional ecological health.

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